Working and Learning in the world of C2C
Concept Chapter 2 What

26.7.2012

What is C2C

Script: Dr. Sonja Eser, SinnenWandel

0.1 Frame

What is Cradle to Cradle?

0.2 Goals

Students have understood that Cradle to Cradle is a modern, circular solution to end the concept of waste and improve the quality of processes for better water stewardship, social standards and use of renewable energy.
Students have learned the three basic principles of Cradle to Cradle.
Students have understood that it is important to see the bigger picture to bring Cradle to Cradle to work.

0.3 Knowledge Transfer

Learn lessons from nature: understand nature´s principles and how to use it in industrial systems
Rethink the three basic principles of Cradle to Cradle
Mindset of C2C – what is different in the thinking about C2C than thinking about being more efficient
Use and learn new vocabulary (nutrient, metabolism, be beneficial, waste equals food, eco-effectiveness)
Understand the problems in products at the moment – raise awareness

0.4 Key Words

Eco-Effectiveness
Nutrients
Biological and Technical Metabolism
Current Solar Income

0.5 Skills

Become creative, start creating the future
Ask different questions (reframe questions into powerful questions, “imagineering”)

2. Cradle to Cradle

What kind of detergence would the river like? How can we produce it so that it will support aquatic life?[1]
What about an ice-cream cone that is only solid while frozen and melts when you throw it away and waters the seeds that are packed inside?

These are new questions to industrial design. These are Cradle to Cradle questions.
Cradle to Cradle is a design-concept guided by nature. It is an innovation framework. It is also a philosophy. It is about a third industrial revolution.
It is about “Remaking the way we make things”. This means to rethink products, processes, systems. And eventually remake them.
.
Cradle to Cradle creates a transition from the current industrial model to a system with healthy and safe products, whose materials stay in cycles.
C2C enables the creation of wholly beneficial industrial systems. This concept does not only apply to products or processes but also to industry business models, services, urban and regional planning and architecture.

The special thing about Cradle to Cradle

It gives hope. Instead of the sentence: “it would be best we weren’t here” it changes depressive future perspectives into the will to be creative and help to build the future. How comes?
Since the 70s environmental protection became more important and we were drilled into the mindset of personal guilt. A lot of young people did not want to have babies in a world which looked so devastated.
If we are scared, our brain leaves us only three ways to react: fight, run or feign death. There is only a very small path to stay capable of acting. And this path we can only reach if there is hope and if we can be creative. This is the biggest power that evolution has given to us. The idea of a positive footprint, about being beneficial and becoming native to our planet gives people the possibility to use their creative powers to build a positive future.

2.1 What Cradle to Cradle is not

Cradle to Cradle is not equal to the term “sustainability”. These are two different concepts. They both have the vision of a better world. But the ways to achieve this are quite different.

Sustainability today is often discussed in the light of efficiency and personal responsibility. This may lead to problems discussed in chapter 1. The aim is to minimize the environmental damage – calculated as ecological footprint. This is an idea of making the things “less bad.”

2.2 What is Cradle to Cradle

Cradle to Cradle instead is the idea of “doing the right things right first time”.
In a world discussing limits and minimizing, it sees a world of abundance. If we would design our production systems properly, our big impact could be beneficial instead of devastating (= positive footprint). This means that we set up cycling material flows, where each material at the end of the product use is used as nutrient for new products.
Where sustainability tries to minimize the impact of human activities, Cradle

[1] McDonough, Remaking the way we make things, p. 145.

to Cradle starts by designing product and processes for environmental purposes.

While sustainability issues are often discussed as additional costs, Cradle to Cradle tries to enhances economic benefits via triggering innovations. It is an economic concept, looking for new business opportunities while integrating an environmental friendly way of producing into the strategy of a company. It adds value for the customer as well as for the manufacturer (enhancing product quality).
With this concept, companies have started making products with surplus value: that improve the quality of life.

Cradle to Cradle actively supports species, e.g. with compostable products that help to rebuild top-soil, or by sending products with toxic substances back into technical metabolisms so they are not released into soils and rivers.

The Cradle to Cradle® design concept is an idea of the German chemist Prof. Dr. Michael Braungart and the American architect William McDonough. Its basis is the Intelligent Product System (IPS) that Braungart's company EPEA (Environmental Protection and Encouragement Agency) developed from 1987 to 1992. Currently, hundreds of enterprises around the world offer products designed after the Cradle to Cradle® design concept – among them many are from the Netherlands, the United States of America, Taiwan, Denmark, Austria, Switzerland and Germany. Even local authorities or institutions use it in their procurement.

2.3 Learning from Nature

Ecosystems are functioning now for over 3,7 billion years. Learning from these successful systems is helpful to create economic systems that work in harmony with nature.

1. There is no waste. Material is constantly transformed from one organism to another. Material – and with it stored energy in the molecules is passed over cascades until decomposer like mushrooms and bacterias in the soil break down the last digestible molecules (biogeochemical cycles of materials). Live necessarily relies on recycling of the limited chemical elements.

2. Organisms use current solar income.
The sun is an eternal energy source. Though plants use only 1-2% of solar radiation in photosynthesis, this is sufficient to support an awesome mass of organisms relying on phyto-biomass to feed on (about 170 billion tons organic substance).

3. Diversity is a characteristic trait of live. Over 1,5 Mio species were discovered until now. The resilience of ecosystems relies on diversity in species.

2.4 Three basic principles

The Cradle to Cradle concept applies principles that we observe in nature to our industrial systems.

At the moment we do not take care enough of the natural processes our economic system is embedded into.
With Cradle to Cradle we change the framework of "Nature as unlimited resource" to "Nature as teacher and Partner"

Cradle to Cradle Basic Principles
Waste = Food
Use current solar income
Celebrate Diversity

These design principles are helping us to find innovative product solutions using the three guiding principles of C2C.

2.4.1. Waste equals food.

To get rid of the concept of waste, we have to start to bring material in cycles.
If we look at a cherry tree we see that a lot of blossoms or fruits fall down to earth. No one would complain about the tree littering the environment, as all these materials decompose and are broken down into nutrients.
So if we want to do it like the cherry tree, we have to design materials out of renewable sources for the biological metabolism:

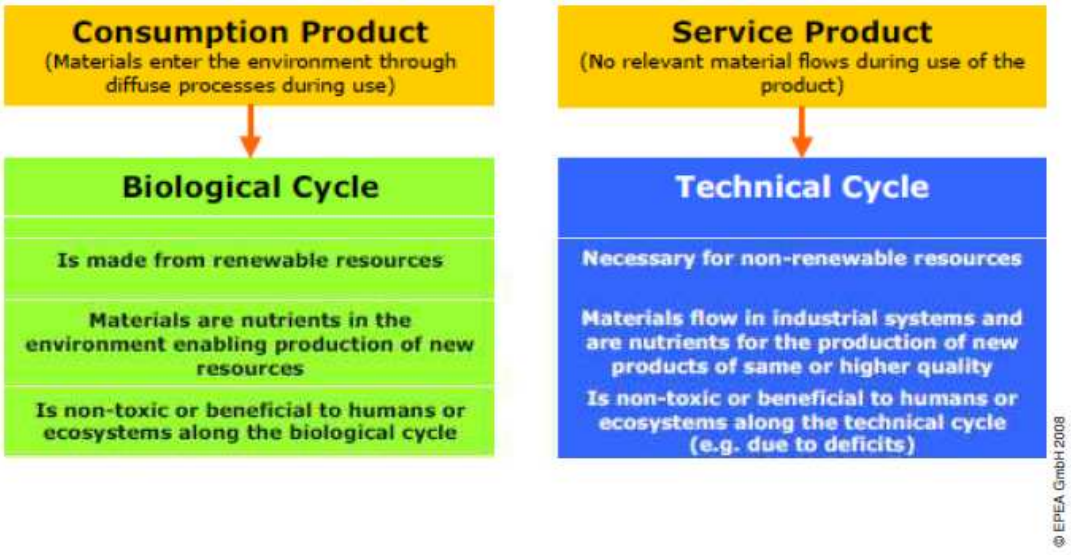
The **biological cycle** is for all products from renewable resources products like wood, maize, and cotton. Products designed for this metabolism are biodegradable and can safely be returned to soil for biological processes. Biological nutrients are ideal for consumption products, i.e. products that enter the environment through diffuse processes during use. Products are: detergents, cosmetics, textiles etc. but also shoe soles and brake pads which are used up.

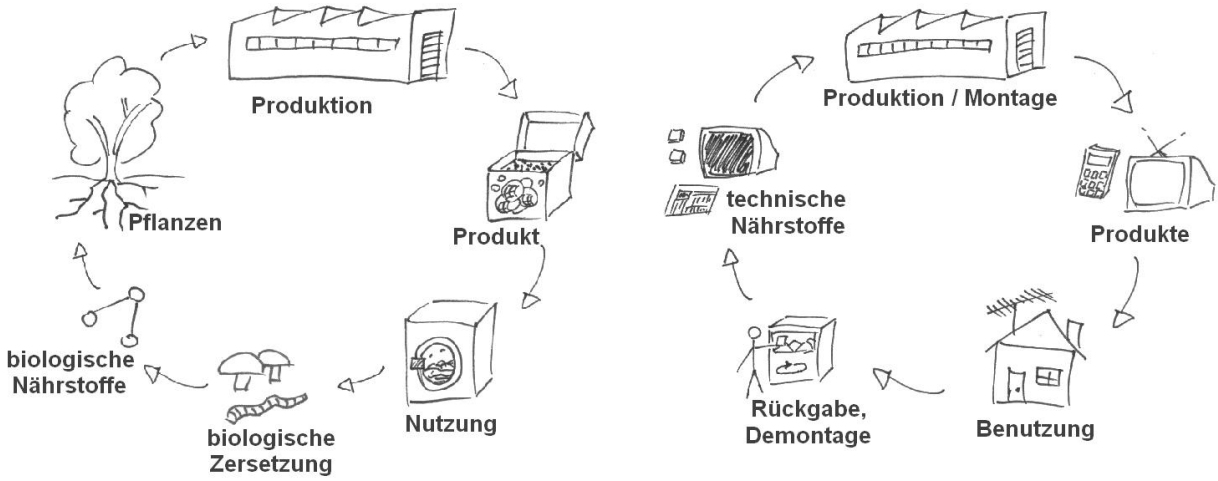
Reminder: Everything that ends in the environment should be designed for the biological metabolism. Also natural minerals like calcium carbonate or clay could be safely used in this metabolism.

But for sure we cannot decompose a computer. So for this we need a second cycle.
Products designed for the **technical metabolism** are made out of non-renewable resources. A technical nutrient is material that can be safely reused in a continuous industrial cycle, in a closed-loop system of manufacture, use, recovery and reuse.
Products must be designed in a way that material will maintain the quality or even is upgraded while cycling. Harmful substances that we cannot substitute have to be kept closely in this cycle, so that they do no harm.
Products are: computers, cars, bicycle, mobile phones, furniture etc.
These products are suitable as service products. They can be rent or leased to customers, so that the manufacturer remains the owner of the material.

Reminder: also products from renewable resources can be kept in technical cycles for a while, e.g. PLA bioplastic can be recycled perfectly. It would be not reasonable to send it to compost after one use.

Products according to Cradle to Cradle should be designed as either biological or technical nutrient or if both in a way that material can easily be separated. Products should be designed to be a nutrient of something else (the next cradle). In that way products are beneficial and useful like material in nature.





Biological and technical metabolism (EPEA GmbH)

Exercise: Analyze the environmental fate of materials of your favorite product. Where does it go if we do take care of the material flow and if we don't take care of it. (e.g. Internetlink Sourcemap)

Exercise: Look at material flow through your school and home. What material gets stuck with you? Can you do something so that it can continues as material for other products?

2.4.2. Use current solar income:
The climate change is due to our use of historic solar income in form of oil or gas. Using current solar income includes wind power, solar thermal energy, photovoltaic electricity production, and the use of biomass.
It is absolutely necessary to shift to renewable energy but we should be careful not to contradict the third principle (celebrate diversity) while using for example biomass.
Example: with biodiesel we try to reduce the use of oil. Biodiesel is produced from soybeans or palm-oil. Both plants are grown in areas, where former tropical forests were cut down to make place for plantations of oil palms and fields of soybeans. This for sure decreases biodiversity. Better solutions take biomass from organic waste, residuals from food plants or other leftovers.

Other regenerative energy forms could also come from tidal power as well as difference between salt- and freshwater or geothermal warmth.

2.4.3 Celebrate diversity:
Healthy ecosystems are complex networks of living organisms.
Our impact in various ways is especially destroying living space for animals and plants. We are losing 100 (!) species a day. To learn from nature means to celebrate diversity in the way to support biodiversity.
Example: Thomas Rau, an architect in The Netherlands, has build nesting aids for birds and holes for bats in a building he has refurbished.
But we also have to be aware to celebrate our cultural or conceptual diversity.

2.4.4 New Vocabulary
In Cradle to Cradle we use different vocabulary. This is important because it evokes in an unconscious way new thinking.

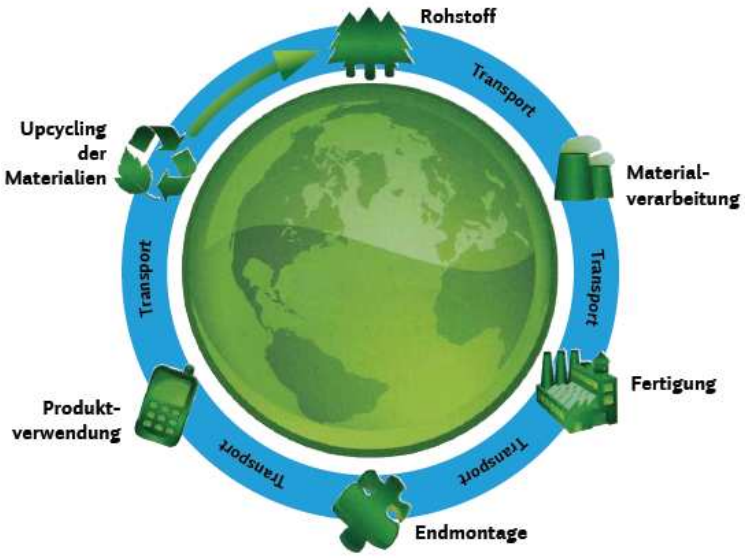
New Vocabulary:
Nutrient: instead of speaking about virgin materials and waste, we use here the term: Nutrient. This helps to think in circular systems.
Metabolism: like in nature we speak of material flows in metabolisms. You can also use the word cycle.
Service product: Manufacturer remains owner of material, the consumer pays for the design, use, and maintenance.
Consumption product: products that enter the environment through diffuse processes during use (wash away, textiles pill off)
Waste = Food: food we eat, it nourishes us. In the same way we use nutrients in C2C to nourish new products.

2.5 Eco-Effectiveness

With the Cradle to Cradle concept we follow the idea of eco-effectiveness.
If we look at a cherry tree, we find that it is not efficient. There are thousands of blossoms at it in spring and hundreds of cherries in summer. But nothing gets lost; everything is nutrient for other organisms. All material is recovered, recycled and flows from one organism to another.

Eco-effectiveness means to implement this principle to our industrial systems and design products as a nutrient. All material should flow either in a biological or a technical cycle.

Discussion in class: what can you imagine our future to look like in a Cradle to Cradle way? Or make a reporter game out of this; ask your classmates or people on the street.



Quelle FullCircleDesign

Teacher's Background Comment:
See product examples and case studies how these three principles help to design and produce different products.

See Almere Principles how to use C2C principles for regional development. See Floriade Guidelines for using C2C principles for a big event.

2.6 Bring C2C into work

2.6.1 Five areas of interest

When we want to make a Cradle to Cradle product, we have to look at five areas to improve:

1. Material health –for safe and healthy ingredients and materials
(this involves ABC-X Categorization and defining for biological or technical cycle)

2. Re-utilization of materials (are materials recyclable/compostable and is a reverse logistic in place?)

3. Use of renewable energy (does production process use energy from renewable sources?)

4. Water Stewardship – it is important to carefully treat water resources in production.

5. Social responsibility – companies need to adopt social and ethical performance goals for fair labor practices e.g. no child labor, no forced labor, freedom of association for workers, no discrimination[2]

2.6.2 Economic benefits (C2C in a nutshell for CEOs etc.)[3][4]

There are many potential business opportunities waiting by going circular.

Competitive advantage of organizations especially in Europe suffers from high price volatility of resources in the past years. Linear system of Take-Make-Waste increases exposure to higher resource prices and supply disruptions, a strategic risk for companies.[5]

> C2C design: Recovery of resources reduces the material bill and expenses of disposal and is the basis to be more independent of the world market with wars, crises, export boycotts.
> Most of the value will come from remanufacture, refurbishing and reselling of goods. Recycling is last in line.
> Optimized processes also save materials and energy.

A company has to be innovative to be successful.

> C2C design: is an innovation platform. While integrating in the strategy of the company, it increases innovation in the organization, a prerequisite to be competitive.
> While focusing on the total system performance rather on a single component, innovative power in a company increases.

Legislations about the use of toxic substances have become stricter.

> C2C design: Risks are known and minimized, Risk prevention for the company as the product is safe for environment and health (no potential claims for damages)

With carbon trading emission quantities have got a price.

> C2C design: CO_2 is treated as nutrient, ways to bring CO_2 back into cycles and rebuild soil.

There is also more pressure also from environmental protection groups to protect biodiversity.

> C2C design: helps to be clear about the whole lifecycle of a product and the possibilities to support biodiversity

The way customer think has changed. The amount of people who are concerned especially about environmental issues has

[2] Cradle to Cradle Certification Outlines, MBDC
[3] C2C pays off!
[4] Towards a circular economy
[5] Resilience in the Round

increased. Businesses are confronted with growing demand for sustainable products and services. E.g. “LOHAS” (a customer model called lifestyle of health and sustainability are buying products which are produced in a sustainable and ethical correct way. This market is increasing every day. But also in B2B market there has been a rapid rise in sustainability requirements.

C2C design: strengthens the brand
Better reputation, more customers, increases customer loyality
Employees love to work for these companies

Customer Relationships are important for companies but marketing and communication is difficult in a saturated market.

C2C design: “C2C sells” is the “Tenor” of the report: C2C pays off! Marketing C2C can be a next step in CSR policy. Certification but especially the C2C story behind the products supports sales. C2C product also automatically generates free publicity. E.g. Van Houtum first compostable toilet paper made the company an “environmental hero”. Sales increased over 50%.
New business models and customer bonds can be achieved from the concept of leasing instead of selling the product. As long as the customer is using the product, the bond between producer and customer will persist. For product developers and marketers there is much information in this.

Investors have started to favor companies who have sustainable goals.

A lot of studies have come to the result that sustainability gives companies not only competitive advantage, promote innovations but also makes an organization more robust and resilient to changing conditions.

And for sure a lot of CEOs and companies have understood the urgency of a shift in the “throw-away economy”.

“The shift to a circular economy will lead to increased growth, jobs and resilience”.
”Circular Economy means an industrial economy that is restorative and eliminates waste… Material flows are of two types: biological… and technical nutrients.” [5]

2.6.3 Enablers and "wheels" that will push continuous material metabolism

Design and innovation: this is the pre-requisite to re-design and re-invent products for continuous metabolism, that are designed for remarketing, refurbishing, repair and disassembly, also for material cascading; about 80% of a product's environmental impact is "locked in" at the design stage [5]

New business models and savings: product performance will be more important in the future than ownership. Leasing instead of selling will be an important step. Customer bonds will last longer. Savings from return of material will be strategic.

Customer decisions: increasing awareness of customers will shift market shares

Product collection and reuse: Infrastructure to collect products after use (reverse logistic) is a prerequisite for a circular economy. And hopefully this will be carbon neutral in the future. There are a lot of new job opportunities in material management, e.g. recycling companies like Van Gansewinkel has renamed itself to a "nutrient management company".

System changes: like revision of regulatory and fiscal framework will be necessary. E.g. cutting taxes on renewables including labour and move it to energy and materials (non-renewables)

Cooperation: between companies especially subcontractors and recycling companies.

2.6.4 Design is crucial

„Design is the first signal of human intention and that our urgent design brief is to design for nine billion people on a thriving planet. “
William McDonough

Designers have a big impact on the ecological quality of a product. Often they do not know this; they are hired to pimp up the look of a product. But they could also decide about material, manufacturing processes, use and afterlife of a product. Or they can even make a service out of a sales product. Cradle to Cradle is a design strategy. It intervenes where products and processes can really be changed – at the design stage. Ingredients and the expected environmental impact of a product are defined at this point.

Strategy: designing products and industrial processes that turn materials into nutrients by enabling their perpetual flow within one of two distinct metabolism: biological or technical.

Ideas matter
While sustainability teaches us to prevent damage, to reduce environmental impact, in Cradle to Cradle we try to be creative in design. Ideas are important.

So we start with values and principles like: “design a product/building that loves all the children of all species for all time”, “design with material and energy flows that support both natural systems and business goals”, “produce with a positive impact on the surrounding environment and local communities”. In architecture we look for ideas to build “houses like trees, cities like forests”.[6] This means buildings that, like trees produce more energy than they consume, purify their own waste water and release it slowly in a purer form.
Ford has rebuilt its premises with the idea: “let’s make it safe for children to play on”.

Discuss: What are good ideas your class comes up with?
If you could redesign your school/university/company, what vision would you chose.

[6] Cradle to Cradle Criteria fort he build environemnt; Douglas Mulhall & Michael Braungart, 2010

2.6.5 Design for Disassembly

= design products so that each part can easily be separated from each other. The goal is to replace fixed connections with reversible ones.

2.6.6 Recycling instead of downcycling

In the attempt to get less waste, recycling was established in countries like Germany in the 70s. Though Germans are world champion in waste separation, a lot of recycling processes lead to quality losses in the technological capabilities of the material. Why? Usually products are not designed for a proper recycling process. E.g. the material composition is often a company secret of the manufacturer. So recycling processes are not suitable for a lot of products, and vice versa products are not suitable for recycling.

The consequence: material loses its quality. This is no re-cycling, but a down-cycling. The time until the material ends up in incineration is only delayed.

Real Recycling

Nature knows no downcycling. Material is continually provided in the same starting quality. This is the goal if we want to have good re-cycling. Or better even to improve the quality = upcycling (see 2.6.9.).

2.6.7 Defined use period

How long should a product last? When discussing this question under a sustainable view, people answer: as long as possible. But when we discuss it under a Cradle to Cradle view, this looks different. Cradle to Cradle products are designed to circulate and are nutrients for other products. So it is also reasonable, that material returns to the circle in a defined period. A lot of products today are old-fashioned in a short period of time – think about computers, mobile phones or clothes. This is due to development in technique, but also changes in lifestyles or taste. A mobile phone that would last for 10 years does not make sense. So it is reasonable to think of a defined use period instead. For example a company could rent instead of sell a computer. They could give an update each year to the customer, and after 3 years the computer returns to the manufacturer. This has also the advantage that the company knows when the material returns.

2.6.8 Material flow management

To set up metabolism also needs to think about material flows. The goal: achieving cyclical material flow that enables materials to maintain their status as nutrients, material quality and productivity over time or even for one company to get its own material back. But this is not necessary.

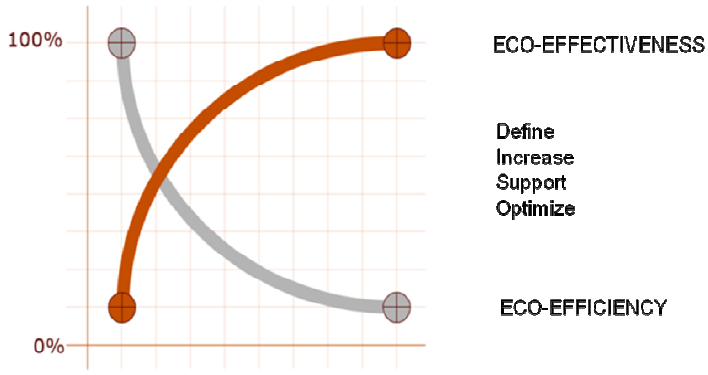
There are several intelligent Take Back Systems already in place:

- Reverse Logistic – one company takes back its own material for recycling (e.g. Desso provides even own recycling facility for its carpets)
- Leasing – producer remains owner of the material
- Service – the customer only pays for the service, manufacturer stays owner of material. At the end of defined use period material is picked up at the customer.
- Campaign days: customer exchanges old product for a new one with discount
- The usual recycling methods by recycling companies which separate defined materials and resell them as secondary raw materials

- New recycling processes to start new material flows (like I:CO for clothes and shoes)

Maersk, a big container ship producer, has made Cradle to Cradle passports so that the company knows exactly what material has been built in where. After the use of the vessel, they can reuse all the material (see film Maersk).

Intelligent Materials Pooling (IMS)
Nature does not close the loops, that mean the material is not used again by the same individual. So it is also reasonable that different companies together form a network, where they use material together, even do research together. This strategic alliance also allows for better purchasing conditions and more market power.
Examples of networks in development:
EcoCircle: Company Tejin/Japan has build a network with over 130 companies to recycle polyester fibres from clothes and drinking bottles.
PV Cycle: over 85% of the European photovoltaic market has joined this network to do research on recycling and reusing the materials of photovoltaic cells.



Source: EPEA GmbH

2.6.9 Quality

The goal of C2C implementation is enhanced intrinsic quality. Product and processes should improve the quality of life.
So a high quality product has:

- Defined ingredients (see ABC-X)
- Material designed as nutrient
- Product is safe for health and environment, during and after use as well as degradation products.
- Defined use period
- Products can easy be disassembled and can be separated by components (design for recycling)
- Concept of nutrient recovery in place

2.6.10 ABC-X Categorization of materials

For improving the intrinsic quality of the products, every ingredient is categorized in a so called ABC-X categorization. Like traffic light system, green ingredients are recommended, red ones should be optimized.

The categorization takes into consideration human health criteria, environmental criteria's and the usability of the ingredient into cycles.

2.6.11 Positive or Preferred List – a tool

Usually we define critical limits for hazardous substances. Or we define which substances we should leave out. The positive list used in Cradle to Cradle give us the opportunity to decide which substance we want to use in a product. The Positive List contains substances that were categorized as yellow (B) or green (A) which are defined actively healthy or harmless in a specific scenario.

2.7 Peak P – history of a scarce resource

Peak P means the depletion of phosphate as fertilizer for agriculture, but also as a raw material for various industrial processes. Phosphate is an essential nutrient for all live, it cannot be supplemented.
Humans have to take up 2g phosphate with their food, but also excrete 2g a day.
Since the industrialization of agriculture, phosphate was mined and used to supplement for the harvest of organic substance from the fields. In former times, the excrements of people and animals was reused on the fields, so the phosphate cycle was closed. Today in highly industrialized countries, toxic substances in waste water make this procedure problematic. Sewage sludge is burned in incineration. (Remark: countries which still can use their sewage sludge to fertilize fields do not have these problems)

The natural resources of phosphate are getting scarce. Experts calculate that stocks will only last for about 20 years[7].

Different countries have now started programs to recycle phosphate from sludge or municipal waste water. There is also another possibility to bring organic fertilizer back into the ground – rebuilding soil with biological nutrients, see 2.8.1.

2.8.1 Compostable products against Climate Change

We lose 5-7 Mio. ha of fertile soil in one year. Erosion by Industrial agriculture and new buildings are the main causes. This is a huge loss of a natural capital. Rebuilding 1 cm of fertile soil layer takes up to 300 years.

Land degradation endangers agricultural production and food security. With humus in topsoil we also lose water retention, soil fertility and CO_2 into the atmosphere.
CO_2 is stored as long carbon chains in the humus (two times more CO2 as in the atmosphere), this is what gives the humus the black color. When humus is degraded, these carbon chains are digested and CO_2 released into the atmosphere. Especially in moors a huge amount of CO_2 is stored in the soil.

There are several ideas to store CO2 into the earth (CCS – carbon dioxide capture and storage) but we could do this easier and safer: we just have to bring back every organic material we use back into the soil. We do this with our green kitchen waste – but what about textiles from cotton or wool, paper from wood, shoes from leather?
These products are not designed for composting – but with Cradle to Cradle they would be. And we could compose our T-Shirts together with our sneakers or make biochar with it and store CO_2 in the soil for hundreds of years. In the same time the problem of Peak P would be solved, as humus is a perfect fertilizer and also contains of course phosphate.

2.8.2 Cascade use and Renewables

Renewable resources are sometimes discussed like "secret weapon" against everything. But no matter if we want to substitute plastic with bio-plastic, use wood as energy source or make bio-diesel from soybeans or palm oil – we have to deal with utilization competition (food, fodder, energy use or material utilization) und limited farmland. The results are rising prices, e.g. the prize of maize was so high in 2010, that people in Mexico could not

[7] A rock and a hard place, peak phosphorus and the threat to our food security. Soil Association http://www.soilassociation.org/LinkClick.aspx?fileticket=eeGPQJORrkw%3d&tabid=1259

buy enough of their basic food anymore. So even if these resources grow in a carbon neutral and ecological way, we have to be very careful using them.

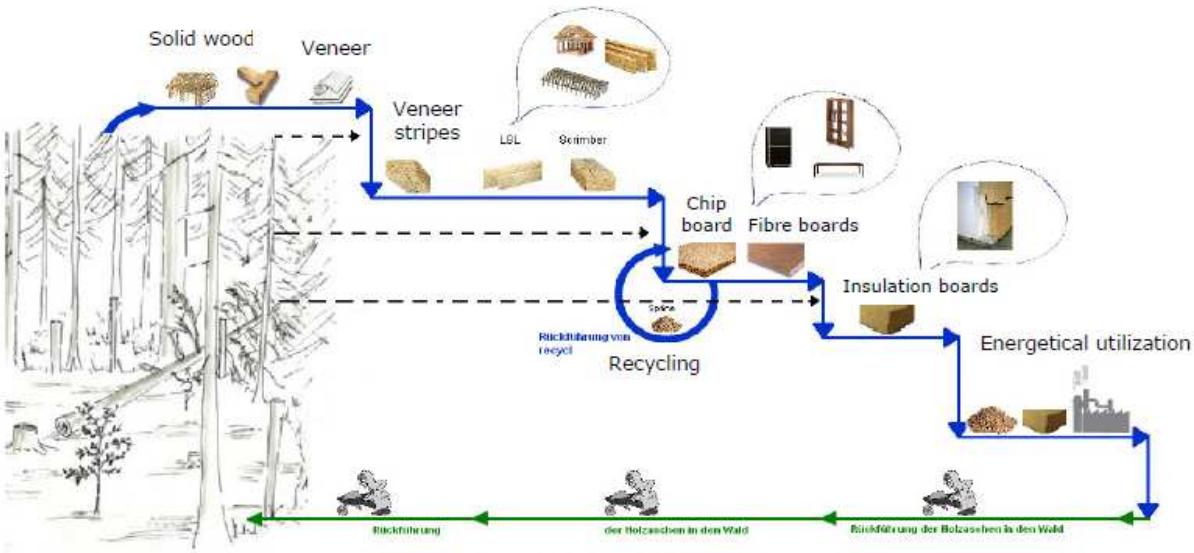
Cascade use is the idea to make the most out of these resources. This is the way material flows can be managed through several defined products. Energy utilization should always be the last step in a long cascade of use, e.g. for wood we can recycle solid wood panels to veneer, to veneer stripes, chip boards etc. and so extend the period of use. Multiple material use is possible because of recycling of products and materials. In the end the organic material will be up-cycled again through natural processes (plant growth).

A tree needs 80 years to grow so this should be the minimum we use the material wood in a cascade.

For food like maize, the use as food has priority. Other material utilization should be reduced to side products and agricultural waste or better use algae instead.

No quick fixes – diversity is crucial

And with all this we always have to keep in mind the third basic principle – celebrate diversity. If we cut down tropical forests to plant oil palms - as happened in Indonesia - we always threaten biodiversity. And we also lose more CO_2 into the atmosphere as the marshy soil degrades with no protecting forest on top, than we can save by using biodiesel. The same is true for monocultures of maize, soybeans etc. We also have to have a close look on social impacts with the use of food as resource for products.



Bringing the ashes back into the woods

2.10 Critical Topics to Discuss

2.10.1 Misapprehensions

- Cradle to Cradle is not only about recycling. It is about bringing materials into metabolisms. This needs new design as well as material management ideas.
- Close the cycle does not necessary mean for one company to take back its own material. Other companies could also use this material – so that material flows from cradle (a.g. a car) to another cradle (e.g. sport article) to another cradle (e.g. chair).
- As it is a tedious way to design and make C2C products certification of a product according to C2C principles not necessarily means that everything is good. There are four certification levels, and only with level platinum all aspects are met completely.

2.10.2 Criticism

Critisism arose as McDonough and Braungart have kept C2C consultancy in their inner circle. Many critics would favor an open development. In response to this critisims the Cradle to Cradle product innovation institute was founded in California. It is responsible now for certification of products.
Also there is criticism that it will not be possible to really get all materials in cycles. According to the second law of thermodynamics, material losses will occur.

2.11 C2C and LCA[8]

Cradle to Cradle is a framework for innovation based on three guiding principles. Life Cycle Assessment, by contrast, is an assessment tool and not a universal design approach. It is designed for use as a measurement tool in eco-design processes.

An objective comparison is difficult because the two concepts do not share the same aims:

LCA: The aim is to provide a tool to help decision makers understand and improve the environmental impact of products and services. One aim is to identify environmental hotspots and identify alternative solutions with lower impacts. LCA is not a design concept. Instead it is designed for use as a measurement tool in eco-design processes for environmental impact. LCA includes all possible aspects of environmental impact over a products life cycle and looks at the whole product chain when analyzing the environmental performance of a product.

C2C: C2C states clear objectives at the beginning of the design process (three guiding principles). The question is not to avoid environmental hotspots but to make a product beneficial in all respects and with a positive footprint.
C2C is enabling companies to develop products and processes which actually create a positive environmental footprint (eco-effectiveness). C2C doesn't provide a common measurement tool.

But there are important differences:

- Direction for design solutions in LCA is depending on analysis of impacts, and not on the basis of guiding principles.
- LCA cannot measure the recyclability of a product. Recyclability is only relevant if the product is actually recycled; whether materials are suitable for recycling is not relevant.
- C2C aims for continuous flows of materials in the biosphere or the technosphere. This makes it very difficult to define the system boundaries, which is required for LCA.
- Under LCA, CO2 and its role in climate change play a very important role. From a C2C point of view, CO2 is a nutrient that has been mismanaged during recent decades and that should be managed – by supplying it to green houses or sequestering it into organic forms for use in topsoil, for example.
- The approach of using renewable energy in the whole product chain is one of the greatest challenges and also one of the main reasons why C2C products do not always perform well in an LCA. C2C aims for a quality statement which considers how energy is produced and how effectively it is used, whereas LCA considers the amount of energy used throughout the lifespan of the product.
- No in-depth toxicity data, Social aspects and water stewardship is taken into account in the LCA.
- In case an LCA talks about Human Health it talks about global impacts rather than local impacts.
- LCA is a simplified model of a complex reality fed by historical data and assumptions.
- LCA results are very difficult to understand and interpreted by non-scientific audience. It is not a good tool for public communication

2.12 C2C and CSR

(Please see 2.1, Discussion about C2C and Sustainability)

[8] *Usability of Life Cycle Assessment for Cradle to Cradle purposes. Position Paper 2011*

2.13 C2C and ISO

…

Time Table

Time (minutes)	Activity	Background/Material
15‘	**Activity: “Pipeline”**	Build up a linear production line, encounter scarce resources, change to circular economy (Material: balls in different colors, half-pipes)
10’	**Input: C2C** **What is C2C and what not**	Slides
5’	**Learning from Nature**	Slides Discussion Excursion/Activity: Food chain in soil
	Input C2C Basic Principles	
30’-90’	**Principle 1: Waste equals food**	Example: show product which produces waste – show product which is a nutrient Picture: how does it work in nature (from leave to humus) Pictures: biological and technical cycle, examples Design for Disassembly Material Box from EPEA Hamburg (Creative Box for C2C Island Project) Handling Collection from Ellen MacArthur Foundation
10-45’	**Principle 2: Use current solar income**	e.g. group work about energy forms, role play: prepare a “television broadcast” from a new energy power plant
5’-30’	**Principle 3: Celebrate Diversity**	Why does this matter. Pictures: green roofs, urban gardening, carrot city etc. Group work/role play: social fairness in production Videos about ants from EMF
5’	**Video Three Principles**	e.g. Gugler, Maersk or others
30-45’	**Simplycycle Round 1**	First level: Learn vocabulary, biological and technical nutrient
	Input: **High Quality, Recycling instead of downcycling, ABC-X, Positive Lists, Management of material flow, Defined use period,**	
20-30’	**Simplycycle Round 2**	Second Level: Material Flow, Take Back of Material
	Input	Slides

	Be beneficial, Positive Footprint	Examples of positive footprint
10'	**Input** **Eco-effectiveness**	Make the right things Example wood cascade Why actual recycling is more a down-cycling Example Degradation of soil, humus as Carbon storage with biological nutrients Example Copper in car doors, too little to recycling if efficient/ gold in mobile phones
20-45'	**Simplycycle Round 3**	Third Level: Be Beneficial, high quality
	Input **Peak P, compostable products against climate change**	
30'	**Activity: Group Work**	Discussion in class: what can you imagine our future to look like in a Cradle to Cradle way? Or make a reporter game out of this, ask your classmates or people on the street
20'	**Alternative Activity: How far do you come?**	Each student gets a card with a product (C2C or other). Ask questions like: is it made with renewable energy, can it be a nutrient – in which cycle?
30-90'	**Alternative Activity: Case Study**	Material: good examples, cards with questions to discuss
30'	**Alternative Activity: Change the concept of waste**	Students should collect the "Waste" from one week, see what they can recover, reuse. Discuss
	Aternative Activity: Garbology	Students are asked to imagine they are archeologists of the future, trying to learn nabout our civilization by straying the wastes we have left behind.
20'	**Input and Discussion: Critical Topics to Discuss**	Slides
15-30'	Be Beneficial in the Region (Preparation for a project)	Collect problem fields in your areas
5'	**Saving the results**	What do you think about C2C? What did interest you about it, what do you like?

Material needed for this Module

Slides	
Video Maersk	http://www.youtube.com/watch?v=PRgp9tcOwaw
Description Activity Pipeline	
Description Case Study	
Description Activity How far do you come	
Video Story of Stuff	http://www.youtube.com/watch?v=9GorqroigqM
Research of Material Flow for Products	http://sourcemap.com/
Video Recycling by Desso	http://www.youtube.com/watch?v=7V90Jn5rVWk
Garbology	http://cwmi.css.cornell.edu/TrashGoesToSchool/Garbology.html
Toxics Lessons	http://cwmi.css.cornell.edu/TrashGoesToSchool/Toxics.html
Change the concept of waste – alternative excercise	http://cwmi.css.cornell.edu/TrashGoesToSchool/Trashor.html

Literature

NL Agency Ministry of Infrastructure and the Environment: *Usability of Life Cycle Assessmentfor Cradle to Cradle purposes. Position Paper, December 2011, page 29*
Cradle to Cradle pays off! NL Agengy, The Terrace
Report Towards the Circular Economy, Ellen McArthur Foundation and McKinsey, 2012 http://www.thecirculareconomy.org/
Resilience in the Round, Aldersgate Group http://www.aldersgategroup.org.uk/reports
Plastiki Expedition

Ideas for Student Projects

- Composting Project of different materials: http://cwmi.css.cornell.edu/resources.htm#youthteacher
- Research good internet websietes explaining toxic substances in household
- Home toxic survey http://cwmi.css.cornell.edu/TrashGoesToSchool/Household.html
- Trash goes to School http://cwmi.css.cornell.edu/TrashGoesToSchool/TrashIntro.html
- Garbology http://cwmi.css.cornell.edu/TrashGoesToSchool/Garbology.html

- **Fieldwork**: Walk in the forest, see how it works (or as video/pictures…)
- **Make an event** like "waste art" or a "T-shirt-Change-Day"

Additional Ideas:
- Simulation Game "Fischteich" by Dr. Markus Ulrich, Switzerland
http://www.iconomix.ch/de/lehrmaterial/m06/
Experience of problems with management of renewable resources, here fish
Debrief Simulation Game: Overshoot/overexploitation and collapse – feedback loops – tragedy of the commons