UNIT-4(MEOE03)

CRADLE TO CRADLE CERTIFICATION:

The Cradle to Cradle Certified™ Products Program is the world's most advanced, science-based standard for designing and making products for the Circular Economy. It acknowledges continuous improvement and innovation of products and processes toward the goal of being not just "less bad" but also "more good" for people and the planet.

The certification program is based on the Cradle to Cradle Design™ Framework, which has been developed and implemented by MBDC over the past two decades. MBDC created the certification program in 2005 to recognize achievement in applying Cradle to Cradle Design principles. In 2010, MBDC donated to the Cradle to Cradle Products Innovation Institute an exclusive license for the certification program and methodology, and the Institute now administers the program and manages the Product Standard as a third-party, nonprofit organization.

CRADLE TO CRADLE CERTIFIED PRODUCTS

Products or materials from any industry or country are eligible to apply for certification. Since the program began in 2005, there have been over 600 certifications from companies in 30 countries. Certificates have been awarded in a variety of categories, including building materials, interior design products, textiles, fabrics, cosmetics, home care products, paper, packaging and polymers.

BENEFITS OF CRADLE TO CRADLE CERTIFIED

Cradle to Cradle Certified is more than a recognized mark of product quality; it is a process that leads companies to make better products, better companies and better communities.

RESULTS OF THE CERTIFICATION PROCESS

Benchmarking of a product's design for safety to human and environmental health, sustainability of manufacturing processes and future use cycles

Defined trajectory for optimizing product design and manufacturing processes

Expert evaluations of product ingredients throughout the supply chain for toxicity hazards and risks in context of use

Third-party assessments that can provide data to verify claims about your products, to meet regulations or to contribute to other certifications

ADVANTAGES OF THE CRADLE TO CRADLE CERTIFIED™ PROGRAM

Joining a community of innovative companies that make certified quality products and that use the power of business to provide social and environmental benefits in the circular economy

Use of the Cradle to Cradle Certified marks on product packaging and marketing materials to indicate commitment to continuous improvement and total quality

Recognition in green building certification programs (USGBC's LEED V4 Rating System, BREEAM-NL 2014 v1.0) and preference for use in certain Cradle to Cradle-inspired buildings, communities, and developments, including Park 20|20 in the Netherlands

Becoming "products of choice" for numerous environmentally preferable purchasing programs

STANDARD CATEGORIES AND THEIR SCOPE Products seeking to be Cradle to Cradle Certified TM are evaluated against criteria in the following five categories: Material Health – The ultimate goal is for all products to be manufactured using only those materials that have been optimized and do not contain any X or Grey assessed materials/chemicals. As such, products are able to achieve increasingly higher levels of certification as the percentage of assessed and optimized materials in the finished product increases. The boundaries of review are drawn at the product leaving the direct production facility. The process chemicals associated with the production of certain inputs are included, where applicable (e.g., textiles, plated parts, paper, foam). Material Reutilization – A key component of Cradle to Cradle design is the concept of technical nutrients and biological nutrients flowing perpetually in their respective metabolisms. Products are evaluated for their nutrient potential and nutrient actualization, as well as the role the manufacturer plays in material/nutrient recovery. The intention of this category is to provide a quantitative measure of a product's design for recyclability and/or compostability. The larger the percentage of a product and/or its components that remain in a technical and/or biological metabolism, the better the score for this category

THE CRADLE TO CRADLE PRINCIPLES In nature, there is no concept of waste. Everything is effectively food for another organism or system. Materials are reutilized in safe cycles. There are no persistent, bio-accumulative materials that can lead to irreversible changes. The earth accrues biota grown from the energy of the sun. We celebrate the diversity of people and of species. We become native to place, celebrating abundance and honoring every child that is born. In short, the design of goods and provision of services can be achieved with three principles in mind: 4 CRADLE TO CRADLE CERTIFIED PRODUCT STANDARD VERSION

Eliminate the Concept of Waste

• Nutrients become nutrients again. All materials are seen as potential nutrients in one of two cycles – technical and biological cycles.

• Design materials and products that are effectively "food" for other systems. This means designing materials and products to be used over and over in either technical or biological systems.

• Design materials and products that are safe. Design materials and products whose nutrient management system leaves a beneficial legacy economically, environmentally, and equitably.

• Create and participate in systems to collect and recover the value of these materials and products. This is especially important for the effective management of scarce materials.

• Clean water is vital for humans and all other organisms. Manage influent and effluent water streams responsibly, and consider local impacts of water use to promote healthy watersheds and ecosystems.

• Carbon dioxide (CO2) should be sequestered in soil. Our current practice where carbon dioxide ends up in the oceans and in the atmosphere is a mismanagement of a material. 2. Use Renewable Energy

• The quality of energy matters. Energy from renewable sources is paramount to effective design.

• Aligning with Green's list of eligible sources, renewable energy sources are solar, wind, hydropower, biomass (when not in competition with food supplies), geothermal, and hydrogen fuel cells. 3. Celebrate Diversity

• Use social fairness to guide a company's operations and stakeholder relationships.

• Encourage staff participation in creative design and research projects to enhance your Cradle to Cradle story.

• Technological diversity is key for innovation; explore different options in looking for creative solutions. • Support local biodiversity to help your local ecosystem flourish; strive to have a beneficial social, cultural, and ecological footprint. Under the Cradle to Cradle design approach, products that result in materials flowing into the biosphere (either from the product contents or the packaging) are considered to be "products of consumption." Materials that are recovered after use can be considered to be "products of service." (Note: some materials such as paper or bio-plastics are products of consumption as they ultimately return to the biosphere after a number of post-use cycles.)

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Renewable Energy and Carbon Management – Cradle to Cradle products are manufactured in a way that positively impacts our energy supply, ecosystem

balance, community, and ultimately strives to keep carbon in soil and earth vegetation where it belongs. The intention of this category is to provide a quantitative measure of the percentage of renewably generated energy that is utilized in the manufacture of the product. Purchased electricity and direct on-site emissions associated with the final manufacturing stage of the product, as well as embodied energy associated with the product from Cradle to Gate, are considered, depending on the level of certification. Water Stewardship – Water is a scarce and valuable resource. Product manufacturers are evaluated against their understanding of (and responsibility for) water withdrawals, consumption, and releases within the local ecology, and are rewarded for innovation in the areas of conservation and quality of discharge. The intention of this category is to provide a quantitative and qualitative measure of water usage and water effluent related directly to the manufacture of the certified product.

Social Fairness – Cradle to Cradle product manufacturers strive to ensure that progress is made towards sustaining business operations that protect the value chain and contribute to all stakeholder interests, including employees, customers, community members, and the environment. The intention of this category is to provide a qualitative measure of the impact a product's manufacture has on people and communities, and it includes some measures of general environmental impacts. Requirements apply to the facility or facilities where the final product is manufactured unless otherwise noted.

Problems of Incineration:

Incineration technology is the controlled combustion of waste with the recovery of heat to produce steam that in turn produces power through steam turbines. MSW after pretreatment is fed to the boiler of suitable choice wherein high pressure steam is used to produce power through a steam turbine. Pyrolysis is extensively used in the petrochemical industry and can be applied to municipal waste treatment where organic waste is transformed into combustible gas and residues. Gasification is another alternative which normally operates at a higher temperature than pyrolysis in limited quantity of air. While both pyrolysis and gasification are feasible technologies to handle municipal waste, commercial applications of either technology have been limited.

Incineration-based technologies have been a subject of intense debate in the environmental, social and political circles. This article evaluates incineration on the basis of three parameters – environmental, human health and economic impact – and proposes an integrated mechanism to maintain a fine balance between energy recovery and environmental concerns.

Environmental Issues

The incineration process produces two types of ash. Bottom ash comes from the furnace and is mixed with slag, while fly ash comes from the stack and contains components that are more hazardous. In municipal waste incinerators, bottom ash is approximately 10% by volume and approximately 20 to 35% by weight of the solid waste input. Fly ash quantities are much lower, generally only a few percent of input. Emissions from incinerators can include heavy metals, dioxins and furans, which may be present in the waste gases, water or ash. Plastic and metals are the major source of the calorific value of the waste. The combustion of plastics, like polyvinyl chloride (PVC) gives rise to these highly toxic pollutants.

Toxics are created at various stages of such thermal technologies, and not only at the end of the stack. These can be created during the process, in the stack pipes, as residues in ash, scrubber water and filters, and in fact even in air plumes which leave the stack. There are no safe ways of avoiding their production or destroying them, and at best they can be trapped at extreme cost in sophisticated filters or in the ash. The ultimate release is unavoidable, and if trapped in ash or filters, these become hazardous wastes themselves.

The pollutants which are created, even if trapped, reside in filters and ash, which need special landfills for disposal. In case energy recovery is attempted, it requires heat exchangers which operate at temperatures which maximize dioxin production. If the gases are quenched, it goes against energy recovery. Such projects disperse incinerator ash throughout the environment which subsequently enter our food chain.

Incinerator technological intervention in the waste stream distorts waste management. Such systems rely on minimum guaranteed waste flows. It indirectly promotes continued waste generation while hindering waste prevention, reuse, composting, recycling, and recycling-based community economic development. It costs cities and municipalities more and provides fewer jobs than comprehensive recycling and composting and also hinders the development of local recycling-based businesses.

Human Health Concerns

Waste incineration systems produce a wide variety of pollutants which are detrimental to human health. Such systems are expensive and does not eliminate or adequately control the toxic emissions from chemically complex MSW. Even new incinerators release toxic metals, dioxins, and acid gases. Far from eliminating the need for a landfill, waste incinerator systems produce toxic ash and other residues.

The waste-to-energy program to maximize energy recovery is technologically incompatible with reducing dioxins emissions. Dioxins are the most lethal Persistent Organic Pollutants (POPs) which have irreparable environmental health consequences. The affected populace includes those living near the incinerator as well as those living in the broader region. People are exposed to toxics compounds in several ways:

* By breathing the air which affects both workers in the plant and people who live nearby;
* By eating locally produced foods or water that have been contaminated by air pollutants from the incinerator; and
* By eating fish or wildlife that have been contaminated by the air emissions.

Dioxin is a highly toxic compound which may cause cancer and neurological damage, and disrupt reproductive systems, thyroid systems, respiratory systems etc.

Financial Impacts

All over the developed world, almost half the investment is put in control systems to reduce toxic emissions such as mercury, cadmium, lead, dioxins, furans, volatile organic compounds etc. For example a 2000 MT per day incinerator can cost upwards of $500 million in Europe, half of the cost being put into emission control. Another problem arises in the case of developing countries because the average calorific value garbage in such countries is about 800 cal / kg. For combustion technologies to succeed they would need about 2000 to 3000 cal / kg, other wise auxiliary fuel has to be added. This makes the process more uneconomical and polluting than it already is.

Most of the size and expense of the incinerator is dedicated to the pollution control equipment. The first component of the pollution control equipment is the stage at which ammonia is injected into the gases produced from the burning process which assists in the removal of NOx. The removal of mercury is achieved by the injection of activated carbon. Lime is then injected in the dry scrubber stage whereby the acid gases are removed. Further, most incinerators have a bag-house or electrostatic precipitator to facilitate the capture of particulate and toxics. Thus, it can be realized that the cost of the pollution control system over-rides the cost of the incinerator by a huge margin.

Incineration experts generally state that to have an economically viable operation, it is required to have an incinerator that burns at least 1000 tonnes of garbage each day. The cost to build such a facility is approximately $100 million. Operating costs to maintain the equipment, especially the pollution control equipment is also high.

It is dangerous to bury fly ash in a regular municipal landfill. A special hazardous waste landfill is required which is almost ten times costlier than a municipal landfill. Therefore, the cost of municipal waste incineration shoots up due to the requirement of a special landfill for fly ash disposal.

Conclusions

The adoption of alternative cleaner methods for the disposal of municipal garbage is necessary. According to the United Nations Environment Programme (UNEP), incinerators are the leading source of dioxin into the global environment. The EPA, in a recent study, identified dioxins as the cause of many cancers, the worst component being TCDD (also known as Agent Orange).

The need for low-cost solutions presents significant difficulties, but it is not an impossible task. The ideal resource management strategy for MSW is to avoid its generation in the first place. In 1993, a Royal Commission on Environmental Pollution in England issued a four-stage decision procedure of which the first two stages state:

* Wherever possible, avoid creating wastes,
* Where wastes are unavoidable, recycle them if possible.

This implies changing production and consumption patterns to eliminate the use of disposable, non-reusable, non-returnable products and packaging.

1. ***Solid waste***

Solid waste is the number one contributor of landfill waste disposal. Homes, schools, restaurants, public places, markets, offices and so on produce a great deal of rubbish, garbage and used materials. The bulk of these wastes eventually end up in the landfills. Examples of the solid waste materials include wood, paper, plastic, broken furniture, glass, grounded cars, obsolete electronic products, and hospital and market waste. Because most of these waste materials are non-biodegradable, they heap in the landfills where they stay for years. The scenario is even worse for poorly managed waste disposal systems and normally results in damage to the land and the surrounding environment.

2. ***Agricultural waste***

Agricultural wastes arise from waste materials generated from animal manure, crop, and farm remains. The solid wastes like the animal manure and other agricultural by products are collected and dumped in the landfills. These agricultural remnants are highly toxic and can contaminate the land and water resources. Once in the landfills, the wastes remain there for years impacting on soil quality and polluting the land.

3. ***Industry, manufacturing, and construction waste***

Industrial processes, construction activities and power plants produce a wide range of solid byproducts and residues. The predominant waste products are generated from oil refineries, power plants, construction works, pharmaceuticals, and agricultural product producers. The solid wastes usually find way to the landfills.

4. ***Urbanization and population growth***

Increasing urbanization and population growth rateis considerably accountable for the increased number of landfills across the world. With the increase of population and urban growth, the demand for manufactured products and materials increases. As the demand increases, so does the increase of solid wastes.

In particular, plastic pollution has been on the rise in the first decade of this century due to rapid urbanization and population growth and most of the used plastic materials simply end up in the landfills. In most urban areas, plastics form the greater part of the landfills and constitute about 80% of all the municipal waste.

Drastic Effects of Landfills

1. *Air pollution and atmospheric effects*

There are more than ten toxic gases emitted from landfills, of which methane gas is the most serious. Methane gas is naturally produced during the process of organic matter decay. On this account, EPA records that the methane expelled during the decomposition of organic matter in unmanaged landfills has the potential of trapping solar radiation 20 times more effective than carbon dioxide.

The outcome is increased urban and global temperatures. Aside from the methane gas, other household and agricultural chemicals that find way to the landfills like bleach and ammonia can generate toxic gases that can greatly impact the air quality within the landfill vicinity. Dust, particulate matter and other non-chemical contaminates can also be expelled into the atmosphere, further contributing to air quality issues.

2. *Ground water pollution*

The primary environmental problem arising because of landfills is groundwater contamination from leaches. There are several hazardous wastes that find way into the landfills and once they are there, the inevitable is the natural deterioration of ground water.

The toxic products in the landfills range from industrial solvents to household cleaners. Besides the chemicals from household and industrial products, electronic wastes contain lead, mercury and cadmium.

A huge percentage of these landfill toxins infiltrate the soil to reach the fresh water waterways, which eventually end up in the domestic water and sadly enough, the foods that we consume. The pollution can also adversely harm animal and plant life. Research reveals that 82% of landfills have leaks.

3. *Health effects*

Increases in the risk of severe health implications such as birth defects, low birth weight, and particular cancers have been reported in individuals living next to landfill areas in numerous studies. For instance, TCE is a carcinogen element often originating from landfill leachate. Other discomfort and self-reported symptoms for people living next to the landfills include sleepiness, headaches and fatigue.

The effects are linked with the toxic actions of the chemicals present in the landfill wastes. From contamination of the air with harmful gases to water pollution, the outcome is adverse human health effects. Landfill toxic gas releases and water pollution are as well associated with lung and heart diseases respectively.

4. *Soil and land pollution*

Landfills directly render the soil and land where it is located unusable. It also destroys the adjacent soil and land area because the toxic chemicals spread over the surrounding soil with time. The upper layer of the soil is damaged, distorting soil fertility and activity and affecting plant life. Industrial and electronic wastes in the landfills destroy the quality of the soil and land thereby upsetting the land ecosystems.

5. *Economic costs*

The economic and social cost of landfill management is very high. From the management of the gases coming out of the landfills to groundwater contaminationmanagement, and ensuring compliance with environmental regulatory policies drains a lot of the municipality's and tax payer's money in terms of integrated waste management.

Because most of the materials disposed in the landfills take millions of years to decompose, designing effective strategies and facilities for managing landfills requires high capital investments with regards to management and recycling initiatives.

6. *Landfill fires*

Landfill gases together with a substantive amount of landfill waste, can easily start a fire. Once fires are ignited, it can be challenging to put it out and further cause air pollution. If not put out immediately, they can get out of control and destroy the neighboring habitats.

Methane is notably the most flammable and combustible gas in the landfill and as such, given its abundant supply it can create havoc. Combustion of the landfill even worsens the situation as the burning of the chemicals adds more chemical load to the area.

Impressive Solutions of Landfills

1. ***Design and implementation of integrated waste management***

The construction of modern landfills with well-engineered and managed disposal facilities can significantly lessen the impacts of landfill on soil, air, and water. Landfills that are well-designed and operated ensure compliance with environmental preservation requirements and it ultimately ensures that the environment is free from contaminant.

The use of such designs also ensures the landfills are not located in environmentally-sensitive areas and are incorporated with on-site environmental monitoring systems. With on-site environmental monitoring systems, signs of land fill gas and groundwater contamination can be easily detected and controlled.

2. *Recycle, Re-use, and reduce*

Landfill management will always remain a major environmental if communities don't embrace the need of recycling, reducing and reuse. The increased demand of manufactured products is what increases the final waste products that end up in the landfill. In this view, the use of recycling systems for electronic wastes, plastics, paper, metal, glass and other non-biodegradable materials can provide an effective means of reducing the landfill effects.

Reducing our demand for manufactured products and embracing re-use can equally favor reduction to both the toxicity and volume of waste that end up in the landfill as waste. People have no option but to embrace the art of using manufactured products to the end of their useful life. These can be split into the following simple steps:

- ***Respect the planet:*** A deep gratitude and recognition of how beautiful the planet is, including the interdependence of living and non-living things will help us exploit the planet positively while also giving it time to flourish and rejuvenate.
- ***Rethink our consumption needs:*** After huge purchases, we find out that most of the products don't make us as happy as we thought they would. In going about our life experiences, we should reconsider our consumption habits and also buy what we think is necessary and useful for the betterment of both our well-being and nature.
- ***Reduce wastage:*** Spending our money on things we don't need drains our wallets and destroys our environment because of waste accumulation. Only spending on what is needed saves out planet and keeps it environmentally friendly. Furthermore, it contributes to a cleaner and more efficient environment since it establishes the need for meaningful production and distribution of manufactured products.
- ***Reuse products:*** Reusing the products that we have already bought keeps them away from the landfill. We can buy used items from internet sites like E-bay, second-hand stores, garage sales, or otherwise donate the items that we don't use.
- ***Recycle materials:*** Recycling is one of the best solutions for landfill management. Materials such as plastics, cans, paper and glass can be recycled.

Introduction in 2007 and 2008 the cradle-to-cradle concept took the Netherlands by storm; something we, working within the Design for Sustainability group at Delft University of Technology, noticed by an increasing number of inquiries by students, journalists, companies, industrial designers, NGOs and (local) governments. All showed great interest in the concept, and were curious about the possibilities of implementation. Cradle to cradle is positioned by the authors William McDonough and Michael Braungart as a manifesto for a new approach towards sustainable design: one which is based on the intelligence of natural systems. For McDonough and Braungart, this means we should stop drawing power from non-renewable fossil fuels, and turn towards the sun and other renewable energy sources for our energy supplies. And we should make all 'materials of consumption' become part of either the biological nutrient cycle or the technological nutrient cycle, meaning that materials should either be biodegradable to be taken up in a natural cycle at the end of a product's life, or be 'upcyclable', and be reused indefinitely in a technological closed loop system. Their manifesto is written in a clear and optimistic style and offered for many an alternative vision to the eco-efficiency approach that has been dominant for years (compliance, doing more with less, or in McDonough and Braungart's words: being 'less bad').We observed a remarkable enthusiasm sparked by the cradle-to-cradle concept, which is drawing new people into the field of design for sustainability. But we also observed professionals, who have been working in this field for some time, take a very critical stance. Some consider it the way forward, while others find it makes no sense. Among academia cradle-to-cradle is criticized among other things for not being new , for having a too limited focus ,for claiming general applicability, for celebrating consumption and for their lack of acknowledgement of day-to-day business reality. Through the design projects that have since been executed, we have acquired a body of knowledge and experience while working with cradle-to-cradle in real business settings, which we feel warrants a scholarly review of the pros and cons of the concept, from the perspective of industrial designers. This leads to the central questions of this paper: How can industrial designers who innovate in a day-to-day business setting implement cradle-to-cradle? And how does the much-used life cycle analysis method relate to cradle-to-cradle? Are these two approaches compatible at all?We will answer this question by analyzing and evaluating C2C student design projects carried out in recent months within our Design for Sustainability group, with companies such as (among others) Royal Philips Electronics and TNT. Both of these companies already have a widely acknowledged commitment to sustainability, as is evident by their ranking in the Dow Jones Sustainability Index.

Cradle to cradle framework -a materials approach. The concept of cradle-to-cradle crystallized during the 1990s, and was championed by McDonough and Braungart in their 2002 book. Several years later, two documentaries about C2C on Dutch national television enthused many designers as well as policy makers to such an extent that several municipalities announced their intent to become C2C-cities . In their book, McDonough and Braungart state that a large body of research is carried out to shift our economy to renewable energy sources. Although a complete shift is still decades away, they choose to focus their attention mainly on materials. Regarding materials, they are concerned with toxicity (for instance off-gassing) and closing material loops. Their focus is on how to design products and buildings (or more narrowly, how to select materials for products and buildings) so that these will not off-gas toxic substances during their use phase, and so that the material loop can either be closed biologically or technically. This requires dealing with issues of biodegradability, disassembly, recyclability (or upcyclability), reverse logistics and material toxicity. McDonough and Braungart implicitly make a distinction between at least three levels of cradle-to-cradle: First, there is a vision of an ideal set-up for industry and the economy as a whole. The C2C framework attacks the eco-efficiency approach taken by industry as the wrong way to a sustainable world, as it aims to be less bad, instead of good. This point is also made by John Ehrenfeld, in his 2008 book Sustainability by Design (2008, p.7), where he states: “Almost everything being done in the name of sustainable development addresses and attempts to reduce unsustainability. But reducing unsustainability, although critical, does not and will not create sustainability”

The second level of cradle-to-cradle is a material selection strategy. And thirdly, the authors describe a certification program. Making this distinction is important, as one need not adhere to all three levels of cradle-to-cradle to agree with one of them . For instance, one can see the sense of the material selection strategy, while simultaneously disagreeing with the vision of the authors that there is

3no need to curb consumerism. Or, one could agree with the vision, without agreeing that material selection is the first thing to focus on as a business.

Life Cycle Analysis versus Cradle to Cradle. In the discussion on cradle-to-cradle versus the eco-efficiency approach a particularly interesting issue is that of the usefulness of Life Cycle Analysis. Industrial designers following a course in sustainable design or eco-design are usually introduced to life cycle analysis (LCA) methodology. The LCA method has become the industry standard for the analysis and valuation of the environmental impacts of a product or service, and in some form an LCA is the starting point for many (if not all) eco-design projects. Products are assessed along their entire life cycle, from raw materials production through manufacture, distribution, use and disposal. The procedures for making an LCA are described in the ISO 14000 environmental management standards .A life cycle analysis differs on a fundamental level from the cradle-to-cradle approach. In this paragraph we will explain this fundamental difference and in the case study that follows we'll show how LCA and C2C can, in a real-world design assignment, complement each other. The first and arguably most important step of any life cycle analysis is the determination of the goal and scope. This means that the product of study should be described in terms of a functional unit, and the system boundaries of the analysis must be established. A functional unit is a measure of the function of the product. In the case of a coffee machine, for instance, the functional unit could be 'making five cups of coffee per day over a period of five years'. This enables the comparison of two different brands of coffee machines, as long as these have the same functional unit. The system boundary determines which processes are included in the LCA. For a coffee machine, a system boundary is typically drawn at the extraction point of the raw materials and the final stages normally include different end-of-life scenarios (e.g. waste incineration, landfill, recycling).

Challenges for C2C implementation1. Reverse logistics If a company has a system of 'reverse logistics' in place, implementing C2C principles becomes much more realistic and possibly cost-effective (as the TNT case 9has shown). A Dutch company like Océ (copiers and printers) that leases its high-end copiers might implement C2C principles with relative ease, as it has a 100% return rate. But companies without a return system in place should question whether redesigning their products following a cradle-to-cradle material selection strategy is sensible, if that product is going to end up in the existing end-of-life systems of landfill and incineration. A company selling –for instance-consumer handbags should probably first set up a take-back system and find a way to get their customers to bring back old handbags before it can seriously consider implementing C2C

The Dutch office furniture company Ahrend has understood this. Having spent many years on eco-efficiency, the company recently announced its intention to restructure its operations in accordance with the cradle-to-cradle philosophy . In January 2009, the company introduced Next Life, which is a new service, focused on extending the useful life of interior products through refurbishment and ultimately the re-use of the material. The challenge of reverse logistics is closely related to a company's business model. In the case of Ahrend, the decision to go for Next Life was taken by CEO Jacq de Bruin, who recently concluded a cooperation agreement with EPEA, the C2C consultancy of Michael Braungart. Industrial designers are not usually in a position to enforce such agreements. If they want to be active in the C2C field they should seek out those companies with a certain amount of influence in their value chain or those that already have a system of take-back in place.

□Opportunities for C2CWe have shown there are still many challenges for businesses and designers seeking to implement cradle-to-cradle. However, we also see several interesting opportunities:1. Inspiration The cradle-to-cradle concept is a great source of inspiration on a conceptual level. Both professional industrial designers and students appreciate the positive approach, the ambition level and the 'design your way out' attitude of McDonough and Braungart. Their C2C framework seems to empower designers. It does away with 'old' notions of guilt and restriction, and opens up new horizons for designers to explore.2. C2C means asking questions Taking a cradle-to-cradle approach will force businesses and designers to ask themselves questions about issues that would otherwise be ignored in a business-as-usual setting. For instance regarding take-back systems and the composition and reuse of materials. C2C encourages designers to dig deeper and (for instance) find out what is really involved in the production and processing of certain materials. In contrast, the application of a Life Cycle Analysis does not encourage this kind of 'digging deeper' at all.3. C2C offers an actionable framework Through its certification system, C2C offers an actionable framework. For a company new to cradle-to-cradle it is relatively easy to get a basic certification, allowing it to work in small steps towards the implementation of more ambitious C2C targets .

Ways to follow C2C:

1. Cradle to Cradle foresees the transition from the current industrial model, that 'takes, makes and pollutes', to a system with healthy and safe products whose materials are renewable on short term (biological nutrients) or stay in cycles (technical nutrients). This new model will require a shift from ownership to 'usership' for products that are made of technical nutrients. The Cradle to Cradle concept does not only apply to products but also to urban and regional planning. Making reference to how nature is managed, Cradle to Cradle stimulates to design our buildings as trees and our cities as forests. Cradle to Cradle must be understood as an essential step in the transition from eco- efficiency to eco-effectiveness.
2. In its Europe 2020 strategy to put Europe's economy back on track, the European Commission considers innovation and resource efficiency as two of its seven flagship initiatives to reach its goal. Almost all initiatives with respect to avoiding or reducing environmental damage are ultimately motivated by an appeal to the economic objective of more growth and jobs, the aim of reducing import dependency and/or to urgency to offset the consequences of climate change. The EU approach with respect to waste sticks almost exclusively to the 3R paradigm (reduce, recycle, reuse). On the good side, although C2C is a new concept also at the EU level, the ideas promoted by C2C are partly and implicitly present in the introductory visionary statements of the more recent policy frameworks. However, they lack in the operational development of the EU policy documents. There is thus a clear and urgent need to speed up this change in order to meet the societal challenges and the ambitions put forward.
3. EU 2020 notably aims for an economy that is more energy and resource efficient, greener and more competitive. Europe should be energy and material independent. But what does that mean in practice? One of the main consequences is a shift with respect to hazardous materials management installing a totally new concept, which could be named a lego approach. In a Cradle to Cradle society consumers buy a service, not a product. Materials carry use functions and should move freely within society. A complete shift towards a service economy may and should be expected. This will have major consequences for the energy debate driving mainly on renewable energy. 'Doing things right from scratch' also applies to policy making. The application of C2C principles is no longer hindered by laws and regulations. To make this happen, Europe has a solid home market for C2C products. This can only work if the market is steered into a direction where innovation with environmental benefits is rewarding. Radical innovation underpins the transformation towards and the further development of the C2C society.
4. The recommendations focus at the strategic, rather than the operational level, guiding EU policy towards eco-effectiveness. The recommendations are proposed on four levels (1) Create a common framework for an eco-effective society (2) Stimulate demand (3) Stimulate supply and (4) Innovation through partnerships.

Water Saving:

1. **Put a brick in your toilet's water tank.** You flush an average of 20 gallons of water a day down the toilet. If you don't have a high-efficiency toilet, try filling your tank with something that will displace some of that water, such as a brick.

2. **Use the right amount of water for each load of laundry.** Typically 15-40 percent of indoor home water use comes from doing laundry. Save water by making sure to adjust the settings on your machine to the proper load size.
3. **Pick your washing machine wisely.** When considering top-load vs. front-load washers, front-loading washing machines generally use less water.
4. **Water plants wisely.** Water your lawn or garden early in the morning or late in the evening, so the water lasts and is not immediately evaporated by the hot sun.
5. **Install a low-flow showerhead.** With a low-flow showerhead, you can save 15 gallons of water during a 10-minute shower.
6. **Check for and repair leaks.** An average of 10,000 gallons of water is wasted every year due to household leaks. One of the most effective ways to cut your water footprint is to repair leaky faucets and toilets.
7. **Use a dishwasher.** Dishwashing accounts for less than 2 percent of indoor water use, but using a machine is actually more water efficient than hand washing, especially if you run full loads. ENERGY STAR® dishwashers save about 1,600 gallons of water over its lifetime of use.
8. **Turn off the water.** Teach your whole household to turn off the faucet while brushing teeth or shaving. Every little bit of water conservation helps!
9. **Defrost food in the fridge.** Instead of running frozen foods under hot water from the faucet, build in time to let them defrost in the refrigerator.
10. **Manage outdoor water use.** Don't forget about water conservation outside as well. Equip all hoses with shut-off nozzles, which can prevent hose leaks.

What else can you do to save water:

When running your dishwasher or washing machine, make sure you fully load each cycle. Running full cycles helps conserve water because these appliances will fill to a certain level and having more dishes or clothes reduces the amount of water needed for each cycle. This ensures that you get the most energy-saving and water-saving use from each run of your appliances. Here's a video on how to save water by packing your dishwasher efficiently:

One of the best water conservation tips out there, with possibly the largest impact, is a simple one: Take showers instead of baths. Baths may be relaxing and enjoyable, but it takes more than 78 gallons of water to fill a tub. Showers are a more water efficient way to bathe. Here are more tips on saving water from taking a shower:

Biomimicry:

Biomimicry is a practice that learns from and mimics the strategies found in nature to solve human design challenges — and find hope along the way.

For all the challenges we face, nature has a solution.

Biomimicry offers an empathetic, interconnected understanding of how life works and ultimately where we fit in. It is a practice that learns from and mimics the strategies used by species alive today. The goal is to create products, processes, and policies — new ways of living — that solve our greatest design challenges sustainably and in solidarity with all life on earth. We can use biomimicry to not only learn from nature's wisdom, but also heal ourselves — and this planet — in the process.

Biomimicry brings relief.

We're stressed. Our planet is stressed. Many are losing hope for solving the climate crisis and its many negative effects on ecosystems across the world. Biomimicry gives us hope, because we know the solutions for our greatest challenges are here, accessible, and validated by the many species still alive today. By using nature as our mentor, we get to experience the powerful healing effects it has by connecting to the natural world — while also finding empowering relief to solve these challenges together.

Biomimicry helps us design generously.

Circularity, sustainability, regenerative design — it all means that the things we humans make become a force for restoring air, water, and soil instead of degrading it. Nature uses structure to change functions and also uses passive forms of energy, whereas our inventions use brute force like mining ancient carbon and a multitude of harmful chemicals. We can create conditions conducive to life, just like nature does.

Biomimicry gets us to sustainable solutions, faster.

Our R&D cycles are slow, and climate change won't wait – we must look to the biological blueprints that have been successful over millennia to launch groundbreaking ideas, faster. We don't need to reinvent the strategies that are already here. We just need to learn how to adapt them.

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Biomimicry changes our lens on the world.

Innovators turn to biomimicry with the hope of achieving a unique product that is efficient and effective, but they often gain a deep appreciation of and connection to the natural world. As Biomimicry Launchpad participant and Mangrove Still co-founder Alessandro Bianciardi said, "I cannot help but feel a kinship with these trees now that I have spent years of my life trying to emulate them. In fact, I see all trees differently now." Biomimicry encourages conservation for ecosystems and its inhabitants, because they hold the wisdom we need.

Biomimicry isn't itself a product but a process, drawing on natural organisms and processes in order to spark innovation. Organizations and even cities can look to ecosystems for inspiration. In Lavasa—described as "India's first planned hill city" by its developers, who hope to eventually build homes for more than 300,000 people there—the guild consulted with landscape architects. Thus the planting strategy included deciduous trees, forming a canopy to catch, and then reflect, through evaporation, nearly a third of the monsoon rain that hits it. That effect acts "like an engine that drives the monsoon inland," says McGee, which helps prevent drought there. The hydrodynamically efficient shape of banyan tree leaves influenced the design of a better water-dispatching roof shingle, while water divertment systems were inspired by the ways harvester ants direct water away from their nests. The first Lavasa "town" has been completed, with four more projected to follow by 2020.

Everyone's talking about ways to reduce the human footprint, or to get to "net zero" impact. But nature, says McGee, usually goes one step further: "It's almost never net zero—the output from that system is usually beneficial to everything around it." What if we could build our cities the same way? "What if, in New York City, when it rained, the water that went into the East River was cleaner than when it fell?" And what if, when forests caught fire, the flames could be extinguished by means that didn't depend on toxic substances "Nature creates flame retardants that are nontoxic," notes McGee.

Blue Economy:

Careful definition and illustrative case studies are fundamental work in developing a Blue Economy. As blue research expands with the world increasingly understanding its importance, policy makers and research institutions worldwide concerned with ocean and coastal regions are demanding further and improved analysis of the Blue Economy. Particularly, in terms of the management connotation, data access, monitoring, and product development, countries are making decisions according to their own needs. As a consequence of this lack of consensus, further dialogue including this cases analysis of the blue economy is even more necessary. This paper consists of four chapters: (I) Understanding the concept of Blue Economy, (II) Defining Blue economy theoretical cases, (III) Introducing Blue economy application cases and (IV) Providing an outlook for the future. Chapters (II) and (III) summarizes all the case studies into nine aspects, each aiming to represent different aspects of the blue economy. This paper is a result of knowledge and experience collected from across the global ocean observing community, and is only made possible with encouragement, support and help of all members. Despite the blue economy being a relatively new concept, we have demonstrated our promising exploration in a number of areas. We put forward proposals for the development of the blue economy, including shouldering global responsibilities to protect marine ecological environment, strengthening international communication and sharing development achievements, and promoting the establishment of global blue partnerships. However, there is clearly much room for further development in terms of the scope and depth of our collective understanding and analysis.

Understanding of Blue Economy

Since the 21st century, the concept of the "Blue Economy" has become increasingly popular. International society believes that blue economy covers three economic forms: economy coping with global water crisisMcGlade et al., 2012; innovative development economy (Pauli, 2009) and development of marine economy (Behnam, 2012).

In the field of academic research, the research literature about blue economy mainly includes the following aspects. Kathijotes (2013) put forward the aim of Blue Economy models is to shift resources from scarcity to abundance, and to start tackling issues that cause environmental problems. Mulazzani et al. (2016) put forward the management tool based on ecosystem service framework to solve the coastal blue growth. Soma et al. (2018) proposed to achieve long-term sustainable blue growth through collaboration, inclusion and trust in the marine sector. van den Burg et al. (2019) focused on summarizing the possible boundaries of the growth of the marine industry from the spatial dimension of blue growth.

Most management research of the blue economy is based on a sustainable development perspective. Keen et al. (2018) designed a conceptual framework for blue economy can be used to assess sustainable marine management. Sarker et al. (2018) also developed a management framework of blue growth emphasizing that it requires joint efforts to promote blue growth and achieve sustainable development goals (SDGs). Howard (2018) had in-depth discussion on the role of stakeholders in sustainable development. The convergence of the blue economy and marine ecosystem, ecosystem accounting is closely linked to blue growth (Häyhä and Franzese, 2014.

Blue growth concept can be traced back to sustainable development, with the increase of international communication and in-depth study of the blue economy concept, more profound connotations are emerging. Interdisciplinary and multidisciplinary research is very important when studying blue economy cases, especially one of the main challenges is how to integrate across the involved disciplines.

Blue Economic Characteristics

Specifically, blue economy presents the following attributes:

Blue Economy Has a General Economy Attribute

Australia launched Blue Well-being Initiative, recognizing that ocean-based industrial development and growth, or blue GDP is of great potential to Australia's economic and social development (Commonwealth Scientific and Industrial Research Organisation [CSIRO], 2008). EU came up the concept of "blue growth" in 2012 (Committee of the regions, 2013). Therefore, many countries use "Blue Economy" as a policy tool or means to drive economic growth and create jobs. Focused on revitalizing economy, the marine industrial activities include construction, transportation, mineral resources development, ship building, communication cable laying, pharmaceutical enterprises, equipment deployment, sustainable energy from waves, currents, seaside leisure tourism, and fisheries and aquaculture. In addition to traditional marine development activities, marine oriented information and science sectors are playing an increasingly stronger role in boosting blue economy development.

As "Blue" Signifies the Sea, Many Countries Consider the Blue Economy Refers to Marine Economy

United States Secretary of Commerce, addressed in 2012 Capitol Hill Ocean Week that United State's sea area actually has always been a strong economic engine. Some people refer it as "blue economy". For example, Australia believes that the blue economy includes traditional and emerging marine industries and regards the value of marine industry as the value of the blue economy. India regards the blue economy as economic activities relying on the marine ecosystem or seabed. Blue development should increase the protection of adjacent waters, which means to enlarge blue economy space by expanding our development and protection to all marine (coastal and open ocean-deep sea) ecosystems. While alleviating pressures that reach the ocean originate in land and it is through atmospheric, riverine or connectivity that impacts reach the coastal ocean, we can further enhance our cognition toward the ocean.

Blue Economy Is a Strategic Framework

Australia believes the essence of blue economy is to promote the development of marine industry which ecologically, economically and socially benefit from marine ecosystem and ensure that the ecosystem-based management model should be the core in decision-making process of industrial and community development (Australian Government, 2012).

Blue Economy Is a Kind of Policy

In 2009, Maria Cantwell, United States Senator of Washington State, pointed out in the opening statement of the hearing on "The Blue Economy: The Role of the Oceans in our Nation's Economic Future" that "The "Blue Economy" – the jobs and economic opportunities that emerge from our oceans, Great Lakes, and coastal resources – is one of the main tools to rebuilding the United States economy."

Blue Economy Is a Part of Green Economy

UNEP and other international organizations extract blue economy from green economy. They encourages to tackle climate change via low-carbon and resource-efficient shipping, fishing, marine tourism, and marine renewable energy industries

Industrial Ecology:

Definition

Industrial ecology conceptualises industry as a man-made ecosystem that operates in a similar way to natural ecosystems, where the waste or by product of one process is used as an input into another process. Industrial ecology interacts with natural ecosystems and attempts to move from a linear to cyclical or closed loop system. Like natural ecosystems, industrial ecology is in a continual state of flux.

B. Main Features

Industrial processes, from material extraction through to product disposal, have an adverse impact upon the environment. Industrial ecology aims to reduce environmental stress caused by industry whilst encouraging innovation, resource efficiency and sustained growth. Industrial ecology acknowledges that industry will continue operate and expand however, it supports industry that is environmentally conscious and has less burden upon the planet. It views industrial sites as part of a wider ecology rather than an external, solitary entity.

Within the industrial ecology concept, industry interacts with nature and utilises the wastes and by products of other industries as inputs into its own processes. Industrial ecology ranges from purely industrial ecosystems to purely natural ecosystems with a range of hybrid industrial/natural ecosystems in between. Covering both industrial management and technology, industrial ecology encompasses other sustainability concepts and tools such as material flows analysis; environmentally sound technologies; design for disassembly; and dematerialisation.

The principles of industrial ecology as defined by Tibbs (1992) are:

- Create industrial ecosystems - close the loop; view waste as a resource; create partnerships with other industries to trade by-products which are used as inputs to other processes.
- Balance industrial inputs and outputs to natural levels - manage the environmental-industrial interface; increase knowledge of ecosystem behaviour, recovery time and capacity; increase knowledge of how and when industry can interact with natural ecosystems and the limitations.
- Dematerialisation of industrial output - use less virgin materials and energy by becoming more resource efficient; reuse materials or substituting more environmentally friendly materials; do more with less.
- Improve the efficiency of industrial processes - redesign products, processes, equipment; reuse materials to conserve resources.
- Energy use - incorporate energy supply within the industrial ecology; use alternative sources of energy that have less or no impact upon the environment.
- Align policies with the industrial ecology concept - incorporate environment and economics into organisational, national and international policies; internalize the externalities; use economic instruments to encourage a move towards industrial ecology; use a more appropriate discount rate; use a more comprehensive index to measure a nation's wealth rather than GNP.

Resource Recovery from waste:

Resource recovery is the process of recovering materials or energy from **solid waste** for **reuse** . The aim is to make the best use of the economic, environmental, and social costs of these materials before they are permanently laid to rest in a **landfill** . The **Environmental Protection Agency** (EPA) and environmentalists have set up a hierarchy for resource recovery: reduce first, then reuse, recycle, incinerate with **energy recovery** , and landfill last. Following the hierarchy will cut solid waste and reduce resources consumed in production. Solid waste managers have turned to resource recovery in an effort to cut disposal costs, and the hierarchy has become not only an important guideline but a major inspiration for local **recycling** programs.

After the industrial revolution made a consumer society possible, **garbage** was considered a resource for a class of people who made their living sorting through open dumps, scavenging for usable items and recovering valuable scrap metals. Once public health concerns forced cities to institute garbage collection and dump owners began to worry about liability for injuries, city dumps were for the most part closed to the public. Materials recovery continued in the commercial sector, however, with an entire industry growing up around the capturing of old refrigerators, junk cars, discarded clothing, and anything else that could be broken down into its raw materials and made into something else. That industry is still strong; it is represented by powerful trade associations, and accounts for three-quarters of all ocean-borne bulk cargo that leaves the Port of New York and New Jersey for foreign markets.

The benefits of industrial ecology include: cost savings (materials purchasing, licensing fees, waste disposal fees, etc); improved environmental protection; income generation through selling waste or by products; enhanced corporate image; improved relations with other industries and organisations and market advantages. Limitations to industrial ecology include: no market for materials; lack of support from government and industry; reluctance of industry to invest in appropriate technology; perceived legal implications and reluctance to move to another supplier.

Access to affordable and sustainable energy is key to economic prosperity and sustainable development in developing countries. Energy plays a critical role not only in ensuring quality of life at individual or household level but also as one of the factors of production whose cost affects other goods and services (Amigun et al., 2008). Access to energy or the lack of it affects all facets of development: social, economic and environmental aspects. It is the key to sustaining the livelihood of the poor as well as ensuring industrial development of a country. Energy is crucial for achieving almost all of the Sustainable Development Goals (SDGs), from eradication of poverty through advancements in health, education, water supply and industrialization, to combating climate change (UN, 2016). SDG 7 is dedicated to the access to affordable, reliable, sustainable and modern energy for all, with target 7.2 calling for a substantial increase of the share of renewable energy including power derived from solid and liquid biofuels, biogas and waste. With the aim of achieving a more sustainable natural environment while providing reliable and affordable energy to different sectors of the economy, interest in alternative sources of energy as a means of reducing dependence on fossil fuels has grown. Studies have shown that energy demand will increase during this century by a factor of two or three while about 88% of this demand is met by fossil fuels (IEA, 2006). The negative effects of the conventional energy sources coupled with the limited capacity of current energy infrastructure and the increase in energy demand have spurred interest in alternative sources of energy which are environment friendly and renewable. Around 3 billion people cook and heat their homes using solid fuels (i.e. wood, charcoal, coal, dung, crop wastes) on open fires or traditional stoves. Such inefficient cooking and heating practices produce high levels of household (indoor) air pollution which includes a range of health-damaging pollutants such as fine particles and carbon monoxide. About 4.3 million people a year die from the exposure to household air pollution (WHO, 2016). Under increasing deforestation, the global waste to energy market was valued at USD 24 billion in 2014 and it is expected to reach USD 36 billion by 2020 – a growth rate of 7.5% . Waste-to-energy is a waste treatment process to generate energy in the form of electricity, heat or fuel from both organic and inorganic waste sources. In this book, the focus is only on cases and models targeting energy generation from biomass (organic waste). While recovering energy from organic waste streams is essential to ensure energy security and sustainable development, waste-to-energy solutions still face numerous barriers including high investment cost, inadequate policy support and insufficient revenue generation due to limited experience with business or cost recovery models. This section addresses this last void, while opportunities and barriers in the enabling environment are discussed in Chapter 19. In this section of the catalogue, waste-to-energy conversion process in all the business cases and models can be broadly presented as in Figure 6. The energy recovery models and cases use one of the waste streams (agro-waste, agroindustrial waste and effluent, livestock waste, fecal sludge and organic fraction of municipal solid waste) to produce energy products in solid (briquette), liquid (bio-fuel/ethanol) and gaseous (producer gas and biogas) forms. These energy products are used to generate heat, electricity or fuel for transport.

Biosphere rules:

The biosphere is built on a parsimonious materials palette, a handful of elemental materials used to create the marvelous biodiversity we see around us. Nature's power source is solar, captured and stored chemically in living things themselves. The materials are enduring, residing temporarily in any given organism before being released into nature's shared materials pool to be value cycled into the next, more evolved, organism. Organisms are expressions of a common underlying production platform that the biosphere leverages for massive scale, scope and information economies, allowing species to take advantage of every habitable niche on the globe.

Organism design and ecosystem function are biologically captured in genetic information technology that is shared widely across the planet, allowing individual organisms to operate in an integrated way that sustains the whole. In the future, we can envision a time where every material thing in our world is made out of a handful of materials, carefully selected to be safe and healthy for living things and infinitely recyclable. Everything from coffee cup to countertop could be broken down on the spot and used as raw materials for a new shawl or lampshade. Instead of looking to the iron mines of **Minnesota** or the well heads of **Iraq** for our raw materials, we would instead look to the skyscrapers of **Manhattan** or even our living rooms. As you read this, look around at what is in the room you are sitting in. Can you imagine that the bulk of it is made from a handful of carefully selected materials. In this world, product designers and engineers would be trained to think differently. Instead of asking, "What novel materials can I use to build this product?", brilliant designers will ask, "How can I use my pallet of proven circular materials to design a solution that delivers my client's desired service?" And, of course, they will come up with original, dazzling solutions.

In this world, manufacturing depends not on the intense industrial heats and pressures that mimic geologic processes, but on manufacturing methods that can be powered by intelligently delivered renewable energy.

The beginnings of this world already exist. **Additive manufacturing technologies** — which build products from the bottom up, like nature — have the potential to incorporate all of the biosphere rules, setting the foundation for a viable circular economy. 3D printing's additive manufacturing approach means that a single plastic polymer can be used to create a nearly infinite number of forms, fulfilling the principle of materials parsimony. Next, the recent development of solar-powered 3D printing fulfills the power autonomy principle, allowing printers to work entirely on local renewable energy. And the final piece has also been demonstrated: An integrated recycling process that can take an old object, grind it down, and reuse it as raw material for the next printing run.