# CRADLE TO CRADLE

# PACKAGING

# DEVELOPMENT

*method* | *case study*


UNIVERSITY OF TWENTE
*enschede*

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*swalmen*

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**Cradle to Cradle Packaging Development**
Method | Case Study


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# Summary

This assignment is aimed at the development of Cradle to Cradle packaging. It is divided in two sections: the development of a method and the illustration of this method in a specific packaging case study.

Van Houtum BV is a medium-sized company in Swalmen, The Netherlands. The company produces hygienic paper under the Satino brand. Products of one of the product lines, Satino Black, are Cradle to Cradle-certified. Within Van Houtum's Cradle to Cradle roadmap, the search for Cradle to Cradle packaging is an important issue. A research on Cradle to Cradle packaging development is structured in this assignment. The assignment is described as:

> *Develop a method to combine elements of Cradle to Cradle and packaging development and illustrate this method by a specifically developed packaging draft*

Cradle to Cradle is a development paradigm which focuses on improving and moving from 'less bad' to 'more good'. Conventional eco-efficient approaches seek to reduce or minimize damage and shrink the 'negative footprint'. Cradle to Cradle focuses on eco-effectiveness: improving the 'positive footprint' by continuous improvement. The Cradle to Cradle design paradigm consists of three main principles:

- *Waste equals food*
- *Use current solar income*
- *Celebrate diversity*

The preliminary research of the assignment is aimed at different issues related to Cradle to Cradle packaging development. Derived from different points of view (both Van Houtum and EPEA, a Cradle to Cradle assessment institute), a certain need for Cradle to Cradle packaging can be assumed. This assumed need contradicts the current approach on packaging development. Currently, there is a striking lack of examples on Cradle to Cradle packaging. This also holds for Van Houtum's current packaging chain. None of the current packaging suppliers focus on Cradle to Cradle implementation in their products. Also, none of the recently executed packaging projects with a focus on Cradle to Cradle (for instance by EPEA Germany) is built upon a structured method. Therefore, a Cradle to Cradle packaging development method is essential.

This method is derived from relevant aspects in both Cradle to Cradle and packaging development. It is intended to be used within companies for which packaging development is no core business, but which are committed to develop Cradle to Cradle packaging, nevertheless. The method is descriptive; it describes the different steps and actions which should be executed to develop Cradle to Cradle packaging. It consists of four sections, which are finished with interim meetings. These meetings act as decision moments, giving the method a stage-gate approach. Essential in the method is its division into layers. The method consists of three layers; a Development Layer, a Material Selection Layer and an External Layer. For Cradle to Cradle, the separation of the Material Selection Layer is essential. Due to the great importance of material contents in Cradle to Cradle, all material-related developments are separated from other packaging development steps in the method.

The practical application of the method is validated during a session within Van Houtum. During this session, a project team is requested to execute an imaginary packaging project, guided by the development method. Resulting from the validation session, the method appears to be suitable as a guideline for Cradle to Cradle packaging development. However, for practical (future) application, several alterations and extensions must be added to the Cradle to Cradle packaging development method, such as the use of reflection documents.

A case study is executed to illustrate the method for Cradle to Cradle packaging development. The subject of the project has come from Van Houtum's aspiration to enter the cash & carry market and to research Cradle to Cradle packaging. The subject of the case study is the following:

> *Develop a Cradle to Cradle suited packaging draft for Satino Black toilet paper, for the cash & carry market*

The project must result in a tangible Cradle to Cradle suited packaging draft. Due to the importance of material health within Cradle to Cradle, the material research of the project is executed elaborately. The developed packaging draft consists of a corrugated board box, closed with a lid out of PaperFoam. This makes the draft suited for a post-use scenario in the waste paper system. The developed variant of this draft can be considered to be 'top-level'. This complies with the brand identity of Satino Black, for which the draft is developed.

The results of the major sections of the assignment show Cradle to Cradle in theory and practice. Quite some discrepancies between the theory and practice show. Some of these issues can be attributed to the novelty of the paradigm. Other issues are simply part of the business case of EPEA. Two issues are considered to be critical: the position of EPEA and the position of the Cradle to Cradle Products Innovation Institute (C2CPII). These strong positions (more or less monopolistic) result in (amongst others) the lack of an innovation driver from the accredited Cradle to Cradle institutes. This will influence the future popularity of the Cradle to Cradle paradigm.

# *Samenvatting*

Deze opdracht is gericht op de ontwikkeling van Cradle to Cradle verpakkingen. Het is opgedeeld in twee delen: de ontwikkeling van een methode en de illustratie van deze methode in een specifieke case study.

Van Houtum BV is een middelgroot bedrijf uit Swalmen. Het bedrijf produceert hygiënepapier onder het merk Satino. Producten uit één van de productlijnen, Satino Black, zijn Cradle to Cradle-gecertificeerd. In de Cradle to Cradle *roadmap* van Van Houtum wordt Cradle to Cradle verpakkingen genoemd als een belangrijk punt. Een onderzoek naar Cradle to Cradle verpakkingen is gestructureerd in deze opdracht. De opdrachtomschrijving is als volgt:

> *Ontwikkel een methode die elementen van Cradle to Cradle en verpakkingsontwikkeling combineert en illustreer deze methode aan de hand van een specifiek verpakkingsconcept*

Cradle to Cradle is een ontwikkelparadigma waarin gefocust wordt op productverbetering en verschuiven van 'minder slecht' naar 'meer goed'. Conventionele eco-efficiënte methoden kijken naar het verminderen van de 'negatieve voetafdruk'. Cradle to Cradle richt zich op eco-effectiviteit: het vergroten van de 'positieve voetafdruk' door continue verbetering. Het Cradle to Cradle ontwikkelparadigma beslaat drie principes:

- *Afval is voedsel*
- *Gebruik de huidige inkomsten van de zon*
- *Respecteer diversiteit*

Het vooronderzoek van de opdracht is gericht op verschillende punten die te maken hebben met Cradle to Cradle verpakkingsontwikkeling. Uit verschillende bronnen (zowel binnen Van Houtum als EPEA, een Cradle to Cradle *assessment*-instituut) kan een bepaalde noodzaak voor Cradle to Cradle verpakkingen worden opgemaakt. Deze noodzaak staat haaks op de huidige aanpak van verpakkingsontwikkeling. Momenteel is er een overduidelijk tekort aan voorbeelden van concrete Cradle to Cradle verpakkingen. Dit geldt ook voor de huidige verpakkingsketen van Van Houtum. Geen enkele van de huidige verpakkingsleveranciers richt zich op het concreet implementeren van Cradle to Cradle in zijn producten. Bovendien is geen van de momenteel uitgevoerde verpakkingsprojecten met een focus op Cradle to Cradle (bijvoorbeeld door EPEA Duitsland) gestoeld op een gestructureerde methode. Daarom is een methode voor Cradle to Cradle verpakkingsontwikkeling essentieel.

Deze methode is afgeleid uit relevante aspecten in zowel Cradle to Cradle als verpakkingsontwikkeling. Het is bedoeld om toegepast te worden binnen bedrijven waarvoor verpakkingsontwikkeling geen hoofdtaak is, maar welke wel toegewijd zijn aan het ontwikkelen van Cradle to Cradle verpakkingen. De methode is beschrijvend, het beschrijft de verschillende stappen die uitgevoerd zouden moeten worden om Cradle to Cradle verpakkingen te ontwikkelen. Het bestaat uit vier secties, welke afgerond worden met een tussenbespreking. Deze besprekingen zijn bedoeld als beslismoment, waardoor de methode een *stage-gate* aanpak heeft. Essentieel in de methode is de verdeling in lagen. De methode bestaat uit drie lagen: een Ontwikkelingslaag, een Materiaalselectielaag en een Externe Laag. Voor Cradle to Cradle is de verdeling met een

Materiaalselectielaag essentieel. Vanwege het grote belang van materiaalinhoud binnen Cradle to Cradle worden alle materiaalgerelateerde ontwikkelingen apart genomen van de andere ontwikkelingen in de methode.

De praktische toepassing van de methode is gevalideerd tijdens een sessie bij Van Houtum. Tijdens deze sessie werd een projectteam verzocht een denkbeeldig verpakkingsproject uit te voeren, aan de hand van de ontwikkelmethode. Uit de resultaten van deze validatiesessie blijkt de methode geschikt te zijn als handleiding voor Cradle to Cradle verpakkingsontwikkeling. Echter, voor praktische (toekomstige) toepassing dienen er enkele wijzigingen en toevoegingen aan de ontwikkelmethode gedaan te worden, zoals het toevoegen van het gebruik van reflectiedocumenten.

Een case study is uitgevoerd, waarmee de methode voor Cradle to Cradle verpakkingsontwikkeling wordt geïllustreerd. Het onderwerp van dit project komt voort uit het streven van Van Houtum om de *cash & carry*-markt te betreden en Cradle to Cradle verpakkingen te ontwikkelen. Het onderwerp van de *case study* is als volgt:

> *Ontwikkel een Cradle to Cradle-geschikt verpakkingsconcept voor Satino Black-toiletpapier, voor de* cash & carry*-markt*

Dit project moet resulteren in een tastbaar Cradle to Cradle-geschikt verpakkingsconcept. Vanwege het belang van materiaalinhoud binnen Cradle to Cradle is het materiaalonderzoek diepgaand uitgevoerd. Het ontwikkelde concept bestaat uit een golfkartonnen doos, welke afgesloten wordt met een deksel uit PaperFoam. Hierdoor is het concept geschikt voor een *post-use* scenario in de oud-papierstroom. De ontwikkelde variant van de verpakking kan gezien worden als *'top-level'*. Dit sluit aan bij de merkidentiteit van Satino Black, waarvoor het concept is ontwikkeld.

De resultaten van de delen van de opdracht tonen aan hoe Cradle to Cradle zich verhoudt, in theorie en praktijk. Er zijn enkele discrepanties op te merken tussen de theorie en praktijk. Enkele van deze punten kunnen toegeschreven worden aan de nieuwheid van het paradigma. Andere punten zijn eenvoudigweg onderdeel van de *business case* van EPEA. Twee punten worden gezien als kritisch: de positie van EPEA en de positie van het Cradle to Cradle Products Innovation Institute (C2CPII). Deze sterke posities (min of meer monopolistisch) resulteren onder andere in een gebrek aan innovatie vanuit de Cradle to Cradle instituten. Dit zal de toekomstige populariteit van het Cradle to Cradle paradigma gaan beïnvloeden.

# *Foreword*

This report is the result of my nine-month graduation assignment, finishing the master track of Industrial Design Engineering at the University of Twente. The assignment is aimed at Cradle to Cradle packaging development.

In recent years, I became interested in Cradle to Cradle development. After taking both master courses on Cradle to Cradle, I was very interested in applying the principles and tools of this paradigm. On top of that, master courses on Packaging Development and Management got me interested in this field of study. The latter is very well due to the interesting and inspiring lectures from Roland ten Klooster. Therefore, for my graduation assignment I was looking for a possibility to combine both Cradle to Cradle and packaging development. This assignment with Van Houtum BV offered me that opportunity.

In January 2013, I started my assignment, at Van Houtum in Swalmen, The Netherlands. This company is very well ahead with its Cradle to Cradle policy, making it an optimal environment to explore the world of Cradle to Cradle packaging development. In nine months, I structured this assignment, with several key elements. First, the preliminary research showed several striking issues related to the subject. For this, openness of both Van Houtum and EPEA was key. I have been fortunate enough to receive this during several interesting discussion sessions, both scheduled and unscheduled. With the research as a basis, a Cradle to Cradle packaging development method was set up. For this, different versions are developed, discussed and discarded, until the final version came up. For this method development, my thanks go out to Jos de Lange and Marten Toxopeus. We have spent many hours in Marten's office, discussing my progress. For me, these discussions were very useful and inspiring to adapt and improve my work.

One of the largest sections of the assignment covers the development of a Cradle to Cradle packaging draft for Satino Black, the flagship brand of Van Houtum. I got the opportunity to shape this case study to my own vision, with hardly any restrictions. This resulted in a packaging draft of which I can proudly say it is based on my design and (material) developments. For this case study, I owe my thanks to different people within Van Houtum. First of all, the members of the project team: Albert Mey, Ruud Eywoudt, Jos Manders and Guus Bruijstens. Every other week we have been discussing my progress, ideas and developments. The project team assisted me with useful input and essential guidance. I also want to thank Sjaak van Zinderen. First of all, for the fun visits to the different suppliers. And secondly, for the interesting discussions on different subjects. I also would like to thank Bas Gehlen for his openness on Van Houtum's policy and his commitment to assist me with my assignment. I thank Henk Bremer and Nick op den Buijsch for their critical view and input for my development results. I want to thank Dave Timmermans and Eric van Hoof, for respectively market research and material input.

Many issues related to my assignment required assistance from EPEA. Therefore, special thanks go out to Frieke Heens, who was willing to answer many of my questions and requests. I also thank Christoph Semisch, Tom Ohlendorf, Christian Skublak and Carsten Haeling for allowing me to talk and

brainstorm about Cradle to Cradle packaging development within EPEA Germany. I owe many thanks to several of Van Houtum's suppliers. First of all, thanks to Chico Aertsen and Bart de Groot with Smurfit Kappa Van Dam, for their unlimited assistance and commitment. I would also like to thank Job Hanterink and his colleagues with PaperFoam, for their cooperation and developments. With VPK Packaging, I want to thank Richard de Brabander and Sander Geboers for their assistance and appreciation for my developments. Many thanks also to Frank van Mourik (Sligro Food Group), for his interest in my assignment and input for the market research.

With the results of my assignment, I hope to have given Van Houtum a starting point for future Cradle to Cradle packaging development. Both as a tangible set up for a packaging draft and as a guideline for future projects.

Bjorn de Koeijer
*Eindhoven, 31 October 2013*

# Glossary

### ABC-X
Material assessment categorisation in which assessed materials are categorised ranging from "optimal" to "not acceptable".

### Additive
A substance which is added to a material to influence properties. Additives can be divided into several groups, like colouring agents, preservatives, plasticizers or stabilizers.

### Adhesive
A substance that, when applied to the surfaces of materials, binds the surfaces together.

### Biobased
Biobased materials are made from substances derived from renewable biological sources.

### Biological cycle
A biological cycle describes a closed-loop process in which materials and substances are being recycled into new biological resources.

### C2C
Cradle to Cradle (C2C) is a design paradigm which views materials as nutrients circulating in healthy, safe metabolisms. The aim of the concept is to improve the quality of products: better consumer quality, without health risks and with an economic and ecological benefit. The Cradle to Cradle design paradigm consists of three main principles:

- *Waste equals food*
- *Use current solar income*
- *Celebrate diversity*

### C2CPII
The Cradle to Cradle Products Innovation Institute (C2CPII) administers the Cradle to Cradle Certified Products Program.

### $CaCO_3$
Calcium carbonate ($CaCO_3$) is a common substance found in rocks. It is for instance used as a filler material in plastics.

### CAS number
A CAS number is a unique numerical identifier for every chemical described in open scientific literature. CAS numbers are assigned by the Chemical Abstracts Service.

### Case study
A case study is a descriptive, exploratory or explanatory analysis.

### Cash & carry
A form of trade in which goods are sold from a wholesale warehouse operated on a self-service basis.

### Certification
Certification is an external quality assessment of a current situation by an independent institute, based on strict standards and requirements.

### CI number
A CI (Colour Index) number is listed in a database of manufactured colour products. Both dyes and pigments are listed according to their colour index number.

### Circular economy
The term circular economy refers to an industrial economy that is restorative and in which materials flows are designed circulate at high quality, either in a biological or technical cycle.

### Composting
Composting is a recycling process for organic material, based on microbial activity.

### *CSR*
Corporate social responsibility (CSR) is a form of corporate self-regulation. It is focused on actions which improve social good, beyond the firm's main interest and legal regulations.

### *Downcycling*
The practice of recycling a material resulting in loss of quality. Common recycling can be categorised as downcycling.

### *Eco-effectiveness*
The transformation of products and their associated material flows to form a supportive relationship with ecological systems and future economic growth.

### *Eco-efficiency*
Eco-efficiency is a strategy focused on reducing the environmental impact of production and products. It assumes a linear flow of materials through industrial systems.

### *Ecosystem*
A community of living organisms within their environment, interacting as a system.

### *EPEA*
The Environmental Protection Encouragement Agency *Internationale Umweltforschung GmbH* (EPEA) works with clients worldwide to apply the Cradle to Cradle methodology to the design of new processes, products and services.

### *EPS*
Expanded polystyrene (EPS) is a low-weight, rigid and tough, closed-cell foam. The material is used in a wide range of applications.

### *FMCG*
Fast-moving consumer goods (FMCG) refer to products which are sold quickly and at relatively low costs (low margin/high volume business). Typical FMCGs are cosmetics, detergents, groceries and other non-durable goods.

### *HDPE*
High-density polyethylene (HDPE) is a variant of polyethylene (PE), defined by a density of 0.941 g/cm$^3$ or greater. HDPE is used in products and packaging such as milk jugs, detergent bottles, butter tubs, garbage containers and water pipes.

### *LCA*
Life cycle analysis (LCA) is a method for researching the total environmental impact of a product during its life cycle.

### *LDPE*
Low-density polyethylene (LDPE) is a variant of polyethylene (PE), defined by a density range of 0.910 to 0.940 g/cm$^3$. LDPE is used for both rigid containers and plastic film applications.

### *LLDPE*
Linear low-density polyethylene (LLDPE) is a variant of low-density polyethylene (LDPE), defined by a density range of 0.915 to 0.925 g/cm$^3$. LLDPE is used predominantly in film applications due to its toughness, flexibility and relative transparency. The material has a higher tensile strength than LDPE.

### *MBDC*
McDonough Braungart Design Chemistry, LLC (MBDC) is an accredited assessor for the Cradle to Cradle Certified Product Program.

### *MDPE*
Medium-density polyethylene (MDPE) is a variant of polyethylene (PE), defined by a density range of 0.926 to 0.940 g/cm$^3$. MDPE is typically used shrink film, packaging film, carrier bags and screw closures.

### *Nutrient*
A nutrient is a resource for a system. This can either be a chemical or material within a biological metabolism or a material within a technical system.

### *PE*
Polyethylene (PE) is the most commonly used type of plastic. It can be categorised in high-density polyethylene (HDPE) and low-density polyethylene (LDPE). PE is commonly used in a wide range of applications, like bottles, film, bags and fibres.

### *PLA*
Poly-lactic acid (PLA) is a type of plastic derived from renewable sources, like corn starch, tapioca roots or sugarcane.

### *PP*
Polypropylene (PP) is a common type of plastic. The material is commonly used in applications ranging from packaging to automotive components.

### *QESH*
Quality, environment, safety and health (QESH) manages business quality, labour conditions and environmental issues within a company.

### *Recycling*
The process in which disposed materials are is reprocessed into new resources.

### *Service product*
Products of which no relevant materials flow, during the use period.

### *Sustainability*
Sustainability is an approach that strives to limiting the environmental impact and meeting the triple bottom line. A sustainable approach aims at satisfying current needs without influencing future needs.

### *Technical cycle*
A technical cycle describes a closed-loop process in which non-renewable materials and substances are being recycled into new technical resources, with equal or higher quality.

### *Triple Bottom Line*
The result of development focused on a sustainable approach in ecologic, economic and social terms. Also known as the Triple P, or people, planet and profit (prosperity).

### *Triple Top Line*
A Triple Top Line approach is focused on a sustainable management of natural, financial, and human capital. In contrast to a Triple Bottom Line approach, it is not focused on trying to balancing ecology, economy and equity, but by honouring the needs of all three.

### *Upcycling*
Upcycling is a type of recycling resulting in material flows with equal or higher quality than the initial state.

# Contents

# 1 Introduction

Van Houtum BV is one of the first companies to implement Cradle to Cradle in its business approach. The development of Cradle to Cradle packaging is considered to be an important next step for the company's Cradle to Cradle policy.

## 1.1 Commissioning Company

Van Houtum BV is a medium-sized company in Swalmen, The Netherlands. The company has been producing hygienic paper products for over 75 years. The annual capacity is 42,000 tons of paper. The company employs nearly 200 employees and has a annual turnover of € 60 million [1].

### Aspiration

A deeply felt respect for people and the environment determines Van Houtum's operations. The company's mission is to develop innovative solutions to improve toilet hygiene with exceptional environmental performance. Within Van Houtum, quality has been secured extensively, for instance by implementing several certified management systems. In recent years, Van Houtum has implemented management systems focused on quality, environment, QESH (quality, environment, safety and health), energy and CSR (corporate social responsibility). This culture within the company has resulted in Satino Black, the first and only Cradle to Cradle-certified hygienic paper in the world.

### Products

Van Houtum produces hygienic paper under the Satino brand. Toilet paper, paper towels and cleaning paper is produced in four different Satino-lines: Black, Premium, Comfort and Basic. The company has a strong belief that disposable products should only be produced with recycled materials. Therefore, all paper products Van Houtum produces are made with 100% recycled paper. Of the products Van Houtum produces, Satino Black products are the top of the line. These products are produced with only renewable energy. Besides paper products, Van Houtum markets products within a complete assortment of washroom solutions: dispensers, soap, cleaners et cetera. For Satino Black, these products have also been Cradle to Cradle-certified.

## 1.2 Assignment

Within Van Houtum's Cradle to Cradle roadmap, the search for Cradle to Cradle packaging is an important focus point. Therefore, the issue of Cradle to Cradle packaging is structured within this assignment.

### Subject

The assignment is aimed on the process of packaging development, with a focus on applying Cradle to Cradle. The aim of the assignment is to describe a method for the implementation of Cradle to Cradle design theories and methods into packaging development. The second part of the assignment

focuses on illustrating the developed method in a case study. A tangible and specific packaging draft is developed, in which the method is applied. This results in a Cradle to Cradle packaging draft for cash and carry retail for one of Van Houtum's Satino Black products. The assignment is described as:

> *Develop a method to combine elements of Cradle to Cradle and packaging development and illustrate this method by a specifically developed packaging draft*

### *Goal Definition*

The assignment must result in a method for the implementation of Cradle to Cradle in packaging development. Besides that, the assignment must result in a tangible, specific packaging draft. Combining these two parts of the assignment will have to result in a method which is tested and illustrated in practice.

### *Approach*

The assignment consists of two major sections. Outlines are determined for both parts of the assignment. This is necessary to keep the project manageable and maintain focus. Both the method and the Cradle to Cradle packaging draft are developed simultaneously.

#### *Method*

Within the method of Cradle to Cradle packaging development, a focus is set on an implementation in general. This implies a broad perspective on packaging development, in which principles of Cradle to Cradle can be applied. Principles and methods related to the Cradle to Cradle paradigm are implemented in relevant aspects of packaging development.

#### *Case study*

The Cradle to Cradle packaging draft must be developed up to a conceptual level. The level of specification for the case study can be described as embodiment design.

## *1.3 Assignment Questions*

The assignment approach is translated into several questions. The main question is focused on the overall scope of the assignment. This question is divided into several sub questions, to cover different parts of the assignment. The sub questions each cover one of the chapters of this report.

### *Main Question*

*In what way can the principles and methods of Cradle to Cradle be applied to a method for packaging development?*

- *Chapter 2*
  What is the current status on Cradle to Cradle implementation in packaging development?
- *Chapter 3*
  How can a method be described for Cradle to Cradle packaging development?
- *Chapter 4*
  How can the described method be applied in a specific packaging development case study?
- *Chapter 5*
  What are the differences between Cradle to Cradle in theory and practice?

# 2 C2C Packaging: Current Status

Cradle to Cradle development has been established as an important paradigm within sustainable development. In this chapter, the link between Cradle to Cradle and packaging development is key. What is the current status of Cradle to Cradle implementation in packaging development?

## 2.1 Importance for C2C Packaging Development

The need for Cradle to Cradle development is described from two points of view: EPEA Germany and Van Houtum. According to Michael Braungart and William McDonough, Cradle to Cradle is well-suited to implement in packaging development [2]. The authors of *Cradle to Cradle: Remaking the Way We Make Things* compare Cradle to Cradle packaging to the traditional eco-efficient packaging:

| *Eco-efficient packaging*<br>*The traditional way* | *Eco-effective packaging*<br>*The Cradle to Cradle way* |
|---|---|
| *Minimize the amount of packaging materials to reduce the environmental impact* | *Use as much packaging as is desired to protect and differentiate the product* |
| *Discourage littering. Materials don't break down and/or release toxic additives* | *Discarded biodegradable packaging that incorporates soil nutrients would benefit the environment* |
| *Consumer is left with the liability of package disposal after product is consumed* | *Packaging will become a technical or biological nutrient after its first use* |
| *Recycled-content packaging can result in reduced performance and attractiveness* | *Packaging can be cheaper to recycle in a true closed loop process with no loss in performance.* |
| *Recycling requires consumers to distinguish among unfamiliar types of materials* | *Consumers need to distinguish between recyclables and biodegradables. Sorting technology does the work* |
| *Deposits may be mandated by law* | *Packagers can create their own deposit systems to recover expensive, desirable packages* |
| *Packaging materials must be as cheap as possible, resulting in difficult or impossible recycling* | *Returnable packaging reduces or eliminates the need to create hybrids* |

**Table 2.1** | Eco-efficient vs. eco-effective packaging [2]

### *EPEA Germany*

During a visit to EPEA Germany in Hamburg, the need for Cradle to Cradle packaging has been discussed. The importance for Cradle to Cradle packaging can be compared to the importance for Cradle to Cradle in general. In other words: material scarcity, waste elimination and material health are important. For packaging, some other issues can be added.

Current packaging development focuses on eco-efficient, end-of-pipe solutions (see table 2.1). It is supposed to be visually attractive, convenient, practical, durable, re-sealable, protective and so on. Packaging has to meet high standards and complex requirements, which is typically achieved by using lots of different substances and materials. This approach has been highly optimised (but on the wrong points, regarding to the Cradle to Cradle paradigm), to reduce the environmental impact. However, according to EPEA employees, packaging development should be focused more on functionality, quality and design. Currently, the public vision is that recycled content is better than virgin material. However, the truth is not always that unambiguous. Due to a lack of focus on material health and continuous material flows, packaging development aims for the wrong issues regarding sustainability. The implementation of a comprehensive quality concept by positively defining ingredients and the subsequent input into (recycling) systems is fundamental.

### *Van Houtum*

For Van Houtum, the development of Cradle to Cradle packaging is important. In the company's CSR roadmap, which is (partly) focused on Cradle to Cradle, the implementation of reusable packaging is mentioned. The development of Cradle to Cradle packaging is not explicitly mentioned. However, derived from several conversations with employees and management, Cradle to Cradle packaging development is considered to be 'the next step' in the company's Cradle to Cradle policy. More specifically, Cradle to Cradle packaging contributes to the Satino Black brand. New developments are initially implemented in Satino Black, since it is the leading brand within Van Houtum's product range. Therefore, Cradle to Cradle packaging will have to be developed for this brand too. The packaging will then add another unique selling point to the product line.

### *Conclusion*

With these visions, a certain need for Cradle to Cradle packaging within different companies (Van Houtum, for instance) can be assumed. This can be compared to the need for Cradle to Cradle products in general. This assumed need for Cradle to Cradle packaging contradicts the current approach on packaging development. To align this, a Cradle to Cradle packaging development method is essential.

## 2.2 *Current Status of C2C*

In 2002, chemist Michael Braungart and architect William McDonough published the book *Cradle to Cradle: Remaking the Way We Make Things*. The Cradle to Cradle philosophy focuses on improving and moving from 'less bad' to 'more good'. Conventional eco-efficient approaches seek to reduce or minimize damage and shrink the 'negative footprint'. Cradle to Cradle focuses on eco-effectiveness: doing the right things or improving the 'positive footprint' [3] by continuous improvement (figure 2.1). Within Cradle to Cradle, products are designed which are beneficial in health, environmental and economic terms. The aim of the design concept is to improve the quality of products: better consumer quality, without health risks and with an economic and ecological benefit [4]. The Cradle to Cradle design paradigm consists of three main principles [5], [6]:

- *Waste equals food*
  All materials used in products must be seen as nutrients for other products, or: 'nutrients become nutrients again', either in a technical or biological cycle.

- *Use current solar income*
  The quality of energy matters. Energy from renewable sources is paramount to effective design. This means using energy sources powered by the sun and its by-products. Systems that use solar energy are systems that use today's energy without risking or impacting future resources [7].

- *Celebrate diversity*
  To improve a system's resilience, diversity is necessary. Focusing on one criterion is to create instability and imbalance in a wider context [7]. Biodiversity, cultural diversity and conceptual diversity improve relationships, creativity and innovation.

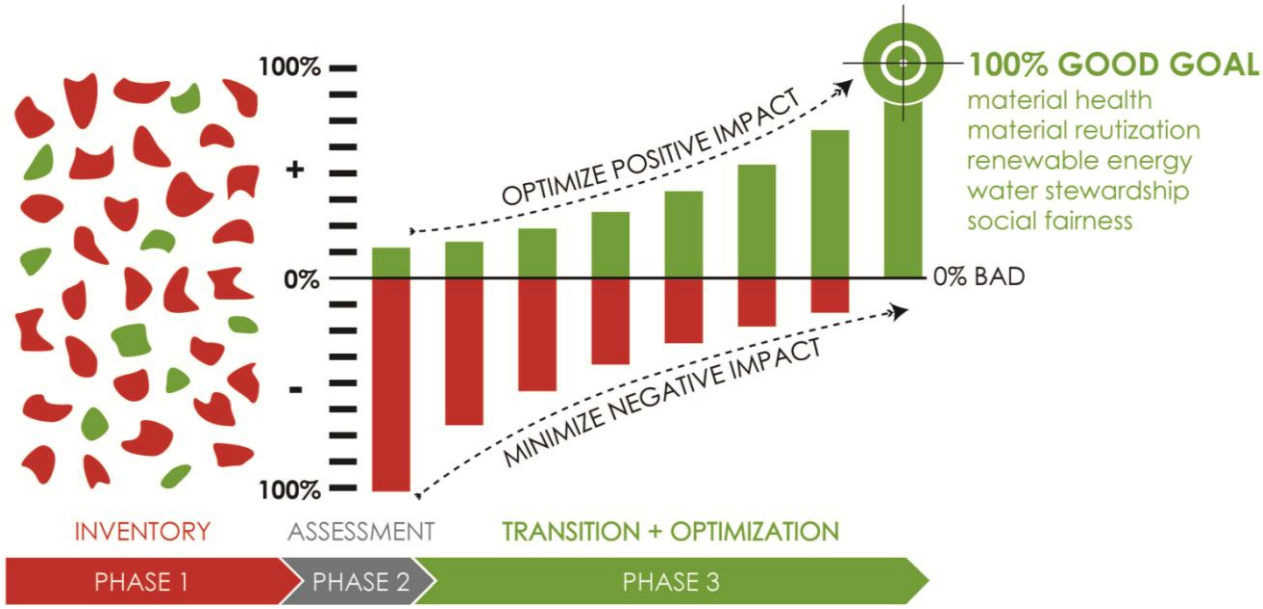


**Figure 2.1** | Continuous improvement [8]

Within the Cradle to Cradle framework, two metabolisms are important: the biological metabolism and the technical metabolism:

- *Biological cycle*
  Within the biological sphere, consumption products can be identified; products of which materials enter the environment during use in diffuse pathways, e.g. via water or air. Products within the biological cycle are made from renewable sources, the disposed materials are nutrients for the production of new resources [5].

- *Technical cycle*
  Within the technological cycle, service products are identified; products of which there is no significant material loss during the use phase of the product. For non-renewable sources, materials flow in industrial systems and are nutrients for the production of new products of equal or higher quality [5].

A third possibility is a cascade model. A cascade has overlap with both a biological and technical cycle. Cascading materials remain in a technical cycle for a certain time, while downcycling in properties. After this, the material can flow into a biological cycle. Paper recycling is a typical example of a cascade model (figure 2.2).

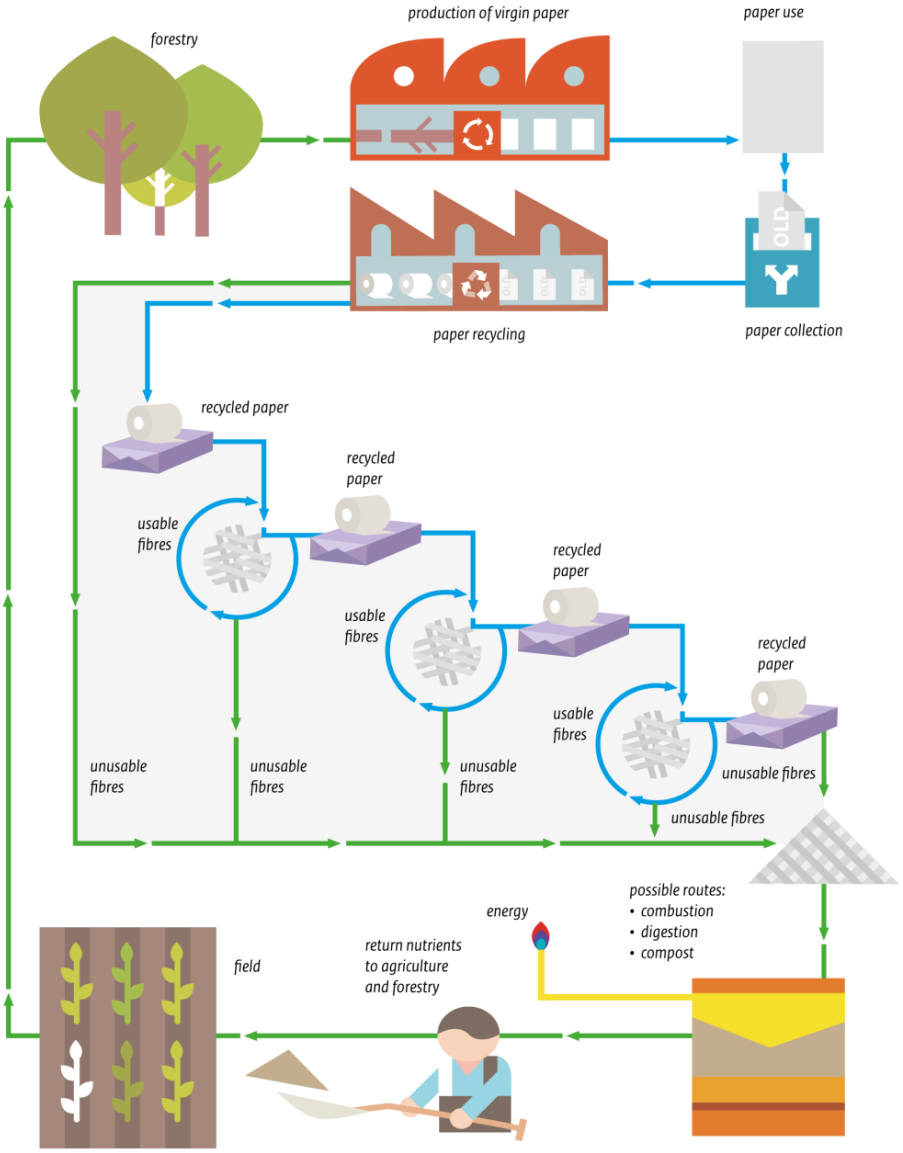


**Figure 2.2** | Cradle to Cradle paper cascade [9]

## *Certification*

The Cradle to Cradle certification framework is designed to support companies in creating Cradle to Cradle products. It is not directly meant as an innovation driver. A Cradle to Cradle certificate provides companies with the opportunity of illustrating the successes and progress their products have achieved [10].

### *Categories*

Within the Cradle to Cradle certification program, products and materials are evaluated against criteria in five categories (see also appendix A):

- *Material health:* value materials as nutrients for safe, continuous cycling
- *Material reutilisation:* maintain continuous flows of biological and technical nutrients
- *Renewable energy:* power all operations with 100% renewable energy
- *Water stewardship:* regard water as a precious resource
- *Social fairness:* celebrate all people and natural systems [8]

### *Levels*

The Cradle to Cradle certification program is not based on the binary pass/fail model. It instead incorporates the concept of continuous improvement. Product certification is available at five different levels (Basic, Bronze, Silver, Gold, and Platinum), with each higher level addressing a more rigorous set of requirements [4]. The minimum level of achievement in any of the five (previously mentioned) categories ultimately determines the final certification level [11].

### *Marks*

Obviously, an important result of the certification process is the certification mark. It can be considered as a backward reward for the efforts and developments a company has performed on the certified product, related to Cradle to Cradle. Companies receiving certification will have the opportunity to license the Cradle to Cradle brand certification mark. The certification mark may be printed on the product with the exception of products certified at Basic level [6].

## *Institutes*

Within the certification process, three institutes are important: the Cradle to Cradle Products Innovation Institute (C2CPII), McDonough Braungart Design Chemistry (MBDC) and the Environmental Protection Encouragement Agency (EPEA).

### *Cradle to Cradle Products Innovation Institute*

The Cradle to Cradle Products Innovation Institute (C2CPII) administers the Cradle to Cradle Certified Products Program. The Cradle to Cradle Certification Standards Board is responsible for reviewing and approving revisions and/or amendments to the Cradle to Cradle Certified Product Standard. C2CPII audits the executed assessments of MBDC and EPEA [12].

### *McDonough Braungart Design Chemistry, LLC*

MBDC is an Accredited Assessor for the Cradle to Cradle Certified Product Program. The Cradle to Cradle assessment methodology was originally created by MBDC in cooperation with EPEA. In 2012, MBDC licensed the Cradle to Cradle Certified Product Standard to C2CPII [13].

### *Environmental Protection Encouragement Agency GmbH*

The Environmental Protection Encouragement Agency *Internationale Umweltforschung* GmbH (EPEA), works with clients worldwide to apply the Cradle to Cradle methodology to the design of new processes, products and services [6].

## *Assessment Process*

### *Inquiry & Application*

The company will have to determine whether the product is appropriate for certification. Therefore, the certification criteria have to be reviewed (see appendix A). After that, the required documents (applicant survey, material appendix, water appendix, supplier data form and mutual nondisclosure agreement [14]) need to be filled out and send to the assessment institute (EPEA or MBDC).

### *Assessment*

Together with the assessment institute, the applicant collects the required data for certification. With this data a profile is compiled, determining to which extent the respective product fulfils the Cradle to Cradle criteria. Included in this is a complete assessment of all materials used in the production process as well as an examination of the production process itself. Every assessed material is ranked by a ABC-X categorisation (figure 2.3 [5]), which is based on assessments of the chemical risk (hazard and exposure) and recyclability of materials (in either a biological or technical cycle) [6]. The ABC-X categorisation consists of the following categories:

A. *Optimal*
The material is ideal from a Cradle to Cradle perspective for the product in question

B. *Optimisable*
The material largely supports Cradle to Cradle objectives for the product

C. *Tolerable*
Moderately problematic properties of the material in terms of quality from a Cradle to Cradle perspective are traced back to the ingredient. The ingredient is still acceptable for use

X. *Not acceptable*
Highly problematic properties of the material in terms of quality from a Cradle to Cradle perspective are traced back to the ingredient. The optimisation of the product requires phasing out this ingredient

*Not characterised*
The material cannot be fully assessed due to either lack of complete ingredient formulation, or lack of toxicological information for one or more ingredients

*Banned*
The material contains one or more chemicals from the Banned List and cannot be used in a Cradle to Cradle Certified product

A summary is compiled by the assessment institute, including a suggested certification level [11]. Then, the completed Certification Packet and supporting documentation is submitted to the Cradle to Cradle Products Innovation Institute (C2CPII) for review [15].

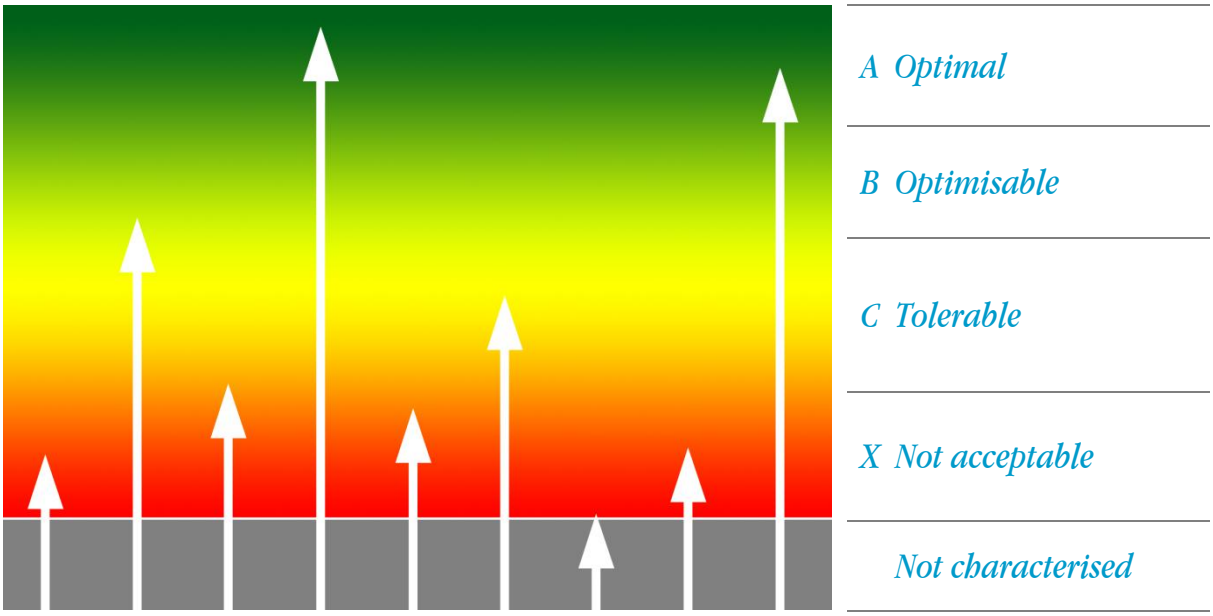


**Figure 2.3** | ABC-X categorisation

### *Certification Issuance*
C2CPII will audit the material assessment and process evaluation and review the Certification Packet and supporting documentation. For Cradle to Cradle certification issuance, only documents submitted via the accredited Cradle to Cradle assessment institutes (EPEA or MBDC) will be considered by C2CPII.

### *Renewal*

Certification is valid for two years from the certification date and must be renewed biennially. Together with the assessment institute, new data is reviewed and changes are evaluated. After that, the completed Certification Renewal Packet will be send to C2CPII for review. The complete certification process is illustrated in figure 2.4.

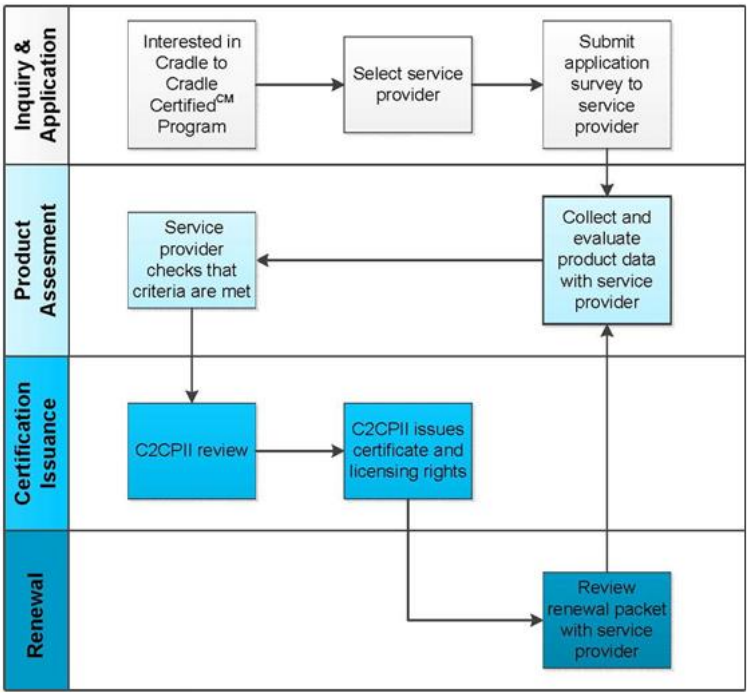


**Figure 2.4** | Process for Cradle to Cradle Certified Program [16]

## 2.3 C2C within Van Houtum

Van Houtum is one of the first companies to implement the Cradle to Cradle paradigm in its business model. Cradle to Cradle packaging is considered to be a possible important next step in the company's Cradle to Cradle activities. Therefore, an insight in the current view on Cradle to Cradle and the current status of the implementation of the principles within Van Houtum is important. This is derived from open meetings with the company's general director and QESH manager.

### *General Manager*

Within the Cradle to Cradle philosophy, two issues are very important from a business point of view: positive circular thinking and stakeholder involvement. In other words: stimulating others by being good yourself. Therefore, the Cradle to Cradle philosophy is regarded a positive way to develop and form a company vision and policy.

So far, EPEA (the Cradle to Cradle assessment organisation linked to Van Houtum) has not driven any innovation within the company. Everything had to be invented or researched by the company itself. However, it is still useful to have an external institute overseeing the developments. Independent research institutes should be able to compete in the field of Cradle to Cradle assessment and certification. Also: the Cradle to Cradle assessment approach should become open-source, focused on open innovation. Currently, the certification is viewed as the scientific validation of a company's developments. The certificate that results from this can be seen as an important communication factor. However, the openness of the certification process is far from sufficient to achieve proper developments. In order to properly validate materials and material quality, not only products should

be certified, but also complete material chains. This way, real quality of all materials in the products can be secured. However, certifying cooperative developments between companies is no point of focus for EPEA.

### *QESH Manager*

Bottom line of the Cradle to Cradle approach within Van Houtum is not limited to this specific paradigm. The most important driver is product and process development in an innovative and substantiated way. What name is related to this approach (Cradle to Cradle or anything else) is not important. Obviously, marketing (being able and allowed to put a certification logo on products) is also an important factor.

Currently, EPEA is regarded to be doing *"what should be done"*. Sometimes there is a 'grey area' (inexplicable), often due to lack of knowledge about specific materials. In those cases, assumptions need to be made, which can cause confusion. Officially, for a company like Van Houtum there is no obligation to recruit an employee of EPEA for support during the certification process. However, application files which are not approved by EPEA will not be considered by the certification authorities.

## 2.4 Packaging Development within Van Houtum

Within Van Houtum, radical packaging development (innovation) is absent. All current packaging is a derivative of standard corrugated cardboard boxes and transparent foils. Product development within Van Houtum is executed in two sections: 'paper products' and 'other products'. The latter consists of dispensers and other washroom products; packaging development is also part of this section. Regarding procedures for packaging development, not much is secured. Application of packaging projects can be initiated by different persons, which is not centrally coordinated. Project teams which carry out packaging products are composed based on relevant functions within Van Houtum. For externally conducted projects (like graphic designs for packaging), design briefs are being used.

## 2.5 C2C Implementation in Packaging Development

In current packaging development, several examples of Cradle to Cradle packaging can be found. These examples show the current status of Cradle to Cradle in packaging, in general. The developments in this field of study can be useful for the specific packaging development within Van Houtum.

### *Moonen Packaging*

Moonen Packaging, a distributor of packaging products and disposables, signed a contract with EPEA. The objective is to have a complete assortment of Cradle to Cradle certified packaging and disposables [17]. Currently, the company has a line in compostable disposables, *Moonen Natural*. These products are produced out of plant-based sustainable materials (including sugar cane, PLA and starch) and comply with the European composting norm EN-13432 [18].

### *Be Green Packaging*

Be Green Packaging was the first food packaging company in the United States to achieve Cradle to Cradle Silver certification for their commitment to prosperity through sustainability [19]. One of the product lines produced by the company consists of trays, containers and portion cups made from plant fibres that will compost in 30 to 90 days in both home and municipal composting environments [20].

### *Ecover*

Ecover is a manufacturer of cleaning products, with a focus on sustainability, plant-based ingredients and eliminating harmful ingredients. Several of the company's products have been Cradle to Cradle certified. The company has also focused on sustainable packaging, made from sugarcane-based PE. This packaging has been extensively researched on sourcing, quality, social aspects and so on. Even though the products are Cradle to Cradle certified, the packaging is not.

### *Cradle To Cradle Products Innovation Institute*

On the website of C2CPII, several Cradle to Cradle certified packaging products can be found, apart from the above mentioned (table 2.2) [21].

| *Product* | *Description* | *Producer* | *Certification* |
|---|---|---|---|
| *BioFoam* | PLA-based foamed EPS | Synbra Technology BV | Silver |
| *Inca Presswood pallets* | Made primarily from recycled wood fibre, including damaged logs, wood waste and other wood by-products | Litco International, Inc. | |
| *RACX pallets* | Fabricated of recycled HDPE plastics | Decade Products | |
| *Aluminium Can Sheet* | Material for the manufacturing of aluminium beverage cans | Alcoa, Inc. | |
| *EcoPaXX UF* | Approximately 70% of the polymer consists of building blocks derived from castor oil as a renewable resource | DSM Engineering Plastics | |
| *Mailing products* | Cradle to Cradle certified mailer, envelopes and boxes | US Postal Service | Basic/Silver |
| *Paint Can/Infant Formula Can* | A variety of cans using both steel (tinplate) and aluminium, printed and unprinted | Ardagh Group | Basic |

**Table 2.2** | Cradle to Cradle certified packaging products

### *Conclusion*

Several examples can be found of Cradle to Cradle packaging. However, the limited amount is striking. Most packaging producers currently mainly focus on eco-efficient 'environmentally friendly' packaging and on biobased and/or biodegradable packaging. Many examples in this can be found, but nearly none with a strict focus on Cradle to Cradle.

## *2.6 C2C in Van Houtum's Packaging Chain*

Several current suppliers within Van Houtum's packaging chain have been addressed with regard to Cradle to Cradle. The suppliers have been selected on their importance for Van Houtum's packaging chain; the largest and most influential suppliers have been selected. A brief overview of the relevant suppliers is listed in table 2.3. A more elaborate description can be found in appendix B. In the current situation, none of Van Houtum's packaging suppliers focus on Cradle to Cradle implementation in their products.

| Supplier | Product | Cradle to Cradle Implementation |
|---|---|---|
| *AVI* | Flexible plastic packaging | None. Focus on regenerate materials |
| *Flexoplast* | Flexible plastic packaging | None, due to assumed difficulties |
| *Flint Group* | Inks and pigments | Analysis of black pigment by EPEA |
| *Henkel* | Adhesives | Several, but none in the field of packaging |
| *Paramelt* | Adhesives | EPEA-assessment of adhesive product: optimisable |
| *Smurfit Kappa* | Corrugated board | None |
| *SunChemical* | Inks and pigments | None. Focus on 'general' sustainability |
| *VPK Packaging* | Corrugated board | Orienting on Cradle to Cradle certification |

**Table 2.3** | Cradle to Cradle implementation within suppliers in Van Houtum's packaging chain

## 2.7 EPEA Germany

EPEA is involved in several projects on Cradle to Cradle packaging development. Of these projects, most are not publicly available (yet) and cannot be published. The institute is involved in packaging projects focused on plastics, metals, cardboard and other materials [21]. Due to confidentiality, exact details of these projects cannot be communicated without permission of the company for which the project is conducted. The questionnaire by which the results have been acquired, can be found in appendix C.

### Vision on Packaging

Employees of EPEA Germany feel that current packaging is mainly developed with a focus on end-of-pipe solutions. It is highly optimised, but not on the issues the Cradle to Cradle paradigm deems important. There is no focus on material health or continuous material flows. Current packaging is supposed to meet high standards and complex requirements. However, the implementation of a comprehensive quality concept by positively defining ingredients and the subsequent input into (recycling) systems is fundamental.

### Packaging Development Approach

Like all Cradle to Cradle product development projects in which EPEA is involved, the project should be fitted in the company's 'bigger Cradle to Cradle picture'. In other words: the strategy is important. The approach is separated in three parts:

- *Inventory and goal setting*
- *Material assessment*
- *Product development*

The approach for Cradle to Cradle development is focused on four issues:

- *Intended function of the product*
- *Material definition*
- *Use scenario(s)*
- *Product*

These are interrelated and need to be met to achieve Cradle to Cradle implementation in development. The scenarios are translated out of the intended cycles in which the product has to be placed. These can be described as past, present and future scenarios; or manufacturing, use and disposal (the return to a new cycle). This approach is key in Cradle to Cradle development: by focusing on the use scenarios, end-of-pipe solutions are avoided and the development is suitable for use in complete metabolisms (development for 'the next cradle').

In Cradle to Cradle packaging development, several issues can be addressed, which could be considered difficult in the development phase:

- *Many layers of suppliers:* the level of inventory must be specified
- *Unknown inventory:* many producers are not completely aware of their ingredient inventory
- *Unknown material content:* for example recycled content)
- *Many used (different) additives:* coatings, glues, inks, et cetera
- *Used mixes of virgin and recycled material*
- *High requirements and complex properties*

### Conclusion

The approach that is used by EPEA Germany for the development of Cradle to Cradle packaging can be very useful in this assignment. It clearly shows in what way the principles have been translated into a useful approach. This approach is far from a utopia, but focuses on feasibility. However, the information that has been gathered at EPEA Germany is restricted under a NDA (non-disclosure agreement). Therefore, specific projects and developments cannot be explicitly mentioned. This way of working under secrecy is common for EPEA; and very well understandable. However, it counters openness, which is important for Cradle to Cradle development.

## 2.8 Conclusion

This chapter shows several important issues related to Cradle to Cradle implementation in packaging development. First of all: a certain need for Cradle to Cradle packaging can be assumed. This need comes forward from both visions of EPEA Germany and Van Houtum. On top that, research on the current status shows that there is a lack of focus on Cradle to Cradle implementation in packaging development (both in general and within Van Houtum's packaging chain). Also, none of the recently executed packaging projects with a focus on Cradle to Cradle (for instance by EPEA Germany) is built upon a structured method. This implies that such a method is required. Therefore, a certain limitation of relevant aspects of both Cradle to Cradle and packaging development is key.

## 2.9 Aspect Selection

The method for the implementation of Cradle to Cradle in packaging development is based on relevant aspects in both fields. By addressing these relevant aspects, Cradle to Cradle implementation in packaging development can be supported. The aspects are underpinned by the research results and conclusions in the previous sections of this chapter.

### Cradle To Cradle Aspects

Within Cradle to Cradle, many aspects can be summed up. However, most of these aspects are principles and general terms, not suitable as strict guidelines for the development of a method. Therefore, this will have to be translated into practical aspects. The following Cradle to Cradle aspects have been selected for the development of the method:

- *Material health*
  Products should be produced using only optimised ('healthy') materials, which are safe for the environment.

- *Intended utilisation*
  Important within Cradle to Cradle is a holistic view. The manufacturing, use and post-use must be described in a scenario. Important in this scenario is the intended utilisation of the product and the definition of the material reutilisation (*the next cradle*), within a technical or biological cycle.

- *Energy supply, carbon management and water stewardship*
  Cradle to Cradle products are manufactured with a positive impact on energy supply, carbon management and water stewardship. The intention is to use renewable energy for manufacturing and recycling of products.

Other aspects mentioned in Cradle to Cradle certification literature, like social fairness, will not be specifically elaborated in the method. These types of aspects are deemed to be self-evident in production and manufacturing in Western countries. Therefore, it is not necessary to focus on in the relevant Cradle to Cradle aspects.

Important within the Cradle to Cradle aspects, is the common approach on Cradle to Cradle design [5]. It could be used as a guideline for the identification of important steps within the method:

1. *Type (innovation or optimisation)*
2. *Purpose analysis*
3. *Cycle (biological or technical)*
4. *ABC-X categorisation of ingredients*
5. *Development of Materials Preference List*
6. *Product Design*
7. *Production and implementation*
8. *Marketing*
9. *Communication*

### *Packaging Development Aspects*

Aspects related to packaging development come from the typical packaging chain. The packaging chain refers to all the links that play a role in the marketing of a packaged product, packaging being the main, recurrent element [22-24]:

- *Resources*
- *Manufacturing*
- *Packing*
- *Distribution*
- *Retail*
- *Use*
- *Recycling*

Other important aspects of packaging development can be related to packaging functions [22, 25]:

- *Container function*
- *Information function*
- *Marketing function*
- *Utility function*

### *Conclusion*

Aspects of both Cradle to Cradle and packaging development have been derived from research on different issues. These aspects combined form the outlines of the method. It limits what will be taken into account for the development of the Cradle to Cradle packaging method and the specific packaging concept. For the development of the method, an accumulation of the aspects in both fields must be found. This accumulation is described in chapter 3.

# 3 C2C Packaging Development Method

The method for Cradle to Cradle packaging development is based on the selected aspects for Cradle to Cradle and packaging development. These aspects have been combined, in order to develop a specific Cradle to Cradle packaging development method.

## 3.1 Method Importance

Both Cradle to Cradle and packaging development are areas on which extensive amounts of literature have been published. In the case of packaging development, this has been derived both from theoretic developments and from practical research. For Cradle to Cradle, the amount of literature on the practical implications of the paradigm is far less extensive. This is partly due to the relatively new approach that Cradle to Cradle is. As a result, the amount of specific Cradle to Cradle packaging products is small. Of this limited amount, only the results have been published. The actual approach and development steps which have been conducted will remain companies' secrets. This results in a lack of descriptions of possible approaches for the development of Cradle to Cradle packaging. That is why a (structured) method is important: a clear and widely applicable approach for the development of Cradle to Cradle packaging is currently missing.

## 3.2 Method Application

For the Cradle to Cradle packaging development method, the application is important. This includes the goal definition: what is the purpose of the method, what should be possible to be achieved by using it? Also, the target group is important to specify; who is going to (or should be able to) use the method?

### *Requirements*

The method meets certain requirements. These requirements must describe the way in which it must be able to be used and what should be possible to be achieved by using the method. The requirements are focused on both the process and the outcome of the application of the method [26].

The method ...

- ... has to enable implementation of Cradle to Cradle in packaging development projects[1]
- ... must be built upon relevant Cradle to Cradle and packaging development aspects
- ... must be able to be used as a guideline for packaging development
- ... must be practically applicable within a packaging development project
- ... must be able to be adapted to a specific packaging development project

[1] *This implies that primary, secondary and tertiary packaging should be possible to be developed using the method. However, this discrimination in packaging levels has deliberately not been mentioned in the aspect selection (chapter 2). This is due to the difference in addressing what these levels of packaging mean.*

### *Target Group*

The method is intended to be used within companies that are committed to develop Cradle to Cradle packaging. The development of the method is based on a development project for a packaging draft for a certain product within Van Houtum's range. Therefore, the resulting method is best applicable in companies comparable to Van Houtum. This implies companies for which packaging development is no core business, but which are committed to develop Cradle to Cradle packaging, nevertheless.

## *3.3 Aspect Accumulation*

Relevant aspects are selected from both the fields of Cradle to Cradle and packaging development (chapter 2). Out of these aspects, the most important are selected, as the outlines of the method. Out of the Cradle to Cradle aspects, material health and material reutilisation are by far the most important. Certification is the intended result of efforts in Cradle to Cradle product development. In certification, most issues regard the material health of products, making this the most relevant aspect. Out of the packaging aspects, the packaging chain is considered to be most relevant. To accumulate these aspects, the relevant Cradle to Cradle aspects are projected onto the mentioned packaging chain (packaging phases). The 'level of Cradle to Cradle' is regarded to be most significant during the first and final packaging phases, visualised in figure 3.1. During the middle phases, the influence of Cradle to Cradle is limited to comprehending the added value of Cradle to Cradle packaging by the stakeholders. For instance: the user of a packaging will have to understand the intended future scenario (recycling in a biological or technical cycle) and has to act on it. However, this is not explicitly mentioned in Cradle to Cradle certification.

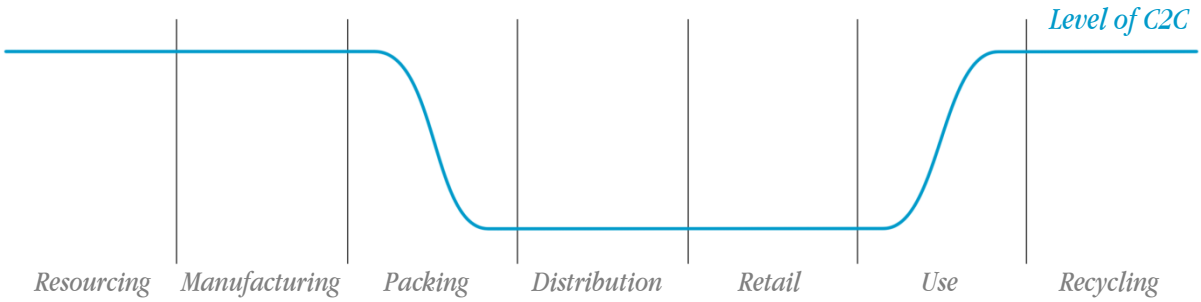


**Figure 3.1** | Level of Cradle to Cradle in packaging phases

## *3.4 Method Description*

The Cradle to Cradle packaging development method is derived from the mentioned aspects. Material health (and reutilisation) and the typical packaging chain are considered to be important aspects for the development of Cradle to Cradle packaging. The method is descriptive. It describes the different steps and actions which should be executed to develop Cradle to Cradle packaging. However, the way in which those steps and actions are executed is not dictated. This means that the users targeted to be working with this method will have to comprehend this level of abstraction.

The method consists of four sections (figure 3.2); the Definition Section (1), Conceptualisation Section (2), Detailing Section (3) and Completion Section (4). The first three sections are finished with an interim meeting, which act as a decision moment (go/no-go milestone): Decision Moments A, B and C. During every decision moment, results from the previous sections are reviewed and discussed. After that, the decision on whether or not to execute the following section of the project is made. Every Decision Moment is concluded with decisions on the required results of the next section.

The most important feature of the method is its division into layers. The method consists of three layers (see figure 3.2); a Development Layer (dark blue), a Material Selection Layer (medium blue) and an External Layer (light blue). Within the Material Selection Layer, the materials are identified, specified and selected. For this packaging development method, the separation of the Material Selection Layer is essential. Due to the great importance of material contents in Cradle to Cradle, all material-related developments are separated from other packaging development steps in the method. This way, it could also be possible to allow external parties to take care of the material-related developments. It thus allows companies with a non-packaging core business to develop Cradle to Cradle packaging, while the material-related developments are executed externally.

Important within the method is the iterative approach; previous phases can be updated with developments in later phases. This will mainly be important for future packaging development projects; it will keep the method up-to-date. A packaging development project could possibly start at any of the four sections, if (and only if) all input for that section is known. For instance: if a project is executed for which all input for the Conceptualisation Section is already known, the Definition Section could be skipped. In that case, the start of the project will be Decision Moment A.

The method is visualised by means of a flow chart, with a stage-gate approach (the go/no-go milestones). This way, it can easily be demonstrated that for each step there is adequate input available, that the anticipated output from the step is likely to occur based on the input, and that the anticipated output is an adequate input to another step [26]. A larger version of the method visualisation (figure 3.2) can be found in appendix D.

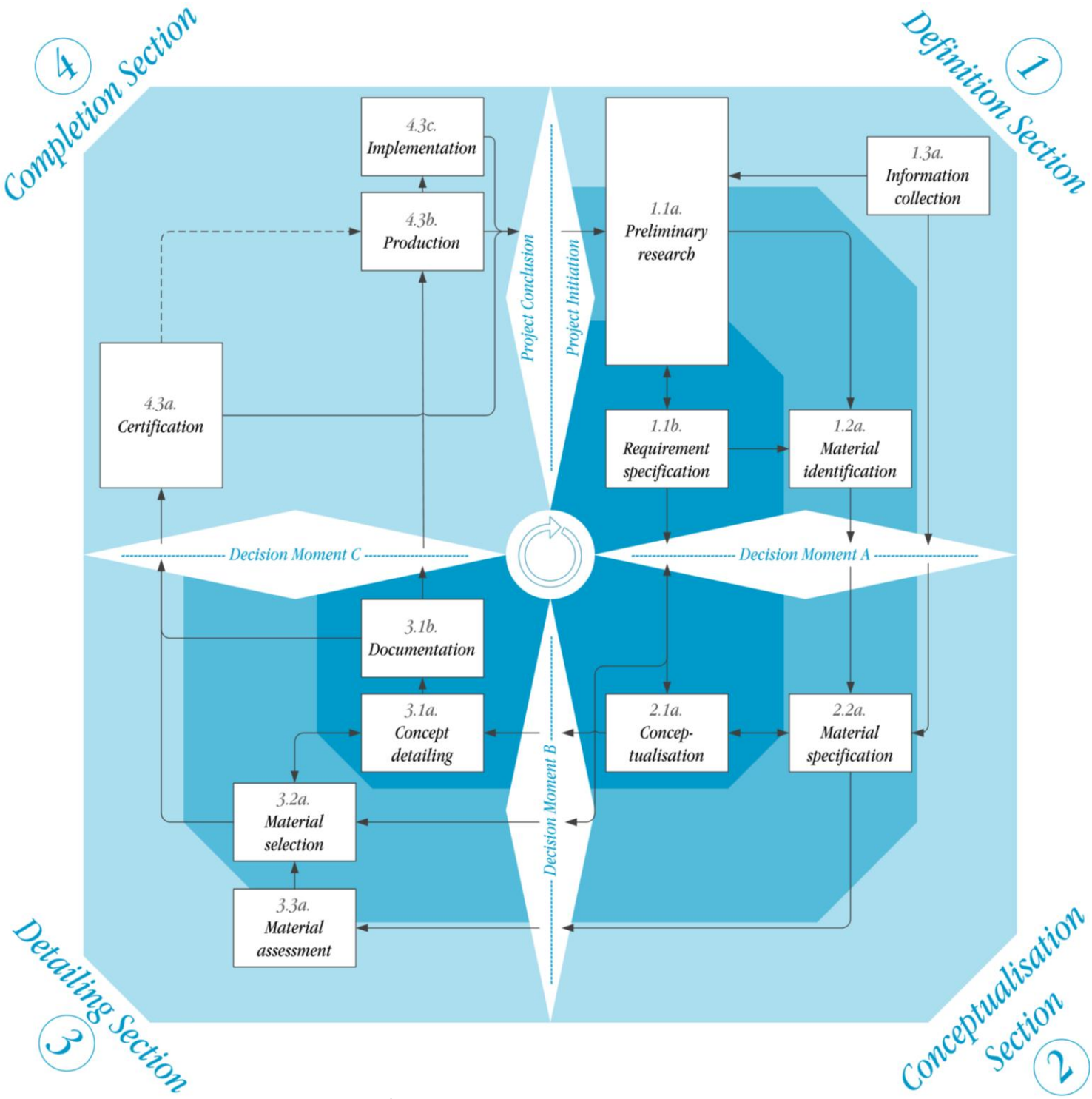


**Figure 3.2** | Cradle to Cradle packaging development method

***Legend***

In the following paragraphs, the method is described and clarified. This is done section per section. To clarify which sections and layers the descriptions regard, symbols in the text's margin are used. These symbols show simplified representations of the method's sections and layers (table 3.1)

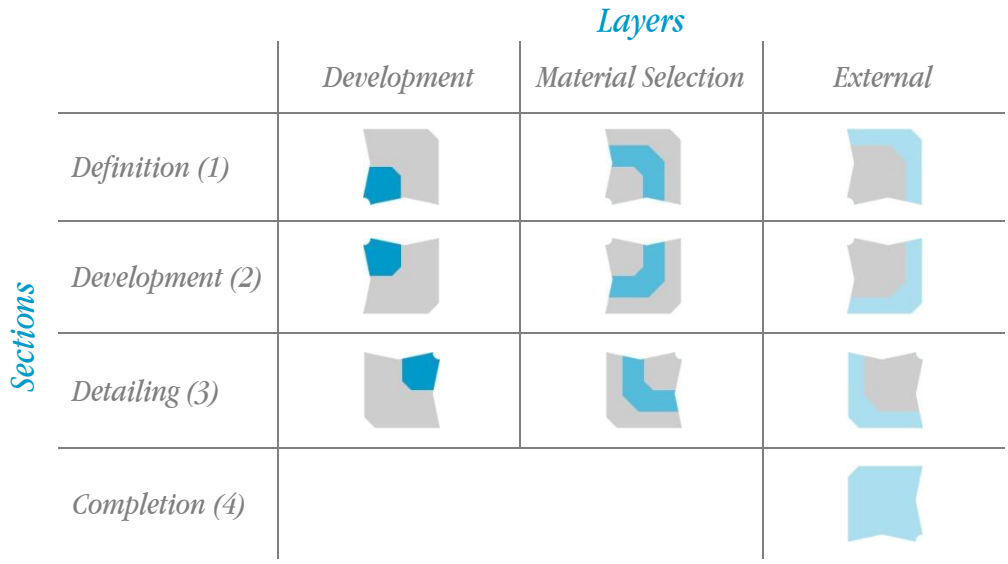


**Table 3.1** | Method description legend

## *Project Initiation*

From different sources of input, a project trigger could be initiated. Depending on the type of project, issues regarding the risks and possibilities must be considered. Since the type and level of packaging development projects can vary highly, general guidelines for these considerations are not set up. It is up to the company's management to decide on the initiation or cancellation of every specific packaging project.

An internal project team must be formed. This project team will have to consist of different positions available within the company. Depending on the type of company, the composition of the project team can vary. In general, the following positions will be important within the project team:

a) *Management (decision-making level)*
b) *Product development*
c) *Purchasing*
d) *Processing*
e) *Sales*

During the Project Initiation session, the requirements for the next decision moment must be specified. The results of the Definition Section will be reviewed during this decision moment. Therefore, it is important to specify what the required level of the resulting documents must be. Of the following documents, issues must be determined:

- *Requirement specification*
  - Types of requirement subjects (e.g. general packaging requirements, company requirements, et cetera)
- *Identified materials*
  - Type of identified materials (e.g. all possibly suited materials from current suppliers)

### 3.4.1 Definition Section

The development method starts with a Definition Section (figure 3.3). This section is intended to determine the boundaries of the packaging development project.

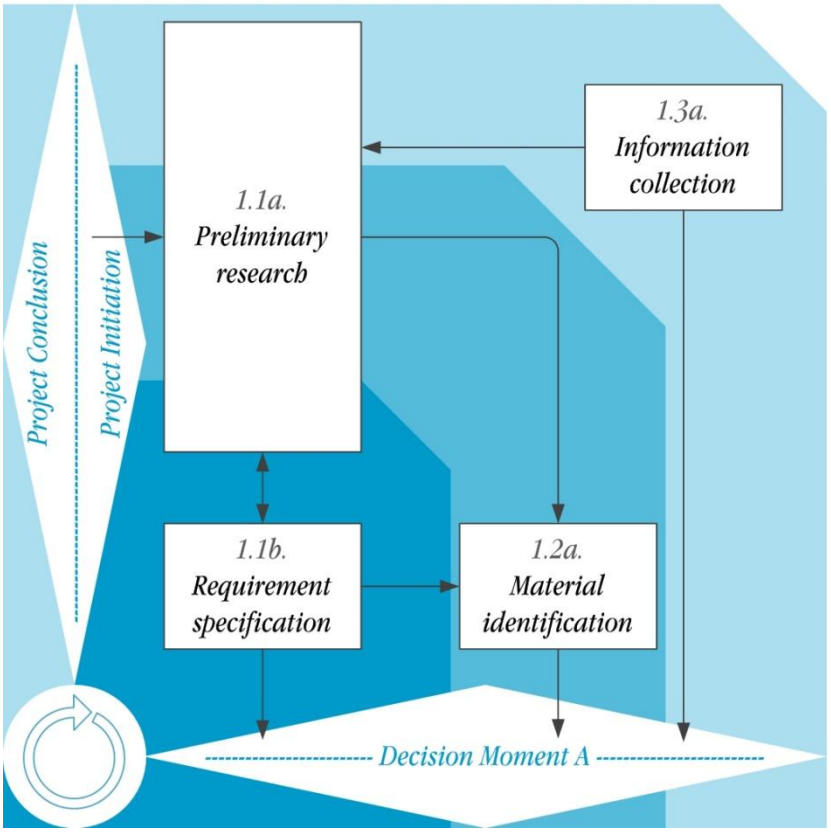


**Figure 3.3** | Definition Section

#### *Development Layer*

In the Development Layer of the Definition Section (the dark blue corner in figure 3.3), several actions are important. The phase starts with preliminary research.

#### *1.1a Preliminary research*

This research is focused on the company, the scoped market and Cradle to Cradle developments. It results in documents on the project conditions and development input.

##### *Project Conditions*

The project conditions describe the (practical) boundaries for the specific packaging project. These conditions can be derived from an analysis of the company's current situation and developments. It consists of the following issues:

a) *Time frame*
b) *Budget*
c) *Cradle to Cradle requirements (depending on certification level)*
d) *Internal stakeholders*
e) *Near-future developments*

The first two issues (time frame and budget) will (partially) have been determined before the start of the project, during the project initiation. The Cradle to Cradle requirements (c) will have to be considered for every new packaging project. Cradle to Cradle requirements in general will probably not change very rapidly (see also appendix A). However, related to the desired certificate the concept

development will have to result in, the requirements may vary. For every project, the internal stakeholders (d) have to be determined. The internal stakeholders do not necessarily have to match the project team. The project team actually executes the project steps, while the internal stakeholders can either have an advising or decision making role in the project. Like the time frame and budget, the company's near-future developments (e) will probably already be known at the start of every packaging development project.

***Development Input***

The development input is the result of the preliminary research which will act as input for the concept development. It consists of the following issues:

a) *Goal definition*
b) *Product*
c) *Brand*
d) *Market*
e) *Target group*
f) *Benchmark*

Within the goal definition (a), the target of the specific packaging development project is determined. This also includes determining the depth of development, ranging from a basic packaging concept up to a certified, marketed and implemented packaging. The product (b), brand (c) and market (d) for which the packaging project will be executed are important issues within the concept input. Before the start of the project, these issues will probably already be determined, but not yet specified. Combined, the product, brand and market determine the target group (e) for the packaging concept. Finally, a benchmark (f) must be described. This focuses on the products from other brands, for the newly developed packaging draft to compete with.

### *1.1b Requirement specification*

Derived from the preliminary research, the requirements can be specified. Within these requirements, a distinction between requirements, targets and bonuses must be made. Requirements are the issues which are essential for the packaging concept, and can be measured (quantitative). Targets are issues that have to be strived for, but can be difficult or impossible to quantify. Bonuses are issues which are not of decisive importance, but could be nice to have in the packaging concept. All requirements must be sorted on their subject, depending on the level which has been determined during the Project Initiation. Subjects could be:

- *General packaging requirements*
- *Developing company requirements*
- *Cradle to Cradle requirements*
- *Market requirements*
- *Technical requirements*

## *Material Selection Layer*

### *1.2a Material Identification*

Within the Material Selection Layer of the method (medium blue in figure 3.3), the Definition Section consists of the material identification (1.2a). Cradle to Cradle certification is mainly focused on material content, therefore the selection of materials for use within a packaging draft is highly important. The material identification is focused on brief descriptions of different possibly suited base materials and additives (coatings, glues, inks, et cetera), depending on the level which has been determined during the Project Initiation. The estimation on whether or not a material is believed to be Cradle to Cradle suited is based on knowledge of certification requirements. On top of that, a certain amount of common sense is required. Apart from the suitability for Cradle to Cradle, the specific packaging requirements (the intended purpose) are important. Of every indentified material,

accompanying material scenarios must be drawn up. These scenarios address the material's manufacturing, use and end of use. A list of identified materials is the result of the material identification. This list is intended to be complemented during every new packaging project. New material are added, building up an extensive Material Knowledge Bank (see also appendix E).



### *External Layer*

#### *1.3a Information collection*

Of every material which is deemed possibly suitable, basic information (1.3a) and material samples must be requested by the supplying/producing companies. The samples are important for analysis within the project team (look, touch and feel).

---

### *Decision Moment A*

The final stage of the Definition Section is Decision Moment A, which acts as a go/no-go milestone. During this milestone, the results of the Definition Section are reviewed and judged, by the level as set up in the Project Initiation. The following documents have to be reviewed:

- *Requirement specification*
  Regarding the requirements for the packaging concept, the different specifications have to be reviewed. Important is the consideration whether or not all requirements can be executed and cover the exact demand the company has.
- *Identified materials*
  The materials have been identified on possible suitability for Cradle to Cradle certification and the specific application. During Decision Moment A, the list of identified materials will have to be reviewed. The identified materials must be considered on the practical application within the intended purpose.

During this Decision Moment, a decision is made on whether or not to execute the next section of the project. The succeeding section of the project can only be executed when the results of the Definition Section are deemed sufficient. After this decision has been made, the level of the next section's documents must be specified. During Decision Moment B, the following documents are being judged on different issues:

- *Defined concepts*
  - Amount of concepts
  - Level of draft (concept) definition
- *Specified materials*
  - All available material information

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### 3.4.2 Conceptualisation Section

During the Conceptualisation Section (figure 3.4), the actual packaging draft development takes place. This phase results in several (basic) concepts, and specified materials and scenarios.

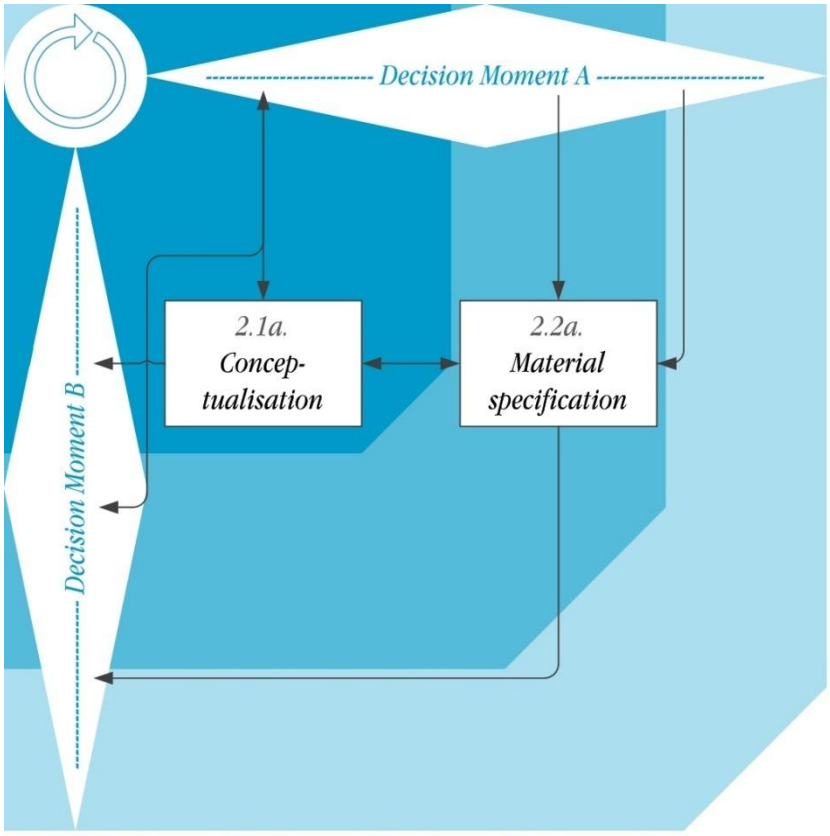



**Figure 3.4** | Conceptualisation Section

***Development Layer***

***2.1a Conceptualisation***

The results of the Definition Section (requirement specification) act as input for the conceptualisation. The identified materials (and scenarios) act as a limitation for the development of draft ideas. During the conceptualisation, several ideas for packaging concepts are generated. This can be done by brainstorming sessions, for instance. After that, the basic ideas need to be selected and developed into structured, defined concepts. The different concepts need to be described up to equal levels, to enable proper concept selection. This step is iterative and could therefore be performed multiple times.

***Material Selection Layer***

***2.2a Material Specification***

The identified materials and scenarios (described during the Definition Section) are used as the basis for the selection of the most suitable materials. The selection is based on the requirements and the drafts which are under development. For every material, the composition and material content is important. It is mainly relevant for base materials and essential additives. Process chemicals et cetera are not yet analysed. The material analysis can be acquired in three different ways:

1. *Material analysis is available and disclosed*
   In this case, the composition and material can easily be determined by the development team. With this information, an estimate of the Cradle to Cradle credibility can be made.

2. *Material analysis is available, but not disclosed*
   If a material supplier does not want to share the information, a secrecy agreement with a third party (for instance an independent Cradle to Cradle assessment body) is a possibility.
3. *No material analysis available*
   In this case, the analysis must be conducted in-house or commissioned by the developing company. For this analysis, several samples of the materials under consideration must be ordered from the supplier. The results of the analysis are primarily for use within the developing company. However, disclosure with the supplier can be discussed.

The material specification results in a list of specified materials, which are suitable for the concepts under development.

## *Decision Moment B*

During Decision Moment B, the most suitable concept(s) must be selected. This is done by comparing the concepts to the project conditions and requirements. On top of that, the subjective requirements from the internal stakeholders can be of decisive importance. This is typically a decision which has to be made by all internal stakeholders of the project. During Decision Moment B, the following issues will be reviewed, by the requirements as set up during Decision Moment A:

- *Defined drafts*
- *Specified materials*

When these documents are deemed sufficient, the Detailing Section of the project can be executed. For this section, the required results must be specified. During Decision Moment C, the following documents are being judged on different issues:

- *Detailed draft*
  - Level of draft detailing
  - Sufficiency for production and certification

- *Selected materials*
  - Material assessment
  - Sufficiency for certification

- *Documentation*
  - Complete documentation package
  - Sufficient documentation for production and certification
  - Sufficient documentation for draft review

### 3.4.3 Detailing Section

During the Detailing Section (figure 3.5), the drafts need to be detailed more elaborately. It can be seen as a second-level Development Section.

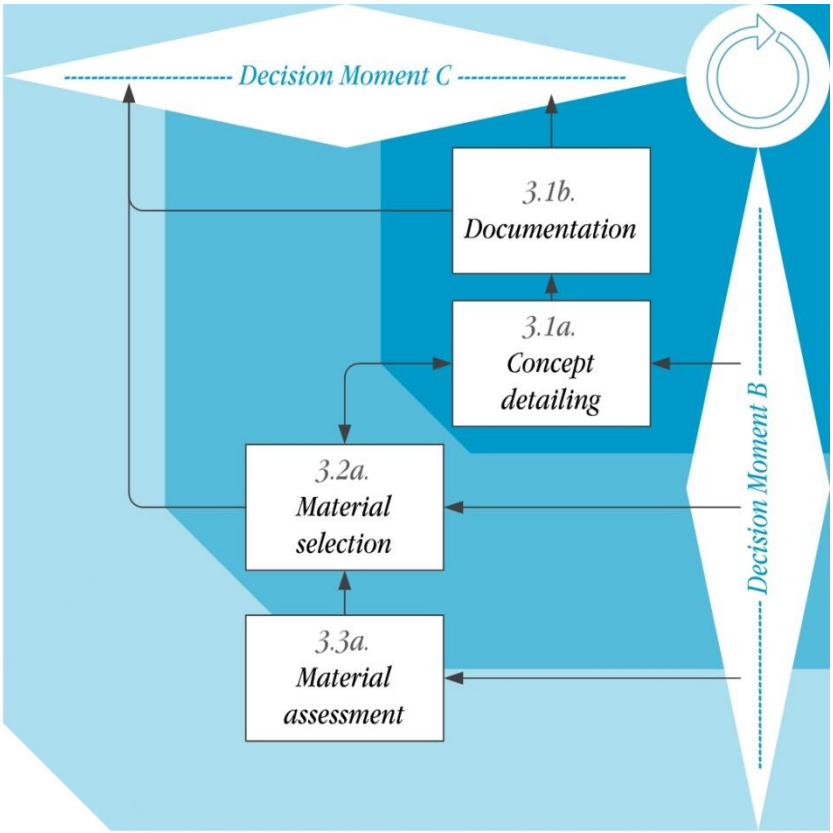



**Figure 3.5** | Detailing Section

#### *Development Layer*

**3.1a Concept Detailing**

The concept detailing stage consists of the development of detailed drafts. The level of detail is partially dependent on the specific project, but 'production-ready' basically covers the level of detail which is required. This includes technical drawings, specific dimensions, graphic design, functional description et cetera. And obviously, the draft's appearance in general. Also, a prototype can be produced, based on the detailed draft. This prototype is aimed at either performing mechanical tests or for a review of the draft's appearance. The testing is done to ensure strength, load resistance et cetera comply with the requirements. The result of this step is a (one or several) detailed draft(s). This step could optionally be performed multiple times (iterative).

**3.1b Documentation**

For every developed packaging draft, the properties must be documented. This includes:

- *Design (physical and graphical)*
- *(Technical) drawings*
- *Material descriptions*
- *Test and analysis results*
- *Production steps and tools*
- *Manual*

### *Material Selection Layer*

#### *3.2a Material Selection*

Out of the assessed materials, some may and some may not be suited for the drafts under development. All materials which are still under consideration, have not yet been selected on issues like producibility, price et cetera. The material selection is based on these issues and results in selected materials. Of every selected material, scenarios (on production, use and post-use) have to be described. This acts as input for the concept detailing (3.1a) and describes the final material possibilities for the packaging draft.

### *External Layer*

#### *3.3a Material Assessment*

During the material assessment, the specified materials (derived from the Conceptualisation Section) are assessed. For every material the actual material content must be determined. This way, is it possible to make a distinction between suitable and non-suitable materials, out of the identified materials. If necessary, this is done externally by an independent Cradle to Cradle assessment body. This results in an official material assessment for Cradle to Cradle certification. During the material specification (Conceptualisation Section), the base material have been analysed (when possible), this is merely for material indication. Specified materials (in combination with each specified scenario) which turn out to be not suitable, are rejected. For every project, the company's knowledge bank of suitable materials will expand. Therefore, not every packaging development project will require the same level of material assessment.

## *Decision Moment C*

Decision Moment C concludes the Detailing Section. All development steps have been executed, and the draft has been detailed completely. This also includes the specific selected materials (and accompanying scenarios) and all documentation. During this Decision Moment, the following issues will be reviewed, by the level as specified during Decision Moment B:

- *Detailed draft*
- *Selected materials (including material assessment)*
- *Complete documentation package*

The final section of the method (the Completion Section) concludes the project. During this section, no internal developments take place. However, several external developments (Cradle to Cradle certification, production and market implementation) are important. The Completion Section is concluded with a Project Conclusion session, during which several results must be reviewed. This session not a decision moment as such, but more of a review moment. First of all, the outcome of the Completion Section is important to review. This includes the results of the certification (the resulting certificate level), production and implementation ("when" and "how much"). These issues regard whether or not a project can be considered to be finished and successful. On top of that, the execution of the total project is reviewed during the Project Conclusion session:

- *Project execution (development method)*
- *Packaging draft (development results)*
  - Certification results
  - Production results
  - Market implementation

### 3.4.4 Completion Section

The final section of the packaging development method is the Completion Section (figure 3.6). It is focused on the completion of the packaging development project, conducting Cradle to Cradle certification and market implementation.

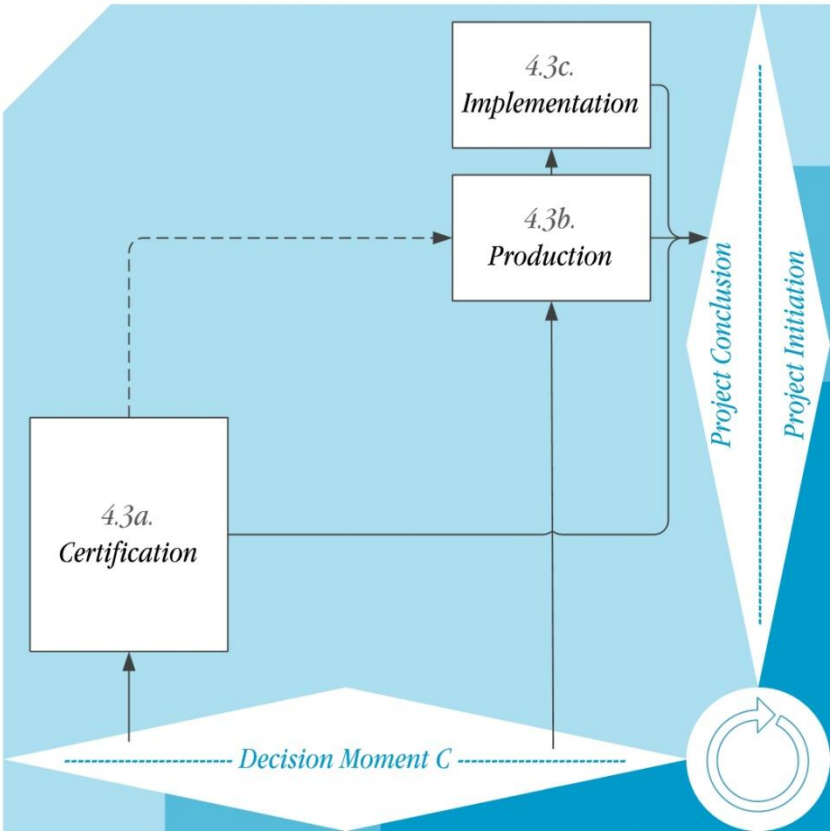



**Figure 3.6** | Completion Section

***External Layer***

***4.3a Certification***

An important issue is the Cradle to Cradle certification. This is executed by an external Cradle to Cradle assessment body, like EPEA. Since the material assessment (3.3a) has already been executed during the Detailing Section, the certification can be completed relatively quick. 'Only' issues regarding renewable energy, water stewardship and social fairness will have to be assessed (see also chapter 2).

***4.3b Production***

Based on the approved draft, the initial production can take place. This includes both the pilot runs of packaging production and filling. It also includes the initial (commercial) runs of production and filling. All required tools, (technical) drawings and preparations have been completed during the Detailing Section. There is no strict link between the certification and the production of the packaging draft. This implicates that certification is not always a required step for production. It depends on the goal definition as drawn up during the Definition Section.

***4.3c Implementation***

With the production (4.3b) completed, the packaging draft is ready for market implementation. This includes filling the first batches of produced packages, transport and storage and placement in the

selected market. But also the physical implementation of the planned marketing actions and sales activities, even though this is not explicitly mentioned in this method.

### *Project Conclusion*

Every packaging project will be concluded during a Project Conclusion session. This is not a go/no-go milestone as such, simply because all project actions have been executed. The goal of the Project Conclusion session is to evaluate the project. This regards both the project as a whole and the specifically developed draft. The issues regarding the executed project act as input for the task selection at the start of the next packaging development project. On top of that, issues regarding the specific packaging draft act as input for the next project's preliminary research and material identification. In other words, during the Project Conclusion session the following issues will be reviewed:

- *Project execution (development method)*
- *Packaging draft (development results)*

These issues can act as input for every next packaging project the company will execute.

## 3.5 Method Validation

Based on the method, a specific packaging project is executed as a case study. This case study must result in a tangible Cradle to Cradle packaging draft. On top of that, the case study is used to further develop the method. In other words: the method and the case study act as iterative development steps. Since both the method and the packaging draft are developed simultaneously and by the same person, there is a risk of a limited approach. Therefore, the method's practical application potential must be validated.

### *Outline*

The method is validated within the company where the developments have taken place (Van Houtum BV). The method has initially been developed for practical implementation within that company. Therefore, it is important to validate whether or not the method is suitable for developing Cradle to Cradle packaging within the company. The method validation is executed as a workshop session. The session has been executed with several people, selected for their function within the company. The people who will probably practically apply the method in future packaging development projects, have been involved. The project team consists of the following business functions:

- *Product development*
- *Product management*
- *QESH management*
- *Processing*
- *Purchasing*

### *Implementation*

During the validation session, the project team is requested to execute a packaging project, guided by the (explained) development method. The subject of the session is an imaginary project, which has been selected on the possibility for practical application. All steps of the first three sections of the

method are executed during the workshop. The fourth section is not executed, since this section does not contain any internal development steps. The development brief for the project is:

*Develop a Cradle to Cradle foil packaging draft for paper towels*

The session takes place in a single room. Separate 'offices' (tables) are placed in the room, for every member of the project team. In the middle of the room, a table acts as the 'conference room' for the project team. This is visualised in figures 3.7 and 3.8. The developer of the method acts as the workshop leader. On top of that, he enacts the external parties involved in the execution of a Cradle to Cradle packaging project (suppliers and EPEA). A person who is not involved in the development of the method or with Van Houtum, acts as an independent observer.

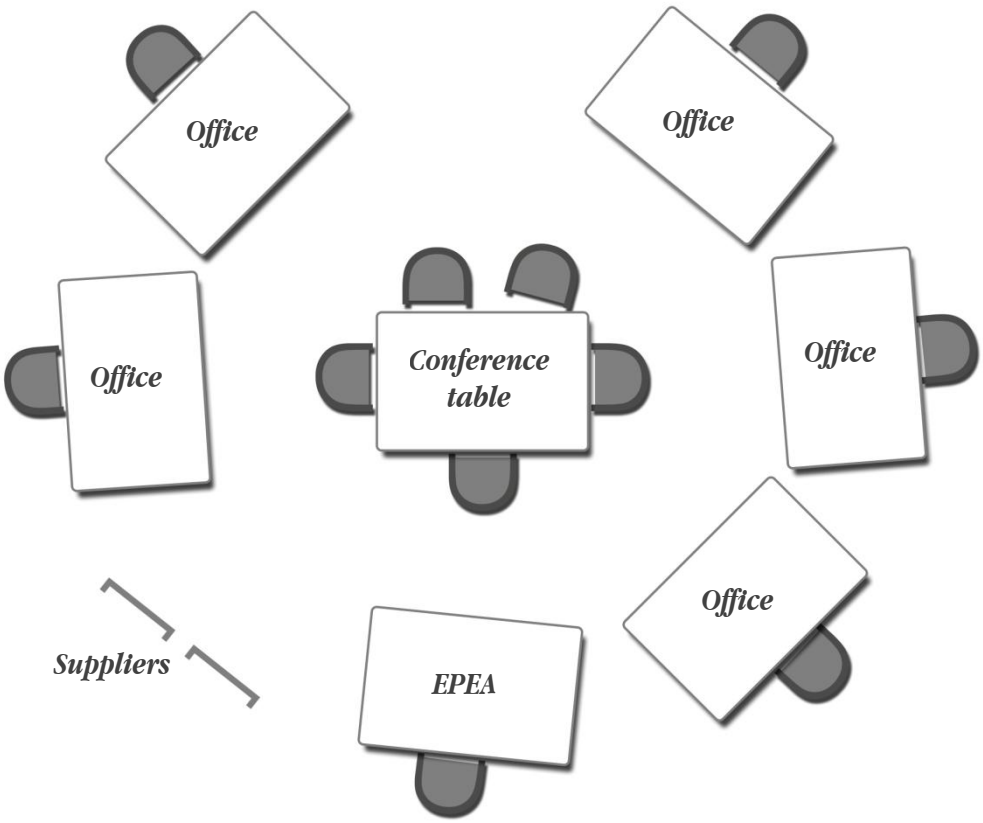



**Figure 3.7** | Validation session layout

## *Results*

The validation workshop is intended to verify the practical application of the method. Two types of results can be distinguished: observations of the execution of the validation workshop and discussed results. Resulting from the observations, several results show. The positive results of the observation are the following:

+ *The project team understands the importance of proper division of tasks and regulates this*
+ *All development steps are executed in the proper order and by the correct project team member*
+ *The preliminary research is separated in different sections, executed by different members of the project team*
+ *Requirements (the basis for the packaging development) are discussed properly within the whole project team*

On the other hand, the observations show the following (more or less) negative issues:

- *There is an obvious necessity for a project leader with a more or less abstract view on the implementation of a packaging development method*
- *Demands for the requirements are unknown. Whether or not the requirements are complete and sufficient is not clear*
- *Instead of deriving a project description from the project initiation step, a project brief would be highly appreciated*
- *Even though the importance of the Material Specification Layer is told to be understood, the material analysis is not executed properly*
- *Use of reflection documents (Cradle to Cradle requirements, Material Knowledge Bank, previous packaging projects) is highly useful (essential), but missing*


**Figure 3.8** | Validation session

Several issues have shown from the validation session of the method. In general, the method appears to be suited for practical application as a Cradle to Cradle packaging development method. This is underpinned by the results of the subsequent discussion. However, when the method will have to be practically applied in future packaging development projects, the members of the project team foresee some issues. When imagining this method to be used in future projects, possibly by other persons within the company, the level of description might be too abstract. Many of the decisions that have to be made by the project team, should be made before the start of a project (during the Project Initiation session), as part of a design briefing. The main issues that have come forward from the discussion, relate to the practical application of the method in future packaging development projects:

- An elaborate project briefing (set up by management) should contain the following:
  - *Project description*
  - *Milestone checklists*
    This might work better than setting up requirements for every milestone by the project team itself
  - *Task division*
    This can be different for every project and should therefore be determined in advance
  - *Budget and near-future developments*
    This is currently a part of the preliminary research
- From the start, it is not always clear when which results are required. This is due to the method not describing chronology between steps, only the sequence

### *Conclusion*

Resulting from the validation session, the method appears to be suitable as a guideline for Cradle to Cradle packaging development. All members of the project team state that the method can be transferred and explained to other persons. For practical (future) application, the different steps and required results should be described in advance, for instance in a project briefing. Therefore, the method should be more prescriptive. A descriptive method (as described in section 3.4) will only work sufficiently when the executing project team can apply a certain level of abstract thinking. On top of that, the use of reflection documents (such as the Cradle to Cradle requirements, Material Knowledge Bank and previous packaging projects) is very useful for the project team. This enables the project team to reflect on the usefulness and required level of certain (essential) steps and decisions.

# 4 Method Application

An important issue within this assignment is the development of a Cradle to Cradle packaging draft. This draft is developed for one specific product. This packaging development project is aimed at illustrating the Cradle to Cradle packaging development method, as a case study.

## 4.1 Case Study Background

The case study is executed to illustrate the method for Cradle to Cradle packaging development. However, due to the approach by which this case study is executed, there are some discrepancies between the case study and the intended practical application of the method. These discrepancies are described as background.

### *Project Initiation*

The project is part of a master graduation assignment. The subject of the project has come from Van Houtum's aspiration to enter the cash & carry market and to research Cradle to Cradle packaging. An analysis of the project's risks and possibilities has not been executed. Due to this and the pilot-like approach of the project, there is also a lack of a precise specification of the project's budget and near-future developments.

### *Functions*

A project team as described in the method has not been structured. The project team consists of one person, with guidance from several persons within Van Houtum. All development and design decisions have been made by one person, in some cases in consultation with different persons within and out of Van Houtum. This also has implications for the decision moments. All development steps of this packaging project are executed, since it is intended as an illustration of the method. The decision moments act as review moments and will never result in the termination of this specific project.

### *Start and Finish*

The case study is part of a larger assignment. Therefore, the preliminary research has been executed more extensively than would be done for just a packaging project. The completion of the project on the other hand, will also differ from a typical packaging development project. Due to several limitations (mainly time-related), the complete project will not be finished. Steps which will not be completed are Cradle to Cradle certification, production and market implementation (the Completion Section). The packaging project is focused on the development of primary packaging.

In this chapter, only the most relevant and critical decisions resulting from the development steps are mentioned. The description of the case study is mainly focused on illustrating the Cradle to Cradle-related issues which are derived from the Cradle to Cradle packaging development method (chapter 3). The complete description of the case study can be found in appendix F.

## 4.2 Project Initiation

### *Assignment Description*

The subject of the case study is the following:

> *Develop a Cradle to Cradle suited packaging draft for Satino Black toilet paper, for the cash & carry market*

### *Project Team*

For this specific project, a project team is not composed. The project is executed by one person, with guidance from several persons within Van Houtum. This can be considered as the project team, with the following members:

- *Albert Mey (Brand Innovation and Research Manager)*
- *Jos Manders (QESH Manager)*
- *Ruud Eywoudt (Converting Manager)*
- *Guus Bruijstens (Product Manager)*
- *Bjorn de Koeijer (Master Graduate University of Twente)*

### *Requirements Decision Moment A*

During the Project Initiation session, the requirements for Decision Moment A have been specified. The results of the Definition Section (the first section of the project) will be reviewed during this decision moment. During Decision Moment A, two documents will have to meet the following requirements:

- *Requirement specification*
  - Issues will have to be separated in requirements, targets and bonuses
  - Requirements regarding general packaging, Van Houtum, the market and Cradle to Cradle have to be addressed
  - Requirements will have to be derived from and discussed with all project stakeholders

- *Identified materials*
  - All possibly eligible (Cradle to Cradle suited) packaging materials have to be researched

## 4.3 Definition Section

### *Development Layer*

#### *1.1a Preliminary Research*

The preliminary research of the project is focused on four major fields of input:

1. *Company*
2. *Cradle to Cradle*
3. *Packaging development*
4. *Market*

### *Project Conditions*

The project conditions regard the (practical) boundaries for the packaging project. It is mainly derived from the company's current situation, the project description and the intended result. The following project conditions are determined:

a) *Time Frame*

The time frame of the packaging development project has been set to 9 months. This time frame does not include Cradle to Cradle certification, production and market implementation.

b) *Budget*

The project is intended as a pilot project, aimed on illustrating the method for Cradle to Cradle packaging development. Therefore, a strict project budget has not been determined.

c) *Cradle to Cradle requirements*

For this specific Cradle to Cradle packaging project, the aim is set to a Cradle to Cradle Silver-level certificate. The requirements for this project are derived from literature on Cradle to Cradle certification, which can be found in appendix A.

d) *Internal stakeholders*

For this project, the setting of internal stakeholders is far from typical. The project is executed by one person, with guidance from several people. Besides the project team, the internal stakeholders (within Van Houtum) are:

- *Henk Bremer (Chief Commercial Officer)*
- *Toin van der Velden (General Sales Manager)*
- *Dave Timmermans (Account Manager)*
- *Nick op den Buijsch (Brand Manager)*
- *Sjaak van Zinderen (Purchaser Packaging Materials)*

e) *Near-future developments*

The near-future developments mainly regard the planned investments and areas of focus. For this specific packaging development, no near-future investments are relevant. However, within Van Houtum, Cradle to Cradle is an important future development. Currently, Cradle to Cradle is explicitly part of Van Houtum's company policy. This is now expressed in the certified paper products and soaps. In the future, this must be extended by the development and use of Cradle to Cradle packaging.

***Development Input***

The development input consists of the issues which act as input for the development of the packaging draft. It consists of the following issues:

a) *Goal definition*

The project must result in a tangible and specific Cradle to Cradle packaging draft. The packaging draft will be developed for cash & carry retail of one of Van Houtum's Satino Black products. The packaging draft must be developed up to a conceptual level (embodiment design). The Cradle to Cradle intention of the packaging is key within the project. Therefore, the result must be a packaging draft which is suited for Cradle to Cradle certification.

b) *Product*

The project is aimed at the development of a Cradle to Cradle packaging for Satino Black toilet tissue. During different meetings, the specific properties for this product have been specified. These requirements have partly been based on the targeted market and benchmark products. The decision is made to develop a packaging draft for the 400-sheet variant of Satino Black. The main reason is that this product is already part of the current range of Satino Black products (see figure 4.1). The diameter of 115 mm ensures the possibility for use of the product with or without a dedicated toilet tissue dispenser (either Satino dispensers or dispensers from competing brands). On top of that, a product with full paper embossing is considered to be important in the targeted market. This can be achieved with 400 sheets of paper in a 115 mm diameter roll.


**Figure 4.1** | Current plastic foil packaging for Satino Black

c) *Brand*

The packaging draft is developed to fit within the line of Satino Black products. This brand can be described by its brand values and brand identity:

- *Brand Values*
  - *Exciting*
  - *Self-willed*
  - *Refined*
  - *Authentic*
  - *Successful*

- *Brand Identity*
  - *Luxury*
  - *Design/style/aesthetics*
  - *Beauty*
  - *Cradle to Cradle*

d) *Market*

The packaging draft is developed for the cash & carry market. This market is specified by its target group and the method of sales. The method of sales is characterized by little or no promotion for products and sober shopping shelves, with stacked products (sometimes in bulk). Customers of a cash & carry market will require an access pass. For this, a Chamber of Commerce enrolment is required. In other words: only businesses can shop in a cash & carry market.

Within this specific project, the packaging draft is developed with input from Sligro Food Group, a wholesaling enterprise in The Netherlands. To acquire information about this market, a meeting with a representative of Sligro has taken place. The questionnaire which guided this meeting can be found in appendix G. Sligro Food Group can be divided in food service and food retail (supermarkets). The food service division can be divided in self-service stores and a delivery section. Currently, no Cradle to Cradle products are marketed at Sligro. The targeted sales of the

Cradle to Cradle Satino Black packaging in the first year after introduction are 10,000 packaging units. In following years, this amount is targeted to increase.

e) *Target group*

Sligro Food Group aims at providing retail for all catering-related clients, varying from snack bars to hotels. Fifty-three customer categories can be distinguished within Sligro, divided in four main groups:

- *Non-food*
- *Food (significant added value)*
- *Food (limited added value)*
- *Retail*

The appropriate customer to develop the Cradle to Cradle Satino Black packaging for, is the non-food customer. This type of customer want to get 'inspired' in a Sligro store and buys products ranging from interior supplies to disposables. The non-food customer considers Sligro to be a 'one-stop shop', and can be qualified as a 'fun shopper'. Product price versus quality is highly important for this customer. Examples of such customers are SMEs (small and medium enterprises), institutional services, business services and schools.

f) *Benchmark*

Within the targeted market, the product will have to compete with several other products. In the case of Satino Black toilet paper for the cash & carry market, the benchmark brands are Page and Edet. Within these brands, the 'regular' products (Page Original, figure 4.2a and Edet Family, figure 4.2b) are considered to be the benchmark in retail amount and retail price. Of these benchmark products, packages containing 24 and 32 rolls of toilet paper are the fast-moving variants. Considering the properties of the selected Satino Black product, a packaging containing 12 rolls of toilet paper is believed to be best suited between the benchmark products. Striking features of the packaging of these benchmark products are carrying handles and tear strips (for easy opening).


**Figure 4.2a** | Page Original


**Figure 4.2b** | Edet Family

### *1.1b. Requirement Specification*

The preliminary research resulted in a requirement specification. All requirements have been sorted as requirements, targets and bonuses, within different subjects:

1. *General packaging requirements*

| | The packaging must ... | Req. | Target | Bonus |
|---|---|---|---|---|
| 1.1 | ... bundle the packaged product | ■ | | |
| 1.2 | ... cover the packed product from: | | | |
| | a) Moisture | | ■ | |
| | b) Splashing | | ■ | |
| | c) Dirt/dust | ■ | | |
| 1.3 | ... protect the packed product against: | | | |
| | a) Mechanical influences | | ■ | |
| | b) Tampering | | ■ | |
| 1.4 | ... remain closed and functionally intact when dropped from 0.5 metres | ■ | | |
| 1.5 | ... remain closed and functionally intact when dropped from 1.0 metres | | ■ | |
| 1.6 | ... aimed at efficient transport and storage | | | |
| | a) Efficient division on a Euro or industrial pallet | ■ | | |
| | b) Efficient division on the retail shelf | ■ | | |
| | c) Efficient storage at the end user's | ■ | | |
| | d) Collomodule | | ■ | |
| | e) Stably stackable with maximum pallet load | ■ | | |
| | f) Volume reduction (flattened or nested) | ■ | | |
| 1.7 | ... be easy to open | | ■ | |
| 1.8 | ... be intuitive in use | | ■ | |
| 1.9 | ... provide possibilities to be carried | ■ | | |
| 1.10 | ... have a maximum weight of 15 kilos (including packed product) | ■ | | |
| 1.11 | ... have a maximum cost price of € 0.50 per kilo packed product | ■ | | |
| 1.12 | ... have a maximum cost price of € 0.30 per kilo packed product | | ■ | |
| 1.13 | ... be suited for functional secondary use | | ■ | |
| 1.14 | ... inform and communicate on: | | | |
| | a) Product (information visible from every viewing angle) | ■ | | |
| | b) Brand (information visible from every viewing angle) | ■ | | |
| | c) Packed amount (information visible from every viewing angle) | ■ | | |
| | d) Producer | ■ | | |
| | e) Use | ■ | | |
| | f) Transport and storage | ■ | | |
| | g) End of use | ■ | | |

2. *Requirements from Van Houtum*

| | The packaging must ... | Req. | Target | Bonus |
|---|---|---|---|---|
| 2.1 | ... be suited for packing Satino Black toilet paper rolls with a diameter of 115 mm and a roll height of 96 mm | ■ | | |
| 2.2 | ... be suited for Cradle to Cradle certification | ■ | | |
| 2.3 | ... be Cradle to Cradle certified at market implementation | | ■ | |
| 2.4 | ... fit within the brand identity of Satino Black | ■ | | |
| 2.5 | ... propagate the graphic style of Satino Black | ■ | | |
| 2.6 | ... have a luxurious finish | | ■ | |

### 3. *Market requirements*

| | The packaging must ... | Req. | Target | Bonus |
|---|---|---|---|---|
| 3.1 | ... be distinctive when placed on a retail shelf | | ■ | |
| 3.2 | ... be aimed at sales to non-food customers | | ■ | |
| 3.3 | ... contain twelve rolls of Satino Black toilet paper per retail unit | ■ | | |
| 3.4 | ... be optimised for annual sales of 10,000 units | ■ | | |

### 4. *Cradle to Cradle requirements*

| | The packaging must ... | Req. | Target | Bonus |
|---|---|---|---|---|
| 4.1 | ... be aimed at the reduction of the use of harmful ingredients | ■ | | |
| 4.2 | ... be produced without harmful ingredients | | ■ | |
| 4.3 | ... be suited for material reutilisation (in a biological and/or technical cycle) | ■ | | |
| 4.4 | ... be designed for a defined use and disposal scenario | ■ | | |
| 4.5 | ... be aimed at a positive impact on energy, water and carbon management | ■ | | |
| 4.6 | ... be produced with a positive impact on energy, water and carbon management | | ■ | |

### 5. *Technical requirements*

| | The packaging must ... | Req. | Target | Bonus |
|---|---|---|---|---|
| 5.1 | ... be suited to be filled automated | ■ | | |
| 5.2 | ... be filled on Van Houtum's current filling lines | | | ■ |
| 5.3 | ... be produced by Van Houtum's current packaging suppliers | | | ■ |

***Material Selection Layer*** / ***External Layer***

**1.2a *Material Identification*** / **1.3a *Information Collection***

As a result from the preliminary research, a list of materials has been drawn up. This list consists of materials which are possibly suited as a Cradle to Cradle packaging material for the packaging of Satino Black toilet paper. This estimation is based on knowledge on the material assessment within Cradle to Cradle certification. In other words: common sense on whether or not a material could possibly be suited as a Cradle to Cradle packaging material. Of every material, basic information and material samples (1.3a) have been requested by the supplying/producing companies. This overview is used as a limitation for the conceptualisation section of the packaging development project.

***Paper/board***

For this project, the types of paper and board for packaging are folding box board, solid board and corrugated board (figure 4.3). Within the material identification, the properties of these types of material are closely related. Therefore, this is considered to be one category.

- *Pro:*
  - + *Matches Van Houtum's area of expertise*
  - + *Positive public opinion regarding 'sustainability'*
  - + *Users are familiar with to the material cycle*
- *Con:*
  - - *Not distinctive*
  - - *Possible need for coating (water resistance)*
- *Cradle to Cradle certificate: Yes, US Postal mailing boxes (level unknown) [21]*
- *Scenario*
  - *Production: waste paper and/or virgin fibres*
  - *Use: possible re-use (e.g. a box for household waste paper)*
  - *End-of-use: disposal within waste paper cycle (cascade to biological cycle)*

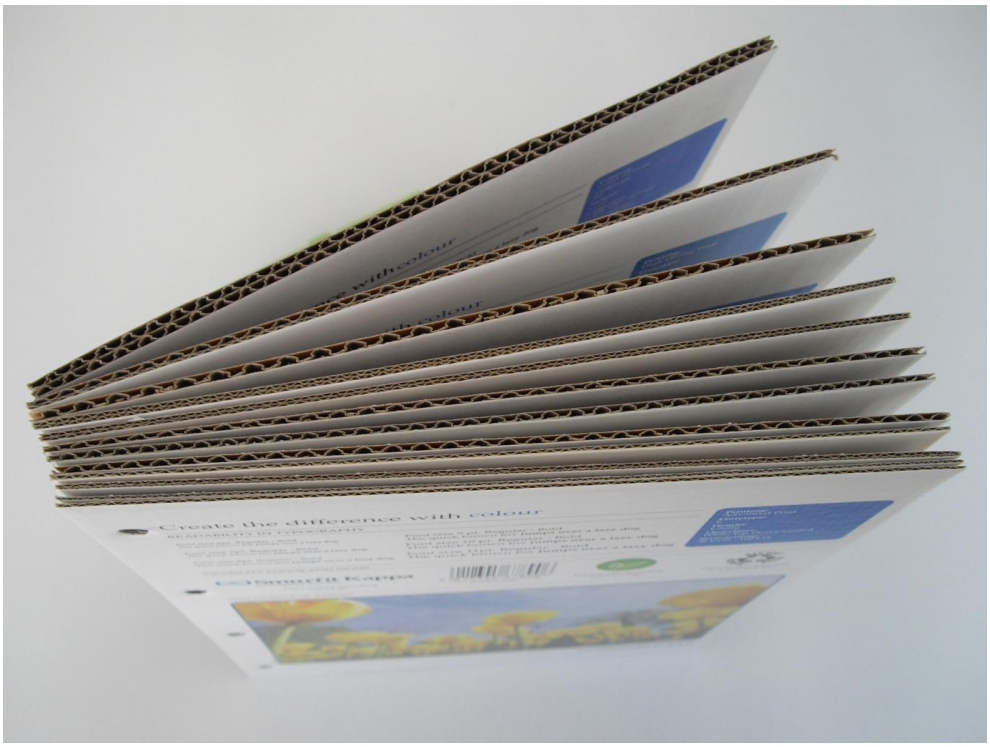



**Figure 4.3** | Smurfit Kappa corrugated board samples

**Figure 4.4** | Huhtamaki moulded fibre product samples

***Moulded fibre***

This material is related to other fibre-based packaging materials (like paper and board). This material (figure 4.4) is currently hardly used as external primary packaging (only for eggs), but could very well be suited for both the application and Cradle to Cradle requirements.

- × *Pro:*
  - \+ *Matches Van Houtum's area of expertise*

- + *Positive public opinion regarding 'sustainability'*
- + *Users are familiar with the material cycle*

× *Con:*

- - *Unknown material content*
- - *Possible need for coating (water resistance)*

× *Cradle to Cradle certificate: No*

× *Scenario*

- × *Production: waste paper (pulp)*
- × *Use: probably disposal directly after opening*
- × *End-of-use: disposal within waste paper cycle (cascade into biological cycle)*

***Petrochemical-based plastic***

Virtually every current packaging for toilet paper within the targeted market is transparent flexible plastic. Therefore, this is an important material category to consider.

× *Pro:*

- + *Virtually unlimited possibilities*

× *Con:*

- - *Traditional ('boring') packaging material*
- - *Suitability for Cradle to Cradle unclear*
- - *Negative public view on sustainability*

× *Cradle to Cradle certificate: No*

× *Scenario:*

- × *Production: petrochemical derivates*
- × *Use: probably disposal directly after opening*
- × *End-of-use: disposal within household waste or separate (technical cycle)*


**Figure 4.5** | Oerlemans Plastics sugarcane-derived PE product samples

***Biobased plastic***

In properties, these materials can be considered to be identical to petrochemical based plastics. However, the source of the material differs. This can vary from poly-lactic acid (PLA) to polypropylene

(PP) and polyethylene (PE), derived from sugarcane ethanol. Several types of biobased plastics are already in use, for instance by Oerlemans Plastics (figure 4.5).

- *Pro:*
  - + *Virtually unlimited possibilities*
  - + *Biobased*
- *Con:*
  - - *Traditional ('boring') packaging material*
  - - *Suitability for Cradle to Cradle unclear*
  - - *Negative public view on sustainability (communication is essential)*
- *Cradle to Cradle certificate: No*
- *Scenario:*
  - *Production: biobased derivates (PLA, PE, PP, et cetera)*
  - *Use: probably disposal directly after opening*
  - *End-of-use: disposal within household waste or separate (technical cycle)*


**Figure 4.6** | GaiaKraft product samples (200 µm and 400 µm)

***GaiaKraft***

This material (figure 4.6) is marketed as an alternative to paper products. The material consists of calcium carbonate ($CaCO_3$), bonded with PE-resin. The amount of $CaCO_3$ in the material can vary from 60% to 80%. GaiaKraft is marketed as a sustainable material, since it is optimised for recycling in a technical cycle, without depleting natural resources. On top of that, it is claimed to be produced using fewer energy and emitting fewer $CO_2$ than the production of comparable 'regular' paper products [27].

- *Pro:*
  - + *Distinctive material (new for packaging applications)*
  - + *Paper-like properties*
  - + *Water resistant*
  - + *Cradle to Cradle certificate*
- *Con:*
  - - *Strict technical cycle (in contrary to material's look and feel)*

- *Cradle to Cradle certificate: Silver*
- *Scenario*
  - *Production: calcium carbonate with PE-resin*
  - *Use: paper-like use*
  - *End-of-use: disposal is required with household waste or separate (technical cycle)*

***PaperFoam***

PaperFoam (figure 4.7) is a lightweight packaging material, made from renewable, locally sourced raw materials. The product can be disposed of in the waste paper cycle since its components starch and fibres are the same as the components of paper. Furthermore, it can be composted. Even by household composting, it will fully compost in a couple of weeks [28]. Currently, the product is mainly used as inlay in packaging for (amongst others) Philips, Microsoft and Motorola. The company has no Cradle to Cradle certified products, but is working with Cradle to Cradle aspects in its products.

- *Pro:*
  - *Distinctive material*
  - *Moulded fibre-like properties (lightweight)*
  - *In-line with paper recycling*
  - *Water resistant*
  - *Cradle to Cradle certificate*
- *Con:*
  - *Expensive*
  - *New for this specific application*
- *Cradle to Cradle certificate: No*
- *Scenario*
  - *Production: injection moulding of fibre, starch, premix and water*
  - *Use: comparable to moulded fibre*
  - *End-of-use: disposal within paper cycle or composting (biological cycle)*

**Figure 4.7** | PaperFoam product samples

***Synbra BioFoam***

BioFoam is expendable polystyrene (EPS) which is currently used for insulation systems and industrial products for different markets. The material is a foamed product, made from poly-lactic acid (PLA). The company has received a Cradle to Cradle Silver-certificate for BioFoam [29]. It could be used for packaging applications, comparable to moulded fibre and PaperFoam.

- *Pro:*
  - + *Distinctive material*
  - + *Lightweight*
  - + *Cradle to Cradle certificate*
- *Con:*
  - - *Unknown properties and possibilities*
  - - *New for this specific application*
  - - *Negative public view on sustainability*
- *Cradle to Cradle certificate: Silver*
- *Scenario*
  - *Production: expanded polystyrene*
  - *Use: comparable to moulded fibre*
  - *End-of-use: disposal is required with household waste or separate (technical cycle)*

***Fibre-based materials***

Within fibre-based materials, several different variants can be distinguished. For instance the food packaging products ValueForm produces [30]. Or the plant fibre-based packaging products made by Be Green Packaging [20] (mentioned in chapter 2).

- *Pro:*
  - + *Distinctive material*
  - + *Plant-based*
  - + *Cradle to Cradle certificate (Be Green Packaging)*
  - + *Positive public view on sustainability*
- *Con:*
  - - *New for this specific application*
- *Cradle to Cradle certificate: Silver (Be Green Packaging)*
- *Scenario*
  - *Production: related to other fibre-based products (e.g. paper)*
  - *Use: comparable to moulded fibre*
  - *End-of-use: disposal within waste paper cycle (cascade into biological cycle)*

***Additives***

Apart from the base materials, also additives are identified. This covers adhesives, inks and coating materials.

- *Adhesives*

  For the identification of adhesives, product ranges of both Henkel and Paramelt have been discussed. Both companies are current suppliers for Van Houtum (mentioned in chapter 2). Due to the diverse materials and yet unknown required properties, specific products cannot be specified.

- *Inks*

  For most of the materials, printing inks and pigments have already been optimised in terms of production and usability. This holds for instance in the case of printing of cardboard and plastic packaging products. However, for this specific packaging project, possibilities for printing are considered separately.
  - *SunChemical/Flint (mentioned in chapter 2)*

Inks produced by both SunChemical and Flint are currently used for printing cardboard and plastic packaging products.

× *Gugler Print*
The Austrian company Gugler has been Cradle to Cradle certified since November 2011. The company is the first to be able to produce Cradle to Cradle certified printing products (figure 4.8) [31]. The printed paper qualities that can be produced with a Cradle to Cradle certificate range up to 300 g/m$^2$. This folding boxboard quality could very well be used for packaging. On top of that, possibilities might be available to cooperate on applying Gugler inks for other Cradle to Cradle packaging products.


**Figure 4.8** | Gugler Cradle to Cradle certified printing product samples

× *Green4Print*
Green4Print is a Dutch manufacturer of biological offset inks. Its products consist of 82% biobased raw materials. Apart from synthetic pigments in the ink products, it is completely biobased. This includes the use of biobased oils, instead of (usually used) mineral oils. Green4Print claims to have eliminated all harmful ingredients in its printing inks, like heavy metals. On top of that, the inks developed by Green4Print are designed to be beneficial on de-inking properties [32]. Currently, the inks produced by Green4Print are suited for sheet offset technology. Research and development is focused on applications in rotation offset and flexography print and eliminating halogens in inks.

× *Coatings*
The requirement specification for the packaging draft include "The packaging must protect the packed product from moisture and splashing". This implicates that for some of the identified materials (fibre-based materials) a coating might be required. Obviously, the currently used 'regular' plastic coatings could be applied. However, this will probably result in several issues during the future scenario (end-of-use). However, a possibility for biobased

paper coating has been found. The company Glycanex has conducted a pilot project on applying modified starch as a coating with barrier properties on paper/cardboard. Mainly due to cost-related considerations, this development (product name Glycapol; appendix H) has not yet been industrialised.

***Material Knowledge Bank***

All packaging materials which have been researched can be found in appendix E. This list of materials is designed to expand with every executed packaging project, by adding new materials.

## *Decision Moment A*

The first decision moment is focused on assessing the requirement specification and the identified materials.

- *Requirement specification*

The requirement specification for this packaging project has been discussed and adapted iteratively. This has been done during different face-to-face sessions, with all members of the project team and the internal stakeholders within Van Houtum. This intensive approach has been selected to assure elaborate discussion on every single requirement. The list of requirement specifications as described before is the result of these discussions.

- *Identified materials*

The elaborate list of identified materials and additives has been discussed during different sessions with the project team. Several materials are considered to be unsuitable for packing Satino Black toilet rolls for a cash & carry environment. The materials which have been rejected are the following:

- *Petrochemical-based plastic*

This type of plastic packaging materials has been eliminated for this specific packaging project. The most important reason is the public opinion related to petrochemical-based plastics. Equal properties can probably be achieved with biobased plastics. However, this type of plastic material will probably fit better within a Cradle to Cradle approach. On top of that, petrochemical-based plastic packaging materials are not distinctive for this specific purpose; virtually all toilet paper currently sold in a cash & carry environment is packed in 'regular' flexible transparent plastic.

- *GaiaKraft*

Currently, GaiaKraft is marketed as a variant of paper. This is very well understandable, since the properties are comparable. However, this will probably result in an unclear end-of-use scenario. GaiaKraft is intended to end up in the plastic cycle, to be recycled with other types of plastic. However, due to its paper-like properties, users will probably dispose of it in the waste paper stream. There it will be sorted as reject, and ending up in the mixed waste stream. In that case, all precious material content is lost, since it will probably be incinerated. This scenario will also hold for a packaging made out of GaiaKraft (with properties like folding boxboard).

- *Synbra BioFoam*

This material is very well suited for Cradle to Cradle, since it has already been certified. However, it is very far from the current packaging material archetypes. In other words: its distinctive look, feel and properties will possibly turn out to be conflicting for this application. On top of that, its material cycle will probably not be considered to be 'sustainable' ("it's still plastic"). Even though it fits within Cradle to Cradle.

- *Fibre-based materials*

  The researched fibre-based materials are all very interesting from a perspective of Cradle to Cradle. However, it is also rather new and experimental. For this specific application, the use of fibre-based materials will possibly turn out to be too distinct.

As mentioned in this project's background, no decision moment will result in a termination of the project. Therefore, Decision Moment A results in a "go" for the following section: the Conceptualisation Section. For Decision Moment B, the following requirements have been set up:

- *Defined drafts*
  - Two drafts will be reviewed
  - Drafts have to be specified up to conceptual level, to review form, function and material

- *Specified materials*
  - All materials out of the identified materials (as specified in the Definition Section) which are applicable in the selected drafts have to be specified
  - All available information on material content and composition has to be listed

## 4.4 Conceptualisation Section

***Development Layer***

***2.1a Conceptualisation***

Based on the requirement specification, drafts have been developed. This ranges from generating basic concepts for the packaging demand, up to structured, defined drafts. The draft development is limited by the previously selected identified materials.

- *Idea generation*

  The initial idea development for the packaging draft started with a brainstorm session. During this session, basic ideas related to the packaging of toilet paper have been written down. For the packaging draft for the Satino Black packaging, four main brainstorm areas have been targeted: *secondary use*, *space-saving*, *easy opening* and *self-fillable*. After this session, the results have been discussed within the project team. Based on this discussion, several concept directions have been selected. These idea directions are illustrated in figure 4.9a-i.

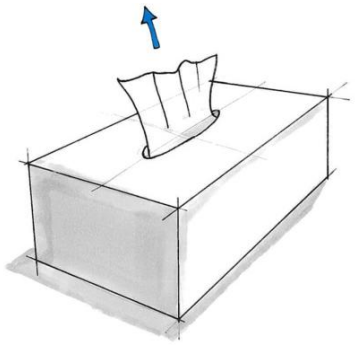


**Figure 4.9a** | Tissue box

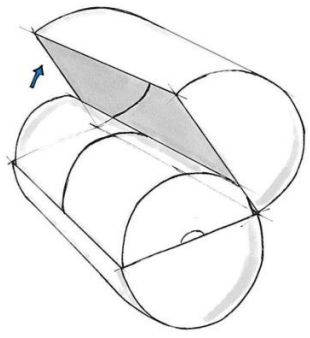


**Figure 4.9b** | Split cylinder

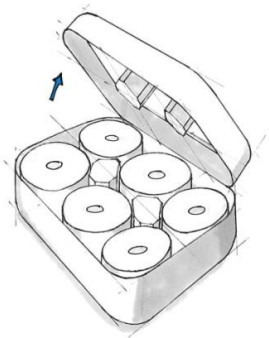


**Figure 4.9c** | Egg box

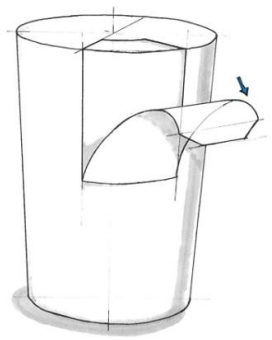


**Figure 4.9d** | Tear cylinder

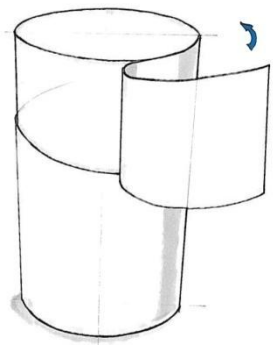


**Figure 4.9e** | Wrap cylinder

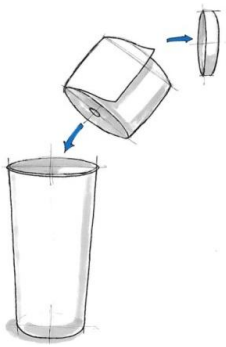


**Figure 4.9f** | Can cylinder

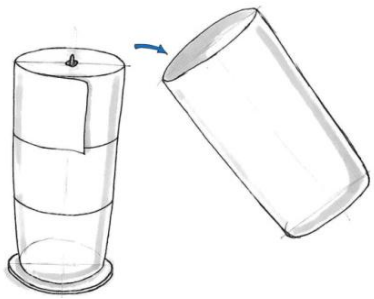


**Figure 4.9g** | Toilet roll stand

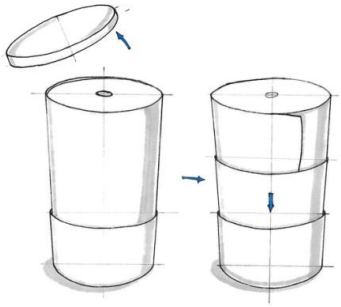


**Figure 4.9h** | Section cylinder

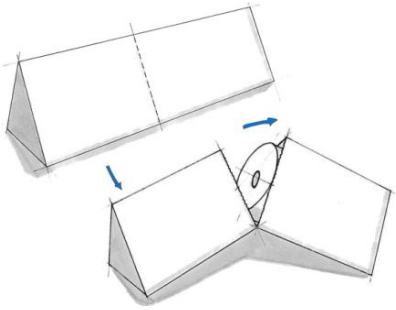


**Figure 4.9i** | Triangle

As can be seen, most of the concepts are a variant to a cylindrical shape. Obviously, this is due to the shape of the product which will be packed. After discussion within the project team, two concept directions have been selected for further development: a cylindrical shaped packaging and the egg box idea. However, when considering the specific requirements, it turns out that a cylindrical shape is not sufficient. The packaging for twelve rolls of toilet paper in a cylindrical shape will be very long (over a meter). Therefore, this idea direction had to be adapted to be more efficient. This has resulted in a cylindrical shape which has been extended in length and/or width: an oval shape. A variant to this shape (an octagon) has been inspired by the limitations of materials like corrugated board.

- *Concept development*

  Two concept directions have been selected: the egg box (figure 4.9c) and the oval/octagonal box. For a structured draft development out of these concept directions, a morphologic scheme is set up. In this scheme, six aspects for the packaging drafts have been selected:

  - *Shape*

    Three shapes/structures for the packaging have been distinguished: an oval box, an octagonal box and an 'egg box'.
  - *Division*

    As determined before: the packaging must contain twelve rolls of toilet paper. To achieve an efficient division, there are two possibilities: two by two (by three) or three by two (by two) rolls.
  - *Handle*

    The benchmark research shows that current packaging in the targeted market are all featured with handles for carrying. Therefore, this is considered important in the Satino Black packaging concept. It can be implemented either as an internal or an external handle.
  - *Hanger*

    In several meetings with the internal stakeholders of the packaging development draft, the possibility for a packaging which can be hung came up as an interesting idea.

- *Opening*
  For the opening of the packaging, three possibilities are deemed plausible: a lid (either separate or loose), a tear strip or a packaging which can be flipped open. This flip-open idea is basically an extended tear strip.
- *Closure*
  Obviously, the packaging must be closed after production. Usually (when considering cardboard) this is done by a hotmelt or coldmelt adhesive. However, for this Cradle to Cradle packaging draft, such a connection is discarded as a possibility. This decision has been made due to the suboptimal material reutilisation cycle of these types of adhesives. It either ends up in the reject stream during paper recycling, or it is embodied in the newly produced paper. Either way: the resources are lost. This is not a specific issue in Cradle to Cradle certification. It can be seen as an added 'gimmick' in the packaging draft.

Out of this morphologic scheme, four drafts have been developed. Of these drafts, two are based on the octagonal shape, one is based on the oval shape and one is based on the egg box idea. Different aspects as described in the morphologic scheme have been embodied in the different drafts.

- *Draft elaboration*
  - *Concept Red*
    The first draft (figures 4.10a and 4.10b) incorporates an oval shape with a fixed lid, on both sides. The packaging's closure is constructed by the handle, which is folded out from the inside.

**Figure 4.10a** | Concept Red (1)

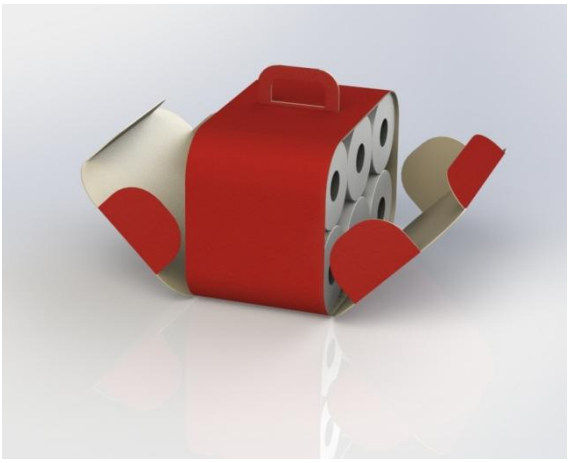


**Figure 4.10b** | Concept Red (2)

  - *Concept Blue*
    The second draft (figures 4.11a and 4.11b) is based on the octagonal shape. Separate lids are placed on both the top and bottom of the packaging (light blue in figure 4.11a). This lid could for instance be constructed out of PaperFoam or moulded fibre material. The packaging can be opened by tearing off a strip and flipping the packaging open (figure 4.11b). The packaging's closure is constructed by the handle, which is folded out from the inside.

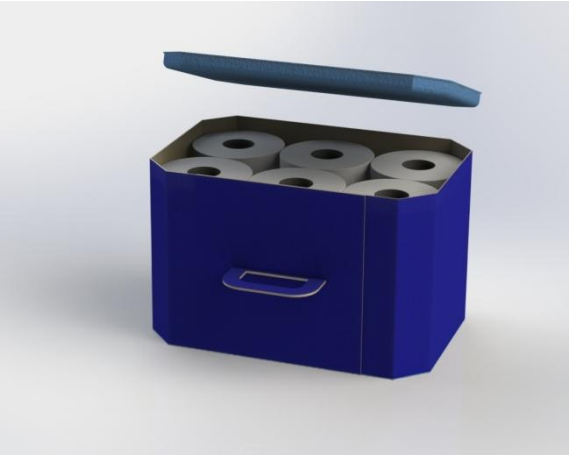


**Figure 4.11a** | Concept Blue (1)

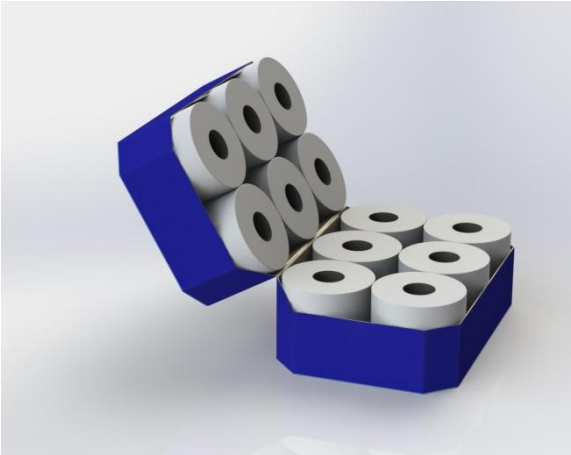


**Figure 4.11b** | Concept Blue (2)

× *Concept Yellow*
The third draft (figures 4.12a and 4.12b) is also based on an octagonal shape. In this draft, the toilet rolls are placed on their sides. The packaging is opened at the front, with a tear strip wide enough to take the toilet rolls out of the packaging. The closure is constructed with a hanger. At the back of the packaging, a handle is placed.

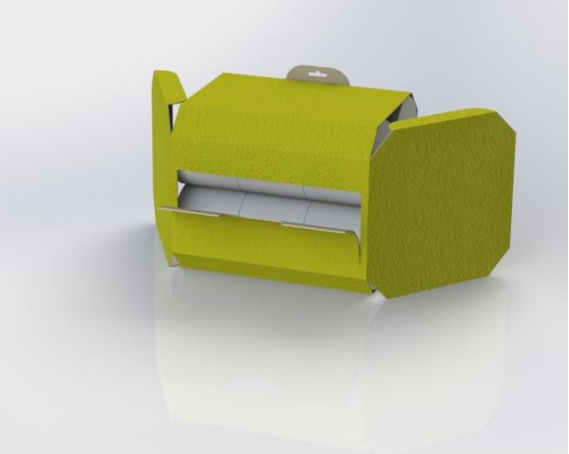


**Figure 4.12a** | Concept Yellow (1)

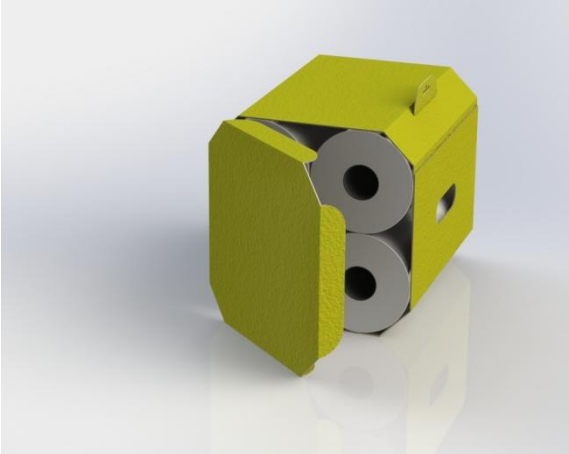


**Figure 4.12b** | Concept Yellow (2)

× *Concept Orange*
The fourth and final draft (figures 4.13a and 4.13b) is based on the 'egg box' idea. The packaging consists of two identical sections, which are placed on top of each other. The packaging is closed by a sleeve. This sleeve will be required for strength (the packaging has to bundle 2 kilos of product) and as substrate for print. The required level of graphic representation related to the brand will not be achieved by printing on the moulded fibre material itself.

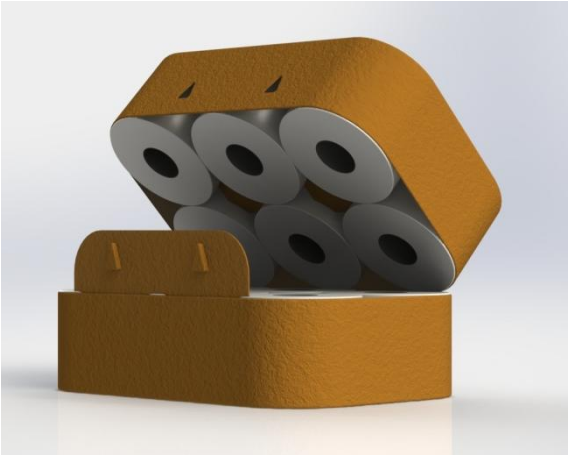


**Figure 4.13a** | Concept Orange (1)

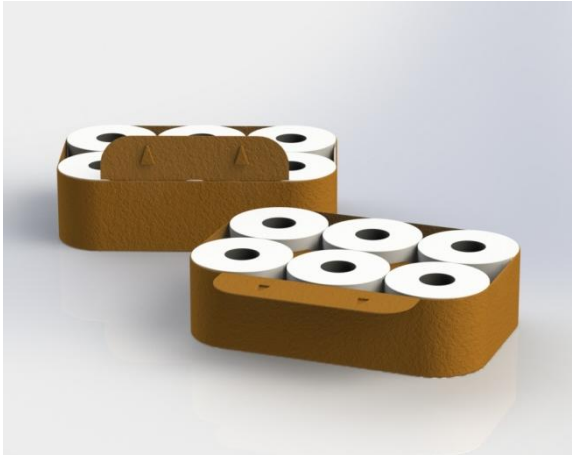


**Figure 4.13b** | Concept Orange (2)

- *Draft elaboration*

  Out of the four described drafts, two directions have been selected. These drafts are elaborated further for Decision Moment B. In this second-level draft development, issues regarding Cradle to Cradle (material use), cost price, producibility and graphic design have been taken into account. After discussion within the project team and several stakeholders within Van Houtum, two drafts have been selected: Concept Blue and Concept Orange:

  - *Concept Octagonal (Concept Blue)*

    This draft (figure 4.14) is a further developed version of Concept Blue. This draft contains one (separate) lid out of PaperFoam, op the top side of the packaging. The base of the packaging consists of a box out of corrugated board. The lid is connected to the box with little hooks. Handles have been placed on both sides of the packaging. The packaging is closed by a (blind) mortise and tenon connection. Depending on material and production possibilities, an additional flip-open tear strip (like in Concept Blue) could be added. Figure 4.14 shows Concept Octagonal with the graphic appearance of the current Satino Black packaging.


**Figure 4.14** | Concept Octagonal

The indicated cost price for the two parts of the packaging is € 0.25 (corrugated board box) plus € 0.50 (PaperFoam lid). The draft has the following pros and cons:

+ *Producibility*
  The box is easily produced, by cutting flat sheets of corrugated board. The PaperFoam lid can be injection moulded
+ *Secondary use*
  Since this draft is basically still a box, it is very well suited for secondary use. All materials can be processed as waste paper; therefore it can at least be used as a box for waste paper, after use
+ *Archetype*
  The draft fits within an archetype of packaging materials and shapes. Even though current toilet paper packaging is merely transparent flexible foil. A box is 'understood' by consumers
+ *Stackability*
  Since the packaging's outer dimensions form a rectangular box, it is very well and efficiently stackable for both transport and storage.
- *Dimensions*
  Due to the relatively large dimensions of the packaging (± 230 mm by 345 mm), the size of the PaperFoam lid is close to the limits resulting from production. However, when this issue turns out to be critical, the PaperFoam lid *could* be replaced by a fixed lid from corrugated board.
- *Opening*
  The top lid is connected to the box with small hooks. However, this could turn out to be impossible to produce or to open easily. A flip-open tear strip in the packaging could be a possibility. Eliminating the PaperFoam lid would however downgrade the draft's appearance and distinction.


**Figure 4.15** | Concept Egg Box

× *Concept Egg Box*
This draft (figure 4.15) is a more extensively developed version of Concept Orange. The draft consists of two identical sections, out of moulded fibre material. Each section can contain six rolls of toilet paper. Both halves of the packaging are connected by a pin and

slot connection. On the outside of the packaging, a paper sleeve is added. This sleeve acts as a cover and keeps both sections of the packaging fixed together. On top of that, it carries the packaging's graphics and information. The sleeve could for instance be printed by Gugler, since this company can supply Cradle to Cradle certified printing products.

The indicated cost price for the packaging is € 1.00 (for two moulded fibre sections) plus € 0.15 (Gugler-printed paper sleeve). The draft has the following pros and cons:

+ *Producibility*
  The box can be produced by moulding paper pulp. The sleeve is printed and cut
+ *Distinction*
  Applying moulded fibre for packing rolls of toilet paper is very distinctive. In between all variants of flexible foil packaging, this draft will be striking
+ *Processing*
  This draft is believed to be easily implemented in a packaging line. Both halves of the packaging can easily be filled with rolls of toilet paper. After that, they are connected and finished with the paper sleeve wrapped around
- *Efficiency*
  The production of the moulded fibre material will result in a shape with angular sides. This results in suboptimal efficiency in transport and storage
- *Secondary use*
  When consumers have used the contents of the packaging, they are left with two empty trays. This empty packaging is not easily used for something else, due to its shape. It will probably be discarded with waste paper, right away. Secondary use of the packaging is not obvious.

### *Material Selection Layer*

### *2.2a Material Specification*

During Decision Moment A, the list of identified materials has been slimmed down. For the two drafts (Concept Octagonal and Concept Egg Box), three base materials are deemed sufficient: corrugated board, PaperFoam and moulded fibre. The sleeve which completes Concept Egg Box is not taken into account in the Material Specification. This could be purchased Cradle to Cradle certified (from Gugler), material analysis is not necessary.

One other material (biobased plastics) also made it to the Conceptualisation Section. However, this material has not been taken into account during the conceptualisation. This is mainly due to the appearance of the material. Since biobased plastic looks and feels just like 'regular' transparent plastic, there is no material distinction from competing packaging in the targeted market. Consumers will probably not appreciate the added value (if any) of biobased plastics, compared to petrochemical-based plastics. Even from a Cradle to Cradle perspective, the choice between biobased and 'regular' plastics is not unambiguous. This mainly has to do with feed stock competition, geographic and political issues. However, to be truly renewable, materials will have to be designed as biological nutrients. On top of that, biobased materials must be designed for a use period which meets or exceeds the reproduction time. Both issues are not met with the application of biobased plastics for toilet paper packaging.

The composition and material content of the concept-relevant materials has been acquired in different ways:

× *Moulded fibre*
  For this material, Cradle to Cradle certification regards the concentration of heavy metals and halogens. Declarations of these substances have been obtained from the supplier (table 4.1).

| Date | Mercury (mg/kg) | Copper (mg/kg) | Cadmium (mg/kg) | Arsenic (mg/kg) | Chromium (mg/kg) | Lead (mg/kg) | Nickel (mg/kg) | Zinc (mg/kg) | Chloride (% m/m) | Fluoride (mg/kg) | Molybdenum (mg/kg) | Selenium (mg/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20-12-01 | <0.01 | 25 | 0.06 | 0.2 | 2.1 | 1.9 | 0.9 | 15 | | | | |
| 28-11-02 | <0.01 | 30 | 0.05 | 0.3 | 3.1 | 3.8 | 1.3 | 30 | <0.02 | | | |
| 11-12-03 | 5.2 | 39 | <0.02 | 0.31 | 3.1 | 3.8 | 1.6 | 26 | 0.12 | | | |
| 02-12-04 | <0.1 | 37 | <0.1 | <1.0 | 4 | 6 | 2 | 40 | | | | |
| 22-11-05 | <0.1 | 21 | <0.1 | <1.0 | 5 | 5 | 3 | 23 | 1.9 | | | |
| 18-12-06 | <0.1 | 31 | <0.1 | <1.0 | 6 | 5 | 3 | 24 | <0.1 | | | |
| 05-12-07 | <0.1 | 32 | <0.1 | <1.0 | 7 | 4 | 3 | 26 | 0.11 | 0.03 | 1 | 1 |
| 04-12-08 | <0.1 | 37 | <0.1 | <1 | 13 | 6.4 | 6.9 | 48 | 0.065 | | | |
| 29-09-09 | <0.1 | 32 | <0.1 | <1.1 | 9.5 | 15 | 6.8 | 31 | 830 | <25 | | |
| 24-11-09 | <0.1 | 32 | <0.1 | 2.1 | 18 | 7.1 | 8.7 | 31 | | | | |
| 17-06-10 | <0.2 | 35 | 0.4 | <2 | 5 | 4 | 4 | 24 | | | | |
| 23-12-10 | <0.1 | 27 | <0.3 | <5.0 | <7.0 | <10.0 | <5.0 | 17 | | | | |
| 27-01-12 | <0.05 | 31 | <0.4 | <4.0 | <15.0 | <13.0 | <3.0 | 23 | | | | |

**Table 4.1** | Heavy metals and halogens in Huhtamaki moulded fibre

**Figure 4.16** | VPK paper samples: 135 white testliner (left), 135 fluting (middle) and 135 testliner (right)

- *Corrugated board*

  For corrugated board, no data on material composition turned out to be available. Therefore, chemical analyses on material samples have been commissioned by the project team. The material samples have been selected from a typical composition of corrugated board for packaging applications. Due to practical reasons, samples from just one supplier (VPK) have

been analysed. The samples are 135 testliner, 135 white testliner and 135 fluting (figure 4.16). The results from the analysis can be seen in table 4.2.

| | 135 testliner (mg/kg) | 135 white testliner (mg/kg) | 135 fluting (mg/kg) |
|---|---|---|---|
| | mg/kg | | |
| *Antimony* | <0.2 | <0.2 | <0.2 |
| *Arsenic* | 0.24 | 0.14 | 0.30 |
| *Beryllium* | <0.2 | <0.2 | <0.2 |
| *Cadmium* | 0.07 | 0.05 | 0.09 |
| *Chrome* | 5.8 | 4.8 | 6.2 |
| *Cobalt* | 0.72 | 0.54 | 0.74 |
| *Copper* | 29 | 16 | 33 |
| *Mercury* | 0.05 | 0.02 | 0.03 |
| *Lead* | 10 | 6.3 | 10 |
| *Nickel* | 2.4 | 1.8 | 2.8 |
| *Titanium* | 450 | 310 | 450 |
| *Zinc* | 29 | 19 | 29 |
| *Total halogens* | 680 | 83 | 250 |
| *Inorganic halogens* | 585 | 67 | 235 |
| *Extractable Organic Halogens* | 2.4 | 2.0 | 2.6 |
| | % (m/m) | | |
| *Moisture content* | 8.0 | 8.2 | 8.1 |

**Table 4.2** | Heavy metals and halogens in VPK corrugated board paper samples

Apart from the paper layers, corrugated board consists of an adhesive. This adhesive consists of the following ingredients:

- *Water (± 74%)*
- *Starch (± 24%)*
- *Caustic soda (± 1.7%)*
- *Borax (± 0.3%)*

Of these ingredients, water, starch and caustic soda are not considered to be harmful from a material health perspective. However, borax is. For the production of corrugated board, this material is added to enhance the flow properties of the glue. Both suppliers of corrugated board (Smurfit Kappa and VPK) use different variants of this chemical:

- *Smurfit Kappa:*

| Product name | Composition | CAS number |
|---|---|---|
| *Borax decahydrate* | >99.9% | 1303-96-4 |

This product is listed as reproductive toxic. The complete data sheet can be found in appendix I.

- *VPK:*

| Product name | Composition | CAS number |
|---|---|---|
| *Prodac* | Amino-polyborate (<65%) | 9405-04-02<br>68425-67-2 |
| | Sodium pentaborate (10-15%) | 120007-92-0 |

For this product, the following statement can be found in its data sheet: "*Prodac contains neither residue of boric acid or borax decahydrate nor any other carcinogenic, mutagenic or reproductive toxic product*". Due to this statement, the variant of this material VPK applies appears to be less harmful than the variant Smurfit Kappa applies. The complete data sheet (in Dutch) of Prodac can be found in appendix J.

- *PaperFoam*

The composition and material of PaperFoam is known by the manufacturer. However, this information is only partially disclosed. The material basically consists of the following ingredients:

- *Industrial starch (± 50%)*
- *Virgin cellulose fibres (± 25%)*
- *Premix (± 25%)*
- *Colouring*

Of these ingredients, starch and cellulose fibres will not be harmful from a material health perspective (sourcing is not taken into account in this phase). Of the premix, material contents are not disclosed by the manufacturer. Therefore, an indication on the suitability for Cradle to Cradle certification cannot be determined. This is possible by setting up a non-disclosure agreement between an independent assessment institute and PaperFoam, commissioned by Van Houtum. This is considered an official part of certification, with financial implications. Due to the pilot-like approach of this project, this step is not executed. The material contents of PaperFoam remain (partially) unknown.

Besides the base material, some colouring could be added to the material. For the application as developed in Concept Octagonal, the PaperFoam lid should be coloured black. Other possibilities would be white (no colouring) or red (the secondary colour of Satino Black). The chemicals used for colouring have the following properties:

| Product name | CI number | CI name | Manufacturer |
|---|---|---|---|
| *Pigmatex Black NG* | 1333-86-4 | CI Pigment Black 7 | SunChemical |
| *Pigmatex Scarlet 268* | 12316 | CI Pigment Red 268 | |

- *Additives*

Apart from the base materials, some additives have to be specified to achieve the representation of the developed drafts. As mentioned before, no adhesives will be used in either of the drafts. Therefore, only inks and coatings are taken into account:

- *Concept Octagonal*

  For printing the corrugated board of Concept Octagonal, three options are available: Gugler, Green4Print and the current ink suppliers. Gugler will only be able to print corrugated board as a separate liner. This would then be transported to the manufacturer of corrugated board. Green4Print is able to supply printing inks which are free of heavy metals and halogens (important in Cradle to Cradle certification). However, this is currently only available for sheet offset technology. The third option is using the currently used inks. Obviously, these will have to be analysed. For printing the two colours of

Satino Black (black and red), different components are applied by Smurfit Kappa (table 4.3) and VPK (table 4.4).

| Colour | Component | Component number | CAS number | CI number |
|---|---|---|---|---|
| *Black* | Black 7 | WZ 16-91KN | 1333-86-4 | 77266 |
| | Varnish | WI 3P-E14N | - | - |
| *Red* | White 6 | WZ 16-02KN | 13463-67-7 | 77891 |
| | Orange 13 | WZ 16-22KN | 3520-72-7 | 21110 |
| | Red 2 | WZ 16-31KN | 6041-94-7 | 12310 |
| | Varnish | WI 3P-E14N | - | - |

**Table 4.3** | Components applied by Smurfit Kappa for Satino Black

| Colour | Ink number | Component | CAS number | CI number |
|---|---|---|---|---|
| *Black* | 90-WP-03 | Black 7 | 98615-67-9 | 77266 |
| *Red* | 46-WB-04 | Yellow 14 | 5468-75-7 | 21095 |
| | | Red 2 | 6041-94-7 | 12310 |
| | | Red 57 | 5281-04-9 | 15850 |

**Table 4.4** | Components applied by VPK for Satino Black

The inks used by VPK are mainly (60-70%) water-based. Regarding black pigments, the concentration of polycyclic aromatic hydrocarbons (PAH) is important from a Cradle to Cradle perspective. Therefore, statements of the ink suppliers have to be obtained. Flint (supplier of inks for Smurfit Kappa) has stated the following:

*"PAH are not intentionally added in any water based printing ink from Flint. The WZ 16-91KN is not analysed for PAH. There is no legal basis for packaging inks limitations of PAH"*

SunChemical (supplier of inks for VPK) has stated the following:

*"In the manufacture of inks and varnishes supplied by SunChemical, polycyclic aromatic hydrocarbons or raw materials containing these substances are not used as intentionally added ingredients. The presence, however, of traces of these substances in the product coming from raw material impurities, from the process or as adventitious contaminant cannot be excluded"*

Concept Octagonal could be equipped with a coating. The starch-based coating Glycapol (produced by Glycanex) might be suited for this application and from a Cradle to Cradle perspective. The complete data sheet of Glycapol can be found in appendix H.

× *Concept Egg Box*

In this draft, two types of additives are incorporated: colouring for the moulded fibre material and printing inks for the paper sleeve. The Cradle to Cradle-related properties of the material colouring (heavy metals and halogens) have already been taken into account in the analysis of the base material. Therefore, a separate analysis on these additives is not necessary. As mentioned before, the paper sleeve could be printed by Gugler. This would result in a Cradle to Cradle certified printed sleeve.

## *Decision Moment B*

During Decision Moment B, the following documents are being reviewed:

- *Defined drafts*

  Two drafts have been developed, up to equal (conceptual) level. These drafts have been reviewed on form, function, material use, price, producibility. **Concept Octagonal** has been selected for detailing. All internal stakeholders related to the project have been consulted for this review. On top of that, a representative of the targeted market has been consulted. The decision has been made on the following main issues:

  - *Appearance*

    Even though the packaging draft is required to be distinctive from current packaging for toilet paper, Concept Egg Box is believed to be too distinct. This draft might be very well possible for market implementation in a few years, when Satino Black is known to consumers. Another issue related to this draft, is the paper sleeve. Once the packaging is opened, the paper sleeve will be discarded of. With that, all Satino Black branding is gone. Therefore, the sleeve would have to be designed as a part which is essential for the closing of the packaging.

  - *Efficiency*

    As mentioned before, efficiency in transport and storage is a downside of Concept Egg Box. Cradle to Cradle is not focused on efficiency (effectiveness is key), but this is still an issue.

  - *Secondary use*

    When empty, Concept Egg Box will probably not be applied for secondary use. This is due to its shape, which is dedicated to packing rolls of toilet paper.

  - *Cost price*

    This project is not focused on developing a packaging draft with as low costs as possible. However, the estimated cost price for Concept Egg Box is believed to be too high. With the current estimation, the cost price will exceed the requirement.

- *Specified materials*

  Of all materials related to Concept Octagonal and Concept Egg Box, available specifications have been listed. These specifications of material content and composition are deemed sufficient for (external) material assessment, as part of the Detailing Section.

With the defined drafts and specified materials reviewed, the Detailing Section of the project can be executed. At the end of this section, during Decision Moment C, the following documents are being judged on different issues:

- *Detailed draft*
  - The detailed draft must be described on shape, function, material and graphic design
  - The level of detail must be sufficient for production and certification

- *Selected materials*
  - All concept-relevant materials must be assessed by an independent assessment institute
  - The level of material assessment must be sufficient for certification

- *Documentation*
  - Documentation must address draft, development and materials

## 4.5 Detailing Section

### *Development Layer*

### *3.1a Concept Detailing*

Concept Octagonal is detailed up to a level which is sufficient for production and Cradle to Cradle certification. The detailing step is executed iteratively during which the draft's dimensions, opening and closure (lid) constructions are addressed.

#### *Lid Construction / Opening Construction*

The construction for the opening of the packaging draft, as specified in the Conceptualisation Section, has been discussed with both PaperFoam and Smurfit Kappa. The latter has been selected out of the current suppliers of Van Houtum, after discussion within the project team. The connection of the lid to the box has been changed, since the triangular hooks (figure 4.14) turned out to be impossible to produce. Therefore, different variants to this idea have been discussed with PaperFoam, Smurfit Kappa and the project team.

The final version of the lid incorporates folded edges on the box, with slots in the PaperFoam lid. This principle is visualised in figure 4.17 (detail A). The underside of the lid lies on top of the products in the packaging. To be able to open the packaging, a tear strip is placed at the front side of the packaging. By tearing off this strip, the lid can be slid out. A technical drawing of the final version of the PaperFoam lid for the packaging draft can be seen in figure 4.18.

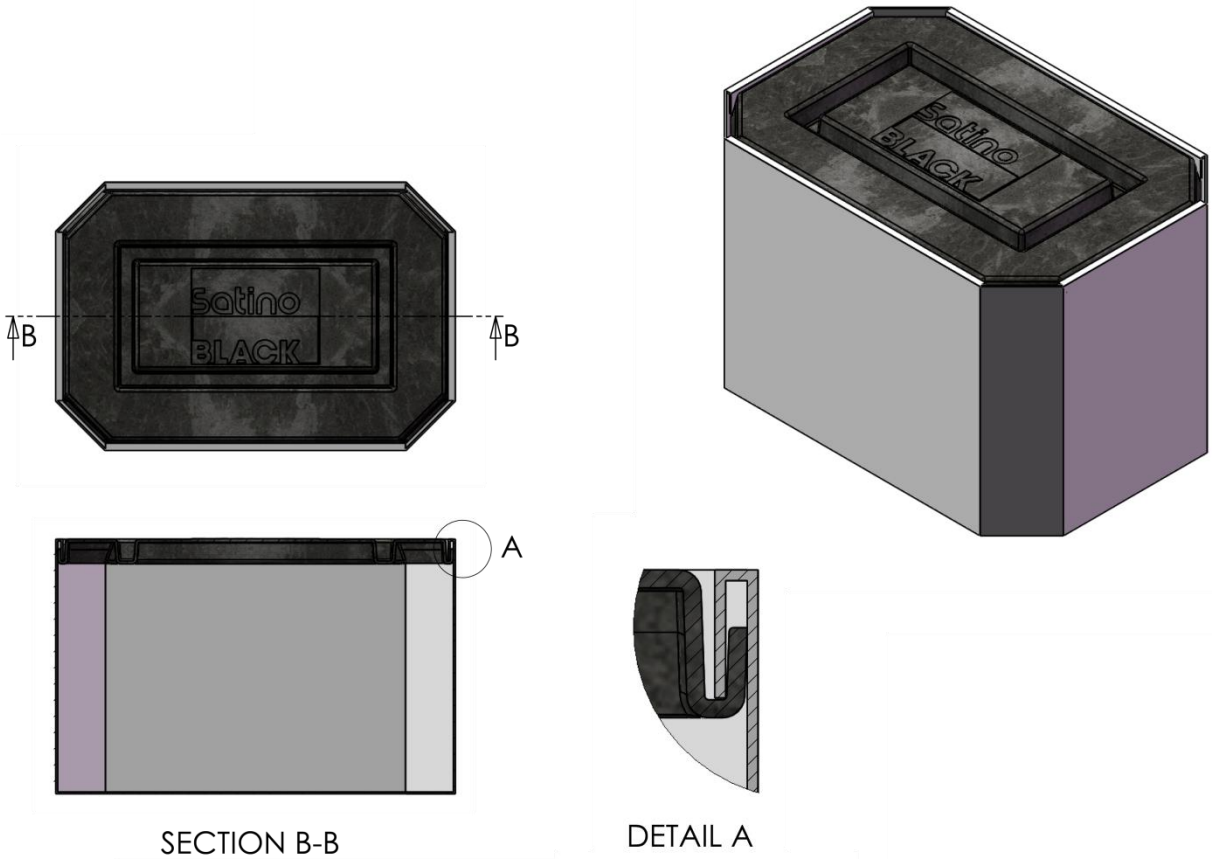



**Figure 4.17** | PaperFoam lid with slotted edges

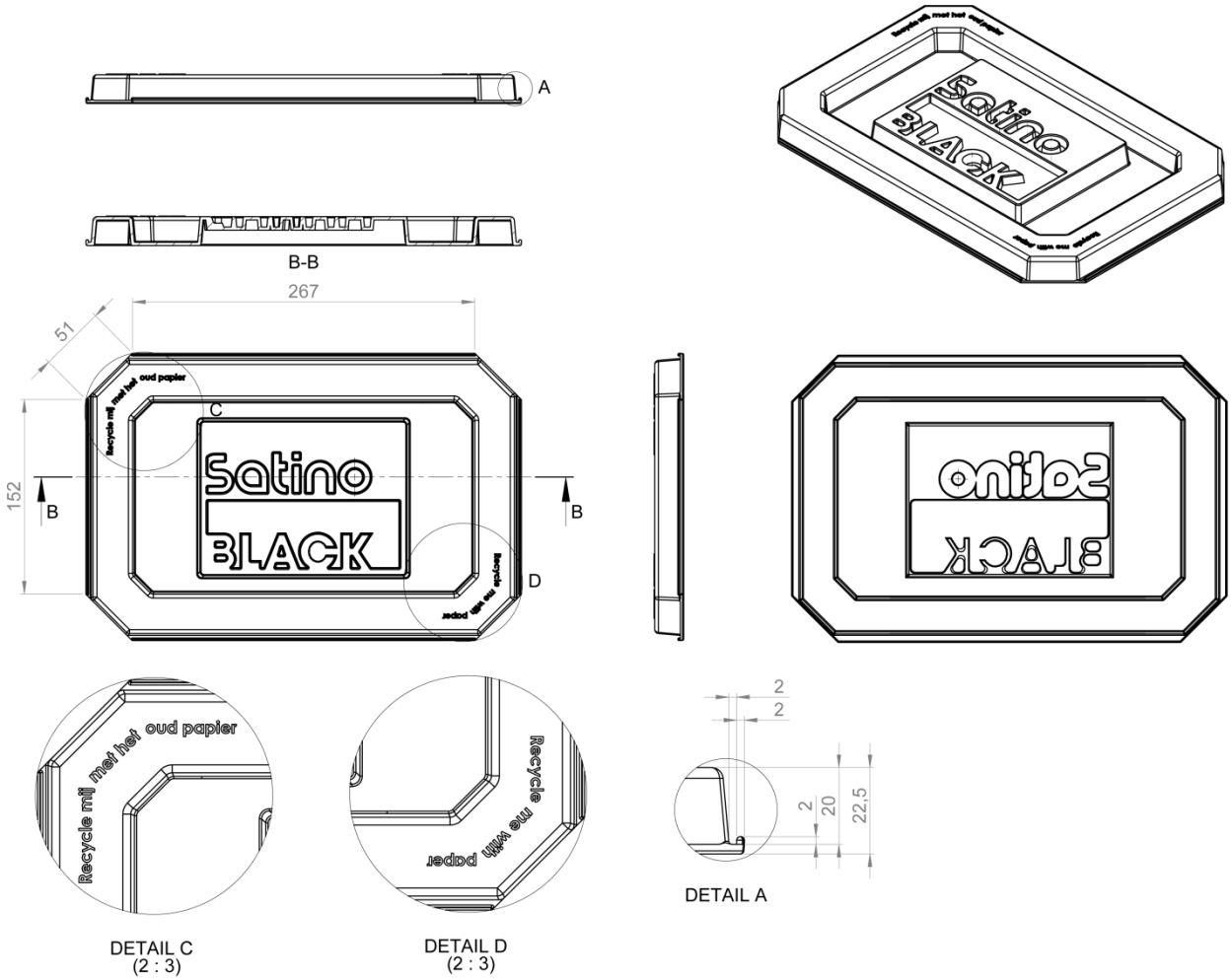



**Figure 4.18** | Technical drawing PaperFoam lid

***Closure Construction***

The design of the corrugated board box is discussed with Smurfit Kappa, during different meetings. Due to the significant weight the packaging will contain (±2 kg), Smurfit Kappa sees some difficulties with the construction of the closure. As mentioned before, the closure of the packaging must be achieved without using any adhesives. Therefore, the construction itself is critical. Several variants of the closure construction have been designed, modelled and discussed, as can be seen in appendix F. The final draft incorporates a 'blind' closure construction, which is visualised in figures 4.19a and 4.19b.

Implementing the construction with folded edges on the cardboard box (figure 4.17) has implications for the used material. This construction will not be possible with a B-flute. Therefore, the corrugated board box will be constructed with E-flute cardboard. The final design (and dimensions) for the draft of the corrugated board box can be seen in figure 4.20.

**Figure 4.19a** | Model of closure design (1)

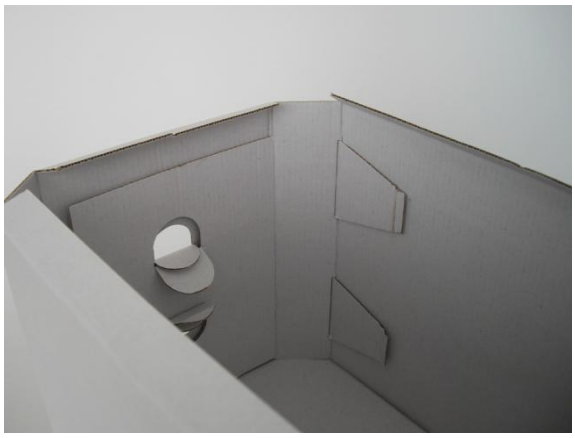


**Figure 4.19b** | Model of closure design (2)

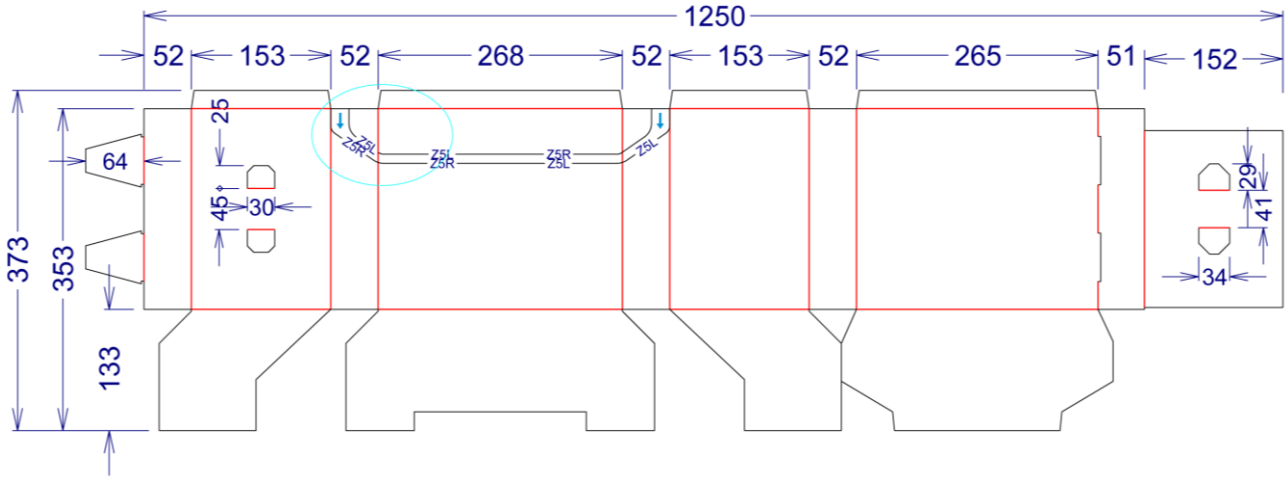



**Figure 4.20** | Outline and dimensions detailed draft

***Graphic Design***

In this packaging project, graphic design is no key issue. However, a proposition for graphic design is considered to be important, to show the potential of the draft within the Satino Black brand. The importance of graphic design has also been demonstrated during the conceptualisation steps. The graphic design is focused on several items:

- *Brand identity*
- *Packaging contents (12 = 32; figure 4.21a)*
- *Ecologic marks (figure 4.21b)*
- *Material contents*
- *Opening of the packaging (figure 4.21c)*

This is completed with (basic) descriptions considering material cycles related to Satino Black and the packaging. For customers who would like to get more information, a QR code is printed on the packaging. This code links to the website of Satino Black. The graphic design is also implemented in the PaperFoam lid. In this lid, the Satino Black logo is embossed. Also, the statement "Recycle me with paper" is embossed, both in English and Dutch. In figure 4.22, the graphic design is visualised. A larger version can be found in appendix K.

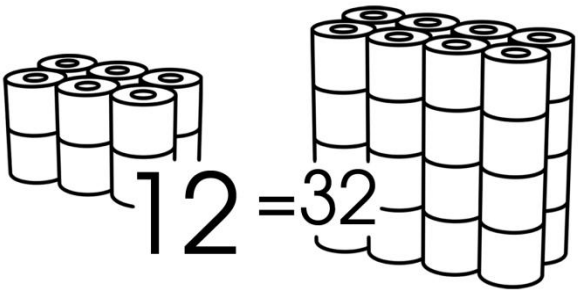



**Figure 4.21a** | 12=32


**Figure 4.21b** | Ecological marks

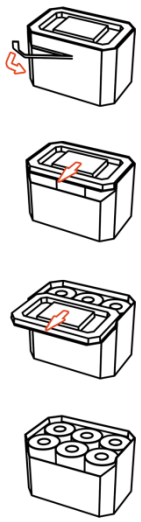


**Figure 4.21c** | Opening description

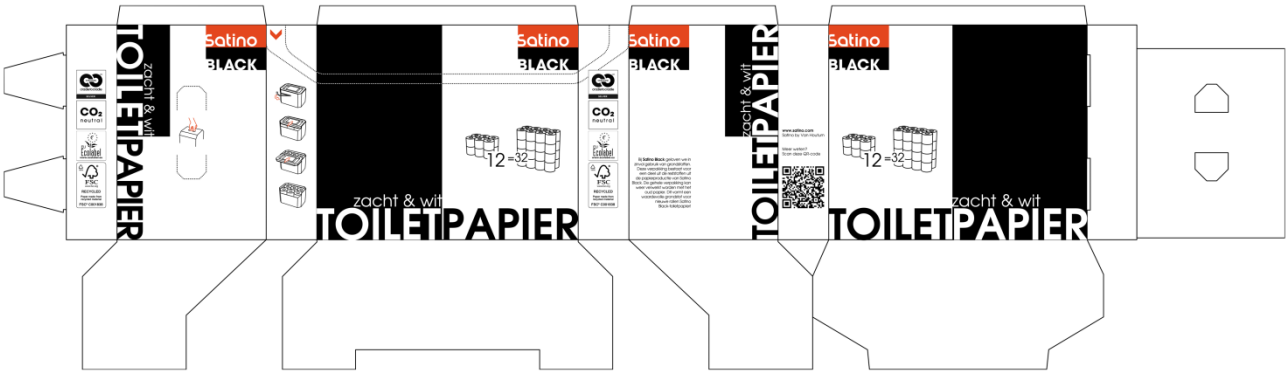



**Figure 4.22** | Graphic design proposition

The detailed design (including graphic design) is visualised in figures 4.23a-d. In figures 4.23e and 4.23f, images of the mock-ups are shown. These models are developed to review appearance, shape, form and function of the packaging draft. Large versions of the figures can be found in appendix K. In appendix F, the packaging development process is described more elaborately. This also includes issues regarding the final draft of the packaging, such as cost price indications and transport and storage.


**Figure 4.23a** | Rendering detailed design (1)


**Figure 4.23b** | Rendering detailed design (2)


**Figure 4.23c** | Rendering detailed design (3)


**Figure 4.23d** | Rendering detailed design (4)


**Figure 4.23e** | Mock-up detailed design (1)


**Figure 4.23f** | Mock-up detailed design (2)

### *3.1b Documentation*

In this report, a selection of the documentation related to the packaging project is described in previous paragraphs. The complete (elaborate) documentation can be found in appendix F. This documentation contains:

- *Design (physical and graphical)*
- *(Technical) drawings*
- *Material descriptions*

## *Material Selection Layer*

### *3.2a Material Selection*

For the developed draft, much of the material selection has taken place simultaneously to the concept detailing. The corrugated board box will be constructed out of E-flute board, with a composition comparable to the analysed paper samples (figure 4.16). The box is printed with inks currently used by the manufacturers of the corrugated board. Other possibilities for printing are (currently) not practically applicable. A typical material composition for this specific draft is illustrated in table 4.5. This table shows a list of material ingredients VPK would use to produce the corrugated board box.

According to the Cradle to Cradle packaging development method, during the Material Selection, scenarios on production, use and post-use must be set up. For this, extensive information from the suppliers is required. However, in this packaging project, this information has not been acquired, due to different (practical) reasons. Therefore, the level of scenario description is limited to the level as described in the Material Identification. The draft is determined to be placed in a biological cycle (within a cascade model). To this, one (possible) scenario cycle is added: the processing of waste sludge from paper production in PaperFoam. The waste from de-inking (one of the steps to make new paper out of waste paper) can be applied as a replacement for the short cellulose fibres in PaperFoam. This is tried out as a pilot with PaperFoam and Van Houtum; it turned out to be possible. This might be a welcome addition to the current level of material reutilisation in PaperFoam. Samples of PaperFoam products with Van Houtum's de-inking residue can be seen in figure 4.24.

| *Material ingredient* | *CAS Number* | *% (by weight)* | *Function* | *Recycled content* | *Supplier* | *Comments* |
|---|---|---|---|---|---|---|
| *White testliner* | - | 33.45 | Outer liner | 100% | Europac | Based on complex E8520, including cut-offs |
| *Fluting* | | 31.19 | E-flute | | VPK | |
| *Testliner* | | 33.45 | Inner liner | | VPK | |
| *Starch* | 68441-21-4 | 1.51 | Glue | - | Tereos Syral | |
| *Borax (Prodac)* | 120007-92-0 | 0.02 | Enhance viscosity | | Ziegler | |
| *Caustic soda 33%* | 1310-73-2 | 0.07 | Gelling point | | Quaron | |
| *Biocide* | 10377-60-3 | 0.01 | Anti-bacterial | | Bewasol | |
| *Black pigment* | 1333-86-4 | 0.26 | Pigment | | SunChemical | Declaration on PAH |
| *Red pigment* | 12237-63-7 | 0.014 | | | | |

**Table 4.5** | Draft material composition (VPK)

**Figure 4.24** | PaperFoam with Van Houtum's de-inking residue

| | *Background value* | *135 testliner (mg/kg)* | *135 white testliner (mg/kg)* | *135 fluting (mg/kg)* |
|---|---|---|---|---|
| | *mg/kg* | | | |
| *Antimony* | 4 | <0.2 | <0.2 | <0.2 |
| *Arsenic* | 20 | 0.24 | 0.14 | 0.30 |
| *Beryllium* | - | <0.2 | <0.2 | <0.2 |
| *Cadmium* | 0.6 | 0.07 | 0.05 | 0.09 |
| *Chrome* | 55 | 5.8 | 4.8 | 6.2 |
| *Cobalt* | 15 | 0.72 | 0.54 | 0.74 |
| *Copper* | 40 | 29 | 16 | 33 |
| *Mercury* | 0.15 | 0.05 | 0.02 | 0.03 |
| *Lead* | 50 | 10 | 6.3 | 10 |
| *Molybdenum* | 1.5 | - | - | - |
| *Nickel* | 35 | 2.4 | 1.8 | 2.8 |
| *Tin* | 6.5 | - | - | - |
| *Titanium* | - | 450 | 310 | 450 |
| *Zinc* | 140 | 29 | 19 | 29 |
| *Total halogens* | - | 680 | 83 | 250 |
| *Inorganic halogens* | - | 585 | 67 | 235 |
| *Extractable Organic halogens* | 100 | 2.4 | 2.0 | 2.6 |

**Table 4.6** | Background value vs. analysis results paper samples

*External Layer*

### *3.3a Material Assessment*

All analysis results of the concept-relevant materials, which have been obtained during the Material Specification, have been discussed with EPEA (in the role of independent Cradle to Cradle assessment institute). However, due to practical implications, of the analyses of PaperFoam's premix and inks for corrugated board, no information is official. This is related to the pilot-like approach of this project, in which these types of 'official' assessments were considered too extensive.

From a Cradle to Cradle certification perspective, arsenic, cadmium, chromium VI, lead and mercury are on the banned list (see paragraph 2.2), for both technical and biological nutrients. However, for biological nutrients (which paper/cardboard in a cascade metabolism is), these heavy metals are tolerated when concentrations do not exceed background values [33]. On top of that, the amount of organic halogens must not exceed 100 ppm. Table 4.6 shows that none of the substances exceeds the legal limits.

The final assessed material is borax. As stated before, this substance is known to be reproductive toxic. Therefore, corrugated board containing borax-enhanced adhesives (even in the smallest amount) will not be allowed to certify any higher than Bronze level. Current developments however, do show some borax-related alternatives, for instance the substance as applied by VPK (Prodac, see appendix J).

## *Decision Moment C*

With the Detailing Section finished, all development steps have been executed. This specific project is finished with Decision Moment C. This session has not been planned with all stakeholders related to the project. However, the documents resulting from the Detailing Section have been discussed individually:

- *Detailed draft*
  - The detailed draft is described and approved on shape, function, material implementation and graphic design.
  - The level of detail and (technical) drawings is sufficient for production
  - The level of development is not sufficient for Cradle to Cradle certification, mainly due to a lack of certain official supplier declarations and material specifications

- *Selected materials*
  - Not all concept-relevant materials are assessed by EPEA. The 'official' assessment is not executed. Only assessments which have been executed internally are completed
  - With this, the level of material assessment is not sufficient for certification
  - Due to the presence of borax in the adhesive for corrugated board, Cradle to Cradle certification will not reach Silver level

- *Documentation*
  - All documentation addressing draft, development, and materials are specified in previous paragraphs.

Typically, Decision Moment C must result in the decision on whether or not to execute the Completion Section of the project. However, in this specific case, this decision is not being made. Therefore, the project ends with the completion of the Detailing Section.

## 4.6 Completion Section

The final section of the packaging development project is not executed for this specific case. This is mainly time based; certification, production and market implementation are extensive steps. It might even be a project on itself. On top of that, for the steps of the Completion section, a management decision is required. This is typically part of Decision Moment C.

***External Layer***

***4.3a Certification***

The actual Cradle to Cradle certification of the packaging draft is not executed for this project. However, significant parts of the material assessment (Conceptualisation and Detailing Section) have been executed. The Materials Appendix for Cradle to Cradle certification is filled in by VPK, for this specific draft (table 4.5). Besides that, issues regarding renewable energy, water stewardship and social fairness will have to be assessed (see also chapter 2). This information must be acquired from the manufacturing companies (PaperFoam and the supplier of corrugated board) and the certification applicant (Van Houtum). Due to several unknown issues related to the draft and some practical implications, the certification aspects have not been completed.

***4.3b Production*** / ***4.3c Implementation***

These steps are not executed for this project.

### Project Conclusion

The Completion Section is not part of this specific packaging development project, even though some steps have been executed. With the certification incomplete, the packaging draft is considered to be 'Cradle to Cradle inspired'. When the final section of this packaging is being executed (in another time frame), at least Decision Moment C must be completed. Another possibility is to redo more of the development steps, for instance the complete Detailing Section.

Since the Completion Section and Project Conclusion session are not executed for this project, there are no stakeholder reviews on the following issues. These issues are (partially) addressed in chapter 6:

- *Project execution (development method)*
- *Packaging draft (development results)*

# 5 Reflection: Theory versus Practice

In this report, Cradle to Cradle is viewed from both a theoretical and a practical perspective. Several discrepancies between theory and practice can be identified. How is Cradle to Cradle theory put into practice and what issues relate to this?

## 5.1 C2C in Theory

Cradle to Cradle theory is described in chapter 2. Out of this theory, relevant aspects are derived. These aspects form the outline of the Cradle to Cradle packaging development method, as described in chapter 3.These different levels of Cradle to Cradle theory are visualised in figure 5.1. In this figure, the Cradle to Cradle theory (principles and metabolisms) is the top level. This is translated in a practical approach, by EPEA. It also acts as input for the development of the method. Other input for the method is the experience EPEA has with Cradle to Cradle packaging development projects. Both EPEA's knowledge on Cradle to Cradle projects and the development method shape the case study. On top of that, the case study and the development method are developed simultaneously and are therefore interrelated. Between the different levels is where the discrepancies show. The most striking examples (which showed during the development of the method and the case study) are described.

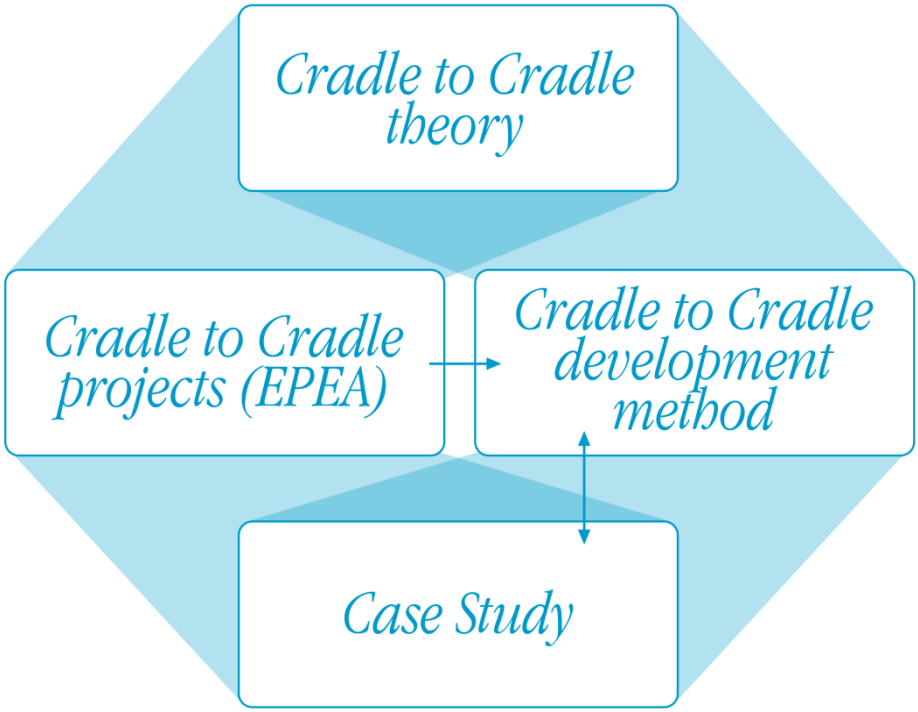



**Figure 5.1** | Levels of Cradle to Cradle theory

Cradle to Cradle theory states that there is a focus on eco-effectiveness; moving from 'less bad' to 'more good' (figure 5.2). Cradle to Cradle packaging development should be focused on functionality, quality and design, in health, environmental and economic terms.

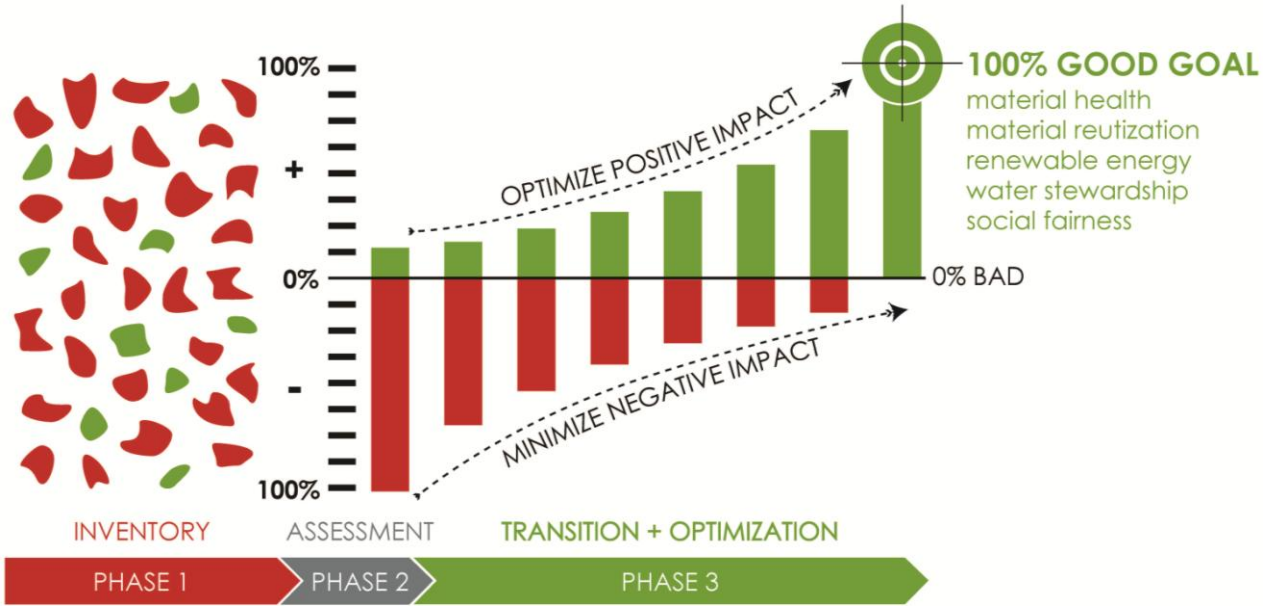



**Figure 5.2** | Continuous improvement [8]

One of the first issues related to a translation of Cradle to Cradle theory, comes from EPEA Germany. A representative of the institute stated: "*100% Cradle to Cradle is impossible. Realistically, an optimum between toxicity and feasibility must be found*". This shows that the principles, tools and metabolisms of top-level theory are not practically applicable one-on-one. Cradle to Cradle is intended as a guide on development improvement. This is also shown in the way the certification levels are set up. Instead of focusing on a binary fail/pass model, certification is intended to trigger development. Companies are expected to be willing to strive for the next level of Cradle to Cradle certification. It is a two-faced paradigm: the idealistic theory versus the marketing-driven certification (including certification marks with accompanying regulations on use).

## 5.2 C2C in Practice

The theoretical Cradle to Cradle issues, which are implemented in the method, have been translated into practical steps in the case study (chapter 4). In this case, several issues concerning the practical application of Cradle to Cradle have been found.

### Certification Aspects

First of all, the practical application of Cradle to Cradle shows that the material health is by far the most important. The other aspects of Cradle to Cradle certification (material reutilisation, water stewardship, energy use and social fairness) are implemented and assessed far less extensively. In most cases, declarations from the manufacturer will suffice for these issues. This way, there is a risk of developing products which do not strictly comply with the theory (waste equals food). For instance when the focus on material health is at the expense of post-use recycling.

### Position EPEA

Another striking issue is the position of EPEA. Obviously, the company's business case is its monopoly on Cradle to Cradle material assessment. Together with MBDC, EPEA is the only institute of which

material assessments are sufficient for Cradle to Cradle certification. All other developments can be executed by other institutes, but the material assessment will only be approved by C2CPII when signed and delivered by EPEA. Therefore, the material analysis as executed in this case study is far from typical, since EPEA was only partly involved. The position of EPEA also has implications for the way developments are being coped with. For the sake of protection of knowledge, most (relevant) Cradle to Cradle-related developments are secured in non-disclosure agreements (NDA) with EPEA and the developing company. This results in a striking lack of open innovation. After all, with a NDA in effect, EPEA cannot communicate on suppliers of the company with whom the NDA has been closed. New developments, which could very well benefit from other Cradle to Cradle developments, are delayed or even cancelled. This results in EPEA lacking in being an actual innovation driver, but merely a guide.

### *Assessment*

The way in which assessment works, is an important part of the business case of EPEA. First, material specifications are acquired from a supplier. These substances are compared to EPEA's material databases. The result of this comparison is the ABC-X categorisation. The material databases EPEA uses are publicly available. However, the specific assessment is not. Therefore, for other institutes it is impossible to reproduce (or check) the ABC-X categorisation.

By far most of the developments that are guided by EPEA are optimisations of current products. The system is less well-equipped for the development of completely new products. In the assessment, some issues are striking due to their absence. First, there is a lack of focus on the use phase of products. In Cradle to Cradle certification, only the beginning (production) and end of the cycle (post-use) are considered. Even though all steps in between can be of critical importance. The only way in which the use phase is involved, is the recommendation to communicate on the 'Cradle to Cradleness' of a product. This must then result in a post-use phase the way it is intended by the manufacturer of the product. Another striking issue is transport. In the certification module, the word "transport" is only mentioned a few times, as one issue regarding energy.

## *5.3 Interrelation Theory and Practice*

There are quite some discrepancies between Cradle to Cradle in theory and practice. Some of these issues can be attributed to the novelty of the paradigm. Other issues are simply part of the business case of EPEA. However, two issues are considered to be critical, which are not related to the paradigm's novelty. The first regards the position of EPEA. The institute should be focusing on setting up partnerships between companies that are working on Cradle to Cradle development. That way, innovation is triggered. Related to this, partnerships and processes can be certified. This way, all companies related to a certain Cradle to Cradle development can benefit, instead of only the applying company.

The other issue is the position of the Cradle to Cradle Products Innovation Institute (C2CPII). Since 2012, this institute administers the Cradle to Cradle certification program. This results in C2CPII being the leading institute (over EPEA and MBDC). During the case, there were several issues that showed that developments by C2CPII, related to the certification standard, were leading for EPEA. In some cases, EPEA turned out to be uncertain how to handle new developments. For instance in the case of the description of the final manufacturing process of the draft or the combination of both a certified product and packaging.

## 5.4 Alternatives to C2C

Several alternatives to Cradle to Cradle can be identified. These alternatives are to some extend focused on sustainable or circular development. Of these alternatives, the key principles are listed.

### Biomimicry

Studying nature's best ideas and imitating these designs and processes to solve problems; innovation inspired by nature [34].

- *Key principles:*
  - *Nature as model:* study nature's models and emulate these forms, process, systems and strategies to solve human problems
  - *Nature as measure:* use an ecological standard to judge the sustainability of innovations
  - *Nature as mentor:* show not what we can extract from the natural world, but what we can learn from it

### Blue Economy

We can imitate nature's designs in our own production – using the waste of one product as the input for another [35].

- *Key principles:*
  - *Solutions are based on physics.*
  - *Substitute something with nothing*
  - *Natural systems cascade nutrients, matter and energy*
  - *Nature evolved from few species to a rich biodiversity; in nature the constant is change*
  - *Nature provides room for entrepreneurs who do more with less*
  - *Gravity is main source of energy; solar energy is the second renewable fuel*
  - *Water is the primary solvent*
  - *Nature only works with what is locally available*
  - *Nature responds to basic needs and then evolves from sufficiency to abundance*
  - *Natural systems are non-linear*
  - *In nature everything is biodegradable*
  - *In natural systems everything is connected and evolving towards symbiosis*
  - *In nature water, air, and soil are the commons, free and abundant*
  - *In nature one process generates multiple benefits*
  - *Natural systems share risks*
  - *Nature is efficient*
  - *Nature searches for the optimum for all involucrate elements*
  - *In nature negatives are converted into positives*
  - *Nature searches for economies of scope*
  - *Respond to basic needs with what you have*

### Circular Economy

An economy which is based on material flows in two types: biological nutrients, designed to re-enter the biosphere safely, and technical nutrients, which are designed to circulate at high quality without entering the biosphere [36].

- *Key principles:*
  - *Design out waste*
  - *Build resilience through diversity*
  - *Rely on energy from renewable sources*
  - *Think in 'systems'*
  - *Waste is food*

### *Sustainable Design*

Designing objects, the built environment, and services to comply with the principles of social, economic, and ecological sustainability [37].

- *Key principles:*
  - *Respect for the wisdom of natural systems:* the biomimicry principle
  - *Respect for people:* the human vitality principle
  - *Respect for place:* the ecosystem principle
  - *Respect for energy and natural resources:* the conservation principle
  - *Respect for process:* the holistic thinking principle

### *Conclusion*

Several alternatives to Cradle to Cradle are listed. Some of these are closely related to Cradle to Cradle (Blue Economy and Circular Economy). Some of the key principles are even identical. However, none of the alternative paradigms incorporates both a theoretical and an extensive and practically applicable framework. Let alone certification marks, which act as marketing tools. Within Cradle to Cradle, both theory and practice (including marketing) are more or less aligned, making it a well-applicable and marketable paradigm within sustainable development.

## *5.5 Conclusion: Theory versus Practice*

Cradle to Cradle will probably not be 'the future'. The theoretic framework is believed to remain interesting for development. However, the specific way in which Cradle to Cradle is currently shaped will probably alter. Also, there will always be a certain conflict between the (more or less utopian) theory and the practical application. To make the current way of practical application of Cradle to Cradle sustain, some of the above mentioned issues will have to alter. There is some consensus about the first major issues that will influence the future popularity of the Cradle to Cradle paradigm. It is very well possible that the innovation driver Cradle to Cradle currently lacks results in a reduction of the current success, on top of some of the other mentioned issues.

# 6 Conclusions and Recommendations

This assignment is focused on the development of Cradle to Cradle packaging. This is implemented in a development method and a case study for a specific Cradle to Cradle packaging draft. Of different sections of the assignment, conclusions and recommendations are set up.

## 6.1 Conclusions

### *Preliminary research*

The basis of the assignment is shaped by the preliminary research. This research is focused on describing the current status of packaging development, with a focus on Cradle to Cradle. On top of that, research is aimed on Cradle to Cradle-related developments within Van Houtum. The preliminary research addresses several issues:

- *Current status of Cradle to Cradle in packaging development*
- *Current vision on Cradle to Cradle within Van Houtum*
- *Current status on Cradle to Cradle in packaging development within Van Houtum*
- *Current status and vision on Cradle to Cradle in packaging development within EPEA*

From this research, different conclusions can be drawn. First of all, a certain need for Cradle to Cradle packaging can be assumed. Within Van Houtum, there currently is a lack of such a structured method. On top of that, there is a striking lack of Cradle to Cradle implementation within current packaging development. Let alone within Van Houtum's current packaging chain. The approach that is used by EPEA Germany for the development of Cradle to Cradle packaging shows in what way the principles are translated into a useful approach. This approach is far from a utopia, but focuses on feasibility, even though there is no strict structure. This underpins the essence and need for a Cradle to Cradle packaging development method.

### *Method*

Aspects of both Cradle to Cradle and packaging development have been derived from the mentioned research issues. These aspects combined form the outlines of a Cradle to Cradle packaging development method. This method describes the different steps and actions which should be executed to develop Cradle to Cradle packaging. The method consists of four sections and three layers. For this packaging development method, the separation into layers (more specific: the Material Selection Layer) is essential. Due to the great importance of material contents in Cradle to Cradle, all material-related developments are separated from other packaging development steps in the method.

The implementation of the Cradle to Cradle packaging development method is validated during a session within Van Houtum. From this validation session, several important issues come forward, related to the (practical) use of the method. In general, the method appears to be very well suited for practical application within Cradle to Cradle packaging development. Some issues related to the

implementation have shown from the validation session, mainly related to the level of abstraction and the use of different reflection documents. For future (practical) application of the method for Cradle to Cradle packaging development, the method must be extended with these issues.

### *Case Study*

A case study is executed, based on and guided by the development method. This case study has resulted in a detailed draft for a packaging for the cash & carry market. Since Cradle to Cradle is essential in the draft, elaborate material research, analysis and optimisation is conducted. The packaging draft consists of a box out of corrugated board, completed with a lid made from PaperFoam. This makes the packaging suited for a post-use scenario in the waste paper system.

Essential within the case study is an illustration of the practical application of the Cradle to Cradle packaging development method. Since both the method and the case study have been developed and executed simultaneously and by the same person, there is a risk of a limited view. Hence the necessity for the previously mentioned validation session. Still, several discrepancies between the case study, the validation session and the (future) practical application of the method have shown. First of all, the use of different reflection documents is essential. This includes documents on the Cradle to Cradle requirements, Material Knowledge Bank, previously executed projects et cetera. These documents turn out to be very useful in guiding a specific packaging development project. The chronology between steps is not described in the method, only the sequentiality. The case study has shown that this might result in a sequence of development steps which alter from the method's prescription. This can either be positive (flexible) or negative (indistinct).

### *Reflection: Theory versus Practice*

In the assignment, both Cradle to Cradle theory (principles and tools) and practice are involved. This results in clear insights in the difference between theory and practice. This reflection shows that different reasons for these discrepancies can be pointed out. The position of EPEA and the system of assessment result some important issues. However, the biggest risk for Cradle to Cradle will probably come from the lack of an innovation driver within the current system of Cradle to Cradle development and assessment. Therefore, Cradle to Cradle is believed not to be 'the future'. This is due to an assumed (future) conflict between the theory and practical application (including marketing) of Cradle to Cradle.

## *6.2 Recommendations*

Recommendations on the results of the project mainly consider the development method, the case study and the reflection on Cradle to Cradle theory and practice. For future practical application, the method will require additional specification. The result of the case study is finished up to a detailed level. However, some steps remain insufficiently described, which are important for certification, production and market implementation.

### *Method*

The method is aimed at developing Cradle to Cradle packaging. It has been developed simultaneously to a specific packaging project. However, to show its validity and applicability, a validation session is required (as mentioned before). Resulting from this session, the method appears to be suitable as a guideline for Cradle to Cradle packaging development method. For practical (future) application, the different steps and required results should be described in advance, for instance in a project briefing. Therefore, the method should be more prescriptive. A descriptive method (as it currently is) will only work sufficiently when the executing project team can apply a

certain level of abstract thinking. On top of that, the use of reflection documents during different development steps is essential. The validation session showed a certain lack of guidance, which could very well be achieved with specific documents on Cradle to Cradle requirements and materials (the Material Knowledge Bank). Also, the Project Initiation session (the start of a project) should be guided by a more elaborate design brief than used in the case study and validation session.

### *Packaging Draft (Case Study)*

The developed packaging draft consists of a corrugated board box, closed with a lid out of PaperFoam. This current variant of this draft can be considered to be 'top-level'. This complies with the brand identity of Satino Black, for which the draft is developed. However, for practical application, this draft could be downgraded:

- *PaperFoam lid*
  The current design for the lid could be replaced by a fixed lid out of corrugated board (decreasing cost price). This depends on the (price) strategy for market implementation for the packaging draft.

- *Graphic design*
  The current design incorporates a set up for graphic design. This design is important for draft review. However, the specific design can be developed further, to improve communication of brand identity aspects and packaging elements.

- *Print*
  The design is based on the current colour scheme or Satino Black. However, research might show that this cannot be achieved with Cradle to Cradle suited inks. Therefore, this could be altered in the design, to enable (possible) Cradle to Cradle certification. The current design does not incorporate any coatings on the material. However, specific material specifications and required look and feel might request this. Glycapol coating might very well be applicable, when considering Cradle to Cradle requirements.

- *Production*
  The draft does not contain any adhesives for the construction of the box. This makes that the current draft is virtually impossible to set up and fill automatically. For this project, that has not been a requirement. However, for implementation, this might be considered important. The draft will then have to be altered to enable automated filling. Before production can be initiated, several tests will have to be executed. This must mainly be focused on strength and load resistance of the packaging. On top of that, issues regarding transport and storage and cost price must be considered more elaborately. Cradle to Cradle certification of the packaging

### *Reflection: Theory versus Practice*

As mentioned, there are several issues which will have a high impact on the future of the current Cradle to Cradle paradigm. The way in which Cradle to Cradle is marketed currently, will lead to a shift in its popularity. This is mainly due to the lack of an innovation driver and open development. Therefore, Cradle to Cradle must become open-source. Companies should be encouraged to develop together and communicate about this. The current practice limits proper (open) development with NDAs and secrecy agreements. EPEA (and other accredited Cradle to Cradle assessment institutes) could act more as a knowledge platform. Then it will be much easier for companies interested in Cradle to Cradle developments to meet, interact and cooperate.

# 7 References


1. Van Houtum BV, *CSR Report* 2011, Swalmen.
2. Newcorn, D., *Cradle-to-Cradle: The next packaging paradigm?* Packaging World, 2003 (Special Report Cradle to Cradle).
3. MBDC LLC. *Cradle to Cradle: Beyond Sustainability*. 28 January 2013; Available from: http://www.mbdc.com/cradle-to-cradle/c2c-framework/.
4. EPEA Internationale Umweltforschung GmbH. *Cradle to Cradle*. 28 January 2013; Available from: http://epea-hamburg.org/index.php?id=69.
5. Scheelhaase, T., *How Cradle to Cradle answers*, 2 May 2012, University of Twente, Enschede, The Netherlands: Cradle to Cradle Design Paradigm 2.
6. MBDC LLC, *Cradle to Cradle Certified Product Standard Version 3.0*. 2012.
7. EPEA Internationale Umweltforschung GmbH. *Principles*. 28 January 2013; Available from: http://epea-hamburg.org/index.php?id=155.
8. MBDC LLC. *C2C Framework*. 28 January 2013; Available from: http://www.mbdc.com/cradle-to-cradle/c2c-framework/.
9. Ministry of Infrastructure and the Environment, *Usability of Life Cycle Assessment for Cradle to Cradle purposes.* Position Paper, 2011.
10. EPEA Internationale Umweltforschung GmbH. *Cradle to Cradle Certification*. 28 January 2013; Available from: http://epea-hamburg.org/index.php?id=165.
11. EPEA Internationale Umweltforschung GmbH, *Step by Step to Cradle to Cradle Certification.* 2009.
12. Cradle to Cradle Products Innovation Institute. *About*. 28 January 2013; Available from: http://c2ccertified.org/about.
13. Cradle to Cradle Products Innovation Institute. *Product certification*. 28 January 2013; Available from: http://c2ccertified.org/product_certification.
14. EPEA Internationale Umweltforschung GmbH, *The Cradle to Cradle Certification Program.* 2008.
15. MBDC LLC. *Certification Process*. 28 January 2013; Available from: http://www.mbdc.com/cradle-to-cradle/cradle-to-cradle-certified-program/process/.
16. MBDC LLC. *C2C Certified Process Map*. 28 January 2013; Available from: http://www.c2cproducts.com/detail.aspx?linkid=2&sublink=10.
17. Moonen Packaging. *Moonen Packaging signs 'C2C' contract*. 4 March 2013; Available from: http://www.moonennatural.com/en/moonen-packaging-signs-c2c-contract.html.
18. Moonen Packaging. *Welcome to Moonen Natural*. 4 March 2013; Available from: http://www.moonennatural.com/en/.
19. Be Green Packaging LLC. *Be Green Packaging Receives the First Cradle-to-Cradle Certification for Food Packaging*. 4 March 2013; Available from: http://www.csrwire.com/press_releases/13988-Be-Green-Packaging-Receives-the-First-Cradle-to-Cradle-Certification-for-Food-Packaging.
20. Edelbrock, G. *Food trays made from bulrush and other plant fibers*. 15 January 2012; Available from: http://www.packworld.com/package-type/containers/food-trays-made-bulrush-and-other-plant-fibers.
21. Cradle to Cradle Products Innovation Institute. *Certified products - Paper and packaging*. 4 March 2013; Available from: http://c2ccertified.org/products/category/paper_packaging.
22. Lutters, D. and R. ten Klooster, *Functional requirement specification in the packaging development chain.* Manufacturing Technology 57, 2008: p. 145–148.
23. Ten Klooster, R., et al., *Zakboek Verpakkingen* 2008, Doetinchem: Reed Business.

24. Simms, C. and P. Trott, *Packaging development: A conceptual framework for identifying new product opportunities.* Marketing Theory 10 (4), 2010: p. 397-415.
25. Oostendorp, J.A., et al., *The (development) life cycle for packaging and the relation to product design.* 2006.
26. Allen, J.K., et al., *Validating Design Methods & Research: The Validation Square.* Design Engineering Technical Conferences, 2000 (Proceedings of DETC '00).
27. GaiaKraft. *GaiaKraft and paper comparison*. 13 May 2013; Available from: http://www.gaiakraft.com/en/sub/consumption.html.
28. PaperFoam. *Sustainability*. 4 March 2013; Available from: http://www.paperfoam.com/Sustainability.html.
29. Synprodo. *What is BioFoam?* 29 March 2013; Available from: http://www.synprodo.com/en/2/236/what_is_biofoam.aspx.
30. ValueForm Ltd. *Food packaging from straw and bio-composites*. 13 May 2013; Available from: http://www.valueform.biz/.
31. Gugler Print, *Cradle to Cradle info package.* 2013.
32. Green4Print. *Sustainability*. 20 June 2013; Available from: http://www.green4print.com/en/company-profile/sustainability.
33. Ministry of Internal Affairs. *Legislation soil quality*. 8 August 2013; Available from: http://wetten.overheid.nl/BWBR0023085/BijlageB/geldigheidsdatum_11-10-2012.
34. The Biomimicry Institute. *What is biomimicry?* 12 September 2013; Available from: http://biomimicryinstitute.org/about-us/what-is-biomimicry.html.
35. Blue Economy. *Our philosophy*. 12 September 2013; Available from: http://www.blueeconomy.eu/page/struktur.
36. Ellen MacArthur Foundation, *Towards the Circular Economy: Economic and business rationale for an accelerated transition.* 2012.
37. McLennan, J.F., *The Philosophy of Sustainable Design*2004.
38. Be Green Packaging LLC. *Cradle to Cradle*. 4 March 2013; Available from: http://www.begreenpackaging.com/eco-social-commitments/.
39. Ardagh Group. *Ardagh is the world's first packaging company to have Cradle to Cradle® certified products*. 25 November 2011; Available from: http://www.ardaghgroup.com/news-app/story.25/title.Ardagh+is+the+worlds+first+packaging+company+to+have+Cradle+to+Cradle+certified+products.
40. Kapferer, J.N., *The New Strategic Brand Management* 2008, London: Kogan Page.

# 8 Appendices

## A Cradle to Cradle Certification Standard

All relevant sections of the Cradle to Cradle Certified Product Standard (version 3.0) are listed in this appendix [6].

### A1 Standard Requirements

| 1. Material Health | Basic | Bronze | Silver | Gold | Platinum |
|---|---|---|---|---|---|
| No Banned List chemicals are present above thresholds | ■ | ■ | ■ | ■ | ■ |
| Materials defined as biological or technical nutrient | ■ | ■ | ■ | ■ | ■ |
| 100% "characterized" (i.e., all generic materials listed) | ■ | ■ | ■ | ■ | ■ |
| Strategy developed to optimize all remaining X-assessed chemicals | | ■ | ■ | ■ | ■ |
| At least 75% assessed by weight (100% for BN products) | | ■ | ■ | ■ | ■ |
| At least 95% assessed by weight (100% for BN products) | | | ■ | ■ | ■ |
| Assessed materials do not contain any carcinogenic, mutagenic, or reproductively toxic (CMR) chemicals | | | ■ | ■ | ■ |
| 100% assessed by weight | | | | ■ | ■ |
| Formulation optimized (i.e., all X-assessed chemicals replaced or phased out) | | | | ■ | ■ |
| Meets Cradle to Cradle emission standards | | | | ■ | ■ |
| All process chemicals assessed and no X-assessed chemicals present | | | | | ■ |

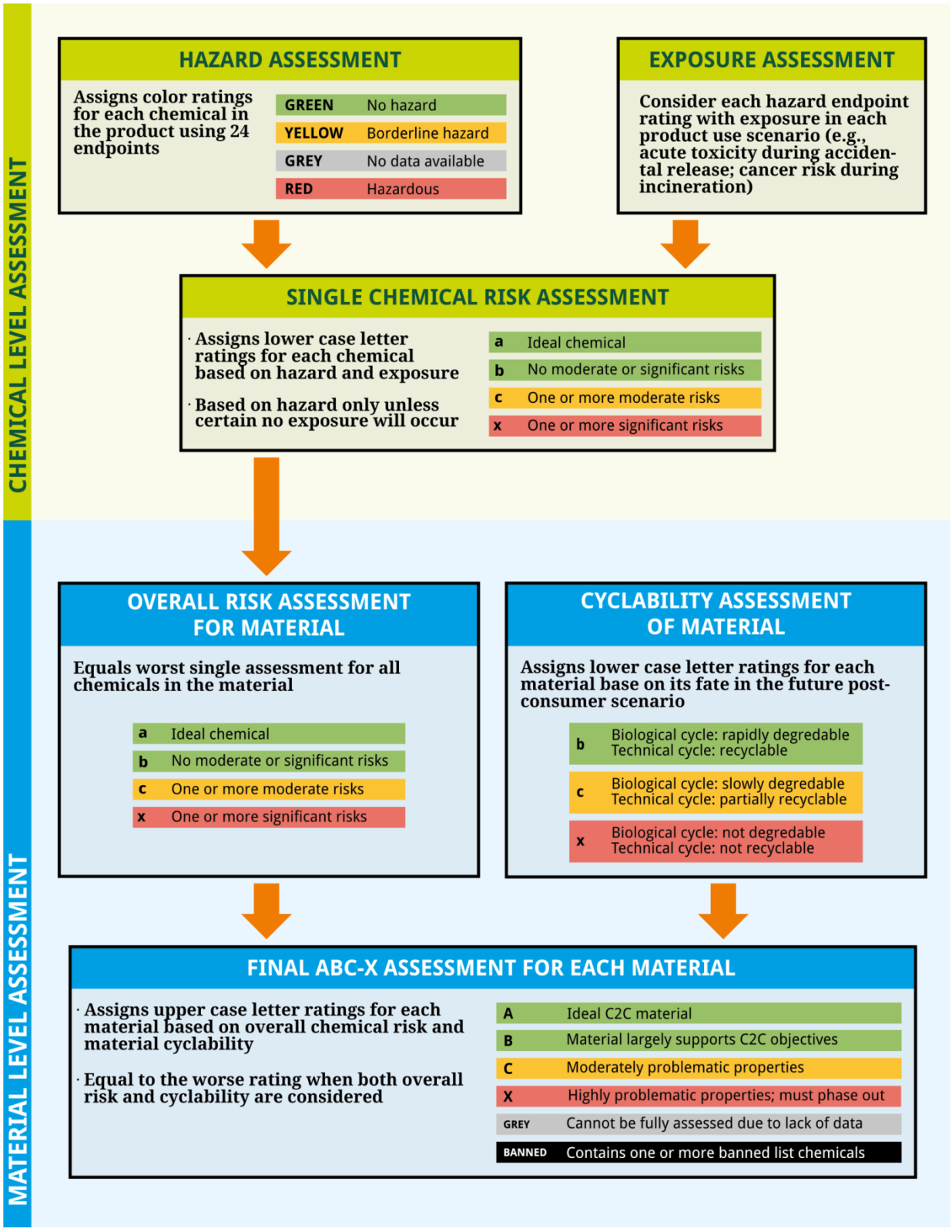
| 2. Material Reutilisation | Basic | Bronze | Silver | Gold | Platinum |
|---|---|---|---|---|---|
| Defined the appropriate cycle (i.e., technical or biological) for the product and developing a plan for product recovery and reutilisation | ■ | ■ | ■ | ■ | ■ |
| Designed or manufactured for the technical or biological cycle and has a material (re)utilisation score ≥ 35 | | ■ | ■ | ■ | ■ |
| Designed or manufactured for the technical or biological cycle and has a material (re)utilisation score ≥ 50 | | | ■ | ■ | ■ |
| Designed or manufactured for the technical or biological cycle and has a material (re)utilisation score ≥ 65 | | | | ■ | ■ |
| Well-defined nutrient management strategy (including scope, timeline, and budget) for developing the logistics and recovery systems for this class of product or material | | | | ■ | ■ |
| Designed or manufactured for the technical or biological cycle and has a material (re)utilisation score of 100 | | | | | ■ |
| The product is actively being recovered and cycled in a technical or biological metabolism | | | | | ■ |

| *3. Renewable Energy and Carbon Management* | *Basic* | *Bronze* | *Silver* | *Gold* | *Platinum* |
|---|---|---|---|---|---|
| Purchased electricity and direct on-site emissions associated with the final manufacturing stage of the product are quantified | ■ | ■ | ■ | ■ | ■ |
| A renewable energy use and carbon management strategy is developed | | ■ | ■ | ■ | ■ |
| For the final manufacturing stage of the product, 5% of purchased electricity is renewably sourced or offset with renewable energy projects, and 5% of direct on-site emissions are offset | | | ■ | ■ | ■ |
| For the final manufacturing stage of the product, 50% of purchased electricity is renewably sourced or offset with renewable energy projects, and 50% of direct on-site emissions are offset | | | | ■ | ■ |
| For the final manufacturing stage of the product, >100% of purchased electricity is renewably sourced or offset with renewable energy projects, and >100% of direct on-site emissions are offset | | | | | ■ |
| The embodied energy associated with the product from Cradle to Gate is characterized and quantified, and a strategy to optimize is developed | | | | | ■ |
| ≥ 5% of the embodied energy associated with the product from Cradle to Gate is covered by offsets or otherwise addressed (e.g., through projects with suppliers, product re-design, savings during the use phase, etc.) | | | | | ■ |

| *4. Water Stewardship* | *Basic* | *Bronze* | *Silver* | *Gold* | *Platinum* |
|---|---|---|---|---|---|
| The manufacturer has not received a significant violation of their discharge permit within the last two years | ■ | ■ | ■ | ■ | ■ |
| Local- and business-specific water-related issues are characterized (e.g., the manufacturer will determine if water scarcity is an issue and/or if sensitive ecosystems are at risk due to direct operations) | ■ | ■ | ■ | ■ | ■ |
| A statement of water stewardship intentions describing what action is being taken for mitigating identified problems and concerns is provided | ■ | ■ | ■ | ■ | ■ |
| A facility-wide water audit is completed | | ■ | ■ | ■ | ■ |
| Product-related process chemicals in effluent are characterized and assessed (required for facilities with product relevant effluent).<br>OR<br>Supply chain-relevant water issues for at least 20% of Tier 1 suppliers are characterized and a positive impact strategy is developed (required for facilities with no product relevant effluent) | | | ■ | ■ | ■ |

| | | | | | |
|---|---|---|---|---|---|
| Product-related process chemicals in effluent are optimized (effluents identified as problematic are kept flowing in systems of nutrient recovery; effluents leaving facility do not contain chemicals assessed as problematic).<br>OR<br>Demonstrated progress against the strategy developed for the Silver level requirements (required for facilities with no product-relevant effluent) | | | | ■ | ■ |
| All water leaving the manufacturing facility meets drinking water quality standards. | | | | | ■ |

| *5. Social Fairness* | *Basic* | *Bronze* | *Silver* | *Gold* | *Platinum* |
|---|---|---|---|---|---|
| A streamlined self-audit is conducted to assess protection of fundamental human rights | ■ | ■ | ■ | ■ | ■ |
| Management procedures aiming to address any identified issues have been provided | ■ | ■ | ■ | ■ | ■ |
| A full social reasonability self-audit is complete and a positive impact strategy is developed (based on UN Global Compact Tool or B-Corp) | | ■ | ■ | ■ | ■ |
| Material specific and/or issue-related audit or certification relevant to a minimum of 25% of the product material by weight is complete (FSC Certified, Fair Trade, etc.)<br>OR<br>Supply chain-relevant social issues are fully investigated and a positive impact strategy is developed.<br>OR<br>The company is actively conducting an innovative social project that positively impacts employee's lives, the local community, global community, or social aspects of the product's supply chain or recycling/reuse | | | ■ | ■ | ■ |
| Two of the Silver-Level requirements are complete | | | | ■ | ■ |
| All three Silver-Level requirements are complete | | | | | ■ |
| A facility-level audit is completed by a third party against an internationally recognized social responsibility program (e.g., SA8000 standard or BCorp) | | | | | ■ |


CHEMICAL LEVEL ASSESSMENT
HAZARD ASSESSMENT
Assigns color ratings for each chemical in the product using 24 endpoints
GREEN No hazard
YELLOW Borderline hazard
GREY No data available
RED Hazardous
EXPOSURE ASSESSMENT
Consider each hazard endpoint rating with exposure in each product use scenario (e.g., acute toxicity during accidental release; cancer risk during incineration)
SINGLE CHEMICAL RISK ASSESSMENT
· Assigns lower case letter ratings for each chemical based on hazard and exposure
· Based on hazard only unless certain no exposure will occur
a Ideal chemical
b No moderate or significant risks
c One or more moderate risks
x One or more significant risks
MATERIAL LEVEL ASSESSMENT
OVERALL RISK ASSESSMENT FOR MATERIAL
Equals worst single assessment for all chemicals in the material
a Ideal chemical
b No moderate or significant risks
c One or more moderate risks
x One or more significant risks
CYCLABILITY ASSESSMENT OF MATERIAL
Assigns lower case letter ratings for each material base on its fate in the future post-consumer scenario
b Biological cycle: rapidly degredable Technical cycle: recyclable
c Biological cycle: slowly degredable Technical cycle: partially recyclable
x Biological cycle: not degredable Technical cycle: not recyclable
FINAL ABC-X ASSESSMENT FOR EACH MATERIAL
· Assigns upper case letter ratings for each material based on overall chemical risk and material cyclability
· Equal to the worse rating when both overall risk and cyclability are considered
A Ideal C2C material
B Material largely supports C2C objectives
C Moderately problematic properties
X Highly problematic properties; must phase out
GREY Cannot be fully assessed due to lack of data
BANNED Contains one or more banned list chemicals

## B Current Suppliers in Van Houtum's Packaging Chain

### AVI

AVI is a manufacturer of flexible plastic packaging, mainly PE-based. The company is a supplier of half-fabricate products. The company produces only LDPE- and MDPE-products (foils, bags, sheets et cetera). These products are (depending on the requirements) completed with additives, like UV-blockers. The company currently focuses on recycling discarded products into regenerate pellets. During recycling it is not possible to extract additives from the material. This results in a regenerate material with undefined quality. To cope with this unknown quality, 20% of additives have to be added. This is necessary to produce the regenerate material.

### Flexoplast

Flexoplast is a large manufacturer of flexible plastic packaging, both flat-foil and bags. Within the company, currently there is no policy to focus on Cradle to Cradle. This is (generally) regarded rather difficult, due to the material properties of foil packaging. Foils need to have several different types of properties, and are therefore built up out of different materials. Post-use recycling into virgin-grade (nutrient) materials is very difficult, if not impossible.

### Flint Group

Flint Group is an international manufacturer of inks and pigments. Flint Group Netherlands BV is working on several developments in the field of Cradle to Cradle inks and varnish. A currently used black pigment has been analysed by EPEA Netherlands.

### Henkel

Henkel is a large, globally operating company with well-known brands and technologies. Henkel has had contact with EPEA Germany, regarding the level and possibilities of Cradle to Cradle in their additives. Henkel is keen on keeping the Cradle to Cradle philosophy in mind, mainly regarding water solubility and material health. However, specific Cradle to Cradle suited packaging adhesives are currently not available.

### Paramelt

Paramelt is an international company, producing different types of waxes, resins and polymers. For this assignment, the company's adhesive products (mainly hotmelts) are of interest. One of Paramelt's products currently used by Van Houtum, has been assessed 'yellow' (optimisable) by EPEA. However, the company has no policy to focus on Cradle to Cradle. Alternatives for the traditional types of hotmelts which are available within Paramelt are based on reducing the required amounts of the product.

### Smurfit Kappa

Smurfit Kappa is a large international manufacturer of paper and cardboard packaging products. Within this assignment, the developments in the field of Cradle to Cradle have been discussed with the Benelux corrugated board branch of the company.

### SunChemical

SunChemical is the world leader in printing inks and pigments. According to a representative of the company, several customers have requested SunChemical to develop Cradle to Cradle-certified inks. However, SunChemical has decided not to focus on Cradle to Cradle, but 'general' sustainability.

### *VPK Packaging*

VPK is a large manufacturer of corrugated cardboard boxes. Implementing Cradle to Cradle within the company is regarded to be difficult. This is mainly due to VPK being a follower of end customer demands in their development. The company's developments are highly driven by the end customers, like large retail companies. For VPK, the highest impact they have on development is supplying alternatives, for instance in material use and properties. There is a limited focus on sustainability, let alone an explicit focus on Cradle to Cradle. However, orienting discussions between VPK, Van Houtum and EPEA have started.

## C Questionnaire EPEA Germany

### *Carsten Haeling (11 March, 16:00)*

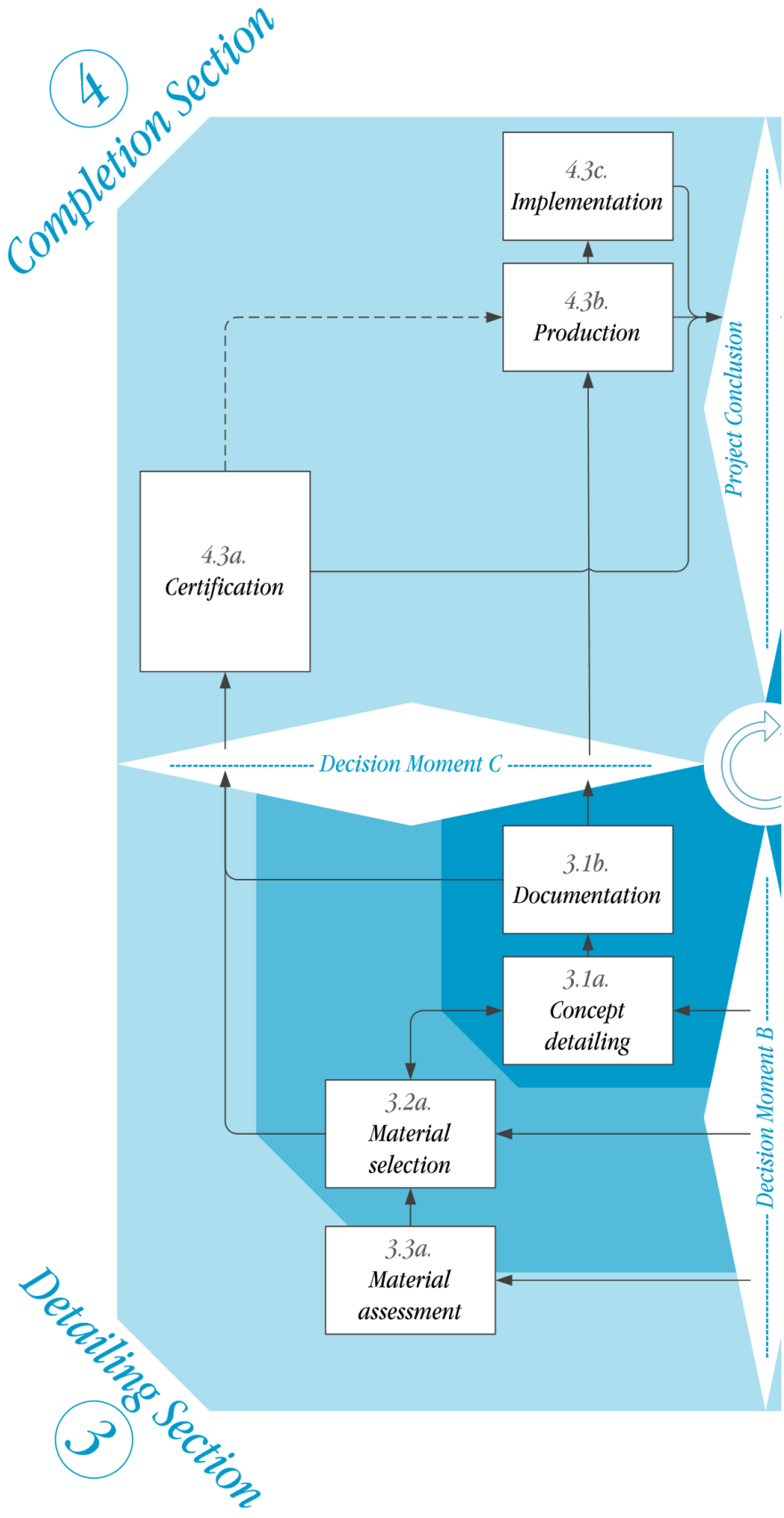
- Packaging
  - What is the relevance of C2C packaging?
  - Definition product and packaging (borders)
- What should C2C packaging do?
- EPEA's perspective on C2C in packaging development
- Current (recent) C2C packaging projects
  - What projects have been executed?
  - How have these projects been executed?
  - What problems/difficulties came up?
- Recent developments in (C2C) packaging development
- What will the future bring?

### *Tom Ohlendorf, Christoph Semisch (12 March, 9:30-11:00)*

- How to develop a C2C packaging theory/method?
  - Goals
  - Scoring (how to score concepts)
  - Approach
  - Roadmap
  - C2C aspects
  - Packaging development aspects
- Assignment outline
  - Surroundings
  - Packaging chain
  - Product
  - How to look beyond limitations?
- How to implement C2C-aspects?
  - How to make continuous flows
  - Technosphere vs. biosphere
  - Service concepts
  - Design for disassembly
  - Intelligent materials pooling
- How to select relevant properties/demands?
- How to implement brand identity aspects in C2C packaging development
- How to address transport?
  - Efficiency as a 'first step'?

### *Christian Skublak (12 March, 11:15-12:15)*

- Intention
- Current status
- Approach
- Current (recent) C2C packaging projects
  - What projects have been executed?
  - How have these projects been executed?
  - Results of these projects?
  - What problems/difficulties came up?
- Recent developments in (C2C) packaging development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Implementation
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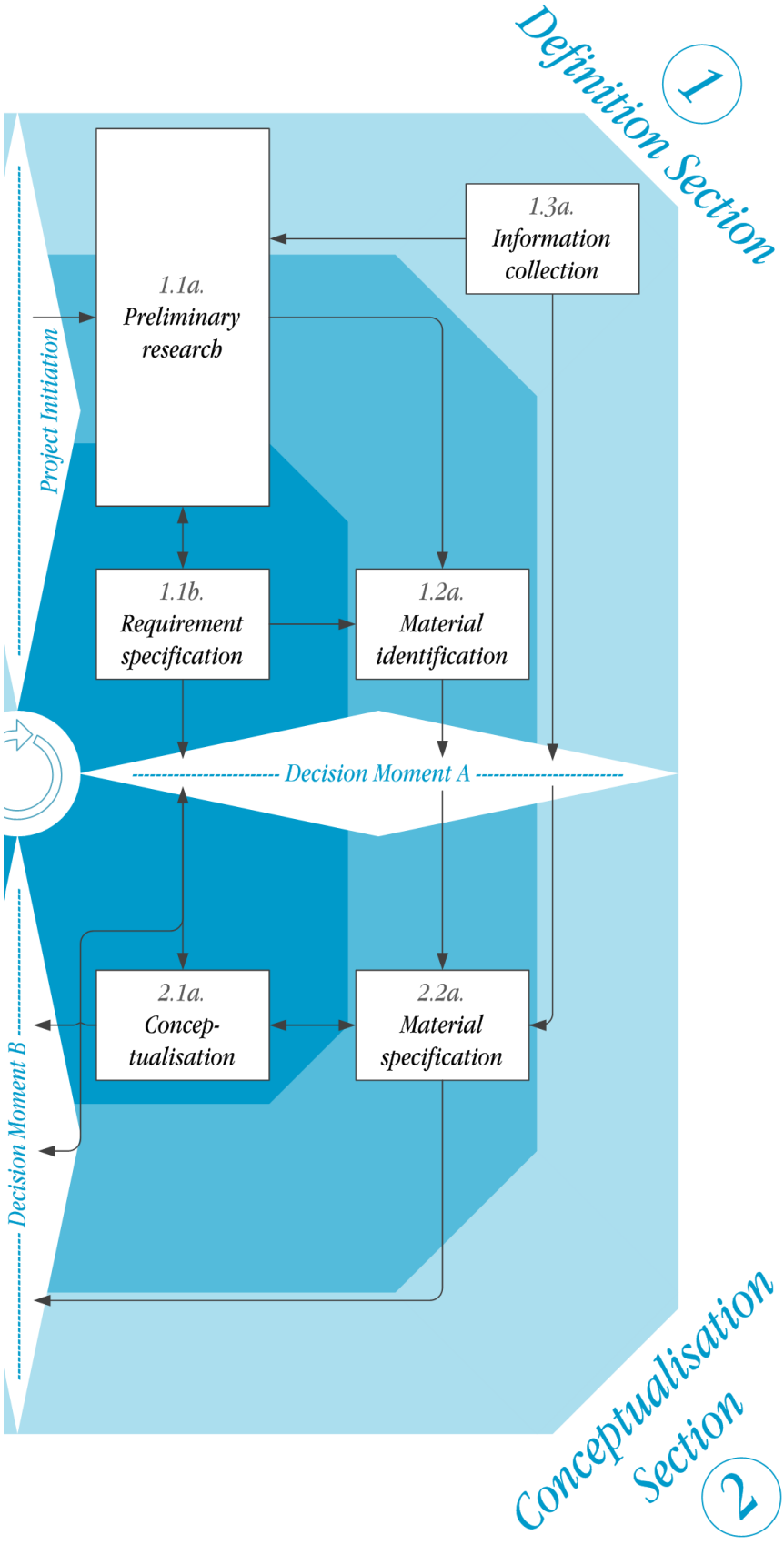
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2

## E Material Knowledge Bank

This material knowledge bank consists of base materials, ready-to-buy products and additives. All materials have been selected on the relevance in Cradle to Cradle packaging applications. The knowledge bank is intended to be expanded with information on materials, derived from new packaging projects.

| Material group | Material | Application | Composition | Supplier | Certificate | Production | Post-use | Comments |
|---|---|---|---|---|---|---|---|---|
| Fibre-based materials | Paper/board | Paper, corrugated board, folding box board | Recycled or virgin fibres | VPK, Smurfit Kappa | - | Pulped recycled or virgin fibres | Biological cycle | |
| | Moulded fibre | Buffer material, food packaging | Recycled fibres | Huhtamaki | - | Pulped recycled fibres | Biological cycle | |
| | Plant fibre materials | Food packaging, disposables | Virgin fibres | ValueForm, Be Green packaging | Silver | Pressed virgin plant fibres | Biological cycle | [30] [38] |
| | Recycled wood | Pallets | Recycled wood fibre | Litco International, Inc. | Silver | Recycled wood fibre (pressed) | Biological cycle | [21] |
| Plastics | Petrochemical-based plastic | Various | Various | Various | - | various | Technical cycle | |
| | Biobased plastic | Various | PLA, PE, PP | Oerlemans | - | Various | Technical cycle | |
| | BioFoam | Buffer material | PLA | Synbra Technology BV | Silver | Foaming of PLA | Technical cycle | [29] |
| | GaiaKraft | Paper-like application | $CaCO_3$, PE-resin | GaiaKraft | Silver | calcium carbonate ($CaCO_3$), bonded with PE-resin | Technical cycle | [27] |
| | EcoPaXX UF | Various | Castor oil (biobased) | DSM Engineering Plastics | Silver | Various | Technical cycle | [21] |
| | RACX | Pallets | Recycled HDPE | Decade Products | Silver | Various | Technical cycle | [21] |
| Additives | Crystal, Nature, Life, Emerald ink | Printing ink | 85% biological | Green4Print | - | Mixture | Biological cycle | [32] |
| | PurePrint | Printing products | Unknown | Gugler Print | Silver | Mixture, printing | Biological cycle | [31] |
| | Printing ink | Printing ink | Unknown | SunChemical, Flint Group | - | Mixture | Biological cycle | |
| | Glycapol | Water-resistant coating | Starch-based | Glycanex BV | - | Unknown | Biological cycle | |
| | Adhesive | Adhesive | Various | Henkel, Paramelt | - | Mixture | Biological cycle | |
| Other | PaperFoam | Various | Industrial starch, virgin cellulose fibres, premix, colouring | PaperFoam | - | Injection moulding | Biological cycle | [28] |
| | Aluminium | Various | Various | Alcoa, Ardagh | Basic/ Silver | Extrusion, sheet forming | Technical cycle | [21] [39] |
| | Mailing products | Various | Various | US Postal Service | Basic/ Silver | Various | Biological/ technical cycle | [21] |

# F Case Study Results

## Project Initiation

### Assignment Description

The subject of the case study is the following:

*Develop a Cradle to Cradle suited packaging draft for Satino Black toilet paper, for the cash & carry market*

### Project Team

The project team basically consists of one person, with guidance from several persons within Van Houtum. This can be considered as the project team, with the following members:

- *Albert Mey (Brand Innovation and Research Manager)*
- *Jos Manders (QESH Manager)*
- *Ruud Eywoudt (Converting Manager)*
- *Guus Bruijstens (Product Manager)*
- *Bjorn de Koeijer (Master graduate University of Twente)*

### Requirements Decision Moment A

During the Project Initiation session, the requirements for Decision Moment A have been specified. The results of the Definition Section (the first section of the project) will be reviewed during this decision moment. During Decision Moment A, two documents will have to meet the following requirements:

- *Requirement specification*
  - Issues will have to be separated in requirements, targets and bonuses
  - Requirements regarding general packaging, Van Houtum, the market and Cradle to Cradle have to be addressed
  - Requirements will have to be derived from and discussed with all project stakeholders
- *Identified materials*
  - All possibly eligible (Cradle to Cradle suited) packaging materials have to be researched

## F1 Definition Section

### Development Layer

#### 1.1a Preliminary Research

The preliminary research of the project is focused on four major fields of input:

1. *Company*
2. *Cradle to Cradle*
3. *Packaging development*
4. *Market*

### Project Conditions

The project conditions regard the (practical) boundaries for the packaging project. It is mainly derived from the company's current situation, the project description and the intended result. The following project conditions are determined:

a) *Time Frame*

The time frame of the packaging development project has been set to 9 months. This time frame does not include Cradle to Cradle certification, production and market implementation.

b) *Budget*

The project is intended as a pilot project, aimed on illustrating the method for Cradle to Cradle packaging development. Therefore, a strict project budget has not been determined.

c) *Cradle to Cradle requirements*

For this specific Cradle to Cradle packaging project, the aim is set to a Cradle to Cradle Silver-level certificate. The requirements for this project are derived from literature on Cradle to Cradle certification, which can be found in appendix A.

d) *Internal stakeholders*

For this project, the setting of internal stakeholders is far from typical. The project is executed by one person, with guidance from several people. Besides the project team, the internal stakeholders (within Van Houtum) are:

- *Henk Bremer (Chief Commercial Officer)*
- *Toin van der Velden (General Sales Manager)*
- *Dave Timmermans (Account Manager)*
- *Nick op den Buijsch (Brand Manager)*

- *Sjaak van Zinderen (Purchaser Packaging Materials)*

e) *Near-future developments*

The near-future developments mainly regard the planned investments and areas of focus. For this specific packaging development, no near-future investments are relevant. However, within Van Houtum, Cradle to Cradle is an important future development. Currently, Cradle to Cradle is explicitly part of the company policy of Van Houtum. This is now expressed in the certified paper products and soaps. In the future, this must be extended by the development and use of Cradle to Cradle packaging.

## *Development Input*

The development input consists of the issues which act as input for the development of the packaging draft. It consists of the following issues:

a) *Goal definition*

The project must result in a tangible and specific Cradle to Cradle packaging draft. The packaging draft will be developed for cash & carry retail of one of Van Houtum's Satino Black products. The packaging draft must be developed up to a conceptual level (embodiment design). The Cradle to Cradle intention of the packaging is key within the project. Therefore, the result must be a packaging draft which is suited for Cradle to Cradle certification.


**Figure F1** | Current plastic foil packaging for Satino Black

b) *Product*

The project is aimed at the development of a Cradle to Cradle packaging for Satino Black toilet tissue. During different meetings, the specific properties for this product have been specified (see table F1). These requirements have partly been based on the targeted market and benchmark products (see table F2). Three variants of Satino Black toilet paper are selected:

| *Variant* | *Weight ($gr/m^2$)* | *Diameter (mm)* | *Sheets* | *Sheet length (mm)* | *Sheet width (mm)* | *Layers* | *Length (m)* | *Surface ($m^2$)* | *Weight (gr)* |
|---|---|---|---|---|---|---|---|---|---|
| *Variant 1* | 16 | 121 | 372 | 121 | 96 | 2 | 45.00 | 4.32 | 138.24 |
| *Variant 2* | | 115 | 400 | | | | 48.40 | 4.65 | 148.68 |
| *Variant 3* | | 121 | 465 | | | | 56.26 | 5.40 | 172.83 |

**Table F1** | Satino Black properties

The decision is made to develop the packaging for the 400-sheet variant. The main reason is that this product is already part of the current range of Satino Black products. The diameter of 115 mm ensures the possibility for use of the product with or without a dedicated toilet tissue dispensers (either Satino dispensers or dispensers from competing brands). On top of that, a product with full paper embossing is considered to be important in the targeted market. This can be achieved with 400 sheets of paper in a 115 mm diameter roll.

c) *Brand*

The packaging draft is developed to fit within the line of Satino Black products. This brand can be described by its brand values and brand identity:

- *Brand Values*
  - *Exciting*
  - *Self-willed*
  - *Refined*
  - *Authentic*
  - *Successful*

- *Brand Identity*

Besides the brand values, aspects which are important within the brand identity of Satino Black, are 'luxury', 'design/style/aesthetics', 'beauty' and 'the Cradle to Cradle-story'. On top of that, Satino Black is regarded to be an 'I'-brand, explicitly marketed as 'robust/tough', 'good' and 'timeless'.

- *Brand Identity Prism*

These brand identity aspects can be placed into a brand identity prism (figure F2). Within this prism, several aspects of both the sender (Satino Black) and the recipient (the target/the customers). The brand identity prism consists of the following parts [40]:

1. *Physique:* Physical specificities and qualities of the brand
2. *Personality:* Human personality traits that are relevant the brands
3. *Relationship:* The way in which the brand relates toward its customers
4. *Culture:* Set of values feeding the brand's inspiration
5. *Reflection:* The target's outward mirror
6. *Self-image:* The target's inward mirror

d) *Market*

The packaging draft is developed for the cash & carry market. This market is specified by its target group and the method of sales. The method of sales is characterized by little or no promotion for products and sober shopping shelves, with stacked products (sometimes in bulk). Customers of a cash & carry market will require an access pass. For this, a Chamber of Commerce enrolment is required. In other words: only businesses can shop in a cash & carry market.

Within this specific project, the packaging draft is developed with input from Sligro Food Group, a wholesaling enterprise in The Netherlands. To acquire information about this market, a meeting with a representative of Sligro has taken place. The questionnaire which guided this meeting can be found in appendix G. Sligro Food Group can be divided in food service and food retail (supermarkets). The food service division can be divided in self-service stores and a delivery section.

Food service accomplishes 2/3 of Sligro's turnover. Of this, 40% is gained by the self-service section, 60% is gained by the delivery section (27% and 40% of Sligro's total turnover, respectively). This is clarified in figure F3. Within this project, the packaging draft will be developed for retail in the self-service stores. When looking at the division of paper products within Sligro (toilet paper, paper towels, tissue paper, et cetera), the yearly turnover equals around 15 million Euros. The turnover of toilet paper is about 7 million Euros. The targeted sales of the Cradle to Cradle Satino Black packaging in the first year after introduction are 10,000 packaging units. In following years, this amount is targeted to increase.


**Figure F2** | Satino Black brand identity prism

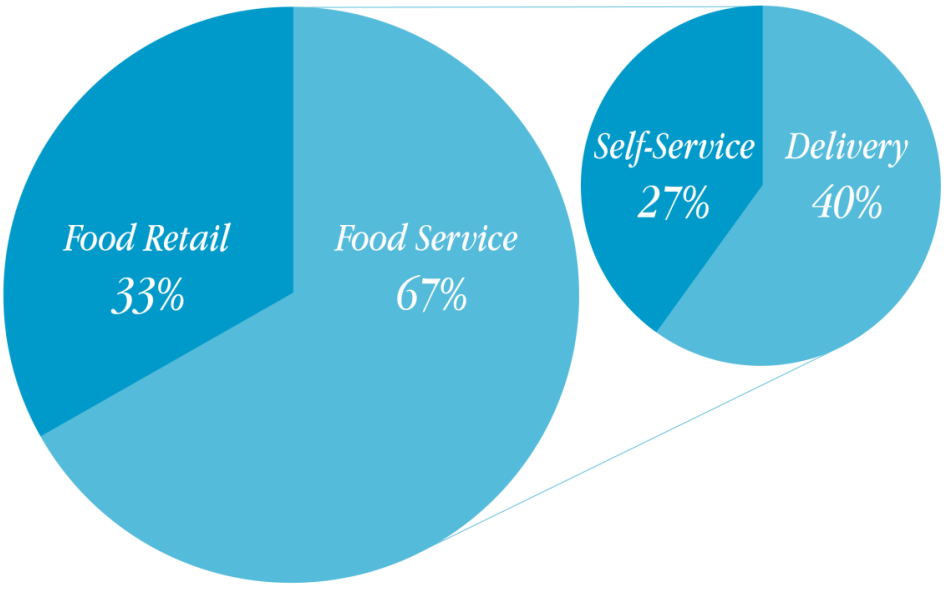



**Figure F3** | Turnover distribution of Sligro Food Group

e) *Target group*

Sligro Food Group aims at providing retail for all catering-related clients, varying from snack bars to hotels. Fifty-three customer categories can be distinguished within Sligro, divided in four main groups:

- *Non-food*
  This customer has a small business with a non-food core business. They make use of the self-service stores. This type of customer wants to get 'inspired' in a Sligro store and buys products ranging from interior supplies to disposables. The non-food customer considers Sligro to be a 'one-stop shop', and can be qualified as a 'fun shopper'. Product price versus quality is highly important for this customer.
- *Food (significant added value)*
  This category consists of customers like a large restaurant or a company like IKEA, Parenco or Total. This type of customer will receive products via the delivery section of Sligro, and will not make use of the self-service possibilities. Products are ordered via internet, Sligro acts as a deliverer. Service and price are of decisive importance.
- *Food (limited added value)*
  This customer can be described as 'small catering'. This covers cafes, cafeteria and canteens. This type of customer makes use of both self-service and delivery possibilities within Sligro and has a need for promotions and an elaborate product range. Price is very important for this customer.
- *Retail*
  This type of customer mainly makes use of the self-service possibilities of Sligro. This also covers customers who borrow someone else's access pass to shop at a Sligro self-service store. This type of customer has a need for promotions and an extensive product range. Price is very important for this customer.

The appropriate customer to develop the Cradle to Cradle Satino Black packaging for, is the non-food customer. In other words: the customer who is looking for inspiration within the product range of Sligro and who is interested in appealing products. Examples of such customers are:

- SMEs
- Institutional services
- Business services
- Schools

f) *Benchmark*

Within the targeted market, the product will have to compete with several other products. In the case of Satino Black toilet paper for the cash & carry market, the benchmark brands are Page and Edet. These brands currently sell the following products at Sligro:

- *Page*
  - *Original*
  - Groen & Zacht
  - Dubbel Lang
  - *Design*
  - Natuurlijk Verzorgend
  - *Extra Comfort*

- *Edet*
  - *Family*
  - *Soft*
  - *Caring Balsam*

Within these product lines, the 'regular' products (Page Original, figure F4a and Edet Family, figure F4b) are considered to be the benchmark in retail amount and retail price. These products have the following properties (per single roll):

| *Product* | *Whiteness (%)* | *Weight ($gr/m^2$)* | *Solubility* | *Diameter (mm)* | *Sheets* | *Sheet length (mm)* | *Sheet width (mm)* | *Layers* | *Length (m)* | *Surface ($m^2$)* | *Weight (gr)* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Page Original* | 83.11 | 36.90 | 3 | 105 | 153 | 121 | 95 | 1 | 18.51 | 1.76 | 64.90 |
| *Edet Family* | 85.02 | 15.51 | 2 | 107 | 140 | 120 | 94 | 3 | 16.80 | 1.58 | 73.48 |

**Table F2** | Benchmark products' properties

Of these benchmark products, packages containing 24 and 32 rolls of toilet paper are the fast-moving variants. Considering the properties of the selected Satino Black product, a packaging containing 12 rolls of toilet paper is believed to be best suited between the benchmark products. Striking features of the packaging of these benchmark products are carrying handles and tear strips (for easy opening).


**Figure F4a** | Page Original


**Figure F4b** | Edet Family

### *1.1b. Requirement Specification*

The preliminary research resulted in a requirement specification. All requirements have been sorted as requirements, targets and bonuses, within different subjects:

1. *General packaging requirements*

| | The packaging must ... | *Req.* | *Target* | *Bonus* |
|---|---|---|---|---|
| 1.1 | ... bundle the packaged product | ■ | | |
| 1.2 | ... cover the packed product from: | | | |
| | d) Moisture | | ■ | |
| | e) Splashing | | ■ | |
| | f) Dirt/dust | ■ | | |
| 1.3 | ... protect the packed product against: | | | |
| | c) Mechanical influences | | ■ | |
| | d) Tampering | | ■ | |
| 1.4 | ... remain closed and functionally intact when dropped from 0.5 metres | ■ | | |
| 1.5 | ... remain closed and functionally intact when dropped from 1.0 metres | | ■ | |
| 1.6 | ... aimed at efficient transport and storage | | | |
| | g) Efficient division on a Euro or industrial pallet | ■ | | |
| | h) Efficient division on the retail shelf | ■ | | |
| | i) Efficient storage at the end user's | ■ | | |
| | j) Collomodule | | ■ | |
| | k) Stably stackable with maximum pallet load | ■ | | |
| | l) Volume reduction (flattened or nested) | ■ | | |
| 1.7 | ... be easy to open | | ■ | |
| 1.8 | ... be intuitive in use | | ■ | |
| 1.9 | ... provide possibilities to be carried | ■ | | |
| 1.10 | ... have a maximum weight of 15 kilos (including packed product) | ■ | | |
| 1.11 | ... have a maximum cost price of € 0.50 per kilo packed product | ■ | | |
| 1.12 | ... have a maximum cost price of € 0.30 per kilo packed product | | ■ | |
| 1.13 | ... be suited for functional secondary use | | ■ | |
| 1.14 | ... inform and communicate on: | | | |
| | h) Product (information visible from every viewing angle) | ■ | | |
| | i) Brand (information visible from every viewing angle) | ■ | | |
| | j) Packed amount (information visible from every viewing angle) | ■ | | |
| | k) Producer | ■ | | |
| | l) Use | ■ | | |
| | m) Transport and storage | ■ | | |
| | n) End of use | ■ | | |

2. *Requirements from Van Houtum*

| | The packaging must ... | *Req.* | *Target* | *Bonus* |
|---|---|---|---|---|
| 2.1 | ... be suited for packing Satino Black toilet paper rolls with a diameter of 115 mm and a roll height of 96 mm | ■ | | |
| 2.2 | ... be suited for Cradle to Cradle certification | ■ | | |
| 2.3 | ... be Cradle to Cradle certified at market implementation | | ■ | |
| 2.4 | ... fit within the brand identity of Satino Black | ■ | | |
| 2.5 | ... propagate the graphic style of Satino Black | ■ | | |
| 2.6 | ... have a luxurious finish | | ■ | |

*3. Market requirements*

| | The packaging must ... | Req. | Target | Bonus |
|---|---|---|---|---|
| 3.1 | ... be distinctive when placed on a retail shelf | | ■ | |
| 3.2 | ... be aimed at sales to non-food customers | | ■ | |
| 3.3 | ... contain twelve rolls of Satino Black toilet paper per retail unit | ■ | | |
| 3.4 | ... be optimised for annual sales of 10,000 units | ■ | | |

*4. Cradle to Cradle requirements*

| | The packaging must ... | Req. | Target | Bonus |
|---|---|---|---|---|
| 4.1 | ... be aimed at the reduction of the use of harmful ingredients | ■ | | |
| 4.2 | ... be produced without harmful ingredients | | ■ | |
| 4.3 | ... be suited for material reutilisation (in a biological and/or technical cycle) | ■ | | |
| 4.4 | ... be designed for a defined use and disposal scenario | ■ | | |
| 4.5 | ... be aimed at a positive impact on energy, water and carbon management | ■ | | |
| 4.6 | ... be produced with a positive impact on energy, water and carbon management | | ■ | |

*5. Technical requirements*

| | The packaging must ... | Req. | Target | Bonus |
|---|---|---|---|---|
| 5.1 | ... be suited to be filled automated | ■ | | |
| 5.2 | ... be filled on Van Houtum's current filling lines | | | ■ |
| 5.3 | ... be produced by Van Houtum's current packaging suppliers | | | ■ |

## *Material Selection Layer* / *External Layer*
## *1.2a Material Identification* / *1.3a Information Collection*

As a result from the preliminary research, a list of materials has been drawn up. This list consists of materials which are possibly suited as a Cradle to Cradle packaging material for the packaging of Satino Black toilet paper. This estimation is based on knowledge on the material assessment within Cradle to Cradle certification. In other words: common sense on whether or not a material could possibly be suited as a Cradle to Cradle packaging material. Of every material, basic information and material samples (1.3a) have been requested by the supplying/producing companies. This overview is used as a limitation for the conceptualisation section of the packaging development project.

### *Paper/board*

For this project, the types of paper and board for packaging are folding box board, solid board and corrugated board (figure F5). Within the material identification, the properties of these types of material are closely related. Therefore, this is considered to be one category.

- × *Pro:*
  - \+ *Matches Van Houtum's area of expertise*
  - \+ *Positive public opinion regarding 'sustainability'*
  - \+ *Users are familiar with to the material cycle*
- × *Con:*
  - \- *Not distinctive*
  - \- *Possible need for coating (water resistance)*
- × *Cradle to Cradle certificate: Yes, US Postal mailing boxes (level unknown) [21]*
- × *Scenario*
  - × *Production: waste paper and/or virgin fibres*
  - × *Use: possible re-use (e.g. a box for household waste paper)*
  - × *End-of-use: disposal within waste paper cycle (cascade to biological cycle)*

### *Moulded fibre*

This material is related to other fibre-based packaging materials (like paper and board). This material (figure F6) is currently hardly used as external primary packaging (only for eggs), but could very well be suited for both the application and Cradle to Cradle requirements.

- × *Pro:*
  - \+ *Matches Van Houtum's area of expertise*
  - \+ *Positive public opinion regarding 'sustainability'*
  - \+ *Users are familiar with the material cycle*
- × *Con:*
  - \- *Unknown material content*
  - \- *Possible need for coating (water resistance)*
- × *Cradle to Cradle certificate: No*
- × *Scenario*
  - × *Production: waste paper (pulp)*
  - × *Use: probably disposal directly after opening*
  - × *End-of-use: disposal within waste paper cycle (cascade into biological cycle)*

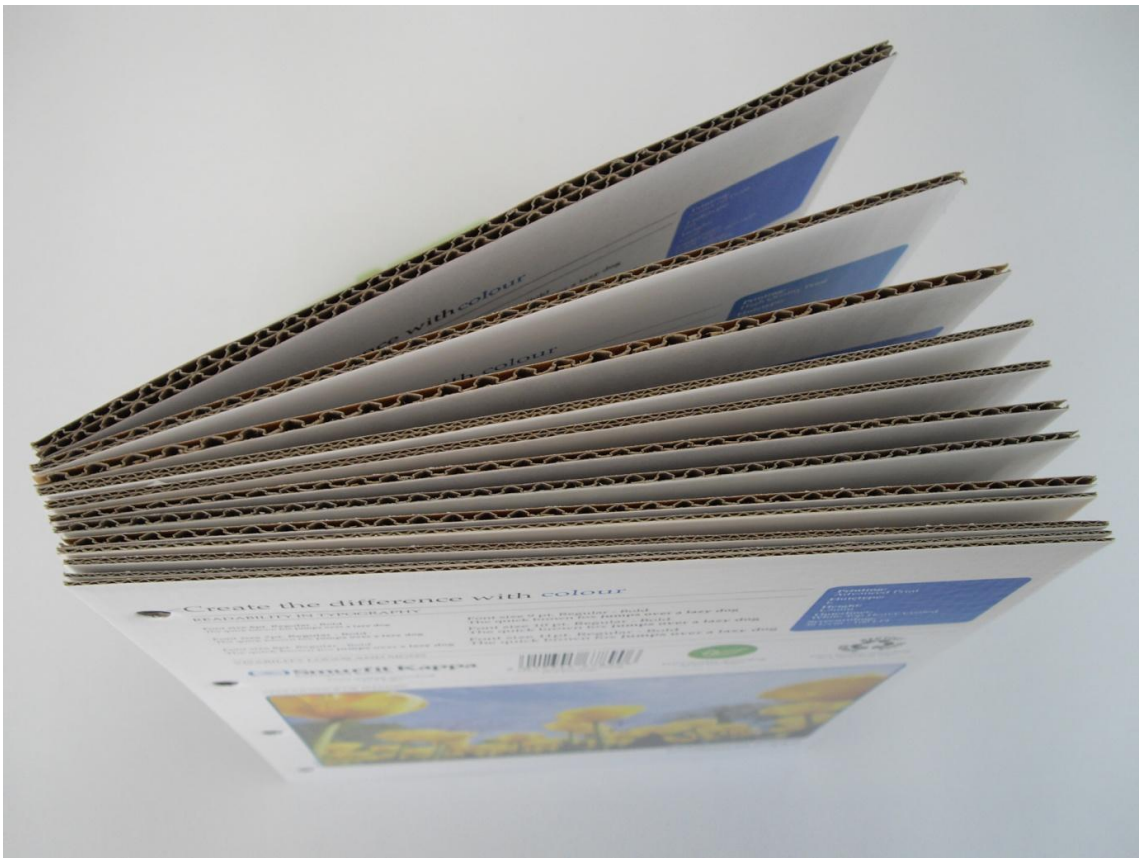



**Figure F5** | Smurfit Kappa corrugated board samples

**Figure F6** | Huhtamaki moulded fibre product samples

### *Petrochemical-based plastic*

Virtually every current packaging for toilet paper within the targeted market is transparent flexible plastic. Therefore, this is an important material category to consider.

- × *Pro:*
  - \+ *Virtually unlimited possibilities*
- × *Con:*
  - \- *Traditional ('boring') packaging material*
  - \- *Suitability for Cradle to Cradle unclear*
  - \- *Negative public view on sustainability*
- × *Cradle to Cradle certificate: No*
- × *Scenario:*
  - × *Production: petrochemical derivates*
  - × *Use: probably disposal directly after opening*
  - × *End-of-use: disposal within household waste or separate (technical cycle)*

### *Biobased plastic*

In properties, these materials can be considered to be identical to petrochemical based plastics. However, the source of the material differs. This can vary from poly-lactic acid (PLA) to polypropylene (PP) and polyethylene (PE), derived from sugarcane ethanol. Several types of biobased plastics are already in use, for instance by Oerlemans Plastics (figure F7).

- × *Pro:*
  - \+ *Virtually unlimited possibilities*
  - \+ *Biobased*
- × *Con:*
  - \- *Traditional ('boring') packaging material*
  - \- *Suitability for Cradle to Cradle unclear*
  - \- *Negative public view on sustainability (communication is essential)*
- × *Cradle to Cradle certificate: No*
- × *Scenario:*
  - × *Production: biobased derivates (PLA, PE, PP, et cetera)*
  - × *Use: probably disposal directly after opening*
  - × *End-of-use: disposal within household waste or separate (technical cycle)*


**Figure F7** | Oerlemans Plastics sugarcane-derived PE product samples

### *GaiaKraft*

This material (figure F8) is marketed as an alternative to paper products. The material consists of calcium carbonate ($CaCO_3$), bonded with PE-resin. The amount of $CaCO_3$ in the material can vary from 60% to 80%. GaiaKraft is marketed as a sustainable material, since it is optimised for recycling in a technical cycle, without depleting natural resources. On top of that, it is claimed to be produced using fewer energy and emitting fewer $CO_2$ than the production of comparable 'regular' paper products [27].

- *Pro:*
  - \+ *Distinctive material (new for packaging applications)*
  - \+ *Paper-like properties*
  - \+ *Water resistant*
  - \+ *Cradle to Cradle certificate*
- *Con:*
  - \- *Strict technical cycle (in contrary to material's look and feel)*
- *Cradle to Cradle certificate: Silver*
- *Scenario*
  - *Production: calcium carbonate with PE-resin*
  - *Use: paper-like use*
  - *End-of-use: disposal is required with household waste or separate (technical cycle)*


**Figure F8** | GaiaKraft product samples (200 µm and 400 µm)

### *PaperFoam*

PaperFoam (figure F9) is a lightweight packaging material, made from renewable, locally sourced raw materials. The product can be disposed of in the waste paper cycle since its components starch and fibres are the same as the components of paper. Furthermore, it can be composted. Even by household composting, it will fully in a couple of weeks [28]. Currently, the product is mainly used as inlay in packaging for (amongst others) Philips, Microsoft and Motorola. The company has no Cradle to Cradle certified products, but is working with Cradle to Cradle aspects in its products.

- *Pro:*
  - \+ *Distinctive material*
  - \+ *Moulded fibre-like properties (lightweight)*
  - \+ *In-line with paper recycling*
  - \+ *Water resistant*
  - \+ *Cradle to Cradle certificate*
- *Con:*
  - \- *Expensive*

- *New for this specific application*

× *Cradle to Cradle certificate: No*

× *Scenario*

× *Production: injection moulding of fibre, starch, premix and water*

× *Use: comparable to moulded fibre*

× *End-of-use: disposal within paper cycle or composting (biological cycle)*

**Figure F9** | PaperFoam product samples

### *Synbra BioFoam*

BioFoam is expendable polystyrene (EPS) which is currently used for insulation systems and industrial products for different markets. The material is a foamed product, made from poly-lactic acid (PLA). The company has received a Cradle to Cradle Silver-certificate for BioFoam [29]. It could be used for packaging applications, comparable to moulded fibre and PaperFoam.

× *Pro:*

+ *Distinctive material*

+ *Lightweight*

+ *Cradle to Cradle certificate*

× *Con:*

- *Unknown properties and possibilities*

- *New for this specific application*

- *Negative public view on sustainability*

× *Cradle to Cradle certificate: Silver*

× *Scenario*

× *Production: expanded polystyrene*

× *Use: comparable to moulded fibre*

× *End-of-use: disposal is required with household waste or separate (technical cycle)*

### *Fibre-based materials*

Within fibre-based materials, several different variants can be distinguished. For instance the food packaging products ValueForm produces [30]. Or the plant fibre-based packaging products made by Be Green Packaging [20] (mentioned in chapter 2).

× *Pro:*

+ *Distinctive material*

+ *Plant-based*

- + *Cradle to Cradle certificate (Be Green Packaging)*
- + *Positive public view on sustainability*

× *Con:*

- - *New for this specific application*

× *Cradle to Cradle certificate: Silver (Be Green Packaging)*

× *Scenario*

- × *Production: related to other fibre-based products (e.g. paper)*
- × *Use: comparable to moulded fibre*
- × *End-of-use: disposal within waste paper cycle (cascade into biological cycle)*

### *Additives*

Apart from the base materials, also additives are identified. This covers adhesives, inks and coating materials.

× *Adhesives*

For the identification of adhesives, product ranges of both Henkel and Paramelt have been discussed. Both companies are current suppliers for Van Houtum (mentioned in chapter 2). Due to the divers materials and yet unknown required properties, specific products cannot be specified.

× *Inks*

For most of the materials, printing inks and pigments have already been optimised in terms of production and usability. This holds for instance in the case of printing of cardboard and plastic packaging products. However, for this specific packaging project, possibilities for printing are considered separately.

- × *SunChemical/Flint (mentioned in chapter 2)*

  Inks produced by both SunChemical and Flint are currently used for printing cardboard and plastic packaging products.

- × *Gugler Print*

  The Austrian company Gugler has been Cradle to Cradle certified since November 2011. The company is the first to be able to produce Cradle to Cradle certified printing products (figure F10) [31]. The printed paper qualities that can be produced with a Cradle to Cradle certificate range up to 300 g/m$^2$. This folding boxboard quality could very well be used for packaging. On top of that, possibilities might be available to cooperate on applying Gugler inks for other Cradle to Cradle packaging products.


**Figure F10** | Gugler Cradle to Cradle certified printing product samples

- *Green4Print*

  Green4Print is a Dutch manufacturer of biological offset inks. Its products consist of 82% biobased raw materials. Apart from synthetic pigments in the ink products, it is completely biobased. This includes the use of biobased oils, instead of (usually used) mineral oils. Green4Print claims to have eliminated all harmful ingredients in its printing inks, like heavy metals. On top of that, the inks developed by Green4Print are designed to be beneficial on de-inking properties [32]. Currently, the inks produced by Green4Print are suited for sheet offset technology. Research and development is focused on applications in rotation offset and flexography print and eliminating halogens in inks.

- *Coatings*

  The requirement specification for the packaging draft include "The packaging must protect the packed product from moisture and splashing". This implicates that for some of the identified materials (fibre-based materials) a coating might be required. Obviously, the currently used 'regular' plastic coatings could be applied. However, this will probably result in several issues during the future scenario (end-of-use). However, a possibility for biobased paper coating has been found. The company Glycanex has conducted a pilot project on applying modified starch as a coating with barrier properties on paper/cardboard. Mainly due to cost-related considerations, this development (product name Glycapol; appendix H) has not yet been industrialised.

### *Material Knowledge Bank*

All packaging materials which have been researched can be found in appendix E. This list of materials is designed to increase with every executed packaging project.

## *Decision Moment A*

The first decision moment is focused on assessing the requirement specification and the identified materials.

- *Requirement specification*

  The requirement specification for this packaging project has been discussed and adapted iteratively. This has been done during different face-to-face sessions, with all members of the project team and the internal stakeholders within Van Houtum. This intensive approach has been selected to assure elaborate discussion on every single requirement. The list of requirement specifications as described before is the result of these discussions.

- *Identified materials*

  The elaborate list of identified materials and additives has been discussed during different sessions with the project team. Several materials are considered to be unsuitable for packing Satino Black toilet rolls for a cash & carry environment. The materials which have been rejected are the following:

  - *Petrochemical-based plastic*

    This type of plastic packaging materials has been eliminated for this specific packaging project. The most important reason is the public opinion related to petrochemical-based plastics. Equal properties can probably be achieved with biobased plastics. However, this type of plastic material will probably fit better within a Cradle to Cradle approach. On top of that, petrochemical-based plastic packaging materials are not distinctive for this specific purpose; virtually all toilet paper currently sold in a cash & carry environment is packed in 'regular' flexible transparent plastic.

  - *GaiaKraft*

    Currently, GaiaKraft is marketed as a variant of paper. This is very well understandable, since the properties are comparable. However, this will probably result in an unclear end-of-use scenario. GaiaKraft is intended to end up in the plastic cycle, to be recycled with other types of plastic. However, due to its paper-like properties, users will probably dispose of it in the waste paper stream. There it will be sorted as reject, and ending up in the mixed waste stream. In that case, all precious material content is lost, since it will probably be incinerated. This scenario will also hold for a packaging made out of GaiaKraft (with properties like folding boxboard).

  - *Synbra BioFoam*

    This material is very well suited for Cradle to Cradle, since it has already been certified. However, it is very far from the current packaging material archetypes. In other words: its distinctive look, feel and properties will possibly turn out to be conflicting for this application. On top of that, its material cycle will probably not be considered to be 'sustainable' ("it's still plastic"). Even though it fits within Cradle to Cradle.

  - *Fibre-based materials*

    The researched fibre-based materials are all very interesting from a perspective of Cradle to Cradle. However, it is also rather new and experimental. For this specific application, the use of fibre-based materials will possibly turn out to be too distinct.

As mentioned in this project's background, no decision moment will result in a termination of the project. Therefore, Decision Moment A results in a "go" for the following section: the Conceptualisation Section. For Decision Moment B, the following requirements have been set up:

- *Defined drafts*
  - Two drafts will be reviewed
  - Drafts have to be specified up to conceptual level, to review form, function and material

- *Specified materials*
  - All materials out of the identified materials (as specified in the Definition Section) which are applicable in the selected drafts have to be specified
  - All available information on material content and composition has to be listed

# *F2 Conceptualisation Section*

## *Development Layer*

### *2.1a Conceptualisation*

Based on the requirement specification, drafts have been developed. This ranges from generating basic concepts for the packaging demand, up to structured, defined drafts. The draft development is limited by the previously selected identified materials.

- *Idea generation*

The initial idea development for the packaging draft started with a brainstorm session. During this session, basic ideas related to the packaging of toilet paper have been written down. For the packaging draft for the Satino Black packaging, four main brainstorm areas have been targeted: *secondary use*, *space-saving*, *easy opening* and *self-fillable* (figure F11).

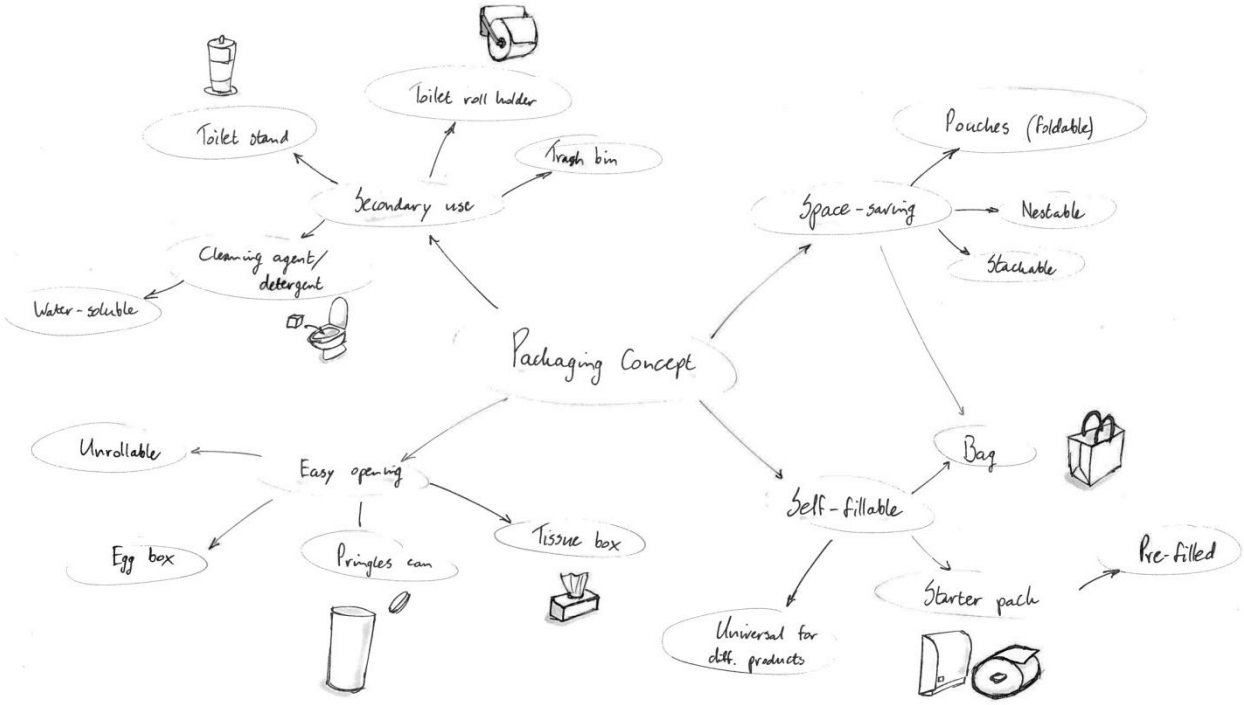



**Figure F11** | Results brainstorm session

After this session, the results have been discussed within the project team. Based on this discussion, several concept directions have been selected. These idea directions are illustrated in figure F12-i.

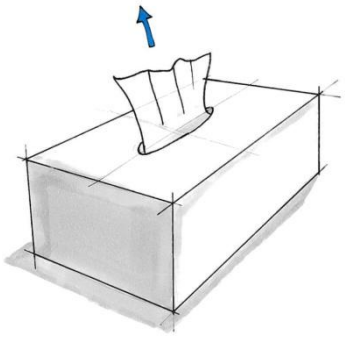


**Figure F12a** | Tissue box

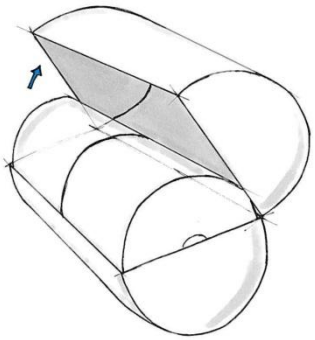


**Figure F12b** | Split cylinder

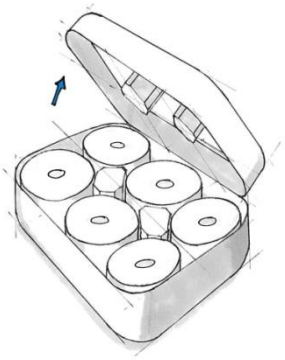


**Figure F12c** | Egg box

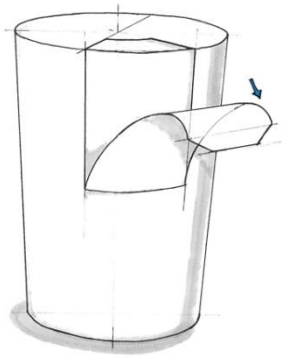


**Figure F12d** | Tear cylinder

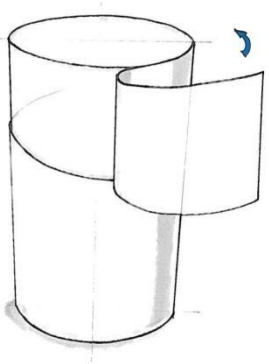


**Figure F12e** | Wrap cylinder

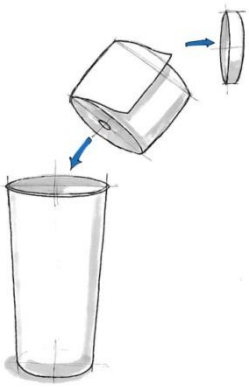


**Figure F12f** | Can cylinder

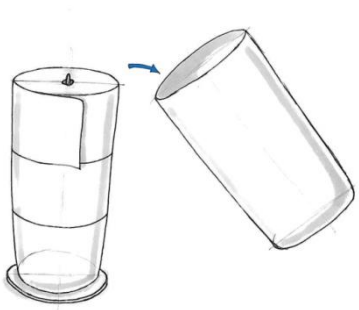


**Figure F12g** | Toilet roll stand

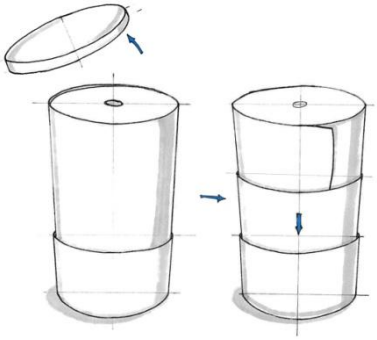


**Figure F12h** | Section cylinder

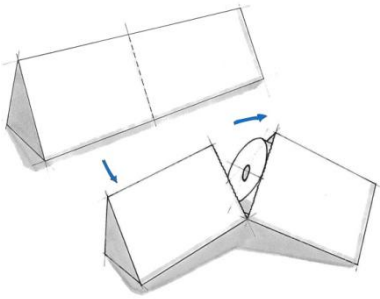


**Figure F12i** | Triangle

As can be seen, most of the concepts are a variant to a cylindrical shape. Obviously, this is due to the shape of the product which will be packed. After discussion within the project team, two concept directions have been selected for further development: a cylindrical shaped packaging and the egg box idea. However, when considering the specific requirements, it turns out that a cylindrical shape is not sufficient. The packaging of twelve rolls of toilet paper in a cylindrical shape will be very long (over a meter). Therefore, this idea direction had to be adapted to be more efficient. This has resulted in a cylindrical shape which has been extended in length and/or width: an oval shape (figure F13a). A variant to this shape has been inspired by the limitations of materials like corrugated board. This octagonal shape can be seen in figure F13b.

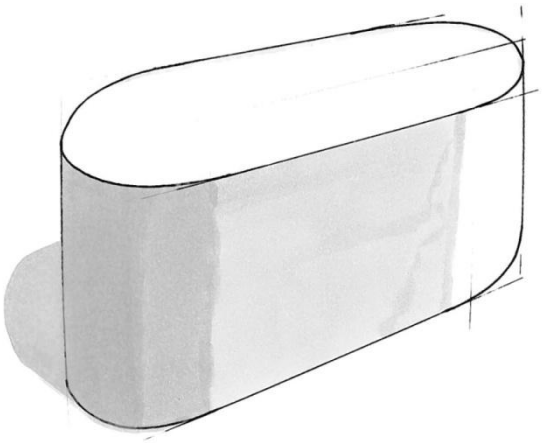


**Figure F13a** | Oval

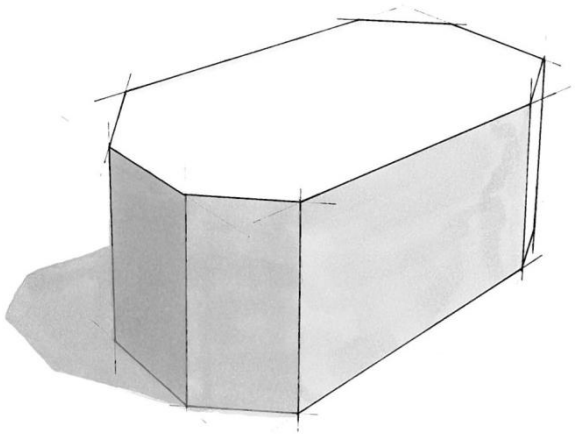


**Figure F13b** | Octagon

- *Concept development*

  Two concept directions have been selected: the egg box and the oval/octagonal box. For a structured draft development out of these concept directions, a morphologic scheme is set up (table F3). In this scheme, six aspects for the packaging drafts have been selected:

  - *Shape*

    Three shapes/structures for the packaging have been distinguished: an oval box, an octagonal box and an 'egg box'
  - *Division*

    As determined before: the packaging must contain twelve rolls of toilet paper. To achieve an efficient division, there are two possibilities: two by two (by three) or three by two (by two) rolls
  - *Handle*

    The benchmark research shows that current packaging in the targeted market are all featured with handles for carrying. Therefore, this is considered important in the Satino Black packaging concept. It can be implemented either as an internal or an external handle
  - *Hanger*

    In several meetings with the internal stakeholders of the packaging development draft, the possibility for a packaging which can be hung came up as an interesting idea. Therefore, a hanger is addressed in the morphologic scheme
  - *Opening*

    For the opening of the packaging, three possibilities are deemed plausible: a lid (either separate or loose), a tear strip or a packaging which can be flipped open. This flip-open idea is basically an extended tear strip. However, this idea was appreciated by the project team and is therefore mentioned explicitly in the morphologic scheme
  - *Closure*

    Obviously, the packaging must be closed after production. Usually (when considering cardboard) this is done by a hotmelt or coldmelt adhesive. However, for this Cradle to Cradle packaging draft, such a connection is discarded as a possibility. This decision has been made due to the suboptimal material reutilisation cycle of these types of adhesives. It either ends up in the reject stream during paper recycling, or it is embodied in the newly produced paper. Either way: the resources are lost. This is not a specific issue in Cradle to Cradle certification. It can be seen as an added 'gimmick' in the packaging draft

Out of this morphologic scheme, four drafts have been developed. Of these drafts, two are based on the octagonal shape, one is based on the oval shape and one is based on the egg box idea. Different aspects as described in the morphologic scheme have been embodied in the different drafts. In the scheme, dots with different colours correspond to the four drafts.

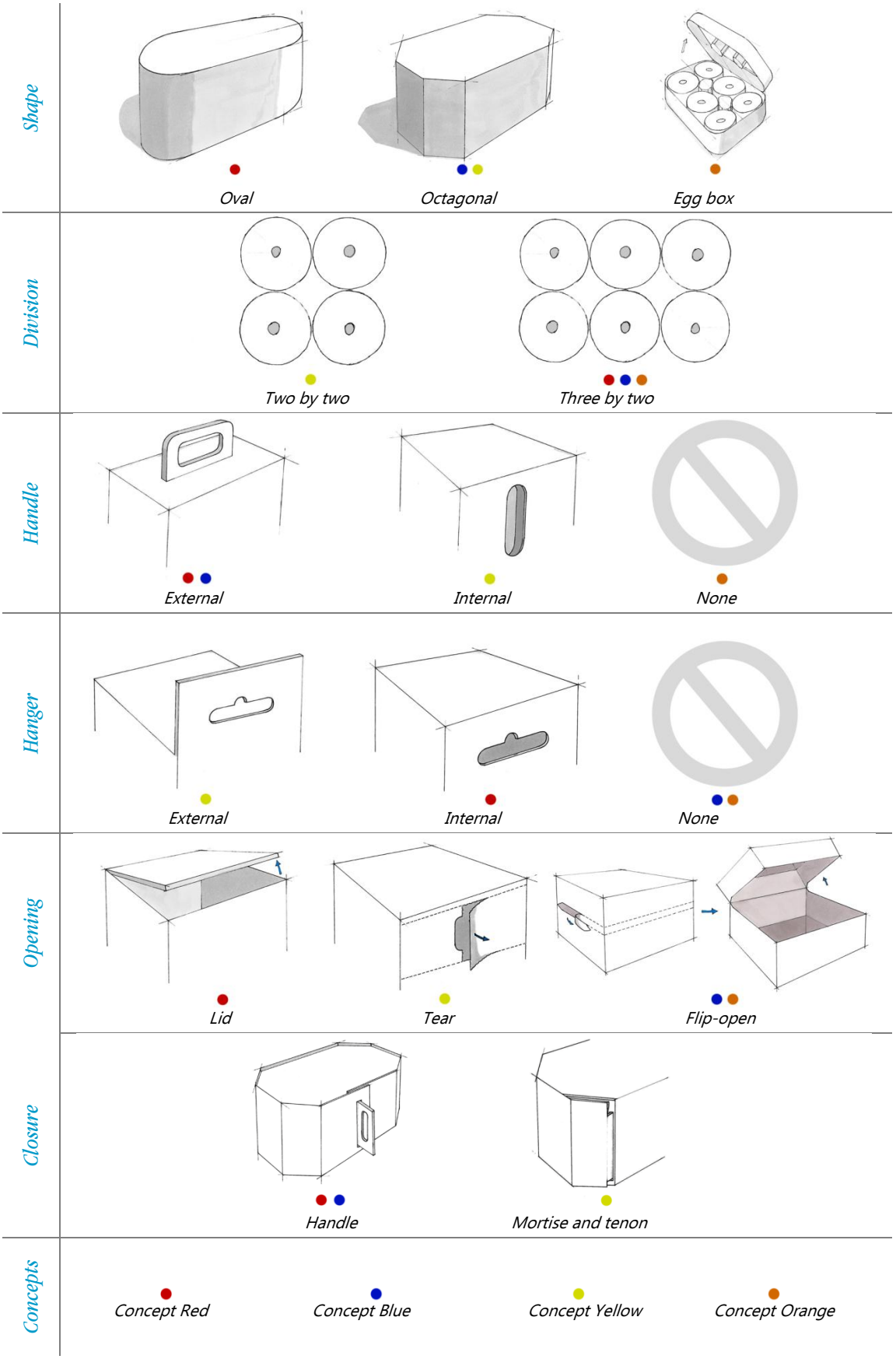



**Table F3** | Morphologic scheme draft development

- *Draft elaboration*
  - *Concept Red*

    The first draft (figure F14a-c) incorporates an oval shape with a fixed lid, on both sides. The packaging's closure is constructed by the handle, which is folded out from the inside. A scale model of this draft has been constructed out of corrugated board (figure F14d).

**Figure F14a** | Concept Red (1)

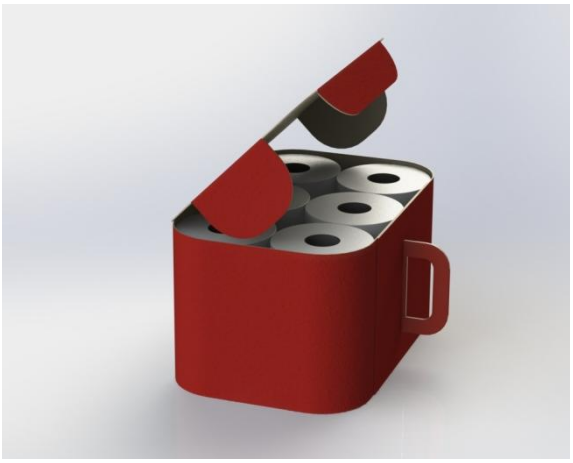


**Figure F14b** | Concept Red (2)

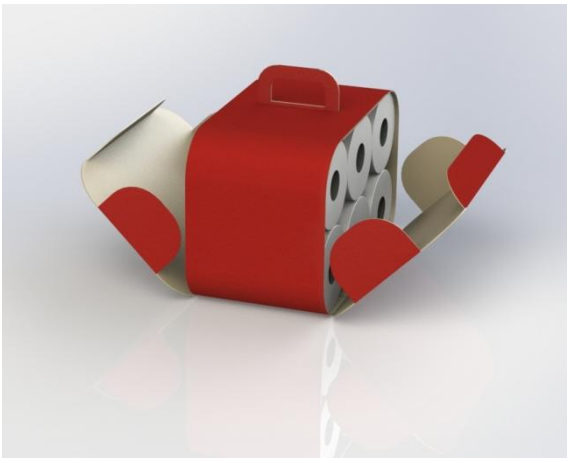


**Figure F14c** | Concept Red (3)

**Figure F14d** | Concept Red (scale model)

  - *Concept Blue*

    The second draft (figure F15a-c) is based on the octagonal shape. Separate lids are placed on both the top and bottom of the packaging (light blue in the figures). This lid could for instance be constructed out of PaperFoam or moulded fibre material. The packaging can be opened by tearing off a strip and flipping the packaging open (figure F15c). The packaging's closure is constructed by the handle, which is folded out from the inside. Of this draft, a scale model has been constructed as well (figure F15d).

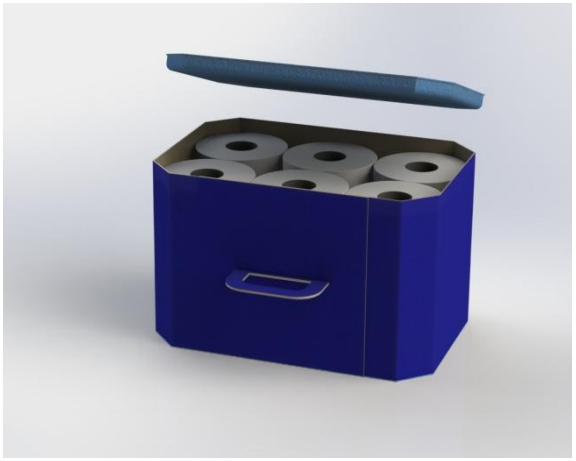


**Figure F15a** | Concept Blue (1)

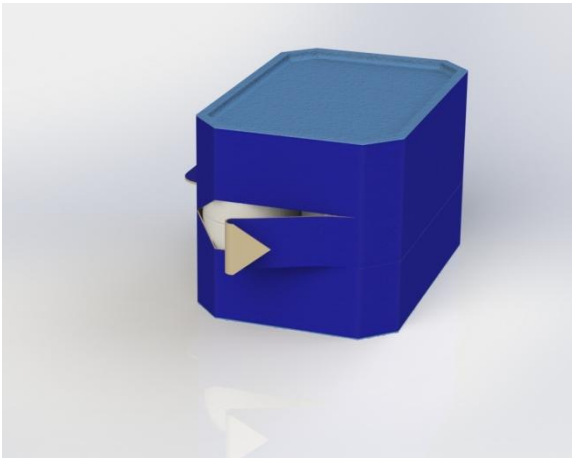


**Figure F15b** | Concept Blue (2)

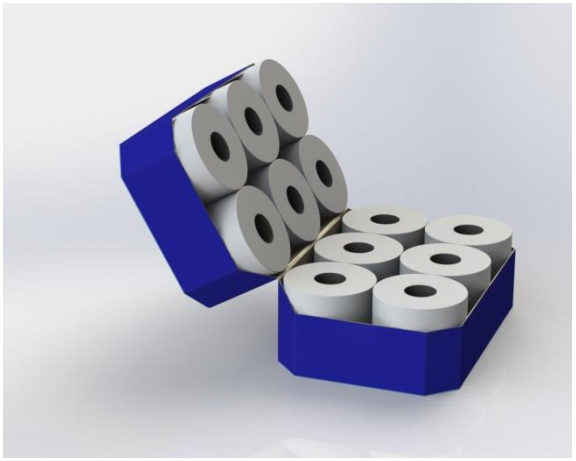


**Figure F15c** | Concept Blue (3)

**Figure F15d** | Concept Blue (scale model)

× *Concept Yellow*
The third draft (figure F16a-c) is also based on an octagonal shape. In this draft, the toilet rolls are placed on their sides. The packaging is opened at the front, with a tear strip wide enough to take the toilet rolls out of the packaging. The closure is constructed with a hanger. At the back of the packaging, a handle is placed. Of this draft, a scale model has been constructed as well (figure F16d).

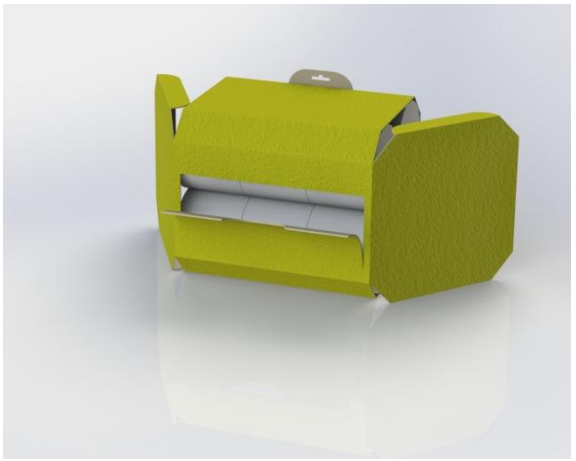


**Figure F16a** | Concept Yellow (1)

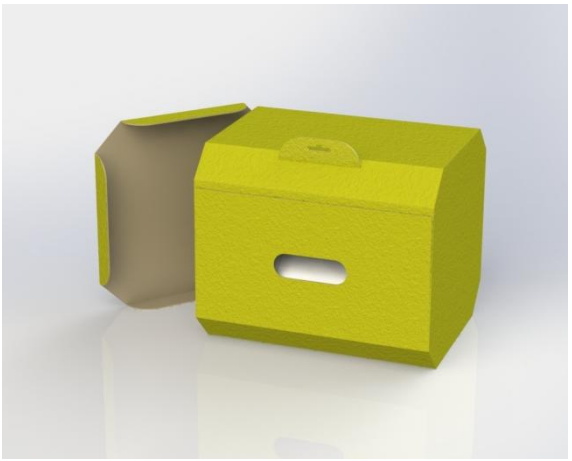


**Figure F16b** | Concept Yellow (2)

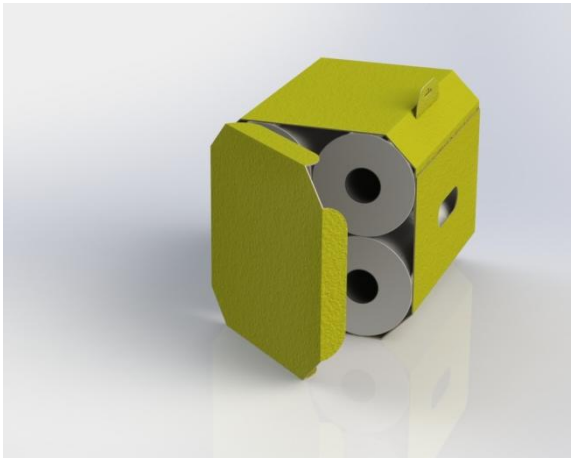


**Figure F16c** | Concept Yellow (3)

**Figure F16d** | Concept Yellow (scale model)

× *Concept Orange*
The fourth and final draft (figure F17a-d) is based on the 'egg box' idea. The packaging consists of two identical sections, which are placed on top of each other. The packaging is closed by a sleeve (figure F17d). This sleeve will be required for strength (the packaging has to bundle 2 kilos of product) and as substrate for print. The required level of graphic representation related to the brand will not be achieved by printing on the moulded fibre material itself.

**Figure F17a** | Concept Orange (1)

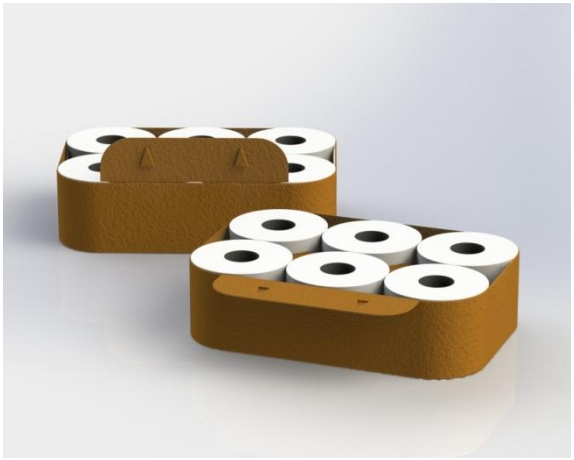


**Figure F17b** | Concept Orange (2)

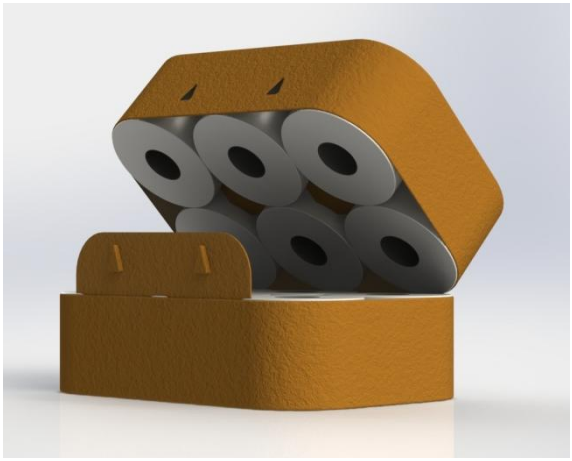


**Figure F17c** | Concept Orange (3)

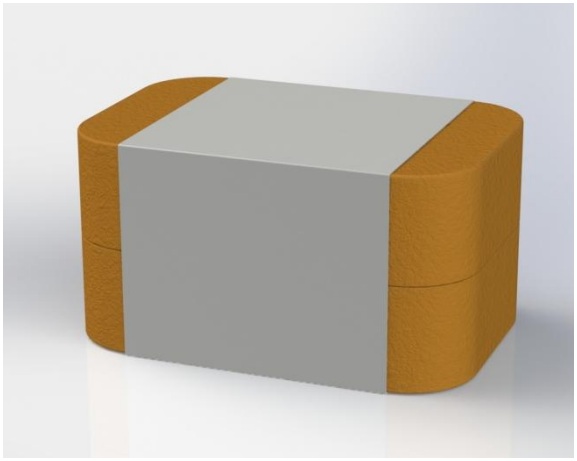


**Figure F17d** | Concept Orange (4)

× *Draft elaboration*

Out of the four described drafts, two directions have been selected. These drafts are elaborated further for Decision Moment B. In this second-level draft development, issues regarding cost price, producibility and graphic design have been taken into account. After discussion within the project team and several stakeholders within Van Houtum, two drafts have been selected: Concept Blue and Concept Orange:

× *Concept Octagonal*

This draft (figure F18) is an further developed version of Concept Blue. This draft contains one (separate) lid, op the top side of the packaging. The base of the packaging consists of a box out of corrugated board. The lid is connected to the box with little hooks. Handles have been placed on both sides of the packaging. The packaging is closed by a (blind) mortise and tenon connection. Depending on material and production possibilities, an additional flip-open tear strip (like in Concept Blue) could be added. Figure F18 shows Concept Octagonal with the graphic appearance of the current Satino Black packaging.


**Figure F18** | Concept Octagonal

The indicated cost price for the two parts of the packaging is € 0.25 (corrugated board box) plus € 0.50 (PaperFoam lid). The draft has the following pros and cons:

\+ *Producibility*

The box is easily produced, by cutting flat sheets of corrugated board. The PaperFoam lid can be injection moulded

\+ *Secondary use*

Since this draft is basically still a box, it is very well suited for secondary use. All materials can be processed as waste paper, therefore it can at least be used as a box for waste paper, after use

\+ *Archetype*

The draft fits within an archetype of packaging materials and shapes. Even though current toilet paper packaging is merely transparent flexible foil. A box is 'understood' by consumers

\+ *Stackability*

Since the packaging's outer dimensions form a rectangular box, it is very well and efficiently stackable for both transport and storage.

\- *Dimensions*

Due to the relatively large dimensions of the packaging (± 230 mm by 345 mm), the size of the PaperFoam lid is close to the limits resulting from production. However, when this issue turns out to be critical, the PaperFoam lid *could* be replaced by a fixed lid from corrugated board.

\- *Opening*

The top lid is connected to the box with small hooks. However, this could turn out to be impossible to produce or to open easily. A flip-open tear strip in the packaging could be a possibility. Eliminating the PaperFoam lid would however downgrade the draft's appearance and distinction.

× *Concept Egg Box*
This draft (figure F19) is a more extensively developed version of Concept Orange. The draft consists of two identical sections, out of moulded fibre material. Each sections can contain six rolls of toilet paper. Both halves of the packaging are connected by a pin and slot connection. On the outside of the packaging, a paper sleeve is added. This sleeve acts as a cover and keeps both sections of the packaging fixed together. On top of that, it carries the packaging's graphics and information. The sleeve could for instance be printed by Gugler, since this company can supply Cradle to Cradle certified printing products.


**Figure F19** | Concept Egg Box

The indicated cost price for the packaging is € 1.00 (for two moulded fibre sections) plus € 0.15 (Gugler-printed paper sleeve). The draft has the following pros and cons:

+ *Producibility*
  The box can be produced by moulding paper pulp. The sleeve is printed and cut
+ *Distinction*
  Applying moulded fibre for packing rolls of toilet paper is very distinctive. In between all variants of flexible foil packaging , this draft will be striking
+ *Processing*
  This draft is believed to be easily implemented in a packaging line. Both halves of the packaging can easily be filled with rolls of toilet paper. After that, they are connected and finished with the paper sleeve wrapped around
- *Efficiency*
  The production of the moulded fibre material will result in a shape with angular sides. This results in suboptimal efficiency in transport and storage
- *Secondary use*
  When consumers have used the contents of the packaging, they are left with two empty trays. This empty packaging is not easily used for something else, due to its shape. It will probably be discarded with waste paper, right away. Secondary use of the packaging is not obvious.

## *Material Selection Layer*

### *2.2a Material Specification*

During Decision Moment A, the list of identified materials has been slimmed down. For the two drafts (Concept Octagonal and Concept Egg Box), three base materials are deemed sufficient: corrugated board, PaperFoam and moulded fibre. The sleeve which completes Concept Egg Box is not taken into account in the Material Specification. This could be purchased Cradle to Cradle certified (from Gugler), material analysis is not necessary.

One other material (biobased plastics) also made it to the Conceptualisation Section. However, this material has not been taken into account during the conceptualisation. This is mainly due to the appearance of the material. Since biobased plastic looks and feels just like 'regular' transparent plastic, there is no material distinction from competing packaging in the targeted market. Consumers will probably not appreciate the added value (if any) of biobased plastics, compared to petrochemical-based plastics. Even from a Cradle to Cradle perspective, the choice between biobased and 'regular' plastics is not

straightforward. This mainly has to do with feed stock competition, geographic and political issues. However, to be truly renewable, materials will have to be designed as biological nutrients. On top of that, biobased materials must be designed for a use period which meets or exceeds the reproduction time. Both issues are not met with the application of biobased plastics for toilet paper packaging.

| *Date* | *Mercury (mg/kg)* | *Copper (mg/kg)* | *Cadmium (mg/kg)* | *Arsenic (mg/kg)* | *Chromium (mg/kg)* | *Lead (mg/kg)* | *Nickel (mg/kg)* | *Zinc (mg/kg)* | *Chloride (% m/m)* | *Fluoride (mg/kg)* | *Molybdenum (mg/kg)* | *Selenium (mg/kg)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *20-12-01* | <0.01 | 25 | 0.06 | 0.2 | 2.1 | 1.9 | 0.9 | 15 | | | | |
| *28-11-02* | <0.01 | 30 | 0.05 | 0.3 | 3.1 | 3.8 | 1.3 | 30 | <0.02 | | | |
| *11-12-03* | 5.2 | 39 | <0.02 | 0.31 | 3.1 | 3.8 | 1.6 | 26 | 0.12 | | | |
| *02-12-04* | <0.1 | 37 | <0.1 | <1.0 | 4 | 6 | 2 | 40 | | | | |
| *22-11-05* | <0.1 | 21 | <0.1 | <1.0 | 5 | 5 | 3 | 23 | 1.9 | | | |
| *18-12-06* | <0.1 | 31 | <0.1 | <1.0 | 6 | 5 | 3 | 24 | <0.1 | | | |
| *05-12-07* | <0.1 | 32 | <0.1 | <1.0 | 7 | 4 | 3 | 26 | 0.11 | 0.03 | 1 | 1 |
| *04-12-08* | <0.1 | 37 | <0.1 | <1 | 13 | 6.4 | 6.9 | 48 | 0.065 | | | |
| *29-09-09* | <0.1 | 32 | <0.1 | <1.1 | 9.5 | 15 | 6.8 | 31 | 830 | <25 | | |
| *24-11-09* | <0.1 | 32 | <0.1 | 2.1 | 18 | 7.1 | 8.7 | 31 | | | | |
| *17-06-10* | <0.2 | 35 | 0.4 | <2 | 5 | 4 | 4 | 24 | | | | |
| *23-12-10* | <0.1 | 27 | <0.3 | <5.0 | <7.0 | <10.0 | <5.0 | 17 | | | | |
| *27-01-12* | <0.05 | 31 | <0.4 | <4.0 | <15.0 | <13.0 | <3.0 | 23 | | | | |

**Table F4** | Heavy metals and halogens in Huhtamaki moulded fibre

**Figure F20** | VPK paper samples: 135 white testliner (left), 135 fluting (middle) and 135 testliner (right)

The composition and material content of the concept-relevant materials has been acquired in different ways:

- *Moulded fibre*
  For this material, Cradle to Cradle certification regards the concentration of heavy metals and halogens. Declarations of these substances have been obtained from the supplier (table F4).

- *Corrugated board*
  For corrugated board, no data on material composition turned out to be available. Therefore, chemical analyses on material samples have been commissioned by the project team. The material samples have been selected from a typical composition of corrugated board for packaging applications. Due to practical reasons, samples from just one supplier (VPK) have been analysed. The samples are 135 testliner, 135 white testliner and 135 fluting (figure F20). The results from the analysis can be seen in table F5.

| | *135 testliner (mg/kg)* | *135 white testliner (mg/kg)* | *135 fluting (mg/kg)* |
|---|---|---|---|
| | *mg/kg* | | |
| *Antimony* | <0.2 | <0.2 | <0.2 |
| *Arsenic* | 0.24 | 0.14 | 0.30 |
| *Beryllium* | <0.2 | <0.2 | <0.2 |
| *Cadmium* | 0.07 | 0.05 | 0.09 |
| *Chrome* | 5.8 | 4.8 | 6.2 |
| *Cobalt* | 0.72 | 0.54 | 0.74 |
| *Copper* | 29 | 16 | 33 |
| *Mercury* | 0.05 | 0.02 | 0.03 |
| *Lead* | 10 | 6.3 | 10 |
| *Nickel* | 2.4 | 1.8 | 2.8 |
| *Titanium* | 450 | 310 | 450 |
| *Zinc* | 29 | 19 | 29 |
| *Total halogens* | 680 | 83 | 250 |
| *Inorganic halogens* | 585 | 67 | 235 |
| *Extractable Organic Halogens* | 2.4 | 2.0 | 2.6 |
| | *% (m/m)* | | |
| *Moisture content* | 8.0 | 8.2 | 8.1 |

**Table F5** | Heavy metals and halogens in VPK corrugated board paper samples

Apart from the paper layers, corrugated board consists of an adhesive. This adhesive consists of the following ingredients:

- *Water (± 74%)*
- *Starch (± 24%)*
- *Caustic soda (± 1.7%)*
- *Borax (± 0.3%)*

Of these ingredients, water, starch and caustic soda are not considered to be harmful from a material health perspective. However, borax is. For the production of corrugated board, this material is added to enhance the flow properties of the glue. Both suppliers of corrugated board (Smurfit Kappa and VPK) use different variants of this chemical:

- *Smurfit Kappa*

| *Product name* | *Composition* | *CAS number* |
|---|---|---|
| *Borax decahydrate* | >99.9% | 1303-96-4 |

This product is listed as reproductive toxic. The complete data sheet can be found in appendix I.

- *VPK*

| Product name | Composition | CAS number |
|---|---|---|
| *Prodac* | Amino-polyborate (<65%) | 9405-04-02<br>68425-67-2 |
| | Sodium pentaborate (10-15%) | 120007-92-0 |

For this product, the following statement can be found in its data sheet: "*Prodac contains neither residue of boric acid or borax decahydrate nor any other carcinogenic, mutagenic or reproductive toxic product*". Due to this statement, the variant of this material VPK applies appears to be less harmful than the variant Smurfit Kappa applies. The complete data sheet (in Dutch) of Prodac can be found in appendix J.

- *PaperFoam*

The composition and material of PaperFoam is known by the manufacturer. However, this information is only partially disclosed. The material basically consists of the following ingredients:

- *Industrial starch (± 50%)*
- *Virgin cellulose fibres (± 25%)*
- *Premix (± 25%)*
- *Colouring*

Of these ingredients, starch and cellulose fibres will not be harmful from a material health perspective (sourcing is not taken into account in this phase). Of the premix, material contents are not disclosed by the manufacturer. Therefore, an indication on the suitability for Cradle to Cradle certification cannot be determined. This is possible by setting up a non-disclosure agreement between an independent assessment institute and PaperFoam, commissioned by Van Houtum. This is considered an official part of certification, with financial implications. Due to the pilot-like approach of this project, this step is not executed. The material contents of PaperFoam remain (partially) unknown.

Besides the base material, some colouring could be added to the material. For the application as developed in Concept Octagonal, the PaperFoam lid should be coloured black. Other possibilities would be white (no colouring) or red (the secondary colour of Satino Black). The chemicals used for colouring have the following properties:

| Product name | CI number | CI name | Manufacturer |
|---|---|---|---|
| *Pigmatex Black NG* | 1333-86-4 | CI Pigment Black 7 | SunChemical |
| *Pigmatex Scarlet 268* | 12316 | CI Pigment Red 268 | |

- *Additives*

Apart from the base materials, some additives have to be specified to achieve the representation of the developed drafts. As mentioned before, no adhesives will be used in either of the drafts. Therefore, only inks and coatings are taken into account:

- *Concept Octagonal*

  For printing the corrugated board of Concept Octagonal, three options are available: Gugler, Green4Print and the current ink suppliers. Gugler will only be able to print corrugated board as a separate liner. This would then be transported to the manufacturer of corrugated board. Green4Print is able to supply printing inks which are free of heavy metals and halogens (important in Cradle to Cradle certification). However, this is currently only available for sheet offset technology. The third option is using the currently used inks. Obviously, these will have to be analysed. For printing the two colours of Satino Black (black and red), different components are applied by Smurfit Kappa (table F6) and VPK (table F7).

| Colour | Component | Component number | CAS number | CI number |
|---|---|---|---|---|
| *Black* | Black 7 | WZ 16-9KN | 1333-86-4 | 77266 |
| | Varnish | WI 3P-E14N | - | - |
| *Red* | White 6 | WZ 16-02KN | 13463-67-7 | 77891 |
| | Orange 13 | WZ 16-22KN | 3520-72-7 | 21110 |
| | Red 2 | WZ 16-31KN | 6041-94-7 | 12310 |
| | Varnish | WI 3P-E14N | - | - |

**Table F6** | Components applied by Smurfit Kappa for Satino Black

| Colour | Ink number | Component | CAS number | CI number |
|---|---|---|---|---|
| Black | 90-WP-03 | Black 7 | 98615-67-9 | 77266 |
| Red | 46-WB-04 | Yellow 14 | 5468-75-7 | 21095 |
| | | Red 2 | 6041-94-7 | 12310 |
| | | Red 57 | 5281-04-9 | 15850 |

**Table F7** | Components applied by VPK for Satino Black

The inks used by VPK are mainly (60-70%) water-based. Regarding black pigments, the concentration of polycyclic aromatic hydrocarbons (PAH) is important from a Cradle to Cradle perspective. Therefore, statements of the ink suppliers have to be obtained. Flint (supplier of inks for Smurfit Kappa) has stated the following:

*"PAH are not intentionally added in any water based printing ink from Flint. The WZ 16-91KN is not analysed for PAH. There is no legal basis for packaging inks limitations of PAH"*

SunChemical (supplier of inks for VPK) has stated the following:

*"In the manufacture of inks and varnishes supplied by SunChemical, polycyclic aromatic hydrocarbons or raw materials containing these substances are not used as intentionally added ingredients. The presence, however, of traces of these substances in the product coming from raw material impurities, from the process or as adventitious contaminant cannot be excluded"*

Concept Octagonal could be equipped with a coating. The starch-based coating Glycapol (produced by Glycanex) might be suited for this application and from a Cradle to Cradle perspective. The complete data sheet of Glycapol can be found in appendix H.

× *Concept Egg Box*

In this draft, two types of additives are incorporated: colouring for the moulded fibre material and printing inks for the paper sleeve. The Cradle to Cradle-related properties of the material colouring (heavy metals and halogens) have already been taken into account in the analysis of the base material. Therefore, a separate analysis on these additives is not necessary. As mentioned before, the paper sleeve could be printed by Gugler. This would result in a Cradle to Cradle certified printed sleeve.

## Decision Moment B

During Decision Moment B, the following documents are being reviewed:

× *Defined drafts*

Two drafts have been developed, up to equal (conceptual) level. These drafts have been reviewed on form, function, material, price and producibility. **Concept Octagonal** has been selected for detailing. All internal stakeholders related to the project have been consulted for this review. On top of that, a representative of the targeted market has been consulted. The decision has been made on the following main issues:

× *Appearance*

Even though the packaging draft is required to be distinctive from current packaging for toilet paper, Concept Egg Box is believed to be too distinct. This draft might be very well possible for market implementation in a few years, when Satino Black is known to consumers. Another issue related to this draft, is the paper sleeve. Once the packaging is opened, the paper sleeve will be discarded of. With that, all Satino Black branding is gone. Therefore, the sleeve would have to be designed as a part which is essential for the closing of the packaging.

× *Efficiency*

As mentioned before, efficiency in transport and storage is a downside of Concept Egg Box. Cradle to Cradle is not focused on efficiency (effectiveness is key), but this is still an issue.

× *Secondary use*

When empty, Concept Egg Box will probably not be applied for secondary use. This is due to its shape, which is dedicated to packing rolls of toilet paper.

× *Cost price*

This project is not focused on developing a packaging draft with as low costs as possible. However, the estimated cost price for Concept Egg Box is believed to be too high. With the current estimation, the cost price will exceed the requirement.

- *Specified materials*
  Of all materials related to Concept Octagonal and Concept Egg Box, available specifications have been listed. These specifications of material content and composition are deemed sufficient for (external) material assessment, as part of the Detailing Section.

With the defined drafts and specified materials reviewed, the Detailing Section of the project can be executed. At the end of this section, during Decision Moment C, the following documents are being judged on different issues:

- *Detailed draft*
  - The detailed draft must be described on shape, function, material and graphic design
  - The level of detail must be sufficient for production and certification
- *Selected materials*
  - All concept-relevant materials must be assessed by an independent assessment institute
  - The level of material assessment must be sufficient for certification
- *Documentation*
  - Documentation must address draft, development and materials

# *F3 Detailing Section*

## *Development Layer*

### *3.1a Concept Detailing*

Concept Octagonal is detailed up to a level which is sufficient for production and Cradle to Cradle certification. The detailing step is executed iteratively during which several issues are addressed:

- *Dimensions*
- *Material*
- *Opening*
- *Closure*

#### *Detailing Development*

The draft description, as specified in the Conceptualisation Section, has been discussed with both PaperFoam and Smurfit Kappa. The latter has been selected out of the current suppliers of Van Houtum, after discussion within the project team. The connection of the lid to the box has been changed, after discussion with PaperFoam. The triangular hooks (figure F18) turned out to be impossible to produce. Two variants have been suggested, as can be seen in figures F21a and F21b.

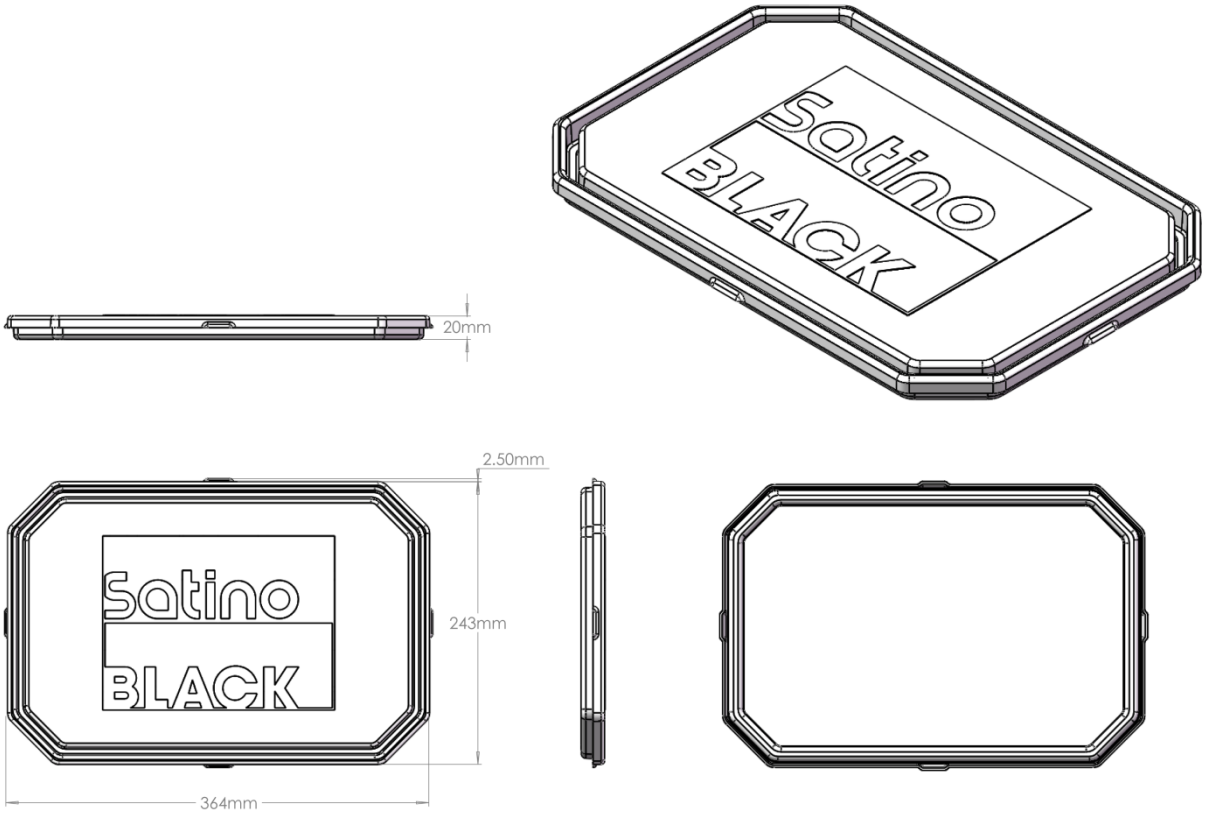



**Figure F21a** | Hook variant 1

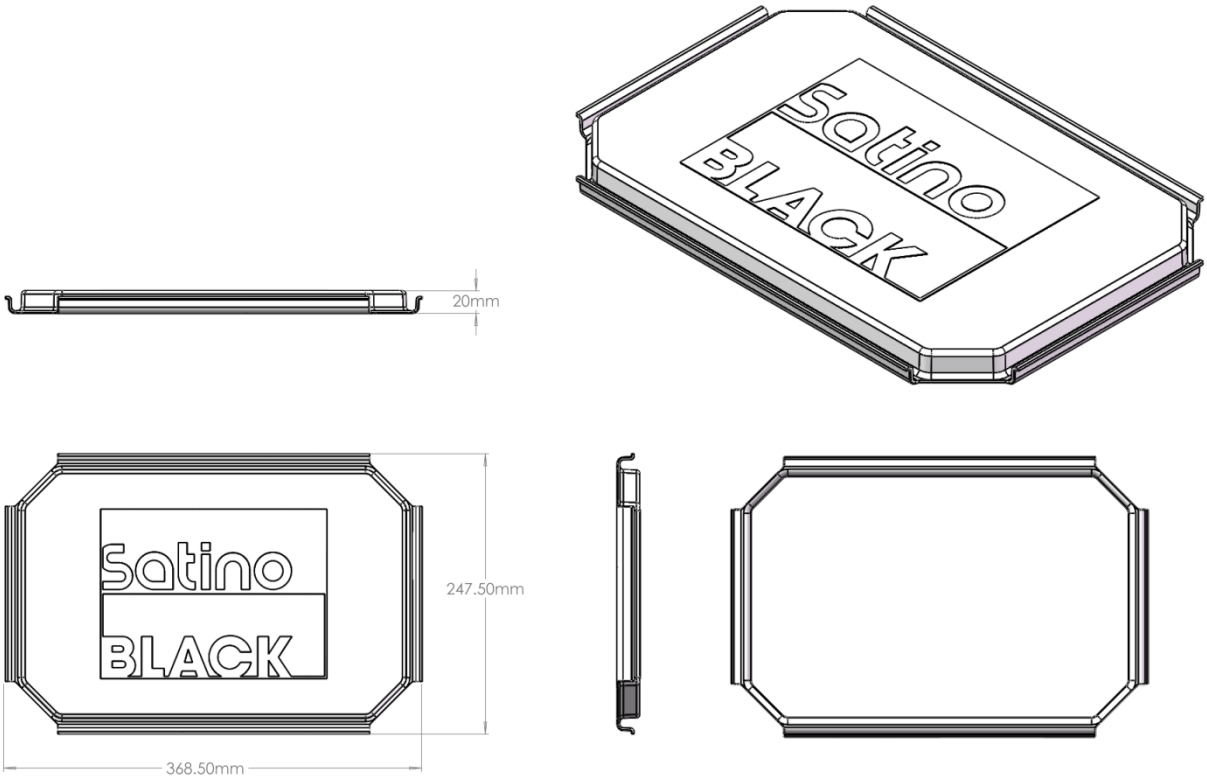



**Figure F21b** | Hook variant 2

Out of these possibilities, variant 1 has been selected. This is implemented in the design for the corrugated board box. Figure F22 shows the outline of this box design. The closure is constructed with a mortise and tenon, the bottom is folded.

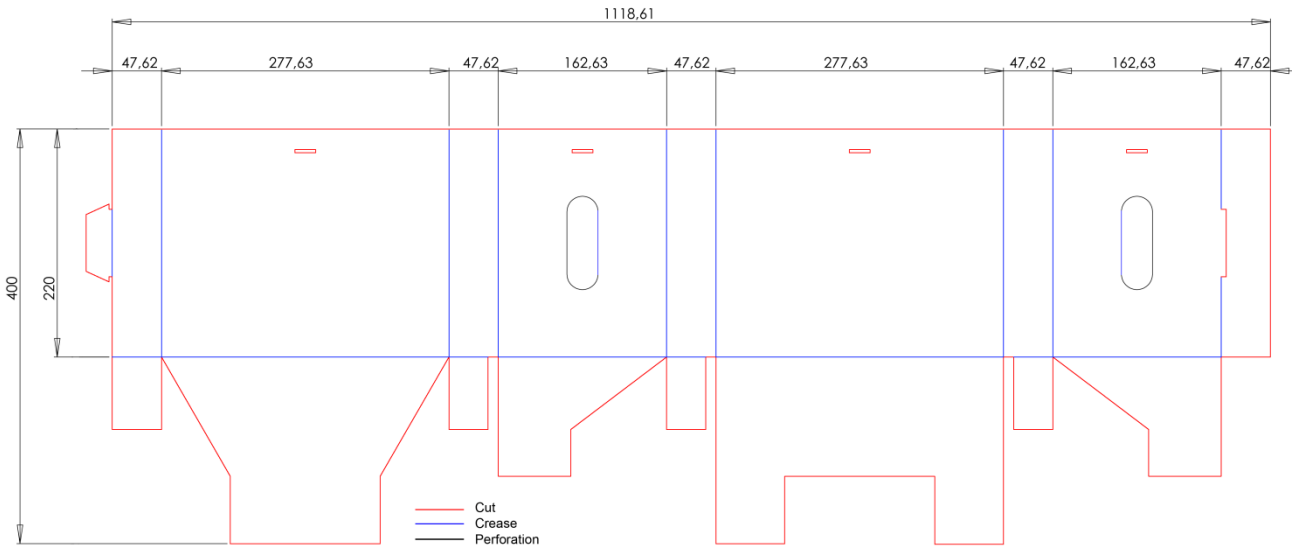



**Figure F22** | Outline box design (version 1)

This design is discussed with Smurfit Kappa. The decision is made to construct the box out of B- or E-flute board. Due to the significant weight the packaging will contain, Smurfit Kappa sees some difficulties with the construction of the closure. Another construction is proposed, of which a model is constructed (figures F23a and F23b).

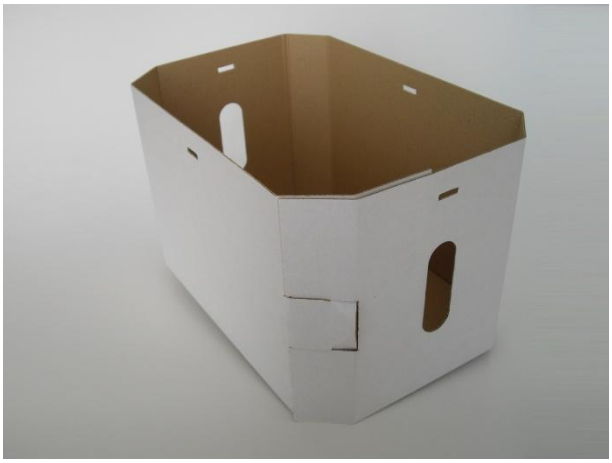


**Figure F23a** | Model of box design version 2 (1)

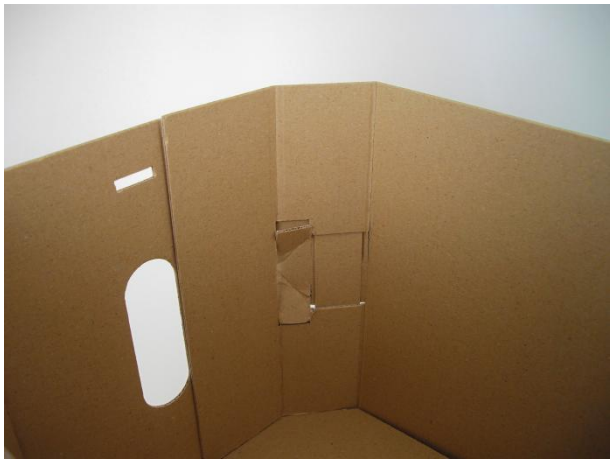


**Figure F23b** | Model of box design version 2 (2)

With both the draft for the corrugated board box and the PaperFoam lid, a meeting is set up. During this meeting, difficulties and possibilities related to this draft have been discussed with both Smurfit Kappa and PaperFoam. It turns out that the current connection of the PaperFoam lid to the box is too problematic. Therefore, an alternative is developed, which incorporates folded edges on the box, with slots in the PaperFoam lid (figure F24a). This principle is visualised in figure F24b (detail A). The underside of the lid lies on top of the products in the packaging.

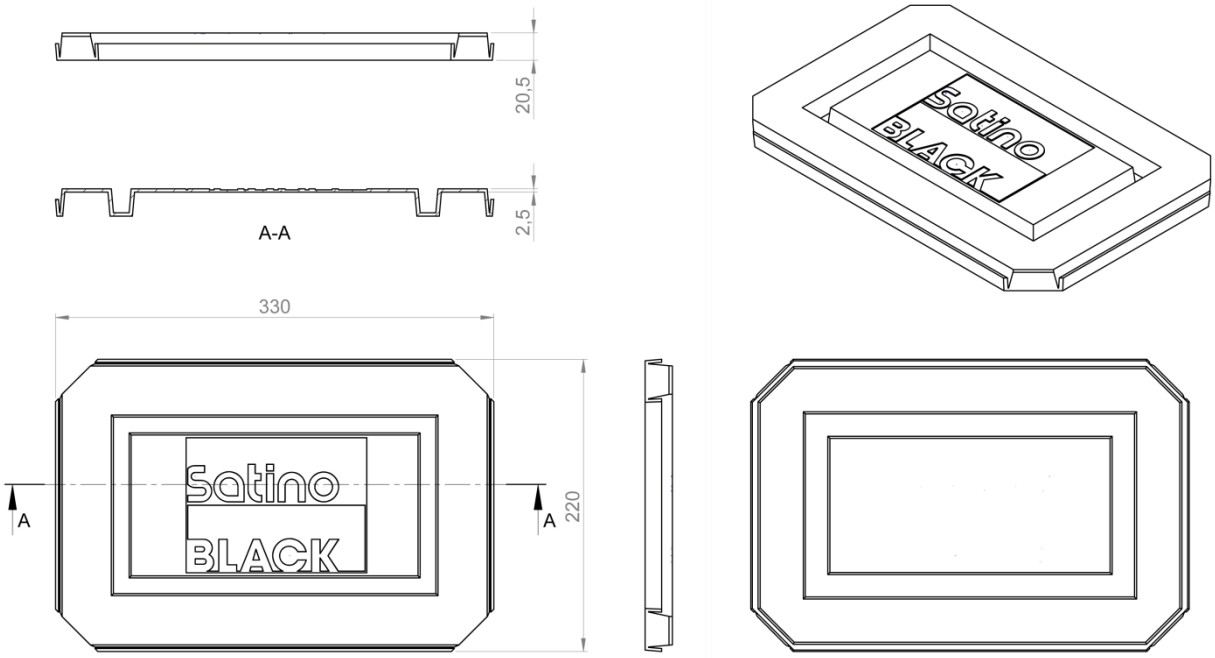



**Figure F24a** | PaperFoam lid with slotted edges (1)

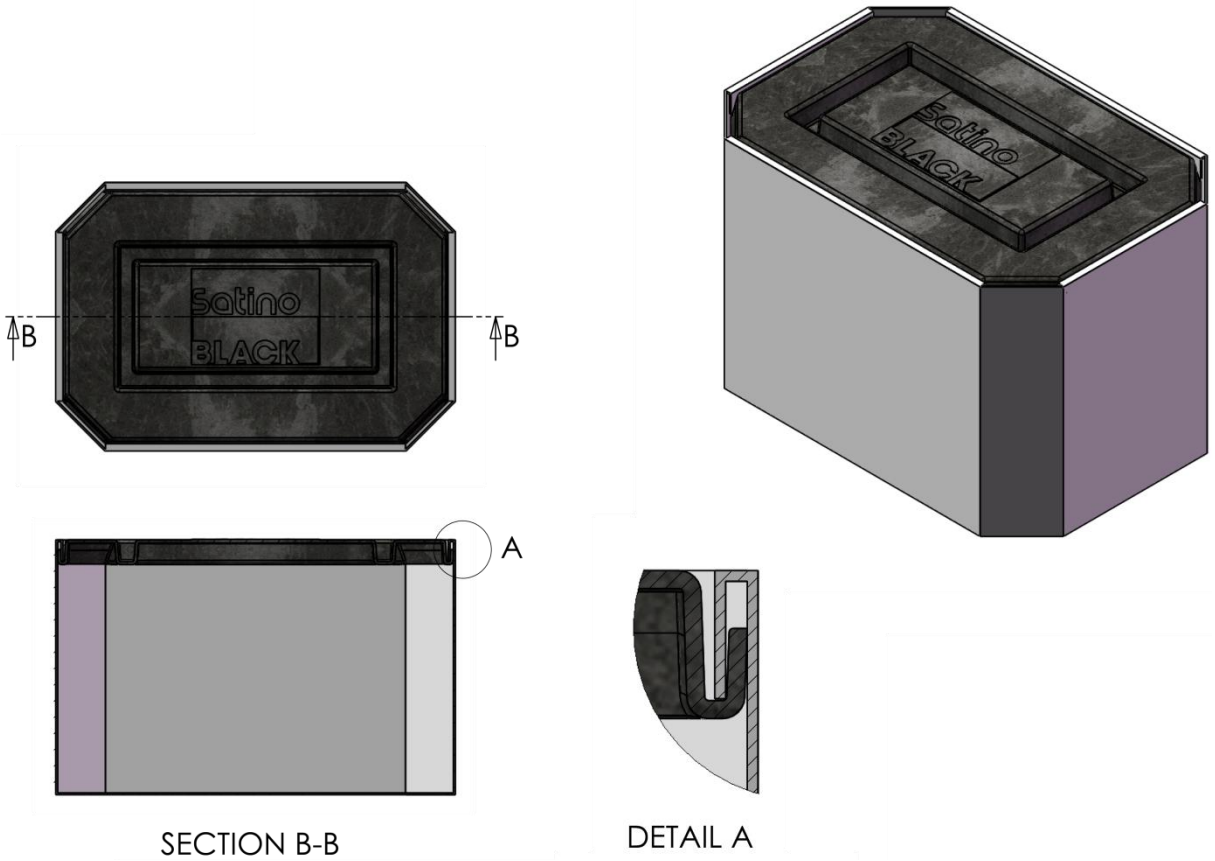



**Figure F24b** | PaperFoam lid with slotted edges (2)

Implementing this construction with folded edges on the cardboard box has implications for the used material. The construction will not be possible with a B-flute. Therefore, the corrugated board box will be constructed with E-flute cardboard. To be able to open the packaging, a tear strip is placed at the front side of version three of the packaging (see figure F25). By tearing off this strip, the lid can be slid out. To eliminate the risk of tearing, one of the two handles (see figure F22) is deleted from the design. On top of that, the remaining handle is constructed with a double layer of cardboard. To improve the ease of

carrying, the handle has been reshaped. The closure as implemented in the draft in figure F23 has been altered. To make sure the closure is not mistaken for a tear strip, it has been changed to a 'blind' connection.

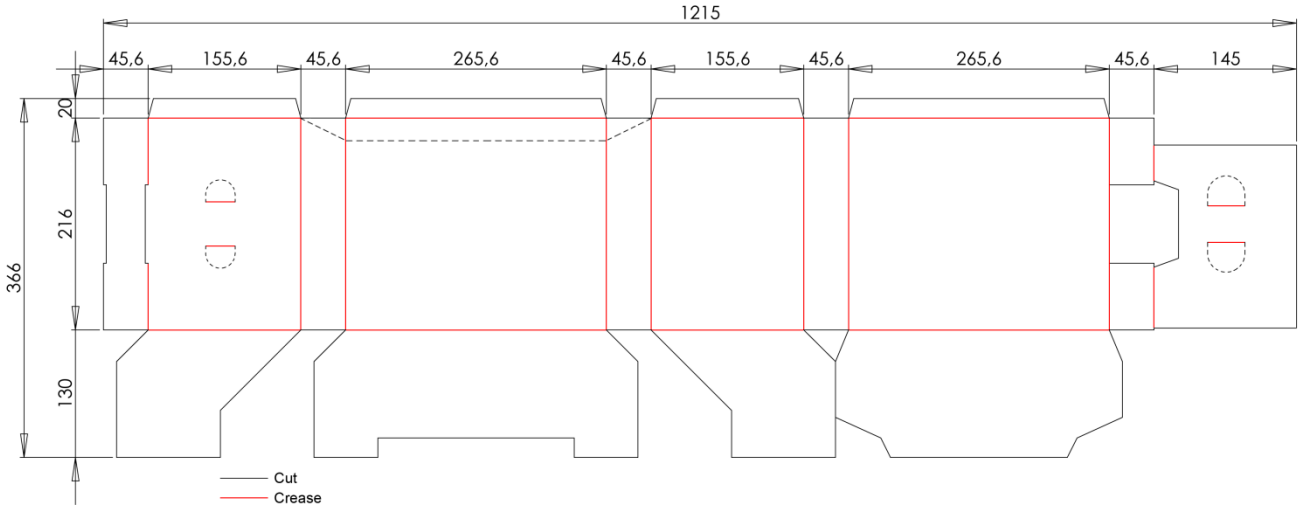



**Figure F25** | Outline box design (version 3)

This design however, is believed to be suboptimal. Therefore, two alternatives have been developed. Version 4 (figures F26a and F26b) combines both a closing construction and finger slots for carrying. Version 5 (figures F27a and F27b) is closed with a double mortise and tenon construction. The finger slots are identical to version 3. Both versions are applicable for the destined application. However, version 5 is preferred, due to its sleeker appearance.

**Figure F26a** | Model of box design version 4 (1)

**Figure F26b** | Model of box design version 4 (2)

**Figure F27a** | Model of box design version 5 (1)

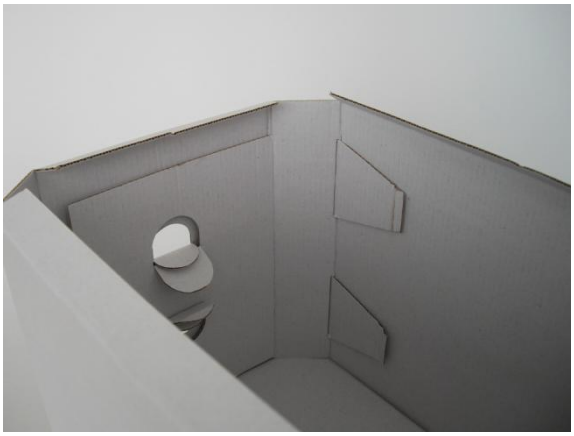


**Figure F27b** | Model of box design version 5 (2)

In PaperFoam's concept database, an (outdated) concept was found. This concept incorporates the connection principle as described (figures F28a and F28b). This product is a draft for a tissue box out of folding box board, with a PaperFoam lid. The concept shows that the principle is very well applicable. Also: the concept shows that the folded edge of the box does not need a slot to be fixed. A simple edge will suffice.

**Figure F28a** | Tissue box lid (1)

**Figure F28b** | Tissue box lid (2)

***Final draft***

All detailing steps lead to a detailed draft, which consists of technical drawings of both the corrugated board box and the PaperFoam lid. On top of that, a plan for the graphic design of the draft is set up. Figure F29 shows the outline and dimensions of the detailed draft. Completing this draft is the PaperFoam lid. Technical drawings of this detailed version are visualised in figure F30. Larger versions of the final draft drawings can be found in appendix K.

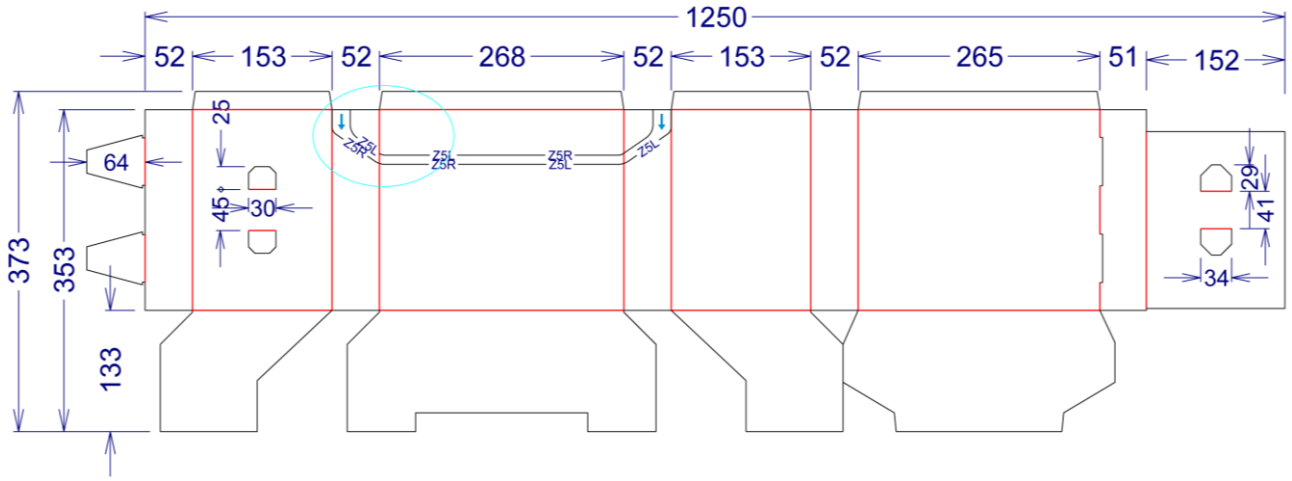



**Figure F29** | Outline and dimensions detailed draft

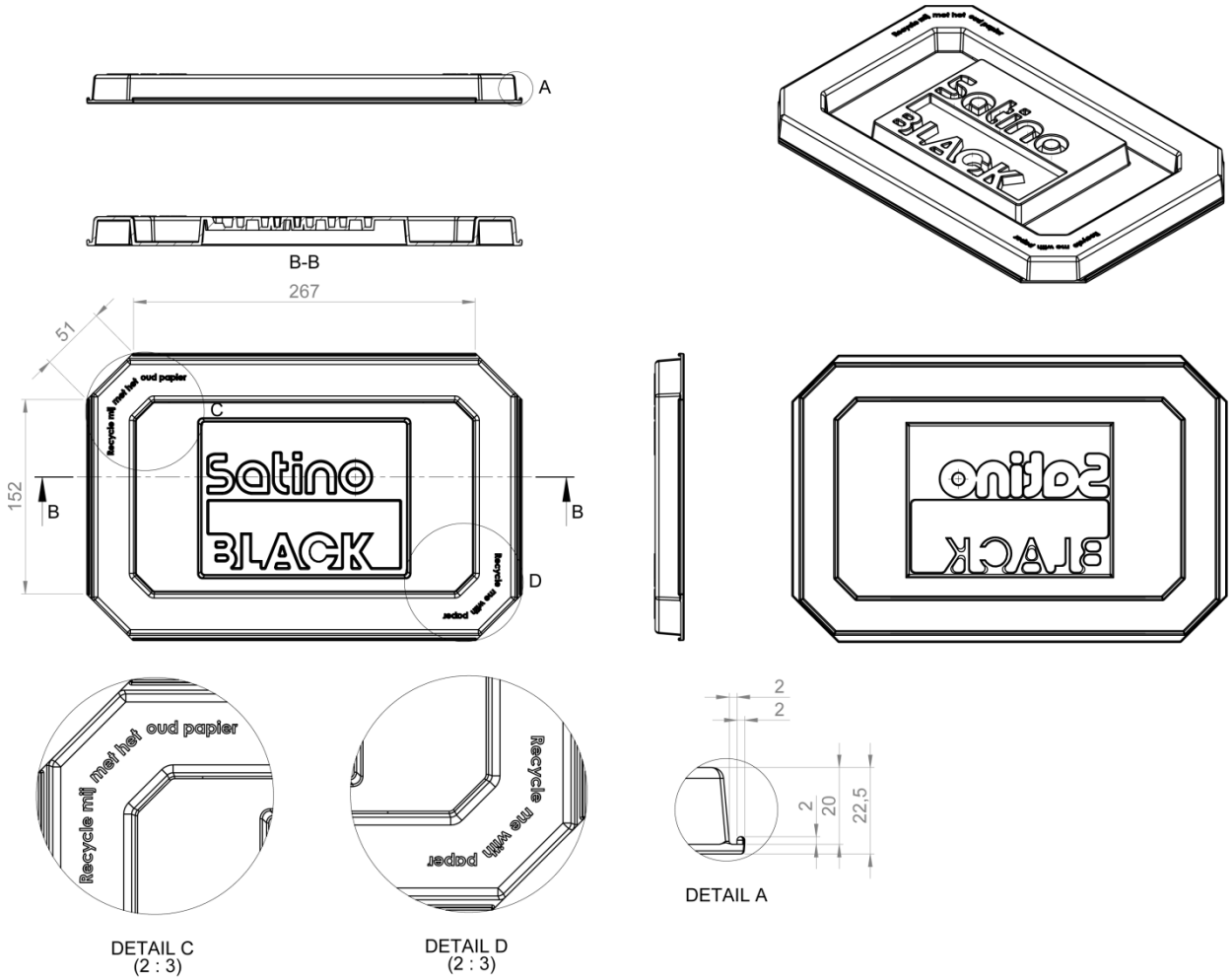



**Figure F30** | Technical drawing PaperFoam lid

### *Graphic Design*

In this packaging project, graphic design is no key issue. However, a proposition for graphic design is considered to be important, to show the potential of the draft within the Satino Black brand. The importance of graphic design has also been demonstrated during the conceptualisation steps. The graphic design is focused on several items:

- *Brand identity*
- *Packaging contents (12 = 32; figure F31a)*
- *Ecologic marks (figure F31b)*
- *Material contents*
- *Opening of the packaging (figure F31c)*

This is completed with (basic) descriptions considering material cycles related to Satino Black and the packaging. For customers who would like to get more information, a QR code is printed on the packaging. This code links to the website of Satino Black. The graphic design is also implemented in the PaperFoam lid. In this lid, the Satino Black logo is embossed. Also, the statement "Recycle me with paper" is embossed both in English and Dutch. In figure F32, the graphic design is visualised. A larger version can be found in appendix K.

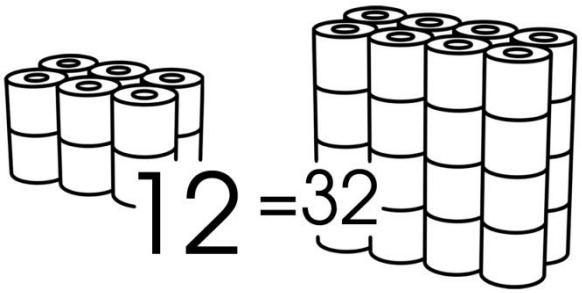



**Figure F31a** | 12=32


**Figure F31b** | Ecological marks

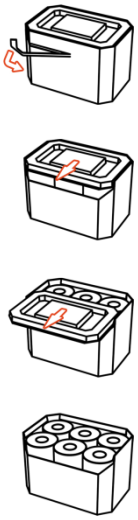


**Figure F31c** | Opening description

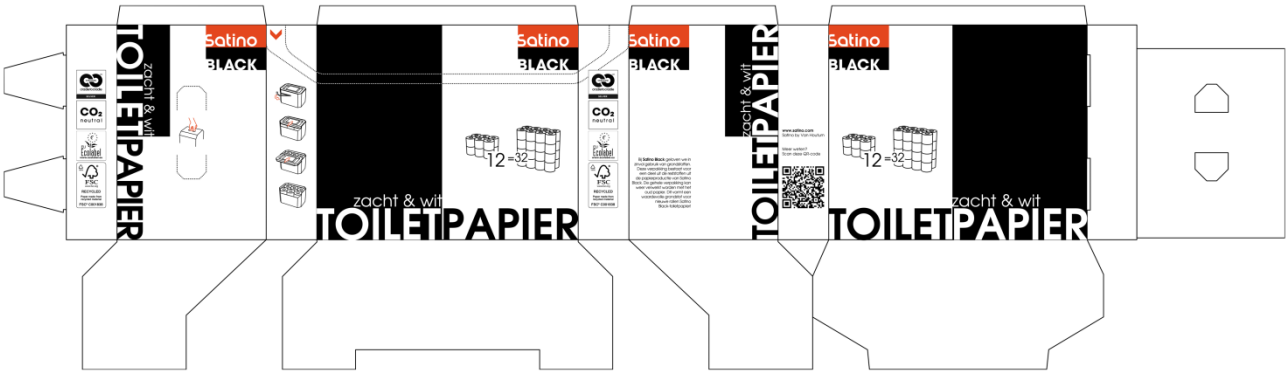



**Figure F32** | Graphic design proposition

The detailed design (including graphic design) is visualised in figures F33a-f. In figures F34a and F34b, images of the mock-ups are shown. These models are developed to review appearance, shape, form and function of the packaging draft. Large versions of the figures can be found in appendix K.


**Figure F33a** | Rendering detailed design (1)


**Figure F33b** | Rendering detailed design (2)


**Figure F33c** | Rendering detailed design (3)


**Figure F33d** | Rendering detailed design (4)


**Figure F33e** | Rendering detailed design (5)


**Figure F33f** | Rendering detailed design (6)


**Figure F34a** | Mock-up detailed design (1)


**Figure F34b** | Mock-up detailed design (2)

### *Cost Price Indication*

For the draft, cost price indications have been requested from the suppliers of the corrugated board box and the PaperFoam lid. The indications for the box are as follows:

| | *Smurfit Kappa* | *VPK* |
|---|---|---|
| *Price per 1000 pieces* | € 265.- | € 264.- |
| *Cutting costs (once)* | € 1100.- | - |

The indicated cost price for the PaperFoam lid is separated in amounts ranging from 25,000 to 250,000 pieces:

| *Amount* | *Cost price* |
|---|---|
| *25,000* | € 0.88 |
| *50,000* | € 0.65 |
| *100,000* | € 0.53 |
| *250,000* | € 0.49 |

### *Transport and storage*

The packaging will have to be transported. Therefore, it is important to specify the most optimal distribution on a pallet. Two pallet sizes can be used: 1200 by 1000 mm and 1200 by 800 mm. For these sizes, the most optimal distributions can be found in figures F35a-c. The distribution on a pallet of 1200 by 1000 mm can be done in two ways, depending on the possibility for overlap. Regarding pallet efficiency, a maximum height of 2500 mm is assumed (including a pallet of 150 mm high). This results in ten layers of packaging on a pallet, with following efficiency:

- *Pallet distribution 1:* 79.4%
- *Pallet distribution 2:* 91.6%
- *Pallet distribution 3:* 76.3%

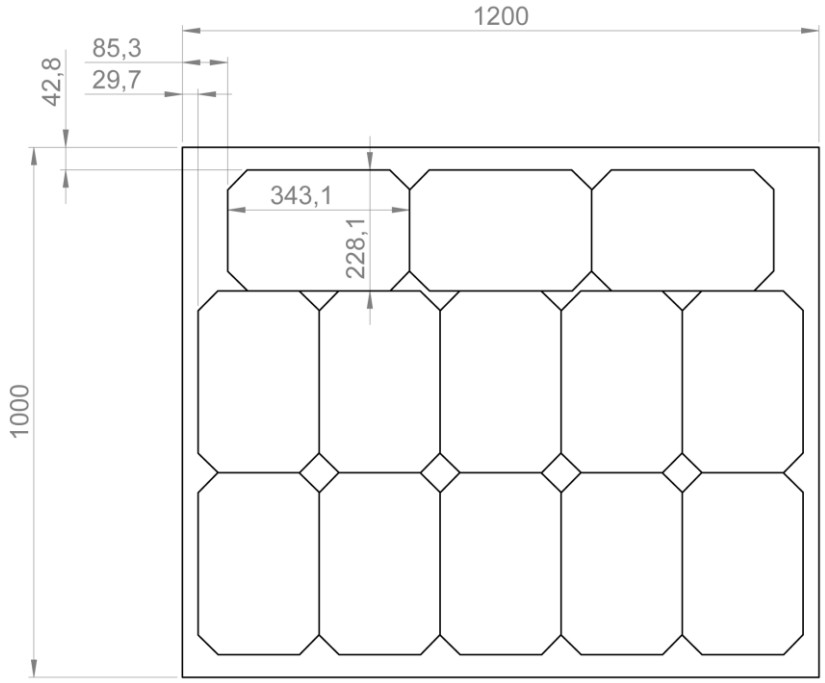



**Figure F35a** | Pallet distribution 1

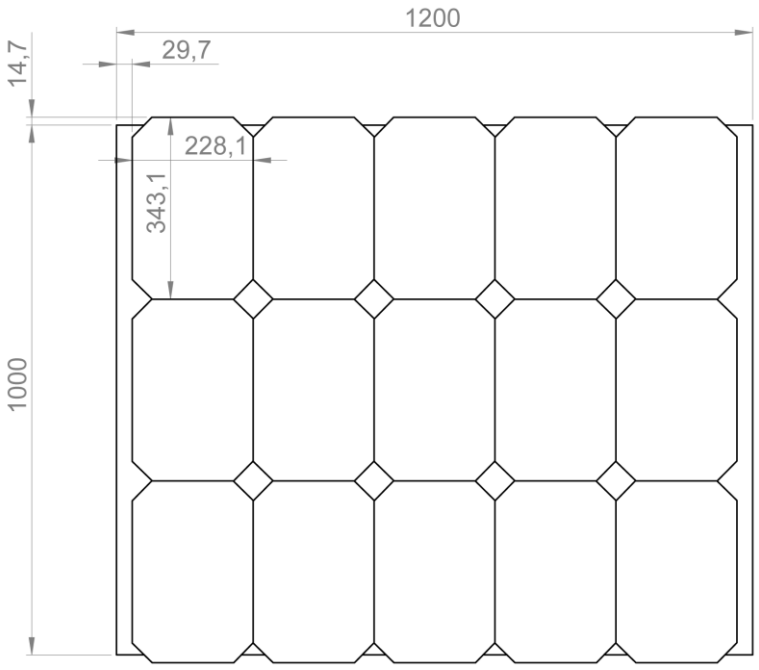



**Figure F35b** | Pallet distribution 2

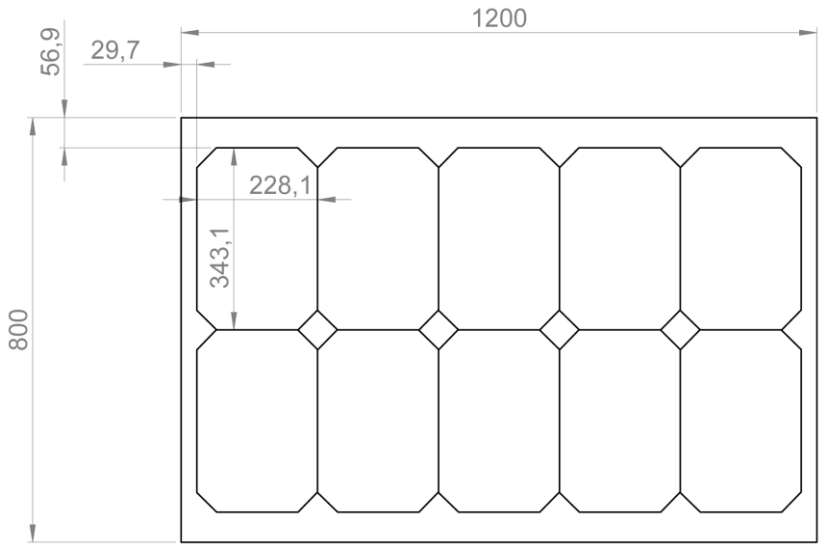



**Figure F35c** | Pallet distribution 3

### *3.1b Documentation*

In this report, all documentation related to the specific packaging project is described in previous paragraphs. This documentation contains:

- *Design (physical and graphical)*
- *(Technical) drawings*
- *Material descriptions*

## *Material Selection Layer*

### *3.2a Material Selection*

For the developed draft, much of the material selection has taken place simultaneously to the concept detailing. The corrugated board box will be constructed out of E-flute board, with a composition comparable to the analysed paper samples (figure F20). The box is printed with inks currently used by the manufacturers of the corrugated board. Other possibilities for printing are (currently) not practically applicable. A typical material composition for this specific draft is illustrated in table F8. This table shows a list of material ingredients VPK would use to produce the corrugated board box.

The lid of the packaging draft is made from PaperFoam. Specific variations in composition of this material depend on the actual application. This must be determined via testing.

According to the Cradle to Cradle packaging development method, during the Material Selection, scenarios on production, use and post-use must be set up. For this, extensive information from the suppliers is required. However, in this packaging project, this information has not been acquired, due to different reasons. Therefore, the level of scenario description is limited to the level as described in the Material Identification. The draft is determined to be placed in a biological cycle (within a cascade model). To this, one (possible) scenario cycle is added: the processing of waste sludge from paper production in PaperFoam. The waste from de-inking (one of the steps to make new paper out of waste paper) can be applied as a replacement for the short cellulose fibres in PaperFoam. This is tried out as a pilot with PaperFoam and Van Houtum; it turned out to be possible. This might be a welcome addition to the current level of material reutilisation in PaperFoam. Samples of PaperFoam products with Van Houtum's de-inking residue can be seen in figure F36.

| *Material ingredient* | *CAS Number* | *% (by weight)* | *Function* | *Recycled content* | *Supplier* | *Comments* |
|---|---|---|---|---|---|---|
| *White testliner* | - | 33.45 | Outer liner | 100% | Europac | Based on complex E8520, including cut-offs |
| *Fluting* | | 31.19 | E-flute | | VPK | |
| *Testliner* | | 33.45 | Inner liner | | VPK | |
| *Starch* | 68441-21-4 | 1.51 | Glue | - | Tereos Syral | |
| *Borax (Prodac)* | 120007-92-0 | 0.02 | Enhance viscosity | | Ziegler | |
| *Caustic soda 33%* | 1310-73-2 | 0.07 | Gelling point | | Quaron | |
| *Biocide* | 10377-60-3 | 0.01 | Anti-bacterial | | Bewasol | |
| *Black pigment* | 1333-86-4 | 0.26 | Pigment | | SunChemical | Declaration on PAH |
| *Red pigment* | 12237-63-7 | 0.014 | | | | |

**Table F8** | Draft material composition (VPK)

**Figure F36** | PaperFoam with Van Houtum's de-inking residue

### *External Layer*

### *3.3a Material Assessment*

All analysis results of the concept-relevant materials, which have been obtained during the Material Specification, have been discussed with EPEA (in the role of independent assessment institute). However, due to practical implications, of the analyses of PaperFoam's premix and inks for corrugated board, no information is official. This is related to the pilot-like approach of this project, in which these types of 'official' assessments were considered too extensive.

From a Cradle to Cradle certification perspective, arsenic, cadmium, chromium VI, lead and mercury are on the banned list (see paragraph 2.2), for both technical and biological nutrients. However, for biological nutrients (which paper/cardboard in a cascade metabolism is), these heavy metals are tolerated when concentrations do not exceed background values [33]. On top of that, the amount of organic halogens must not exceed 100 ppm. Table F9 shows that none of the substances exceeds the legal limits.

The final assessed material is borax. As stated before, this substance is known to be reproductive toxic. Therefore, corrugated board containing borax-enhanced adhesives (even in the smallest amount) will not be allowed to certify any higher than Bronze level. Current developments however, do show some borax-related alternatives, for instance the substance as applied by VPK (Prodac, see appendix J).

| | *Background value* | *135 testliner (mg/kg)* | *135 white testliner (mg/kg)* | *135 fluting (mg/kg)* |
|---|---|---|---|---|
| | *mg/kg* | | | |
| *Antimony* | 4 | <0.2 | <0.2 | <0.2 |
| *Arsenic* | 20 | 0.24 | 0.14 | 0.30 |
| *Beryllium* | - | <0.2 | <0.2 | <0.2 |
| *Cadmium* | 0.6 | 0.07 | 0.05 | 0.09 |
| *Chrome* | 55 | 5.8 | 4.8 | 6.2 |
| *Cobalt* | 15 | 0.72 | 0.54 | 0.74 |
| *Copper* | 40 | 29 | 16 | 33 |
| *Mercury* | 0.15 | 0.05 | 0.02 | 0.03 |
| *Lead* | 50 | 10 | 6.3 | 10 |
| *Molybdenum* | 1.5 | - | - | - |
| *Nickel* | 35 | 2.4 | 1.8 | 2.8 |
| *Tin* | 6.5 | - | - | - |
| *Titanium* | - | 450 | 310 | 450 |
| *Zinc* | 140 | 29 | 19 | 29 |
| *Total halogens* | - | 680 | 83 | 250 |
| *Inorganic halogens* | - | 585 | 67 | 235 |
| *Extractable Organic halogens* | 100 | 2.4 | 2.0 | 2.6 |

**Table F9** | Background value vs. analysis results paper samples

## Decision Moment C

With the Detailing Section finished, all development steps have been executed. This specific project is finished with Decision Moment C. This session has not been planned with all stakeholders related to the project. However, the documents resulting from the Detailing Section have been discussed individually:

- *Detailed draft*
  - The detailed draft is described and approved on shape, function, material implementation and graphic design.
  - The level of detail and (technical) drawings is sufficient for production
  - The level of development is not sufficient for Cradle to Cradle certification, mainly due to a lack of certain official supplier declarations and material specifications

- *Selected materials*
  - Not all concept-relevant materials are assessed by EPEA. The 'official' assessment is not executed. Only assessment which has been executed internally is completed
  - With this, the level of material assessment is not sufficient for certification
  - Due to the presence of borax in the adhesive for corrugated board, Cradle to Cradle certification will not reach Silver level

- *Documentation*
  - All documentation addressing draft, development, and materials are specified in previous paragraphs.

Typically, Decision Moment C must result in the decision on whether or not to execute the Completion Section of the project. However, in this specific case, this decision is not being made. The project ends with the completion of the Detailing Section.

# F4 Completion Section

The final section of the packaging development project is not executed for this specific case. This is mainly time based; certification, production and market implementation are extensive steps. It might even be a project on itself. On top of that, for the steps of the Completion section, a management decision is required. This is typically part of Decision Moment C.

### *External Layer*

### *4.3a Certification*

The actual Cradle to Cradle certification of the packaging draft is not executed for this project. However, significant parts of the material assessment (Conceptualisation and Detailing Section) have been executed. The Materials Appendix for Cradle to Cradle certification is filled in by VPK, for this specific draft (table F8). Besides that, issues regarding renewable energy, water stewardship and social fairness will have to be assessed (see also chapter 2). This information must be acquired from the manufacturing companies (PaperFoam and the supplier of corrugated board) and the certification applicant (Van Houtum). Due to several unknown issues related to the draft and some practical implications, the certification aspects have not been completed.

### *4.3b Production / 4.3c Implementation*

These steps are not executed for this project.

## Project Conclusion

The Completion Section is not part of this specific packaging development project, even though some steps have been executed. With the certification incomplete, the packaging draft is considered to be 'Cradle to Cradle inspired'. When the final section of this packaging is being executed (in another time frame), at least Decision Moment C must be completed. Another possibility is to redo more of the development steps, for instance the complete Detailing Section.

Since the Completion Section and Project Conclusion session are not executed for this project, there are no stakeholder reviews on the following issues. These issues are (partially) addressed in chapter 6:

- *Project execution (development method)*
- *Packaging draft (development results)*

# G Questionnaire Sligro

## Importance

- Target group definition
- Specific concept development
- Results available for Sligro
- Results might trigger other manufacturers

## Target Group

- What are the target groups of Sligro?
- What are these groups' profiles?
- How are these groups quantified?
- Are demographic models of these groups available?
- Who of these groups currently buys tissue paper products at Sligro?
- Who of these groups currently buys sustainable products at Sligro?
- Who of these groups would be best targeted with Satino Black?

## Products

- What are the most important products within Sligro's range of tissue paper?
- Which Satino Black product would be suitable for retail at Sligro?

## Amounts

- What size should a retail unit be?
- What should the targeted annual retail amount be?
- What requirements related to shelf pay-off are essential?

## Other

- What requirements related to material use are relevant?
- What other requirements are relevant for the packaging?
  - Transport
  - Storage (efficiency)
  - Information
  - Promotion

# H Material Safety Data Sheet Glycapol

Date Updated: 12/APRIL/2011

**1 - Product and Company Information**

Product Name **Glycapol 2007**

Company Glycanex BV
Koninginneweg 11-13
1217 KP Hilversum
The Netherlands
Phone +31-35-625-0628
Fax +31-35-625-0627
Emergency +31-64-637-0038

**2 - Composition/Information on Ingredients**

Product Name Conc (wt%) Annex I Index Number
STARCH, modified 80-83% None
WATER 17-20% None
This product is a modified starch derived from potato starch.

**3 - Hazards Identification**

SPECIAL INDICATION OF HAZARDS TO HUMANS AND THE ENVIRONMENT
The chemical nature of this product does not give occasion to caution against hazards for adverse human health and environmental effects. Not hazardous according to Directive 67/548/EC. As with any starch-based product, there is a risk of dust explosion. MSDS Glycapol 2007 Glycanex BV

**4 - First Aid Measures**

AFTER INHALATION: If inhaled, remove to fresh air. If breathing becomes difficult, call a physician.
AFTER SKIN CONTACT: In case of skin contact, wash skin thoroughly with water. If irritation persists, call a physician.
AFTER EYE CONTACT: In case of contact with eyes, flush with copious amounts of water for at least 15 minutes. Assure adequate flushing by separating the eyelids with fingers. If irritation persists, call a physician.
AFTER INGESTION: If swallowed, wash out mouth with water. If you feel unwell, call a physician.

**5 - Fire Fighting Measures**

EXTINGUISHING MEDIA
Suitable: Water spray. Carbon dioxide, dry chemical powder, or appropriate foam. SPECIAL PROTECTIVE EQUIPMENT FOR FIREFIGHTERS Wear standard self-contained breathing apparatus.
FIRE AND EXPLOSION HAZARDS As with any starch-based product, there is a risk of dust explosion.

**6 - Accidental Release Measures**

PROCEDURE(S) OF PERSONAL PRECAUTION(S) No special personal and environmental precautions are recommended.
METHODS FOR CLEANING UP: Sweep up, place in a bag and hold for waste disposal. Avoid raising dust. Ventilate area and wash spill site after material pickup is complete with cold water. Wet material on floor can be a slipping hazard.

**7 - Handling and Storage**

HANDLING: Directions for Safe Handling: Proper ventilation should be available for dust removal. Minimize raising dust and avoid inhalation. Avoid contact with eyes, skin, and clothing. Avoid prolonged or repeated exposure. STORAGE: Conditions of Storage: Keep package tightly closed and store in a dry, cool place preferably not in direct sun contact. Avoid high temperatures.

**8 - Exposure Controls / Personal Protection**

ENGINEERING CONTROLS: Mechanical exhaust required. Safety shower and eye bath.
GENERAL HYGIENE MEASURES: Wash thoroughly after handling.
PERSONAL PROTECTIVE EQUIPMENT: Special Protective Measures: Wear appropriate government approved dust masks when exposed to dust. Use gloves, safety goggles, and other protective clothing as reasonably required for handling powders.

**9 - Physical and Chemical Properties**

Appearance Physical State: Powder
Colour White / Crème
Property Value
pH N/A
BP/BP Range N/A
MP/MP Range N/A
Flash Point >200 ˚C
Explosion limits >0.008%
Auto-ignition Temp >300 ˚C
Oxidizing Properties N/A
Explosive Properties N/A
Explosion Limits N/A
Vapour Pressure N/A
SG/Density N/A
Partition Coefficient N/A

Viscosity N/A
Vapour Density N/A
Saturated Vapour Conc. N/A
Evaporation Rate N/A
Bulk Density approximately 700 kg/m3
Decomposition Temp. >160 ˚C
Solvent Content N/A
Water Content 17-20%
Surface Tension N/A
Conductivity N/A
Solubility N/A

**10 - Stability and Reactivity**

STABILITY: This product loses its original microscopic structure upon heating in water above 50° C. Materials to Avoid: Strong oxidizing agents.
HAZARDOUS DECOMPOSITION PRODUCTS: Hazardous Decomposition Products: Nature of decomposition products not known.
HAZARDOUS POLYMERISATION: Hazardous Polymerisation: Will not occur

**11 - Toxicological Information**

SIGNS AND SYMPTOMS OF EXPOSURE: To the best of our knowledge, the toxicological properties have not been thoroughly investigated.
ROUTE OF EXPOSURE: Skin Contact: May cause skin irritation. Under prolonged contact, starch can dry skin and mucous membranes.
Eye Contact: May cause slight eye irritation.
Multiple Routes: May be slightly harmful by inhalation, ingestion, or skin absorption – not thoroughly investigated.

**12 - Ecological Information**

ECOTOXICITY: The product is not harmful or poisonous for water living organisms because LC50 (fish, 96h), EC50 (Daphnia, 48h) and IC50 (algae, 72h) is >100 mg/L. According to SSVL's "Test methods for additive chemicals" the product shows no toxicity according to MICROTOX on EC20 level up to 50 times normal dosage.
DEGRADABILITY: The product is easily degradable according to OECD's demand for biological degradation.
ACCUMULATION: The product is not bio-accumulatable.
OTHER INFORMATION: The product increases BOD- and COD-value in water recipients. WGK (Water hazard class, a classification in Germany): 1.

**13 - Disposal Considerations**

SUBSTANCE DISPOSAL: Observe all federal, state, and local environmental regulations. This material may be land filled or incinerated together with household refuse. To be considered as a combustible waste.

**14 - Transport Information**

RID/ADR: Not classified as dangerous goods for road transport.
IMDG: Not classified as dangerous goods for sea transport.
IATA: Not classified as dangerous goods for air transport.

**15 - Regulatory Information**

This product is not classified as dangerous for health or the environment. Not hazardous according to Directive 67/548/EC. No EC label.

# I Material Safety Data Sheet Borax Decahydrate

Revision nr : 4
Date : 19/3/2013
Supersedes : 18/2/2011
**BORAX DECAHYDRATE**
Code : 11010
Responsible for distribution: In case of emergency:
BRENNTAG N.V. Belgium:
Nijverheidslaan 38 - BE-8540 DEERLIJK Antipoison Center - Brussels :
TEL: +32(0)56/77.69.44 - FAX: +32(0)56/77.57.11 TEL: 070/245.245
E-MAIL : info@brenntag.be - Website: www.brenntag.be
BRENNTAG Nederland BV The Netherlands:
Donker Duyvisweg 44 - NL-3316 BM DORDRECHT National Poisoning Information Center - Bilthoven :
TEL: +31(0)78/65.44.944 - FAX: +31(0)78/65.44.919 TEL: 030/274.88.88 (Information only for professionals in
E-MAIL : info@brenntag.nl - Website: www.brenntag.nl case of acute intoxications)

**SECTION 1. Identification of the substance/mixture and of the company/undertaking**

1.1. Product identifier
* Chemical description : Borax decahydrate , Disodiumtetraborate decahydrate , Sodium borate decahydrate .
Type of product : Pure product .
* Reach registration number : 01-2119490790-32
1.2. Relevant identified uses of the substance or mixture and uses advised against
* Identified use(s) : Ceramic , Detergent , Borosilicate glass , Insulation fibreglass .
* Use(s) advised against : At this time we do not yet have information on uses advised against. They will be included when available.
1.3. Details of the supplier of the safety data sheet
Company identification : See heading of Material Safety Data Sheet.
1.4. Emergency telephone number
Emergency phone number : See heading of Material Safety Data Sheet.

**SECTION 2. Hazards identification**

2.1. Classification of the substance or mixture
Classification according to Directive 67/548/EEC or 1999/45/EC
* Irritant (Xi; R36)
Toxic (T; R60-61)
Classification according to Regulation (EC) No 1272/2008
* Eye irritation - Category 2 - Warning (Eye Irrit. 2; H319) - Reproductive toxicity - Fertility - Unborn Child - Category 1B - Danger (Repr. 1B; H360FD)
2.2. Label elements
Label in accordance with Regulation (EC) No 1272/2008
• Dangerous ingredient(s) : Borax decahydrate
* • Hazard pictogram(s)
* • Signal word : Danger
* • Hazard statements : H319 - Causes serious eye irritation. H360FD - May damage fertility. May damage the unborn child.
* • Precautionary statements
* - Prevention : P201 - Obtain special instructions before use. P202 - Do not handle until all safety precautions have been read and understood. P264 - Wash skin thoroughly after handling. P281 - Use personal protective equipment as required.
* - Response : P305+P351+P338 - IF IN EYES : Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. P308+P313 - If exposed or concerned : get medical advice. P337+P313 - If eye irritation persists: Get medical advice.
* - Storage : P405 - Store locked up.
* - Disposal considerations : P501 - Dispose of this material and its container to hazardous or special waste collection point.
2.3. Other hazards
* Physical/chemical hazards : The substance decomposes in a fire or a hot surface forming toxic, corrosive and metallic fumes.
* Hazards for the health : Disodiumtetraborate is included in the candidate list . (SVHC). Evaporates practically not at 20°C; will be as a powder quicky squirt a dangerous concentration in the air.
* Hazards for the environment : Product causes a rise of the pH-value of water and soil. This product is no substance or contains no PBT or vPvB (in accordance with Annex XIII).
* Hazards for the safety : No significant danger.

**SECTION 3. Composition/information on ingredients**

3.1. Substances

| *Name component(s)* | *Weight %* | *CAS nr* | *EINECS nr* | *Index nr* | *Reach nr* | *CLASSIFICATION* |
|---|---|---|---|---|---|---|
| Borax decahydrate | > 99.9 % | 1303-96-4 | 215-540-4 | 005-011-01-1 | 01-2119490790-32 | Repr. Cat. 2; R60<br>Repr. Cat. 2; R61<br>Xi; R36<br>Eye Irrit. 2; H319<br>Repr. 1B; H360FD |

The full text of the R-phrases and (EU)H-statements is in section 16.

**SECTION 4. First aid measures**

4.1. Description of first aid measures

General : In case of doubt or persistent symptoms, call a physician. Never give anything by mouth to an unconscious person.

First Aid Measures

- Inhalation : Remove victim into fresh air. Allow the affected person to rest. If not breathing, give artificial respiration. Consult a doctor.

* - Skin Contact : Remove contaminated clothing. Rinse skin immediately with mild soap and plenty of water. ( at least 20') (shower if necessary). Consult doctor if irritation develops.

- Eye Contact : Rinse immediately thoroughly and long (at least 15 min.) with plenty of water. Remove contact lenses. Consult eye doctor.

- Ingestion : DO NOT INDUCE VOMITING. Rinse mouth with water. Give victim plenty of water to drink. Seek medical advice.

4.2. Most important symptoms and effects, both acute and delayed

* See section 11.

4.3. Indication of any immediate medical attention and special treatment needed

* For specialist advice doctors should contact the NVCI or the Belgian Poison centre.

**SECTION 5. Firefighting measures**

5.1. Extinguishing media

Extinguishing Media

* - Suitable : Extinguishing powder , Foam , Carbon dioxide (CO2) , Water spray .

* - Unsuitable : Not known .

5.2. Special hazards arising from the substance or mixture

Special Exposure Hazards : Fire may liberate toxic and metallic vapours.

5.3. Advice for firefighters

* Special Protective Equipment for : Use self-contained breathing apparatus and wear protective clothes when in close. Firefighters proximity to fire. Special Procedures : Apply water spray or fog to cool nearby equipment. Avoid fire-fighting water to enter environment.

**SECTION 6. Accidental release measures**

6.1. Personal precautions, protective equipment and emergency procedures

* Personal Precautions : Evacuate all personnel immediately and ventilate area. Avoid breathing product and contact with skin and eyes and clothing. Wear recommended personal protective equipment. (See section 8)

6.2. Environmental precautions

Environmental Precautions : Prevent entry of product in public water, sewers or soil. Notify authorities if product enters sewers or public waters.

6.3. Methods and material for containment and cleaning up

Methods for Cleaning Up : Collect the spillage in closable, suitable disposal containers. Residue is to be washed down with plenty of water.

6.4. Reference to other sections

* For personal protection, see section 8. For the removal of the waste product, see section 13.

**SECTION 7. Handling and storage**

7.1. Precautions for safe handling

* Handling : PREVENT THE SPREAD OF DUST. STRONG HYGIENE !

Prevent exposure to (pregnant) women. Avoid breathing powder and contact with skin and eyes and clothing. Wear recommended personal protective equipment. (See section 8) When using, do not eat, drink or smoke. Emergency eye wash fountains and showers should be available in the immediate vicinity of any potential exposure.

7.2. Conditions for safe storage, including any incompatibilities

* Storage : Keep only in the original, safely locked container in a well ventilated and dry place. All dangerous products should be placed on a drip tray or should be barrelled. Keep away from : Strong reducing agents.

* Packaging Material : Synthetic material .

Unsuitable Packaging Material : Not known .

7.3. Specific end use(s)

* For identified uses, see subsection 1.2 and/or exposure scenarios.

**SECTION 8. Exposure controls/personal protection**

8.1. Control parameters

* Occupational Exposure Limits : Borax decahydrate : Limit value (BE) : 2 mg/m$^3$ (2011). Borax decahydrate : Short time value (BE) : 6 mg/m$^3$ (2011). Biological limit values : They will be included when available.

* DNELs : • Borax decahydrate : Worker, acute - local effects, inhalation : 22,3 mg/m$^3$

• Borax decahydrate : Worker, long-term - systemic effects, inhalation : 12,8 mg/m³
• Borax decahydrate : Worker, long-term - systemic effects, dermal : 42478 mg/day
• Borax decahydrate : Consumer, acute - local effects, inhalation : 22,3 mg/m³
• Borax decahydrate : Consumer, acute - systemic effects, oral : 1,5 mg/kg bw/ day
• Borax decahydrate : Consumer, long-term - local effects, inhalation : 22,3 mg/m³
• Borax decahydrate : Consumer, long-term - systemic effects, inhalation : 6,5 mg/kg bw/ day
• Borax decahydrate : Consumer, long-term - systemic effects, dermal : 303,5 mg/kg bw/ day
• Borax decahydrate : Consumer, long-term - systemic effects, dermal : 1,5 mg/kg bw/ day
• Borax decahydrate : Consumer, long-term - systemic effects, oral : 1,5 mg/kg bw/day
* PNECs :
• Borax decahydrate : Fresh water : 1,35 mg B/l
• Borax decahydrate : Marine water : 1,35 mg B/l
• Borax decahydrate : Fresh water sediment : 1,8 mg B/kg
• Borax decahydrate : Marine water sediment : 1,8 mg B/kg
• Borax decahydrate : Soil : 5,4 mg B/kg
• Borax decahydrate : Intermittent release : 9,1 mg B/l
• Borax decahydrate : Sewage treatment plant : 1,75 mg B/l
8.2. Exposure controls
* Engineering Measures : Ventilation , Local exhaust. Personal Protection Equipment
* - Respiratory protection : CE-approved dust respirator . ( Filter type P3)
- Skin protection : Suitable protective clothing .
* - Hand protection : Suitable material for safety gloves (EN 374): Butyl rubber , PVC.
- Eye/Face protection : Chemical goggles .
* Environmental exposure controls : See sections 6, 7, 12 en 13.

**SECTION 9. Physical and chemical properties**

9.1. Information on basic physical and chemical properties
Physical State (20°C) : Crystalline solid.
Form/Colour : White .
Odour : Odourless .
* Odour threshold : Not applicable.
pH value : 9,2 (1% sol. , 20°C)
Melting/Freezing point : 741 °C
Boiling Point/Range (1013 hPa) : 1575 °C
Flash point : Not applicable.
Fire hazard : Not applicable.
Evaporation rate : Not applicable.
Explosion limits in air : Not applicable.
Vapour pressure : Not applicable.
Relative density (water=1) : 1,7
* Solubility in water (20°C) : 5 g/ 100 ml
Log P Octanol/Water (20°C) : 1,53 - 1,58
Auto-ignition temperature : Not applicable.
Minimum ignition energy : No data available.
* Decomposition temperature : 320 °C
* Viscosity : Not applicable.
* Explosive properties : No chemical groups associated with explosive properties .
* Oxidizing properties : No chemical groups associated with oxidizing properties .

**SECTION 10. Stability and reactivity**

10.1. Reactivity
* Reactivity : Reacts violently with: Strong reducing agents. Reacts with strong oxidizing agents and strong acids.
10.2. Chemical stability
* Stability : Stable at normal circumstances. For heating: Loss of water => Creation of: Borax anhydrous
10.3. Possibility of hazardous reactions
* Hazardous reactions : Reacts violently with: Strong reducing agents ( Metal hydrides , Alkalimetals ). Creation of: Combustible gas. ( Hydrogen gas ) => May cause explosion and fire .
10.4. Conditions to avoid
Conditions to avoid : Heat .
10.5. Incompatible materials
* Materials to avoid : Strong reducing agents ( E.g. Metal hydrides , Alkalimetals ), Strong oxidizing agents, Strong acids .
10.6. Hazardous decomposition products
* Hazardous Decomposition Products : Hydrogen gas , Sodium oxides , Borium .

**SECTION 11. Toxicological information**

11.1. Information on toxicological effects
Acute toxicity

* - Inhalation : Irritating to respiratory system. Symptoms include: Sore throat , Cough , Shortness of breath .
* - Skin contact : No irritant effects expected.
• Borax decahydrate : LD50 (Rabbit, dermal) : > 2000 mg/kg
- Eye contact : May be irritating to eyes. Symptoms include: Redness , Pain .
* - Ingestion : Irritating to mouth, throat and digestive system. Symptoms include: Burning feeling , Nausea , Abdominal cramps , Diarrhea , Blue skin .
• Borax decahydrate : LD50 (Rat, oral) : 6000 mg/kg
* Skin corrosion/irritation : No effects expected.
* Serious eye damage/irritation : Causes serious eye irritation.
* Aspiration hazard : High concentrations : May cause lung disorders.
* Respiratory or skin sensitisation : Not sensitive .
* Carcinogenicity : Not listed as carcinogenic .
* Mutagenicity : Not listed as mutagenic .
* Reproductive toxicity : May damage fertility. May damage the unborn child.
The Netherlands : Borax decahydrate is included in the SZW-list. May impair fertility. (cat. 2). May cause harm to the unborn child. (cat. 2).
* Specific target organ toxicity - single : To human : Listed not for organ toxicity. exposure For animals : No effects known.
* Specific target organ toxicity - repeated : To human : Listed not for organ toxicity. exposure For animals : No effects known.

**SECTION 12. Ecological information**

12.1. Toxicity
* Ecotoxicity : • Borax decahydrate : EC50 (Daphnia magna, 48 h) : 133 mg B/l
• Borax decahydrate : EC50 (Algae, 72 h) : 40 mg B/l (Pseudokirchneriella subcapitata)
• Borax decahydrate : LC50 (Fish, 96 h) : 79,7 mg B/l (Pimephales promelas)
12.2. Persistence and degradability
* Persistence and degradability : • Borax decahydrate : Persistence and degradability : No data available.
12.3. Bioaccumulative potential
Bioaccumulation : • Borax decahydrate : Bioaccumulation : No bioaccumulation . .
12.4. Mobility in soil
* Mobility : • Borax decahydrate : Mobility : Moderatly soluble in water .
12.5. Results of PBT and vPvB assessment
* Evaluation : • Borax decahydrate : PBT/vPvB : No
12.6. Other adverse effects
WGK class (DE) : 1 ( Weak water pollutant ). Water damaging (NL) : 12. Decontamination exertion (NL) : C
* Photochemical ozone creation potential : No data available.
* Ozone depletion potential : No data available.
* Endocrine disrupting potential : No data available.
* Global warming potential : No data available.

**SECTION 13. Disposal considerations**

13.1. Waste treatment methods
Waste from residues/Unused products : The product has to be destroyed according to national or local legislation, by a company specialised in handling hazardous waste products.
* European list of waste products : XXXXXX - European waste product code. This code is assigned on the basis of the most current applications and cannot be representative for pollutions which are arisen at the effective use of the product. The producer of the waste has to evaluate its process himself and has to grant the appropriate waste coding. See Decision 2001/118/EC. Removal contaminated packaging : Packing is to be used exclusively for the packing of this product. After use, empty and close the packing very carefully.

**SECTION 14. Transport information**

14.1. UN number
* UN Number : -
14.2. UN proper shipping name
* ADR Name : -
* ADN Name : -
* IMDG Name : -
14.3. Transport hazard classe(s)
Class : -
14.4. Packing group
Packaging Group : -
14.5. Environmental hazards
* Environmentally hazard : No
* Marine pollutant : No
14.6. Special precautions for user
* Danger number : -
Hazard Label(s) : -
* EmS-N° : -

14.7. Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code
* Type ship : No data available.
* Pollution category : No data available.

**SECTION 15. Regulatory information**

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture
* Inventories : Canadian inventory (DSL): Listed in inventory.
European inventory (EINECS): Listed in inventory.
Japanese inventory (ENCS): Listed in inventory.
Korean inventory (KECI): Listed in inventory.
Inventory of the United States (TSCA): Listed in inventory.
NFPA n° : 1-0-0
* Relevant EU Rule(s) : Directive 92/85/EEC of the Council of 19 October 1992 on the introduction of measures to encourage improvements in the safety and health at work of pregnant workers and workers who have recently given birth or are breastfeeding. Directive 96/82/EC of the Council of 9 December 1996 on the control of major accident hazards involving dangerous substances. Directive 98/24/EC of the Council of 7 April 1998 on the protection of the health and safety of workers from the risks related to chemical agents at work Directive 2004/37/EC of the European Parliament and of the Council of 29 April 2004 on the protection of workers from the risks related to exposure to carcinogens or mutagens at work. Decision 2001/118/EC of the Commission of 16 January 2001 amending Decision 2000/532/EC as regards the list of wastes. Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006 Regulation (EU) No 453/2010 of 20 May 2010 amending Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (Reach)
* Other rules : Europe : Disodiumtetraborate anhydrous is included in the candidate list . (18/06/2010)

15.2. Chemical Safety Assessment
* At this time we do not yet have information on a chemical safety assessment.

**SECTION 16. Other information**

* This safety data sheet has been drawn up in accordance with Regulation (EU) No 453/2010. This safety data sheet is exclusively made for industrial/professional use.
* Has changed compared to previous revision.
* Changes : General revision .
* Sources of used key data : The information contained herein is based on the present state of our knowledge (Producer(s) ,...). See also on the webaddress: http://apps.echa.europa.eu/registered/registered-sub.aspx#search
R-phrase(s) : R36 - Irritating to eyes.
R60 - May impair fertility.
R61 - May cause harm to the unborn child.
* (EU)H-statement(s) : H319 - Causes serious eye irritation.
H360FD - May damage fertility. May damage the unborn child.
* List of abbrevations and acronyms :
ADN (Accord européen relatif au transport international des marchandises. Dangereuses par voie de Navigation interieur) : European agreement concerning the international carriage of dangerous goods by inland waterways
ADR (Accord européen relatif au transport international des marchandises. Dangereuses par Route) : European agreement concerning the international carriage of dangerous goods by road
DNEL (Derived No Effect Level) : an estimated safe exposure level
EmS (Emergency Schedule) : the first code refers to the relevant fire schedule and the second code refers to the relevant spillage schedule
IMDG (International Maritime Dangerous Goods code)
NFPA (National Fire Protection Association) or fire diamante
NVCI : National Poisoning Information Center PBT : persistent, bioaccumulative and toxic
PNEC (Predicted No Effect Concentration) : concentration below which exposure to a substance is not expected to cause adverse effects.
REACH : Registration, Evaluation, Authorisation and restriction of Chemicals.
SVHC: (List of) substances of very high concern (SVHC) for authorisation.
SZW-list : Non-limitative list of reproduction toxic substances to which the additional registration obligation applies as referred to in Article 4.2a, second paragraph of the Working conditions decree.
TWA (Time-Weighted Average) : the average exposure over a specified period
vPvB : very persistent and very bioaccumulative.
WGK (Wassergefahrdungsklasse) : a German classification of substances that indicate the environmental hazard for surface water.
This information is to our knowledge correct and complete on the date of issue of this safety data sheet. The information only concerns the product and does not give any guarantee for the quality and the completeness of the properties of the product, or in case of mixing or using in any other process. It remains the responsibility of the user to assure himself that the information is suitable and complete concerning the special use he makes of the product. BRENNTAG denies all responsibility for loss or damage resulting from the use of these data.

# J Material Safety Data Sheet Prodac

**1. Identificatie van de stof / preparaat en van het vennootschap/ de onderneming**
Identificatie van het preparaat:
Naam: PRODAC®
Productcode: PR90.
De bereidingsprocedure is gepatenteerd.
**Frans patent no. FR 95 02391 - Frans patent no. FR 00 15067 -**
**Europees patent no. EP 0811 044**

Gebruik van de stof / preparaat: boraatformule voor zetmeellijm
Details van de onderneming / de leverancier: Ziegler & Co GmbH
Dr.-Hohenner-Str. 4
D-95632 Wunsiedel
Tel. 0049-151-17431096 or 0049-9232-9918-0
In geval van nood: Telefoon: +49-(0)9232-9918-0
Tijdens de kantooruren: 08.00 – 17.00
(Vrijdag: 08.00 – 15.30)

**2. Identificatie van risico's; bereiding**
Het hoofdbestanddeel van PRODAC® is een mengeling van aminoboraat sodiumzout en pentaboraat sodium, twee niet-ontvlambare, niet-brandbare substanties.
PRODAC® heeft een neutrale pH.
Mogelijke effecten op ecologie
Het sodiumpentaboraat in dit product kan gevaarlijk zijn voor planten en andere natuurlijke levensvormen. Contact met ons milieu moet daarom worden beperkt, voornamelijk omwille van de sterke oplosbaarheid van het product.
Mogelijke effecten op de gezondheid
Inademing: Het product heeft een lage volatiliteit, en de dampdruk komt voornamelijk van water.
Contact met de ogen: licht irriterend.
Contact met de huid: Aminoboraat zout en sodium pentaboraat tasten de huid niet aan, maar de aanwezigheid van quaternaire ammoniumpolymeren zorgt voor een lichte irriterende dimensie bij het product.
Inname: Inname van dit product kan zorgen voor maag-, lever- of darmaandoeningen. Kanker: Aminoboraat zout en sodium pentaboraat zijn niet kankerverwekkend.
Reproductie / Ontwikkeling:
De PRODAC® formule bevat geen gedecahydrateerd borax. Alle PRODAC® componenten zijn niet-giftig en wateroplosbaar. Dat betekent dat er absoluut geen risico is om alkaliboraat te inhaleren als een vluchtig poeder.
PRODAC® bevat noch residu van boorzuur noch gedecahydrateerd borax, noch enig ander KMR (kankerverwekkend, mutageen, reproductief) giftig product, zoals geclassificeerd door REACH.
Tekenen en symptomen van overmatige blootstelling: braken, diarree, vertraagd-effect erytheem, desquamatie en tekenen van allergieën.

**3. Bestanddelen: compositie en informatie**
Chemische beschrijving / waterhoudende oplossing:
Mengelingen van borate / mengelingen van sodium aminoboraatzout en sodium pentaboraat in aanwezigheid van carbonaat, met bacteriële, algen- en schimmeleffecten.
Chemische familie / synoniemen:
Organisch boraat / Aminoboraat zout
Details van de bestanddelen:

| *CAS No.* | *CE No.* | *Naam* | *Symb.* | *R:* | *%* |
|---|---|---|---|---|---|
| 94095-04-2 | 302-207-4 | Sodium aminoboraatzout | | | x % < 65 |
| 12007-92-0 | 234-522-7 | Sodium pentaboraat | | | 10<= x % < 15 |

**4. Eerste hulp**
Algemeen advies: Verwijder besmette kleding om een verlengd contact te vermijden.
In geval van inhalatie: Indien bepaalde symptomen zichtbaar worden na blootstelling in een begrensde ruimte : voorzie een rustige omgeving, frisse lucht en medische hulp.
In geval van contaminatie van de ogen: onmiddellijk zorgvuldig wassen met water; als de irritatie langer dan 30 minuten aanhoudt, contacteer dan een dokter.
In geval van contact met de huid: Zorgvuldig en overvloedig wassen met water. Geen verdere behandeling noodzakelijk.
In geval van inslikken: Spoel de mond grondig. Een kleine hoeveelheid inslikken zal normaal gezien geen gevolgen hebben op lange termijn. Toch moet er steeds een dokter oordelen over eventuele verdere behandeling.

**5. Brandpreventie**
Algemeen risico: erg klein, omwille van het niet-vluchtige karakter van aminoboraatzout en sodium pentaboraat, waardoor het vuur niet wordt aangewakkerd.
Brandblussers: alle modellen
Het blijft desondanks aangewezen om het bluswater te verzamelen.

**6. Acties in geval van een ongewenst lek**

Algemeen: Voorkom verspreiding en morsen in de buurt van de huid, ogen en mond.
Indien mogelijk: ruim op met absorberend materiaal.
Indien gemorst op de grond: Gebruik een zuur om de oplosbaarheid van het zout en het pentaboraat tegen te gaan. Calciumhydroxide kan ook aangewezen zijn in een open ruimte.
Indien gemorst op de grond: Laat het product niet lekken in het afvoersysteem.

**7. Behandeling en bewaring**

Geen bijzondere voorzorgen nodig. Denk wel aan de hoge dichtheid van het product: wanneer het zich verspreidt over een grote oppervlakte kan het dikker worden. Ook krijgt het stilaan een gele kleur. Hou het product weg van vrieskou, en zorg dat de containers dicht blijven tijdens de bewaartijd.

**8. Blootstelling en persoonlijke beschermingsmaatregelen**

In industriële omgeving: het product niet sproeien of sprayen.
Veiligheidsbrillen en –handschoenen zijn aangewezen.

**9. Fysieke en chemische kenmerken**

Uitzicht: transparante, visceuze vloeistof.
Specifiek gewicht: 1.39 +/- 0.02 kg/l
Viscositeit: approx. 550 cps bij 21°C
Dampdruk: Ongeveer hetzelfde als bij water.
Kookpunt/Interval: 100°C, omwille van het watergehalte van PRODAC®
Verdampingsratio: ongeveer 13%
Ontvlambaar: Nee
Water-oplosbaarheid: Oplosbaar, ongeacht de verhouding water
Smeltpunt: Glazige verharding, van –15 °C.
Alkaliniteit: pH van het onverdunde product 7.5 + / -0.5; pH in wateroplossing van 1/100, 8.5
Afscheidingscoëfficiënt: n-octanol/water: niet gemeten
Thermale ontleding: meer dan 500°C
Flash point: geen
Oxiderende kenmerken: geen
Risico op explosie: geen
Vetoplosbaarheid: nee

**10. Stabiliteit en reactiviteit**

Algemeen: PRODAC® is een stabiel product, maar het concentreert zich gewoonlijk aan de oppervlakte door middel van evaporatie.
Effecten van andere samenstellingen kunnen beter worden vermeden: PRODAC® wordt aangetast door andere ionische samenstellingen, in het bijzonder sterke en zeer basiszuren. Oxidanten en metaalkationen kunnen de oplossing destabiliseren – gel kan verschijnen, of boorzuurkristallen of alkalische boraten kunnen vrijkomen.

**11. Toxicologische gegevens**

Acute giftigheid: De boormengeling vertoont lage orale giftigheid bij ratten, LD 50 (van 3500 tot 4100mg/kg).
In the formule is de quaternaire ammoniumgiftigheid LD 50> 2000mg/kg (bij ratten).
Dit betekent een virtuele afwezigheid van een inhalatierisico.
Huidirritatie: Tot op heden werd er geen irritatie vastgesteld bij accidenteel contact, op voorwaarde dat de blootstelling van korte duur is.
Oogirritatie: De combinative van quaternaire ammoniumpolymeren en een lage waterinhoud maken PRODAC® irriterend voor de ogen.
Gevoeligheid: aminoboraatzout tast de huid niet aan, maar enkele gevallen van huidallergieën werden gemeld, en dit bij aminoboraten die een lange warmtebehandeling hadden ondergaan.
Giftigheid en reproductie / ontwikkeling:
De PRODAC® formule bevat geen gedecahydrateerde borax. Alle PRODAC® componenten zijn niet-giftig en wateroplosbaar. Dat betekent dat er geen risico is om alkaliboraten in te ademen als een vluchtig poeder.
PRODAC® bevat noch residu van boorzuur noch gedecahydrateerd borax, noch enig ander KMR (kankerverwekkend, mutageen, reproductief) giftig product, zoals geclassificeerd door REACH.
Kankerverwekkende / Mutagene effecten: Tot op vandaag hebben de drie hoofdbestanddelen geen bekende (Amest test) kankerverwekkende of mutagene effecten.

**12. Ecologische gegevens**

Phytotoxicity: Boor is een oligio-element aanwezig in de ontwikkeling van planten in de agricultuur. Wanneer het wordt gebruikt in grote hoeveelheden is het schadelijk voor de plantengroei.
Gegevens in verband met het actief boor in PRODAC®
Daphnia giftigheid: 48 u, 242 mg B/L (i.e. ong. 350 mg / L boorzuuroplossing of 150 mg MEA/L)
Giftigheid bij zoetwatervissen: hangt vooral af van het boorgehalte.
Forel, salno gairdneri (embryo's)
24 dagen LC 50 = 150 mg B/L
32 dagen LC 50 = 150 mg B/L
Goudvis, Carassius auratus (embryo's): 7 dagen LC 50 = 46 mg B/L
Verspreiding in de grond: het product is wateroplosbaar en kan dus in de grond sijpelen.

**13. Overwegingen bij het wegwerpen**

Algemene informatie: besmette verpakkingen moeten worden geleegd en zorgvuldig gereinigd.

**14. Transportdetails**

Internationaal transport: **PRODAC®** heeft geen UN nummer en is niet onderhevig aan internationale controles in verband met transport via de weg, het spoor, de lucht of het water.

**15. Regulerende informatie**

REACH reguleringen voor KMR-geclassificeerde producten: GEEN

Risico-logo: GEEN

Enkele voorzorgen:

Dit product inslikken veroorzaakt maag-, lever- en darmaandoeningen.

Indien er sprake is van contact met de ogen: was ze onmiddellijk uit met een grote hoeveelheid water, als de irritatie langer dan 30 minuten aanhoudt: raadpleeg een dokter.

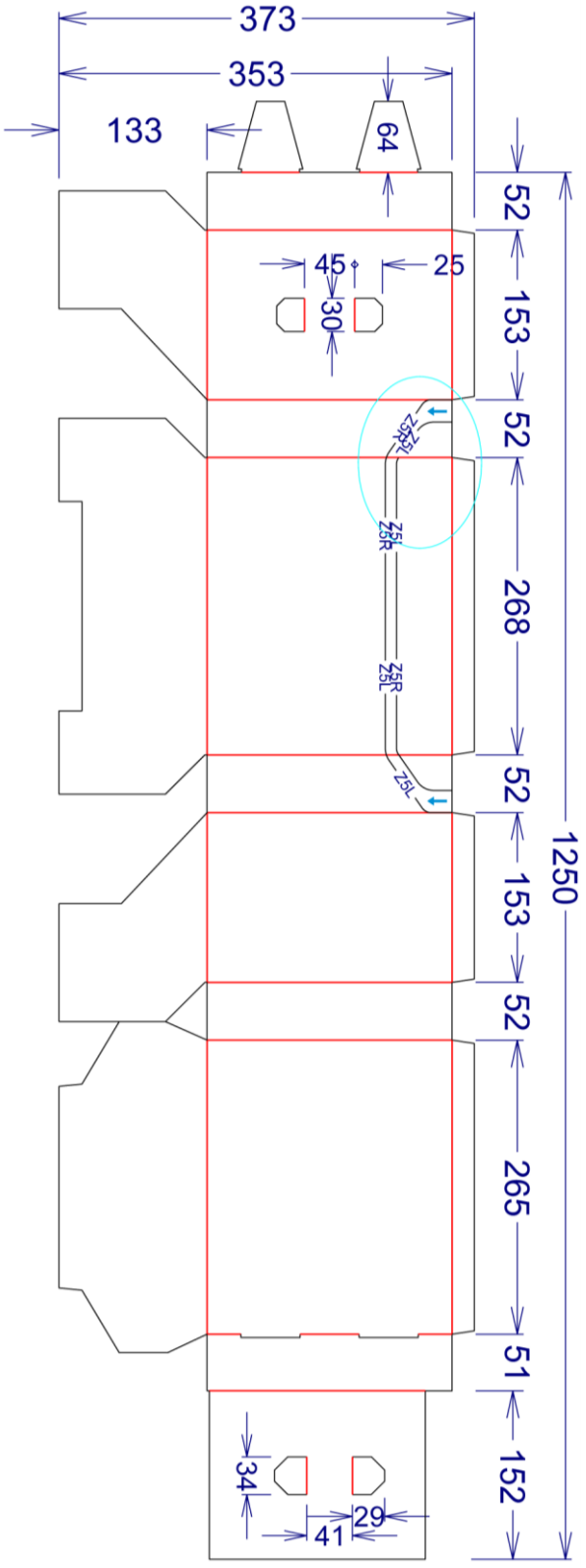
**16. Overige informatie**

Mogelijke kleurveranderingen na een lange bewaarperiode.

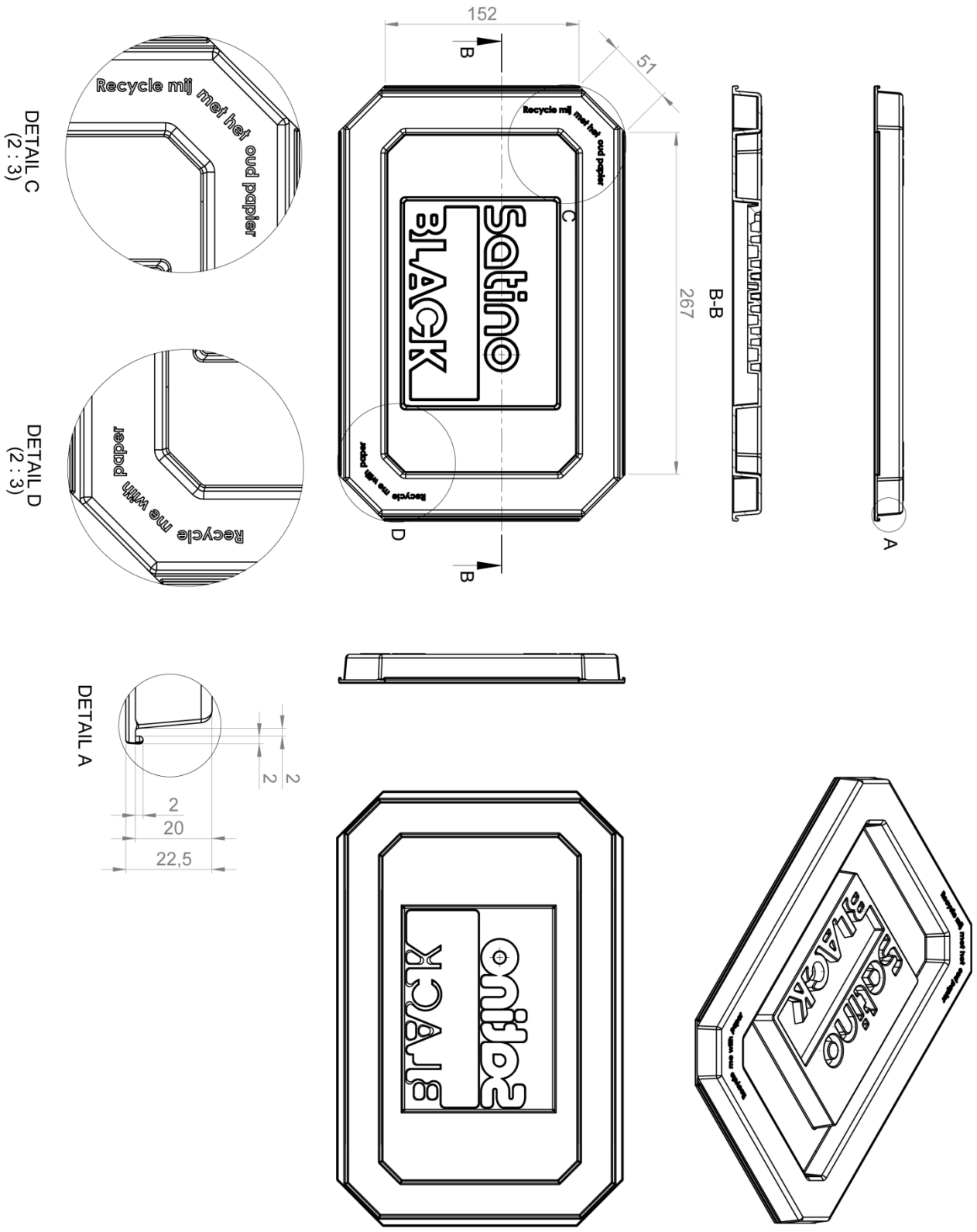
Toepassing: een intermediaire booroplossing kan als een vloeistof tussenkomen in formulaties van zetmeellijmen. De bovenstaande informatie is gebaseerd op onze huidige informatie en op de bestanddelen van de mengeling. Antagonisme in het bijzonder, maar ook synergie is altijd mogelijk. Gebruikers van onze producten handelen op hun eigen verantwoordelijkheid en moeten de relevante wetgeving, regulaties en instructies respecteren.

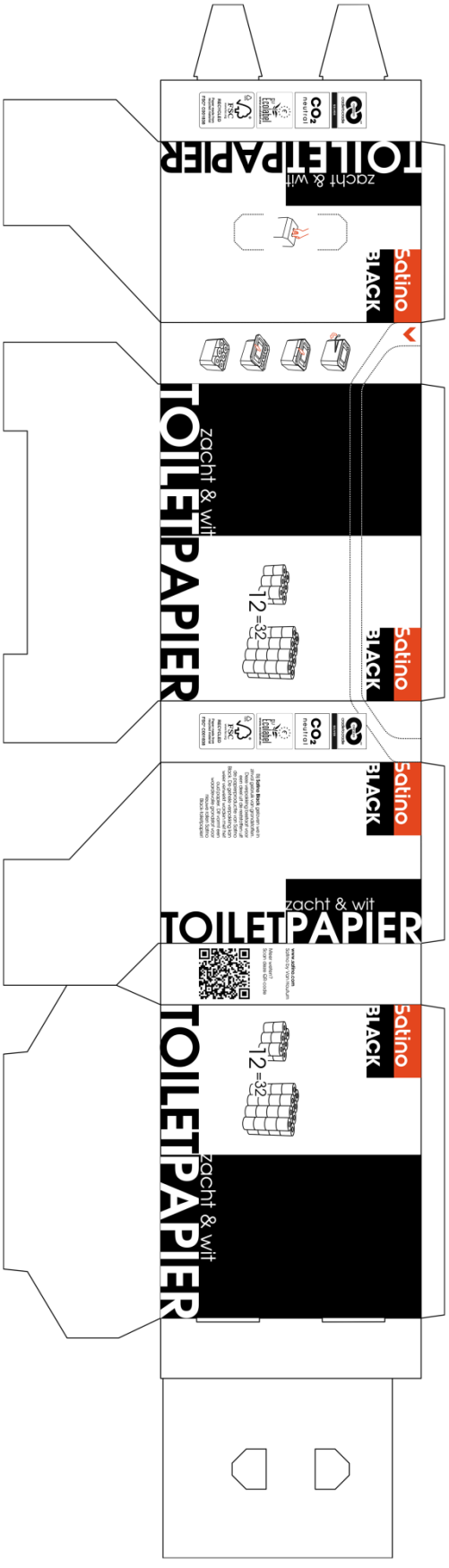
## K Detailed Draft

### K1 Outline and Dimensions box



## K2 *Technical Drawing lid*

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*K5 Mock-up*


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