Green-washing or best case practices? Using circular economy and Cradle to Cradle case studies in business education

Abstract

Closed loop or ‘circular’ production systems known as Circular Economy and Cradle to Cradle represent a unique opportunity to radically revise the currently wasteful system of production. One of the challenges of such systems is that circular products need to be both produced locally with minimum environmental footprint and simultaneously satisfy demand of global consumers. This article presents a literature review that describes the application of circular methodologies to education for sustainability, which has been slow to adopt circular systems to the curriculum. This article discusses how Bachelor and Master-level students apply their understanding of these frameworks to corporate case studies. Two assignment-related case studies are summarized, both of which analyze products that claim to be 'circular'. The students' research shows that the first case, which describes the impact of a hybrid material soda bottle, does not meet circularity criteria. The second case study, which describes products and applications of a mushroom-based material, is more sustainable. However, the students' research shows that the manufacturers have omitted transport from the environmental impact assessment and therefore the mushroom materials may not be as sustainable as the manufacturers claim. As these particular examples showed students how green advertising can be misleading, applying “ideal” circularity principles as part of experiential learning could strengthen the curriculum. Additionally, this article recommends that sustainable business curriculum should also focus on de-growth and steady-state economy, with these radical alternatives to production becoming a central focus of education of responsible citizens.

Keywords

Circular Economy; Cradle to Cradle; education for sustainability; sustainable production

1. Introduction

Green marketing often stimulates consumers to buy “sustainable” products to stimulate continuous demand for new products intended not to last – or made with “planned obsolescence” (Waldman 1993). This practice is known as the “rebound effect”, defined as the reduction in expected gains from new efficient technologies due to changes in people's behavior or the necessity to keep producing new products (e.g. Berkhout et al 2000; Kopnina 2016a). This is supported by political and economic assumptions that “green” consumption is both desirable and environmentally innocuous (Washington 2015). Many purportedly ‘sustainable’ companies promise societies new sources of wealth through immense savings, clever designs (Isenhour 2010) and smart marketing, in effect stimulating more consumption (Greening et al 2000). The rebound effect is often associated with greenwashing, the term coined by Jay Westerveld in 1986, describing corporate practice of making sustainability claims to cover a questionable environmental record (Watson 2016).

One of such questionable claims is that profit-oriented production and consequently economic growth can be decoupled from natural resource consumption. Empirical evidence illustrates that absolute decoupling of economy from resource consumption is impossible (Ward et al 2016) and that in fact unsustainable consumption increases with GDP growth (Rammelt and Crisp 2014). While there is a moral objective to equalize access to economic benefits, without a drastic decrease in consumption in developed economies, rapidly growing developing countries’ economies are likely to contribute to the global scale overconsumption and eventual collapse (Wijkman and Rockstrom 2012; Jackson 2016). Considering this evidence, critical scholars have argued that economic growth based on continuous production needs to be radically challenged (e.g. Isenhour 2010; Rees 2010; Victor and Jackson 2015; Vieira 2016). Proponents of de-growth (Kallis 2011) and steady-state economy (Daly 1991, 1996, 2014) have maintained that population and economic growth are directly linked to environmental degradation. Accelerated depletion of natural resources makes the challenge of decoupling increase every year (Washington 2015).

Addressing this challenge of decoupling through ‘green growth’ (Dale et al 2016) and ‘natural capitalism’ (Hawken et al 2013), the circular economy (CE) and Cradle to Cradle (C2C) frameworks offered hope (Blomsma and Brennan 2017; Murray et al 2017). This approach stems from the field of industrial ecology (Mont and Heiskanen 2015) that draws on “natural models” as inspirations for industrial production (Lifset and Graedel 2002). Both frameworks are focused on products that are designed from the start of the manufacturing process so that the materials can be easily reused or ‘circulated’, simultaneously eliminating unproductive waste (e.g. Cormier et al 2006; Braungart et al 2007; Braungart 2013). In circular models, recycling is seen as downcycling, involving energy-intensive process that still leads to the “slow death” as products made of recycled materials are both smaller in volume and of lower quality than original materials (McDonough and Braungart 2002).

At its basis, C2C addresses a number of principles of industrial design (McDonough and Braungart 2002). The first principle, “waste equals food” means that one organism’s waste provides nutrients for other organisms, as for example fallen tree leaves provide food for worms that in turn help formation of the soil. Production of organic “waste” by a cherry tree, rather than being harmful also contributes to production of oxygen through photosynthesis (McDonough and Braungart 2002).

The second principle classifies infinite sources of energy such as the sun, wind, thermal or tidal waves as truly renewable as they can be replenished, as opposed to ‘slowly’ degraded sources or biomass such as plant matter commonly used for biofuels (Braungart 2013; Diesendorf 2014; Kopnina 2016b). Unlike the supposedly “green” garbage incineration used for biofuel, these sources of energy do not require burning of biomass (Braungart 2013). One needs to note, however, that capture and storage devices needed for generating this renewable energy – such as neodymium used in wind turbine magnets or silicone for solar panels – will be needed. However, once produced and installed, these installations do not contribute to carbon emissions (Cleveland and Morris 2013). As their harnessing, storage and transfer technology becomes more advanced, wind and sun energy becomes increasingly affordable (Cleveland and Morris 2013).

The third principle involves understanding of natural diversity, drawing on the knowledge of healthy ecosystems, with billions of living organisms possessing a unique response to its surroundings and interacting with each other (McDonough and Braungart 2002 p. 435, 439). Drawing inspiration from ecological diversity to inspire design (De Pauw et al 2014), C2C uses local materials to make products congruent with surrounding environment. Thus, C2C takes nature’s diversity as a model to maximize the positive effects to local ecosystems. In sum, both C2C and CE propose an industrial system that is *not* environmentally or socially harmful (Lieder and Rashid 2016).

While the “ideal” CE/C2C principles are uncompromising, many real-life applications of the CE/C2C ideas and definitions seem less restrictive. Murray et al (2017) analyze multiple interpretations of CE, outlining some limitations both to the use of the term and to practical applicability. For products with high-energy consumption during use, Llorach-Massana et al (2015) conclude that C2C does not guarantee environmental improvements, since it does not account for the product's complete environmental impact. Kirchherr et al (2017a) reflect that some companies engaging with circular economy think of economic savings first, with environmental quality and in some cases social equality following as an afterthought. In C2C/CE growth is seen as beneficial – indeed as “green growth” (Lieder and Rashid 2016). Indeed the Ellen MacArthur foundation describes CE is a 'new engine of growth' (Ellen MacArthur 2012). If economic savings cannot be realized, environmental and social aspects of circular economy may be simply ‘dropped’.

While the closed loop frameworks offer alternative transformative models, education for sustainability has rarely explicitly engaged with CE/C2C. As there are few articles in the leading environmental education journals (e.g. *Environmental Education Research, Journal of Environmental Education*, etc.) that explicitly deal with circular models, this article is intended to expand the existing literature on CE/C2C in education. In doing so, this article will discuss how understanding of circular frameworks can be applied to real-world case studies in Bachelor and Masters level courses. In the sections below, the difficulties facing manufacturers, and the gap between theory and practice will be exposed. Consequently, the author shall reflect on how students can learn to distinguish between "best practice" and less successful applications of CE/C2C. The objective of this inquiry is to reveal how theory of CE/C2C can instruct students' judgment of purportedly circular products and processes. Wider implications of teaching CE/C2C will be discussed.

2. Teaching CE and C2C

Circular economy education, pioneered by Ellen MacArthur Foundation, a charity that works to popularize circular economy (https://www.ellenmacarthurfoundation.org/resources/learn/higher-education-resources), and Cradle to Cradle education, pioneered by the C2C Product Innovation Institute (https://www.c2ccertified.org/education) provide practical web-based education program and teaching materials for designers, architects, but also other interested students and practitioners developing practical product design strategies. C2C-related courses include Cradle to Cradle Certified™ Catalyst Program (https://education.c2ccertified.org/lms/). As part of this program, the online course "Designing Cradle to Cradle Certified Products for the Circular Economy" covers the foundations, principles, strategies, and examples of designing products for circularity.

The Ellen MacArthur Foundation has developed a number of educational materials (Andrews 2015). One such initiative, supported by the United World Colleges "Exploring a complexity" module, highlights the importance of complexity to view real-world systems, encouraging students to meet complex challenges with new ways of seeing and thinking (Ellen MacArthur 2017). These and other materials published by the Foundation have not yet made it into the wider curriculum. A few initiatives reported by various researchers and educators were loosely based on the work of the Foundation or C2C Institute (Gerber et al 2010; Kopnina 2012, 2015, 2016c, 2018b; De Pauw et al 2014; Gonzalez 2015; Ashby and Vakhitova 2018).

However, some of the free online courses offered by The Ellen MacArthur in combination with universities disappeared a year after they were offered (e.g. "*Redesigning Plastics* lesson"). Also, neither of these courses teaches students how to distinguish between greenwashing and more genuine application of CE and C2C frameworks. The following sections will bridge this gap.

3. Key principles and certification of C2C/CE products

C2C criticizes eco-efficiency, as it makes "the wrong things" last longer (McDonough & Braungart 2010:938). For example, efficient use of fossil fuels allows their use to be "stretched out" rather than substituted by renewable energy sources. Supposedly sustainable electric cars often use electricity derived from fossil fuels and require costly and unsustainable materials for making new models (Isenhour 2010). Many products produced today are either made of virgin materials or materials that combine both technical and organic nutrients (such as recyclable paper and poly-vinyl-chloride) in a way that cannot be easily separated, thereby rendering the material useless for recycling, let along reuse. These materials are known as “monstrous hybrids” (McDonough & Braungart 2002).

By contrast, CE/C2C promotes re-use of materials in the new biological (organic nutrients) or industrial (technical nutrients) cycle (Brennan et al 2015). As Braungart et al (2007) claim, by modeling human designs on nature’s operating systems, C2C design creates a new paradigm for the industry, generating a wide spectrum of ecological, social, and economic value and thus results in ‘upcycling’.. CE/C2C aims to avoid take-make-waste production by substituting harmful or wasteful materials with the types of materials that can be used endlessly in an industrial cycle.

Organic cycle and can be used for fertilization of the soil. By contrast, technical nutrients cannot return back to “nature” but can circulate in industrial cycles (McDonough and Braungart 2002:91). The Product-Service System (PSS) that enables the producer to lease rather than sell products to the customers (Mont 2002) is helped by the sharing economy or “collaborative consumption” (Piscicelli et al 2015). Sharing of infrequently used products (e.g. building equipment in the average household) is made possible via digital sharing platforms (Piscicelli et al 2018).

In sum, C2C is based on a few key principles, operationalized into C2C certification schemes, which grant achievement labels in five categories, Material Health, Material Reutilization, Renewable Energy, Water Stewardship, and Social Fairness. The intention of the certification schemes is to create a functional framework designed to implement the Cradle to Cradle Certified™ Products Program, which is administered by the Cradle to Cradle Products Innovation Institute (C2CPII). Certification schemes are instructed by MBDC, founded in 1995 by McDonough and Braungart. MBDC has been promoting C2C, working with companies to intentionally design products in accordance with C2C principles.. Material health certification involves a number of steps, including disclosure of chemical ingredients, consulting restricted substance lists, and hazard and risk assessment. The final step of material health assessment involves cooperation between the assessor and manufacturer to optimize the product to only have A/B- or C-rated materials, corresponding to one of four achievement levels—Bronze, Silver, Gold, or Platinum (https://www.c2ccertified.org/news/article/an-easier-way-to-specify-healthy-products).

4. Assignment descriptions

The educational practice and assignments described in this article are inspired by the online course "Designing Cradle to Cradle Certified Products for the Circular Economy" (https://education.c2ccertified.org/lms/). This course explores the five attributes of Cradle to Cradle Certified™, and enables students to reflect on how these attributes can spur innovation in product design and development. This course was offered to the Bachelor-level liberal arts interdisciplinary-focus course at Leiden University College (LUC), and anthropology Masters-level anthropology course at Leiden University (LU) in The Netherlands between 2016 and 2017. Both in the case of LU and LUC, the course "Environment and Development" focused on critical analysis of real-life cases using 'ideal' framework principles.

Following "classroom ethnography" method (Grenfell 2008), the students were asked to evaluate a product, service or processes using Cradle to Cradle (https://mbdc.com/portfolio/) or circular economy (http://www.ellenmacarthurfoundation.org/case_studies/) case study. Consequently, the students were asked to consult the assessment websites: https://mbdc.com/how-to-get-your-product-cradle-to-cradle-certified/ and http://www.c2ccertified.org/get-certified/product-certification or http://circulareconomytoolkit.org/Assessmenttool.html. Finally, after submitting assignments, in a feedback session, the students were asked to reflect on what has been learned and how companies or products could improve. The evaluation was conducted after the assignments were graded.

The case studies below are researcher-edited versions of student assignments (the first case was chosen by five students, the second case was chosen by two students) retaining most of the original references used by students. Researcher selected and combined student assignments on the same subject (soda company or mushroom materials as reported below), checked and if necessary updated or added references. Direct quotes from student assignments or reflections are indicated by "Anonymous student" reference.

4.1. The Multinational Drinks Manufacturer

One of the case studies on Ellen MacArthur Foundation website involves a multinational soda company that has been identified for its greenwashing in the past (e.g. Holcomb 2008; Mohan 2009; Karnani 2014; Reilly and Hynan 2014). The company has worked with its bottling partners to "light weight" its packaging (Lubin and Esty 2010). In cooperation with its bottlers and some large NGOs, the company has expressed commitment to "water neutrality", aiming to reduce its strategic risk and environmental impact by replenishing watersheds after extraction (Lubin and Esty 2010). The soda company aims to improve the overall recyclability, reduce material use and use more renewables in order to “maximize the usage and value of the plastics”, establishing two plastics cycling joint ventures: Continuum in Great Britain with ECO Plastics, and Infineo (Ellen MacArthur Foundation 2016).

In 2010 the company created a PlantBottle™ that is “made with up to 30 percent plants — and up to 30 percent less petroleum” (Boyle 2011). Soon after, *The Huffington Post* has reported that its “advertising has tricked people”, and that the bottle has been recalled for contamination, receiving a “grade of D on Environmental Working Group’s evaluation of bottled waters” (Boyle 2011). C2C-center blog (Starmans 2013) reported that the PlantBottle™ contains up to 30% plant-based PET (BioPET) “because it was not technically feasible yet to produce a 100% biobased PET bottle” (Ibid). The company attempts to crack the code on plant-based PTA that “will produce the first 100% biobased PET bottle” (Starmans 2013). However, commenting on the fact that the plant component of the bottle is made of sugarcane grown in Brazil, Allen Hershkowitz, a senior scientist at the National Resources Defense Council, has remarked that growing crops for plastic “causes a lot of land conversion, it affects the price of food, it uses a lot of fertilizers” (quoted in Neuman 2011). The PlantBottle was also described as greenwashing by the English newspaper *The Guardian* (O’Connor 2014). The non-compostable plastic in PlantBottle is branded as if it were compostable and non-recyclable bioplastic is “positioned as a seamless swap-in for oil-based cups and clamshells”, misleading consumers to deposit these essentially unrecyclable bottles into the recycling bin (O’Connor 2014).

The soda company is not alone in its sustainability claims. Will and Jaden Smith, Hollywood celebrities, have launched Just, the supposedly “eco-friendly” bottles, made of mixed plant and plastic materials (Cohen 2018). Many companies, including Nestle, spend millions of dollars trying to convince the public that their “eco- bottles” that are made of less plastic and more vegetable materials are “good for the planet” (Watson 2016). Due to the strategic use of the word “plant”, “the color usage, and circular arrow logo inspired by the symbol for recyclability”, and the inclusion of “moving towards a circular economy” the product, as Zara (2015) states, “fools its consumers”.

This soda company announced that they hope to use 40% of rPET or renewable plastics by 2020, instead of virgin and 30% recycled materials (LetsRecyle 2015). Initially the large percentage of virgin materials, defined as resources extracted from nature in their raw form (Virgin Materials n.d) may give the impression that they are 100% recyclable. PET (recycled Polyethylene Terephthalate) and recycled PET (rPET) can be distinguished (Keresztes et al 2013). PET is made of strong, durable and recyclable materials (Sojobi et al 2016), while rPET represents material of lower quality due to downcycling (Geyer et al 2016). Neither PET nor rPET are not biodegradable or compostable (Virgin Materials n.d.; HPC n.d.), and thus not suitable for upcycling that needs to convert low-value materials into high-value products (McDonough and Braungart 2002). More generally, as one of the students has noticed, the soda company's aspiration to "maximize the usage and value of the plastics", according to C2C framework, makes the bad material last longer.

The evaluative discussion of this product occurred in a group of five students. One of the students reflected that the company "seems to get away with their efforts of appearing green without producing bottles for re-use" (Anonymous student). Another student has reported that the company "lacks documentation that proves that their bottles have provided positive environmental impacts or reduced CO2 emissions" (Anonymous student). A third student has noted, that as of present, no 100% biodegradable bottle exists. In fact, the student continued, the PlantBottle represents a case of "monstrous hybrid" (quoting McDonough and Braungart 2002), a combination of plant and technical materials. Two other students reflected that the new initiative of this soda company, that has been launched after they have submitted the written assignment, has unveiled plans for having 100% bottles returned to the producer, intending to make all their bottles reusable, without specifying how they intend to do so.

The five students debated whether Ellen MacArthur Foundation rewarded "intention to do better", and thus stimulated positive change, or was complacent in downright consumer deceit. A particularly emotional discussion resulted from the question as to whether this complacency stemmed from ignorance ("after all, Ellen herself was a sportswoman, maybe [the company] just tricked her?") or hidden interests ("I wonder whether this Foundation is really nonprofit"). One of the students has noted that since the 100% biodegradable bottle is still not produced, it means that petrochemical waste the company uses to make its hybrid bottles is simply cheaper. The section 'Discussion' following case 2 below will delve further into the question as to what the students learned from this experience.

4.2. Mushroom Materials as Alternative to Plastics

Mushrooms are tasty they can be used as antibiotic or antiviral medicine, as a textile dye, as well as means to clean pollution (Miller 2013). Mushrooms grow from spores in dark and moist environments either indoors or outdoors (Stamets 2011) and require straw, sawdust, grain or liquid as nourishment (Sánchez 2010). Mycelium, part of a root structure of mushrooms or fungus-like bacterial colony, can also be used as an alternative to plastic materials (Gunther 2013).

Recognizing mushrooms' many useful properties, Eben Bayer and Gavin McIntyre teamed up as students at the Rensselaer Polytechnic Institute in 2006 and invented a new insulation material using agricultural waste and mycelium (Ecovative, "About"). Following this invention, their professor convinced them to pursue the technology as a company producing mushroom packaging materials (Ibid). The vision of the company is to "envision, develop, produce, and market Earth friendly materials, which, unlike conventional synthetics, can have a positive impact on our planet's ecosystem" (Ecovative, “About”). In 2008 Ecovative won $750,000 from the Dutch Postcode Lottery Green Challenge, the largest international green business plan competition (Postcode Lottery 2008). After that, Ecovative has expanded to 60 employees with headquarters and manufacturing space in Green Island, New York (Ecovative, “About”).

The United States is the largest producer country of corn, with the corn kernels consumed, with the stalks wasted (World of Corn 2016). Ecovative has found a way to use mycelium to bind stalks and other agricultural waste together through intricate network of thread-like fibres (Kurtzman 2010). Ecovative is using a specific fungus (which is edible but not tasty) to grow materials into any shapes out of agricultural waste bought from local farmers. The organic waste product is mixed with the mycelium cells in a turning pasteurization vessel. When the organic waste is added to the mycelium, the mycelium grows as it feeds on this waste, until it has filled the mold it is in (Ecovative). When the heat is applied to the mold, it dries up, which stops the mycelium from growing further and producing more spores (Stamets 2011). The mixed material is then stored in bags for five days, with the shape and size determined by the mold it is grown in (Bayer in Postcode Lottery 2008). After the initial mixing of corn stalks and mycelium, squeezed under heat and pressure to become strong structural material it is finally dried (Bayer in Postcode Lottery 2008). Subsequently the material is ready for further processing as one of the three types: Myco Board, Myco Foam, and Myco Make.

Myco Board is an “engineered wood alternative” (Ecovative “About”). Myco Board is produced locally and does not contain urea-formaldehyde or volatile organic compounds (VOC). At the time of writing the assignment, Ecovative was producing custom-moulded Myco Board shapes as well as 3x6' panels on their own presses in the Green Island facilities (Ecovative “Myco Board”). In 2016 Ecovative has launched a new line of first-of-its-kind, fully grown furniture made with MycoBoard panels.

Myco Foam has the same basic production processes as Myco Board but after the five day growing process it can be still reshaped and resized (Ecovative “Myco Board”). Myco Foam is used for three types of products: Mushroom Packaging, Mushroom Insulation and Acoustics, and Mushroom Buoys and Rafts (Living Circular 2016). Mushroom Packaging “replaces EPS, EPP, and EPE plastic foam packaging parts to package and protect everything from servers to furniture” (C2C Mushroom Materials). At the time of assignment writing, Ecovative was still seeking partners, including IKEA, in order to expand its operations (Brodwin 2016).

Myco Make consists of GIY Mushroom® Material - a mixture of mycelium, corn stalks and husks. It requires some water and flour to come back to life, and then grows into a desired form (Ecovative “Myco Make”). The biological waste is used as a base instead of oil or other petrochemical product, which is conventionally used to produce styrofoam and plastics (Brodwin 2016). This production process of do-it-yourself kit of Myco Make is “extremely energy-efficient, occurring in the dark, at room temperature”, and “without any petroleum inputs” (Bayer in Postcode Lottery 2008).

Mushroom materials are certified C2C gold in four of the five subcategories and platinum in material health. A material health platinum certificate means that “all process chemicals have been assessed and none have been assessed as X” with “X” meaning toxic or dangerous materials (C2C Achievement Level Summary). Material reutilization gold certificate includes that the product has a Material Reutilization Score that is ≥ 65 and that the manufacturer has completed a “nutrient management” strategy for the product (Ibid).

In order to achieve gold category in renewable energy and carbon management, Ecovative had to make sure that “for the final manufacturing stage of the product, 50% of purchased electricity is renewably sourced or offset with renewable energy projects, and 50% of direct on-site emissions are offset” (C2C Achievement Level Summary). Gold certification in water stewardship meant that Ecovative made sure that “product-related process chemicals in effluent are optimized (effluents leaving facility do not contain chemicals assessed as problematic)” (Anonymous student).

Finally, social fairness gold requirement requires that the two out of the following three criteria are met:

“1. Material specific and/or issue-related audit or certification relevant to a minimum of 25% of the product material by weight is complete (FSC Certified, Fair Trade, etc.);
2. Supply chain-relevant social issues are fully investigated and a positive impact strategy is developed;
3. The company is actively conducting an innovative social project that positively impacts employee’s lives, the local or global community, social aspects of the product’s supply chain, or recycling/reuse” (C2C Achievement Level Summary). Mushroom Material has thus met all of the above -mentioned criteria and has been certified C2C gold in June 2015 (C2C Mushroom Materials).

While Ecovative ships mushroom packaging internationally, one of the students discovered that the methods of transportation used are not mentioned. It can be assumed that mushroom materials are transported conventionally by ship, plane and truck (Anonymous student). Ecovative ships its products to several companies, who then use their own method of shipping to customers. Dell, for instance, ships products as much as possible via rail and sea, instead of by truck or plane (Dell 2016). One of the students has found that some companies mushroom materials were supplied to are using biodiesel for transportation to their customers. The same student noted using Steer and Hanson (2015) as a reference that biodiesel is not as sustainable as advertised. Some biofuels require literally “burning greenery” such as trees or algae (Haberl et al 2011; Steer and Hanson 2015; Kopnina and Blewitt 2018). ‘Fuel forests’ compete with agricultural land for food (Walsh 2014). Indeed, biofuel plantations have taken increasingly larger proportion of pristine habitats, contributing to demise of biodiversity through CO2 emissions when burned, but also the process of fertilizing, harvesting, processing, and distribution (Haberl et al 2012;

Steer and Hanson 2015). While the use of Canadian wooden pellets in Europe has been branded as "green" (https://www.pellet.org/) the use of wood for energy was termed 'Environmental lunacy in Europe' (*The Economist* 2013). The European Environment Agency has admitted that the assumption that biomass combustion would be inherently carbon neutral is incorrect as it ignores the fact that using land to produce plants for energy typically means that this land is not producing plants for other purposes, including carbon otherwise sequestered (EEA 2011; Haberl et al 2012). This shows, as student reflected, that biofuel use exemplifies unsustainable linear production. To Ecovative's credit, students have noted that according to its website the company attempts to make mushroom growing technology work globally, reducing international transportation and enabling the use of regionally various bio-waste.

After use packaging can be composted by consumers at home or by industrial composting facilities, adding natural materials to the soil (Ecovative). In order to compost, mushroom packaging needs to be exposed to living organisms in soil or moisture (Ibid). This also means that the packaging is not fully waterproof, as Myco Foam is only temporarily resistant to salt water (Ecovative "Myco Board"; Living Circular 2016). Longer water exposure will start the decomposition process, with packaging break downing in 30-90 days (The Huffington Post 2016).

Ecovative attempts to develop techniques for material to be more durable, but still decompose when the product is discarded in natural environment (Ecovative "Myco Board"). The company claims that that mushroom packaging is cost-competitive with expanded polystyrene, polyethylene and polypropylene, chemical based foam packaging (Ecovative). Even if the consumer is not able to compost the packaging or it ends up on the street, it is still harmless (Bayer in The Huffington Post 2016).

One of the major advantages of Mushroom Materials, according to Ecovative, is that the technology is easily transferable to other countries using other organic waste products as food for the fungi and therefore is scalable in a way that most C2C products fail to achieve. Another advantage of Mushroom Material is that it uses waste as a base product (Ecovative). This product can be produced locally and transport emissions can be kept at a minimum whilst boosting the local economy (Ibid). Mushroom packaging can biodegrade fully and quickly, adding nutrients to the soil when it is composted.

Two students who chose this company to write their essays on have reflected that their overall impression of Ecovative was positive. For example, since Mushroom Materials does not require much energy to produce, "it illustrates a positive case of material health and material utilization" (Anonymous student). Both students felt that Ecovative has managed to design a material that meets most requirements for C2C in an innovative way using fungi and waste to create a practical and price-competitive alternative to plastics. One student stressed that mushroom packaging is 100% biodegradable, and can be replaced by new mushroom packaging and thus renewed endlessly (Anonymous student). The same student noted that since Ecovative enables the use of regional bio-waste this accords with "respect diversity" principle

(Anonymous student). As this student reflected, there is "no extraction of virgin resources and because it is organic it can biodegrade easily, becoming a garden nutrient". However, as another student noted, Myco Foam cannot be used recycled and used endlessly, but it does fall under one of the C2C's key principles: waste equals food (the student quoted McDonough & Braungart 2002). Both students wondered whether "endless" recycling is possible with any durable material, as there might be limits to just how much re-use material can withstand.

If all is considered, as students reflected, adhering to C2C's accreditation process becomes a difficult task. Mushroom materials will still require physical space to grow, and if consumed by billions of consumers, will require plenty of room for growing monocultures. Both students also felt puzzled by the idea of "upcycling" as even in this "best practice" case study no added benefit for nature was observed. As one of the students concluded, after disposing of mushroom packaging or eating mushrooms, one still needs to consider what to do about "waste washed down the toilet" – which, he reflected, "requires system thinking" beyond immediate consumption. The same student evoked another subject discussed in Environment and Development course, degrowth economy, and reflected that overall, "mushroom materials still need to grow and be eaten", and without "degrowth in the number of consumers" it is unlikely that mass production of mushroom materials can be sustainable.

During sharing and comparing session, the students confirmed that they have learned that circular frameworks call for elimination of harm that reaches beyond eco-efficiency. The students also reflected that they have learned how advertising and PR can be misleading. In the discussion following submission of assignments, students have reflected that C2C and CE might be too optimistic.

5. Discussion

Based on the case studies, it became apparent that C2C accreditation process (Material Health, Material Reutilization, Renewable Energy, Water Stewardship & Social Fairness) requires strict measures. While the "reduce" and "recycle" are commonly used, the complete "reuse" or "upcycling" may be impossible. The students have learned that implementation of CE/C2C in 'real-life' situations is more challenging than the more optimistic (or consciously misleading) company advertisements may lead to believe.

While the soda multinational advertises improvement in a fraction of their operation or products, there is no radical change of the *entire* mode of operation, as PlantBottle is likely to fail almost all aspects of C2C accreditation. As students have noted in the reflection session, while the soda company does comply with some aspects of material reutilization, material health, renewable energy, water stewardship, and social fairness, these are only partially addressed – if addressed at all. By contrast, the Mushroom materials do indeed go beyond the familiar the R motto of "reduce, reuse, recycle" (Kirchherr et al 2017a) but still need to address the challenge of transportation and economies of scale (global supply of their product).

The preference of companies for the "low-hanging fruit" (e.g. simple, easy and foremost cheap 'solutions' rather than more difficult and costly ones) is understandable. For many companies, rampant greenwashing will not pay as continuous vigilant consumer organizations or NGO's help to move companies beyond the basic requirements of Pubic Relations (PR). Greenwashing can backfire not only because it has limited benefits (perceived environmental performance), but also because it poses a major threat to business operations if publically disclosed (perceived integrity). At times, greenwashing has no true competitive advantage or purchase interest (De Jong et al 2018). In this light, consumer awareness and realization of company's failure to meet the standards could lead to corporate reform. However, some other ethical or sustainability reforms are not that easy to achieve. Producing "green" products is very different from stopping consumption altogether. This is due to the fact that some products, such as food, form basic necessities - although food waste can certainly be tackled (Gonzalez 2015). The refusal to stop consumption of non-essential material goods is often due not just to the lack of consumer awareness of environmental or social costs, but also to social (e.g. "keeping up with the Joneses'), lifestyle (e.g. habits), economic (e.g. 'green' products might be more expensive), and political barriers (Isenhour 2010).

Government regulation is needed to overcome these barriers (Isenhour 2010; Kirchherr et al 2017b). Without government regulations consumer responsibility is limited to a committed margin, with most consumers still having the "freedom" to choose unsustainable products (Isenhour 2010: 466). The most effective form of intervention is environmental regulations for 'consumer choice editing', with governments simply banning "bad" products (Assadourian 2013). Unfortunately, corporate regulation is currently unpopular in neoliberal economies (Kopnina and Blewitt 2018).

The challenge of combining profitability, sustainability and scale was recognized by students as one of the key challenges of green production. As bottles made of petrochemical waste are cheap, and as materials required for the production of 100% plant bottles are likely to require massive monoculture plantations, as long as the bottles are made for billions of consumers no easy solution is available. Critical scholars have noted that "green growth" or absolute decoupling is an ideological claim that lacks evidence (Twomey and Washington 2016; Ward et al 2016; Washington and Kopnina 2018). The promise of continuous production without any environmental damage in order to serve further advancement of economic development is over-optimistic (Twomey and Washington 2016). The dream of absolute decoupling of products such as food and clothes for almost eight billion consumers from resource use excuses continuous unsustainable production (Rammelt and Crisp 2014). Granted existing lobbying structures and the governments' reluctance to support unpopular measures, it remains to be seen whether strict environmental regulation supported by democratic consensus is feasible (Lidskog and Elander

2010). In fact, as the author has described (ANONYMOUS REFERENCES), the students can be taught to recognize this conundrum as well as learn to think in terms of possible democratic solutions.

This leaves room for further thinking about teaching that simultaneously addresses production and consumption challenges as well as the root causes of unsustainability – population growth and increase in material demands (Meadows et al. 1972). Just learning which products are advertised as "good" and which are less so may only lead so far. "Good" examples such as mushroom materials to foster inspiration in students willing to make changes is needed. But also, on a larger scale, in order to address sustainable production in educational practice, the students need to address government policy and corporate institutions as sources of potential reform. This policy awareness can also provide the students with cognitive tools that help them to distinguish between "ideal" theory and subverted practice (Watson 2016; De Jong et al 2018) as well as understanding why subversion happens. In business education, this means involving students in discussions about alternative values that dispute profit-driven imperatives of the supposedly green business (Kopnina 2016d, 2018a, 2018b). Considering that any human activity has an impact on resources, and taking into account the planetary limits for growth, CE/C2C might need to include more restrained rhetoric (Llorach-Massana et al 2015). Student learning for CE/C2C needs to include critical thinking about regulation, lobbying, and political structures that support growth-oriented ideology that hamper meaningful action for change.

The next step is applying CE/C2C principles to students' own projects to further explore practical challenges and opportunities for circular production. Assuming that experiential learning is more powerful than passive learning (Kolb and Kolb 2005), asking students try to apply CE/C2C principles to their own projects as part of advanced practice course could be a useful direction for future curriculum development.

If "ideal" aspiration of sustainable future is maintained, CE/C2C education needs to retain its focus on ecosystems. Thus, the Planet, and not Profit needs to become the ultimate "bottom-line", not just in terms of side-benefits of the more 'circular' and thus profitable production. The consequence steps in building a critical curriculum (ANONYMOUS AUTHOR REFERENCE) involves subjects that engage with larger issues of population growth and consumption. This challenge requires a critical discussion of de-growth and steady-state economy (Daly 1991; 2014; Dietz and O'Neill 2013). This challenge can also involve corporate social responsibility initiatives that support voluntary, 'non-coercive' population control (Washington 2015) by contributing to family planning services, for example as Bayer, pharmaceutical company, does (https://pharma.bayer.com/microsites/csr/reports/ethiopia_family_planning_as_decision/). The broader understanding of the root causes of unsustainable production and consumption needs to remain a central focus of its effort to educate citizens that are concerned about and motivated to address environmental problems, as the original aim of the Belgrade charter has stated (UNESCO-UNEP 1976).

Conclusions

This article reflected on educational benefits for engaging students with corporate case studies, involving deepening understanding about production processes, materials used, and challenges involving financial sustainability. In reflection on their projects, the students have also demonstrated their ability for critical thinking not just about mushroom materials and soda bottles, but also about the question of feasibility of decoupling of resource consumption from economic growth. The case studies discussed above illustrate just how challenging implementation of circular models that reach beyond clever green marketing can be. Educational initiatives that encourage critical reflection on self-advertisements by manufacturers using C2C certification, as discussed in this article, is the starting point in critical awareness. The students have noticed that subverted practice can serve to mask the impossibility of absolute decoupling of production from resource consumption in a soda company. Some form of relative decoupling occurs in the “best case study” of Ecovative. However, Ecovative still have to prove whether mushroom materials can be both produced locally with minimum environmental footprint and simultaneously satisfy global demand. Even if the mushroom packaging is fully biodegradable, the challenge of scale might be insurmountable if mono-cultural plantations are to be avoided. Providing product packaging to almost eight billion people without any environmental depletion might be too optimistic, a lesson that students have to learn in order to come up with more realistic solutions. The example of energy use for transportation by soda company demonstrated to students a larger issue: differences between “ideal” and “real-life” applications of circular frameworks. While “ideal” CE/C2C systems are restrictive, as they do not allow for compromises, in promoting themselves as a new engine of economic growth, some of the Ellen MacArthur’s case studies might unintentionally serve as a good educational example of bad practice. While trying to minimize impacts, achieve 'zero footprints', ban harmful substances or reduce energy use, circular frameworks may reinforce belief in unlimited economic growth.

While this article discusses how CE/C2C frameworks can be seen as best cases as in the case of mushroom materials, or subverted to “business-as-usual” practices in the case of PlantBottle, applicability of circular frameworks to real-life cases has a unique pedagogical value. Both in production and education, “ideal” CE/C2C can empower future conscientious designers, innovative manufacturers, well-informed policy-makers and visionaries to make the transition to circular economy a reality.

Bibliography

Andrews, D. 2015. The circular economy, design thinking and education for sustainability. *Local Economy*, 30(3):305-315.

Ashby, M. and Vakhitova, T. 2018. Analyzing and Measuring Circularity—Teaching and Industrial Tools by Granta Design. *MRS Advances*, pp.1-8.

Assadourian, E. 2013. 'Re-engineering cultures to create a sustainable civilization', in Starke, L. (ed) *State of the World 2013: Is Sustainability Still Possible?*, Washington: Island Press.

Berkhout, P.H., Muskens, J.C. and Velthuijsen, J.W. 2000. Defining the rebound effect. *Energy policy*, 28(6-7):425-432.

Blomsma, F. & Brennan, G. 2017. The emergence of circular economy: A new framing around prolonging resource productivity. *Journal of Industrial Ecology*, 21(3): 603-614.

Boyle, L. K. 2011. No Glee from Environmentalists for Coca-Cola "Plant Bottle". *Huffington Post blog*. https://www.huffingtonpost.com/lisa-kaas-boyle/dasani-plant-bottle_b_852190.html

Braungart, M. 2013. Waste to Energy. http://catalystreview.net/2010/02/cradle-tocradle-transitioning-from-waste-incineration-to-beneficial-materials/

Braungart, M., McDonough, W. and Bollinger, A. 2007. Cradle-to-cradle design: creating healthy emissions–a strategy for eco-effective product and system design. *Journal of Cleaner Production*, *15*(13-14) :1337-1348.

Brennan, G., Tennant, M. and Blomsma, F. 2015. Business and Production Solutions: Closing the Loop. In *Sustainability: Key Issues*. H. Kopnina and E. Shoreman-Ouimet, eds. New York: Routledge. pp. 219-239.

Brodwin, E. 2016. A startup founded by 2 college friends is turning mushrooms into walls — and it's already doing deals with major companies like Dell. August 25. *UK Business Insider*. http://uk.businessinsider.com/ecovative-turns-mushrooms-into-packaging-ikea-dell-2016-8?international=true&r=UK&IR=T

Cleveland, C. J., and Morris, C. G. 2013. *Handbook of Energy: Chronologies, Top Ten Lists, and Word Clouds*. Vol. 2. Elsevier.

Cormier, S.A., Lomnicki, S., Backes, W. and Dellinger, B. 2006. Origin and health impacts of emissions of toxic by-products and fine particles from combustion and thermal treatment of hazardous wastes and materials. *Environmental Health Perspectives*, 114(6): 810.

C2C Achievement Level Summary. [Accessed April 5 2018] http://s3.amazonaws.com/c2c-website/resources/certification/standard/C2CCertified_Achievement_Levels_V3.0.pdf

C2C Mushroom Materials. n.d. [Accessed April 5 2018] http://www.c2ccertified.org/products/scorecard/mushroom_material

Cohen, S. 2018. Will and Jaden Smith create eco-friendly water company: Just. *Seattle Times*. [Accessed April 5

2018] https://www.seattletimes.com/business/will-and-jaden-smith-create-eco-friendly-water-company-just/

Dale, G., Mathai, M.V. and de Oliveira, J.A.P. eds., 2016. *Green growth: ideology, political economy and the alternatives*. Zed Books Ltd.

Daly, H. 2014. *From Uneconomic Growth to a Steady State Economy*, Cheltenham: Edward Elgar.

Daly, H. 1996. *Beyond Growth: The Economics of Sustainable Development*, Boston: Beacon Press.

Daly, H. E. 1991. *Steady-state Economics: with new essays*. Island Press.

De Jong, M.D., Harkink, K.M. and Barth, S. 2018. Making Green Stuff? Effects of Corporate Greenwashing on Consumers. *Journal of business and technical communication*, *32*(1) :77-112.

Dell. 2016. 'Green Packaging & Shipping' [Accessed April 5 2018] http://www.dell.com/learn/us/en/uscorp1/corp-comm/earth-transportation-logistics?c=us&l=en&s=corp

De Pauw, I.C., Karana, E., Kandachar, P. and Poppelaars, F. 2014. Comparing Biomimicry and Cradle to Cradle with Ecodesign: a case study of student design projects. *Journal of Cleaner Production*, 78:174-183.

Diesendorf, M. 2014. Sustainable Energy Solutions for Climate Change, Sydney: UNSW Press and London: Routledge-Earthscan.

Dietz, R. and O'Neill, D. 2013. *Enough is Enough: Building a Sustainable Economy is a World of Finite Resources*, San Francisco: Berrett-Koehler Publishers.

Ecovative, "About". [Accessed April 5 2018] http://www.ecovativedesign.com/about

Ecovative, "How it works". [Accessed April 5 2018]. http://www.ecovativedesign.com/how-it-works

Ecovative, "Ecovative design". [Accessed April 5 2018]. http://www.ecovativedesign.com/

Ecovative n.d. "Myco Board, Myco Foam, Myco Make". [Accessed April 5 2018] http://www.ecovativedesign.com/myco-board

Ellen MacArthur. 2012. Towards a Circular Economy: Economic and Business Rationale for an accelerated transition, Isle of Wight, UK: Ellen Macarthur Foundation, online, available at: www.ellenmacarthurfoundation.org/business/reports/ce2012 [Accessed November 15 2018).

Ellen MacArthur. 2016. Increasing post-consumer plastic content in packaging. [Accessed April 5 2018] https://www.ellenmacarthurfoundation.org/case-studies/increasing-post-consumer-plastic-content-in-packaging

Ellen MacArthur. n.d. [Accessed April 5 2018] 'Case studies'. https://www.ellenmacarthurfoundation.org/case-studies/growing-alternatives-to-petroleum-based-packaging

Ellen MacArthur 2017. [Accessed November 15 2018] New complexity module teaches students to think systemicallyhttps://www.ellenmacarthurfoundation.org/news/new-complexity-module-teaches-students-to-think-systemically

EEA (European Environment Agency Scientific Committee) 2011. Opinion of the EEA Scientific Committee on Greenhouse Gas Accounting in Relation to Bioenergy https://www.eea.europa.eu/about-us/governance/.../sc-opinion-on-greenhouse-gas [Accessed November 15 2018]

Gerber, E., McKenna, A., Hirsch, P. and Yarnoff, C. 2010. Learning to waste and wasting to learn? How to use cradle to cradle principles to improve the teaching of design. *International Journal of Engineering Education*, 26(2):314-323.

Geyer, B., Lorenz, G. and Kandelbauer, A. 2016. Recycling of poly (ethylene terephthalate)-A review focusing on chemical methods. Express Polymer Letters, 10(7):559.

Gonzalez, J. 2015. *Vermicomposting at a middle school campus: A cradle-to-cradle approach to food waste*. California State University, Fullerton.

Greening, L.A., Greene, D.L. and Difiglio, C. 2000. Energy efficiency and consumption—The rebound effect—A survey. *Energy Policy*, 28:389–401.

Grenfell, M. J. 2008. Bourdieu, language and classroom ethnography. AERA 2008 Annual Meeting, New York, USA, 24 - 28 March 2008. 1-24.

Gunther, M. 2013. “Can mushrooms replace plastic?” The Guardian [Accessed April 5 2018] https://www.theguardian.com/sustainable-business/mushrooms-new-plastic-ecovative

Haberl, H., Sprinz, D., Bonazountas, M., Cocco, P., Desaubies, Y., Henze, M., Hertel, O., Johnson, R.K., Kastrup, U., Laconte, P. and Lange, E., 2012. Correcting a fundamental error in greenhouse gas accounting related to bioenergy. *Energy policy*, *45*, pp.18-23.

Hawken, P., Lovins, A.B. and Lovins, L.H., 2013. *Natural capitalism: The next industrial revolution*. Routledge.

Holcomb, J. 2008. Environmentalism and the internet: corporate greenwashers and environmental groups. Contemporary Justice Review, 11(3):203-211.

The Huffington Post. 2016. ‘This Company is Making Packaging Out of Mushrooms’ [Accessed April 5 2018] http://www.huffingtonpost.com/entry/the-future-of-packaging-is-mushrooms_us_56f54c80e4b0143a9b47fc12.

HPC Corporate Group n.d. What is the Coca-Cola Bottle [Accessed April 5 2018] http://www.hpcorporategroup.com/what-is-the-coca-cola-plantbottle.html

Isenhour, C. 2010. On conflicted Swedish consumers, the effort to stop shopping and neo-liberal environmental governance. Journal of Consumer Behavior, 9: 454-469.

Jackson, T. 2016. Prosperity without Growth: Foundations for the economy of tomorrow. London:

Routledge.

Kallis, G. 2011. In defence of degrowth. *Ecological Economics*, *70*(5):873-880.

Karnani, A. 2014. Corporate social responsibility does not avert the tragedy of the commons. Case study: Coca-Cola India. Economics, Management and Financial Markets, 9(3):11-23.

Keresztes, S., E. Tatár, Z. Czégény, G. Záray & V.G. Mihucz. 2013. Study on the leaching of phthalates from polyethylene terephthalate bottles into mineral water. Science of the Total Environment, 458-460: 451-458.

Kirchherr, J., Reike, D. and Hekkert, M. 2017a. Conceptualizing the circular economy: An analysis of 114 definitions. Resources, Conservation and Recycling, 127:221-232.

Kirchherr, J., Hekkert, M., Bour, R., Huijbrechtse-Truijens, A., Kostense-Smit, E., Muller, J.

2017b. Breaking the barriers to the circular economy. Joint report Deloitte and Utrecht University. [Accessed April 5 2018] https://www.uu.nl/sites/default/files/breaking_the_barriers_to_the_circular_economy_white_paper_web.pdf

Kolb, A.Y. and Kolb, D.A., 2005. Learning styles and learning spaces: Enhancing experiential learning in higher education. *Academy of management learning & education*, *4*(2) :193-212.

Kopnina, H. and Blewitt, J. 2018. *Sustainable Business: Key issues*. Second Edition. Routledge, New York.

Kopnina, H. 2018a. Teaching Sustainable Development Goals in The Netherlands: a critical approach. *Environmental Education Research*, 24(9): 1268-1283.

Kopnina, H. 2018b. Circular economy and Cradle to Cradle in educational practice. *Journal of Integrative Environmental Sciences*, 15(1): 123-138.

Kopnina, H. 2016a. Animal cards, supermarket stunts and World Wide Fund for Nature: Exploring the educational value of a business-ENGO partnership for sustainable consumption. *Journal of Consumer Culture*, 16(3): 926–947.

Kopnina, H. 2016b. Energy Policy in European Union: Renewable energy and the risks of subversion. *Governance and Security Issues of the European Union: Challenges for the Future*. Ed. by De Zwaan, J., Lak, M. and Makinwa, A., Williams, P. TMS Asser Press/Springer. Pp.167-184.

Kopnina, H. 2016c. 'Closed loop production models in Environmental Education: Teaching circular economy and the business of subversion'. *A Future Beyond Growth: Towards a Steady State Economy*. Ed. by H. Washington and Twomey, P. New York: Routledge.

Kopnina, H. 2016d. Challenging economic development: the case study of teaching alternative cultural values in business education. *Journal of Integrative Environmental Sciences*, *13*(1):67-84.

Kopnina, H. 2015. Sustainability in Environmental Education: New Strategic Thinking. *Environment, Development and Sustainability*, 17(5): 987-1002.

Kopnina, H. 2014a. 'Education for Sustainable Development (ESD) as if environment really mattered'. *Environmental Development*, 12: 37-46.

Kopnina, H. 2014b. 'If a Tree Falls: Business students' reflections on environmentalism'. *International Journal of Environment and Sustainable Development*, 8(3): 311-329.

Kopnina, H. 2014c. 'Future Scenarios and Environmental Education'. *The Journal of Environmental Education*, 45(4): 217–231.

Kopnina, H. 2011. Consumption in environmental education: Developing curriculum that addresses Cradle to Cradle principles'. *In Factis Pax*: *Journal of Peace Education and Social Justice*, 5(3): 374-388.

Kurtzman Jr, R.H. 2010. Pasteurization of mushroom substrate and other solids. *African Journal of Environmental Science and Technology*, *4*(13) :936-941.

LetsRecycle 2015. CCE to reduce virgin plastic use. [Accessed April 5, 2018] http://www.letsrecycle.com/news/latest-news/coca-cola-enterprises-to-reduce-virgin-plastic-use/

Lidskog, R., and Elander, I. 2010. Addressing Climate Change Democratically. Multi-level Governance, Transnational Networks and Governmental Structures. *Sustainable Development*, 18(1): 32–41.

Lieder, M. and Rashid, A. 2016. Towards circular economy implementation: a comprehensive review in context of manufacturing industry. *Journal of Cleaner Production*, 115: 36-51.

Lifset, R. & Graedel, T. E. 2002. Industrial ecology: goals and definitions. In: Ayres, R. U. & Ayres, L. W. (eds.) *The Handbook of Industrial Ecology*. UK & USA: Edward Elgar. Pp. 1-18.

Living Circular. 2016. Myco Foam a new 100% biodegradable material to replace plastic! [Accessed April 5, 2018] https://www.livingcircular.veolia.com/en/industry/myco-foam-new-100-biodegradable-material-replace-plastic

Llorach-Massana, P. Farreny, R. and Jordi, O. L. 2015. Are Cradle to Cradle certified products environmentally preferable? Analysis from an LCA approach. *Journal of Cleaner Production* 93: 243-250.

Lubin, D.A. and Esty, D.C. 2010. The sustainability imperative. *Harvard Business Review*, 88(5):42-50.

McDonough, W. and Braungart, M. 2002. *Cradle to Cradle: Remaking the Way We Make Things*: New York: North Point Press.

Meadows, D. H., Meadows, D. L., Randers, J. and Behrens III. W. W. 1972. *The Limits to Growth*. New York: Universe Books.

Miller, K. 2013. How Mushrooms Can Save the World. Discover Magazine. [Accessed April 5, 2018] http://discovermagazine.com/2013/julyaug/13-mushrooms-clean-up-oil-spills-nuclear-meltdowns-and-human-health

Mohan, A. M. 2009. Coke's carbon footprints are revealed. [Accessed April 5, 2018] http://www.greenerpackage.com/metrics_standards/coke's_carbon_footprints_are_revealed

Mont, O. K. 2002. Clarifying the concept of product–service system. Journal of Cleaner Production, 10(3):237-245.

Mont, O. K. and Heiskanen, E. 2015. Breaking the stalemate of sustainable consumption with industrial ecology and a circular economy. Handbook of Research on Sustainable Consumption. Edward Elgar Publishing, pp.33-48.

Murray, A., Skene, K. and Haynes, K., 2017. The circular economy: an interdisciplinary exploration of the concept and application in a global context. Journal of Business Ethics, 140(3):369-380.

Neuman, W. 2011. The Race to Greener Bottles Could Be Long. New York Times. December 15. [Accessed April 5 2018] https://www.nytimes.com/2011/12/16/business/energy-environment/coca-cola-and-pepsico-race-for-greener-bottles.html

O'Connor, M. C. 2014. Five sustainable boondoggles: greenwashing all the way to the bank. The Guardian. 25 August. [Accessed April 5 2018] https://www.theguardian.com/sustainable-business/2014/aug/25/5-sustainability-greenwash-products-ecofriendly-boondoggles-design

Piscicelli, L., Cooper, T. and Fisher, T. 2015. The role of values in collaborative consumption: insights from a PSS for lending and borrowing in the UK. Journal of Cleaner Production, 97 :21-29.

Piscicelli, L., Ludden, G.D. and Cooper, T., 2018. What makes a sustainable business model successful? An empirical comparison of two peer-to-peer goods-sharing platforms. Journal of Cleaner Production, 172 : 4580-4591.

Postcode Lottery. 2008. Postcode Lottery Green Challenge 2008 winner Eben Bayer"-Video." [Accessed April 5 2018]. http://www.greenchallenge.info/index.php/competition/about-us

Rammelt, C., & Crisp, P. 2014. A systems and thermodynamics perspective on technology in the circular economy. Real-world economics review, 68, 25-40.

Rees, W. 2010. What's blocking sustainability? Human nature, cognition, and denial. Sustainability: Science, Practice, & Policy, 6(2):13-25.

Reilly, A.H. and Hynan, K.A. 2014. Corporate communication, sustainability, and social media: It's not easy (really) being green. Business Horizons, 57(6) :747-758.

Sánchez, C. 2010. Cultivation of Pleurotus ostreatus and other edible mushrooms. *Applied microbiology and biotechnology*, *85*(5) :1321-1337.

Sojobi, A.O., Nwobodo, S.E. and Aladegboye, O.J. 2016. Recycling of polyethylene terephthalate (PET) plastic bottle wastes in bituminous asphaltic concrete. *Cogent engineering*, 3(1):113-140.

Stamets, P. 2011. *Growing gourmet and medicinal mushrooms*. Berkeley, California: Ten Speed Press.

Starmans, E. 2013. Blog by EPEA: Battle of the bottles. [Accessed April 5 2018]. http://www.c2c-centre.com/news/blog-epea-battle-bottles

Steer, A. and Hanson, C. 2015. Biofuels are not a green alternative to fossil fuels. *The Guardian*. [Accessed 15 November 2018] http://www.theguardian.com/environment/2015/jan/29/biofuels-are-not-the-green-alternative-to-fossil-fuels-they-are-sold-as.

The Economist. 2013. Wood: The fuel of the future. Environmental lunacy in Europe. [Accessed 15 November 2018] http://www.economist.com/news/business/21575771-environmental-lunacy-europe-fuel-future.

Twomey, P. and Washington, H. 2016. 'Relating the Steady State Economy to the Green, Circular and Blue Economies', in Washington, H. and Twomey, P. (eds) A Future Beyond Growth, London: Routledge.

UNESCO-UNEP. 1976. *The Belgrade Charter: A global framework for environmental education.* Connect: UNESCO-UNEP Environmental Education Newsletter, 1(1): 1-2.

Vieira, P. 2016. Is Overpopulation a Growth? The Pathology of Permanent Expansion. Oxford Literary Review, 38(1):67-83.

Victor, P. and Jackson, T. 2015. 'The problem with growth', in Starke, L (ed) 2015 State of the World Report, Confronting Hidden Threats to Sustainability, Washington: Worldwatch Institute.

Virgin Materials. n.d. [Accessed April 5 2018] http://www.caslab.com/Virgin_Materials_Meaning/

Waldman, M. 1993. A new perspective on planned obsolescence. The Quarterly Journal of Economics, 108(1):273-283.

Walsh, B. 2014. Even Advanced Biofuels May Not Be So Green. Time. http://time.com/70110/biofuels-advanced-environment-energy/. Accessed November 15 2018.

Ward, J.D., Sutton, P.C., Werner, A.D., Costanza, R., Mohr, S.H. and Simmons, C.T., 2016. Is decoupling GDP growth from environmental impact possible?. *PloS one*, *11*(10), p.e0164733.

Washington, H. 2015. Demystifying Sustainability: Towards Real Solutions. London: Routledge.

Washington, H. and Kopnina, H. 2018. 'The insanity of endless growth.' *Ecological Citizen*, 2(1):57:63.

Watson, B. 2016. The troubling evolution of corporate greenwashing. *The Guardian*. August 20. [Accessed April 5 2018] https://www.theguardian.com/sustainable-business/2016/aug/20/greenwashing-environmentalism-lies-companies

Wijkman, A. and Rockstrom, J. 2012. Bankrupting Nature: Denying our Planetary Boundaries, London: Routledge.

World of Corn. 2016. 'World Corn Production' [Accessed April 5 2018] http://www.worldofcorn.com/#world-corn-production

Zara, C. 2015. Coca-Cola Company Busted For 'Greenwashing': PlantBottle Marketing Exaggerated Environmental Benefits, Says Consumer Report. [Accessed April 5 2018] http://www.ibtimes.com/coca-cola-company-ko-busted-greenwashing-plantbottle-marketing-

exaggerated-1402409