



C2C

N E T W O R K

CRADLE TO CRADLE: THEORETICAL FRAMEWORK



Colophon

This Theoretical Framework provides more detailed information on the principles of the Cradle to Cradle concept and its implications at a theoretical level. The framework helps to develop a common language for the Network and underpins the perspective studies and the ongoing work of the C2CN.

The perspective studies will serve as frame of reference for follow-up activities and exchanges both within and outside the Cradle to Cradle Network (C2CN) and aim to reflect the current challenges and opportunities associated with implementing a Cradle to Cradle approach. In total, four perspectives have been written, in the areas on industry, area spatial development, governance and on the build theme. These studies are not formal academic literature reviews, but are written from a practical point of view and offer some general understanding and guidelines for those engaged in C2C initiatives, as well as policy makers. They aim to consider 'on the ground' delivery of the C2C philosophy and reflect on both theory and practice.

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Disclaimer

The Cradle to Cradle concept was developed by W. McDonough and M. Braungart. The term Cradle to Cradle is a registered trademark.

The Cradle to Cradle Network project is not designed to develop a criteria-based evaluation tool to determine whether the applications are Cradle to Cradle. It considers that C2C is an approach designed to assist (the search for) better solutions (and ultimately (at) good solutions). Rather than being a score sheet for compliance, the Cradle to Cradle Network approach is oriented to help people understand what the wider implementation of Cradle to Cradle principles in the areas of industry, buildings, governance and area spatial development might look like; and, to disseminate and learn from current and emerging good practice.

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Table of content

1	Cradle to Cradle: Theoretical Framework	
1.1	Objectives	5
1.1.1	Overall objective of C2C Network	
1.1.2	Objectives of the Cradle to Cradle Framework	
1.2	Perspective: from efficiency to effectiveness	6
1.3	Cradle to Cradle: a framework for eco-effective solutions	9
1.3.1	Concept: Cradle to Cradle Framework	
1.3.2	Cradle to Cradle Principles	
	Waste equals food	
	Use of current solar income	
	Celebrate diversity	
1.3.3	Cradle to Cradle applications	
2	Cradle to Cradle and the four target areas of the C2C Network	
2.1	Cradle to Cradle and Industry	13
2.1.1	Cradle to Cradle on the product level	
2.1.2	Cradle to Cradle in the supply chain	
2.1.3	Cradle to Cradle on the level of business	
2.1.4	Conclusions	
2.2	Cradle to Cradle and Building design	14
2.2.1	Concept	
2.2.2	Principles	
2.2.3	Cradle to Cradle in relation to other concepts introducing sustainable development in building design	
2.2.4	Conclusions	
2.3	Cradle to Cradle and Area Spatial Development	20
2.3.1	Concept	
2.3.2	Principles	
2.3.3	Conclusions	
2.4	Cradle to Cradle and Governance	
2.4.1	Concept	23
2.4.2	Principles	
2.4.3	Applications	
2.4.4	Conclusions	
3	Summary	24
4	Frequently used Cradle to Cradle terms	25

1.1 Objectives

1.1.1 Overall objective of C2C Network

In its Europe 2020 strategy to put Europe's economy back on track, the European Commission considers resource efficiency as one of its seven flagship initiatives to reach this goal. Although this primarily refers to energy related resources, also sustainable materials management topics gain importance. For instance the key question at the informal Environmental Council of July 2010, as part of the Belgian Presidency of the EU during the second semester of 2010, was: *To what extent can EU policy contribute to the objective that materials – regardless of whether they are raw materials, semi-processed products or waste products – are used as efficiently and in an as environmentally friendly way as possible*¹.

The new strategy is aimed at making Europe a recycling society. Integrated Product Policy² principles, which are based on life-cycle thinking are becoming integrated in the new Waste Framework Directive³. Also The Thematic Strategies on the Sustainable Use of Natural Resources⁴ and on the Prevention and Recycling of Waste⁵ have endorsed the life-cycle thinking and the call for continuous improvement, as well as the principle of working with the market. This will reduce the negative environmental impact on natural resources and increase the resource efficiency of the European economy, which is essential for sustained economic development.

The way we handle waste has fundamentally changed over the past 30 years. A lot of EU Directives and national/regional legislation were issued and member states established 'integrated waste management systems'. Despite increasing legislation technology and efficiency, these systems are limited in solving structural problems like decoupling economic development from environmental pressure. The challenge is to go beyond quick fixes by raising European waste management onto a higher sustainable level. In this respect, the focus will be on integrated material (waste) management which addresses environmental impacts over the whole life-cycle of materials and products.

In 2006, thanks to a TV documentary, the concept of Cradle to Cradle started to inspire people, industry and governments (national, regional and local) in the Netherlands. The concept was immediately popular because of its embedded promise that it could impulse the economy in such a way that it leads us to a 'better world'. Since 2006, several initiatives have been undertaken, especially in the Province of Limburg where Cradle to Cradle became the backbone of its sustainable development strategy. These initiatives are not limited to products but also to buildings and spatial area development.

The power of the Cradle to Cradle concept lies in its innovativeness and its ability to mobilise and inspire. The Cradle to Cradle approach is a positive one, starting with an initial intelligent design. It is also a concept that integrates, as it incorporates a design approach and a systematic way of thinking. It covers supply chains (the recycling of natural resources via product and manufacturing design, to high value reuse) and also involves systems (key supplies, ecosystems, space and energy) as well as management (via money, rules, spatial planning). It is a concept that contributes to a reduction of the use of raw materials, generates less environmental pollution, contributes to our economic growth and allows us to make better use of scarce space. It envisages a challenging future and incites us to moving to a complete new way of product design and innovation. Cradle to Cradle is innovative given the very ambitious goals to create continuous loops in production, to integrate high standard principles in building and spatial design.

Challenged by the Cradle to Cradle philosophy and in line with Europe's strategies Limburg mobilised nine other regions to make an application under the INTERREG IVC program for their Cradle to Cradle network. The C2C Network is a Capitalisation network (Interreg IVC) which aims to reduce raw materials' utilisation, to generate less waste and less environmental pollution, as well as to enhance innovation and economic development. The C2C network brings together EU regions to share and capitalise on regional good practice in implementing C2C principles in relation to waste prevention and management. And do so by producing sustainable solutions, economic development opportunities and social well-being.

The overall objective of the C2C Network is to develop regional action plans, reflecting the principles of the Cradle to Cradle concept, systematising its regional interpretations and setting out how the good practices will be implemented within regional mainstream Structural Funds Programmes.

Within the overall more strategic objective the C2C Network project aims on the short term to reach the following sub objectives or operational objectives:

- To create an enduring network of regions related to Cradle to Cradle
- To promote regional stakeholder involvement
- To disseminate and communicate to wider EU audiences outside the partnership (awareness raising) and to the European Commission (policy recommendations) on approved methods for waste prevention/reduction based on the Cradle to Cradle philosophy.

- 1 See also A. Rossy, P.T. Jones, D. Geysen, K. Bienge (2010). Sustainable Materials Management for Europe. From efficiency to effectiveness, background paper for the informal Environmental Council on the 12th and 13th July, 2010
- 2 Communication from the Commission to the Council and the European Parliament (2003). - Integrated Product Policy - Building on Environmental Life-Cycle Thinking (2003)/COM/2003/0302 final
- 3 Directive 2008/98/EC of the European Parliament and the Council on waste
- 4 Communication from the Commission to the Council and the European Parliament, the European Economic and Social Committee and the Committee of the regions -, Thematic Strategy on the sustainable use of natural resources COM (2005) 670 final
- 5 Communication from the Commission to the Council and the European Parliament, the European Economic and Social Committee and the Committee of the regions - Taking sustainable use of resources forward: A Thematic Strategy on the prevention and recycling of waste. COM (2005) 666 final

Cradle to Cradle is considered to be a framework that supports the transition to a society with healthy, safe and reusable materials. Within this broader Network, a Cradle to Cradle theoretical framework needs to be developed in order to obtain a common language and understanding between partners and interested parties. It will be looked at from a systems perspective which means that next to materials also energy, logistics and social aspects will be included. This allows also broadening the scope from products to the areas of build design and spatial area development.

1.1.2 Objectives of the Cradle to Cradle Framework

The main objective of setting up a theoretical Cradle to Cradle framework is to develop a common language for the Network. This framework will help the members of the Network in the selection of the good practices but may also form the basis of the regional action plans to be developed. The framework has not the intention to include a list of eliminating criteria but will build upon the conceptual characteristics to come to eco-effective solutions (beneficial for human and the environment) and is not – in this context – an evaluation tool such as the Cradle to Cradle certification system.

The theoretical framework focuses on the general description of Cradle to Cradle. It presents Cradle to Cradle in general. Complementing work will explain Cradle to Cradle further with a focus on 4 individual target areas: industry, building design, spatial area development and governance. One general theoretical framework is proposed which will be of use for all target areas. Each target area needs an explanation to position it in the wider theoretical framework. The aim of this project is to collect the relevant (existing) information. No new research has been conducted. Questions which will be answered are e.g.

- how do we define Cradle to Cradle within our network?
- what is Cradle to Cradle in concept, its principles and applications?

Cradle to Cradle is not a waste management concept, but a radical innovation in a business context that aspires to get rid of all negative environmental impacts associated with human activities, including waste.

1.2 Perspective: from efficiency to effectiveness

The world is changing ... fast!

The world has not deteriorated. Certainly when the focus is on the West, there is much more prosperity. Just think for a moment how things were 30, 50 or less than 100 years ago. It could also be said that there is much more well-being too, but a statistic similar to Gross National Product (GNP) does not exist for this. In the last 40 years, however, people have come to realise that this prosperity has come at a price. An impoverished south, social exploitation, an uncontrolled exhaustion of the natural environment - these must all be discounted should a GWP (Gross Well-being Product) be calculated. (see also the work of The Commission on the Measurement of Economic Performance and Social Progress established by President Sarkozy in 2008 and the Communication of the European Commission on measuring progress in a changing world in 2009)^{6,7}. It's the sudden disasters and scandals that get into the newspapers and remain in everyone's memory: The explosion of the pesticide factory in Bhopal (1984), the nuclear disaster in Chernobyl (1986), the oil spill of the tanker in Alaska (Exxon Valdez, 1989) and very recently the oil disaster in the Gulf of Mexico (2010). If global development continues at the same rate and especially in 'the same way' we will be able to say with misplaced pride within 100 years that the total destruction of the environment has been achieved. Environmental challenges have a local and a global scale. An impoverished in-house air quality leads to chronic diseases while end-of-life products are shipped to southern hemisphere countries creating foreign waste lands. Add to this an exponential population growth⁸ and the challenges are clear. The figures are perhaps not widely known, but the story is.

Fortunately there is growing awareness. It is not the first time that the bowstring has been drawn for a 'better' world. In 1968 with 'The Limits to Growth' of the Club of Rome, in 1987 with 'Our Common Future' of the Brundtland Commission in which the term sustainable development was coined for the first time, in 1992 with the UN World Summit in Rio where a global sustainability agenda was drawn up. Economic, social and environmental legislation was expanded, enforceable at national and regional levels, permissive at international level. Contributions to sustainable development have come from all sides. International labels such as FSC (sustainable wood), MSC (sustainable fisheries), the EU Ecolabel, and many more were created to guide the consumer in the choice of products. Financial markets established separate stock market indices (Dow Jones Sustainable World Indexes in 1999, FTSE4GOOD in 2001). Sectors (textile, diamond, soya, palm oil, ...) started collaborating with NGOs in order to draw up codes of good conduct. Proactive entrepreneurs and companies joined forces on new platforms (World Business Council on Sustainable Development and CSR Europe, both established in 1995).

6 Stiglitz, J.E.; Sen, A.; Fitoussi, J.-P. (2008). Report by The Commission on the Measurement of Economic Performance and Social Progress

7 Communication from the Commission to the Council and the European Parliament (2009). GDP and beyond measuring progress in a changing world

8 From 3,3 billion in 1965 to an anticipated 7,8 billion in 2025 and 9 billion in 2050

The staggering pace at which the world changes remains in stark contrast to the pace at which the awareness of the consequences hereof changes. We witness an increase in material use, in volume and number. Although the size of electronic equipment (computers, phones, cameras) has decreased, the size of many appliances increased. Coffee machines, toasters, but also cars have become much bigger and heavier. This also has an effect on the space we need to live in and store the appliances⁹. It has taken more than 30-40 years to see attitudes change from initially defensive (waste cost reduction, compliance with legislation) to collaborative (preventive measures, management approach) to a proactive approach (product accountability, life cycle analysis, eco-efficiency). But even with this eco-efficient approach there is no guarantee of success because of the rebound effect. Reducing the emissions of a car by 10, 30 or 50% will not lead to an overall emission reduction if the traffic intensity eventually increases with a similar or higher range. Eco-efficiency does not necessarily change the process or the product. A diesel engine with a carbon filter remains a combustion engine with (much less) emission¹⁰.

According to Verfaillie et al¹¹ eco-efficiency strategies focus on the reduction of environmental impacts made by human activity, without allowing the (socio-) economic value to drop (2000). Eco-efficiency thinking is actually a translation of the traditional efficiency thinking that has long been incorporated into the Western economic thought.

Flanders DC (2006)¹² outlines 3 major phases in the development of the economy: a factor-driven economy, an efficiency-driven economy and an innovation-driven economy.

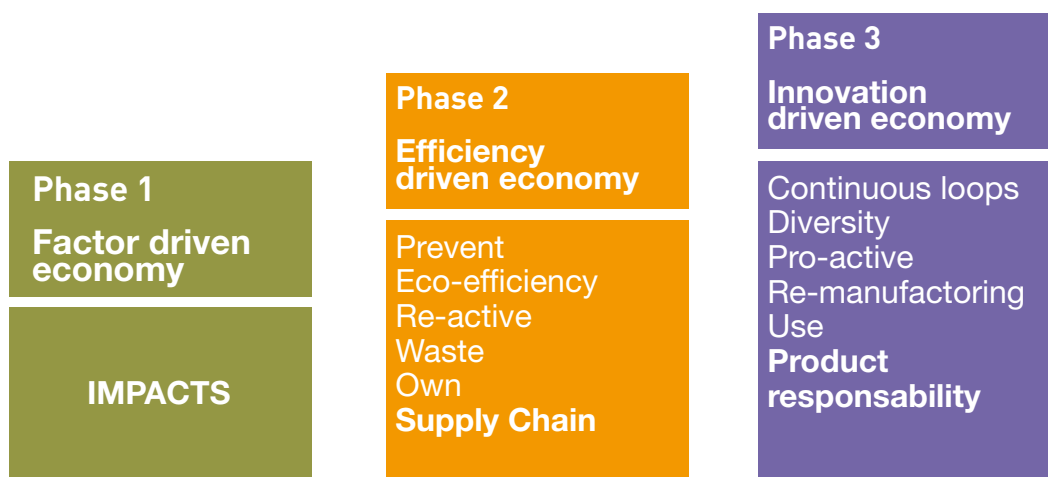


Figure 1: Major phases in the development of the economy, april 2006¹²

A factor-driven economy is an economy in which institutions are built without taking into account impacts on humans and the environment. In the efficiency-driven economy the human capital is adequately trained, involving functioning financial markets and production systems. The big trend in this phase includes involving efficiency in the production base and an extension thereof, even in terms of impacts on humans and the environment. Concepts such as the prevention of waste and emissions, eco-efficiency will be further developed. Everything takes place in a linear thought, in which the chain is extended at a slower pace to a full cycle of the product.

It is this way of thinking that McDonough and Braungart, the inventors of the Cradle to Cradle concept, try to tackle. According to them, eco-efficiency is a reactionary approach that stands in the way of a fundamental redesign of industrial material flows. For example, on a global scale, the amount of energy that is applied in the production of aluminium decreased by 10% over the period of 1991-2000 (UNIDO 2003)¹³. In the same period, however, demand - and hence the volume of production - increased worldwide by 40%, resulting in the increment of the total amount of energy applied for aluminium production (Pirker et al 2002)¹⁴.

Hereby, eco-efficiency techniques would lead to a reduction of the effects, without suggesting a real alternative to the linear "cradle to grave" material flows. In this perspective, the majority of known recyclable materials are reused in lower applications (downcycling) due to not (being able to) separate valuable materials at the end of their useful life span. Gradually these materials are dumped or they are incinerated with or without any single energy recovery.

- 9 Sustenuto, Material Research Center and Wuppertal Institut for Climate, Environment and Energy (2010). Sustainable materials management for Europe. From efficiency to effectiveness
- 10 Le Roy, D. (2009). Building sustainable business models for the future. The Fifth Conference, <http://www.thefifthconference.com/topic/clean/building-new-business-models-future>
- 11 Verfaillie H.A., Bidwell R., (2000). Measuring eco-efficiency a guide to company performance, World Business Council for Sustainable Development
- 12 De Voldere I., Janssens E., Onkelinx J. and Sleuwaegen L. (2006). The Creative Economy: challenges and opportunities for the DC-regions, Flanders District of Creativity, April 2006
- 13 UNIDO (2003). Industry and environment: the need for a new industrial revolution, UNIDO position paper
- 14 Pirker U., Pschernig G., Gwehenberger G., Schnitzer H. (2002). Implementation of zero emissions waste technologies, 8th European Roundtable on Cleaner Production Conference, October 9-11, 2002, Cork, Ireland, http://zeria.autograz.at/pics/zeria_round_table.pdf

In response to the negative effects of this reduction approach (known as “doing more with less”) within eco-efficiency strategies, McDonough and Braungart suggest the concept of **eco-effectiveness**. A **positive agenda** plays a central role in the design and manufacturing of products and services, in which the synergy between economic, ecological and social (business) objectives will be strongly promoted.

“Our goal is a delightfully diverse, safe, healthy and just world, with clean air, water, soil and power – economically, equitably, ecologically and elegantly enjoyed.”

Mc Donough William, 2005¹⁵

15 McDonough W., William McDonough on cradle to cradle design, presentation at TED2005 conference (2005). http://www.ted.com/talks/william_mcdonough_on_cradle_to_cradle_design.html

16 McDonough W., Braungart M., Anastas P., Zimmerman J. (2003). Cradle-to-Cradle Design and the Principles of Green Design – Toward New Perspectives and Practices for Engineering and Design, Environmental Science and Technology, December 2003

Eco-effectiveness provides a broad **conceptual framework** for effectively solving some social - and especially environmental - issues such as the conservation of raw material quality, rather than reducing waste. In highest ambition known as zero waste, and the manufacture of fully healthy products, instead of reducing harmful substances (similarly zero emission). While eco-efficiency strategies promote a smaller consumption (cf. consumption cut back) and the extension of the lifespan of products, eco-effective measures allow for an immoderate consumption and short life spans - provided that the quality of raw materials is guaranteed and that renewable energy feeds the production and consumption. While one of the key elements is providing safe and healthy products which involves a drastic substitution of toxic elements, toxic substances can be applied in transition when no alternatives are presently available. At least if these substances are not exposed to man or environment and remain in a closed material system (McDonough et al 2003)¹⁶. In this way, Cradle to Cradle is the next step in the evolution towards an eco-effectiveness economy. Figure 2 describes the evolution of sustainable materials management approaches showing the shifts from reactionary to proactive approaches and from focus on business-process-product towards a focus on the integrated chain-system and society interaction.

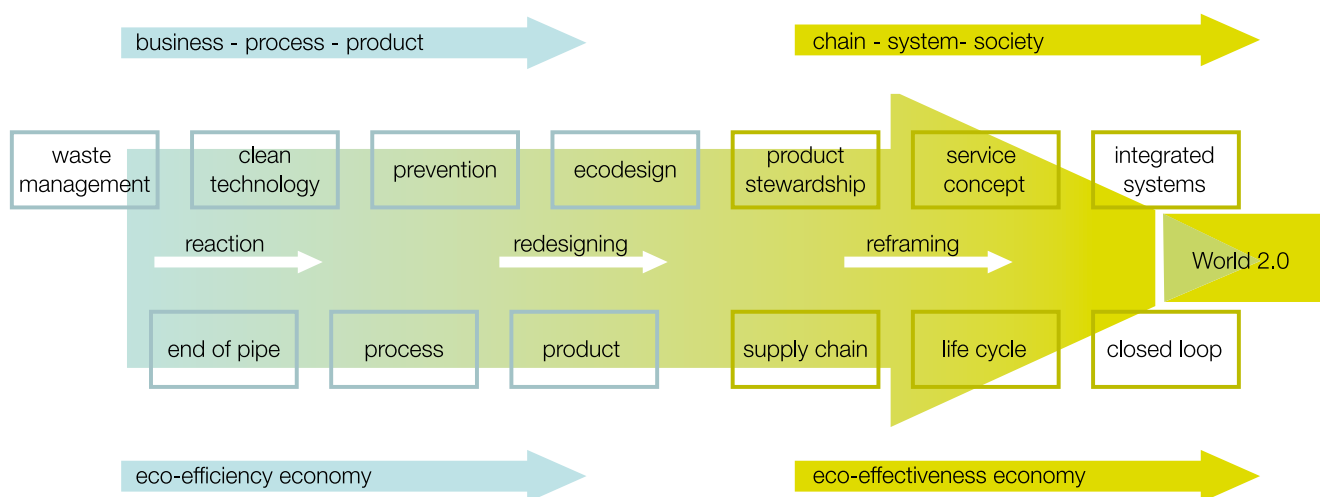


Figure 2: Sustainable materials management approaches: evolution from an efficiency towards an effectiveness approach¹⁷

17 A. Rossy, P.T. Jones, D. Geysen, K. Bienge (2010). Sustainable Materials Management for Europe, from efficiency to effectiveness, background paper for the informal Environmental Council on the 12th and 13th July, 2010

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

19 More on this topic in ‘David J.C. McKay (2007). Sustainable Energy – Without the hot air, UIT, Cambridge, England’

Such high aspirations require among other things a different way of product development/design and intelligent handling of materials after use. In an economy driven by innovation (phase 3) rather than efficiency (phase 2) strategies can evolve through partnerships and cooperation to meet these new societal challenges.

This development is proactive rather than reactive. Moreover, producers assume central responsibility for their product and service. It is clear that the transition from efficiency to effectiveness concerns not just a small step but essentially a rethinking and redevelopment of the economic and social system.

Despite the fact that Braungart and McDonough focus on the shortcomings of applying an eco-efficiency strategy, they recognise the fact that efficiency and effectiveness can be complementary strategies. The concept of efficiency on itself has no value, they state, it can be either good or bad. For example the slimming down of material flows per product or service unit (eco-efficiency) can only be beneficial in the longterm if the goal of closing material flows (eco-effectiveness) has first been achieved. By this meaning efficiency improvements are not necessary anymore from an environmental necessity perspective but are a matter of equity – it is to ensure the fair distribution of goods and services (Braungart et al., 2007)¹⁸.

From a transitions perspective eco-efficiency strategies will still be necessary to bridge the period for which eco-effective solutions are not yet available or 100% feasible. For example it is not yet 100% feasible to rely solely on renewable energy to meet our current energy demands¹⁹.

Most of the eco-effective solutions suggested in the framework of Cradle to Cradle such as the separation between biological and technical cycles, safe products, product service systems and use of renewable energy were already known within the framework of eco-efficiency approaches. However, Cradle to Cradle places these solutions in a vision of where we want to go to instead of what we want to avoid and therefore places it into a positive agenda.

1.3 Cradle to Cradle: a framework for eco-effective solutions

When speaking about Cradle to Cradle, many capture the idea of closing the material cycle, in order that materials are not lost from society but used and reused again. Cradle to Cradle is however broader and consists of a conceptual framework, principles which underpin this framework and a wide set of applications of which a part is certified by means of a certification system.

1.3.1 Concept: Cradle to Cradle Framework

Cradle to Cradle as a framework is a new business model with the ambition to develop products which are safe, healthy and reusable. Since 1987 the “Environmental Protection Encouragement Agency” (EPEA), founded by Prof. Michael Braungart, works step by step on the development of the framework and the principles of Cradle to Cradle Design™²⁰. The definition of materials and products and their optimisation by Cradle to Cradle creates a new dimension of product quality, based on materials that serve as nutrients for either biological or technical systems. The framework is developed in accordance with how nature has managed to evolve to a very diverse set of ecosystems and populations where waste is unknown.

The definition of very high ambitions is basic in developing Cradle to Cradle. It builds vision on where regions and organisations want to be in the future. It sets the beacons and directions where innovation should lead to. It is a shift from eco-efficiency towards eco-effectiveness. It is not about ‘doing more with less’ and reducing waste (cradle to grave) but about ‘doing right from scratch.’ It is logical that these huge improvements are not made overnight. Developing a growth path to these newly set goals is needed and continuous improvement is thus an implicit requirement of engaging towards Cradle to Cradle.

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 stay in cycles. This new model will require a shift from ownership to ‘userhip’ for products that are made of technical nutrients. These products are only used by consumers for the time needed and the product will then return into the re-manufacturing chain. This demands a completely new kind of cooperation between suppliers, producers, customers, consumers and material managers. An intensive cooperation between these parties is needed to come to Cradle to Cradle products. Cradle to Cradle is by consequence a strategy for product and process innovation in which creation of continuous material loops is key. As technological materials are considered to be the means by which services are delivered, cooperation between producers becomes a new challenge as well. This leads to the creation of innovation platforms in and between sectors around material pools.

The Cradle to Cradle concept, however, does not only apply to products but also to urban and regional planning and architecture. Here ‘Doing right from scratch’ means that from the design stage on the various functions of living, working, recreation, transport, nature, food production,... are fully integrated. The use of resources and renewable energy and water treatment is conceived from a life cycle perspective including production, use and recovery. The quality of the built environment has to ensure a safe, healthy and pleasant environment for its users. Making reference to how nature is managed, Cradle to Cradle stimulates to design our buildings as trees and our cities as forests.

The Cradle to Cradle concept is not the only concept or philosophy about how we should rethink our products and processes from a sustainable development point of view. For instance the concept of Industrial ecology introduces the idea of an industrial ecosystem that would function as an analogue to biological ecosystems (Frosch R.A. et al., 1989)²¹. Materials should circulate in continuous loops and the waste of one process becomes the food for another process.

One of the main differentiating elements of Cradle to Cradle in relation to these other concepts is its ambition level. Other strategies are generally embedded in the idea of eco-efficiency and therefore minimizing the harmful impact of human activities. The ambition of Cradle to Cradle is to create completely safe and healthy products and to maximize the positive impact of human activities. Its attractiveness towards business comes from its focus on adding value by enhancing quality. This makes Cradle to Cradle distinct from general interpretations in which sustainability and environmental aspects are rather seen from an efficiency or cost perspective.

²⁰ The term Cradle to Cradle is a registered trademark

²¹ Frosch, R.A.; Gallopoulos, N.E. (1989). “Strategies for Manufacturing”. *Scientific American* 261 (3): 144–152

1.3.2 Cradle to Cradle Principles

Together with the architect William McDonough, Michael Braungart has further developed the framework which resulted in the book *Cradle to Cradle: Remaking the Way We Make Things* (2002). Here, they describe how new products, but also buildings, areas, etc ... should be designed in order to meet eco-effective objectives (McDonough et al 2002)²².

Three principles are essential in developing Cradle to Cradle:

- **“waste equals food”**: Everything is a nutrient for something else. Biological and technological “nutrients” are reused as nutrients for natural and/or human production processes
- **“use of current solar income”**: The use of energy sources that are renewable in the timeframe they are used.
- **“celebrate diversity”**: promoting and combining biological, cultural and conceptual diversity.

These principles are key to any Cradle to Cradle development and are supplemented with other principles based on local conditions and interests. In this way, principles were further developed for the World Expo in Hannover (2000), or for the regional development of Almere (2008) or Limburg (2008) in the Netherlands.

Waste equals food

The main trademark of Cradle to Cradle is undoubtedly the “waste = food” concept. Cradle to Cradle is based on the idea that after the use of products and services, the embedded materials, water and energy cannot be wasted. Cradle to Cradle would however make optimal use of these resources by pertinently creating continuous material loops. In short, this is understood as closing the material cycle. In practice, much as in nature, materials may but do not need to come back to the original producer. Essential is that the material is reused, be it by the same producer, by other actors in the same sector or in other sectors.

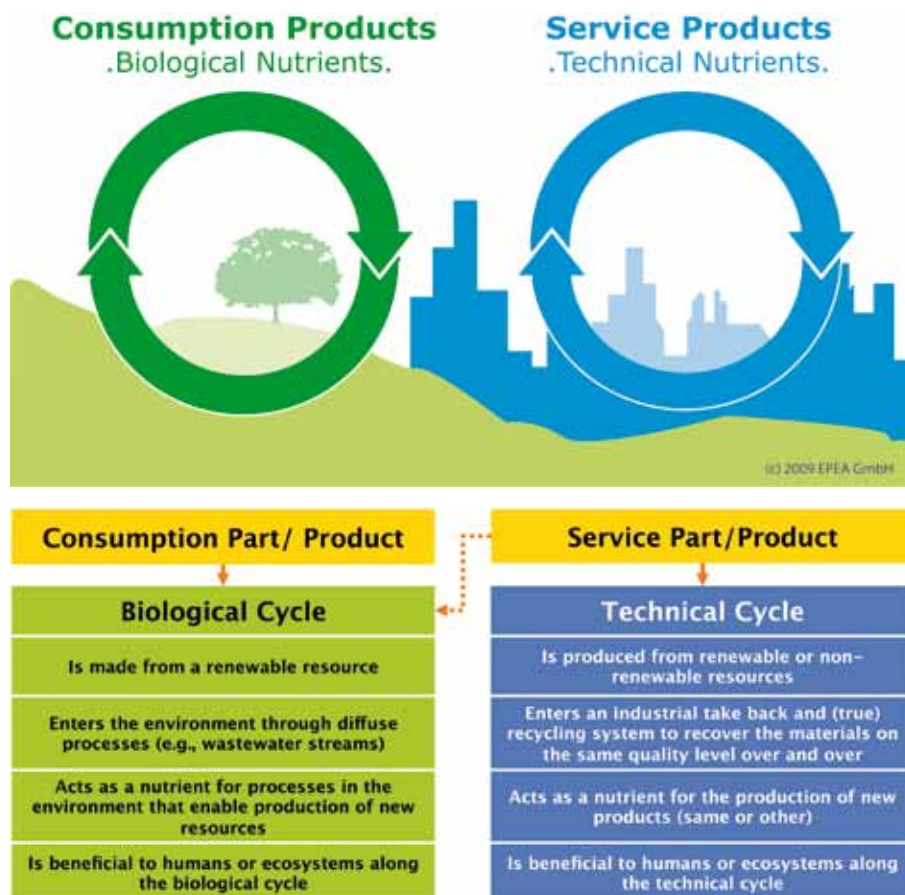


Figure 3: representation of the biological and technological metabolism in function of the use type of the product (EPEA)

²² McDonough W., Braungart M. (2002). *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press, New York, USA, 196p

Inspired by the functioning of living organisms, Cradle to Cradle defines a framework in order to design product systems and industrial processes so that the used materials change into **nutrients**, after their

use, for new natural or industrial production processes. This requires that the material considered - from the design stage - is housed in one of two different types of metabolism, namely technological or biological **metabolism**.

Materials that flow through the biological metabolism are referred to as **biological** nutrients. These involve biodegradable materials, which are not harmful to living systems after human use, and can be safely returned to nature for biological processes. Biological nutrients usually have a natural origin, but can also include synthetic materials such as biopolymers that are safe for human and natural systems. According to McDonough and Braungart biological nutrients are ideal for **consumption products**, i.e. products that are gradually consumed through their period of use, such as textiles, brake discs, pads and the like. A **technical nutrient**, in the Cradle to Cradle context, is defined as a material - often a polymer or mineral - that has the potential to be securely (re) used in a continuous industrial cycle. Within this technological metabolism, it is important that the quality of technical nutrients are ever maintained or upgraded through the multiple cycles of production, recovery and reuse. The negative effects of down cycling are thus avoided! McDonough and Braungart argue that technical nutrients are suitable for use as **service products**, which are durable products that emphasize a service to the users. The godfathers of Cradle to Cradle propose the disengagement of the ownership and the use of a service product: the product remains (to some extent) the ownership of the manufacturer with the aim of multiple recycling of nutrients in technology. Customers can rely on a service without the physical responsibility.

Cradle to Cradle products have to be successfully designed as either a Technical or Biological Nutrient or both if materials are easily separable. Hence, the appropriate materials and chemical input need to be intentionally selected to support the metabolism for which the product was designed. In cases where the current technology allows only for a product that contains both biological and technical nutrients at the same time, it is essential that they can be separated easily after use of the product.

In addition to the design of Cradle to Cradle products, the chain management of nutrients must also be guaranteed. **Integrated chain management** provides collaboration between various economic actors for bundling material resources, vocational knowledge and purchase power in order to recover, transform and sell technical nutrients.



Figure 4: Example of partners of integrated chain management (EPEA)

Use of current solar income

The Industrial Revolution brought with it new technologies and the new opportunities related to these technologies brought prosperity, as well as well-being for an increasing share of a growing population.

These technologies, however, linked Western society inextricably with fossil fuels, creating the illusion that humanity was no longer dependent on nature. Post-modern buildings, factories and even entire cities still form a barrier to nature and its local energy sources. Moreover, they have become more dependent on international supplies of a dwindling inventory of fossil fuels and nuclear fuels. Throughout the centuries, the knowledge and skills on the extraction and manipulation of local energy flows have therefore substantially been reduced.

Living organisms thrive thanks to the energy of the sun. Plants produce food through solar energy, a continuous source of energy for our planet. As solar energy can be considered to be an eternal over-abundant energy source. McDonough and Braungart promote the use of this renewable energy source

for heating, electricity and day lighting within buildings and for manufacturing processes within the industry. In addition to the direct use of solar energy, wind, biomass, hydro, tidal, wave and geothermal (partially) energy are also positive effects of solar energy. The use of renewable energy as such is an accepted broadening of the second Cradle to Cradle principle.

Celebrate diversity

After millions of years, the earth has evolved into a place where thousands of life forms coexist. The design pattern of nature leads to exuberant diversity, in which biological systems are constantly evolving. However, some of human kind's actions destroy this (bio-) diversity and replace them with monotony. For example, large-scale deforestation globally leads to deserts, intensive agriculture to arid soils, asphalt and concrete layer leads to inert landscape where only the strongest species survive such as cockroaches and rats.

Healthy ecosystems are complex networks of living organisms. Each of them is involved in maintaining the system as a whole and each member of the ecosystem works creatively and effectively together growing the system. Diversity in nature builds resilience. Such diversity should serve as a model for human design, which would lead to more resilient organisations and even economies. So not only biodiversity should be encouraged, but diversity in its different forms. Diversity in nature is taking into account local conditions. This principle essentially leads to innovation based on adaptation to local conditions. For example, an office or warehouse can be designed so that it can be used by multiple generations. Instead of building it for one specific application - which must later be demolished or impractically renovated - it can be adapted for multiple uses and take into account the different needs for each user.

1.3.3 Cradle to Cradle applications

Cradle to Cradle applications are products, processes, buildings, industry business models, spatial areas, services... that are inspired by the Cradle to Cradle concept and its three basic principles. The latter also being principles that inspired the creation of a wider set of Cradle to Cradle principles used in regional contexts such as the Limburg principles, Almere Principles or Hannover principles.

At the moment a validation tool by means of a certification methodology only exists for products to evaluate how the application is in line with the concept and principles of Cradle to Cradle. In 2005 McDonough Braungart Design Chemistry (MBDC) has started to issue Cradle to Cradle certificates on demand of industry for products developed according to the Cradle to Cradle™ Design principles (www.mbdc.com, 2010)²³. Meanwhile, more than 300 products from different sectors (building, health care, textile, ...) have been certified in 2010, a large part being of American origin. The list of certified products can be found on www.c2ccertified.com.

The certificate is issued on four levels: basic, silver, gold and platinum with an expected continuous improvement for increasing from one level to the next. The process of certification uses 5 Cradle to Cradle modules:

1. Material evaluation – for safe and healthy ingredients and materials
2. Reusability of materials
3. Use of 'current solar income'
4. Water use
5. Social responsibility

Certification creates an operational set of guidelines and criteria for the use of environmentally safe and healthy materials, the design for material reuse such as recycling and composting, the support of the production through a renewable energy supply and water use and applied CSR (Corporate Social Responsibility) strategies.

In recent years this certificate has been a subject of discussion because of its private and non-transparent character. Braungart and McDonough intend to open this certification system and involve independent third parties. The latest evolution in this opening process was the founding of the The Green Products Innovation Institute, Inc. (GPPI) (2010). The GPPI is a non-profit organization based in California that, among other Cradle to Cradle related activities, is entitled to issue the products certificate.

For the other applications no such validation or certification system exists yet. The C2CNetwork project's ambition is to help understand what the implementation of Cradle to Cradle for some of these applications (governance, industry, buildings and area spatial development) could look like and to disseminate and learn from good practices. It is not the objective to use a criteria-based evaluation tool that states which applications are Cradle to Cradle and which are not.

Final note: This Cradle to Cradle Framework is complemented with perspective studies on four target areas.

²³ McDonough Braungart Design Chemistry (2010). <http://www.mbdc.com>, consulted in June 2010

2 Cradle to Cradle and the four target areas of the C2C Network

In this chapter the Cradle to Cradle concept is placed in relationship to the four target areas of the C2C Network: industry, building design, spatial (area) development and governance. Also an inventory is made of the target area specific principles that are inspired by the C2C concept and its general principles.

2.1 Cradle to Cradle and Industry

Three different perspectives can be used to understand the implications of Cradle to Cradle for industry. The most common perspective is that of the product itself that is produced. Producing a product however, involves a series of suppliers and partners. On a second level, Cradle to Cradle will have major implications on the wider level of the supply chain. Thirdly, it is foremost and evidently a totally new business concept. These different perspectives or levels are closely interlinked.

2.1.1 Cradle to Cradle on the product level

Developing products within the philosophy of Cradle to Cradle implies the use of the 3 basic Cradle to Cradle principles in the design and production stage, that are: waste equals food, use current solar income and celebrate diversity. Applying these principles will have different meanings according to the type of the product and the region where it is produced. However, all Cradle to Cradle products match the ambition for creating healthy and safe products for man and the environment. These ambitions can be validated by means of a certification system. At this moment, products are the only group that can be Cradle to Cradle certified. Five modules are key when developing Cradle to Cradle products according to this certification system²⁴:

1. Material identification

Every single ingredient within a product needs to be identified and checked for its quality with respect to human and environmental health. With this knowledge it can be assured that no materials present in the product are damaging to human health or the environment. Rather than eliminating substances, it is the aim to come to a list of positive ingredients.

2. Material reutilization

How can the ingredients or the product made fit for reuse after end-of-first-use. In such a way, material cycles are made continuous.

3. Sun as energy

How to use sun as prime energy source, or in a more broad perspective, how can renewable energy be used during production.

4. Water

A responsible attitude towards water usage needs to be shown. How to minimise water use and how to close the water cycles.

5. Social responsibility

A commitment to social principles, i.e. matching social conditions on the work floor and in the supply chain.

What are the implications of developing and producing products according to Cradle to Cradle?

When working according to Cradle to Cradle one needs to make a choice to develop a product either belonging to the biological or to the technical material cycle. This may seem obvious but isn't as a drinking cup, for example can be made of PLA (bio-plastic) as well as of synthetic plastic. In addition to this, if it is technically unfeasible to develop a product according to one single material cycle, and it is actually a mixture of both technical as well as biological ingredients, the design of the product needs to allow for easy separation of these ingredients after use of the product.

Real Cradle to Cradle development requires a wide set of criteria to be taken into consideration. These are human health criteria and environmental health criteria. There are five priority human health criteria, that show some known or suspected human and/or animal effect.

- Carcinogenicity
- Disruption of Endocrine System
- Mutagenicity
- Reproductive Toxicity
- Teratogenicity

²⁴ The C2C-certificates are issued by McDonough Braungart Design Chemistry (MBDC). More information on the certification system can be found at <http://mbdc.com/default.aspx>.

There are additional human health criteria such as acute toxicity, chronic toxicity, irritation of skin/mucous membranes, sensitization and other. Environmental health criteria are:

- Aquatic toxicity
 - Fish toxicity
 - Daphnia toxicity (water flies)
 - Algae toxicity
- Bioaccumulation
- Climatic Relevance/Ozone Depletion Potential
- Persistence/Biodegradation
- Toxic Heavy Metal Content
- Other

In addition to the ingredient list of the product also the business processes in the production of the product need to be scrutinized. Sometimes, a problematic substance in the product does not come from its ingredients but from something in or around the machinery used to produce it.

2.1.2 Cradle to Cradle in the supply chain

One prerequisite of developing products according to Cradle to Cradle is that the knowledge of the ingredients of the materials needs to be made complete. It leads rather soon to the realisation that not all required knowledge is present in one company. Therefore, a close collaboration between the suppliers has to be created as they deliver the ingredients or half-made products. The knowledge of the composition of materials is to be found in the supply chain, sometimes not even with the direct supplier but somewhere further along the chain.

Cradle to Cradle does not only have implications for suppliers. It also affects how the value chain is organised towards consumers, even after use of the product. It implies that materials can be returned after use which leads to the 'organisation of reverse logistics'. It needs to be noted that reverse logistics does not necessarily imply a return of the material to the original producer. Materials within a continuous loop can be collected by other partners in the chain and be returned to any producer in the production cycle.

2.1.3 Cradle to Cradle on the level of business

Creating products where every ingredient is known for its effect on human and environmental health and is selected for a positive contribution, creating products which need strong cooperation with suppliers, creating products where materials are ought to come back after use, implies that these ambitions need to be taken into consideration already at the outset during the design of the product. When designing from this perspective, one arrives almost automatically at innovation. As such, it is not surprising that Cradle to Cradle is foremost called an innovative business concept, with consequences on all levels including how products are sold or how strategic decisions are made within a company. On the sales level, there is a change towards leasing products instead of selling them (renting the use instead of ownership) in order to guarantee the return of end-of-use products. On the strategic level, companies such as Desso choose to implement a full Cradle to Cradle strategy²⁵ for the whole business in which it is operating. It involves the decision that any of the products in the portfolio will be developed according to Cradle to Cradle, that the whole energy supply of the company is redirected to renewable energy, that the cooperation with the suppliers is strengthened to lead them too towards a Cradle to Cradle approach, that finally the whole business concept is innovated to meet demands of our society in the future.

2.1.4 Conclusions

In conclusion, the implications of Cradle to Cradle for Industry can be summarised as ranging from product specific requirements in the design and production stage over far reaching supply chain challenges and opportunities to leading to a completely new innovative business concept.

2.2 Cradle to Cradle and Building design

2.2.1 Concept

The Cradle-to-Cradle Design concept was developed from the practice of integrating diverse elements such as products, processes, architectural design and economic development. For example one of the first practical C2C building approaches in the early 1990s and continuing until today is based on biomass facilities in rural communities for recycling nutrients in effluent, and involves creating gardens in neighbourhoods, so area design and economic development have been a central part of the approach from the start. Although it is best known for setting up continuous material loops, either technical or biological, it is also a philosophy represented by a set of measurable principles that are implemented using defined application tools that use innovative processes.

²⁵ Cradle to Cradle brochure downloadable at http://www.desso.com/Desso/home/EN/EN-Cradle_to_Cradle/EN-Cradle_to_Cradle-Cradle_to_Cradle.html

The building and construction industry has its specific place in the Cradle to Cradle story. Some early C2C certified products such as office chairs result from experience with designs of the factories where they are built. Not only do buildings consist of a multitude of products, and therefore technical and biological nutrients, they also have an important impact on water and energy cycles, air quality (indoor and outdoor) and the nearby fauna and flora.

More specific the current building industry results in a net negative environmental impact on following aspects:

- The building and construction industry is responsible for 40% of fossil fuel consumption, one third of greenhouse gas emissions and 40% of raw material consumption worldwide.
- Contribution to waste production (the building and construction sector is estimated to produce up to 40% of our solid waste.²⁶).
- The European Community's air pollutant Emission Inventory Report (EEA, 2009)²⁷ reveals that in 2007 the housing sector was the biggest source of pollution – due to PM2.5, NMVOC, CO, SOx and NOx emissions from household energy use - before road transport and power plants.
- In addition to this, pollutant concentrations within buildings (mainly stemming from finishes and paints) can be over twice as high – in some cases as much as 100 times as high – as concentrations outside (UNEP 2003)²⁸.
- The loss of fertile land due to infrastructural development (buildings, roads, infrastructure,...).

Buildings typically have a large environmental footprint which is negative because of the above described arguments.

From an eco-efficiency approach green buildings are considered to be buildings that are attempting to reduce these negative impacts as much as possible. From an eco-effective or Cradle to Cradle approach it is not the size of the footprint that matters but the nature of this footprint. Instead of a negative footprint we should maximize positive impacts to result in a final positive footprint.

McDonough and Braungart suggest to look how nature does and introduce the concept of “houses like trees” and “cities like forests”. Buildings should be, just like trees, harvesting energy from the sun, removing dust and CO2 from the air, etc... In their book McDonough and Braungart generally refer to the cherry tree metaphor:

“As it [the cherry tree] grows, it seeks its own regenerative abundance. But this process is not single-purpose. In fact, the tree’s growth sets in motion a number of positive effects. It provides food for animals, insects and micro organisms. It enriches the ecosystem, sequestering carbon, producing oxygen, cleaning air and water, and creating and stabilizing soil. Among its roots and branches and on its leaves, it harbors a diverse array of flora and fauna, all of which depend on it and on one another for the functions and flows that support life. And when the tree dies, it returns to the soil, releasing, as it decomposes, minerals that will fuel healthy new growth in the same place.”

A main difference between the building and construction sector with other industries is the long lifetime of buildings and constructions. Structures built in developed countries have an average lifetime of 80 years (UNEP, 2003). As a consequence of this most parts of it have to be replaced or repaired during its use phase. These structures are furthermore often particularly rigid and difficult to adapt to changing circumstances and needs (e.g. adaptation of existing building patrimonium to reduce energy consumption and greenhouse gas emissions).

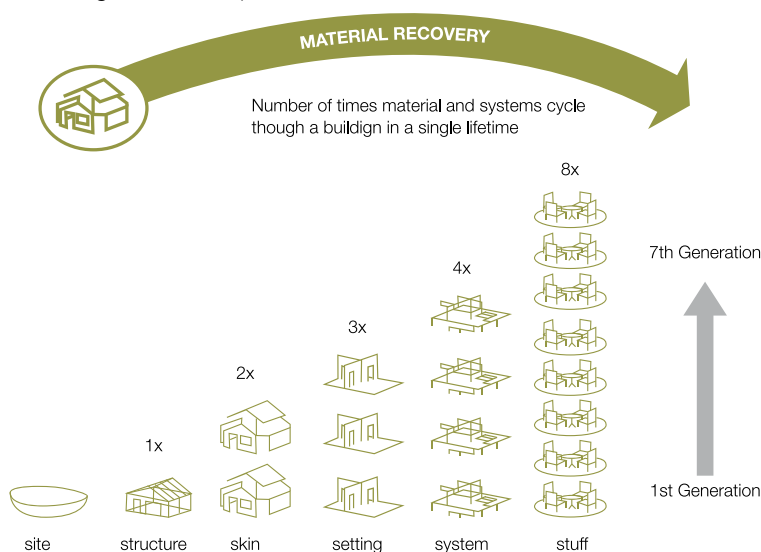


Figure 5: The flow of materials through buildings over their use period. (Source of drawing is William McDonough & Partners architects, but borrows from a description in an earlier book by Stewart Brand: How buildings learn : what happens after they're built. Viking, New York, 1994)

26 UNEP (2007). Buildings and Climate Change: Status, Challenges and Opportunities. Lead authors P. Huovila, M. Ala-Juusela, L. Melchert, and S. Pouffary, UNEP Sustainable Buildings and Climate Initiative, Paris

27 EEA (2009). European Community emission inventory report 1990–2007 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP), EEA, Copenhagen, 2009

28 UNEP (2003). Sustainable building and construction: facts and figures, Industry and Environment, vol.26 N°.2-3 - Sustainable and construction April - September 2003, pp. 5-8

Looking from a C2C point of view you can imagine that a C2C inspired house will be a large source of nutrients instead of a waiting room for materials to become waste. Depending on their function these nutrients will become available sooner or later.

2.2.2 Principles

In the book 'Cradle to Cradle: Remaking the way we make things' McDonough and Braungart describe how the three general C2C design principles (waste equals food, use of current solar income and celebrate diversity) can be applied at the level of products and even of buildings. These approaches have been applied individually in various buildings since the 1990s²⁹, and have been elaborated in various documents contributed to by the founders. It all started with the Hannover principles which in 1992 were worked out by William McDonough and his partners for the Hannover World's fair of 2000. Based on this work new variants have been derived.

Next to the Limburg Principles – which are the reference principles for the C2CNetwork, these include, the manifest "Cradle to Cradle in architecture" – an initiative of five architectural firms – and the Cradle to Cradle building charter – signed by Braungart and McDonough. All these principles have in common that they help building designers in guiding them to develop eco-effective buildings and will be discussed below.

At press time of this document a new publication called 'Cradle to Cradle Criteria for the built environment' will become available. This document is written by Douglas Mulhall and Michael Braungart and considered to be the authorised version of all recent publications that attempt to interpret Cradle to Cradle in relation to the built environment.

The Limburg principles and building design

Since 2008 the Province of Limburg has expressed the ambition that buildings in the Province should be designed with respect to the needs and health of the people who live and work in it and with respect to the surroundings and the environment. An important starting point of Cradle to Cradle is that a building is linked to its surroundings and offers pleasant living and working conditions. The Province is convinced that this will increase the economic value of the building stock in the future. Providing both a living and working function.

This ambition is stated in the 'Policy Framework on Sustainable Development 2008-2011' which is inspired by the Cradle to Cradle concept. In this Policy Framework the Province chooses to combine the Cradle to Cradle way of thinking (doing the right things) with the efficient use of resources and energy. The latter is added because the ultimate form of Cradle to Cradle requires that transitions at different areas such as energy production, resources, building techniques,. In collaboration with McDonough and Braungart, various parties, including the Province of Limburg, developed Cradle to Cradle principles in mid-2007 for the Floriade 2012 World Horticultural Expo. These principles turned out to be so widely applicable, that the Province of Limburg is using them as a framework for all Cradle to Cradle developments in Limburg.

The framework implies 6 principles that are Cradle to Cradle based but also take into account aspects that relate to the regional scale of their scope. These are called the **Limburg Principles**:

- We are native to our place
- Our waste is our food (is equal to general C2C-principle "waste equals food")
- Sun is our income (is equal to general C2C-principle "use of current solar income")
- Our air, soil and water are healthy
- We design enjoyment for all generation
- Provide enjoyable mobility for all

The Province of Limburg therefore promotes the approach where the potential added value of using natural and healthy materials, sustainable energy sources and the integration into surrounding eco-systems for the building's development are looked at already at the design phase. It facilitates this approach by for instance organising workshops with stakeholders and C2C-experts.

Cradle to Cradle in architecture

In 2009 an international group of architects published the manifesto "C2C in Architecture" (<http://c2c-architecture.org>). This group was composed of Art & Build Architect (Belgium, France, and Luxemburg), RAU architects (The Netherlands), A00 architects (China, Canada), Zahn Architektur (Germany) and OPAi, the OnePlanetArchitecture institute. With this manifesto this group tried to identify the characteristics that define a C2C built environment. It has been the ambition to separate the totality of architectural considerations into distinct and measurable parts.

²⁹ examples can be found at: <http://www.mcdonoughpartners.com>

The C2C-principles are translated into milestones in the areas of ecology (materials, energy and site), economy and equity/society:

Table1: Milestones

Ecology

Materials

- Eliminate waste: only use materials that will become resources for further biological or technical production loop.
- Only use materials whose impacts are measurably beneficial for human health and environment.
- Design buildings free of radioactive, hazardous and toxic off-gassing materials.
- If hazardous materials are necessary, they are not released in the environment and are completely recoverable in technical pathways.

Energy

- Use only energy from present solar income.

Site

- Create topsoil, clean water and clean air and improve biodiversity as a result of human intervention.
-

Economy

- Design buildings that can be mined for materials in the future. If waste is a resource, materials become the new currency.
 - Promote building products leasing and by doing so make producers responsible for them.
-

Equity | Society

- Create a diverse environment of equal opportunity. Create a healthy, safe and inspiring environment.
-

Cradle to Cradle building charter

Following this manifesto in October 2009 a group of C2C practitioners, coordinated by William McDonough and Michael Braungart, have written the Cradle to Cradle building charter. This charter is also available at the website where the manifesto has been published: <http://c2carchitecture.org>. The charter describes the guiding principles for buildings to be Cradle to Cradle as well innovation concepts that a building design team should actively use and specific intentions or goals for building and sites that should be strived for.

Guiding principles

Cradle to Cradle buildings will:

- Incorporate materials that are technical and biological nutrients which can be safely reusable nutrients.
- Measurably use renewable energy. Examples of renewable energy include solar thermal, ground based and air-based heat exchange, wind, biomass, hydro and, photo-voltaic).
- Actively and measurably support biodiversity according to well-established biological tools for measuring species diversity.
- Anticipate evolution and change, incorporating strategies and approaches that enhance the ability for the building to adapt to a variety of uses over time.

Innovation concept to be actively used are:

- Think beneficially instead of how to be less bad.
- Think big healthy footprint instead of a less bad minimized one.
- Think eco-effectiveness instead of just eco-efficiency.
- Improve quality of building systems, products and processes in measurable steps.
- Partner with customers & suppliers to establish material partnership communities.
- Think “materials opportunity” instead of “energy problem”.
- Design building systems and processes according to their intended use for building occupants and for biological and technical metabolisms.
- Improve indoor air quality so it contributes healthy air to the building occupants, and to the outdoors
- Design buildings areas and processes that are energy positive.

Cradle to Cradle Intentions and Goals for buildings and sites

- Use building materials whose contents are measurably defined in Cradle to Cradle terms of chemical contents, effects on air, soil and water, and effects on human health from manufacturing through use and recovery in biological or technical pathways.
- Integrate topsoil production and carbon re-use into structures and landscapes to produce more biomass and soil than before development. Topsoil is defined here as the upper layer of soil, used for growing biomass. Topsoil is a main repository for carbon and for CO₂ capture and storage. (Example: green roofs).

- Integrate renewable energy into buildings and area plans so they produce more energy than they use.
- Integrate healthy air production into buildings and area plans so they produce more healthy air than they use.
- Integrate measurable recycling of water and biological nutrients in buildings, landscaping, and spatial plans.
- Support measurable increases in species diversity (Flora and Fauna) according to accepted biological methods, so the area contains more diversity than before development of the building or site.
- Social Fairness: define, quantify and practice social responsibility criteria. Adopt and make publicly available statements regarding social performance goals and demonstrate it will be obtaining a third party social accreditation.

Cradle to Cradle Criteria for the built environment

C2C-experts of the C2C-chair at the Erasmus University (Rotterdam, the Netherlands) have some minor comments to some of the above described initiatives. Regarding the manifesto for instance they criticize the first milestone: 'Eliminate waste...' as it preserves the traditional concept of waste as the opposite of a resource while Cradle to Cradle is about redefining waste, namely "waste is food", which is shorthand for "everything is a resource for something else". The first milestone would be better formulated as 'Redefine waste...'. Also the second and the fourth milestone should be combined since they affect the same issue.

Because of this proliferation of these initiatives and the risk of misinterpretations, the Cradle to Cradle chair of the Erasmus University has taken the initiative to develop Cradle to Cradle criteria for the built environment³⁰.

The criteria describe the guiding principles, innovation concepts and intentions and goals further in detail. It also comes up with following definition for a Cradle to Cradle building.

A Cradle to Cradle building contains defined elements that add value and celebrate innovation and enjoyment by: measurably enhancing the quality of materials, biodiversity, air, and water; using current solar income; being deconstructable and recyclable and performing diverse practical and life-enhancing functions for its stakeholders.

The purpose of this publication is to provide planners with guiding criteria for developing a building with measurable features.

2.2.3 Cradle to Cradle in relation to other concepts introducing sustainable development in building design

Since the 1990s, environmental assessment methods and accreditation systems have been developed as BREEAM (UK), LEED (US), HQE (FR) and DGNB (DE).³¹ These accreditation systems are comprised of sets of criteria, some mandatory, some voluntary, grouped in categories such as energy use, water, materials, waste, transport, land use and ecology. According to the overall score, the building under assessment is accredited a label/certificate from bronze to platinum, or, from pass to outstanding. Buildings can relatively easily obtain a basic score in this accreditation scheme, typically attempting to have a large market impact, moving the market towards more sustainable building practices.

According to C2C experts, the main difference between Cradle to Cradle and approaches such as BREEAM and LEED is that the first step for designers is to state their intentions as goals, then achieve those over time by using roadmaps. Stating intentions and establishing roadmaps to achieve goals is absent from most other methods (Mulhall, 2010)³².

It is important, however, to mention that these schemes are adapted over time, continuously evolving and improving along with uptake of sustainability measures in building practices. Green Building Councils, managing these accreditation schemes have expressed their interest to collaborate with Cradle to Cradle advocates to incorporate C2C into their accreditation systems, as is the case for the Dutch Green Building Council. A cooperation between the US GBC (LEED) and Braungart and McDonough on C2C building materials already took place.

On the other hand, several initiatives have sprung up, attempting, as C2C does, to raise the bar and conceive the most advanced measure of sustainability in the built environment possible today. We refer to two schemes: the Living Building Challenge and the One Planet Communities initiative.

The Living Building Challenge was originally conceived by Jason F. McLennan and has been further developed and managed by the Cascadia Region Green Building Council and International Living Building Institute. The challenge was launched in 2006. In contrast to the above mentioned accreditation scheme, these schemes for renovation, landscape or infrastructure, buildings or neighborhoods, all imperatives are mandatory and certification is based on actual, rather than modeled or anticipated performance. The 20 imperatives of the Living Building Challenge are:

30 Mulhall, D., Braungart, M. (2010). Cradle to Cradle@Criteria for the built environment. Duurzaam Gebouwd/ CEO Media BV.
 31 **BREEAM**: BRE Environmental Assessment Method, **LEED**: Leadership in Energy and Environmental Design, **HQE**: Haute Qualité Environnementale (High Quality Environmental standard), **DGNB**: Deutsche Gesellschaft für Nachhaltiges Bauen e.V. (German Sustainable Building Council)
 32 Mulhall D. (2010). e-mail correspondence, 20/08/2010

- Projects may only be built on greyfields or brownfields – previously developed sites.
- All projects must integrate opportunities for agriculture.
- For each hectare of development, an equal amount of land must be set aside as part of a habitat exchange.
- Each new project should contribute towards the creation of walkable, pedestrian-oriented communities
- One hundred percent of occupants' water use must come from captured precipitation or closed loop water systems.
- One hundred percent of storm water and building water discharge must be managed on-site or on adjacent sites.
- One hundred percent of the project's energy must be supplied by on-site renewable energy on a net annual basis.
- Every occupiable space must have operable windows that provide access to fresh air and daylight.
- Projects must meet certain criteria to ensure good indoor air quality.
- The project must be designed to include elements that nurture the innate human attraction to natural systems and processes.
- The project cannot contain any of the materials or chemicals on the Living Building Challenge Red List.
- The project must account for the total footprint of embodied carbon (tCO₂e) from its construction and projected replacement parts through a one-time carbon offset tied to the project boundary.
- The project must advocate for the creation and adoption of third-party certified standards for sustainable resource extraction and fair labor practices.
- Source locations for materials and services must adhere to certain restrictions to limit transportation distances to the building site.
- All project teams must strive to reduce or eliminate the production of waste during design, construction, operation, and end of life in order to conserve natural resources.
- The project must be designed to create human-scaled rather than automobile-scaled places, so that the experience brings out the best in humanity and promotes culture and interaction.
- All primary transportation, roads and non-building infrastructure that are considered externally focused must be equally accessible to all members of the public regardless of background, age and socioeconomic class.
- The project may not block access to, nor diminish the quality of, fresh air, sunlight and natural waterways for any member of society or adjacent developments.
- The project must contain design features intended solely for human delight and the celebration of culture, spirit and place appropriate to its function.
- Educational materials about the performance and operation of the project must be provided to the public to share successful solutions and to motivate others to make a change.

A second advanced measurement scheme of sustainability in the built environment is the One Planet Living initiative by WWF, and the related One Planet Communities initiative. It attempts to limit the per capita ecological footprint of building occupants/residents to the "Earthshare", i.e. the available worldwide per capita biocapacity. The 10 One Planet principles are:

- Zero carbon: making buildings more energy efficient and delivering all energy with renewable technologies.
- Zero waste: reducing waste, reusing where possible, and ultimately sending zero waste to landfill.
- Sustainable transport: encouraging low carbon modes of transport to reduce emissions, reducing the need to travel.
- Sustainable materials: using sustainable healthy products, with low embodied energy, sourced locally, made from renewable or waste resources.
- Local and sustainable food: choosing low impact, local, seasonal and organic diets and reducing food waste.
- Sustainable water: using water more efficiently in buildings and in the products we buy; tackling local flooding and water course pollution.
- Land use and wildlife: protecting and restoring biodiversity and natural habitats through appropriate land use and integration into the built environment.
- Culture and heritage: reviving local identity and wisdom; supporting and participating in the arts.
- Equity and local economy: creating bioregional economies that support fair employment, inclusive communities and international fair trade.
- Health and happiness: encouraging active, sociable, meaningful lives to promote good health and well being.

It is clear that a certain convergence between principles included in these advanced sustainable buildings scheme and Cradle to Cradle criteria for building design can be noticed. However, the idea to regard upon waste as a resource is not explicated in either of these two cases. On the other hand, the Living Building Challenge and the One Planet Principles contain elements that can certainly enrich the current Cradle to Cradle principles for building design. These highly challenging schemes demonstrate an integral approach on sustainability, reaching from land use, material and food consumption, waste generation, energy dependency and production, mobility, agricultural production, human health and state of ecosystems. Both the Living Building Challenge and the One Planet Communities initiative manage to translate this integral

approach into clear quantitative (e.g. first/second One Planet principle: “Zero carbon”, “Zero Waste”) and/or qualitative objectives (e.g. first imperative of the Living Building Challenge: “Projects may only be built on greyfields or brownfields – previously developed sites”). Building developments complying with these schemes are therefore certainly milestones as test cases on the path towards sustainable building design.

2.2.4 Conclusions

Next to the Limburg Principles also other initiatives have been taken to interpret Cradle to Cradle in relation to building design. All have in common that Cradle to Cradle in relation to building design is not (only) about using the right materials but about creating added value to the building, its surrounding and the people who live or work in it.

2.3 Cradle to Cradle and Area Spatial Development

2.3.1 Concept

The definition of very high ambitions is basic in developing Cradle to Cradle. It builds vision on where regions and organisations want to be in the future. It sets the beacons and directions where innovation should lead to. It is a shift from eco-efficiency towards eco-effectiveness. It is not about ‘doing more with less’ and reducing waste (cradle to grave) but about ‘doing right from scratch.’

When looking at spatial area development, ‘Doing right from scratch’ means that from the design stage on the various functions, of living, working recreation, transport, nature, food production,... are fully integrated. The use of resources and renewable energy and water treatment are conceived from an integrated perspective including production, use and recovery. The quality of the built environment has to ensure a safe, healthy and pleasant environment for its users. Making reference to how nature is managed, Cradle to Cradle stimulates to design our buildings as trees and our cities as forests. This also indicates that there is a certain overlap between how Cradle to Cradle relates towards the target areas spatial area development and building design.

2.3.2 Principles

In the book ‘Cradle to Cradle: Remaking the way we make things’ McDonough and Braungart describe how the three general C2C design principles (waste equals food, use of current solar income and celebrate diversity) can be applied at the level of products and even buildings. The implementation of Cradle to Cradle at the scale of spatial area development is new and firstly introduced in The Netherlands in the Greenport Venlo case³³.

This example but also the nationwide enthusiasm for the Cradle to Cradle concept and its possibilities to use it as a leading principle in the sustainable development of The Netherlands inspired several stakeholders to develop new Cradle to Cradle inspired principles. Except for the Limburg Principles, which have a broader scope of target areas, most of these principles are specifically related to the domain of spatial area development.

Due to the lack of practical experience of Cradle to Cradle in spatial development, only guiding principles are discussed below. Next to the Limburg Principles also the ‘Five notions for Cradle to Cradle spatial development’ and the Almere principles are described.

Also reference is made to the publication ‘Cradle to Cradle Criteria for the built environment’ (see also 2.2 Cradle to Cradle and Building design) by the Cradle to Cradle Chair at the Dutch Research Institute for Transitions (DRIFT), Erasmus University. The purpose of this publication is to provide guiding criteria for developing a building with measurable features. However developed for buildings, according to its authors, most of the criteria are also applicable to spatial development (Mulhall, 2010)³⁴.

The Limburg principles and area spatial development

Since 2008 the whole Province of Limburg is aiming to design and implement spatial planning programmes based on the Cradle to Cradle concept. In collaboration with McDonough and Braungart, various parties, including the Province of Limburg, developed Cradle to Cradle principles in mid-2007 for the Floriade 2012 World Horticultural Expo. These principles turned out to be so widely applicable, that the Province of Limburg is using them as a framework for all Cradle to Cradle developments in Limburg³⁵. In this Policy Framework the Province chooses to combine the Cradle to Cradle way of thinking (doing the right things) with the efficient use of resources and energy. The latter is added because the ultimate form of Cradle to Cradle requires transitions at different areas such as energy production, resources, building techniques,... In the mean time efficiency strategies may help to bridge the period for which eco-effective solutions are not yet available.

- 33 Jongeneel S. (2009). C2C in sustainable spatial development in Greenport Venlo: a case study, <http://irs.ub.rug.nl/dbi/4ac30780a6293>
- 34 Mulhall D. (2010, e-mail correspondence, 20/08/2010
- 35 Parliament of the Province of Limburg (2009). Beleidskader duurzame ontwikkeling 2008-2011 (Policy Framework on Sustainable Development 2008-2011). Maastricht, 13 February 2009

The framework implies 6 principles that are Cradle to Cradle based but also take into account aspects that relate to the regional scale of their scope. These are called the **Limburg Principles**:

- We are native to our place**
- Our waste is our food (closing the cycles)**
- The sun is our income**
- Our soil, water and air are healthy**
- We provide enjoyable mobility for all**
- We design enjoyment for all generations**

An important aim in the area-spatial development strategy of the Province is to exploit the dynamic force and strength of the area itself and the various levels of recycling and social energy. The added value of these C2C inspired principles is mainly considered in case of linking aspects within the spatial area. Linking aspects have to be considered at the three layers of the spatial area (Figure 6):

- Physical base layer (Dutch: 'ondergrond');
- Network layer (Dutch: 'netwerk')
- Occupation layer (Dutch: 'Occupatie')

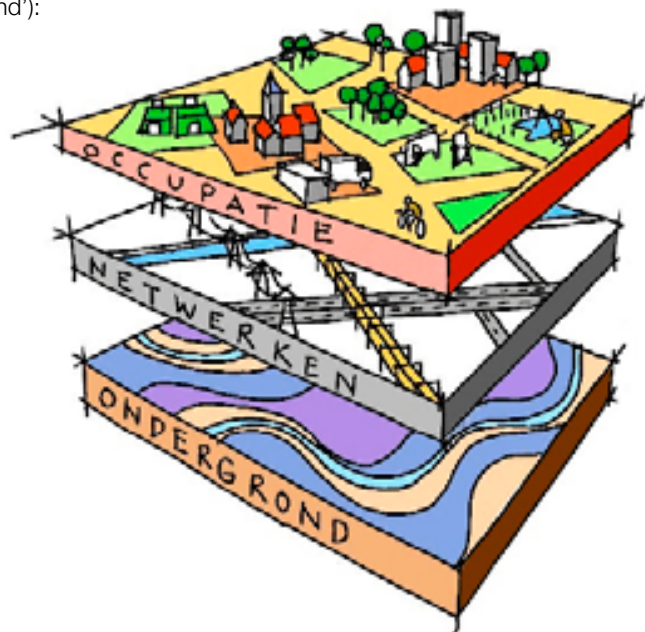


Figure 6: Layer approach of spatial area development

In this way, the Cradle to Cradle principles will ensure that:

- the building elements match to the areas blue and green qualities/values (the physical base layer);
- the various flows/networks in the region (water, air, food, energy) are linked to the area's functions (the network layer);
- the inhabitants and users are linked to the area's flows/networks and function through cooperation and cohesion (the occupation layer).

Five notions for Cradle to Cradle spatial development

In 2009, the Government Service for Land and Water Management³⁶(DLG) which is an agency of the Dutch Ministry of Agriculture, Nature and Food Quality (LNV) published a brochure on Cradle to Cradle as an inspiration for sustainable spatial development.

In this brochure five notions are formulated. These notions could be seen as the answers to the question: "Which are the basic conditions needed to ensure that the Cradle to Cradle principles are integrated in the spatial development". These five notions are rather concepts, ideas and thoughts than ready-made solutions. They should be applied joined together. Most of them are not new but appear to be seldom used in practice.

³⁶ DLG (2009). Cradle to Cradle als inspiratiebron voor duurzame gebiedsontwikkeling (Cradle to Cradle as an inspiration for sustainable spatial development).

Five notions for Cradle to Cradle spatial development:

- Notion 1: develop clean cycles in time and space (*inspired by the C2C principle 'waste equals food' but also includes energy, water and CO2 and even financial and social cycles – see notions 4 and 5*).
- Notion 2: Create added value for people, planet, profit and collaboration (*inspired by the Triple-E innovation strategy described in the C2C book. This strategy helps you to maximise the positive effects on economy, ecology and equity. It is an alternative to the Triple-P bottom-line that assists in minimizing the negative effects on Profit, Planet and People. The aspect of collaboration refers to the idea of look for a maximum of collaboration options within the spatial area before going outside the area*).
- Notion 3: The development process has to be both strategically and operational. (*The strategic part is necessary to formulate the objective (refers to the need for eco-effective measures). The operational part is about realizing these objectives*).
- Notion 4: Make use of the existing capital: landscape and people (*this closely relates and gives an interpretation to the C2C principle 'celebrate diversity'*).
- Notion 5: Consider spatial development as a sustainable evolution (*Sustainable development should be considered as the central starting point – it is a continuous ongoing process - not as a final goal. Each area development is just a step in a larger development process.*).

The final conclusion of the DLG brochure states that Cradle to Cradle is useful inspiration for sustainable spatial development. It helps to set new and ambitious goals and challenges to think and handle differently.

Almere principles:

The city of Almere (The Netherlands) has the ambition of becoming an economical, ecological and social sustainable city by 2030. To do so, the city of Almere together with McDonough elaborated seven principles³⁷. These principles will inspire everybody who will be involved in the further development of this city.

The seven principles are:

- Celebrate diversity (this includes diversity within ecological, social and economical systems).
- Link place and context (this principle is about intense involvement of the local community and its social, cultural and economical power and make use of local energy- and material streams).
- Combine city and nature (the combination of urban and natural structures will lead to an increased awareness of the connection between man and nature).
- Anticipate changes (include always some kind of flexibility and adaptability within sustainable development plans).
- Keep innovating (promote new and improved processes, technologies and infrastructure and support experiments and knowledge exchange).
- Develop healthy systems (implementation of the waste equals food principle at the urban level).
- People make the city (key principles are individual freedom, emancipation, social cohesion, self-realization, self-organisation and self-regulation).

2.3.3 Conclusions

Cradle to Cradle in relation to spatial area development is not yet developed as it is for the building design. However, many similarities within the approaches can be determined as buildings are linked in one way or another to the area where they are constructed.

The role Cradle to Cradle in spatial area development is that of helping to state intentions on how to come to the beneficial links between building elements and the physical layer, the various flows (water, air, food, energy) and the functions needed in the area. The Cradle to Cradle approach is not a snapshot evaluation but in contrary an integrated continuous development approach relying on continuous innovation.

³⁷ The city of Almere (2008). De Almere Principles: Voor een ecologisch, sociaal en economisch duurzame toekomst van Almere 2030 (The Almere Principles: for an ecological, social and economical sustainable future of Almere 2030).

2.4 Cradle to Cradle and Governance

Three distinctly differentiated perspectives can be used to understand the implications of Cradle to Cradle for governance. The first perspective is that of the concept itself in relation to governance. On a second level, there is governance in relation to the Cradle to Cradle principles. Thirdly, what are the implications of governance in relation to the Cradle to Cradle applications, i.e. industry, buildings and spatial area development.

2.4.1 Concept

In the transition from an eco-efficiency economy to an eco-effectiveness economy, the Cradle to Cradle concept plays an important role. Governance is key in order to make this transition possible. The role of governance on this metalevel is to manage the transition. Eco-effectiveness as a conceptual framework requires governance actions that allow and encourage the necessary societal and economic changes to take place.

2.4.2 Principles

The Cradle to Cradle principles such as “waste equals food” create high ambitions. Governance is needed to translate these high ambitions to actual paths that can be developed. Governance has a function to connect the Cradle to Cradle principles with practical implementation. On the other hand, governance can play a role in using the principles as inspiration, as has been demonstrated by the Limburg Principles and the Almere Principles. Especially the third principle ‘Celebrate diversity’ is a challenge at the level of governance.

Limburg Principles

The Limburg Principles have incorporated the diversity principle as ‘we design enjoyment for all generations’. A general principle has been transformed almost to a practical action point. The challenge at governance level is to connect Cradle to Cradle developments to the principles and take inspiration from it.

Almere Principles

The Almere Principles also illustrate how governance can be incorporated into the Cradle to Cradle principles. Three of the Almere principles are a direct example of how governance can be applied to the third C2C principle.

- ‘Anticipate changes’ - this has a direct implication for governance to pay sufficient attention to anticipate future changes.
- ‘Keep innovating’ demonstrates that innovation has to stay part of the governing process itself.
- ‘People make the city’ is a reference to involving stakeholders as part of the governing action. Citizens’ involvement is part of the diversity principle of Cradle to Cradle.

2.4.3 Applications

The third strategic line in the relationship between Cradle to Cradle and governance that needs to be examined is the role of governance in relation to applications. These application areas of Cradle to Cradle, namely Industry, Buildings and Spatial area development are at the heart of the C2C Network project. Their relation to governance is thus crucial.

Whether it is an application on the micro level in industry where product development takes place, or on the micro-meso level in buildings where construction and design are key or on the meso level within the spatial area development pertaining to infrastructure and community, the role of governance stays overall the same and relates mainly to strategy and implementation.

Strategy is needed to set ambition levels and show leadership. Whether on the micro or meso level, strategic choices need to be made in order to make Cradle to Cradle applications possible. The example of Carpet manufacturer DESSO comes to mind³⁸. They have decided to set their ambition level to becoming ‘100% Cradle to Cradle by 2020’ and their leadership is demonstrated by their CEO, Stef Kranendijk, who is also very vocal about their commitment to this goal.

Once strategic choices are taken, implementation of the action plan developed in order to make Cradle to Cradle developments is at hand. The role of governance becomes more practical in order to monitor and validate the milestones.

2.4.4 Conclusions

In conclusion it can be stated that the role of governance in the Cradle to Cradle context can be very diverse, ranging from transition governance to setting strategies and the monitoring and validation of implementation.

38 Cradle to Cradle brochure downloadable at http://www.desso.com/Desso/home/EN/EN-Cradle_to_Cradle/EN-Cradle_to_Cradle-Cradle_to_Cradle.html

3 Summary

The Cradle to Cradle (C2C) Network is a Capitalisation network (funded under the Interreg IVC programme) which aims to reduce raw materials' utilisation, generate less waste and less environmental pollution as well as to enhance innovation and economic development.

The overall objective of the C2C Network is to develop regional action plans, reflecting the principles of the Cradle to Cradle concept, systematising its regional interpretations and setting out how the good practices critically assessed by the network, will be implemented within regional mainstream Structural Funds Programmes.

The main objective of this document is to develop a common language for the network and an understanding between its partners and other interested parties. This framework sets a basis for the network activities through the rest of the project. This document provides more detailed information on the cradle to cradle concept, its principles and its implications at the theoretical level for the target areas industry, build design, area spatial development and governance. The framework is not intended to be exclusive but instead looks to identify those characteristics of projects and approaches which deliver eco-effective solutions. However, this framework does not and is not intended to develop an evaluation tool such as the cradle to cradle certification system.

Cradle to Cradle as a conceptual framework is a new business model with the ambition to develop products which are safe, healthy and reusable. The framework is developed in accordance with how nature has managed to evolve to a very diverse set of ecosystems and populations where waste is unknown. The definition of very high ambitions is basic in developing Cradle to Cradle. It builds vision on where regions and organisations want to be in the future. It sets the beacons and directions where innovation should lead to. It is a shift from eco-efficiency towards eco-effectiveness. Three principles are essential in developing Cradle to Cradle:

- waste equals food
- use of current solar income
- celebrate diversity

Cradle to Cradle applications are products, processes, buildings, industry business models, spatial areas,... that are inspired by the Cradle to Cradle concept and its three basic principles.

In this document the Cradle to Cradle concept is also placed in relationship to the four target areas of the C2CNetwork: industry, building design, area spatial development and governance. An inventory is made of target area specific principles that are inspired by the Cradle to Cradle concept and its general principles. In summary: The implications of Cradle to Cradle for Industry range from product specific requirements in the design and production stage, over far reaching supply chain challenges and opportunities to leading to a completely new innovative business concept.

The role of governance in the Cradle to Cradle context is also very diverse, ranging from transition, to setting strategies to monitoring and validation of the implementation.

Next to the Limburg Principles also other initiatives have been taken to interpret Cradle to Cradle. In relation to building design, all have in common that Cradle to Cradle is not (only) about using the right materials but about creating added value to the building, its surrounding and the people who live or work in it. Cradle to Cradle in relation to spatial area development is not yet developed as it is for the building design. However, many similarities within the approaches can be determined as buildings are linked in one way or another to the area where they are constructed.

The role Cradle to Cradle in spatial area development is that of helping to state intentions on how to come to the beneficial links between building elements and the physical layer, the various flows (water, air, food, energy) and the functions needed in the area. The Cradle to Cradle approach is not a snapshot evaluation but in contrary an integrated continuous development approach relying on continuous innovation.

In conclusion: This document helps to develop a common language for the Cradle to Cradle Network and underpins the developed perspective studies and the ongoing work of C2CN. The developed perspective studies in the area on build, governance, industry and area spatial development serve as a frame of references for future activities by the C2CN, building on current knowledge, guidance and good practice to enable better exchange of information within and outside the project network, and the wider uptake of the Cradle to Cradle approach.

4 Frequently used Cradle to Cradle terms

In this chapter the frequently used terms that are used in the context of Cradle to Cradle are listed. For each of these terms a definition is given to clarify what is meant.

Cradle to Cradle - philosophy

A model of industrial systems in which material flows cyclically in appropriate, continuous biological or technical nutrient cycles. All waste materials are productively re-incorporated into new production and use phases, i.e. “waste equals food”³⁹ Cradle to Cradle is also used as a synonym for the broader concept of eco-effectiveness (see below).

Cradle to Cradle - principles

According to William McDonough and Michael Braungart three **principles** are essential in developing Cradle to Cradle (products, buildings,...):

- **“waste equals food”**
- **“use of current solar income”**
- **“celebrate diversity”**

Inspired by these three Cradle to Cradle principles, secondary principles are developed to be used in specific areas. The most commonly known are:

- The Limburg principles that form the policy framework for sustainable development in the Province of Limburg (The Netherlands). (http://www.limburg.nl/upload/pdf/Flyer_ENGELS.pdf)
- The Almere principles which were developed for a vision towards 2030 for the development of Almere (<http://english.almere.nl/>)
- The Hannover principles which were developed for the world exhibition in 2000³⁹

Biological nutrient

A raw material used by living organisms or cells to carry on life processes such as growth, cell division, synthesis of carbohydrates and other complex functions. Biological nutrients are usually carbon-based compounds.³⁹

Continuous loop

Material flows cyclically in appropriate, continuous biological or technical nutrient cycles. All waste materials are productively (without any form of downcycling) re-incorporated into new production and use phases, i.e. “waste equals food.”³⁹ Sometimes it is referred to as closed loops. A closed loop may however induce the assumption that waste materials need to come back to the same initial producer while, as in nature, re-incorporation of waste materials can be in complete new production and use phases. In this sense, the term continuous loop gives a broader understanding to the concept of Cradle to Cradle.

Downcycling

The practice of recycling a material in such a way that much of its inherent value is lost (e.g. recycling plastic into park benches).³⁹

Eco-effectiveness

The Cradle to Cradle Design’s strategy for intelligent and healthy materials use, designing human industry that is safe, profitable, and regenerative, producing economic, ecological, and social value.³⁹

The term eco-effective is generally used in its relation to the term eco-efficiency. Whereas eco-effective is defined as: ‘Meet our own goals while others prosper’ and eco-efficiency as: “minimising our impact and taking the shortest route to our ends” (van der Grinten B, 2008)⁴⁰. Even shorter it is stated that effectiveness means “doing the right things” while efficiency means ‘doing the things right’. In this way efficiency and effectiveness can be complementary strategies since the concept of efficiency in itself has no value; it can be either good or bad (Braungart et al., 2006).⁴¹

Eco-efficiency

The World Business Council for Sustainable Development (WBCSD) defined eco-efficient companies as those which create ever more useful products and services – in other words, which add more value – while continuously reducing their consumption of resources and their pollution. Eco-efficiency describes a vision for the production of economically valuable goods and services while reducing the ecological impacts of production. In other words eco-efficiency means producing more with less. According to the WBCSD, critical aspects of eco-efficiency are:

- A reduction in the material intensity of goods or services (dematerialisation);
- A reduction in the energy intensity of goods or services;
- Reduced dispersion of toxic materials;
- Improved recyclability;
- Maximum use of renewable resources;

39 www.braungart.com/terminology.htm, 2010

40 van der Grinten B., Cradle to Cradle in a nutshell, C2C summary and design tools, 2008.

41 Braungart M., McDonough W and Bollinger A., Cradle-to-cradle design, creating healthy emissions – a strategy for eco-effective product and system design, Journal of Cleaner Production, 2006

- Greater durability of products (extended product lifespan);
- Increased service intensity of goods and services.

Product of consumption

A product designed for safe and complete return to the environment, which becomes nutrients for living systems. The product of consumption design strategy allows products to offer effectiveness without the liability of materials that must be recycled or “managed” after use.³⁹

Product of service / Product Service Systems

A product that is used by the customer, formally or in effect, but owned by the manufacturer. The manufacturer maintains ownership of valuable material assets for continual reuse while the customer receives the service of the product without assuming its material liability. Products that can utilize valuable but potentially hazardous materials can be optimized as Products of Service.³⁹

Rebound effect

Rebound effects refer to increased consumption that often occurs when efficiency improvements reduce user costs. For example home insulation may have the potential to reduce energy consumption with 50%. However, residents will experience that their spending on heating will reduce dramatically. This may give them the incentive to heat their houses to a warmer level (since heating became cheap). Because of this effect the final reduction in energy consumption shall probably be less than 50%.

Technical nutrient

A material of human artifice designed to circulate within industrial lifecycles--forever.³⁹

Upcycling

The practice of recycling material in such a way that it maintains and/or accrues value over time (the opposite of downcycling).³⁹

The Cradle to Cradle Network (C2CN) is an Interreg IV C capitalisation project consisting of ten partners from ten European regions which aims to reduce raw materials' utilisation, to generate less waste and less environmental pollution, as well as to enhance innovation and economic development.

Province of Limburg (NL)
www.limburg.nl

Flemish Public Waste Agency (BE)
www.ovam.be

Milano Metropoli Development Agency (IT)
www.milanomet.it

Department for Economics and Tourist Development of the City of Graz (AT)
www.wirtschaft.graz.at

ARDI Regional Agency for Development and Innovation (FR)
www.ardi-rhonealpes.fr

Kainuun Etu Ltd (FI)
www.kainuunetu.fi

West-Transdanubian Regional Development Agency (HU)
www.westpa.hu

Suffolk County Council (UK)
www.suffolk.gov.uk

North-East Regional Development Agency (RO)
www.adrnordest.ro

Government Office for Development and European Affairs (SI)
www.svrez.gov.si

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