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**Publication date**  
2017

**Document Version**  
Final published version

**Published in**  
Alive Active Adaptive

### Citation (APA)

Majumdar, P., Karana, E., Ghazal, S., & Sonneveld, M. (2017). The Plastic Bakery: A Case of Material Driven Design. In E. Karana, E. Giaccardi, N. Nimkulrat, K. Niedderer, & S. Camere (Eds.), *Alive Active Adaptive: International Conference on Experiential Knowledge and Emerging Materials EKSIG 2017* (pp. 116-128). TU Delft OPEN.

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# The Plastic Bakery: A Case of Material Driven Design

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## Keywords

Materials Experience,  
Material Driven Design,  
Do-It-Yourself Materials,  
Recycling, Plastics

## Abstract

A growing number of scholars argue that understanding how people experience materials in products, i.e. Materials Experience, is essential in designing meaningful material applications. Material Driven Design (MDD) has been developed as the method to understand these experiential traits of materials and embed them in the design process. However, the MDD method is yet to find its way as a mainstream design practice across diverse projects. This paper presents one of these projects, in which a designer followed the MDD method to design (1) a service system for collection and recycling of plastic wastes, and (2) a product that brings forward the unique qualities of recycled plastics and make people cherish re-cycled plastics as personal Do-It-Yourself souvenirs.

## Introduction

In a global economy, where manufacturing companies compete neck to neck to cut costs and deliver higher product value, plastics have become ubiquitous. They are inexpensive, durable, lightweight and easily moldable into various products. From the moment we lift up a toothbrush in the morning till the moment we switch off our bedside lamps, we are surrounded by them. The British Plastics Federation (2008) estimates that around 4% of the world oil and gas production serves as raw materials for plastics and a further 3-4% provides energy for the manufacturing process. In 2014, the European Union alone produced 25.8 million tonnes of plastic wastes (PlasticsEurope, 2016). Most of such waste finally ends up in landfills or oceans becoming persistent organic pollutants in terrestrial and marine habitats

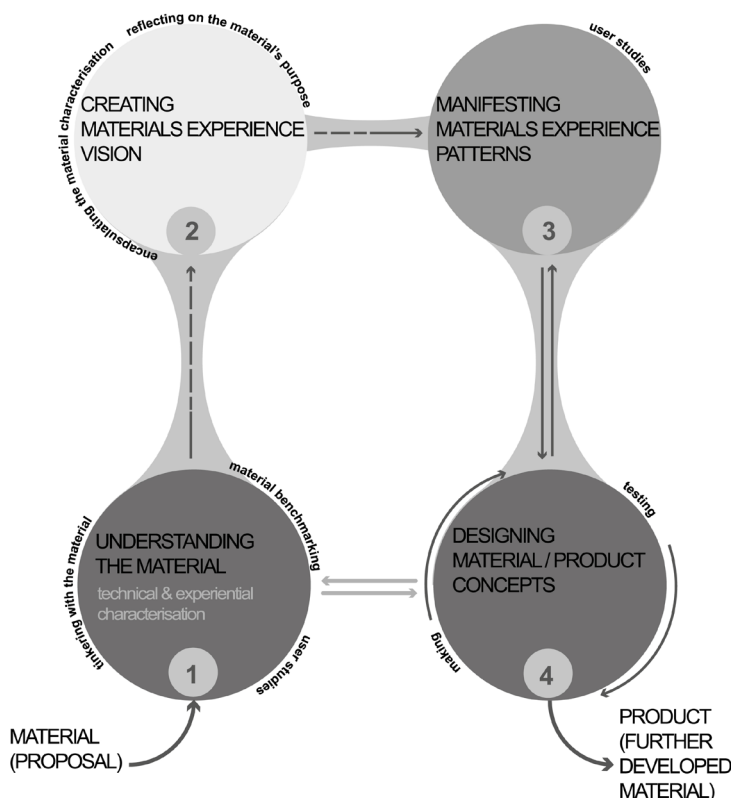
Hopewell, Dvorak and Kosier (2009) state that approximately 50% of the plastics are used for short-term disposable consumer items and packaging. In view of the growing need to curb plastic dumping, designers today attempt to design products that are meant for longer use or reuse, and packaging that uses eco-friendly materials or minimum plastics. Designers also attempt to minimize the number of components in packaging to facilitate separation of different kinds of plastics and easier



recycling. However, recycling plastics is a process that is much easier said than accomplished. Reheating plastics progressively degrades the long polymer chains causing a reduction in strength and stiffness of the material (Möller, Strömberg and Karlsson, 2008). Companies that use plastics for their products, therefore, do not always prefer recycled plastics. Yet low technical performance is not the only reason behind the resistance of companies towards using recycled plastics. Designers, in general, dismiss recycled materials as inexpensive and inferior quality before exploring new applications with them (Dehn, 2014)

Introduced by Karana, Hekkert and Kandachar (2008), the notion of Materials Experience emphasizes the role of materials as simultaneously technical and experiential. Giaccardi and Karana (2015) introduce four levels of materials experience as: sensorial, interpretive, affective and performative. While the sensorial level describes how a material is perceived through our senses of touch, vision, smell, sound and taste, the interpretive level depicts the meanings we assign to materials. The affective level describes the emotions that are elicited by materials and the performative level speaks of the actions and performances that are established around the material object. We argue that if a designer can systematically explore the experiential qualities of recycled plastics and embed this thinking in the design process, he/she can reach to richer, more meaningful applications, which bring the unique qualities of the material forward.

In this paper, we present the journey of a designer (Ghazal, 2016) who followed the Material Driven Design (MDD) method (Karana, Barati, Rognoli and Zeeuw van der Laan, 2015) in the context of developing a product made of recycled plastics and a service system to support the collection and recycling of plastic wastes. The method provides a step-by-step approach from understanding a material to its final embodiment in a product. It guides the designer to envision and develop the material by bridging the gap between technical properties and experiential qualities through questions such as: “what it does, what it expresses to us, what it elicits from us, and what it makes us do” (Karana et al. 2015).



The MDD method developed by Karana et al. (2015) begins with a thorough understanding of the material from the technical perspective (through laboratory tests) and experiential perspective (through user studies). Material benchmarking confers the designer with knowledge of the current products in the market and activities with that material. The second step of the MDD process involves creating a vision of the experience that the designer wishes the user to have when the material is incorporated in a product. The third step comprises of understanding the perception of the material that exists in the society and the final step involves creating a meaningful product or product system that builds on the understanding of all technical and experiential traits of the material as well as the existing material experience patterns.

## The Design Assignment

We asked the designer to explore the experiential qualities of recycled plastics and design a Product Service System (PSS) which brings forward the unique qualities of the material and motivates people to recycle and collect plastics.

### Step 1: Understanding the material

The designer decided to triangulate on Polyethylene as her working material since Polyethylene does not emit dangerous fumes while heating. She conducts several tinkering studies with the material to understand its properties, its behaviour under different production methods and the opportunities it presents.

### Tinkering with Recycled Plastics

#### *Painting*

She painted on a canvas with molten plastic using a soldering iron. Beautiful “brush-strokes” could be created and the layered texture created depth in the paintings. But she reported a time constraint in making the strokes since the molten plastics congealed fast.



#### *Plastic Wool*

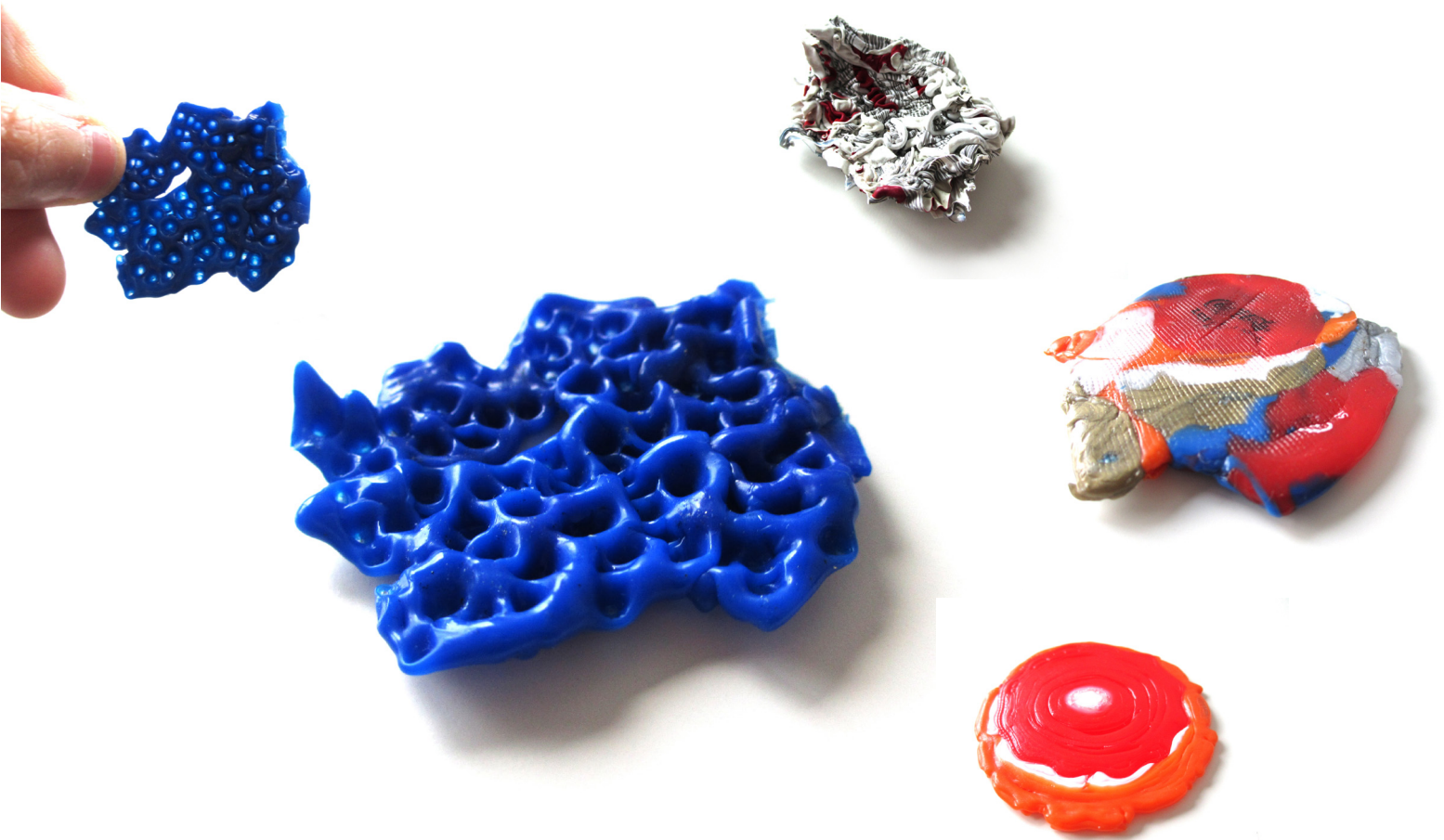
She created Plastic wool in the shredder but the process gave out plastic dust which is dangerous when inhaled.





### *Baking*

She baked various combinations of coloured bottle caps in an oven at 180°C for 10 minutes. She then subjected it to cooling with air or water or pressing while cooling.



### *Plastic Blocks & Tiles*

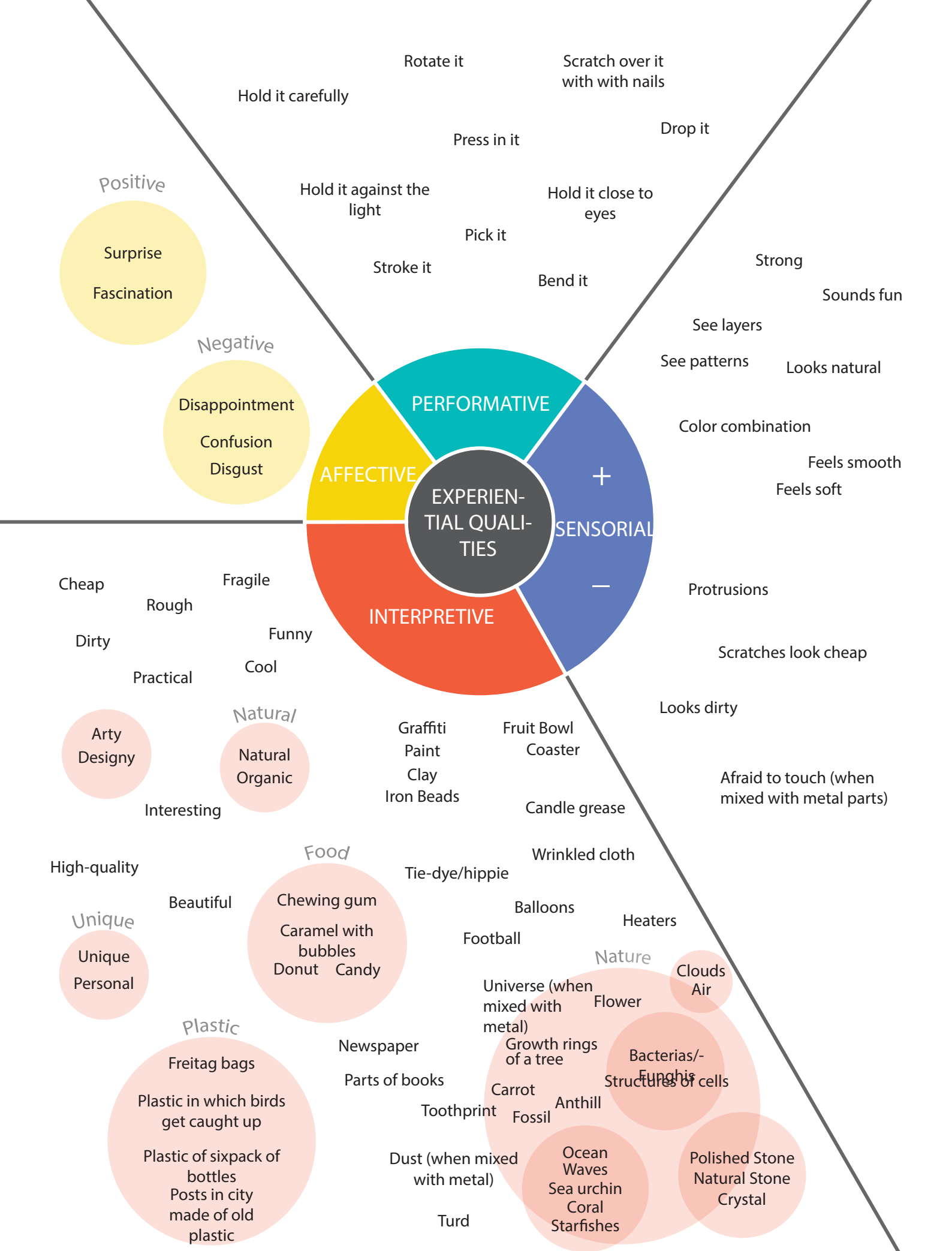
She finally created blocks and tiles with plastics. While the blocks could be give a very layered look, the thin plastic tiles presented a delicate translucent appearance. It was possible to knead the blocks with hands and give different shapes and to create imprints on the tiles with stamps.





### Understanding Experiential Qualities of Polyethylene


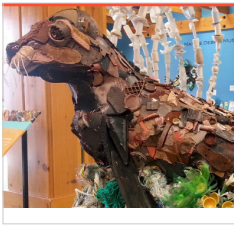

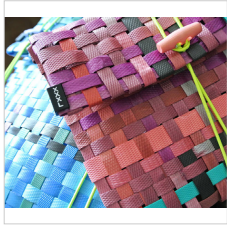





As the MDD method suggests, understanding a material fully involves understanding its technical as well as experiential qualities and their interrelationships. The designer interviewed 12 students from the Masters program in TU Delft in an attempt to characterize polyethylene at the four experiential levels (sensorial, interpretive, affective and performative). In the interviews, she used the samples she had created through tinkering with the material. The participants expressed a range of emotions from pleasant surprise to disgust. They made interesting associations of the materials with objects found in nature such as wood, fossils, skies, sea-urchin, etc. They curiously held the sample close to their eyes, scratched it, stroked it and held it against light. The following chart shows a breakdown of the various reactions and emotions elicited in the participants when they were presented with the various material samples.





## Material Benchmarking

The first step of MDD also recommends 'material benchmarking'. The designer explored different products and production methods of goods in the market made from recycled plastics to find new material applications and experiential opportunities. She, specifically explored the unseen potential of the material. She categorized her findings with the aid of Material Benchmarking cards and tables. She found the idea of people collecting plastics in beach cleanup drives particularly interesting. She also sought inspiration from the product ideas that involved people through group Do-It-Yourself activities and fostered community spirit.

MATERIAL BENCHMARK TABLE (MB)		USE		
APPLICATION PICTURE / SAMPLE				
NAME	Dopper	Washed ashore-sculptures	Melting pot table	XXXL Sakke
MANUFACTURER	Dopper	Washed Ashore	Dirk van der Kooij	Leonie&Lois
COMPOSITION	PP, ABS, TPE - Not recycled.	Marine Debris	Different types of plastic	PP - Packaging straps
RAW STATE PICTURE / SAMPLE				
TECHNICAL PROPERTIES	Strong, Waterproof, Hygienic.	Different colors, textures.	Strong, waterproof, colorful	Appropriate for weaving, colors, textures.
EXPERIENTIAL QUALITIES	Transparent & non-transparent. Funny shapes (cap). Tilt cup and use it as a glass.	Depth by trash, detailed, arty.	Color patterns flowing into each other, attractive appearance, curiosity, unique.	Interesting textures.
APPLICATIONS	Bottles  Wave of bottles for festivals	Art objects	Table	Clutches, wallets, laptop sleeves, bags.
ACTIVITIES		Exhibitions.	Tables for bars/ restaurants.	Packaging (for money/ laptop/belongings)
ULTIMATE PURPOSE	Decrease single-use plastic, increase awareness of single-use plastic.	Educating and creating awareness about marine debris and plastic pollution through art.	Show the beauty and uniqueness of recycled plastic materials.	Show African culture, reuse plastic waste.

MDD Table (Karana et al., 2015)



## STEP 2. Materials Experience Vision

The designer reflected on the results of her tinkering experiments with recycled plastics, her understanding of its experiential qualities and her findings from the material benchmarking. The element of surprise that the participants expressed at the colour patterns arising from the flow of plastics and the translucency of the tiles captured her interest. However, she felt that the emotion of surprise was heightened for her owing to her involvement in the whole process from melting the plastics to seeing the beautiful striated patterns in the final form. She retained the idea of passage of light through the material and envisioned a product wherein this feeling of “creating beauty” is infused. When the surface was imprinted with a stamp and the pattern and the irregularities of handcrafting became visible when the sample was held against light, it further added to the feeling of surprise.

In conceptualizing her PSS, she reckoned that “making” is a fun experience. From her personal experience, the final product was very gratifying since she was part of the “baking” activity and saw the process unfold right from heating the plastics to molding them in various shapes which can be even more enjoyable when conducted in a group. The design of the “First Supper” - An Extraordinary Dinner (2008) by Berlin based designer, Jerszy Seymour illucidates how people came together and built the bench by melting plastics which lead to a richer experience for the product user.



*“When the users witness plastic wastes transform into beautiful products, it makes them aware of the possibilities and value of waste and also motivates them to collect it.”*

- Designer, after engaging people.



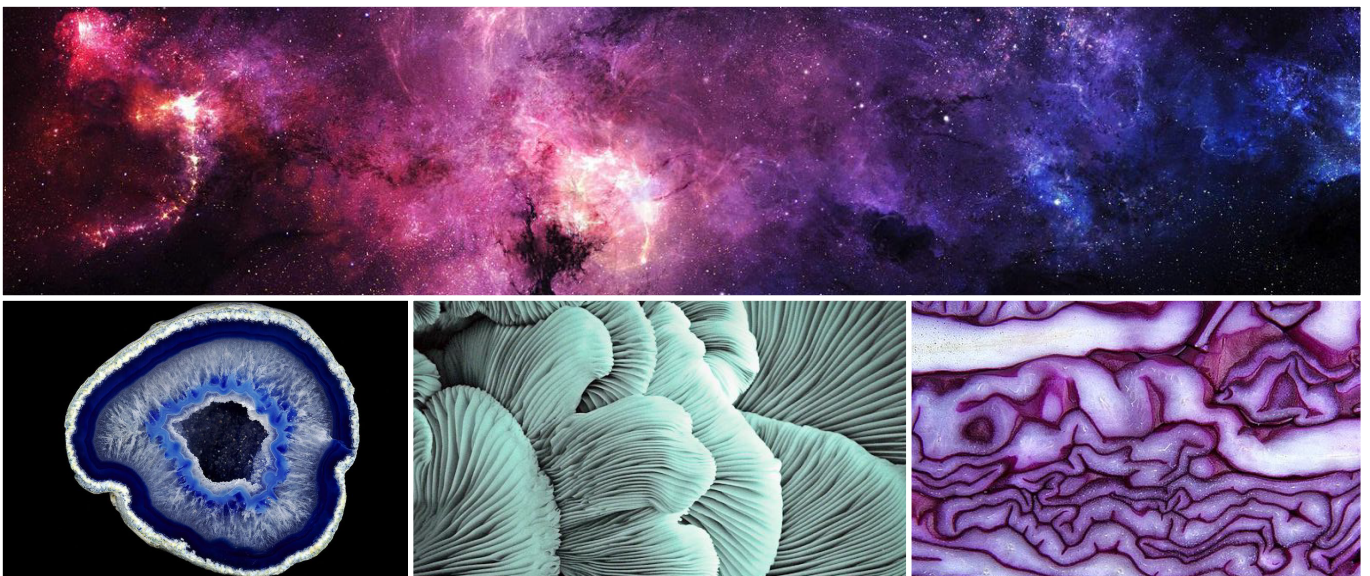
### STEP 3. Manifesting Material Experience Patterns

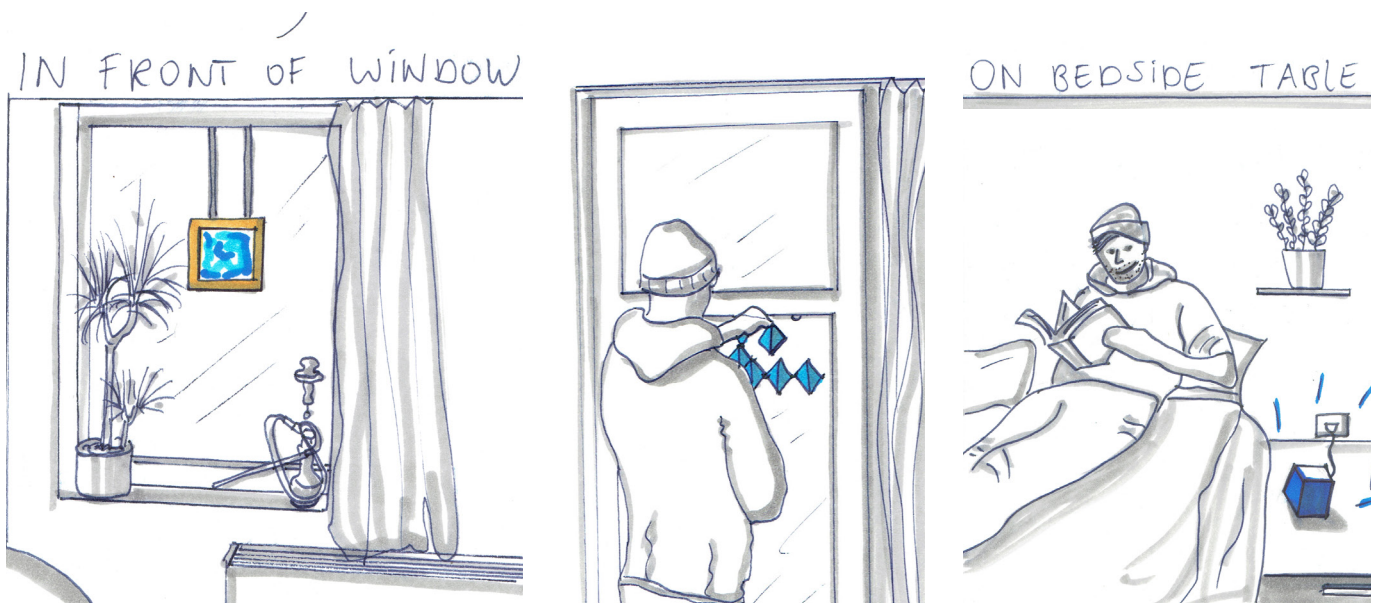
The third step of the MDD method focuses on understanding the patterns that exist in the society concerning how certain materials are experienced in particular ways. The designer however focused on understanding how people experience baking instead of the material-people relationships. She conducted an online survey and asked the respondents if they liked baking and the reasons behind their liking or disliking it. Keywords were collected and charted on a mindmap. The responses manifested a perception of baking as an activity that is relaxing and leaves room for expression. This result further inspired the designer toward her final PSS concept.



### STEP 4. Conceptualizing a PSS: The Plastic Bakery

The project, creatively named as the “Plastic Bakery” (Ghazal, 2016), aimed at converting plastic waste into do-it-yourself items of craft. The design phase was split into design for material application and design for services around the material.



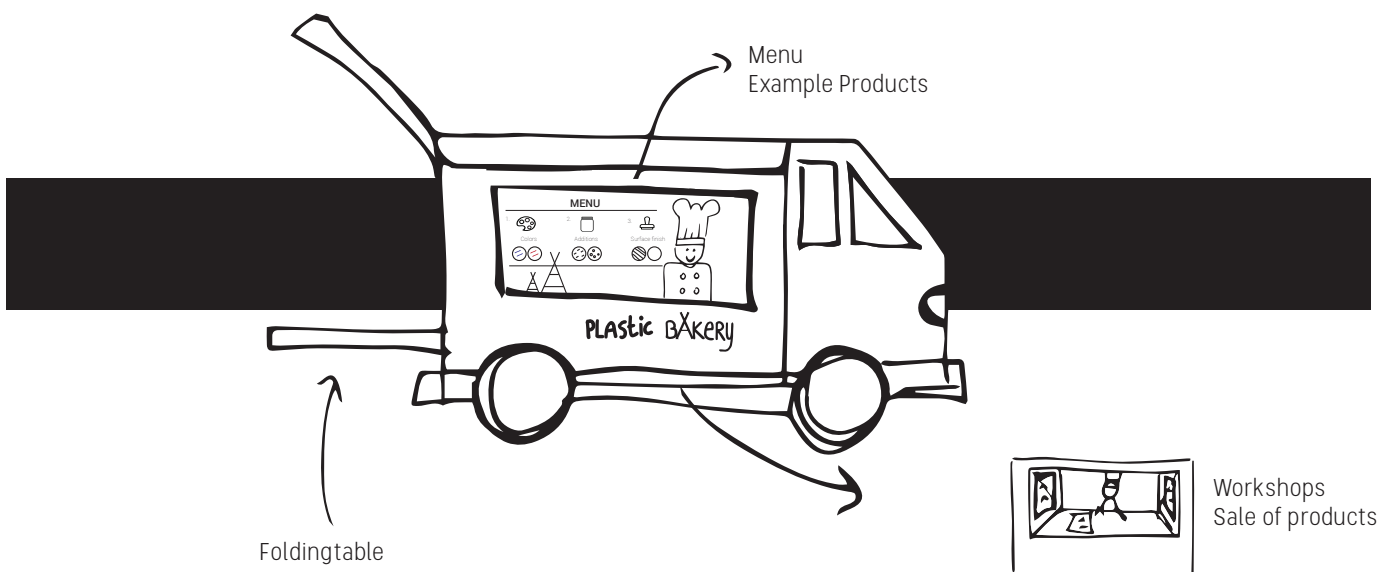


### Product

Through concept drawings, the designer arrived at three product concepts that utilized the passage of light through a thin plastic tile- “Nature in a frame”, a “window curtain” and a “bedside lamp”. She made rough prototypes of the three concepts, but eventually converged on the bedside lamp as it evoked the best imagery of nature.

### Service

Collecting the waste raw materials for the product was a crucial part of the making process since it made the people feel like they built the product from scratch and have a greater sense of belonging for it. She also ideated that the baking of the plastic wastes can be organized as a group activity to make it more enjoyable. She assigned it a very creative name: “The Plastic Bakery.” Here the “baking” analogy not just alludes to the similarity of processes, but also to the feeling of satisfaction from shaping the material with one’s own hands. Having the whole process done as a community activity promotes social cohesiveness and leads to higher social sustainability of the PSS (Vezzoli et al. 2014).





The designer set up a “Plastic Bakery” truck with tools, products and a “menu” of different motifs for the lamps. It was essential to encompass the satisfaction of having the whole process in their hands- from choosing the bottle caps for the chosen motif, melting and moulding the plastics and giving it final shape.

She also fabricated several wooden stamps with logos. The participants could press the molten plastics either with their hands or feet. Inspiration was drawn from the community activity of stomping on grapes to make wine. Some participants were so involved that they even improvised their own sprinkles for their lamps. When the final PSS was put to test, people enjoyed the whole experience from chosing the motifs to baking and fabricating their own lamps.



Elements	Bottle caps (Amount of caps per mold)	Impression	Examples
<div>Air</div>	<div>  2            2            2            1         </div>	<div>  Cozy Clouds         </div>	<div>  Cozy Clouds         </div>
<div>Air</div>	<div>  1            1            3            2         </div>	<div>  Starry Sky         </div>	<div>  Starry Sky         </div>
<div>Water</div>	<div>  1            3            2            1         </div>	<div>  Cool Ocean         </div>	<div>  Cool Ocean         </div>
<div>Fire</div>	<div>  2            2            2            1         </div>	<div>  Warming Flames         </div>	<div>  Warming Flames         </div>
<div>Earth</div>	<div>  3            1            1            2         </div>	<div>  Magic Marble         </div>	<div>  Magic Marble         </div>
<div>Earth</div>	<div>  2            2            2            1         </div>	<div>  Funky Forest         </div>	<div>  Funky Forest         </div>





*"This can really be a success."*

*"So, can I make this at home?"*

*"If I see this, I really want to make one myself."*

*"Surprising."*



The products were exhibited on the Future Materials exhibition at TU Delft. The display succeeded in exciting people and making them wonder if they could make it themselves.

## Conclusions

The process of developing a PSS through the lens of Material Driven Design can unfold unanticipated and surprising avenues for capturing the interest of people. While designers predominantly focus on the experience of people with products, MDD offers a new methodological approach to consider the lesser known experiential aspects with materials in designing products. The designer of the Plastic Bakery discovered several unexplored experiential traits of plastics that guided her in transforming a waste material into a product of personal delight. She designed a product that people can conceive and make themselves and cherish as a souvenir of their creativity. The designer reached the conclusion that active participation of the makers will add a whole new dimension to her PSS. Her constant tinkering and reflective approach aids her in developing a product which mobilizes the performative qualities of recycled plastics such as holding it against light.

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## **Prarthana Majumdar**

Prarthana Majumdar is a PhD candidate in the department of Design Engineering at Delft University of Technology, the Netherlands. She graduated as a Mechanical Engineer from Indian Institute of Technology Guwahati (IIT) and later received her Masters from Stanford University, USA. Her current project, as a PhD scholar, focuses on promoting Do-it-Yourself material practices in the Base of the Pyramid, primarily India and Bangladesh. She focuses on Social Innovation and Materials Experience to understand how local eco-materials and recycled materials can be used more in such developing countries. The project aims at democratization of innovation and manufacturing in this segment that constitutes 70% of the global population.

## **Elvin Karana**

Elvin Karana is Associate Professor of Design Engineering at the Delft University of Technology, where she founded and directs the Materials Experience Lab. Her research aims to understand and enhance the relationships people have with the materials of products. She has undertaken this topic with a holistic approach, capitalizing on not only the technical properties of materials, but also meanings, emotions and actions materials in products elicit. She coined the term “materials experience” to describe this holistic view. She is the main editor of “Materials Experience: Fundamentals of Materials and Design”. The Material Driven Design method she developed is applied in design courses in major European universities.

## **Sabrin Ghazal**

Sabrin Ghazal is recently graduated from the Master Design for Interaction at Delft University of Technology, the Netherlands. For her graduation she developed the Plastic Bakery, the design of a product and service around recycling plastic waste. Her aim was to show people the value of plastic waste, by surprising them with the beauty of the material. She explored the material qualities of plastic bottle caps and found out that the material can look natural and that patterns can arise. Workshops were developed during which people can bake their own product and see the transformation of waste into a valuable material. She is currently turning her concept into a business.

## **Marieke H. Sonneveld**

Marieke H. Sonneveld is an Assistant Professor at the Department of Industrial Design Engineering in Delft University of Technology. In addition, she was a design teacher for many years at the Design Academy Eindhoven. In both positions, her research and teachings focus on the meaning of touch in human-product experience. She developed a framework to unravel the tactual experience, in order for designers to be able to have access to it, to explore it, and to develop their sensitivity towards the aesthetics of the tactual experience. Developing sensitivity, becoming ‘super feelers’, is crucial for designers to design meaningful tactual experiences.