PLASTIC BAKERY

A new taste for plastic waste

Master Thesis
Sabrin Ghazal
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“It feels like baking, but even better.”
(participant of workshop)

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Preface

I have always been inspired by the beauty of nature: feeling the power of the waves with surfing, watching the sun sinking behind the horizon and colouring the ocean in the most beautiful colors. It triggers the senses.

The experience of triggering the senses, enhancing curiosity and physical activity has been my aim for this project. I wanted to amaze people, make people curious.

Elvin introduced me to the topic of material experiences. Materials that can have certain effects on people and that can make people do. I decided to do a different project, try something new. I was going to design with waste materials, plastic waste materials. Plastic is the type of waste that stays on our planet. There is a whole island of plastic floating around in the ocean, so why not do something with it?

I wanted to use the plastic waste materials to amaze people and to highlight the aspect of waste in a fun way. The company Plastic Whale (http://plasticwhale.com/), that organises trips to go plastic fishing in the Amsterdam canals, is a good example of doing a fun activity and making people aware of the waste problem at the same time. I really don’t believe in pointing fingers and telling other people what to do. People should do things, because they truly believe in it.

I want to thank the people that helped me to make this project be amazing. At first I want to thank my coaches. Elvin, thank you for helping me to translate my interests into a very interesting graduation assignment, for introducing me to the MDD method, for all the support and great feedback. Marieke, thank you for your enthusiasm, openness, inspiring advice and beautiful images. I want to thank my family and special thanks to my parents for always supporting me and believing in me, my sister for your honest opinion and advice. Wieke, I want to thank you for your all your help and motivating peptalks. Wessel, Luuk and Lotte thanks for your help, great energy and optimism. Samuel, Brigitte, Dorian and Marianne, thanks for your support, inspiring tips and ideas. Roos, Noortje, Paula, Ruby, Julia and Bob, thank you for your great ideas during the brainstorms. Annemarie, Paulien, Laura, Lilseth, Mirja, Marjorie, Kate, Koen, Myrthe, Aad, Elske, Karlien and Annie. Thanks for your creative input during the workshops and/or user studies. Thomas, thanks for your enthusiasm and reactions on the blog. Mascha thank you for your help with the machines and the use of the oven. I want to thank Kaspar Jansen for sharing his knowledge about the safety of melting plastic. And last but not least, I want to thank all the people from the pmb to help me make great things.
Executive Summary

This master thesis describes the process of finding a new purpose for plastic waste materials. It shows the design of a material application and a service around recycling Polyethylene bottle caps. The project assignment is self formulated, in collaboration with Elvin Karana. The Material Driven Design method (Karana et al., 2015) was applied for the design of the material application in which the unique material qualities come forward.

The goal of this project is to find an application for plastic waste materials that changes the perception of waste into valuable and looks at motivations for people to do something with waste.

The material focus of Polyethylene was determined through talks with experts about the safety of melting the material. Insights in the material qualities of Polyethylene were generated by several tinkering experiments and user studies. These experiments showed the unique qualities of the arise of wonderful patterns that surprise people, when different colors of caps are mixed, and showed the semi-transparency of the material. The combination of both qualities give the material a magical appearance when light shines through and shows the stratification of the material. Material Benchmarking proved that the combination of the discovered material qualities was not applied by others. The associated meanings of the material, natural, unique, personal and beautiful, were evoked during the user studies.

Different ways of motivating people to do something with waste were explored, by mapping existing solutions and their motivational strategies. The fun aspect of collecting, the size and availability in many different colors, encouraged to focus on Polyethylene bottle caps. The vision aimed at surprising people with the material, combined with light. Experiments with the material were done to investigate how the element of surprise can be enhanced.

The Design phase is divided into the design of the service and the material application. The service implies the collecting and processing aspects of the material. For the service, several ways of collecting bottle caps were tried out. The experiences were translated into stories. The enthusiasm and dedication during the making process was tested with a workshop. People liked to create something out of plastic bottle caps. They associated the experience with baking. The processability of the material by hand was tested with a set of experiments. It was discovered that processing by hand (with an oven and some basic kitchen tools) is possible as long as the dimensions of the material are kept small. In this way mixing the material and creating patterns is possible, considering the short cooling time and thus processing time of the material. The requirement of small dimensions, encouraged to decide on a modular application, that consists out of multiple plastic plates.

A creative session and brainstorm with a group of students was executed to find applications for the material with light. The ideas were translated into three concept and tested by prototypes with using artificial and natural light. Different connection methods for the material were explored.

A product and a service was developed: The Plastic Bakery. The product, Tipi Table lamp, is a lamp shade that consists out of four plastic plates, four sticks, a piece of cord and an elastic band that can easily be assembled. A led lamp is used as a lightsource. It does not become warm and has a long lifetime. The product can either be bought or made yourself during a workshop. By processing yourself, the transition can be visible from bottle cap to new material. People can select a theme, based on nature, with the aid of a menu and collect the specific caps. They can melt the material inside a mold and mix it with spatulas. People can add sprinkles and create a message with a stamp. The material can be made flat by using ones body weight.

Both concepts were evaluated. The product was evaluated during the exhibition of Future Materials and the service during a workshop. The material application surprised people and was seen as beautiful. It is managed to create something valuable out of plastic waste. People liked the activity of making during the workshop and could express themselves. The short cooling time of the material worked against the joy of making. A set of recommendations is presented that suggests further research into the cooling time and thus processing time of the material, together with the safety of melting plastic for DIY purposes.
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Introduction

This chapter introduces the problem of plastic waste, the goal and the approach. The structure of the report is explained.

CHAPTER 1

The rise of the prosperity and population has caused an increase in the amount of waste from households, industry and construction. Processing waste costs energy and a part of the waste that can include harmful substances, ends up in the air, the water or the soil (Milieuloket, n.d.). This causes a negative impact on the environment. There are already ways to limit the impact of waste on the environment. The waste can be reduced, recycled, reused (CREM & Milieu Centraal, 2013) and remade. The question remains: How can you motivate people to decrease their impact on the environment in a positive way? In other words: How can you motivate people, without playing the role of a parent by telling other people what to do (Figure 01), or by shocking people (Figure 02)?

Figure 01 - An attempt of motivating people to pick up waste, by foundation ‘Klean’ (Smith, 2012).

Figure 02 - An Albatros cut open in order to show the plastic in its stomach, by Jordan (2012).

The focus of this project is on plastic waste material. Due to the great set of possibilities (strength, stiffness, density, heat resistance, electrical conductivity), the material is often used (Lower, 2009). Many plastics are designed to be used only once, being thrown away after the use. However, thrown away is not away. Plastic is the type of waste that will last forever. Currently only five to ten percent is recycled of all the produced plastics (source: http://www.5gyres.org/the-plastic-problem/).

As mentioned by Eriksen et al. (2014) there are around five trillion pieces of plastic floating in world’s oceans, out of which eighty percent, originates from the land (Jambeck et al., 2015). The plastic breaks down into smaller pieces by the sunlight (Moore, C., 2014) and releases toxins. All sorts of organisms living in or off the sea mistakenly take in plastic debris and microplastic for food. This results in the often toxic waste to enter our food chain (Plastic Soup Foundation, 2016).

1.1 Problem Definition

The focus of this project is on plastic waste material. Due to the great set of possibilities (strength, stiffness, density, heat resistance, electrical conductivity), the material is often used (Lower, 2009). Many plastics are designed to be used only once, being thrown away after the use. However, thrown away is not away. Plastic is the type of waste that will last forever. Currently only five to ten percent is recycled of all the produced plastics (source: http://www.5gyres.org/the-plastic-problem/).

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1.2 Goal

The goal is to find an application for plastic waste materials that are already thrown away. This application should change the perception of waste amongst people. People need to see the material as something valuable. In the application the material qualities need to come forward. Next to finding an application, the experience around the material is taken into account as well, the motivation of people to do something with waste. Figure 03 on page 14 shows the two circles that represent the project. The research question of this project is: How to change the perception of plastic waste materials from useless into valuable?

In order to answer this question, the following subquestions were posed:
- What are the unique qualities of plastic waste materials that are not applied by others?
- In what material application do these unique material qualities come forward?
- How can people be motivated to do something with waste?
1.3 Approach

During this project the Material Driven Design (MDD) method (Karana et al., 2015) is used. The method offers support and structure when designing for material experiences. It helps to create an innovative application for the material, by finding unique material qualities that no one else has yet applied and translate these into an application that opens up new ways of looking at things. Properties of materials can make people perform actions (Giaccardi & Karana, 2015). Materials feel, make a sound, have an appearance and sometimes even smell. It is the materials, people are in contact with, that create sensual experiences with products and can elicit emotions (Karana, 2009, p. 23).

The MDD method consists of four steps (Figure 04). At first the technical and experiential qualities of the material are identified, together with the existing solutions. Next, the vision is created which implies the intended new materials experience. Step three aims at finding the interrelationships between the vision and the material qualities, which eventually leads to the last step, the material concept. A concept in which the unique discovered material qualities are embedded.

1.4 Report structure

This report is divided into three phases (Figure 05): Explore, Design and Evaluate. The Explore phase presents motivational factors for collecting waste and shows the explorations with the material Polyethylene (PE). It shows the tinkering studies and user studies and describes the existing solutions for the material (Material Benchmarking). The focus on plastic bottle caps is described and the vision for the material, that implies the unique material qualities. The second phase, Design, presents the development of a material application for the bottle caps, together with a service around it. In the last phase Evaluate, both the material application and service are evaluated.

1.5 Terminology

Plastic
Plastics incorporate both of the thermoplastics and thermosets. This report focuses on thermoplastics, the plastics that can be melted again and do not stay solid like thermosets do. When the term plastic is used, it is referred to the thermoplastics.

Waste
Waste is described throughout the report as: “Material that does not (from the viewpoint of the customer) add value to a good or service.” (Definition from: http://www.businessdictionary.com/definition/waste.html#aczxzuqswr91m5i)

If the product does not add value to the consumer (any more), the consumer will throw it away and it will become waste.

Service
The service includes a solution for the collecting and processing of plastic waste.

Product
The product is the application for the material.

Plastic Bakery
The service and product. It is the name for the total concept.

Bakery Bus
The Bakery Bus is part of the Plastic Bakery. It is the space for giving workshops, exposing products and storing the equipment.
EXPLORE
Motivation

This chapter describes motivation factors to collect waste.

2.1 Motivation factors

Aim
This study aims at finding different motivation factors for collecting waste and determining a motivation factor that is used for the design of the service.

Research Question
How can people be motivated to collect waste?

Method
Existing solutions around collecting waste were selected through delving into material websites (http://materia.nl/), design inspiration websites (http://design-milk.com/) and sites around sustainability (https://www.voordewereldvanmorgen.nl/). The solutions were analysed and categorized into different motivation factors.

Data analysis
The experiential opportunities and constraints of each collecting activity together with the motivational factors were identified with the aid of the Material Benchmarking cards. These cards are part of the MDD method and meant to find new application areas for the material at hand. However, in this project the use of the cards is extended. Figure 07 shows an example of a card. For all the cards and table, please find Appendix F.

Results
Plastic waste is collected in various ways. It can be collected through plastic fishing in the canals or on the ocean, through picking it up or throwing it in a bin or “blikvanger” or through storing it and bringing it to a collection point. It can be done individually or within a group. The most important difference between all those ways of collecting is the way of motivation. Figure 08 shows the different motivation factors in a framework, together with examples. People can be motivated by doing a good deed, receiving a reward, having a fun experience or by showing others that you’re a good person. Waste can be dealt with in a fun and positive approach and in a serious and negative approach. Plastic fishing as a company trip in the Amsterdam canals (Plastic Whale, 2016) is an example of a fun and positive approach. People are having a good time together, are doing a physical activity and while doing it, they can see the waste problem through the amount of plastic in their fishing nets. So no one needs to explain, the people can experience it themselves. The initiative of picking up one piece of waste a day (Stichting Klean, 2012) is a serious and negative approach. In this case all the problems and misery of waste are being enhanced by talks and shocking images and the people need to do something about it; solve the problem. Several charities (Kika; KNGF geleidehonden, 2016) have the initiative of collecting bottle caps. They have a network throughout the Netherlands of households collecting caps and transporting them to several collection points. These collection points store the caps and make sure the plastic recycling companies come.
pick them up for twenty cents per kilo. This money is used for charity. It is a nice initiative since people can donate in the form of plastic waste and get a good feeling. Still, twenty cents a kilo is not a lot of money. People can be motivated by money, when handing in their (>1 Liter) bottle of soft drinks, even though they do not earn anything since it is deposit money. An example of motivation through receiving a new product, is the scenario of Wasted, an initiative of Cities Foundation (2015). People hand in their local household waste at the Laboratory of Wasted and receive coins that can be spent on local shops to get discount. With the local waste, Wasted creates new products for the neighbourhood, like benches or planters. This enhances the community feeling in the neighbourhood.

**Figure 08** - Conclusion of existing solutions for collecting waste

**Conclusion**

Different types of motivating people, with the advantages and disadvantages, were discussed. Most potential is seen in the positive approach of motivating people. This project will focus on the positive approach of collecting waste.

The activity should be a fun experience that intrinsically motivates people. If the activity itself is worthwhile to do and people see value in it, there is no person or initiative needed to warn people or tell them what to do; to correct their behaviour. After all, when a person does something, he or she should truly believe in it and when fully supporting it, the person will do it out of inner drive.
Defining the material

This chapter describes general information about plastics and explains the focus on the plastic Polyethylene.

CHAPTER 3

EXPLORE

3.1 General Plastics

Thermoplastics and thermosets
Plastics are composed of very large molecules, called polymers. Plastics are synthetic polymers (Callister, 2007, p. 490) and can be divided into two categories: thermoplastics (or thermoplastic polymers) and thermosets (or thermosetting polymers) (Callister, 2007, p. 506). The difference between these is the ability to be re-heated and melted again. Thermoplastics can be melted again once they have solidified; thermosets stay solid and cannot be remelted (Callister, 2007, p. 506-507). The thermosets are excluded in this project, due to their inability to be reheated.

There are different types of thermoplastics, each displayed with a number within a triangle (Figure 09). This logo can be found on the bottom of a product. Each type has different properties and within each type, the properties can vary as well. The reason for this is the additives, the chemicals that are added to increase the ability of certain properties, like the fire resistance. Pigments also determine the properties.

Thrown away plastics
The next two pages (Figure 10) show four scenarios of what can happen if plastic is thrown away. As can be seen, there are many steps needed to process the waste. Unfortunately not all the collected plastic is recycled (Hakkens, 2013; Bos, 2014). In the plastic bin, all the types of plastic are mixed. It is hard to identify the type of plastic, the products look similar and the triangle with the number that identifies the type of plastic, is not always visible. Besides, the plastic products are often combined with other materials. For example the labels that are attached to it, or a different type of plastic that is inserted into the product, like the rubber inside a Coca Cola bottle cap. The people who sort out the plastics, can make mistakes, so the plastic is not hundred percent accurate (Bos, 2014). In addition, the plastic production companies do not give all the information of the plastics they produce. The complete list of substances is unknown. The companies can add substances in order to optimize the properties of the material.

When recycling, the plastics are heated again which causes a reduction in strength and stiffness of the material, because of the molecules that break and molecule lengths that shorten (Ploegmakers, 2015). Companies that produce plastic products don’t always dare to use recycled plastics (Ploegmakers, 2015), because it might damage their machine or slow down the production (Hakkens, 2013; Bos, 2014). The machines that produce plastic products are expensive, extremely complex and are optimized in order to make the process as efficient as possible, to keep the costs low (Hakkens, 2013).

In the current situation companies use a small part of recycled plastics (for example twenty percent) and mix it with new plastic, when producing plastic products. In this way, the properties are easier to determine. (Ploegmakers, 2015)

Figure 09—Different types of thermoplastics
1. **Environment**
   - **Land**
   - **Water**
     - **Canals, Rivers, Lakes, Ocean**
   - **Wind**
   - **Waterways**

   (van der Velden et al., 2018)

   - **Combustion**
     - **Landfill**
   - **Generate electricity**

   - **Sun + Time**
   - **Plastic “photodegrades”: breaks down into smaller pieces**
   - **Ocean animals eat the plastic or get entangled and die.**
   - **Plastic enters our food chain**

   (Milieu Centraal, n.d.; 5 Gyres, n.d.)

   (Continues on next page ->)

2. **Throw away**
   - **Trash bin**
     - **Container**
   - **Picked up & transported**

   (Jambeck et al., 2015)

   - **Wind**
   - **Waterway**

   - **Ends up in air**
   - **Generate electricity**

   - **Plastic is sorted and controlled on quality**

   - **Recycled plastic mixed with new plastic**

   (Plastic Heroes, n.d.)

   (Stichting ons stapelgeld (SOS), 2016)

3. **Supermarket**
   - **Collection point Plastic Bottles: 1L, 1.5L, 2L**
   - **Plastic Bin**
   - **Picked up & transported**

   **Plastic is sorted and controlled on quality**

   **Transported to plastic recycling company**

   - **Wash & Dry**
   - **Grind**
   - **Compress**
   - **Shredded**
   - **Granulate**
   - **Recycled plastic mixed with new plastic**
   - **Products**

   (Plastic Heroes, n.d.)

   (Stichting ons stapelgeld (SOS), 2016)

4. **Throw away**
   - **Supermarket**
   - **Collection point Plastic Bottles: 1L, 1.5L, 2L**
   - **Plastic Bin**
   - **Picked up & transported**

   **Plastic is sorted and controlled on quality**

   **Transported to plastic recycling company**

   - **Wash & Dry**
   - **Grind**
   - **Compress**
   - **Shredded**
   - **Granulate**
   - **Recycled plastic mixed with new plastic**
   - **Products**

   (Stichting ons stapelgeld (SOS), 2016)
Conclusion

The scenarios showed that many steps are needed to recycle the plastic (if people even take the effort to do so). It is good that the material is recycled, however all these steps require energy and money and only a small percentage is recycled. A better solution could be to locally recycle plastic. People bring their local waste to a collection point in their neighbourhood and receive a reward for it. For example a new product that is made out of the waste.

3.2 Polyethylene

Safety

The decision is made to only focus on Polyethylene since this type is free from additives and has the lowest melting point. In the types PET (#1), PVC (#3) and PS (#6) acids are processed and harmful fumes are released during heating (Schoemaker, 2015). According to Jansen (2016), Polyethylene and Polypropylene can be seen as refined wax and are not dangerous to melt.

Figure 11 shows the structure of PE; it has no dangerous substances. The ‘n’ in the Figure means the amount of units (in between square brackets); for PE this unit is repeated a 1000 times (Jansen, 2016). If you compare the structure of PE to the structure of for example PVC, you can see a different group, namely Chlorine (red ‘Cl’) which is released and toxic when heated. Polyethylene has no dangerous rest group. Important is to stay under a certain temperature when heating the plastic, since the material only needs to be melted and not burned. When burning plastic, soot is released which is harmful. When keeping temperatures below the injection molding temperature of the material, it is safe to heat the material (Jansen, 2016). Kohne (2016) also mentioned that when only melting Polyethylene, no dangerous substances are released.

It is important not to exceed the temperature of 210 degrees Celsius (injection molding temperature). Therefore it is important to use a precise oven. A hot air oven is constant (Weeber, 2015), since it circulates the air through the entire oven. With constant a variation is meant of 3 to 6 Degrees Celsius. The oven needs be placed underneath an exhaust or outside. Specialist in technical polymers Ploegmakers (2015) suggested to melt Polyethylene at 180-190 Degrees Celsius. The higher the temperature, the more the material will flow (Jansen, 2016). But also, the higher the temperature, the higher the chance that the material starts to degrade and release fumes. At 150 degrees Celsius the material is too viscous to process, it is like chewing gum. At 200 degrees Celsius the temperature is close to the injection molding temperature. According to the material safety data sheet (msds) of Polyethylene, the material is: “not considered a hazardous substance according to Reg. (EC) no. 1272/2008 and its amendments. Not classified as dangerous goods for transport.” Van Oossanen (2016).
Discovering the material

The tinkering studies and material sample studies with Polyethylene are presented in this chapter. These studies serve as a way to get an understanding of the material.

CHAPTER 4

EXPLORE

4.1 Properties of Polyethylene

This paragraph explains the two tinkering studies with Polyethylene. Both High-Density and Low-Density Polyethylene were explored.

Aim

The tinkering studies were executed to get an understanding of the material at hand and to identify its opportunities and constraints. It is up to the designer to seek new possibilities for the material and to introduce new meanings and user experiences. Understanding the material is the first step of the MDD method (Karana et al., 2015). The designer is guided by what the material can do.

Research Question

“What are the material properties of Polyethylene?”

The following sub-questions were posed:

- How does the material behave under a variety of production methods?
- What are the opportunities and constraints of the material?

Method

Two studies were done. Study 1 served as an exploratory study; to get to know the material. It can be seen as an introduction to Polyethylene. Since limited knowledge existed about processing Polyethylene yourself, the tool for melting the material was kept constant, namely the oven. In Study 2 more advanced production methods were tried out. Figure 13 shows a table of all the variables per processing step. The variables are further explained per Study on the next pages.

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The material was processed in different ways, each time with different variables. Pictures were taken of the process and end result. The MDD cards (Karana et al., 2015) were used as a guide to identify the behaviour of the material, the opportunities and constraints, with different manufacturing methods. Figure 12 shows an example of a filled in MDD card. For all the cards, please check Appendix B.

The next pages display the results of the two studies, including the created samples with the specific variables.

Figure 12: Example of a filled in MDD card.

Figure 13: Table with the variables of the tinkering studies per processing step.
Study 1 – Orientation
Figure 14 shows all the variables that were tried out, together with the tools that were used.

Setup
The oven was placed underneath an exhaust. The tools were placed left from the oven. (Figure 15)

Procedure
The oven time was and temperature were kept constant, namely ten minutes at 180 Degrees Celsius. The procedure was kept constant as well. The main steps are as follows:
1. Plastic is put in the oven for ten minutes.
2. Plastic is taken out of the oven when the plastic is melted and has a shiny appearance (Figure 16).
3. Plastic is shaped.
4. Plastic is cooled down.

Results
The next pages show the created samples with the different variables. Each sample has a number, that will come back in the next paragraph of the material sample study.

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Figure 15 - Setup of experiment study 1.

Figure 14 - Table with all tested variables and tools used.

Figure 16 - Left: Plastic bags in melted state. Right: plastic bottle caps in melted state.
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Study 1 gave insight into the material properties of Polyethylene. The opportunities and constraints of the material are discussed below.

Opportunities
The oven is a convenient production method for heating up the material. It heats up equally. The material is very easy to melt and shape. In a melted state, the material can be mixed and fused together. If you mix the material, color patterns arise. In this way you have influence on the outcome. You can mix the colors, however the oven decides what exactly happens; what color patterns arise. The patterns are different every time and therefore unique. It is also possible that logos of the bags and bottle caps are still visible (Sample C11). Furthermore it is found that the material is strong, waterproof and floats. Besides, the material can serve as ‘glue’ when mixing it with another material (Sample C17). When you process the material – if you make a thin sheet of plastic, or you press a shape into it- and hold it against the light, the material is semi-transparent (Figure 17). Textures can be easily created by pressing an object into the plastic when it is melted. When adding iron particles to the PE, the total material is magnetic and sinks.

Constraints
The material has a short cooling time and thus short processing time; the material solidifies very fast. When the material is cooled in air without pressure, the material has no predefined shape. The edges curl up or wrinkles arise (Sample C2). The material is very brittle when it is pulled apart (Sample C18). If you bend it multiple times, it breaks. Holes arise in the bottle caps when melting (Figure 18). A lot of uniform pressure is needed to get a flat surface. Heating the material into a mold that shapes and heats the plastic, would be more convenient. More defined shapes can be created.

Conclusion
The opportunities and constraints of the material were identified. Naturally, whether something is an opportunity or a constrain depends on the purpose of the material. In this case the designer was led by the beauty of the material. The technical properties, like strength or stiffness, were not considered to be the focus.

Study 2 – Production Methods
In this study different production methods were explored. The different tools that were used can be found in the table below (Figure 19), structured per processing step. The explorations are described per production method from this page on.

The following production methods were executed:
2-1 Painting with plastic
2-2 Creating threads
2-3 Creating defined shapes
2-4 Heating up quickly
2-5 Kneading by hands
2-6 Creating messages in plastic

2-1 Painting with plastic
During this experiment it was tried to paint with plastic bags and bottle caps using a soldering iron.

Setup
A piece of mdf or canvas was placed on the table in the welding area, underneath the exhaust. On the table, the standard with soldering iron, prime, scissors, the bottle caps, plastic bags and gloves were placed (Figure 20).

Procedure
1. Creating Layers
A piece of (mdf) wood was placed underneath the exhaust. Gloves were put on to protect against the heat. The plastic bags were cut. With the left hand a piece of plastic bag was held against the wood, with the right hand the soldering iron was held. When the piece of plastic bag was stuck against the plate, another layer was added and heated. Multiple layers were melted on top of each other. The assembly was cooled down and sawn in half.
2. Paint with plastic
   - Exploring
   A piece of (mdf) wood was placed underneath the exhaust. Gloves were put on. Pieces of bottle caps and plastic bags were heated with the soldering iron and pressed against the plate of wood. The soldering iron allowed to add heat and press on the material at the same time (Figure 22). Patterns were created with a prime, by pushing the prime into the material. The material was cooled down.
   - Create a sunset painting
   A piece of canvas was placed underneath the exhaust. Gloves were put on. With pieces of plastic bags and bottle caps a painting of a sunset was tried to create. The colors of the different plastic pieces were mixed by going over them with the soldering iron. The material was cooled down. Inspiration was retrieved from the images in Figure 21.

Results

Opportunities
The soldering iron heats up the material and presses it at once. So you can melt and shape the material in one movement. The soldering iron can also be used as a cutting tool, when using the sharp edge and pressing on the material. It is possible as well to glue the plastic bags together by going over the overlapping part of the bags with the soldering iron. A structure can be created inside the material. When soldering multiple layers of plastic bags on top of each other, and by sawing it through, all the layers are visible, like the showing the history of how it was made. (Figure 23) The material can be spread over the surface. By doing so, it is possible to create a paint-like structure. It looks like the technique of Van Gogh. The painting technique is called Impasto: “a technique where paint is laid on an area of the surface very thickly, usually thickly enough that the brush or painting-knife strokes are visible. Paint can also be mixed right on the canvas. When dry, impasto provides texture, the paint appears to be coming out of the canvas.” The colors of the plastic pieces can be mixed when the material is still hot. Besides it is possible to create shapes with a prime when the material is in a melted state (Figure 24). The activity is fun to do, is emerging and enhances the desire to see progress.

Constraints
The soldering iron was too hot. Fumes were released, smoke was coming off and caused eye irritation and a sore throat. The soldering iron was still covered with tin from previous users, so the tin made the colors look dirty. Therefore it is important to use a clean soldering iron that consists of an adjustable temperature meter. Also, wear eye protection and a safety mask with the right filters against the fumes, to be sure when experimenting. It was hard to make strokes with the bottle caps, like painting, since the bottle caps consist of edges that you have to push down first. It is better to shred the caps into pieces or possibly work with filaments on a roll.

![Figure 20-Setup of experiment.](image)

![Figure 21-Inspirational images for painting with plastic.](image)

![Figure 22-Using the soldering iron to paint with plastic.](image)

![Figure 23-Results of creating layers.](image)

![Figure 24-Results of ‘painting with plastic’. Top: created shapes with a prime. Bottom: An attempt to create a sunset out of bottle caps and plastic bags.](image)
2-2 Creating threads

Threads of plastic were created by first shredding the plastic and then inserting it in the extruder. The machines—shredder and extruder—of Dave Hakkens (http://preciousplastic.com/machines/) were used. An alternative of creating threads by hand was explored with a pastry bag. However, the material did not end up through the nozzle; it was already cooled down.

Setup

The shredder and extruder were positioned in the lab. The nozzle of the extruder was placed underneath the exhaust. (Figure 25)

Procedure

The bottles were washed. Polyethylene (HDPE) bottles from shampoo, milk, detergent, were first shredded into flakes and then put in the extruder. Bags were shredded as well.

Results

Opportunities

The attention was caught by the Shredder, a lot was happening. The plastic was cut and the shredded pieces dropped in the box below. Using the Shredder felt like feeding the piranhas. The plastic bottles are the bait and the blades are the piranhas. It looked like a monster. You could throw in complete bottles, ending up in plastic flakes. There is less space needed to store the plastic, compared to the complete shampoo bottles. Using the Extruder was like someone continuously squeezed a tube of toothpaste. It felt nice to push into the thread of melted plastic, with a screwdriver. The material dented. By throwing in different colors of plastic, the colors get mixed inside the extruder and nice color combinations come out.

Constraints

Shredded pieces are static and stick to your skin (Figure 26). It gives a mess and there is a chance of inhaling the plastic pieces. Things that you try to create with the thread coming out of the Extruder, tend to look dirty quite fast (Figure 28).

2-3 Creating defined shapes – Blocks

In this section, plastic bags and bottle caps were processed into defined blocks.

Setup

An oven was placed underneath the exhaust and set to 180 degrees Celsius.

Procedure

1. A block of bottle caps

The caps were placed next to each other on a baking mold. The bottle caps were melted in the oven. After ten minutes the caps were kneaded. The caps were placed in the square mold and put into the oven for ten minutes. In between the mold with caps was taken out in order to press the caps and decrease the amount of air in between. The mold with caps was taken out of the oven, the caps were pressed once more. When cooled, the mold was kept upside down, to drop the block. The block was placed in a vise. With a hammer and chisel, a piece of the block was removed.

2. A block of plastic bags

The plastic bags were cut and pressed inside the square mold (left in Figure 29). The mold was placed in the oven. In between the mold was taken out twice to press the bags. The mold was taken out of the oven. The bags were pressed with a frame clamp while cooling down. The block was taken out and sanded with the sanding machine.

Results

Opportunities

When applying force, the material will get the shape of the mold. The arrangement of the plastic waste material determines the appearance of the layers. By sawing (Figure 33), sculpting (Figure 31), or sanding (Figure 32), the layers become visible.

Constraints

If there is too much air in between the bottle caps, not all the caps will melt; only the outer caps (Figure 30). So, placing the caps next to each other and melting them separately first, works better.
2–3 Creating defined shapes – Tiles
This section describes the experiment of processing plastic bottle caps into tiles.

Setup
The oven was placed underneath the exhaust on 180 degrees Celsius.

Procedure
Bottle caps were melted in the oven for 10 minutes on a baking mold. The caps were mixed with the aid of a steel plate. After mixing the baking mold was placed in the oven for another ten minutes. When melted again, the melted caps were taken out of the oven and pressed (Figure 34). The material was cooled down and a rectangle was sawn. The edges were sanded.

Results
Opportunities
The material can get very sharp and refined. Material is semi-transparent and a certain stratification is visible. As discovered before the material is very strong, but brittle. The material can be made flat. The press works well to have a uniform weight on the material.

Constraints
Creating a sandwich construction in order to see the layers when cut open (Figure 36) is not necessary, since the material patterns arise when only melting the caps and mixing them. There is no need to steer this process. It was difficult to create a thick solid sheet of caps, since holes arise in the bottle caps when melting. So spreading the material is needed (Figure 35).

Figure 31–Results of creating a block out of bottle caps and finishing it with hammer and chisel.

Figure 32–Results of creating a block out of plastic bags.

Figure 33–Results a block out of plastic bags, sawn in middle.

Figure 34–Using the Press to make the melted bottle caps flat.

Figure 35–Melting bottle caps and spreading them with a metal plate. Right: The material after trying to bend it.

Figure 36–Creating a sandwich construction of layers and colors.
2-3 Creating defined shapes – numbers
Shapes were created with existing baking tools.

Setup
Oven, placed underneath exhaust at 180 Degrees Celsius.

Procedure
The bottle caps were placed on the baking mold and melted in the oven. The molten caps were taken out and kneaded with two spatulas; one in each hand. The caps were placed back into the oven to melt again. A number was pressed into the material (Figure 37). The material was cooled down and the number was pushed out.

Results
Opportunities
The push out form numbers worked well, it was easy to push out the number.

Constraints
The material had some irregularities on the edges (Figure 38).

2-4 Heating up quickly
It was tried to heat up the material quickly by using a heatgun of 250 degrees Celsius.

Setup
1. Two plastic bags were placed on a table and weighed down by a rock.
2. Bottle caps were placed in a mold.

Procedure
1. The bags were heated by the heatgun and cooled down.
2. The bottle caps were heated by pointing the heatgun from above directly into the mold.

Results
Opportunities
The material melts within ten seconds with the heatgun. The material sticks to each other and shrinks.

Constraints
The material is more brittle since it is not as equally heated by the heatgun as in the oven. The heatgun burns the plastic and heats it at a specific point.
2–5 Kneading by hands

This section explains the experiment of kneading plastic by hands covered in heat resistant gloves. The aim was to actually feel the material.

Setup

On the table, a piece of wood, rolling pin, gloves and a cutlery holder were placed. Wood is chosen since the material is little heat conductive so the heat of the plastic will stay in the material itself, as opposed to metal. Metal conducts heat very well, causing the plastic piece to cool down rapidly.

Procedure

The bottle caps were placed inside a baking tray and heated in the oven. When melted, the caps were placed on the wooden plate. The plastic was kneaded while wearing gloves. The piece of plastic was put back in the oven to melt again. After ten minutes the plastic was taken out and placed on the wooden plate. It was made flat by the rolling over it with a rolling pin. An effort was made to knead the slab of plastic around the cutlery holder (Figure 40). The cutlery holder served as a mold, to shape the plastic.

Results

Opportunities

It felt nice to knead the plastic and to press it by rolling over it with the rolling pin. By kneading the material gets the appearance of clay and the imperfections cause a handmade appearance.

Constraints

Due to the short cooling time, it was hard to knead the plastic around the cutlery holder. Besides the material was not fluid but viscous. This leads to too many imperfections and a messy appearance (Figure 41).

2–6 Creating messages in plastic

With the aid of stamps, messages were created into the material.

Setup

Oven at 180 Degrees Celsius, underneath exhaust.

Procedure

The bottle caps were placed on the baking mold and melted in the oven. When melted the caps were taken out and kneaded with two spatulas; one in each hand. The caps were placed back into the oven to melt again. A silicone and rubber stamp was pressed into the melted material (Figure 42). The stamps were not pre-heated. The material was cooled down and the stamp was released.

Results

Opportunities

The silicone stamp worked very well, it gave a very precise shape into the plastic. When holding the plastic with shape against light, the shape comes forward (Figure 43). It is fun to have a new way of writing messages through pressing a stamp into the material.

Constraints

The rubber stamp started melting away. The silicone stamp did not.
Conclusion Tinkering Studies

The aim of the experiments was to get an understanding of Polyethylene, to identify the opportunities and constraints of the material. During the experiments the designer was guided by the behaviour of the material at hand. The distinctive material qualities, extracted from the experiments, aim to find new possibilities for the material and to attribute new meanings to the material. The discovered qualities are listed below.

Opportunities
- Products made out of Polyethylene are always waterproof.
- Out of the colorful input, the material creates colorful output.
- Ability to be shaped in many forms when melted.
- Ability of colors flowing into each other (when mixing and melting).
- Ability to stick to other materials as an adhesive (when melted).
- Material is floating.
- The material emits light when thin enough (thickness of approximately 3 millimeters)

Constraints
- The time of processing the material is short, due to the short cooling time.
- Shredded pieces are static and stick to skin.
- Strength and stiffness of the material decreases every time it is heated.

The qualities per processing step are further explained on the right.

Melting the material
The experiments showed that the oven is the most appropriate way of melting plastic. The oven can be set to a specific temperature, it encloses the material and it heats up the material in a uniform way. In addition the transition can be observed from bottle cap into molten material. Melting the material as a whole is preferred, since no cutting tools are necessary. In addition shredded pieces are static and stick to the skin, which is not desired.

Mixing the material
An important constraint is the short cooling time and therefore short processing time of the material. The molten material can be processed for one minute. Afterwards it is solidified. Mixing the molten material with wooden tools works very well since no gloves are needed for using the tools, there is more grip. Spatulas are appropriate tools for mixing. The molten material can be spread by using two spatulas, one in each hand. If the material is mixed inside a mold, no new waste is created, which is a strong point. Opposed to melting on a plate and cutting the right shape out of it. The decision is made to melt the caps inside a mold.

Shaping the material
The quality of the material to be shaped in many forms when melted, is very promising. E.g. pushing a stamp into the material gives a very detailed result. After mixing the material with wooden tools works very well since no gloves are needed for using the tools, there is more grip. Spatulas are appropriate tools for mixing. The molten material can be spread by using two spatulas, one in each hand. After melting the material can be processed for one minute. Afterwards it is solidified. Mixing the molten material with wooden tools works very well since no gloves are needed for using the tools, there is more grip. Spatulas are appropriate tools for mixing. The molten material can be spread by using two spatulas, one in each hand. If the material is mixed inside a mold, no new waste is created, which is a strong point. Opposed to melting on a plate and cutting the right shape out of it. The decision is made to melt the caps inside a mold.

4.2 Experiencing Polyethylene

Aim
The aim of the material samples study is to see how the material samples – created during Orientational Study 1 – are received by people. The experiential qualities of Polyethylene were discovered, on four experiential levels: sensorial (interpretations), affective (emotions) and performative (actions, performances). These levels are part of the experiential characterization of the material in the MDD method, as described by Giaccardi and Karana (2015).

Research Question
“What is the effect of the material samples on people?”. In order to find an answer to the research question, the following sub-questions were posed:
- What do people do with the material? (smell, stroke, bend etc)
- How do people describe the material? (meanings)
- Does the material elicit any particular emotions? (emotions)
- Is the material associated with other things or materials? (associations)
- Which samples are preferred and why?

Method
Participant Selection
Participants were master students from Industrial Design from the master directions: Design for Interaction, Integrated Product Design and Strategic Product Design. One participant had a background in Animation and Autonomous Art. In total nine persons participated.

Setup
At one side of the table, the participant was seated. The material samples were put on the table (Figure 42). At the other side of the table the interviewer was seated. A telephone was laying on the table, that recorded the things that were said. A template (Appendix C), was laying on the table with pictures of every sample, to write down the observations per sample.

Procedure
The interviewer explained the procedure of the research, namely: a graduation project with the aim to find a new purpose for plastic waste. The participant could start when everything was put on the table. There was no order. The participant could start with the ones...
Data Analysis

The transcriptions of the participants were processed into a list of quotes (Appendix D). Different marks were used:

- Pau_01: Number of quote per person.
- [B1]: Number of the sample.
- (Logo): Added explanation.
- <Bends>: Action of participant.

For example:

Mis_16: "It [B7] feels soft. <bends it> These are supermarket bags that you would usually throw away in the trash bin. The edges are hard. <tries to open it> It is crumpled."

Patterns and themes (e.g. ‘nature’) in the quotes were identified with the aid of statement Cards (Sleeswijk Visser et al., 2005).

The samples with the concerning quotes were divided into the four levels, with the MDD cards (Karan et al., 2015). The cards contain questions per experiential level and provide structure. Figure 45 shows two examples of an experiential characterization card. For all the cards, please check Appendix G.

Results

The results are described per identified theme and clarified with examples. The quotes are added in between brackets.

Intentional vs. Unintentional

Participants (Ann_21, Koe_35) appreciate it when the sample has the appearance of being created in a natural way. The uniqueness makes it interesting (Lau_07, Mis_09). Especially because usually the plastic bags and bottle caps are quantity produced. One participant stated “To bring back authenticity in products that are mass produced, is a weird contrast. I think it is good.” (Koe_30)

Sometimes imperfections are appreciated: “[...it does have nice irregularities][...]” (Ann_06) and sometimes it can look unfinished or useless: “[...I don’t like these useless parts <points at thread hanging loose> <picks it>.” (Ann_16)

EXAMPLE - UNIQUE

“[...] It is shaped in a more free manner than you are normally used to. [...] It makes it unique. It is interesting to look at.” (Mis_09)

Association

Shapes and colours can trigger associations.

EXAMPLE - COLOURS

“This [C2] is like clouds and air. <drops it> Blue is beautiful, it is the air but also the ocean. <feels with fingers> It works calming[...].” (Adr_14)

EXAMPLE - SHAPES

“Ok. These [B4] are balloons, you can see it because of this <points at ‘tuutje’>. The material really has changed. I can only see it because of this ‘tuutje’.” (Myr_22)

EXAMPLE - CORAL

“It [C3] looks natural, like coral. It is anti-coral! Plastic is far from nature and yet it looks natural now.” (Pau_13)

EXAMPLE - ORIGIN

“I really like this one [B2]. If you would injection mould this, you would lose all the letters. That is a pity. It is nice because of the letters, that you can see the origin. That people see it and say ‘O nice, this is recycled’.” (Lau_07)

EXAMPLE - IDENTIFY FEEL

“This [B7] feels nice and soft but if it feels soft I immediately have to think of plastic. <Bends it>” (Adr_05)

Intentional vs. Unintentional

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EXAMPLE - UNIQUE

“[...] It is shaped in a more free manner than you are normally used to. [...] It makes it unique. It is interesting to look at.” (Mis_09)

Nature

Some samples were reminded of things from nature. One sample [C3] reminded several participants (Pau_13, Lau_04, Koe_24, Myr_03) of coral. This made some participants (Pau_13, Lau_04, Lis_02) think that it is a contrast of plastic damaging nature and plastic having a natural appearance.

Story

Participants (Mis_06, Koe_12) appreciate it when there is a story behind the sample. Identifying what the material of the sample has been before needs to be exiting: “It [in general] has to be something exciting, the text, texture, colour. That you can’t see immediately what it is[...].” (Ann_05)

However, participants (Lau_07, Lis_15, Ann_07) do like to see what the origin was.

Identify

Participants can identify what the material has been through the brand/logo and through the colours: “[...] Was that <points at logo> 7up?” (Pau_17) The shape is used as well to recognize the origin. The sound also plays a role to identify the material.

Several participants indicated that the feel of the material plays a role in identifying the plastic.

Association

Shapes and colours can trigger associations.

EXAMPLE - COLOURS

“This [C2] is like clouds and air. <drops it> Blue is beautiful, it is the air but also the ocean. <feels with fingers> It works calming[...].” (Adr_14)

EXAMPLE - SHAPES

“Ok. These [B4] are balloons, you can see it because of this <points at ‘tuutje’>. The material really has changed. I can only see it because of this ‘tuutje’.” (Myr_22)

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“It [C3] looks natural, like coral. It is anti-coral! Plastic is far from nature and yet it looks natural now.” (Pau_13)

EXAMPLE - ORIGIN

“I really like this one [B2]. If you would injection mould this, you would lose all the letters. That is a pity. It is nice because of the letters, that you can see the origin. That people see it and say ‘O nice, this is recycled’.” (Lau_07)

EXAMPLE - IDENTIFY FEEL

“This [B7] feels nice and soft but if it feels soft I immediately have to think of plastic. <Bends it>” (Adr_05)
A summary of the results is shown below.

**Industrial versus Handmade**
Plastic is mainly used for industrial products that are mass produced. It is interesting that plastic can be unique through the colors and color patterns that are different every time. Besides, the plastic can have imperfections, like protrusions or irregularities, that can show that the plastic is handmade and authentic. These imperfections need to be small because when having many imperfections, it can look unfinished.

**Associations**
The association of plastic with nature is very interesting. Especially because plastic is damaging nature, and now it looks natural. Waves, clouds, fossils, crystals, bacteria’s are examples of associations that people had (Right page). Other associations with plastic were e.g.: paint, candy, candle grease and graffiti.

**Origin**
The participants liked to see the origin of the material through the logo, the colors, sound or the shape. People could also be surprised by the beauty of the material when they heard that it’s plastic afterwards. It is important that they get to know that it is made of plastic waste somehow.

**Emotions**
The emotions surprise, fascination, disappointment, confusion and disgust were triggered among people. Surprised by the color patterns and fascinated by the discovery of an H&M logo on the sample [B2] or by the association of a sample with a fossil [C16]. Disappointment was triggered by one participant because the origin of the material could not be recognized. Participants were confused due to the fact that the plastic had a natural appearance. Disgust was experienced when looking at the sample with metal in it [C4].

**Meanings**
The material can be experienced as: unique, personal, beautiful, natural, organic, arty, designy, fragile, rough, interesting, high-quality, dirty and cheap.

**Performative qualities**
It makes people: bend, stroke, prick, drop, press, hold against the light, hold carefully or scratch with nails.

**Sensorial Qualities**
The unique sensorial qualities of the material are the layers or patterns, the natural appearance, the soft and smooth feel and the color combinations (Figure 47). The least pleasing sensorial qualities are the protrusions, scratches and dirty appearance (Figure 48). For all the results, please find the MDD cards in Appendix D.

On the next pages, the associations of the material with nature are shown (Figure 49) and a framework is presented that categorizes results of the study into the different experiential levels (Figure 50).

**Discussion**
Samples
The samples do not differ that much in size, which might bias the results. People could identify the plastic bags, possibly due to sample [B7], which was very recognizable.

Participants
Students from Industrial Design already have some background knowledge about plastic materials; maybe more creative. The participants already knew that the project was about plastic waste. Participants were sometimes influenced by other people walking around. Those people who didn’t know that the project is about plastic waste, thought (2 persons) that it (the samples) was paint that was laying on the table. The participants were Dutch. So translating the remarks, might influence the results. For example the Dutch words ‘leuk’ and ‘mooi’ are translated into ‘nice’ and ‘beautiful.’ These words can have a slightly different meaning in English.

**Conclusion**
The initial aim of the material sample study was to find out what the effect is of the samples on people, considering the four experiential levels (performative, sensorial, interpretive and affective). It is discovered that the material can surprise people and can make people do (stroke, bend, drop). The associated meanings of the material, natural, unique, personal and beautiful, are very inspiring and distinctive to continue with. The meanings can create new material experiences.
Figure 49 - Associations of Polyethylene with nature.

Experiential qualities, Performative qualities, and Sensorial qualities are interrelated in the Experiential characterization framework. The diagram illustrates how these qualities can influence our experiences and associations with Polyethylene. For example, fragility and beauty might be associated with Polyethylene, while durability and practicality might come from its use in everyday objects.

Table of Associations:
- **Associations of material with nature**
- **Experiential Qualities**
  - Beautiful
  - Unique
  - Personal
  - High-quality
  - Interesting
  - Natural
  - Organic
  - Arty
  - Designy
  - Cool

- **Performative Qualities**
  - Sharp
  - Scratchable
  - Fragile
  - Strong
  - Soft

- **Sensorial Qualities**
  - Smooth
  - Brick
  - Hold it
  - See layers

- **Emotions**
  - Surprise
  - Fascination
  - Disgust
  - Confirmation
  - Confusion
  - Beautiful
  - Rough
  - Practical
  - Funny
  - Unique
  - Personal
  - High-quality
  - Interesting
  - Natural
  - Organic
  - Arty
  - Designy
  - Cool

- **Actions**
  - Hold it carefully
  - Scratch over it
  - Bend it
  - See layers
  - Sounds fun
  - Feels soft
  - Protrusions
  - Looks dirty
  - Scratches look cheap
  - Afraid to touch
  - Looks natural
  - Color combination

- **Objects**
  - Paint
  - Candle grease
  - Graffiti
  - Balloons
  - Donut
  - Candy
  - Newspaper
  - Parts of books
  - Heaters
  - Flower
  - Fossil
  - Clay
  - Crystal
  - Growth rings of a tree
  - Clouds
  - Sea urchin
  - Structures of cells
  - Tie-dye/hippie
  - Wrinkled cloth
  - Football
  - Coaster
  - Chewing gum
  - Toothprint
  - Turd
  - Iron beads
  - Dust (when mixed with metal)
  - Universe (when mixed with metal)

- **Process**
  - Press in it
  - Pick it
  - Hold it close to eyes
  - Rotate it
  - Hold it against the light
  - Sensorial qualities

This framework can be used to understand how Polyethylene interacts with nature and human experiences.
4.3 Focus on bottle caps

The material Polyethylene (HDPE caps and LDPE bags) came into focus early on. Subsequently the opportunity of colors flowing into each other was found.

HDPE bottle caps have many different colors, illustrated in Figure 51. Besides they do not need a lot of room to store and are fun to exchange, like flippo’s. In addition, the caps can be melted as a whole and do not need to be shredded first. For these reasons it was decided to focus on bottle caps.

Caps on shampoo and shower gel bottles are excluded because of the chemical substances inside. If not cleaned well, these substances (leftovers in bottle) can be toxic when heated. Therefore the focus is on bottle caps of drink packages. With soft drinks and juices, it is mainly the sugars that can burn, which are not harmful. Still, it is important to clean the caps well. The leftovers can cause stains on the end result.

High Density Polyethylene bottle caps can be found on cartons of milk, yoghurt and juices. Besides they can be found on -0.5 Liter, 1 Liter and 1.5 Liter - bottles of soft drinks. Figure 52 presents an average refrigerator and the bottle caps that can be found.

Figure 51-Bottle caps in many different colors.

Figure 52-Polyethylene bottle caps on milk cartons, juice bottles and soft drinks.
5.1 Production Processes

Aim
The analysis of current production methods was done to gather inspiration and to find out possible new areas for production methods.

Research Question
What are current production methods around plastic waste?

Method
Existing solutions were selected through delving into material websites (http://materia.nl/), design inspiration websites (http://design-milk.com/) and sites around sustainability (https://www.voordewereldvannorgen.nl/). The search for production methods was taken broader than only plastic waste in order to be more inspired by several production processes.

Data analysis
The production methods were categorized with the aid of the Material Benchmarking cards and table. The experiential opportunities and constraints were identified. Figure 55 shows an example of a MB card used for production methods. For the table and all of the material benchmark cards, please check Appendix F.

Results
Most production methods leave the making process to the designer. A few solutions do involve the user in the making process. The Perpetual Plastic Project aims at empowering consumers by letting them create something out of plastic waste with the aid of an interactive installation (Bos, 2014). People can create 3D-printer filament out of plastic cups, with a shredder, an extruder and eventually the 3D-printer prints a ring out of the filament. Next to this, López Pradas (2014) created a toolkit for people to make things out of plastic waste. The toolkit allows people to weld, carve and cut plastic. Note that people need inspiration to create things. Figure 54 shows both projects. One example of the existing solutions (Duffy et al., 2014) can almost be seen as a craft. The designers created a sneaker, made from 100% recycled plastic (Figure 53). They created it by making a sheet of plastic and folding it around a mold in the form of a shoe. Every step is done by hand, with a lot of dedication and attention. They even made
many holes in the plastic by pricking into it with a knife for the shoe lace.

A project of Steenfatt (2013) can be compared to baking. The designer made a dough out of leftovers from wood-, coffee- and skin production. From the dough, a flat sheet of material is made by pressing and rolling the dough (Figure 56). This processing method is very original and makes every sheet of material unique. Also, this production method allows to be in direct contact with the material.

Figure 57 shows examples of processing methods, divided into two categories: few and much contact with the material. Contact with the material is when you can really feel the material; you can feel the viscosity and textures. The first category, few contact with the material, can either be a machine that can be operated by a person, by rotating a handle (Perpetual Plastic Project, 2014): a shredder or extruder. Or it can be a machine that does all the work: e.g. a 3d-printer. With machines the user has little influence on the end result, since this is often pre-determined. It is a passive activity. The other category involves processing methods for much contact with material. The hands need to be used for making and the person is really involved. The hands can be in direct contact with the material, e.g. with claying, or the hands can operate a tool, e.g. sculpting with a hammer and chisel. These are active activities and inspiration is needed. A person has much influence on the end result.

Figure 56–Inspiration project (Steenfatt, 2013). Making dough from leftovers.

Figure 57–Conclusion of existing solutions for processing waste.
5.2 Material Applications

Aim
The purpose of this step is to map current solutions around plastic waste; to see which material qualities are already incorporated into an application and to find new application areas.

Research Questions
What are current solutions for plastic waste? or Which material qualities, found in chapter 4, are already incorporated into an application?

Method
Existing solutions were selected and categorized into the material qualities that were found in chapter 4.

Data analysis
The material benchmark cards were used to categorize the applications into experiential opportunities and constraints, activity opportunities, application opportunities and ultimate purpose opportunities. For all the cards and table please find Appendix F.

Results
Figure 58 shows the discovered material qualities, already implemented by others. Common application directions are furniture and decoration. Other application directions are: art, gifts, clothing, toys and sports/leisure.

Figure 58-Framework of existing solutions for products out of waste.

5.3 Conclusion

The aim was to map current production methods and applications for plastic waste.

It was found that production processes often focus on end results, rather than making process. This leaves little room for expressions through inherent markings and traces from these processes, other than what was specified beforehand.

The quality of arising color patterns in the material is already applied in several applications. In these applications, the material quality does not make sense. For example: “What is the aim of translating the color patterns into a chair or table?” An example of an application that does make sense is the planter. The quality of being waterproof is implied in a product for outside.

The quality of color patterns in combination with the semi-transparency of the material, is not commonly applied in the already existing solutions.

The selected material qualities are summarized on the right. The qualities are divided into the experiential levels of the MDD method.

Experiential Levels
- Sensorial level (aesthetic)
  The different colors of the bottle caps flowing into each other, when melting, create a beautiful appearance. The transition from bottle caps into new material is visible while processing it. Processing by hand makes people feel the material, treating it like dough or clay. The material is semi-transparent. Holding the material patterns against the light, gives a magical effect and the stratification is visible. It enhances curiosity. Usually with plastic products, only the finish is visible; the outer layer.
- Interpretive level (meaning)
  The way in which the different bottle caps fuse together during the melting process, varies every time. Therefore every creation is unique. Beauty is the meaning attributed to the material’s unexpected patterns. The plastic can have a natural appearance, like a crystal, that can surprise people. There is a contrast between plastic polluting nature and plastic having a natural appearance. This can make people think.
- Affective level (emotions)
  When mixing different colors of bottle caps in a melted state, patterns arise. These patterns are unexpected to arise and people will be surprised. Fokkinga and Desmet (2013) defined the emotion of surprise as follows: “To be pleased by something that happened suddenly, and was unexpected or unusual.”
- Performative level (actions)
  By being part of the making process, people can be more surprised about the material. They can have influence on the outcome and therefore really make it their own. They are performing a physical activity, in order to process the material.
6.1 Material Experience Vision

As described in the previous chapter, current solutions for plastic waste materials already incorporate the wonderful patterns that can arise by melting the material, but the focus is often on the outcome. The designer is the one who is involved in the making process and the one who can be surprised about the color patterns arising in the material. Showing others the end result will not transfer the same surprising feeling that the designer experienced. It is the personal experience of the making process that adds value to the product. When the user experiences the transformation of ‘waste’ into a new material him- or herself, the user will be more aware of the possibilities and value of ‘waste’. The waste will no longer be seen as waste, but as valuable material.

“I want the material to surprise people and make people process the material to a certain extent.”

The semi-transparency together with the color patterns and uniqueness (Figure 59), makes people see the waste material as valuable.

“I want to let people see the beauty and value of plastic waste materials.”

Vision

In this chapter the vision for the material is presented, together with a set of design requirements.
6.2 Activity of making

**Aim**
Find out why people want to make things to back up the choice of letting people process plastic waste themselves.

**Research Question**
"Why do people want to make things?"

**Method**
A literature study was executed.

**Results**
Since industrialization people purchased their goods instead of making them. The consumer is left with a passive attitude, the user is not involved in the product development and the consumer’s need is often created (Hoftijzer, 2012) for the sake of making money. These goods have been produced with the aid of automated processes and quality controls, that have led to the almost total elimination of errors and imperfections (Rognoli et al., 2015). Rognoli et al. (2015) indicated that what we have witnessed across the last century, is the dominance of an aesthetic model tied to perfection in every sphere of human life. Passive consumption is in contrast to people’s needs (Atkinson, 2006). People have an innate urge to be creative (Csikszentmihalyi, 1998; Nieuwenhuys, 1969) and are in possession of the ability to create (Csikszentmihalyi, 1998), as mentioned by Hoftijzer (2012). People are getting more involved in the design process as active participants (Press, 2007). People often spend time on creating things, because they want to feel alive in the world; they want to be active and recognised (Gauntlett, 2011). Atkinson (2006) stated that when making something, the feeling of being your own boss can be experienced. People consist of the desire to have control (Rompay, Galetzka et al., 2008; Thompson and Schlehofer, 2008). By making, people can express themselves (Rognoli et al., 2015; Atkinson, 2006), leave traces (Sennet, 2008), make their mark on the world and make the world their own (Gauntlett, 2011). Research (Thaler, 1980; Kahneman et al., 1990, 1991) has shown that if people create their own object, they interpret it more as “theirs”, compared to when they just buy it, as mentioned by Franke et al. (2010). Simply buying an object, might lead to a far lower degree of psychological ownership (Pierce et al., 2003), which can be defined as: “the state in which individuals feel as though an object is theirs” (Pierce et al., 2003). Marx (1978) even said: “If the production tools are not owned by the man who uses them, he is related to the product of this work as to an alien object.” The process of making it is enjoyed for its own sake, since there is pleasure in seeing a project from the start to finish and the process provides space for thought and reflection (Gauntlett, 2011). There is anticipation about how the end result will be and when finished, there is pride (Hoftijzer, 2011): “Look, I made this, I made it myself”. The person wants to share the result with others, impress them. In this way, the person is connecting and communicating with others, as interpreted from Gauntlett (2011).

In addition, by making, people will be more aware of the used materials, since they are forced to arrange the materials in some way. The people will learn about the materials as soon as they start to process them. They will learn about e.g. the strength or heat resistance of the material. The actions and consequences of people are more visible when making yourself. You will start to look at things differently. For example if you made a teapot, you will look at other existing teapots and see how they are made, what materials are used et cetera. It is important that the material is attracted by people. Sennett (2008) states that whether a craftsman is willing to do good-quality work, depends on the curiosity about the material at hand. When people make things, there will be imperfections in the material. These imperfections show that the artefact is made by a human and that human beings are not perfect either. Rognoli et al. (2015) state that valorising imperfection is a way of expressing workaday reality and creating innovation.

**Conclusion**
There are many reasons why people want to make things, but the most important is the urge to express themselves and make their mark on the world. Therefore it is important that the production method offers much room for people to personalize their product.

6.3 Motivation for material

People need motivation to do something with the material at hand. This can be done to show material applications made of bottle caps, the ‘eye-catchers’, to people. People might start questioning where the product is made of and how. When finding out that the product is made out of plastic waste materials, people will learn that plastic waste can be beautiful. The applications can attract people’s attention and motivate to make or buy one themselves.

People will start to collect bottle caps, because they can do something valuable with them. Besides, it is a fun activity to collect bottle caps. It can be compared like collecting flippo’s. You are searching for the right image or color and you can exchange them with others; a treasure hunt.
6.4 Baking as a metaphor

The process of baking a pie is used as inspiration (Figure 60) for processing the bottle caps. The anticipation in front of the oven, the melting and mixing of the bottle caps in a baking mold, matches with the baking process. The steps of the baking process are shown in Figure 62. People were asked if they like to bake and why. Different elements around baking were collected from the reactions and are summarized in the mindmap in Figure 61. Baking is experienced as a relaxing activity and leaves room for expression.

Figure 60-Inspirational images of baking tools.

Figure 61-Results from respondent’s answers on the question what do you like about baking?

Figure 62-Steps of baking a pie.

6.5 Direction of light

The chosen direction for the material application is light. Light enhances the beauty of the material and gives an extra dimension to the material. Inspiration was retrieved from the images in Figure 66 on page 70. Experiments were done with the material to find out how the processed material trigger surprise with the aid of light. The experiments are described below.

Surface finish

The surprise effect can be enhanced through the surface finish of the material. When pressing a stamp into the material and placing the material with the stamp downwards, the stamp is not visible. If the light goes on, suddenly the stamp appears (Figure 63), like a smart material.

Imperfections

Since the material is processed by hand, it will have some imperfections. In this case these imperfections can enhance the beauty of the material. In Figure 64, an example is shown of a sample with an irregular surface that is created by mixing the material with the spatulas. The side of the irregularities is rather ugly. However, if you turn this side and hold it against the light, these irregularities make the material even more exciting.

Colored Light

Colored light (led-strips) changes the appearance of the material. Some colors strengthen and some weaken each other (Figure 65).

Figure 63-The stamp into the material that becomes visible when the light turns on.

Figure 64-Irregularities can look ugly (left) and can make the appearance exciting (right).

Figure 65-Material sample (left) with light blue led light (middle) and purple led light (right).
6.6 Design Requirements

The requirements are divided into the requirements for the service and for the product.

**Service**
- User needs to (partly) collect his/her own bottle caps.
- The material needs to be processed in a safe and accessible way:
  - Precise oven with constant temperature
  - Maximum temperature is 190 degrees Celsius
  - Oven Gloves against heat
  - Area with Ventilation or outside
  - Tools that are easy to operate
- The mold needs to fit in the oven.
- User needs to be motivated to make something:
  - Workshop time is 120 minutes.
  - User needs to see patterns arising.
  - User needs to be attracted by the product he/she can make.
  - User can make one finished product in a workshop.
- The user can express him or herself in the making process. There is room for personalization.
- The material needs to be used as a whole; so no waste is created.

**Product**
- The material qualities need to come forward in the application:
  - Beautiful (color patterns)
  - Colorful
  - Unique
  - Semi-Transparent
- The product surprises people.
- The product can be made within one workshop of 120 minutes.
In this chapter the development of the service and development of the material applications are discussed separately.

The design phase is split up into the design for the material application and the design for the service around the material. The overview is presented in Figure 67.
7.1 Service

This paragraph describes the development of the service around the material application. The service implies the collection of the bottle caps and the processing method of the material. At first the collecting aspect is discussed and after the processing method.

Collecting bottle caps
The collecting part of the service is discussed below.

Aim
The aim was to explore different ways of collecting bottle caps and to see how the activity can be fun and attractive.

Research Question
How and where can bottle caps be collected?

Method
I have collected bottle caps myself in the Netherlands and Portugal. Other people have collected caps for me in the Netherlands, Tenerife and Equatorial Guinea.

Data analysis
Experiences were written down and pictures were taken. The results were translated into stories, divided into stories about me collecting caps and other people collecting caps for me.

Results
Stories about me:
- "I searched for bottle caps on the beach in Portugal (Figure 68). It felt like collecting shells, like a beach combor. I thought: What if you people have to do something, in exchange for taking a shell home, like picking up one piece of waste; one for one?" 
- "I asked the airports Schiphol and The Hague Airport if I can have caps of the gate. After a long silence on the phone, woman of Schiphol told me that it is not allowed, because it would diminish their rate of recycling. However, at the restaurant/bar of the airport, many drinks are consumed and these bottles are just thrown away and not recycled. My plane was delayed so I had to wait for two hours. So in these two hours I asked people in the restaurant if I can have their bottle cap. The waiter of the restaurant even made a special cup for me to put in all the bottle caps he picked up from the tables. The waiter saw that he made me happy by doing this, so this worked as a motivation for him to do a little extra effort. Result: fifty caps in approximately two hours at one restaurant."

Stories about other people
- My roommate collected bottle caps for me. When I walked out of my room, suddenly this smiley of bottle caps was welcoming me. My roommate had a very special way of giving the collected caps to me (Figure 69).
- A friend who works in Café Zondag placed a cup behind the bar so that the waiters can put the caps inside the cup, instead of throwing them away. After a while she gave me several bags filled with caps. This was a smart way of her to collect the caps.
- In my house a "doppenpot" was made and placed on the kitchen table (Figure 71) so that all eleven roommates could place their cap inside.
- A friend who worked at a hostel in Tenerife collected

Figure 68 – Me searching for bottle caps on the beach in Portugal.

Figure 69 – My roommate who surprised me with a smiley in front of my room, out of bottle caps.

Figure 70 – Picking up 60 kilos of bottle caps in a shed. Made possible by Kika’s campaign ‘Doppen voor Kika’.

Figure 71 – The ‘Doppenpot’ in my house.
all the caps of her water bottles and those of the guests. You cannot drink tap water, so many bottles were consumed. I went there during my birthday and one of the birthday presents was a bag of 125 bottle caps, collected during one and a half month.

- My mother saves all the bottle caps from the milk, yoghurt and juice cartons and also of the bottles of soft drinks, after I told her that you don’t need to hand in the bottle caps to get your deposit of 25 cents in the supermarket. She saves them, washed them in the dishwasher and then gives them to me (Figure 72).

- Kika runs a campaign called “Doppen voor Kika” (http://www.doppenvoorkiego.nl/). People throughout the Netherlands collect bottle caps and bring it to the collection points. At these points a recycling company picks up the caps and pays 20 cents per kilo. This money goes directly to Kika. I called the founder Monique and asked her if I can buy the caps instead of the recycling company. I explained her my idea of making new things out of caps and she was very enthusiastic. Kika could be the supplier. I picked up 60 kilos of bottle caps in a shed in Brabant (Figure 70). And the great things is... this initiative has no end date! So people are constantly collecting bottle caps.

Conclusion
Collecting caps can be very fun and also personal. You can make someone happy with it and you put time and effort in the activity of collecting (Figure 73).

It is important that people collect themselves to experience the fun of collecting and people can really feel like they contributed to the product that is made. The initiative of Kika is a good way to gain a supply of extra bottle caps when needed.

Processing molten bottle caps by hand
This section describes the development of production methods, that are suitable for the envisioned service. The emphasis of the search lies on attainability within this specific context, as opposed to the broader research described in chapter 4.1, which was aimed at material understanding.

Aim
Experiment with which production method(s), the molten material can be processed into a finished shape by hand.

Figure 72 - The bottle caps placed in the dishwasher for cleaning at my parent’s home.

Research Question
How to process the material into a defined shape by hand?

Method
The following experiments were done with the material:
1. Make a big surface of the material flat.
   - with wooden rolling pin.
   - with warmed up metal cylinder.
2. Create three-dimensional shapes.
   - with two warmed up metal bows, pressed on top of each other.

Results
1. Make a big surface of the material flat.
   In order to get the patterns, the material needs to be mixed. However, when mixing a large amount of bottle caps, a thick piece of melted plastic arises. Making this thick piece flat again with the rolling pin does not work. You do not have enough force and the cooling time is very short. Besides, the material needs to be thin enough for the light to shine through. With small pieces (around 7 caps) you do have enough time to mix and to make it flat. Figure 74 shows the results of making the piece of plastic flat with a warm metal roller on a warm plate. The tools were heat up, to try if the material cools less fast. This did not work; the material got stuck against the roller. Without mixing the caps, it was possible to press the material with a rolling pin (Figure 75). However no patterns arise when you don’t mix the material.

3. Fold the plastic.
   - with a metal form.
   The results are described per experiment.

Figure 74 - Using a warmed up roller to make the material flat.

Figure 75 - Result of making the caps flat with the rolling pin without mixing.

Figure 76 - The outcome of melting bottle caps in between two bowls and pressing it by hand.

Figure 77 - Result of pushing a metal form into the material (left) and trying to heat up and fold the material with a hot wire (right).
hand: there is not enough force and the material cools down too fast. Figure 76 shows the result of melted bottle caps in between two bowls and pressed.

3. Fold the plastic
When pressing a form (triangle Figure 77) into the material, the material can be folded if it is still warm. The thin edges serve as a film hinge. Cooled down, the material breaks when folding. Pressing a form into a sheet of material, means that everything around this form becomes waste. An option is to make jewellery out of these space edges (Figure 78). However, it is better to have no waste. It is also tried out to heat up the an edge of material by placing it above a hot wire. The material got stuck against the wire and the remainders of material attached to the wire started to burn and released fumes. It is not a safe option.

Conclusion
The research question, posed was: “How to process the material into a defined shape by hand?” Different experiments were tried out. Two-dimensional shapes are possible to make flat, smooth and look finished by hand. The short cooling time forced participants to remelt and shape the material multiple times, as the material was already solidified. This causes a long waiting time for the participants during a workshop. For this reason people will make small plates. This decision affects the application as well. The application will exist out of multiple small plates that can be attached to each other. The further development of the application is written in paragraph 7.2.

Workshop

Aim
In order to determine to processing qualities of the material, a workshop was given.

Research Question
“to what extent do people like the activity of making something out of plastic bottle caps?” The following sub questions were created in order to answer the main question:
- What do people want to make out of the bottle caps?
- What do people find a valuable product to make?
- Which production processes do people like?
- How long does it take for participants to make an object?

Method

Participant selection
Five participants were selected.
5. Sam, Male, 24, Student Industrial Design – Master Design for Interaction.

The first three letters of each name are displayed to indicate the participant and to maintain privacy.

Setup
The workshop was given in the welding lab at the faculty of 3me, because of the strong exhaust and large space.

Procedure
Duration workshop: 10.15-11.30 → 75 minutes.
At the start an explanation was given about safety of melting plastic and the temperature of the oven. The procedure was explained. Participants were asked to put the baking mold with six bottle caps into the oven. The participants were told to wait until the plastic bottle caps have an entirely shiny appearance, which means that the caps are melted and ready to process. When the caps are melted, the mold with caps was taken out of the oven.

A. Tile
Place the melted bottle caps into the mold for the tile. Push the handle bar on top of the mold. Wait a bit. Take out the tile by pushing the hole on the bottom of the mold; the plate with tile comes up. Let the tile cool down.

B. Number
Make the melted bottle caps flat by rolling over it with a rolling pin. Press the push-out form of the number on the melted plastic. Let the plastic cool down. Press the number out.

C. Stamp
Make the melted bottle caps flat by rolling over it with a rolling pin. Press the stamp and wait a bit. Remove the stamp and let the plastic cool down.

D. Free choice
The participant is free to come up with an idea him/herself. Guidance is given.

Object

Way of processing

Pictures

Table with different objects and the procedure for making them.

The participant kneaded the bottle caps with a spreader or hands covered in heat resistant gloves. The mold with caps was put back in the oven. When the caps are melted again, the participant processes the material in one of the possible ways: A,B,C or D (see table). The participants took home their made objects. At the end the participants were thanked for their participation. An evaluation form (Appendix G) with questions about the workshop was sent to the participants. The filled in form is presented in Appendix H.

Results
Two Participants (Kar_01, Els_01) indicated to like the freedom they had and to do what they wanted. The new technique of processing plastic was appreciated (Wes_01). It was experienced as baking. Ann_01 stated: “It was a lot of fun. It felt like baking but then better.” Another participant mentioned: “…I sort of treated it like clay or cookie dough.” (Kar_06)

The moment when the plastic bottle caps started to melt was really liked among the participants (Ann_02,Els_02, Wes_02). “I liked the moment you saw the colors mixing and the material melting, that you really see it changing in something else (Els_02).” Also, kneading the plastic with your hands was an enjoyed moment (Kar_02,Sam_02). “I didn’t like it that we had to wait for the plastic to melt in the oven, I am impatient I wanted to make stuff.” (Kar_02).
The silicone stamp was used by two of the participants. The Stanley knife, mold for the tile and contour numbers were used by three of the participants. Four participants used the rolling pin. All participants used the gloves and spatulas. The participants made: a number (two participants, Figure 84), a tile (one participant, Figure 82), a plate with ‘home made’ (one participant) and a surfboard model (one participant). Buttons were created as well (Figure 83). One participant (Kar_04) liked using the rolling pin to make the plastic flat. Sam_04 indicated that the gloves were one of the tools he liked to use: “THE GLOVES! touchy feely with a material that is used so much but never like this.” Wes_04 said that the contour cutters for the numbers and the rolling pin were very effective. The Stanley knife was easy for cutting the plastic when melted (Ann_04).

There are different reasons for choosing to make a specific object. The Els_06 said that she wanted to make something that made her smile. Kar_06 has a different reason: “[…] I wanted to make something that I could “use” and would not just be laying around in my room. I already have enough random stuff laying around in my room.” Two participants (Sam_06, Wes_06) wanted to make something as decoration. One participant used the colors of the made object in a special way: Els_07. It (the object) is in my office, and when I’m bored I start holding it and looking at the colors […] Wes_07 uses the surfboard object he made as inspiration now.

The participants had varying answers on the question what they wanted to make out of bottle caps. Jewellery, buttons, a lamp shade, surfboard fins, coat protectors for the bike and floor tiles were given answers.

Conclusion
The initial research question was: “To what extent do people like the activity of making something out of plastic bottle caps?”

Different production processes have been explored and have proven to be attainable in the desired context of DIY plastic production.

The excitement and commitment displayed in the workshop showed that making something out of plastic waste is an activity in which you can fully immerse. The process of anticipating in front of the oven, kneading the melted bottle caps when wearing gloves, using the rolling pin and pushing a shape into the material, feels like making cookies or playing with clay. The feeling of baking something is enhanced, since the same tools are involved.
### 7.2 Material Application

This section describes the creative session and brainstorm.

**Aim**
Finding out of the box solutions for material applications with light.

**Research Question**
What are possible applications or application areas for the material with the aspect of light?

**Creative Session**

**Method**

Participant selection
Five participants were selected for the session: three females and two males. All the participants were students of the Master direction: Design for Interaction.

Setup
The participants were situated around a table. The facilitator provided drawing material.

Procedure
The duration of the session was 75 minutes. The diamond model (Tassoul & Buigé, 2007) was used for the setup. This model consists of three diamonds:
- Problem analysis and problem definition.
- Idea generation and idea selection.
- Concept development.

In this session only the first two diamonds were used. For the session plan and all results, please check Appendix I. Each diamond consists of a diverging and converging phase. The second diamond was specially used for the diverging phase. At first the problem was explained, namely finding an application for the material with light. An idea dump was created on a flipover sheet. If a participant already had an idea, he or she could write it down on a postit and place it on the idea dump. The ideas of the idea dump were used for the second diamond. The first assignment was to write down or draw all the associations the participants had with light. This is called the “purge”-phase, or “shredding the known” (Tassoul, 2009, p. 29). The participants were free to empty their minds and to write down everything that comes up. Ideas come up and if these haven’t been shared, the participants will continue to hold on to these. Therefore it is good to share everything in the first diamond. The material was not yet shown in order to prevent limiting the participants in their creativity. A flip over sheet was placed down on the table, together with some inspirational images and postits. After fifteen minutes the material samples were put on the table and the participants were asked to study them and write down other associations that came up (Figure 85). All the ideas were clustered. Each participant was given four stickers, that needed to be placed on the ideas that the participant liked most or found most inspiring. All these ideas were placed on a sheet together and the participants were asked to create a design goal out of these results. Five How-To’s (Tassoul, 2009, p. 184) were formulated in order to create many solutions for the given design goal later. In the second diamond the How-To’s were placed on the table. Each participant had one How-To in front of him/her and 2 minutes to write or draw solutions for the given How-to (Figure 86). After this two minutes the sheet was given to next participant who continues; a clockwise rotation of sheets. This method is called “brainwriting” (Tassoul, 2009, p. 54). When every participant has had every sheet, the brainwriting is finished. Each participant was asked to read out loud the ideas that he or she found most inspiring. The session was closed.

**Setup**

The participants studying the material samples.

**Results**

The associations with light were clustered by the participants into different groups, see Figure 87. The formulated design goal of the participants was: How can you use this material to show the dynamics of natural light? Five sub questions were created, which are discussed below. Per sub question the most interesting and useful solutions are highlighted. The first question was: “What should be the atmosphere of the light?” Inspiring answers were: natural, intuitive and subtle. Another answer was the light of waking up or going to bed. The connection with the sun is interesting. The second question: “How can you influence the material through light?” The participants wrote down that it can be influenced through a varying thickness of the material. So thin pieces emit more light than thick pieces. Also, by placing different sheets of the material over each other. Holes can be applied or other shapes where the light can shine through. Through movement was given as a solution. The material moves according to the light. This can be done for example by moving the material over the light source. The third question was: “How can you make artificial light look natural?” The participants indicated to achieve this by playing with the color of the light and the light intensity. When varying the light intensity the effect can be obtained of a candle. For colored light, led-strips can be used.

![Figure 86 - Brainwriting with How-To’s.](image)

![Figure 87 - Clustered associations with light.](image)

“Which material properties can be communicated and how?” Inspiring was the answer of the imperfections. Participants also liked to see the origin of the material by seeing the original bottle caps somewhere in the final product. The thickness can be communicated as well. The fourth question was: “How can you make light dynamic?” Again the answer of movement was given, so either the material moves or the light. The element water was given as a solution as well, namely by making use of the reflection on moving water. One solution really extends the surprise effect that occurs during making. When you hide something in the material that you can only see when the light goes on, this surprising effect occurs when using the final product too. The last question was: “How can you make artificial light look natural?” The participants indicated to achieve this by playing with the color of the light and the light intensity.
Brainstorm

Method
A brainstorm was done with three students. Together with the students, products were written down that come in contact with light.

Results
Conventional solutions were found like a lamp shade or candle holder, but also more original ones. For example: a postcard on a line, swimming pool tiles or something floating in water. The solutions made use of artificial light, natural light and reflection of light. All solutions are shown in Figure 88.

Context
Since the product looks natural, the product makes most sense in an environment which lacks nature. Like a house in the city: ‘Bring back nature in your home.’ E.g. the application placed on the beach does not make sense, since the beach and the ocean already provide relaxation and beauty enough to look at.

For me nature serves as a way to relax and to be amazed by its beauty (Figure 89). Therefore the product is placed in a relaxing environment in which it can be observed well. It provides ambiance, decoration and light. Examples of such environments are a restaurant, bedroom and living room. In a restaurant people have to wait for their food and the table with tableware are the objects that are well observed. The bedroom is suitable for both adults and children. For children to be less afraid for monsters underneath their bed or for grown-ups as ambiance light. In the living room, the product can be placed on the coffee table. This table is often placed in front of the couches; a place to relax after a day of work. The window-sill is also suitable, since the daylight can be used well.
Concepts

Three concepts were worked out and tested with a prototype. These concepts are examples of what you can do with the material, focused on light. Of course there are more possibilities, but this is a selection.

Nature in a Frame

This concept consists of a wooden frame with a plate of plastic inside and light behind it. The idea is that you can hang up the product on the wall or place it in front of the window. It is a mix of a painting and ambiance light. Through the light behind the material, it seems that the plastic material is infinite. Experiments were done with colored led strips, with candle light, daylight and with white artificial light. Led strips are easy to attach, but the colored strips are not suitable. The colors are too present and distract the attention from the material (Right: Figure 92). White artificial light (Left: Figure 92) and daylight (Figure 93) are appropriate. For more pictures and movies of the experiments, please check my blog: https://projectcamp.us/projects/a-new-taste-for-plastic-waste/items.

Figure 90 - Drawing of the concept.

Figure 91 - Making process of concept.

Figure 92 - Concept with artificial light. Left: with a surface of white light. Right: With colored led strips.

Figure 93 - Concept with daylight.
Window Curtain
This concept makes use of daylight. It decorates your window and gives some privacy. It consists of plates that can be attached to each other with simple rings. For the exploration study of an appropriate connection method to attach the plastic plates, please check Appendix J. With appropriate is meant: a type of connection that is easy to attach and does not distract attention from the material.

The amount of openness can be adapted through changing the amount and position of the plates. A strong point of this concept is that people can keep building and create a big surface of plates. So they need to come back for a workshop. Figure 94 was used as inspiration. It has the idea of butterflies and has a playful and subtle appearance. The plastic plates can be folded, as explained in the previous paragraph. It is possible to play with the light and discover the material.

Table Buddy
This concept consists out of building blocks that can be attached to each other.

Shape
Figure 98 shows the images that were used as an inspiration source for the shape. These shapes are simple but attractive. Several experiments were done with cardboard and tape, to come up with different arrangements and shapes. The shapes need to enclose the light, exist out of a maximum of 6 plates (in 1 workshop of 1.5-2 hours, 6 plates can be created) and with the same building blocks, multiple arrangements need to be possible. If the shape gets boring, the person can either change the arrangement of shapes or come back for a workshop to extend the product. An inspiration booklet is provided for inspiration. Three different shapes were created that can be assembled. The experiments of the shapes are presented in Appendix K.

Connection
The connection method needs to be easy for people and needs to give the total product a finished look. These two requirements seemed to be difficult to go hand in hand. Different connection methods were tried out, that can be found on the next pages. For all the images of the experiments, please find Appendix L.
Different connection methods were tried out in order to find one that is easy to attach, stable and does not distract from the material. The product needs to have a finished look. In Figure 100 all the processes are shown, together with the tools used. Figure 101 shows the stamps that were made and used to create the plastic plates.

**Melt edges together**
No extra material is needed for this attachment method, the material is the glue. However, it was hard to only melt the edges of the plates and to position the plates. The rest of the plate warmed up as well and buckled. The heatgun became too hot and fumes were released.

**Thread through holes**
Threading the rope through the holes was very easy. Making a tight and stable knot on the inside was not possible, due to the enclosed shape. There was no room for your hands. A knot on the outside creates an unfinished appearance (Figure 102).

Tie-wraps were easy to attach and to pull for stability. This connection has a cheap and unfinished appearance. The metal wire was difficult to tighten and to finish well. A clamp was needed. There was still movement in between the plates and pieces of wire were sticking out.

**Stick through holes**
Sticking the wooden sticks through the holes was very easy. The sticks served as a way to hold the plates and could be the legs of the lamp. Creating sticks out of bottle caps was difficult. When rolling the melted material, it sticks to the gloves or baking mold. Besides, the stick had a cheap and unfinished appearance (Figure 103).

**Position the plates**
Attaching the profiles with linchpins was very easy. However, the pins have a rough and distracting appearance (Figure 104). Rivets were more difficult to attach, since a lot of force is required to press the climp. Attaching profiles with double sided tape is not an optimal solution as the tape does not stick well, when exposed to dust or heat. Profiles placed on the outside of the shape, distract attention from the material, but can cover the imperfect edges (Figure 105). Placed on the inside, the profile is visible when light shines through (Figure 106).

**Stick edges together**
Polyethylene is a difficult material to glue. Due to its greasyness, it does not attach to each other. One shape, glued with kunststofkleber (Figure 107) stayed together, until it was dropped accidentally. It was difficult to apply the glue precisely on the edges, since they are so small (around 2 millimeters). Apart from the spilled pieces of glue, the connection does not attract attention. The same counts for connecting with double-sided tape.

<table>
<thead>
<tr>
<th>Process</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melt edges together</td>
<td>Heatgun</td>
</tr>
<tr>
<td>Thread through holes</td>
<td>Shoe laces, ropes, yarn, metal wire, tie-wraps</td>
</tr>
<tr>
<td>Position the plates</td>
<td>Profiles + double-sided tape, profiles + linchpins, profiles + rivets</td>
</tr>
<tr>
<td>Stick through holes</td>
<td>Wooden sticks, sticks out of plastic bottle caps</td>
</tr>
<tr>
<td>Stick edges together</td>
<td>Two components epoxy glue, glue gun, universal glue, kunststofkleber, superglue, double-sided tape</td>
</tr>
</tbody>
</table>
**Choice of connection**

A Harris Profile was created for testing each attachment method to the requirements. The connection method of sticks is chosen. Sticks are easy to attach and do not distract attention from the material. Figure 110 shows a prototype of the plates, attached with sticks. The arrangement of sticks determines the shape as well. It is decided to skip the possibility of extending the shape and creating different arrangements. By extending, more plates are needed and thus more attachment methods. The shape will lose its stability and the (many) connections can distract attention from the material. The next chapter elaborates on this concept.

**Amount of caps per mold**

Seven caps per mold are needed for the optimal thickness (Figure 108). The plate is thin enough for the light to shine through.

---

### Table: Attachment choice

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Melt edges</th>
<th>Thread through holes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ease of assembling the plates</td>
<td>Heatgun</td>
<td></td>
</tr>
<tr>
<td>2. Attention on the material</td>
<td>Rope</td>
<td></td>
</tr>
<tr>
<td>3. Finished look</td>
<td>Wire</td>
<td></td>
</tr>
<tr>
<td>4. Stable connection</td>
<td>Tie-wraps</td>
<td></td>
</tr>
</tbody>
</table>

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### Harris Profile

- **Figure 108**: Mold, filled with seven bottle caps.
- **Figure 110**: Prototype of the plates, attached with sticks. A lamp is placed inside.
- **Figure 109**: Harris Profile, used to determine the most appropriate attachment for the plastic plates.
8.1 Service

The service consists of a bus with tools, products and a menu (Figure 111). Workshops are given and products are exposed. The aspects of collecting and processing the material are part of the service.

The Bakery Bus stands at several places, like a food truck (Figure 113). E.g. at the campus of Universities, at markets or the parking lots of companies. People get attracted by the bus and the created products that are exposed. They can create a product themselves during a workshop or they can buy one. Since the workshop is done outside, no exhaust is needed.
Setup of the bus
The side of the bus has a big window. Behind this window, there is the counter and ‘Meesterbakker’ (masterchef) standing behind. On the counter the products and flyers are exposed. The menu is hanging on the wall. Next to the bus a banner is present to promote the Plastic Bakery and attract attention. A sign shows information about plastic waste and shows what happens if plastic ends up in the ocean. The bag of bottle caps is placed next to the bus. On the foldable table there is room for the oven, tools and making area. The trunk of the bus provides storage for all the equipment. In order to enhance the surprise effect around the bus, a set of show boxes are presented (Figure 112). The box covers the lamp and is black inside, in order to create a dark environment. On the outside the light switch is attached. People can look through the hole and turn on the light. They will be amazed by the beauty of the material when it suddenly lights up.

Attending a workshop
People need to sign up for the workshop. At the website of the Plastic Bakery, it is announced at which places the Bus is situated. Subscribing for a workshop is possible at the website as well. The duration of the workshop is 1.5 to 2 hours and takes place around the bus. A price for the workshop is asked, which is around 25-30 euros; based on prices for already existing workshops of lamp making and needed lamp accessories. People have to collect caps themselves ("brave bird") or to pay for the caps ("lazy bird"). It is both possible to attend a workshop individually and with a group of people. For example, as a company trip or birthday party. The workshop is suitable for people from 13 years and older. Children are excluded because of the hot equipment and steps that need to be followed correctly. The following scenarios show the possibilities with the workshop:

1. Workshop for individuals
   1.1 People make one small lamp in one workshop.
   1.2 People make a bigger lamp in two workshops.

2. Workshop for groups. E.g. friends, companies, families.
   2.1 Each person makes their own lamp.
   2.2 The group makes one big lamp together for in the office, home etc.

The workshop is including:
- Bottle caps (extra), provided by Kika (free for brave birds, paid for lazy birds).
- Flyer with the natural themes.
- Use of oven and tools.
- Use of stamps for your own message or texture. E.g. Birthday wishes, love messages.
- A cord, wooden sticks and elastic for assembling the plates.
- Cable with switch and plug, fitting (size E14) and Led lamp. (Snoerboer is possibly interested in sponsoring: https://www.snoerboer.nl/)

Programme of the workshop
- Introduction about plastic waste (type PE, behavior, problem of plastic when ending up in ocean).
- Explanation of Safety Rules (oven has fixed temperature, dont touch temperature button. Wear kitchen apron and heat resistant gloves. Communicate with the ‘meesterbakker’ when you want to process the caps.)
- Pick color of bottle caps. Choose one of the nature themes or create one your own.
- Place the caps in the mold and place mold in the oven.
- Ten minutes melting time. During this time: pick a stamp for a message or texture and decide if you want any additions (Menu is shown in Figure 114).
- Melt caps in mold
- Take mold out of oven and mix caps
- Melt caps
- Press plastic and let cool down
- Place mold back in oven for ten minutes.
- The plate is cooled down.
- The lamp is assembled.

Four plates need to be made for the lamp. For each plate the following steps are required:

1. Place the caps in the mold and place mold in the oven.
2. Mix the caps
3. Melt the caps
4. Shape the caps
5. Add ‘sprinkles’

The steps are summarized in Figure 115

<table>
<thead>
<tr>
<th>Colors</th>
<th>Options</th>
<th>Add 'sprinkles'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth</td>
<td>Wood dust</td>
<td>Flat</td>
</tr>
<tr>
<td>Air</td>
<td>Metal powder</td>
<td>Texture</td>
</tr>
<tr>
<td>Fire</td>
<td>Stamp</td>
<td></td>
</tr>
</tbody>
</table>

Per person there are two molds. So two plates can be created in 30 minutes, and the total of 4 in one hour. Some extra time is calculated if the material is not mixed well the first time and has to be put back in the oven again. Also, the lamp can be assembled in the extra half an hour.

The lamp is assembled.
- The plates is cooled down.
- Make holes in the plate.
- Use of stamps for a message or texture and decide if you want any additions (Menu is shown in Figure 114).
- Place mold back in oven for ten minutes.
- The plate is cooled down.
- The lamp is assembled.

Figure 113–Inspirational image of the desired atmosphere of the Bakery Bus.

Figure 112–Drawing of the show box, with lamp inside.

Figure 114–Menu of the Bakery Bus.

Collecting bottle caps
People collect bottle caps in the colors they prefer. In order to prevent that the material will look childish, different color combinations are created, based on nature and natural light (Figure 117 on page 100). They can either choose a theme, e.g. magic marble or funky forest, or create their own theme. The flyers show which caps to collect per group. People can also exchange their caps, like flippo’s. People need to collect a minimum amount of ten caps, the entry fee. Two caps out of ten need to be transparent, so that the light shines through well. Figure 116 shows the difference in transparency of the bottle caps. The rest of the bottle caps can be bought out of the storage of Kika (http://www.doppenvoorkika.nl/). These bottle caps are collected, for their campaign, by people throughout the Netherlands and brought to collection points. In this way you buy material and support Kika at the same time.

Figure 116–Difference in the degree of transparency of the bottle caps. Right: most transparent.
<table>
<thead>
<tr>
<th>Elements</th>
<th>Bottle caps (Amount of caps per mold)</th>
<th>Impression</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td><img src="image" alt="Air caps" /></td>
<td>Cozy Clouds</td>
<td><img src="image" alt="Cozy Clouds" /></td>
</tr>
<tr>
<td>Water</td>
<td><img src="image" alt="Water caps" /></td>
<td>Cool Ocean</td>
<td><img src="image" alt="Cool Ocean" /></td>
</tr>
<tr>
<td>Fire</td>
<td><img src="image" alt="Fire caps" /></td>
<td>Warming Flames</td>
<td><img src="image" alt="Warming Flames" /></td>
</tr>
<tr>
<td>Earth</td>
<td><img src="image" alt="Earth caps" /></td>
<td>Magic Marble</td>
<td><img src="image" alt="Magic Marble" /></td>
</tr>
<tr>
<td>Earth</td>
<td><img src="image" alt="Earth caps" /></td>
<td>Funky Forest</td>
<td><img src="image" alt="Funky Forest" /></td>
</tr>
</tbody>
</table>

Figure 117—Natural themes that can be created with bottle caps. The number of caps per (small) mold is indicated.

Tools
A mold, stamp, spatulas and a two sets of additions are presented for creating a plastic plate (Figure 118). The metal mold exists of an outer shape with a hole in the bottom that holds a plate on top. The caps are melted in the mold, on top of the plate. When processed, you can lift up the plate by pushing it through the hole in the bottom (Figure 119). In this way it is easy to get out the plastic material. The outer edges of the mold make it easier to take the mold out of the oven without touching the melted material. The molds are created with CNC milling.

Figure 118—Tools for creating a plate out of plastic bottle caps.

Figure 119—Mold in two sizes with a hole in the bottom and plate on top to easily remove the melted material.

Figure 120—Metal molds created with CNC-milling machine.
The stamps are made of wood and produced by lasercutting. Wood does not conduct heat and therefore the participant can press the material without wearing heat protecting gloves. The wood is covered with a layer of oil, to prevent sticking against the melted material. There are two types of stamps: one for making the material flat, and one for creating a message (Figure 122). The stamps for making flat have different two icons on top, one of feet and one of hands. These icons motivate people to either stand on the stamp or push by hands. When standing, there is more force on the piece of plastic, than pressing with your hand. Still, it is up to the participant which one to choose. Inspiration was taken from grape stomping for making wine, a fun activity (Figure 121).

**Figure 121**—Inspirational image of wine stomping.

**Figure 122**—Wooden stamps for pressing the plastic (top) and creating a message (bottom).

**Figure 123**—Use of stamps for individual participants (top) and groups (bottom). Note: Icons of people created by Ivan Sakoman from the Noun Project.

**Group activity**
The explained process of making, can be suitable for team building activities. Mixing the big plate of plastic together and making it flat by all standing on top of the stamp. Each person can press his or her name into the material, to personalize the product and to see the contribution (Figure 123).
### 8.2 Material Application

This paragraph presents the Tipi Table Lamp, a developed material application made out of bottle caps. The worked out concept is an example of the possibilities with plastic waste, that brings forward to beauty of the material with light.

#### Parts of the Table Lamp

The Tipi Table lamp is a lamp shade that consists out of four plates of processed bottle caps, four sticks, a piece of rope and an elastic band (Figure 125). As described before, the connection of the plates needs to be easy and not distractive from the material. This type of connection meets both requirements. The sticks form the frame of the lamp; they hold the plates and the cable of the light source. The sticks are positioned on the outer edges of the plates and are therefore not visible, when the light shines through. With a cord the plates are attached to the frame. By threading the cord through the holes of the plates, tabs arise on the inside. These tabs are used as connection pieces for the sticks. The angle of the frame can be adapted by the position of the elastic band (arrow in Figure 124) on top. When moving the elastic downwards, the sticks move inwards and the other way around. In this way the gaps in between the plates (white circle, Figure 124) can be enclosed and plates can be joined. The shape of the Table Lamp is easy and every part of it has its function.

#### Light accessories

A led lamp is chosen (Figure 126), since this type of lamp does not become warm and has a long lifetime of 15 years. A light bulb does become warm, heats up the plastic and warps the material. A black lamp holder, wire, plug and switch were selected. Black does not attract attention, so the attention can be on the material. A stain relief is needed to fasten the cord well in the fitting and to make sure that the lamp does not hang directly on the copper wire. This part is attached on top of the fitting.

#### Personalize

This concept leaves room for personalizing. The colors of the bottle caps, the patterns, additions and texture are of influence by the user who makes it. Next to the plastic plate, other parts can be personalized as well. The sticks are offered in different colors and materials. There are brass- and silver colored metal sticks and wooden sticks. The elastic on top, can be selected on color as well.

#### Assembling the Table lamp

On the next page it is shown how to assemble the parts and to create the Tipi Table Lamp. The steps are indicated below:

1. Drill four holes in each plate.
2. Thread the cord through the holes on the top and bottom.
3. Tighten the cord and make a knot on the inside.
4. Cut off the spare edges of the cord with a pair of scissors.
5. Place the sticks behind the tabs.
6. Fix the four sticks on top by placing the elastic band around them.
7. Place the socket inside the shade and place the cable around the sticks.
8. The lamp is ready to use!
Dimensions of the Table Lamp

The dimensions of the plate (Figure 129) are based on the processability. "Is it easy to make and does the beauty of the material come forward?" Experiments with the material showed the short cooling time and the need for mixing well. It is chosen to keep the plates small, so that ideally the material only needs to be mixed once and the waiting time is limited (of course it can happen that the material is not mixed well enough and that the plastic needs to melt again for ten minutes). There is a small and a larger version of the Table lamp. The small version can be made within one workshop of 1.5 to 2 hours. The large version can be made in two workshops. For the larger version more mixing is needed and can be made in 3 hours. The size of the plates is also adapted to the dimensions of the light accessories. The smallest available lamp holder (Size: E14) needs to fit in the connected shape of the plates. Naturally, it is also possible to create bigger shapes (e.g. with a group). You could compare it with making sculptures. If you choose to sculpt a big piece of stone, you logically need more (workshop) time. The dimensions of the holes and stick result from the dimensions of the plates.

Presentation of Table Lamp

The next spread presents the Tipi Table lamp, the created color themes and lamp in use.

Figure 129—Instructions of the assembly of the Table Lamp.

Figure 129—Dimensions of the two variations of the Table Lamp, in Millimeters.
Figure 130—Presentation of the set of Table lamps (without light accessories)

Figure 131—Presentation of Warming Flames lamp in use.

Figure 132—Presentation of Funky Forest lamp in use.

Figure 133—Presentation of Magic Marble lamp with message in use.

Figure 134—Presentation of Cool Ocean in use.

Figure 135—Presentation of plates with color themes, based on nature.
EVALUATION
CHAPTER 9

Concept Evaluation

This chapter evaluates the concept of the Plastic Bakery and the material application.

9.1 Service

Aim
Evaluate the service, test if people without prior knowledge can make a beautiful plate and if they enjoy the activity of making.

Research Question
"To what extent is the workshop appealing to people?" The following sub questions were created in order to answer the main question:
- To what extent can people, without prior knowledge about processing plastic waste, make a finished plastic plate?
- To what extent are people surprised about the material?
- To what extent are people happy about their creation?
- To what extent do people like the activity of making?

Method
Participant selection
Three participants were selected:
1. Mar, Female, 24, Graduated in Strategic Product Design.
3. Lau, Female, 24, Student Industrial Design - Master Design for Interaction.
The first three letters of each name are displayed to indicate the participant and to maintain privacy.
Duration workshop: 10.00-12.00 -> 120 minutes
Setup
The workshop took place outside at the Freezone, an area with grass and electricity in front of the faculty of IDE (Figure 137 on page 113). No exhaust is needed and the workshop can attract passers.

Intro – Selecting
The menu with color themes was shown and the participants were asked to select a theme or to create their own theme. They were asked to select the bottle caps out of the bag. Each participant could choose one mold.

Body – Processing
The participants were asked to place the bottle caps in the mold and when ready, to place the mold with caps in the oven. It was explained that the caps are ready when they have a completely shiny appearance. The participants were told to wear heat protecting gloves before taking out the mold. The participants could choose to either make the caps flat by standing on it or by pressing it with hands. The stamps with different messages were shown as an option to use, together with the sprinkles. The principle of taking out the plastic was explained, by showing the hole on the bottom of the mold and demonstrating the use.

Closure
The participants were asked what they thought of the workshop and their creations. They were thanked for their participation.

Results
For the movies of the workshop, please check the blog: https://projectcamp.us/projects/a-new-taste-for-plastic-waste/items. The results are described per processing step.

Selecting
The participants liked searching for the bottle caps. Figure 138 shows the participants searching for bottle caps. Pau_02: “It is nice that you actually have to search for it (bottle caps), then you really have the feeling that you are creating it yourself.” One participant (Mar_01) stated that it feels like a treasure hunt. There was some confusion about which bottle caps were allowed to pick, since the bag was filled with both Polyethylene caps and Polypropylene caps. Lau_09 mentioned that it is good to make people aware of the different types of plastic and different properties. One participant even started to recognize the number on the bottom of the caps. Mar_12: “This (cap) is a 2. That is allowed right?” (talking about the plastic type).

Sometimes it was difficult to fit the selected caps in the mold. Lau_01: “It is like puzzling in the shape.” One participant (Pau_01) started to cut the bottle caps with a pair of scissors that required a lot of strength and eventually with a Stanley Knife (Figure 139). This was quite easy for the participant. The opinion towards recognizing logos varied. One participant (Lau_02) was searching for caps with logos, whereas Mar_04 did not want the logos to become visible: “Is this logo going off when melting?”

Melting
The participants (Lau_03, Pau_10) experienced the waiting time as something negative. Pau_10: “You want to do something to speed up the process while waiting for the caps to melt.” One participant (Mar_14) found it difficult to determine if the plastic was melted enough. The participants opened the door of the oven often to see if the plastic was ready. This caused some irritation among one participant (Pau_16): “Do not open the oven so often.” Opening the oven means a loss of heat inside the oven and an increase in waiting time.

Mixing
The moment of taking the plastic out of the oven and mixing the material was quite a haste. Pau_07: “I find this (mixing the caps) quite a stressful moment, because you need to do it so fast.” All three participants mentioned to need more time. One participant (Pau_08) gave the suggestion to mix the caps beforehand: “You could throw the caps in the blender. I mean that you do it yourself so that you are still aware. Then you can mix everything well before you melt it and you don’t need to mix it in between.” It is very important that the participant mixes the entire caps. When only mixing the top of the material, the bottom will still show all the caps fused together instead of the patterns.

Additions
Two participants added something to the plastic. One added the metal sprinkles and one participant used her imagination and picked flowers to add. Participant (Pau_11) said: “It is a bit like bringing back nature to the plastic.” About adding flowers to the plastic, the participant (Mar_15) that did not add anything indicated: “I would have used the sprinkles if I knew what it would look like. Examples really help. Especially for people who aren’t very creative.”
Making flat

Sometimes the plastic was taken out of the oven when not melted enough. As a consequence the material is not deformable enough to make it flat and disappointment can arise. Mar_08: "Hmm, it (created plastic plate) is not really flat." All the participants made the material flat by standing on top of the stamp (Figure 142). This interaction even made some participants do a dance on top of the stamp. It was a funny activity. The element of surprise arose the moment when one participant (Pau_18) released the mold and the edge of the plastic plate was visible: "Look, this looks so cool!" The participants were very curious about their end result and therefore released the mold and stamp very quick when the plastic was still warm. Consequently the material can bend.

Finished creation

The participants liked their creation (Pau_05, Lau_13). Imperfections are not experienced as something negative (Lau_12, Pau_05). Pau_05: "[...] there is a hole in it, but I do not mind." Two of the participants wanted to remove the edges of their plate with a Stanley Knife. Pau_13 indicated the importance of filling up the entire shape: "The corners are important, if they are not filled up well it looks messy." One participant (Mar_06) mentioned that her creation is a good gift: "I want to give this to someone that will be happy with it. It is a good gift for Mother’s day. She likes something crafted but I'm not going to make a coloring page anymore." The overall experience of the workshop was positive. Different associations came up. Participant Mar said: "It is just like knitting, very calming, but you still have to think about it" (Mar_07) and "this (workshop) is really something that you could do in Nemo (Mar_05)."

One participant (Lau_6) compared it to ceramics and standing in the darkroom. The use of kitchen tools was appreciated (Lau_05), as well as the location "I like that it is outside, it is relaxing" (Pau_15). The element of baking came back again: "It smells baked. Maybe it is because of the oil." (Mar_11) Pau_04 indicated the importance of not creating any waste: "It is good that with this you are not creating waste, except for these little leftovers." (cuts off the edges with a Stanley knife.)

The side effect of processing bottle caps in such an easy way is that people can do it at home themselves. One participant (Mar_12) suggested to do it at home. This is not a good idea. Furnaces of the plastic might get released in the oven so the oven is not appropriate for processing foods anymore. Preventing this effect to occur can be done by warning people about the safety risks and through tools that people don’t have at home, like the molds, stamps and parts for assembling the table lamp.

There was not enough time for the participants to assemble the plates and to create a table lamp. Three plates were created per participant. Each participant had one mold. When having two molds per person, there is less waiting time and more time for processing. Pau_14 stated: "Two hours is too short. You could do..."
9.2 Material Application

This paragraph describes the evaluation of the material application; the Tipi Table lamp. Page X shows an impression of the exhibition.

Aim
Find out what people think of the material application.

Research Question
To what extent is the product appealing to people?

Method
The products were exposed on the Future Materials exhibition in the Aula of the TU Delft. Professors, faculty members and relatives of Kaspar Jansen visited the exhibition, that was organised around the inaugural speech of professor Kaspar Jansen.

Setup
The set of table lamps was presented on a table with covered with a black cloth(Figure 147). In front of the lamps, the material samples, stamps, molds and menu were situated. A jar filled with bottle caps was standing on the right. A poster with information about the project was attached to the wall.

Data Analysis
The reactions were written down and pictures were taken.

Results
The reactions on the set of table lamps were very positive. “Nice”, “Wow”, “Cool” and “Very beautiful” were examples of reactions people gave. Two persons actually wanted to buy a lamp. They asked if the lamps were for sale. One man wanted to pay 35 euros for the small warming flames- lamp:

“So, I can just do this at home?”

One woman was willing to pay 50 euros for the big cozy clouds- lamp. This woman even came back when the exhibition was closing, to ask me if there had been more bids and if the lamp was still available. She told me:

“This can really be a succes.”

Conclusion
The lamps were very attractive. Both of the scenarios are appealing to people: to make a lamp yourself or to buy one. The material surprised people, made people curious and invited to touch. People touched or stroked the plastic plates of the lamps. One person mentioned that the lamps, especially the warming flames, look like the Moroccan lamps, made of animal skin.

When explaining her that she could also make her own lamp during a workshop, she said: “No, I’m not really into crafts.” The opinions varied towards buying a lamp or making one yourself. One man mentioned: “If I see this, I really want to make one myself. When is the bakery bus going on the road?” The earrings were liked as well. After the first reactions, people started to ask how the lamps were made. “Did you melt this?”

The preferences of the lamps varied. People indicated to prefer the warming flames, cool ocean, or cozy clouds. The products were liked among people with different ages. Some people mentioned that the products look finished. The lamps were inviting to touch. People touched or stroked the plastic plates of the lamps.

“The preferences of the lamps varied. People indicated to prefer the warming flames, cool ocean, or cozy clouds. The products were liked among people with different ages. Some people mentioned that the products look finished. The lamps were inviting to touch. People touched or stroked the plastic plates of the lamps. One person mentioned that the lamps, especially the warming flames, look like the Moroccan lamps, made of animal skin.

Surprising, that’s what it is.”

One woman was willing to pay 50 euros for the big cozy clouds- lamp. This woman even came back when the exhibition was closing, to ask me if there had been more bids and if the lamp was still available. She told me:

“This can really be a succes.”

The lamps were very attractive. Both of the scenarios are appealing to people: to make a lamp yourself or to buy one. The material surprised people, made people curious and invited to touch. People need to be warned not to melt plastic at home in their own oven, because it is unsafe without any knowledge of the material and equipment. Especially, when people prepare their food in the same oven in a kitchen with not enough exhaustion.

Figure 147- Setup of the exhibition space.

Figure 148- Set of pictures that give an impression of the exhibition.
9.3 Conclusions

The main research question of this project was: “How to change the perception of plastic waste materials from useless into valuable?”

The subquestions were:
- “What are the unique qualities of plastic waste materials that are not applied by others?”
- “In what material application do these unique material qualities come forward?”
- “How can people be motivated to do something with waste?”

The material Polyethylene was explored and unique material qualities (arising color patterns and semi-transparency) were found. A set of table lamps was designed in which the discovered material qualities come forward. A service was designed to make people aware of the transition of bottle cap into new material and to see the patterns arise in the material. The service and material application were evaluated. The material application (table lamp) surprised people and was seen as beautiful. It is managed to create something valuable out of plastic waste. People liked the activity of making during the workshop (part of the service) and could express themselves. The short cooling time of the material worked against the joy of making.

The attractiveness of the material and offering the possibility to create something yourself, worked as motivation factors for people to do something with waste.

9.4 Recommendations

This paragraph describes the recommendations of different aspects around the service.

Types of plastic

Results from the evaluation of the service showed that the participants did not know which caps to pick, since the bag of caps consisted of caps of the material Polyethylene and Polypropylene. Of course the caps could be organized beforehand, but it is a nice opportunity to learn people about the different types of plastic. This can be done with a sign for example (Figure 149).

Short cooling time

The participants experienced a lack of time for mixing the plastic. More research needs to be done about how to extend the cooling time of Polyethylene. An example could be to integrate warmed up plates in the table. The participants experienced irritation when the oven was opened, by others. It could be an idea to create an oven with multiple doors, one for each person. Important is that the feeling of baking is still enhanced.

The sliding mold

When mixing, the material needs to be pulled apart. This causes movement of the mold. It would be better to fix the mold. For example by cutting the shape of the mold out of the table. The mold can be placed in the opening after melting and the table holds the mold.

Safety of melting Polyethylene

Some research was done into the safety of melting Polyethylene. However, to be able to fully guarantee the safety of participants of a workshop, more research need to be done. Since the production steps are quite easy, people could start to melt plastic at home in their own oven or buy a cheap oven at Marktplaats. This is an unwished effect. It is good that people want to make things out of waste, but it is not safe. Ways have to be found to prevent health risks and to motivate people to come to the bakery bus instead of melting at home.

Locally recycle plastic

At the beginning of the report, it was shown that many steps were needed to recycle plastic. A suggestion was given to locally recycle plastic waste, in order to diminish the amount of steps. The presented concept definitely decreases the steps for recycling plastic waste. However, this project only focused on one type of plastic. Further research need to be done into the feasibility and succes of locally recycling plastic waste.
Project Evaluation

This chapter reflects on the process. It includes the evaluation of the approach, Material Driven Design (MDD) method and a personal reflection on the project.

CHAPTER 10

10.1 Approach

The Material Driven Design method was used throughout the project. It consists of four steps: Understanding the material, Creating Material Experience Vision, Manifesting Material Experience Patterns and Designing the material/product concepts. I noticed that the first step, understanding the material, takes a lot of time. I also spent much time on doing research into the safety of melting plastic. The first step did provide a very solid basis of knowledge for the rest of the project. The user study with material samples was very helpful and provided a lot of inspiration. E.g. that plastic can look natural. The method included several cards for structuring the material insights. I took the cards for experiential and technical characterization too literal. I started to fill them in for each created sample and ended up with too many cards. Instead of providing structure, they made me confused. I created a selection of the cards afterwards, that helped me to find gaps between the discovered material qualities and already existing solutions. I think that this step of the method is very smart. Because if you find an inspiring material quality that no one else has used before, you automatically create something new and innovative.

The method was aimed at finding an application for the material at hand. I found it difficult to follow the steps of the method, because I designed a service around the application as well that implies collecting and processing of the material. Maybe I stucked to the method too much instead of using it as a guidance throughout the project. I also think that it can be useful to add more aspects to the cards. For example with waste materials there is always the aspect of collecting. Adding more aspects can help the user of the method to think broader and can provide inspiration. It was a good choice to discover the qualities of collecting and processing the material. It really helped me to create a good story. It was fun to ask people to collect bottle caps for me, because the most original ways came across. Giving workshops to people was very useful to see if other people can make beautiful things and to work out the activity of making.

It took some time for me to understand the third step of the method, Manifesting Material Experience Patterns. I have done some research into how surprise can be enhanced, but I think that if you would execute quantitative research (as suggested with the Meanings of Materials tool) there is not enough time to follow all the steps of the method.

My vision of surprising people with the material, was still very broad. I found it quite difficult to decide on an idea direction. It felt a bit random to just say, okay I’m going to make a vase or a chair. Once I found the direction of light, it became clear. The beauty of the material is enhanced with light, so light is needed to shine through the material. With this requirement it was more easy to find solutions that do not feel random and that do make sense. The Table lamp is not just the material in the form of a lamp shade; the object surprises people and shows that the material can be beautiful and valuable. It is definitely an interesting aspect of the method, to find an application in which the discovered material qualities make sense. Especially if you don’t expect the material to behave in this way. Once I found the application for the material, everything fell in place.
10.2 Personal Reflection

I really liked working on this project. The MDD method was new for me. At the start I found it exciting to follow a different approach, to start with the material instead of the user, but it turned out very well. The tinkering with the material, was something I enjoyed a lot (except for accidentally burning the plastic...). Letting you guide by the material and your curiosity, finding unique material qualities and creating a vision: I loved it.

I did have some difficulty with the design phase. I realized that I tried to control the process and that changing plans made me nervous. I learnt that changing plans is actually what designing is. You’re diving into a new topic, try to understand it, discover things, new things. That’s why your design always changes. If everything goes as how you plan it, there is a small chance of a very original idea popping up in your head. I learnt that forcing to come up with ideas does not work and that it is good to let go of your project sometimes. Often the ideas come up at moments when you’re not expecting them. I guess, you could compare designing with life, you can try to control it, but there are always unexpected things happening.

I am very proud of the end result. I managed to design a set of appealing table lamps and a fun service around it. The keywords where I started this project with, actually come back in my final design: bodily interaction, make people do, trigger senses and amaze people.

I wanted to make progress, solve the problems I encountered. Meet the high standards that I set. I did not want to stop, sit down and document. I learned that you just have to do it, go for it. It is good to think and reflect, but not too much. Sometimes I found myself thinking and overthinking possibilities while I just had to try out things. I learnt to work with machines in the pmb I had never touched before. I spent a lot of time in the pmb. I remember that Roland (one of the employees) screamed: “Don’t give it to her, she will melt it!” when a person was carrying some plastic inside. That was funny. Everybody was very kind and helpful. I learned that you need patience to make beautiful things and that it always takes longer than planned.

It was a great opportunity for me to attend the Future Materials exhibition. All the positive reactions of people gave me a lot of energy. I very much like the domain of new materials.

It was a great project! I’m very curious about the continuation of it, how it will turn out when I have set up my own business. The Plastic Bakery will be continued...
Appendices

Additional documents are presented.
A. Part of the Material Safety Data Sheet (MSDS) of Polyethylene

Gevaar Alarm Code:

**RUBRIEK 1 IDENTIFICATIE VAN DE STOF OF HET MENGSEL EN VAN DE VENNOOTSCHAPONDERNEMING**

1.1. Productidentificatie

- Identificatie van de stof of het mengsel: POLYETHYLEEN

- Chemische Naam: polyethyleen

- Synoniemen: polyethyleen, POLYETHYLEEN, poly(methyleen)

- Chemische formule: (C2-H4)x

- CAS Nummer: 9002-88-4

1.2. Relevant geïdentificeerd gebruik van de stof of het mengsel en ontraden gebruik

Relevant geïdentificeerd gebruik van de stof of het mengsel:

- Gesteunde volgens de aanwijzingen van de fabrikant.

- Gebruikt volgens de aanwijzingen van de fabrikant.

1.3. Details betreffende de verstrekker van het veiligheidsinformatieblad

- Gebruikte bedrijven: China National Chemical (Qenos) Quantum Chemicals Redox

- Adresseerstichting:

  - PO Box 9040 A B WITHOUT VINC Australia
  - 2 Swettenham Road, Botany 2564, Sydney Australia

- Telefoonnummer voor noodgevallen:

  - Niet beschikbaar

- Telefoonnummer voor noodgevallen:

  - +61 2 9733 3000

- Website:

  - https://www.quadrantepp.com

- Email:

  - info@redox.com

  - info@redox.com

**RUBRIEK 2 IDENTIFICATIE VAN DE GEVARREN**

2.1. Indeling van de stof of het mengsel


**B. MDD cards Technical Characterization of Polyethylene**

**TECHNICAL CHARACTERIZATION OF THE MATERIAL (TCM)**

**Q1**

HDPE bottle caps. Kneaded to fuse caps. Pressed with pricker (top left) when taken out of the oven. Pressed against slump (bottom right) during heating and cooling. Various colors, depending on slump. Type of slump, amount of pressure.

**Q1**

HDPE bottle caps. Heated and kneaded (repeated several times) > Changes color pattern. Thin and not pressed when cooled > Material curls up (on the right).

**Q1**

HDPE bottle caps, mixed with iron particles. Pressed when cooled. More iron is added to the plastic, the material is more magnetic. The iron particles have a shiny appearance. When adding iron, the material sinks. Usually, (only plastics) it floats. The pattern of the iron particles varies.

**Q1**

HDPE bottle caps. Shredded and kneaded. Coated with paint (top left) when taken out of the oven. Pressed against slump (bottom right) during heating and cooling. Various colors, depending on slump. Type of slump, amount of pressure.
What are the key technical properties of the material? How do they change when the material ingredients vary?

**HDPE bottle caps, mixed with wood particles.** Kneaded to mix two materials. Pressed when heated and when cooled. Patterns with wood are variable and position (underneath plastic on top of plastic).

**Material can be spread over the surface.** Textures can be made into the material with a prime. Is possible with plastic bags and bottle caps.

**Plastic bags.** Pressed when cooled. Top left: matte, did not touch baking mould. Top right: shiny, did touch the baking mould. Maybe depends on the type of plastic bag (Albert Heijn or Men At Work).

**When applying force, the material will get the shape of the mold.** There shouldn't be too much air in between the material because then not everything will melt (with the bottle caps).

**Symmetrical patterns.** Every time the pattern and colors are different. Made by sculpting.

**Variable: colors of plastic material, processing temperature, speed of extrusion.** When temperature is higher, the material flows better but the chance of burning and thus fumes, is higher.
**Q2** What are the most convenient manufacturing processes to form the material?

- **Oven and stamp** (pricker or something else).
- **Oven** (with clean window to be able to see what happens). You have to take out the samples every time to blend the bottle caps and have influence on the color pattern.
- **Screwdriver** (make bottle caps into small pieces), oven (melt plastic and fuse all particles).
- **Oven, mould, weight that presses the caps. A toaster/grill could work.**
- **Scissors/cutting machine**
- **Pan with boiling water.**
- **Soldering iron** + anything that has a fixed temperature and with which you can heat up and press at the same time.
- **Hammer, chisel and vise. Plastic is heated in the oven. When plastic is heated with a heatgun, the material is more brittle, since it is not as equally heated as in the oven.**
- **With a shredder** (sometimes the machine needs to be cleaned if its full of shredded pieces).
- **Mold in oven with shredded material or folded plastic bags. Distributed load on top until material is cooled down.**
**Q3**

What about other manufacturing processes? How does the material behave when subjected to other processes?

- **Stamp**
  - Plastic
  - For bigger samples, a big stamp would be more appropriate. For example, a stamp on a surface, the melted plastic on the stamp and a roller that pressed the material into the stamp (see image).

- **IMPASTO**
  - Pictures, Other Materials, Material Samples
  - When heating the plastic and placing it into a mould, more defined shapes can be created.

- **TCM**
  - Pictures, Other Materials, Material Samples
  - An enclosed aluminium mold that is put in the oven and tightened. Texture can be made by the mold. The caps are more equally pressed. Mold weighs 70 kgs. Would be more defined, less irregularities.

**Q3**

What about other manufacturing processes? How does the material behave when subjected to other processes?

- **Ironing plastic bags.**
  - Making threads out of plastic bags for weaving.
  - Rick Claassen - Het Afval Atelier

**Q3**

What about other manufacturing processes? How does the material behave when subjected to other processes?

- **Bottle cutter,** even suitable for children.

**Q4**

What are the technical constraints of the material?

- **Melting temperature,** undefined patterns of iron with plastic.

**Q4**

What are the technical constraints of the material?

- **Melting temperature,** undefined shapes, colour patterns.

**Q4**

What are the technical constraints of the material?

- **Material breaks faster,** undefined shapes arise.

**Q4**

What are the technical constraints of the material?

- **Colors of plastic bags.** Can actually also work as an opportunity.
**What are the technical constraints of the material?**

- Material deforms when heated, no control.
- Short cooling time so limited time to adjust the material.
- Melts faster (less air in between materials) and more uniform. Less space needed to store the material.

**What are the technical opportunities of the material?**

- Organic shapes, natural appearance. Material is waterproof. Floating. Light shines through holes, created by the stamp (when holding against the light). Textures can be created.
- Every sample is unique, has a different color pattern. Material is waterproof, floating.
- Material is waterproof. Sinks. Material is magnetic. Unique products.
- Plastic can be reinforced by metal. Plastic can be the ‘glue’ to stick the metal together.
- Movement of material when heated.
- Ability to be melted and shaped. Colors can be mixed, when material is still hot.
- Material can both be matte and glossy. Unique products. Waterproof. Floats.
- Strong, grip through texture.
- Use traces (scratches) in the material as a way of increasing the product attachment.
- Soft material: outer part wears out, inner part becomes visible. Material is soft and sensitive to scratches.
Paulien – IPD
Pau_01: This [B3] even looks more like trash than it already was; crumpled bags. It is ugly. It is not useful either.
Pau_02: It [B2] feels light and strong. I like the colours, it is a good combination. I could see that it is made out of plastic bags because of the H&M logo. Where is this from <points at the blue bags>?
Pau_03: I don’t like this [C4], there is metal in it. I don’t dare to touch it, since I am afraid that the metal pieces will go into my hand. Is it magnetic?
Pau_04: My favourite is this [C11]. It feels very nice because of the texture. I see this more as a material where you can make a new product from. The circle with bottle caps [C8] is not appropriate, it looks dirty. It appears that the molten parts were not intended to look in this way.
Pau_05: The brown colour [C12] looks very dirty. I don’t like it.
Pau_06: It [C19] has beautiful colours. It feels light. Looks kind of like a mat appearance. It does not feel like plastic, it feels a bit like paper. Pau_07: It [C4] feels hard because of the smoothness. The surface tension is higher I think. I want to do this <melt plastics myself as a hobby>.
Pau_08: This [B4] reminds me of the poverty in Africa. It makes me think of a car made of cans over there. Using plastic, it feels a bit like paper. Lau_11: There need to be some contrast in the colours as well. Lau_09: What is this? Did you do this <C4> to make it more practical things?
Pau_07: I really like this one [B2]. If you would injection mould this, you would lose all the letters. That is a pity. It is nice because of the letters, that you can see the origin. People see it and say “Oh, nice, this is recycled”. You can get very unique things and unique makes it interesting. Do you know the bags of Freitag?
Pau_09: The top [C16] looks like a candy and the bottom looks like a carrot.
Pau_10: One side [B3] is matt and one side is shiny. The matt side feels better. The shiny side looks cheap. It is shiny because the bags were shiny already?
Pau_11: This [C17] is cool. What is this <points at the plates>? It is really strong and I tried to bend it. The plastic attached to the plates very well.
Pau_12: You know when I see all of this <looks at table with samples> I have to think of the beach. I feel like a beachcomber. It is like you are searching for shells or glass. Coloured and changed by the ocean, on the beach.
Pau_13: It [C3] looks natural, like coral. It is anti-coral! Plastic is far from nature and yet it looks natural now.
Pau_14: The stripes [C2] look like pant. <studies sample, holds it close to her eyes>. It doesn’t look like ceramics.
Pau_16: Does the plastic float?

Misja – IPD
Mis_01: It [C2] feels very smooth. <Bends material> 
Mis_02: Wauw! [C3] Very beautiful. I have to think of the app Topology Optimization (TopOpt). Then you can calculate how much material is needed to capture the forces. This [C3] also looks like it. It is pretty cool, all kinds of organic shapes are coming out. I like this. It gives me the feeling of going back to nature.
Mis_03: This [C4] looks like a noticeboard. I like it. That you can realize your dreams. I think that these are also <compared to C33> woodchips. It looks like the universe. A little bit spacy. I think that it is really beautiful.
Mis_04: <Drops Material> It is like this comes from a cheap country. I don’t like this. The design is even below those cheap shops like the Action. It looks like it is a second hand product because you can see all the scratches, it has been used for a thousand years. It is shiny.
Mis_05: This [C8] looks like it has been made by a toddler. <Rotates the sample> <feels with finger> You can immediately what it is. It is more like a statement: you can see clearly what it has been before. It is more acceptable.
Mis_06: This [C11] is less clear what it has been before than [C8]. You do have a landmark of one (coca cola logo). This looks like a plastic chair where you can sit on the tram or metro. It would look more active when you would have a table of this, but a chair is different. It is nice when there is a story behind. Well you can also have <peek up samples> D it is waste! That works for a short moment and then it goes away. Yeah, I don’t know. 

Kate – SPD
Kat_01: I am really obsessed by fonts. For me it is a game to identify, the brand. 
Kat_02: I can’t see if it [C3] was a bottle cap. It is clearly melted too hot.
Kat_03: Here’s [C6] something added to make it more shiny. Maybe a coating or something. 
Kat_04: This [C7] is really recognizable, I don’t know why. It feels nice and smooth. A higher surface quality.
Kat_05: It [C8] is clear that these are bottle caps. I am wondering why all these colours are mixed. It is not very handy.
Kat_06: Bottle caps [C9]. It still looks like its original form.
Kat_07: This [C11] one is pressed more and ribs are applied. Maybe it is handy when a coating is applied.
Kat_08: This [C12] is clearly a bottle cap with a bottle cap in it.
Kat_09: There [C14] is something in it. A screw.
Kat_10: This [C17] is clearly with metal. I am wondering...
why.
Kat_11: It [C18] is from the neck of a bottle, the ring. Look, points at protrusion) you can still see the protrusion of the ring.
Kat_12: I’m hesitant about this [B1]. It looks like an Albert Heijn bag.
Kat_13: This [B2] is clearly an H&M bag. feels sample)
It feels different than a bag. It doesn’t feel like plastic, it feels made of wood. The other samples have more contrast in texture or colour use.
Kat_14: [B3] doesn’t feel nice, it is rough. It is not pressed well. You can see clearly that it was an H&M bag, because of the colour and font. It is difficult to make something beautiful out of this.
Kat_15: You can see very well what it [B7] had been. It still feels like a bag.
Kat_16: This [P1] is plastic used for packaging. The plastic that is used when you buy six bottles. It is a bit thicker plastic.
Kat_17: A Pet Bottle [P2].
Liselotte – IPD
Lis_01: I think that the colours do not come into their own [C1,C2]. The other samples have more contrast in texture or colour use.
Lis_02: It [C3] is made from a kind of wood chip because of the holes. I don’t know what it had been before. I like the pattern. It feels nice, looks like something natural, while it is made of plastic. I like contrasts.
Lis_03: This [C4] makes me think of a night sky. There is something shiny through it, something Silver. I quite like it. It is the same material as [C5]. Was it a plastic bottle? I don’t know.
Lis_04: It [C4] looks like this [C11] but then smooth, it [C4] feels nicer. It depends on where you will be using it for, depends on the context. I think it feels nice.
Lis_05: You can see what it [C8] is. The back looks like paint. I prefer the front, that is more a whole because it flows into one another.
Lis_06: This [C11] one is nicer [compared to C8], because it flows more into each other. This one has a pattern, something is pushed in. It is also nice, it would have been smooth. It looks rough. It makes me think of a street view with skateboarding and graffiti.
Lis_07: It [C13] makes me think of graffiti. Is it a package? You can see the woodchips through it. Plastic and wood is a weird combination. Usually if a package is made of wood, there is no plastic in it to show that it is natural. It looks nice, but it is a weird combination.
Lis_08: (grabs it) [C17] am wondering if it is supposed to be mixed like this or that it is randomly molten. Is it funny those combinations, it is special. You don’t see it so often.
Lis_09: It [B1] has kind of the same appearance as this [B2]. The same structure. Both of them feel smooth. It really becomes strong.
Lis_10: This [B2] is cool. It looks ‘designy’ because of the pattern. It is really beautiful. It feels nice. Like the colour combination, it looks beautiful. I think that these were plastic bags as well? This logo points at H&M logo looks like the Bijenkorf.
Lis_11: I think that you melted a plastic bag. I like it pretty much [B3], I think due to the colour combination. It looks a bit like a newspaper. The white-red-grey is a nice combination. I like it that you can still see the text. Is it H&M?
Lis_12: This [B4] one is nicer because it is hard (compared to B7). It feels more like a product. Could be a dish for the coffee. I think that you can make something designy out of this.
Lis_13: This [B5] is of the same kind as this [B7]. Only this one is burnt ten times longer (pulls the ends of the sample).
Lis_14: (looks at it carefully) [B6] You can see the layers. It is a kind of trash.
Lis_15: These [B7] are bags from Jumbo and Albert Heijn. Ah so you’re doing something with reusing waste? I like it that it is recognizable. You get the idea that it is not finished. It feels soft.
Myrthe – DFI
Myr_01: Yes these [C1,C2] all look a bit the same, so that’s why I did not grab them. This [C1] looks like a natural stone because of the shape and… or a bird turns its beak. It is almost a little product already. That is funny.
Myr_02: You can’t see anymore what it [C2] has been. It is quite beautiful. I think that these were bottle caps as well. I don’t want to bend this because it is bend already.
Myr_03: This [C3] looks like coral or tissue (‘weefsel’). Did you make this yourself by pricking it into it with a pen or something? [scratches in sample] I like it.
Myr_04: There is something else through it [C4]. Iron fillings. [bends]
Myr_05: Sam [C4] materials, only smaller [compared to C4]. The [C5] colours seem lighter, more intensive.
Myr_06: This [C6] is also made from bottle caps (ridges on the side) it is funny that this is attached to it (feels protrusion) moves on table).
Myr_07: This [C7] is nice to play with (scratches with fingers). There are dots in it, but are these dots here intentionally or not? It feels nice. It changes the structure a bit. I like it less because it is just one colour blue.
Myr_08: This [C8] is funny because the shape is round and the bottle caps that are in it are round as well. You can also see faster that these are bottle caps. [moves something like a car wheel] Because of the holes that is in between the different bottle caps, you can see that these are different materials. It looks a bit like iron beads.
Myr_09: This is a bottle cap [C1]
Myr_10: It is clear that these [C10] are bottle caps because of the Coca Cola. You can still see the shape.
Myr_11: More bottle caps. The gold [C11] is Coca Cola Zero, right? [scratches with nails]
Myr_12: This [C12] is a donut with a bottle cap. It is frustrating, I want to get this out (brown cap). [tries to get it out] Is it stuck or something? Is it melted?
Myr_13: This [C13] is something with wood through it.
Woodchips. [picks and tries to pick out the woodchips]
Myr_14: This [C14] is a bottle cap as well. O there is metal in it. A ring or something? I don’t like it that much.
Myr_15: [drops several samples on table] This [C15] sounds fun. I like the colour combination. It has a beautiful gloss. I like it when it is glossy. Did it become glossy because you melted it, or was it already glossy? In general I prefer matte. The colours are brighter when it is glossy. I like the colours of this sample.
Myr_16: You can see the shape [C14] and the ribs and you can see where it was bend as a bottle cap. [bends it]
Myr_17: There are pieces of iron melted in here [C17]. Pieces of a lid.
Myr_18: This [C18] is a bottle cap torn apart in pieces (bends it, almost breaks it). I notice that with everything you want to try to bend it. Especially when it is flat. This one [C2] is already bended, so than it is like ok, this is not going to work.
Myr_19: This [C19] looks like tie-dye, a bit hippie-like. [bends it]
Myr_20: I like this [B1]. [bends it] [scratches with nails] Yes this is from Albert Heijn. ‘Gebruik deze tas opnieuw’ I think that is on here. I like it. I don’t know what the green one is. I notice that I’m really looking at all the brands. The brands is what you recognize, it is the first things you see. O this is a bag, if this would be green with orange. I could not come up with what it would be that fast. Yellow is clearly Jumbo, blue is clearly Albert Heijn, and the H&M bag as well. It (the brand) resembles what material it is.
Myr_21: These [B2] are plastic bags. It is completely different than this one [B7]. The material has totally been changed. That is bizarre. You can’t feel the original texture. It feels hard and is more melted into one piece [compared to B7]. Because of the colours you can still see the different pieces, but it is still one whole [scratches].
Myr_21: Here [B3], another H&M bag. That is funny. It looks like a bag that is entirely shrunken. It has the structure of a balloon because of the edges that are cut. I think it looks cool. There are not ballons, it just looks like it.
Myr_22: Oke. These [B4] are balloons, you can see it because of this points at ‘tuutje’. The material really has changed. I can only see it because of this ‘tuutje’. Myr_23: These [B5] are plastic bags, right? [picks materials] Why are some of the samples so beautiful and some so..not beautiful?
Myr_24: Everything (in general) with different colours is nice. The colour has a big influence. Myr_25: This [B6] looks a bit dirty. Woodchips and . a kind of sandwich construction. It looks like it has been laying the ‘bush bush’ for a very long time. Like someone dropped his bag and after fifty years it looks like this.
Myr_26: I could recognize this [B7] immediately, because of Albe[t Heijn and Jumbo]. I can feel it, because it is flexible. This is crispy material. Here it is still soft and flexible and the sound, crispy like a bag. Also, this part is even loose [compared to B2].
Myr_27: Is this [P1] from a sixpack tray or something? Packaging material?
Myr_28: The shape is nice to play with [P2]. [pulls it apart]
This is perfect, because from a distance. I have to think of heaters. I don’t know why. But if you grab it and try to identify what it is, you start to notice the patterns and see you am an M, and you think hey! Ah yes. H&M of course. I think that this is the best way to go from mystery to the clue without having to ask someone within ten seconds. It is nice that you can discover something. That is your own discovery.

Koe_14: The colour pattern [B1] is equally distributed. It drops it.

Koe_15: I keep finding the contrasts in colour the most interesting.

Koe_16: I don’t really like the colours of this [C8] one, but I do like the Drippy appearance (‘drupingen’). But it is just some bottle caps placed against each other. The ribs make it interesting, it looks like there is life in it (drippy side). The air bubbles don’t say much.

Koe_17: This [P1] reminds me of the pieces of plastic in the sea, in which the birds get caught up. I don’t understand what you can do with it. But that is if you look at the practical side.

Koe_18: This [P2] is pretty nice. It does immediately create jewellery. These two [P1,P2] are really separated from the rest.

Koe_19: It [C15] feels like the structure of wax, so smooth. It has a finger over it. It feels as a new candle with a smooth surface. It feels fake. I can’t come up with what it is, plastic or wax. It is not food safe. Do you hear it? I drops it!

Koe_20: This [C13] is interesting. It feels but I don’t know if I think that it is beautiful or dirty. Maybe it is in between. The textures are interesting. I want to feel what is inside and if I can go through it. Can I look through it or pick it out, can it fall out. I don’t like the colours. It gives me the feeling of rest material, of thrown away material. If you would make a table top out of it. If something is made of old material, you want to be reminded of it. That I bought this table for a low price and that it did not contribute to… that there are no birds caught up in it. It keeps having the feeling of wax. If you would go over it with your nail you can know that it does not come off, so it is no wax or candles. Scratches on the sample. Everything is very tactile. People are used to feel. Next to the sight, the touch is the most important sense. Especially with a smooth surface. There are not many materials that you can finish in such a smooth way and which do not feel cold.

Koe_21: This [B3] is an H&M bag. It drops it. Its kind of like it holds it carefully. It is made by ironing or maybe you added plates of metal. It is you can see the folds very well next to each other. I like it. Koe_22: This is stupid [C7] because you pressed a shape into it. It would have been different if you would make deeper and equal holes. It looks unfinished and cheap. It is not symmetric. You can see that someone just made it by hand.

Koe_23: Metal fillings [C5]. I don’t like the brown, that it’s because of the blue colour. You can’t see the colour very well. It looks like there is copper mixed through it. The silver is interesting. The copper or bronze fades away next to the dark colour. Maybe if you would mix it with transparent plastic. But then you need to watch out that it doesn’t look like a cheap toilet seat. That looks kitch because they mix it with sand or pearls.

Koe_24: I like this pattern [C3]. It makes me think of coral and of bacteria’s or fungi’s. This is the most interesting pattern, because it is so natural. It looks like one continuous pattern. Like a lot of starfishes that are connected through their tails. Like it is not created intentionally.

Koe_25: If you added pieces of metal [C17]. It is dirty. It looks like snotty paper, paper – mache. Paper pieces that are slimy.

Koe_26: It [C4] looks dirty, the top and the bottom. The top is interesting, the bottom is boring. The top is attracting because of the differences in height. The smooth bottom is ugly. It looks dirty and combined with the smooth surface, it looks like pressed waste material, plastic waste, something cheap. It doesn’t work well.

Koe_27: This [C18] is less interesting. You should maybe see it on a big surface. It is not warm enough for being shaped by gravity. You can really see that it is treated. You can really see it when it is created in a natural way and when it is produced, the actions, the shapes. For me that is the difference between what is beautiful and what is not. What feels authentic and what doesn’t. What feels created intentionally and what feels created spontaneously. The logo is better than [C9].

Koe_28: I like the colour contrast [C9]. It is clean. Everything shines, but you still have the relief of the bottle caps, you have a piece of the logo that is not completely fade away. It (the logo) attracts more attention than the rest.

Koe_29: It is about imperfection. (example Andy Warhol-stamp – screen printing).

Koe_30: Feel cheap the smoothness [C16]. It has the sound of a poker chip.

Koe_31: If something happens (with logo), it starts to destroy it. Sometimes the patterns work distracting from the imperfections.

Koe_32: This [B5] puts it back. Koe_33: Feel cheap the smoothness [C16]. It has the sound of a poker chip.

Koe_34: This [C18] looks like someone has been pressing into it with a lighter or something. It looks fragile because of the threads. It looks like it can fall apart.

Koe_35: I drops it in [C19] It is thin. Feels cheap. You can see that it is intentionally fabricated. It is not natural.

Adriaan – IPD

Adr_01: You can hear the density, the shape, the thickness. It drops all samples. Identifies sound, categorizes samples in three groups.

Adr_02: This [C12] is a piece of poo donut. It looks really dirty.

Adr_03: This [C8] is a football made of plastic caps. It bounces in a nice way. It drops it. You can’t break this easily.

Adr_04: This [C16] looks like a carrot, sounds like a poker chip. This has the best sound together with this [C15]. I think that the reason is this little hole.

Adr_05: This [B7] feels nice and soft but if it feels soft I immediately have to think of plastic. I bends it!

Adr_06: It [B4] has nice colours but does not feel nice (picks edges).

Adr_07: This [P1] makes me think of when you buy a six-pack, to hold the six bottles. It looks like it is rotting by the sea. Feels threads! That the fish and other animals are suffering from this.

Adr_08: This [C4] is too dirty.

Adr_09: This [B3, B5] is a mess.

Adr_10: This [B1] looks like an amulet. It is beautiful. The colours are intense, it feels nice and soft. Here is it shiny and here it is softer.

Adr_11: This [P2] is like a spring, really relaxed. When you are talking or something it is also nice to have something in your hands, like a pen, pulls edges it is fun to do.

Adr_12: This is very well melted [C6], very strong as well. I bends it!
Adr_13: This is beautiful [C3]. It feels nice to rub your thumb over it [rubs thumb over surface]. The structure is nice, it could work calming, when you’re stressed.
Adr_14: This [C2] is like clouds and air. [drops it] Blue is beautiful, it is the air but also the ocean. [feels with fingers] It works calming. The colours are beautiful together. Even if it is nog entirely smooth, it feels smooth. It is interesting that it is curved. It is different than this [B1], this is just flat.
Ann_15: The ribs are nice [C11]. If there is a cut, you automatically start to follow it with your finger, when you don’t look at it [follows cut with nail]. It is fun to see the fonts, that it is shrunked. It is a funny effect. Coca Cola is big brand that is responsible for a lot of waste and they don’t care. It is good to see that it is so small here. The material itself determines what happens. It is a company with a lot of power. The people of the company decide what the material is going to do, it is forced into a specific shape. When it is thrown away, the material goes its own way. The material is no longer dominated by people. It is broken. Here (sample) you can see a small piece of Coca Cola. It makes you aware that a big brand takes no responsibility of their own material, that they do not take it back. It looks like a sad brand right now, because now you can see the waste that they produce and that they don’t care.
Adr_16: This [C7] is funny. It looks like a dead sea urchin. Because of the dots. A sea urchin shell.
Adr_17: It [B2] is funny that it is mingled. It looks like a crystal that you cut open. This increases the value of the plastic.
Ann_18: It [C13] is mixed with fibers, with wood. It is beautiful. [scratches with nails]
Adr_19: These [C15, C16] are kind of similar because of the center and an outer edge. They both sound nice. [drops it] You can see the teeth, it is almost a fossil [C16]. That is cool.
Adr_20: In some way you have the association with the ocean. Coal [C3], sea urchin [C7]. These [C3, C7, C15, C16] have the appearance of organisms. Like fossils or spongy.

Annemarie – Phd
Ann_02: Smoothness feels cheap [C13].
Ann_03: It is like a hidden message [B1].
Ann_04: I like the colour combination [B2] and the structure that flows through it.
Ann_05: It (in general) has to be something exciting. The text, texture, colour. That you can’t see immediately what it is, something exciting.
Ann_06: It [C2] is a bit flexible [bends it]. It does have nice irregularities. I can’t relate it to anything. It is very subjective. I just don’t like it very much. The shape is not that interesting.
Ann_07: A coaster [C8]? [picks the thread] With this I have to think of that. Too many colours. These are all bottle caps. It is nice that you can see what it was before, that you can recognize the original material.
Ann_08: It feels nice [B7]. You can clearly see that these were plastic bags. It makes a sound.
Ann_09: That is cool [C4] with the silver dots in it. This one has an elegant appearance. It is thin [bends and ticks].
Ann_10: This [B5] is really the sad plastic of the recycled plastics. It is a nice attempt, but did not work. [laughs] [picks sample]. There are some loose things, it looks like it is failed.
Ann_11: This [C18] is a better attempt than this [B5] [holds against light], but it is still a silly thing. It is nice that it is spread, but it has random things sticking out, without any function.
Ann_12: I like this [C6] shiny side, but I don’t like this side. It’s because the light is reflected in various ways. Maybe it isn’t the shininess, but the incidence of light or something. Yes, this one is interesting.
Ann_13: This [C16] is cool because of the layers and the eye that is in the middle. I don’t like the bottom.
Ann_14: Interesting incidence of light [C15]. I don’t like the pink colour, it has no eye.
Ann_15: It [C10] has too many colours, too much of texture. too much of everything.
Ann_16: The colours are nice [B3] but it is too rough. The strings are fun. [bends it] I don’t like these useless parts [picks at thread hanging loose] [picks it].
Ann_17: This [C12] is a turd.
Ann_18: I [C14] can be a connection piece to attach something to the wall.
Ann_19: It [C9] is a flower.
Ann_20: This [C17] is a very solid cap with finger. There is a different material in it, that makes it interesting for me and artistic. It can strengthen each other. It has the ‘Schwung’, it is interesting.
Ann_21: This [C7] is forced. Like, let’s add some dots and then it can be nice.
Ann_22: It [B6] is dirty. Do I want to touch this? It is a little bit grey.

People that dropped by during research:
Jip - DFI
Jip_01: This [B2] one is most beautiful. The colour combination and the distorted letters. It is soft to touch and feels a little bit greasy.
Jip_02: This [B3+C4] is dirty.
Jip_03: [dips in tea] Well, it can be a spoon, right? I just wanted to try.

Mark – IPD
Mar_01: This an H&M bag [B2].
Mar_02: It [B1] is cool that the plastic bag has a shape now. Usually a plastic bag has an undefined shape, and now it has a defines shape. I also like it that the bag goes from soft to something solid.
Mar_03: Did you cool this [C3] with water? It has bubbles. Is it a bottle cap from Spa? Or a Smint box? It looks like caramel, with bubbles.
Mar_04: This [C8] just looks like bottle caps. You can immediately identify what it is.

Ruby – DFI
Rub_01: It would be better if you use a lighter colour when mixing it with this [C4].
Rub_02: This [B3] looks like cloth that is wrinkled. You can make a dress out of this.
Rub_03: This [C18] looks like a piece that is chewed.
Rub_04: This [C10] looks like chewing gum.
Rub_05: This [C16] looks like a carrot.
Rub_06: The wood is natural [C13]. It looks like nerves, the green stone, like a natural stone.
Rub_07: It [C2] could be a fruit bowl.
### E. Experiential Characterization of Polyethylene – MDD Cards

#### EXPERIENTIAL CHARACTERIZATION OF THE MATERIAL (ECM)

<table>
<thead>
<tr>
<th>Q1</th>
<th>What are the unique sensorial qualities of the material?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HDPE - Bottle caps</strong></td>
<td>Feels nice, structure feels nice, structure can warp-sensing when stressed, feels artsy. Looks natural and organic.</td>
</tr>
<tr>
<td><strong>HDPE - Bottle caps + metal particles</strong></td>
<td>don’t dare to touch.</td>
</tr>
<tr>
<td><strong>HDPE - Bottle caps</strong></td>
<td>feels very smooth, feels nice.</td>
</tr>
<tr>
<td><strong>HDPE - Bottle caps</strong></td>
<td>It feels strong but it is also soft material. If you would cut it, it is very easy. It is plastic can keep metal together (adhesive).</td>
</tr>
<tr>
<td><strong>HDPE - Bottle caps</strong></td>
<td>Light, strong, smooth, good color combination. Feels nice. Feels sticky. It feels fluent, there is dynamics, movement. Soft to touch.</td>
</tr>
<tr>
<td><strong>PET bottle</strong></td>
<td>Looks soft. Feels static, shredded pieces stick to hand.</td>
</tr>
<tr>
<td><strong>HDPE packaging</strong></td>
<td>Tips: When you are talking or something it is nice to have something in your hands, like a pen. It is fun to do. The shape is nice to play with. Bottom: it could be a good stress ball, it feels nice when you squeeze it a little, just like a pen. You are really feeling the shape. It gives more feeling.</td>
</tr>
</tbody>
</table>
EXPERIENTIAL CHARACTERIZATION OF THE MATERIAL (ECM)

Q1: What are the unique sensorial qualities of the material?
- You can see all the layers. Like the history of a product.
- Looks like oil paint.
- Natural appearance, structure/pattern.

Q2: What are the most and the least pleasing sensorial qualities of the material (according to users)?
- + smoothness
- - scratches
- + Beautiful appearance
- - Dirty appearance, don't want to touch.
- + texture
- - Shiny
- + The colour pattern
- - Shiny side
- + smoothness/glossiness
- - can't see origin
- + protrusions
- - Rough
- + Protrusions
- - Industrial look
- + The colour pattern
- - Shiny side

Q3: Is the material associated with any other material due to its similar aesthetics?
- HDPE - Plastic bags
- - It looks like a dead sea urchin. Because of the dots. A sea urchin shell.
ECM Q3
Is the material associated with any other material due to its similar aesthetics?

Coral, anthill, 'weefsel', structures of cells, a lot of starfishes connected through their tails, bacteria/fungus, caramel with bubbles.

HDPE - Bottle caps

ECM Q3
Is the material associated with any other material due to its similar aesthetics?

Dust, notebook, universe, night sky, silver dots, copper, metal particles.

HDPE - Bottle caps

ECM Q3
Is the material associated with any other material due to its similar aesthetics?

Chewing gum, tooth print, natural stone, lens shape, polished stone (because of flat surface with differences in height).

PE - Bottle caps

ECM Q3
Is the material associated with any other material due to its similar aesthetics?

Paint because of stripes, clouds and air, ocean, fruit bowl.

HDPE - Bottle caps

ECM Q3
Is the material associated with any other material due to its similar aesthetics?

Plastic chair where you can sit on the tram or metro, street view with skateboarding and graffiti.

HDPE - Bottle caps + Wood particles

ECM Q3
Is the material associated with any other material due to its similar aesthetics?

Plastic for sixpack bottles, plastic in sea in which animals get caught up, plastic bags.

HDPE - Packaging

ECM Q3
Is the material associated with any other material due to its similar aesthetics?

Growth rings of a tree

Paint (top), iron beads, football, coaster.

HDPE - Bottle caps

ECM Q3
Is the material associated with any other material due to its similar aesthetics?

Graffiti, rest material, natural stone, wax.

HDPE - Bottle caps

ECM Q3
Is the material associated with any other material due to its similar aesthetics?

Candy. A new candle with smooth surface.

HDPE - Bottle caps

ECM Q3
Is the material associated with any other material due to its similar aesthetics?

Candy (top), Carrot (bottom), Flower, Fossil (bottom)

HDPE - Bottle caps
### EXPERIENTIAL CHARACTERIZATION OF THE MATERIAL (ECM)

**ECM Q3**

**Is the material associated with any other material due to its similar aesthetics?**

<table>
<thead>
<tr>
<th>Material</th>
<th>Similar Aesthetics</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDPE - Bottle caps + metal plates</td>
<td>snotty paper, papier-mâché.</td>
</tr>
<tr>
<td>HDPE - Bottle caps</td>
<td>Tie-dye, hippie.</td>
</tr>
<tr>
<td>HDPE - Rings of Bottle caps</td>
<td>Tiedye, hippie.</td>
</tr>
<tr>
<td>HDPE - Bottle caps</td>
<td>HDPE - Rings of Bottle caps</td>
</tr>
<tr>
<td>LDPE - Plastic bags</td>
<td>Bags of Freitag, clay (look and feel), growth rings of a tree, graffiti, newspapers, dripping paint, parts of books, the ocean, waves, heaters, crystal.</td>
</tr>
<tr>
<td>LDPE - Plastic bags</td>
<td>newspaper, balloons (because of curled inside), wrapping paper.</td>
</tr>
<tr>
<td>LDPE - Plastic bags</td>
<td>Balloons (because of &quot;surfyc&quot;), prints in the city made of city-pressed plastic.</td>
</tr>
<tr>
<td>LDPE - Plastic bags</td>
<td>This is a pity. You can’t see the brands anymore. Here’s something added to make it more shiny. Maybe a coating or something. It’s so funny that this protrusion is attached to it. You kind of lose the connection with the material because the association with plastic is gone. It’s the combination of the shape with the glossiness.</td>
</tr>
<tr>
<td>HDPE - Bottle caps</td>
<td>It looks like this comes from a cheap country. This is even below those cheap shops like the Action. It looks like it is a second hand product because you can see all the scratches (circle), like it has been used for a thousand years. It is pure 100% pressed color blue. This is stupid because you pressed a shape into it. This is forced.</td>
</tr>
<tr>
<td>HDPE - Bottle caps</td>
<td>Dirty, looks like it has been made by a toddler. It is clear that these are bottle caps. Funny because the shape is round and the bottle caps that are in it are round as well. With this I have to think of a product. Nice to see the origin.</td>
</tr>
<tr>
<td>HDPE - Bottle caps</td>
<td>&quot;Wow&quot;, Natural, Organic, Art, beautiful, melted too hot, created unintentionally.</td>
</tr>
<tr>
<td>HDPE - Bottle caps + metal particles</td>
<td>Elegant, thin, dirty, spacy, beautiful, &quot;cool&quot;, shiny, cheap (combination of smoothness and association with pressed waste material).</td>
</tr>
<tr>
<td>HDPE - Bottle caps</td>
<td>Heads to be some contrast materials, beautiful, can't see what it has been, don't want to bend it because it is bend already, beautiful colors, can't relate it to anything, shape is not that interesting.</td>
</tr>
</tbody>
</table>

**ECM Q4**

**How do people describe this material? What kind of meanings does it evoke?**

<table>
<thead>
<tr>
<th>Material</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDPE - Bottle caps</td>
<td>&quot;Wow&quot;, Natural, Organic, Art, beautiful, melted too hot, created unintentionally.</td>
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</tr>
</tbody>
</table>
### EXPERIENTIAL CHARACTERIZATION OF THE MATERIAL (ECM)

#### ECM Q4

<table>
<thead>
<tr>
<th>Material Sample</th>
<th>How do people describe this material? What kind of meanings does it evoke?</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDPE - Bottle caps</td>
<td>I see this more as a material where you can make a new product from. I like that you can still see the brands. Make practical things out of it. Beautiful. It is fun to see the fonts, that it is shrunken. It is a funny effect. Coca Cola is big brand that is responsible for a lot of waste and they don't care. It is interesting. High quality, shaped in free manner, unique, interesting.</td>
</tr>
<tr>
<td>LDPE - Plastic bags mixed with wood particles</td>
<td>This is really nice, mixing wood with plastic. Plastic and wood is a weird combination. Beautiful. Like the recognition. Interesting. Smoothness feels cheap. Natural. The textures are interesting. I want to feel what is inside and if I can go through it.</td>
</tr>
<tr>
<td>HDPE - Bottle caps</td>
<td>Fragile</td>
</tr>
</tbody>
</table>

#### ECM Q4

<table>
<thead>
<tr>
<th>Material Sample</th>
<th>How do people describe this material? What kind of meanings does it evoke?</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDPE - Shampoo bottles</td>
<td>Clean, something with reusing waste. Hidden message.</td>
</tr>
</tbody>
</table>

#### ECM Q4

<table>
<thead>
<tr>
<th>Material Sample</th>
<th>How do people describe this material? What kind of meanings does it evoke?</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDPE - Plastic bags</td>
<td>It reminds me of Poverty in Africa. You can make a scooter out of it. Beautiful.</td>
</tr>
<tr>
<td>LDPE - Plastic bags + Wood particles</td>
<td>Something. Has value.</td>
</tr>
</tbody>
</table>

#### ECM Q5

<table>
<thead>
<tr>
<th>Material Sample</th>
<th>How do people describe this material? What kind of meanings does it evoke?</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDPE - Bottle caps</td>
<td>Surprise “To be pleased by something that happened suddenly, and was unexpected or unusual.” (Fokkinga &amp; Desmet, 2013)</td>
</tr>
<tr>
<td>LDPE - Plastic bags</td>
<td>“Wow the plastic works quite well as an adhesive for the metal plates.”</td>
</tr>
<tr>
<td>LDPE - Plastic bags</td>
<td>“Wauw!” (block of colored caps)</td>
</tr>
</tbody>
</table>

---

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EXPERIENTIAL CHARACTERIZATION OF THE MATERIAL (ECM)

How do people interact and behave with the material? (Q6) What are the performativity qualities of the material?

† Sample: HDPE - Bottle caps

Disappointment: The sinking feeling when you find out that something you hoped for has not happened, and will also not happen anymore." (Fokkinga & Desmet, 2013)

Disgust: "The nauseating feeling when you don't want to sense (see, hear, feel smell, taste) because you feel it is bad for you. You want to get away from it or avoid it." (Fokkinga & Desmet, 2013)

Confusion: "The disorienting feeling when you perceive information that does not make sense to you, leaving you unable to know what to do with it." (Fokkinga & Desmet, 2013)

Fascination: "To experience an urge to explore, investigate, or to understand something." (Fokkinga & Desmet, 2013)
### Experiential Characterization of the Material

#### Material Benchmark Table

<table>
<thead>
<tr>
<th>Material</th>
<th>Use</th>
<th>Collect and Process</th>
<th>Technical Properties</th>
<th>Qualities</th>
<th>Experiential Qualities</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDPE packaging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDPE - Rings of Bottle caps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDPE - Bottle caps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Way of Processing**: Presses it, pinches sample, feels threads.
- **ACTIVITIES**: Bends it, almost breaks it, holds against the right hand.
- **QUALITIES**: Strong, ability to be reshaped.
- **COLLECT AND PROCESS**: F. Material Benchmarking / Table

#### Material Benchmarking / Table

<table>
<thead>
<tr>
<th>Material</th>
<th>USE</th>
<th>COLLECT AND PROCESS</th>
<th>TECHNICAL PROPERTIES</th>
<th>QUALITIES</th>
<th>EXPERIENTIAL QUALITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDPE - Plastic Bags</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PET + HDPE - Water</td>
<td></td>
<td></td>
<td>Washing, Shredding, Extruding, 3D printing</td>
<td></td>
<td>Transparent, colors, strong, little pieces</td>
</tr>
</tbody>
</table>

#### HDPE Packaging

- **ACTIVITIES**: Tries to get out the woodchips, feels threads.
- **QUALITIES**: Strong, ability to be reshaped.
- **COLLECT AND PROCESS**: Rotational Moulding, Shredding, Extrusion, 3D Printing

#### HDPE Rings of Bottle Caps

- **ACTIVITIES**: Opens it, takes mold out of oven, presses it, pinches sample, feels threads.
- **QUALITIES**: Strong, ability to be reshaped.
- **COLLECT AND PROCESS**: Rotational Moulding, Shredding, Extrusion, 3D Printing

#### HDPE Bottle Caps

- **ACTIVITIES**: Tries to get out the woodchips, feels threads.
- **QUALITIES**: Strong, ability to be reshaped.
- **COLLECT AND PROCESS**: Rotational Moulding, Shredding, Extrusion, 3D Printing

---

**Note**: The table and images illustrate various ways HDPE waste is collected, processed, and utilized to create new products or artworks, reflecting on the experiential qualities of the material in terms of interaction and behavior.
<table>
<thead>
<tr>
<th><strong>MATERIAL BENCHMARK TABLE</strong></th>
<th><strong>USE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MANUFACTURER</strong></td>
<td><strong>SAMPLE</strong></td>
</tr>
<tr>
<td></td>
<td><strong>APPLICATION PICTURE</strong></td>
</tr>
<tr>
<td><strong>TECHNICAL CHARACTERISTICS</strong></td>
<td><strong>WAY OF PROCESSING</strong></td>
</tr>
<tr>
<td></td>
<td><strong>WAY OF COLLECTING</strong></td>
</tr>
<tr>
<td></td>
<td><strong>EXPERIENTIAL QUALITIES</strong></td>
</tr>
</tbody>
</table>

**WASHED ASHORE**

- **Manuscript**: Dirk van der Kooij
- **Title**: Leonie & Lois Thing-thing
- **Factory**: Polyfloss
- **Product**: Breaded Escalope

**MATERIAL BENCHMARK TABLE (Karana et al., 2015)**

- **TU Delft**

**APPLICATION PICTURE**

- **Picture**

**COLLECT AND PROCESS**

- **Way of Collecting**
  - **Manuscript**: Cleaning from earth
  - **Title**: Together
  - **Factory**: Waste Land

**WAY OF processes**

- **Process**
  - **Manuscript**: Trash to treasure
  - **Title**: Waste Land

**EXPERIENTIAL QUALITIES**

- **Way**
  - **Manuscript**: Recycling of waste
  - **Title**: Waste Land

- **Waste**
  - **Manuscript**: Recycling of waste
  - **Title**: Waste Land

**WAY OF COLLECTING**

- **Manuscript**: Collection from recycling
  - **Title**: Waste Land
  - **Factory**: Waste Land

**COLLECT AND PROCESS**

- **Way of Collecting**
  - **Manuscript**: Cleaning from earth
  - **Title**: Together
  - **Factory**: Waste Land

**WAY OF processes**

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**EXPERIENTIAL QUALITIES**

- **Way**
  - **Manuscript**: Recycling of waste
  - **Title**: Waste Land

- **Waste**
  - **Manuscript**: Recycling of waste
  - **Title**: Waste Land
**COLLECT AND PROCESS**

**TECHNICAL PROPERTIES**
- **Way of Collection**: Plastic fishing, solar extruder, washing, shredding, melting, blowing, casting, casting.
- **Application**: Plastic fishing, renewable energy, art, decoration, personalization.
- **Quality**: Awareness of waste, creative, original, many applications.
- **Experimental**: Awareness of plastic, plastic reuse, plastic recycling.
- **Material**: Plastic waste laying, plastic cups, plastic bottles, plastic caps.
- **Way of Processing**: Solar pre-processing, washing, cutting, sanding, melting, blowing, casting.

**COLLECT AND PROCESS**

**USE**
- **Technique**: MDD Table (Karana et al., 2015)
- **Materials**: Scrap XL collects waste, plastic cups, plastic bottles, plastic caps.
- **Application**: Consumers can upcycle, make use of the sun, become shiny.
- **Composition**: Polyurethane, polyethylene, polypropylene, PET bottles.
- **Experiential**: Soft material, color, easy to melt, within the bathtub.

**COLLECT AND PROCESS**

**USE**
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**COLLECT AND PROCESS**

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### Material Benchmarking / MDD Cards

#### MATERIAL BENCHMARKING OPPORTUNITY CARDS

<table>
<thead>
<tr>
<th>MATERIAL / OPPORTUNITY</th>
<th>USE</th>
<th>TECHNICAL OPPORTUNITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to melt and solidify. Create solid pieces of plastic.</td>
<td>MB</td>
<td>TECHNICAL OPPORTUNITIES</td>
</tr>
<tr>
<td>Ability to shine through</td>
<td>MB</td>
<td>TECHNICAL OPPORTUNITIES</td>
</tr>
<tr>
<td>Different colors, shapes and textures.</td>
<td>MB</td>
<td>TECHNICAL OPPORTUNITIES</td>
</tr>
<tr>
<td>When heated different plastic pieces flow into each other. Create beautiful patterns. Strong.</td>
<td>MB</td>
<td>TECHNICAL OPPORTUNITIES</td>
</tr>
<tr>
<td>Risk of fumes releasing while heating. It is not 100% safe you don’t know what additives are added to plastic. Mask is needed when working completely safe.</td>
<td>MB</td>
<td>TECHNICAL OPPORTUNITIES</td>
</tr>
</tbody>
</table>

#### MATERIAL / OPPORTUNITY | USE | TECHNICAL OPPORTUNITIES |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Waterproof</td>
<td>MB</td>
<td>TECHNICAL OPPORTUNITIES</td>
</tr>
<tr>
<td>Ability to shine through</td>
<td>MB</td>
<td>TECHNICAL OPPORTUNITIES</td>
</tr>
<tr>
<td>Ability to be shaped. Stamps. Create textures. Floating</td>
<td>MB</td>
<td>TECHNICAL OPPORTUNITIES</td>
</tr>
<tr>
<td>Ability to create flat surface with pressure. (short cooling time=cool in water)</td>
<td>MB</td>
<td>TECHNICAL OPPORTUNITIES</td>
</tr>
</tbody>
</table>

#### PROCESS

- Make threads out of plastic bags. Weaving.

---

**F. Material Benchmarking / MDD Cards**
Material Benchmarking (MB) Materials for Design Course TU Delft

**Material Benchmarking Constraint Cards**

**Material / Opportunity**

- Pictures, Other Materials, Material Samples

**MB**

**Date**

**Group / Name**

**Technical Constraints**

- A lot of material is needed to create a strong and solid sheet of plastic. Around 700 bottle caps!
- Not hygienic. Plastic needs to be cleaned well before using it. Not appropriate for food/drink purposes. Short cooling time, short time to work with plastic and create shapes if not using a mold.
- Properties are undefined. Different types of plastics and within the types you have variations as well. You need to have a fixed temperature.

**Experiential Opportunities**

- Want to touch appearance.
- Colorful Ability to recognize origin.
- Every product is unique
- From closeby you can see the trash, but from far away you can see the image; the art piece.
- Cute, colorful, cheerful, soft. Bottle cap house. Looks like knitted or painted.
EXPERIENTIAL OPPORTUNITIES

An entire shoe made of plastic is amazing. Unique.

At first it looks like a painting, but if you take a closer look you can see the waste.

Community feeling, bringing together people from neighbourhood - helping each other.

Active, physical, curiosity, together, outside.

Process: Adapt the material. Workshop with guidance and together.

Feels like baking something in oven, surprise effect when taking mold out of oven and opening it.

Process: Adapt the material. Workshop with guidance and together.

Feels like baking something in oven, surprise effect when taking mold out of oven and opening it.

Contact with material. Activity of making itself is/feels nice.

Awareness about waste. Coloring yourself with waste.

Create a painting with a blower.

Process: Adapt the material. Workshop with guidance and together.

Feels like baking something in oven, surprise effect when taking mold out of oven and opening it.

Process: Adapt the material. Workshop with guidance and together.

Feels like baking something in oven, surprise effect when taking mold out of oven and opening it.
MATERIAL BENCHMARKING OPPORTUNITY & CONSTRAINT CARDS (Template)

**MATERIAL / OPPORTUNITY**

**MB**

**PROCESS**

**EXPERIENTIAL OPPORTUNITIES**

Be creative yourself.

**MB**

**PROCESS**

**EXPERIENTIAL OPPORTUNITIES**

Unique, DIY, dedication, attention. Feels like clay. Easy and fun.

**MB**

**PROCESS**

**EXPERIENTIAL OPPORTUNITIES**

Low motivation, playing role of a parent. Telling other people what to do (pick up waste).

**MB**

**PROCESS**

**EXPERIENTIAL OPPORTUNITIES**

Funny and cute to put the caps in the bathtub, like you're washing a baby.

**MB**

**PROCESS**

**EXPERIENTIAL OPPORTUNITIES**

Lose a bit money, rough.

**MB**

**PROCESS**

**EXPERIENTIAL OPPORTUNITIES**

Limited control over color distribution. Flowing materials into each other.

**MB**

**PROCESS**

**EXPERIENTIAL OPPORTUNITIES**

Lose contact with the material. Machine does all the work.

**MB**

**PROCESS**

**EXPERIENTIAL OPPORTUNITIES**

DIY. Enough inspiration is needed to make something nice/successful/wanting to keep.

**MB**

**PROCESS**

**EXPERIENTIAL OPPORTUNITIES**

Own creation vs. Pre-determined. The balance needs to be investigated, the extent to which people are steered during the making.

**MB**

**PROCESS**

**EXPERIENTIAL OPPORTUNITIES**

Low association with material > plastic waste.

**MB**

**PROCESS**

**EXPERIENTIAL OPPORTUNITIES**

Low motivation, playing role of a parent. Telling other people what to do (pick up waste).

**MB**

**PROCESS**

**EXPERIENTIAL OPPORTUNITIES**

Many bottle caps needed. 1 kg (400 caps)=0.22 cents

**MB**

**PROCESS**

**EXPERIENTIAL OPPORTUNITIES**

Lose association with material > plastic waste.

**MB**

**PROCESS**

**EXPERIENTIAL OPPORTUNITIES**

Low motivation, playing role of a parent. Telling other people what to do (pick up waste).

**MB**

**PROCESS**

**EXPERIENTIAL OPPORTUNITIES**

Low association with material > plastic waste.

**MB**

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Low association with material > plastic waste.

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**PROCESS**

**EXPERIENTIAL OPPORTUNITIES**

Low association with material > plastic waste.
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Materials for Design Course TU Delft

MATERIAL BENCHMARKING OPPORTUNITY CARDS (Template)

Toolkit for making something with the plastic

Pics, Other Materials, Material Samples

MATERIAL / OPPORTUNITY

DATE

GROUP/NAME

APPLICATION OPPORTUNITIES
e.g. Packaging, Decoration, Structural

Building blocks

Tools to collect plastic: Fishing rod, fishing net, pincer, 'blikvanger'.

Tools to process the waste: Baking tools.

Painting toolkit for plastic waste

Workshops. Tinkering with plastic waste.

Workshops with machines.

Make art together.

Create something with bodily involvement + together. Could be done in the city or at exhibitions/design festivals.

Plastic Bakery
MATERIAL BENCHMARKING OPPORTUNITY CARDS (Template)

MATERIAL / OPPORTUNITY: Ceramics class - with plastic waste.
- Activities:
  - Paint with melted plastic
  - Expeditions: search for plastic waste together and make something out of it.

MATERIAL / OPPORTUNITY: De club van makers.
- Workshop: making sculptures with a block of melted plastic waste (instead of stone).
- Participants bring their waste and create their own 'stone' with plastic waste.

MATERIAL / OPPORTUNITY: Expeditie Robinson - TV show
- Different tests: make fire, melt plastic, make key out of plastic, open the box etc.
- Workshops: making sculptures with a block of melted plastic waste (instead of stone).
- Participants bring their waste and create their own 'stone' with plastic waste.

MATERIAL / OPPORTUNITY: Toolkit to create something with the plastic waste, like a craftsman. The activity itself is worth doing.
- Ultimate purpose: A new type of wall paint or graffiti. Cover the walls in plastic; it is like the earth is more covered by all the plastic.
- Made out of plastic from the ocean. Is something for in the ocean.
- So: from the ocean, for the ocean.
### G. Template reflection workshop

**Template reflection**

https://sabl1n.typeform.com/to/26l604

**Questions**

1. Did you already have something in mind to make before going to the workshop? If yes: what?
2. What did you think of the workshop?
3. Can you pick one moment that you really liked during the workshop and one moment that you did not like? And why?
4. Which tools did you use?
   - Silicone stamp
   - Rolling pin
   - Stanley Knife
   - Mold for tile
   - Gloves
   - Shapes in form of a number.
   - Spatula
   - Other:

5. Which tool(s) did you like to use? And why?

6. What did you make?
   - Tile
   - Number
   - A plate with ‘home made’
   - Other

7. Why did you choose to make this?
8. What did you do with the object you made?

**Where is it now?**

9. Is there something you really want to make out of the bottle caps?
10. Age?
11. Gender
1. What did you think of the workshop?
Els_01: “I really liked it, it was a bit clumsy (I mean we were not really knowing what we were doing) but that also made it quite creative and that I wasn’t afraid to try thing out.”
Kar_01: “FUN! I really liked it, it was nice that you started with explaining the possibilities and then just let everyone do what they wanted.”
Sim_01: “I really liked it (the workshop), especially the hand molding was awesome to do.”
Wes_01: “Inspiring! And I learned a lot, in the form of experience. I love to craft things and this is a new technique.”
Ann_01: “It was a lot of fun. It felt like baking, but then better.”

2. Can you pick one moment that you really liked during the workshop and one moment that you did not like? And why?
Els_02: “I liked the moment you saw the colors mixing and the material melting, that you really see it changing in something else. The waiting in between when it cooled down really fast was a bit harder, cause I just want to continue crafting, but it had to be put back in the oven every time.”
Kar_02: “I really liked it when we decided to knead the plastic with our hands instead of only the spatulas. I didn’t like it that we had to wait for the plastic to melt in the oven, I am impatient I wanted to make stuff.”
Sim_02: “I really liked the hand molding but the making of a tile was kind of a deception as the plastic hardened too quickly.”
Wes_02: “Dancing around because of a new idea that popped up between us (me and Ann), to make buttons. Also seeing the melt for the first time.”
Ann_02: “The moment I saw the plastic starting to melt.”

3. Which tools did you use?
Els_03: Silicone stamp, Rolling pin, Gloves, Spatula.
Kar_03: Rolling pin, Stanley Knife, Mold for tile, Gloves, Shapes in form of a number, Spatula.
Sim_03: Rolling pin, Mold for tile, Gloves, Shapes in form of a number, Spatula.
Wes_03: Rolling pin, Stanley Knife, Gloves, Shapes in form of a number, Spatula.
Ann_03: Silicone stamp, Stanley Knife, Mold for tile, Gloves, Spatula.

4. Which tool(s) did you like to use? And why?
Els_04: “Maybe scissors? Just to see if it works, and something with other patterns, like wood for example or a coin.”
Kar_04: “I wanted to just explore the possibilities and I sort of treated it like clay or cookie dough. I liked rolling it nice and flat with the rolling pin and then press shapes in it. I didn’t like to wait so I took the number shapes out and cut it after.”
Sim_04: “THE GLOVES! touchy feely with a material that is used so much but never like this.”
Wes_04: “Contour cutter for numbers and rolling pin, both very effective.”
Ann_04: “Stanley knife because it cut so easily trough and the mold for the tile to make it square and flat.”

5. What did you make?
Els_05: A plate with ‘home made’
Kar_05: Number
Sim_05: Number
Wes_05: Surfboard model
Ann_05: Tile

6. Why did you choose to make this?
Els_06: “It was easy and looked awesome:) I just want to make something that made me smile.”
Kar_06: “Because you had the numbers, I wanted to make something that I could "use" and not just be laying around in my room. I already have enough random stuff laying around in my room.”
Sim_06: “House decoration.”
Wes_06: “I liked it as decoration and I used it to try a technique, being cutting the contour with the knife.”
Ann_06: “I wish I had a bathroom floor with those tiles.”

7. What did you do with the object you made? Where is it now?
Els_07: “I think you can also make a lot of nice jewellery from it.”
Kar_08: “I really liked the idea of making buttons, but I think we would need a good mould for that.”
Sim_08: “A lamp shade.”
Wes_08: “Surfboard fins and coat protectors for my bike, and buttons for coats.”
Ann_08: “buttons & floor tiles”
1. Creative Session

Session Plan

Problem Statement

Briefing

Associations with light

Inventorizing

Clustering and selection

Design Goal

Formulate How-To’s

Idea generation with How-To’s

Idea Generation

Concept Development

How-to’s Creative Session

Tassoul & Buijs (2007)
Several attachment methods for connecting the plates of the concept Window Curtain, were explored.

Aim
An attachment for the plates that are placed in front of the window and can be connected to each other.

Research Question
How can you connect the plates in an easy and beautiful way?

Requirements:
- The attachment can be opened and closed easily.
- The attachment does not distract attention from the material.
- The total product has a finished look.
- The plastic plates are positioned close to each other.

Approach:
Different attachment methods were explored: key rings, simplex hooks, s-hooks, key clamps and key cords. The connections were attached to the plastic plates and were evaluated with the requirements (Harris profile).

Results
The Harris profile below shows what each type of connection scores per requirement. The key rings are most appropriate since they do not distract attention from the material, due to the size, shape and thickness. The key claps and S-hooks are most easy to assemble, but too visible and take up a lot of space in between the plastic plates.
K. Shapes of Table Buddy

Aim:
Determine the shape of the plates that can be attached to each other and form a 3d shape.

Research Question:
What shapes are most suitable for creating a 3d shape in an easy way?

Requirements:
- 6 Plates (building blocks) of 9x9 cm can be created in 1 workshop of 98 minutes. So a maximum of 6 plates can be used for the 3d shape.
- The plates need to be connected to each other and therefore have the same edges.
- The plates can be connected to a standing or hanging object.
- There is a maximum of three different shapes.
- With the same building blocks, different arrangements are possible.
- The material covers the light.

Method:
The shapes were realized by pieces of cardboard, attached to each other with tape.

Results:
Geometric shapes with a twist. Three different plates were developed that can be connected.

1 square = 2 right triangles
1 parallelogram = 2 equilateral triangles

1x 3x
2x 1x
4x

3x 2x
3x 3x
2x 6x
4x 4x
2x 3x
4x
L. Connections Table Buddy

Rope

Tie-wraps

Double-sided tape

Sticks
Glue

Profile