Arenga Rainforest Sugar

Designing a tool to enhance the experience of the Arenga Rainforest Sugar for coffee bar guests

Klara Kohler

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Preface

I selected this assignment for my graduation project because it combines nicely my focus points of Sustainability, Food Design and Material Driven Design, which I chose to add to my Integrated Product Design master studies. I could learn a lot during the past 5 years studying in Delft. This graduation project is rounding off my student time and I feel well prepared to start working as an Industrial Designer.

I would like to thank my great supervisors Rick and Bahar for supporting and guiding me through this project. I appreciated that you shared your knowledge and experience with me, gave honest feedback and that you pushed me to explore for me new areas and try out different approaches. You gave me inspiration and helped me focus and improve a lot.

I also want to thank Forestwise for the great and meaningful assignment and the big freedom you gave me.

The PMB staff was amazing support in the workshop to build my prototype.

I met a lot of very open and helpful owners, managers and waiters of cafés in Delft and Den Haag, who took time to give me feedback and valuable insights at different points during this project. Also fellow students participating in my user study were a big help.

My family, friends and fellow students were furthermore a huge help during the whole process, giving me feedback, inspiration and good tips.

I want to specially thank my boyfriend Christoph for your great support!

Master thesis
Designing a tool to enhance the experience of the Arenga Rainforest Sugar for coffee bar guests

MSc. Integrated Product Design
Faculty of Industrial Design Engineering
Delft University of Technology
The Netherlands

Chair of supervisory team: Rick Schifferstein
TU Delft mentor: Bahar Barati
Company: forestwise
Company mentor: Dirk-Jan Oudshoorn

Student:
Klara Kohler, 4355962
klara.l.kohler@gmail.com

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Summary

Forestwise wanted a suitable way to serve their Arenga Rainforest Sugar in Dutch cafés. This brown sugar comes from Indonesia and is a tasty, healthy and sustainable alternative to regular sugar. It is wild-harvested from the Arenga palm tree, which grows naturally inside the jungle. The Arenga sugar provides the local farmers with an income from their existing forests and motivates them to halt deforestation and protect biodiversity. This background story should be communicated to end-consumers.

The final design proposal is a grater made out of bamboo, which is placed on the café's tables. It is filled with cylindrical sugar blocks with chocolate-like texture. The café guest can grate sugar flakes by rotating the base of the grater. A mechanism turns and pushes the sugar blocks against a knife with two blades, shaving off a layer of spiral of flakes.

The sugar comes out at the top of the grater in the shape of a flower. The user can observe the sugar “growing” inside an illustration of the rainforest, which is engraved in the bamboo around. This lets the user experience how the sugar naturally grows inside the biodiverse rainforest in Indonesia, contrary to being cultivated in monoculture plantations. The background story of the sugar is illustrated with engravings on the outside of the greater, showing how the sugar is wild-harvested and processed. The café guests become part of the process by grating their own sugar flakes to sweeten their drinks. This drives a sustainable system of rainforest and local farmers. The sugar is presented as special and natural, in an attractive and novel way.

The concept is tested with a working prototype and evaluated by users and cafés.

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Introduction

This chapter introduces the project and its stakeholders. The problem definition and goal of the project are presented and followed by an overview of the final design, to show how the problem was solved. Afterwards the approach and methodology are explained to follow along the design process and understand how the design was developed. The project brief can be found in the appendix.

Project Description

This project is about developing a rainforest sugar-based product for Forestwise (www.forestwise.earth). Forestwise is an Indonesian based company, providing sustainable alternatives for the forest communities in Indonesia. They help them to earn an income from their existing rainforest, motivating them to protect the rainforest, instead of turning it into monoculture palm oil plantations. The company produces and promotes a range of products that are wild-harvested from the natural forest system, without harming it and are produced using zero-waste production systems.

Their current range of products includes Arenga Rainforest Sugar (used as food ingredient or in beverages), Cold-Pressed Virgin Coconut Oil (used in food or cosmetics) and Illipe Butter (a cosmetic ingredient). This project focuses on the sugar products. The sugar is harvested from the Arenga palm tree, which naturally grows in the rainforest and requires this biodiverse surrounding. Rainforest sugar is made from the sweet sap of the Arenga tree, which can be tapped year-round and in vast quantities. The Arenga sugar is brown and has a light caramel-like flavour. Not only the taste of the Arenga sugar is unique, but also the environmentally friendly manufacturing process and the perceived health benefits (Stichting Masa-rang International, n.d.).

The project is focused on designing a product with the Arenga rainforest sugar for Dutch end-consumers, to be served in cafés to sweeten hot beverages. The starting point was granulated, brown Arenga sugar (see Figure 1).

Stakeholders

The stakeholders involved in this project are introduced in this chapter. The design student Klara Kohler selected the project, aligning it with her interests and learning goals. TU Delft provides the supervisory team and sets requirements for the formalities and content of the graduation thesis. Forestwise formulated the initial assignment and wants their products to be promoted and tell their story to the end consumer. They are interested in an innovative idea, which can be quickly implemented. The cafés play a big role for this project, since they are the customers buying the product and providing the context of use. Finally the guests of the café are the users of the product, who have to be able to understand it and the story behind. The production of the (sugar) product might be taken into account and is depending on the design. Distributors can be interestingly to take into account in order to make use of the existing distribution channels of coffee and tea.

Problem Definition

There is a rising interest and awareness about the origin and story of food ingredients and their impact on society and environment. People are looking to make more conscious decisions about their food. Nevertheless sugar is currently not valued as resource and its origin and story is not often communicated.

The Arenga Rainforest Sugar has a positive impact on deforestation and the livelihood of forest communities in Indonesia. This is a story, worth sharing. The Arenga sugar is one of the sustainably wild-harvested rainforest products. Promoting these increases the forest’s value and makes it economically beneficial for the local farmers to preserve the rainforest areas and the animals that live there and halts deforestation. That is an urgent issue because we are quickly loosing big parts of rainforest, which has a huge impact on biodiversity and climate change. Due to its increasing consumption, coffee is one of the (future) drivers for deforestation (Conservasion International, 2016).

Goal

The expected outcome of this project is an Arenga sugar based product, to be served with hot drinks in Dutch cafés. It will present the Arenga sugar in an interesting and appealing way, emphasizing its unique qualities. Forestwise’s story about the sugar’s background will be communicated to the end consumer. This will stimulate people to value the sugar and think about its origin. A physical prototype will be made, which proves the concepts feasibility, desirability and viability.
Final Design

The outcome of this graduation project is a tool to serve the Arenga Rainforest Sugar in coffee bars. Traditional hard sugar blocks are grated into beautiful sugar flakes by the café guests, to sweeten their hot drinks, such as coffee and tea. The detailed final design is presented at the end of this report (page 64).

The context of use for the sugar grater are cafés in the Netherlands. The focus lies on small speciality coffee bars with hip guests, offering a range of tasty, healthy and sustainable products with a transparent story (see "Product Context" on page 8 and "Target Group" on page 26).

The Arenga sugar is sustainably wild-harvested from the rainforest on Borneo (Indonesia) by the local forest communities. The sugar is made from sweet sap, tapped from the Arenga pinnata palm tree, which naturally grows in the biodiverse rainforest, instead of monoculture plantations (see "Arenga Sugar Source" on page 12). This background story (see page 104) is depicted on the grater tool with engravings (Figure 3), showing the balanced eco-system of forest community and rainforest, both benefiting from each other. The café guest’s role is to keep this system running and have an impact with conscious consumption behaviour. While grating, the user can observe the sugar grow in the shape of a flower, inside the engraved rainforest (see Figure 2), same as the sugar palm naturally grows in the rainforest.

The tool is placed on the table and café guests can use it to sweeten their drinks. It enhances their experience of the Arenga Rainforest Sugar and facilitates a new way of serving sugar (“Benchmarking” on page 10). The bottom compartment of the tool is filled with sugar blocks by the café personnel beforehand. The guest then only has to turn the bottom part of the tool, which pushes and rotates the stacked sugar blocks against knives (see “Mechanism” on page 68), shaving off sugar flakes (page 46), which come out on the top like a flower.

This way the sugar is presented as something special and natural and the user is stimulated to appreciate it through active engagement and the way the tool is held. The Arenga sugar is a healthy sweetener with a low glycemic index and a number of nutrients ("Arenga sugar characteristics" on page 16).

The sugar is packed in stylish paper rolls with the Arenga logo (page 75) and shipped from Indonesia to the Netherlands in compact, hard, cylindrical blocks, as traditionally made in south east Asia. Those blocks support the authentic image and help to differentiate the Arenga sugar from regular brown sugar and make its unique story more clear for the user.

The grater supports the natural appearance of the sugar and the material choice of bamboo matches the sugar’s source, since the farmers also use bamboo tubes to collect the sugar sap from the Arenga trees. The cylindrical shape fits the size of the sugar blocks and gives hints to the user about the rotational grating function. The grater also serves as a decorative element, drawing the guests’ attention and being a visual statement for the café’s sustainability efforts.

The design is evaluated (page 78) by user tests and interviews with personnel, managers and owners of cafés. The main parts of the desired user experience (see “Material Experience Vision” on page 22 and the more detailed “Vision” on page 40) could be confirmed. The Arenga Rainforest Sugar is experienced as natural, special and authentic with emotions such as curiosity, pleasant surprise, fascination and virtuousness. The message of a healthy, sustainable and transparent product was also conveyed by the grater.
Day 80 in a process with big and small iterations. The approach for this project is illustrated in Figure 4, showing the process in a chronological way, with the three big iterations as loops (1. Analysis, 2. Design Development, 3. Design Detailing). Each project step was stretched over a longer period and covered several times, resulting in a process with big and small iterations.

The analysis for example was first a very broad collection of information. Afterwards it was prepared for a presentation, which required to dive deeper into certain topics, structure them and draw conclusions from the insights. At the same time idea development was already started. Many insights could be used as inspiration and to refine ideas, resulting in 9 design directions. For the midterm meeting a first report was drafted, stimulating another iterative cycle, supporting the selection of concepts and refinement of them.

Three concepts were developed, from which one was selected and further detailed. A more specific vision for this concept was drafted and used to detail the design of a sugar grater tool, considering the user experience and integrating the sugar’s background story in the different design elements. A functioning prototype was made to test the working principle and several models were made to define the tools shape and material. Studies were conducted to evaluate and improve the design.

Methodology

Several design methods have been used and (partially) adapted for this project. Integrated Product Design serves as a basis, which is combined with aspects of Material Driven Design and Food Design.

Integrated Product Design

Integrated Product Design is a continuation of the bachelor Industrial Design Engineering at TU Delft. Design challenges are approached holistically, with focus on designing user-centered, innovative products and product service combinations. It is based on a balance between the interests of users, business and societal challenges, implementing technology in a meaningful way. It covers the entire design process, starting from a design brief and ending with a complete product that is feasible, desirable and viable and fit for mass or small series production. The focus lies on conceptualisation and embodiment design, using integrative approaches to cover aesthetic, ergonomic, engineering-related and environmental issues.

Material Driven Design

The Arenga sugar is seen as a material, and a starting point for this project. The Material Driven Design (MDD) method (Karana, Barati, Rognoli, & Zeeuw van der Laan, 2015) is applied to further develop the material and find a suitable product application for the Arenga sugar. As opposed to classical product design the material serves as starting point, instead of first developing a product and then selecting a suitable material afterwards. The method facilitates designing for meaningful material experiences. This requires qualifying the material not only for what it is, but also for what it does, what it expresses to people, what it elicits from them, and what it makes them do. The process describes 4 iterative steps (see Figure 5). It starts with a material (or a material proposal), and ends with a product and/or further developed material.

Food Design

In Food Design designers’ methods and approaches are applied to creatively solve food related issues considering agriculture, industrial processing, distribution and marketing, kitchen management, the eater, consumption situation and policy and legislation (Lee, 2017). Designers have trained specific abilities, enabling them to take the following four roles, which have added value for the food industry: ‘widen the scope of innovation projects, shape tools in order to engage others, structure and facilitate cooperation among team partners and integrate the knowledge from these different areas’ (Schifferstein, 2016).

On the other side working with foods offers multiple ways to enrich the design discipline, opening up unique multisensory aesthetics and connecting designers with local cultures and social contexts, enabling people to connect with the origins of their food (Schifferstein, 2016). Furthermore food offers a rich set of prototyping materials, also facilitating the development of DIY materials (Parisi, Rognoli, & Sonneveld, 2017). Like any other material, food is something designers can explore in the workshop, and experiment with modelling its properties and qualities (Materials Experience Lab, n.d.).
Product Context

The context of use of the final product is supposed to be cafés, coffee bars, lunch rooms, restaurants and hotels or such places, serving hot beverages like coffee and tea in The Netherlands. Here the owner, employees, guests (customers) and related trends and culture in general can be of interest. Internet research, observations and interviews with café guests, service employees, owners and managers were used to learn more about the design context.

Analysis

This chapter gives an overview of the analysis, necessary to understand the context of the to be designed product, the source of the Arenga sugar and its material characteristics.

Market Trends

Market trends are identified and shown in Figure 6. A good summary is the statement on the website of the café Pistache in Den Haag: “Our mission is to provide clean, organic, fresh and tasty food for both naughty and healthy eaters.” (Pistache Café, n.d.).

Enjoyment

On one side people like to treat themselves and enjoy tasty food. “Consumers view food not only as a bundle of attributes like nutrients and sensory properties, but also holistically as a source of pleasure and happiness.” (Grunert et al., n.d.). Hip coffee bars, design cafés and restaurants are spreading in the cities, serving delicious cakes, snacks and special meals. People increasingly spend more money on eating out; in 2017 Dutch people spent about half of their money while going out. Many cafés use (tropical) plants as decoration and have natural interiors with clean, organic, fresh and tasty food for both naughty and healthy eaters.”

Healthy

On the other side people prefer to eat more healthy and natural, causing the demand for natural sweeteners to grow (CBI, 2016). Natural and authentic food ingredients are perceived as being healthier and safer than synthetic ones, therefore also synthetic sweeteners are losing momentum. There is a consumer backlash against added sugar, because of health concerns, regarding for example obesity, heart disease, tooth decay and diabetes (Ananda Venture, 2017). According to CBI (2016) there are also more consumers looking for products with a low glycemic index. The interest to experiment with alternative ingredients and the general exposure to it is also increasing (Ananda Venture, 2017), making more people interested in alternative natural sweeteners. Rising awareness about sustainability and the fact that people want to make a difference, favours organic and transparent products.

Many cafés use (tropical) plants as decoration and have natural interiors with white (refined) sugar. Honey is normally offered with (fresh) tea. Palm sugar is not well known yet and one café owner expected it to be very expensive. More awareness for organic and fair trade coffee is arising and in 2014 already half of the market share in the Netherlands was fair trade coffee (CBS, 2014). Coffee plantation causing deforestation is nevertheless not well known and the deforestation free solution of shade grown coffee neither. Cafés increasingly try to be perceived as sustainable and guests are willing to pay a bit extra for this.

The personal preferences on how people like to drink their coffee or tea vary a lot. Some people for example like to only sweeten the milk foam, whereas others prefer it if only the coffee below gets sweet, and other prefer not to add sugar at all. It was found that roughly half the people add sugar (or other sweeteners) to their hot drinks. Factors such as personal taste, quality of the drink, health concerns and way of presenting the sweeteners have a big influence on this percentage. Most cafés present the sugar in a rather boring way, mostly in sugar sachets and sometimes sugar cubes served per cup, or in jars, pots or sugar shakers on the table. Cafés prefer sugar packets, because they are convenient, clean and cheaply provided by coffee suppliers. Convenience is an important aspect for cafés, therefore they prefer to order everything (coffee, tea, sugar etc.) from one supplier and be able to compactly store and easily prepare and serve it. Brown (cane) sugar is becoming a popular alternative for white (refined) sugar. Honey is normally offered with (fresh) tea. Palm sugar is not well known yet and one café owner expected it to be very expensive. More awareness for organic and fair trade coffee is arising and in 2014 already half of the market share in the Netherlands was fair trade coffee (CBS, 2014). Coffee plantation causing deforestation is nevertheless not well known and the deforestation free solution of shade grown coffee neither. Cafés increasingly try to be perceived as sustainable and guests are willing to pay a bit extra for this.
Arenga sugar is a type of palm sugar. The broader term palm sugar is often used, without clearly indicating that the sugar may be also made of the sap of the palm tree. Arenga sugar brings advantages for harvesting. All palm sugar can be found in granulated form, as hard blocks, or syrup.

In the Netherlands, different types of palm sugar are available in Asian supermarkets and in organic and health stores. The granulated Arenga sugar is mostly sold in plastic pouch bags (see Figure 7). Jars are sometimes also used to package granulated sugar or syrup. The sugar blocks are normally packaged in a roll of plastic. The simple designs give often hints about its source, depicting either the palm tree or an orangutan, and some packages have an organic or fair trade label and state the sugar’s health advantages.

In Figure 8 a broader range of existing sweetener products are categorised in ordinary, more healthy, adding taste, special / exclusive, original and communicating a message.

Ordinary sweeteners are sugar packets with white or brown sugar, sugar shakers, jars, sugar cubes or rock sugar. Other sweeteners perceived as more healthy are for example cocos sugar, different palm sugars, agave syrup, maple syrup and honey. In China black sugar blocks with flower petals, herbs, spices and tea are mixed with hot water and seen as very healthy. Many sweeteners also add taste. A range of syrups with added flavours such as vanilla, hazelnut or caramel are also often offered with coffee. There are many ways how sugar can be served in a special and more exclusive way, but rarely found in regular cafés. Original ideas include using sugar as a cup, making shapes out of sugar foam (marshmallow or meringue), decorating cappuccino with illustrations using latte art or cacao, or interestingly shaped sugar pots or spoons. In some examples sugar is also used to communicate a message, mainly with images, or by giving the sugar or the container a special shape.
Forestwise

Forestwise (forestwise.earth) was previously called The Wild Bunch and is a social enterprise, based in Indonesia (Kalimantan). Their mission is to halt deforestation and keep the forest wild by protecting its biodiversity, instead of turning it into monoculture palm oil plantations. They support farmers to sustainably produce high quality, wild harvested, non-timber rainforest products, from existing forests and without harming the forest. Their current range of products includes Arenga sugar, cold-pressed virgin coconut oil (used in food or cosmetics) and Illipe Butter (a cosmetic ingredient). Forestwise currently mainly sells B2B to customers that use their products as an ingredient. They would like their products and story also to reach the end-consumer. By increasing sales of these products, they simultaneously increase the value of the forest and empower the forest inhabitants to keep protecting it.

Rainforest

Rainforests are the most biodiverse places on earth and home to more than half the world’s animal species (Rainforest Alliance, 2016), even though they cover less than 5% of the earth’s surface (Augustina, 2018). A century ago most of Borneo was covered by forest, but the island has lost half of its forest already and deforestation is continuing in an alarming rate (WWF - World Wide Fund For Nature, n.d.). Borneo is estimated to still be home to around 222 mammals (including 44 not found anywhere else in the world; endemic), 420 birds (37 endemic), and at least 15,000 plants, of which 6,000 are endemic (WWF - World Wide Fund For Nature, n.d.). Many of those animals and plants are depending on the rainforest. A well known species and easy to relate to are the Orangutans, who already lost big parts of their habitat, due to deforestation. A big driver for deforestation is palm oil production, replacing wild forests with monoculture plantations. This has not only big influences on CO2 emissions and global warming, but also affects the local climate and for example the drinking water quality.
Arenga Palm Tree

The Arenga palm tree (Arenga pinnata, see Figure 12) is native to humid areas growing in coastal and tropical climate around the equator, especially in South-east Asia. The Arenga palm tree should not be confused with the oil palm, which is normally grown as monoculture and causing deforestation. The Arenga trees on the other side naturally grow in the biodiverse rainforest and can help reforestation, with amongst others their deep roots (over 12m) stabilizing the forest soil, preventing landslides, and resisting fires (National Geographic, 2015).

Wild-harvesting products from the Arenga palm trees can help to make it economically beneficial to preserve the rainforest areas and the animals that live there. On Borneo the local forest communities harvests the sugar, who belong to the native Dayak people having a rich tradition.

Tapping

The Arenga palm is also called sugar palm, because of its high sugar content sap. The sugary sap can be wild-harvested year-round and in vast quantities. Twice a day a thin layer can be sliced from the end of the stalk on which (male) flowers are growing. If done properly, the tapping extends the life of the tree, by “stealing” some of the tree’s energy that was intended as storage for its seeds, and therefore delays the ripening of the fruit (Lavelle, 2011). Tapping is a skill that takes practice, but when well-cultivated, according to National Geographic (2015) in North Sulawesi it can earn proficient tappers up to $2,500 per month, which is 8.5 times Indonesia’s per capita GDP. Only 5 Arenga trees are sufficient to provide the farmers’ family with their basic needs. In West Kalimantan alone, The Wild Bunch (now forestwise) can help at least 2340 farmers with a sustainable daily income, straight from their existing forest, from trees that are ready to be cultivated (The Wild Bunch, 2018).

Sugar Sap

The palm sap is transparent, with a sugar content of 100 – 144 g/kg, a pH of 7.0 – 7.4 and traces of ethanol (Lasekan et al., 2007). Other sources state even a higher sugar percentage of 17% and a daily harvest of 15-50 litre sap per day per tree (Hartman, 2014). PT Gunung Hijau Masarang researched how to control the volume of sap from the tree. Trees can be pushed up to 100 litre per day, but this level of tapping drains, and eventually kills the tree. Tapping 25 litre per day ensures a steady amount of sap (Ananda Venture, 2017).

Processing

The fresh palm juice will decolourise into a dull colour (Faridatul Ain et al., 2014). It is therefore important to quickly process the sugar sap by cooking it to preserve it. Ultimately it must be boiled to evaporate the water and make sugar from it. The traditional way is to pour the thick syrup in moulds and let it harden (partially crystallized) to blocks of Gula Aren. If the pH is above 7 the syrup can be also completely crystallized to granulated sugar, still a bit sticky, because of the molasses. Instead of making sugar, the sap can be also fermented to for example palm wine or to make ethanol, which can be used as fuel. The fruits can be also eaten and the roots and flowers traditionally find medicinal uses (Ananda Venture, 2017). At the end of the tree’s life cycle its wood, fibres (e.g. for bio-composites) and leaves can be used as building material.
The Arenga sugar must be understood as material, therefore its composition, properties and processing possibilities are explored. This helps to find a suitable way to present it in cafés.

The Arenga sugar consists of 94.2% sucrose and 0.6% other sugars. Next to this per 100 g it contains 0.2 g Fat, 2.5 g Protein, 1.1 g Fibres, 13.2 mg Vitamin C, 1.12 µg Vitamin B12, 3.3 mg Calcium, 36.7 mg Magnesium, 0.7 mg Phosphate, 760.0 mg Potassium, 4.1 mg Sodium, 0.9 mg Iron and 0.2 mg Zinc (The Wild Bunch, 2018).

Arenga sugar is seen as ‘superfood’, containing 50 times more minerals than white sugar, three times more potassium than bananas, plus vitamins C and B12. It is a more healthy alternative sweetener to regular white cane or beet sugar. Its low glycemic index (GI) is almost half that of white sugar and honey, making it diabetic-friendly, because it takes longer to process the sugar, causing blood sugar levels to rise only slowly (The Wild Bunch, 2018).

The biggest part of the Arenga sugar is sucrose, which is the scientific name for table sugar and is a polar compound made of carbon, hydrogen and oxygen (C12H22O11). Sugars are categorized as monosaccharides or disaccharides. Disaccharides are made up of two, linked monosaccharides and broken back down into the latter during digestion. Sucrose is a disaccharide consisting of one glucose and one fructose molecule. Glucose is a simple sugar or monosaccharide and the body’s preferred carb-based energy source (Macdonald, 2016).

The processes are mainly about changing the texture, taste and ultimately shaping the sugar two- or three dimensionally. The end result can range from fine powdered sugar over normal granulated sugar to big rock candy, and from airy marshmallow, meringue and cotton candy to syrup and glass like sugar, ranging from soft to hard. Some results of the tinkering are shown in Figure 13, at page 17 (Technical characterisation) and at page 20 (Experiential characterisation).
Technical Characterisation

The material's technical properties are highly influenced by the processing and what ingredients are added to the Arenga sugar.

Density

The density of sucrose is 1.59 g/cm³, but with the Arenga sugar it is also dependent on the humidity (water content) and its processing, as for example being compressed or foamed. The packaging weight is also dependent on the shape.

Dissolving

Adding granulated sugar to water, makes it break apart because the water molecules are attracted to the sucrose molecules through intermolecular forces. Each sucrose molecule is surrounded by water molecules and is carried off into the solution. The dissolving process happens in two steps, where first the water molecules bind to the sucrose molecules; and second the water molecules pull the sucrose molecules away from the crystal and into the solution (Husband, 2014). This process is accelerated in hot water and hot water can solve a higher percentage of sugar. Arenga sugar (and brown sugar in general) was observed to dissolve slightly quicker than regular white sugar, because of its finer structure and higher moisture content. With sugar cubes and other candy like shapes the solution time also depends on the shape, contact area and density.

Moisture

Sugar draws humidity because water and sucrose are attracted to one another based on the attractions of opposite charges. It was observed that the Arenga sugar products draw humidity from air contact and become sticky. Adding Xanthan gum reduced this effect and glucose syrup made it worse, same as inverted sugars are very hygroscopic. When granulated Arenga sugar is left at open air it becomes hard and forms lumps. For brown sugar this is explained by the drying out of the moist molasses, which makes the sugar crystals stick to each other.

Stiffness

The material's stiffness can be also highly influenced by processing. The candy with water, glucose syrup or Xanthan gum are more flexible and can almost behave like a (slow) liquid. More glass like, stiff objects can become flexible after drawing humidity. Sugar cubes and other crystalline structures can be very brittle, which is also influenced by how well the crystals are connected (e.g. pressing sugar cubes).

Figure 18: Technical characterization
Experiential Characterisation

Experiential characterisation is about investigating how a material is received, what it makes people think, feel and do. The Material Driven Design method (Karan- na et al, 2015) presents a list of questions in the MAZE4 tool kit, that guides the understanding of the four experiential layers: sensorial, performative, affective and interpretive. This tool kit was used to get detailed insights about a series of results from tinkering processes (see samples in Figure 18).

Furthermore the granulated sugar was presented in a jar and labelled as sugar at coffee bars and coffee machines at TU Delft campus. Observations and short feedback discussions during several days gave insights about how people receive the sugar as first impression and with their hot drinks. Most people reacted a bit hesitant when seeing the granulated brown sugar, being surprised that it is so dark and thinking that it is for example cinnamon, spices, cookie crumbles or chocolate. Many people also associated it with other brown sugars and thought it was “Basterd” sugar, brown cane sugar or coconut sugar. Most people first shook the jar and smelled the sugar. Reactions on the smell where divided, some really liked the smell, whereas others were negatively surprised. Carefully tasting a tiny bit pure sugar gave rather positive reactions and people described the noticeable different taste as caramel, coffee, malty, but overall sweet. When adding the sugar to the coffee it was perceived as sweet and not much difference to regular sugar was noticed.

All reactions are summarized and categorised in the four experiential layers in Figure 18.

A general conclusion is that it is very important to find the right balance between familiar and different. People should be able to recognise and understand that the Arenga sugar can be used as sweetener, to overcome the first hesitation. If the first impression is positive (mainly influenced by look and affective experience), people are curious to find out more. To emphasize this curiosity it is fine if the sugar has unknown and surprising aspects too.

It could be interesting to use the performative experience in the design, such as breaking a piece and crumble a slice or block of sugar. Also shaking the jar can be inspiring for designing the product interaction. The in the first place negative stickiness of the sugar candy (sensorial/feel) after air contact could be also used as something positive in the design.

The unique quality of the Arenga sugar having a distinct scent can be also used to distinguish it from odourless regular white sugar.

Figure 19: Experiential characterisation
Material Experience Vision

In step 2 of the Material Driven Design method a material experience vision is created, which is “an encapsulation of material experience and technical characterisation as a cohesive whole”, envisioning “the design intentions for ‘new’ materials experience” (Karana et al., 2015).

This material experience vision is used for the first design phase, described in the next chapters, where design directions and concepts are presented. In the second phase of the project, where the selected concept is detailed, another more specific design vision will be presented (see page 40), describing the desired experience and interaction with a metaphor for the sugar grater.

The material experience vision is drafted by answering a set of questions suggested in the Material Driven Design paper (Karana et al., 2015) and building the basis of Figure 20.

Technical & Experiential

The Arenga sugar’s unique technical qualities, which should be emphasised are its sweet taste, low glycemic index and high nutrients content and the variety of properties possible through processing. Its interesting unique experiential qualities are the dark brown colour, its scent and the natural and curious appearance.

Context

The material would make a positive difference in the context of cafés and coffee bars, where it can add to the coffee or tea experience.

Interaction

The café guests would interact with the Arenga sugar in an active and engaging way, but partially also in a more passive way observing and discovering.

Contribution

The Arenga sugar’s role is to communicate its background story and create awareness for and protect the rainforest.

Interpretive & Sensorial

The material should be interpreted as natural and special and sensed as sweet (smell and taste) and delicate (look).

Affective

The material should elicit curiosity, appreciation and surprise with the café guests and give them a good feeling.

Performative

The Arenga sugar should invite people to interact with it, change its texture and dissolve it in their drink to taste it.
Design Criteria

From the analysis many requirements for the product design could be derived. In Figure 19 the most important design criteria (yellow bubbles) are mapped with the different elements of the project (green bubbles). This first collection of broad design criteria is further specified later in the second phase of the project for the design detailing in a programme of requirements (page 62).

Source

Related to the source of the Arenga sugar, it is required that forestwise’s story about the role of the Arenga sugar for the rainforest (animals & plants) and the people is communicated to the end consumer (café guest). Furthermore a steady sugar demand is required to guarantee a reliable income for the farmers. The production of the sugar product (and possibly related tools and packaging) should be as much as possible taking place in Indonesia to create work locally. This sets high demands on quality control and clear production instructions.

Packaging

It is important to package the sugar safe and airtight, to maintain its quality. The products should be also able to be packaged compactly, for more sustainable transportation. Ultimately the (inner, small batch) packaging can also be used to be presented to the customer and should therefore provide information and look attractive.

Supplier / Distributor

In case the sugar will be distributed through existing channels for coffee and tea (convenient for cafés), it could be considered to add branding (advertisement) information to achieve a more competitive price. In order to be able to compete with regular (cheap) sweeteners, it is important that the Arenga sugar is offered with an added value for cafés and guests.

Café Guests

The design should add to the guests’ coffee or tea experience and inform them about the Arenga sugar and create awareness about deforestation. A second layer with more information (for example online) should be also provided for interested guests. The product must be easy to use and be balanced between being perceived as familiar and new, regarding both look and taste. A hand made and natural look should be achieved, and the product should be seen as sustainable and healthy. It should be possible for guests to sweeten their drinks according their preferences (foam or coffee) and adapt the amount of sweetness added, without creating waste.

Sustainability

Throughout all aspects of the design, sustainability must be considered and a positive impact on environment and people is desired. This implies a honest design and is in line with the vision of forestwise. Integrating sustainability in the project is also required to be able to graduate with the annotation ‘Technology in Sustainable Development’ at TU Delft. The fact that this is an Integrated Product Design graduation project also requires an innovative product as outcome, which is feasible, desirable and viable.

Figure 21: Design criteria
Target Group

The target group for the product are the guests of cafés (see Figure 22). The focus is put on individual cafés and small chains, lunch rooms, and speciality coffee bars. The cafés are nicely decorated and have a comfortable and personal atmosphere. The guests are hip and like to eat healthy but tasty. They prefer sustainable products, but are not extra conscious. This decision is done to reach a wider mass and also address people, who would not do much effort to find sustainable solutions.

Figure 22: Target group
Many ideas were generated and structured into the following 9 design directions: 3D shape, pot, shaker, slice, block, syrup, foam, lollipop and cookie (see Figure 23 and Figure 24, next page). The design directions are based on a variety of different textures and shapes of the sugar, resulting from the process taxonomy (page 16) and combined with suitable ways of serving.

### 3D Shape

This idea is about making sugar cube-like portions by either pressing granulated sugar with some water or pouring sugar syrup (with very low water content) into a mould. Three dimensional shapes are possible, depicting for example an orangutan. They can be either served per cup (open or packaged) or be offered on the table in a sugar pot with pincers, or in a special dispenser.

### Pot

Granulated sugar can be offered in a pot on the table. It needs to have a lid in order to store the sugar airtight and the sugar must be served with a spoon. The story can be nicely integrated in the shape and look of the pot and possibly also the spoon.

### Shaker

A shaker can be used for granulated sugar to serve it without the need of an extra spoon. Turning around the shaker normally gives one portion of sugar. With powdered sugar it is also possible to “shake” the sugar through a stencil, making a pattern or illustration on the coffee foam.

### Slice

A one portion slice of sugar can be made by moulding, extruding, or dripping (molten) sugar in a pattern or illustration. It can be placed on top of coffee foam, leaving an illustration in several shades, which is slowly dissolving and this way sweetening the drink.

### Block

A bigger block of sugar can be made by either pressing granulated sugar with some water or pouring sugar syrup (with very low water content) in a mould. One solid block can be produced, which is served in a handy tool to grind sugar flakes. Alternatively a mould with predefined breaking lines can be used. Guests can break off pieces of sugar (with sugar nips / pincers), similar to chocolate bars.
Syrup

Syrup can be made by either diluting sugar in water or by not completely evaporating the water during sugar production. It can be served in an interestingly shaped bottle or in a dispenser and also nicely used to sweeten tea.

Foam

The sugar can be made airy (foam-like) either by making cotton candy or mixing sugar with an agent as egg (meringue) or gelatine (marshmallow). This can be served on top of a hot drink. The increased volume can decrease sugar consumption, but it would be preferable to make the foam at the café (or close by) because of inefficient transportation of a low density product.

Lollipop

The sugar can be offered as a lollipop or a candy on a spoon, integrating directly something to stir the drink. In case the drink is found to be sweet enough before dissolving all the sugar, the remaining can be still eaten as a lollipop candy.

Cookie

The cookie, which is often served with the drink, can be integrated with the sugar. Part of the cookie can be made of or covered with sugar. This sugar part then dissolves when dipping the cookie in the drink. The shape of the cookie can be used to communicate the story.
The following three concepts were further developed from the idea directions sugar shaker, sugar pot and sugar block and selected because they seemed the most interesting, feasible and possible to fulfill all the design criteria.

Stencil Shaker

The stencil shaker concept is filled with powdered Arenga sugar and placed at the café’s tables. When guests want to sweeten or decorate their drink, they place the shaker on top of their cup, where it rests on the cup’s rim on its three feet. When the ball on the top is pulled, an internal mechanism gets activated, which stirs the sugar to break potential lumps and pushes one portion of sugar through a sieve and then through a stencil. A surprise illustration (the pattern of the stencil) will come out on the drink and will nicely decorate for example a cappuccino with frothed milk. This design makes use of the dark colour of the Arenga sugar by putting a high contrast illustration on the white milk foam, which slowly dissolves, creating gradients. This design is mainly suitable for cappuccino or latte macchiato. Regular coffee or espresso sometimes also have enough foam to carry the decoration, only the colour contrast might be lower. With tea it is nevertheless not possible to show the illustration.

The stencil is interchangeable and can be different at each table, surprising the guests. The illustration will depict animals and plants from the rainforest, to communicate the source of the sugar. More detailed information will be printed on the top and side of the sugar shaker. The stencils are easy to update (with new sugar deliveries) and special stencils can be offered to the cafés for branding purposes or seasonal activities.

In order to add more sugar to the drink, another button (on the side of the cylinder) can be activated to give a “sugar boost” coming out on the side (bottom), to not destroy the foam and the illustration. More details and alternative ideas are shown in Figure 25.

Similar products are already on the market for decorating with cocoa or cinnamon powder. Current designs can be thought improved regarding usability and precision and adapted for the Arenga sugar, for easy and fun usage for guests in a café. The tool’s shape, material choice and decorations should be also designed to support the sugar’s background story and fit the materials experience vision.

Figure 25: Stencil shaker

Concepts
Rainforest Globe

The rainforest globe (see Figure 26) is a sugar pot inspired by a snow globe. The jar is filled with granulated sugar and stands on its lid on the café tables. The sugar will look like soil, providing the basis for a healthy rainforest. The outside of the glass globe is decorated with (real) leaves and trees and has many details to discover, such as flowers and all kinds of animals, showing the richness of the forest. The rainforest globe is a decorative element, potentially replacing flowers etc. on the table. Standing on the table it invites people to interact with it and shake it, serving as a conversation starter. On the bottom of the lid more information about the sugar’s source is provided.

People who want to add sugar to their drinks can grab the globe, turn it up side down and unscrew the lid. A spoon is attached to the lid, turning and breaking sugar lumps, while opening the lid. It then can be used to scoop sugar to the cup. Integrating the spoon in the pot ensures that it stays clean and people do not use their own used spoon to serve sugar. This spoon represents an Arenga palm tree, which same as the depicted animals need the rainforest around.

The screw top lid ensures that the sugar is stored airtight and the wide opening facilitates easy refilling. The globe is made of glass, allowing to see when it needs to be refilled and is easy to clean. The spoon can be wood, porcelain or stainless steel. The (outside of the) lid can be made of natural material such as wood (bamboo), clay or stone and refer to the Arenga tree’s important roots.

The sugar globe is easy to use and does not require any complicated mechanism. The regular granulated sugar can be used.
Block Grater

This concept (Figure 27) is a tool to grate and serve traditional sugar blocks or loaves (gula aren). A cylindrical sugar block (produced for example in a bamboo mould) is placed in the bottom of the grinder, which is standing on the café tables.

The bottom vessel is made of glass to see the sugar (and when it needs to be refilled). It has thick walls to be heavy as a usecue to leave this part on the table and only move the upper part. The upper part is made of stainless steel and has a grate blade on the bottom, touching the top surface of the sugar block. By turning and pushing the top part, sugar flakes are grated and collected in the upper part.

This part can be taken out and be used as a spoon to scoop the sugar into the cup. Grooves on the bottom of the glass vessel ensure that the sugar block is fixed in place and not turning with the rotational motion of the upper grating part.

Alternatively can the design be also a closed cylinder, similar to a pepper mill or cheese grater.

Figure 27: Block grater

put in rainforest container

grooves on the bottom ensure that the block is fixed

can be taken out and be used as a spoon

grooves on the bottom of the glass vessel ensure that the sugar block is fixed in place and not turning with the rotational motion of the upper grating part.

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36 37

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put in rainforest container

grooves on the bottom ensure that the block is fixed in place and not turning with the rotational motion of the upper grating part.

Alternatively can the design be also a closed cylinder, similar to a pepper mill or cheese grater.

36 37
Selection

The three concepts were evaluated in order to be able to select one design to further develop in the next phase. Evaluation was done by presenting the concepts to and asking feedback from the stakeholders. Potential users (café guests), owners and employers of 10 different cafés in Delft and The Hague, the project supervisors and Dirk-Jan Oudshoorn and Arjan Verschoor from forestwise were all asked for feedback. Furthermore it was reflected back on the initial analysis and the design criteria where checked. The concepts generally can fulfill the requirements and it is possible to align them with the material experience vision. Some aspects however were still kept relatively open with the concepts and would need to be developed further to completely match with the criteria and vision statement.

The strengths and weaknesses of each concept are shown in Figure 28, which is a variation of the Harris Profile (Boeijen, Daalhuizen, Schoor, & Zijlstra, 2014, p. 139), where the criteria ranked, with the most important one on top. Scores are given from -2 to 2 to prevent neutral scoring. A visual representation can show to which side ‘the tower would fall’ to make a selection between conceptual designs.

The first criteria is that the sugar’s background story is integrated in the design. The Stencil shaker achieves this as long as the rainforest illustration stencils are used and more decorative elements can be added to the body. The rainforest globe highly integrates the story by depicting the whole ecosystem. The block grater is still a very plain design without making people experience the story. It currently scores low on this criteria but the shape can be redesigned and decoration can be added.

It is important that the design is perceived as clean and hygienic to make it more appealing to the café guests. The integrated spoon with the rainforest globe makes people not use their own used spoon, but nevertheless is openly accessible. The block grater can be made closed so that the guests cannot touch the sugar block.

The third criteria is how easy the design is to use and understand. The Stencil shaker requires some explanation, because it has to be placed on top of the cup, and two portion sizes are possible (decoration and sugar boost). The globe design is relatively simple, but it may not be clear that it is sugar and edible and the globe has to be turned around before opening. The sugar grater is unknown but simple and similar to a pepper mill.

The first arena sugar should be used for coffee and tea. The Stencil shaker is though only working on plain milk foam and not suitable for barista coffee with late art or tea. The rainforest globe design works with all (hot) beverages like normal sugar, but might be less likely to replace honey, normally served with fresh tea. Same counts for the block grater, but since the sugar flakes are perceived as different and special they might me also used to replace honey.

It is very difficult to make a choice in this stage of concept development, were some points are still to be further developed. It becomes visible in Figure 28 that no concept is a very clear winner. The block grater scores only slightly better than the others, since it is weak on the first criteria. It is though decided to further develop this concept of the sugar block grater and look for ways how to better integrate the story in the design. For this, valuable elements from all the different ideas may be taken to improve the sugar grater concept. This concept is innovative and special and grasping the traditional sugar block is authentic and conveying an artisanal style. It allows also to distinguish the arena sugar from regular brown sugar and therefore making its unique story more clear to the end consumers. Using the sugar blocks instead of granulated sugar also gives less problems when drawing humidity, making it less critical to keep the sugar airtight on the café tables.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Stencil shaker</th>
<th>Block grater</th>
<th>Rainforest globe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated story about the rainforest</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Perceived as clean and hygienic</td>
<td>2</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>Usability, easy to understand</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Suitable for different drinks</td>
<td>-2</td>
<td>1</td>
<td>-2</td>
</tr>
<tr>
<td>Explanation needed</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Only with plain milk foam, not for barista coffee and not for tea</td>
<td>-1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

![Figure 28: Evaluating concepts based on Harris Profile](image)
After selecting the concept of the Sugar Block Grater, it is further developed and details are worked out. This is done based on a more specific and targeted vision statement and a programme of requirements (see page 62).

With this, the background story of the Arenga Rainforest Sugar is further integrated in the design, the grating mechanism is developed and the product user interaction is shaped with detailing the design.

**Vision**

The desired experience is envisioned as described in the following statement in Figure 29. Its elements are further explained on the next pages. It is composed of the vision, the reason for it (why), the design implementation (what), and the way it is experienced (how).

**Story**

The sugar’s background story should be experienced by the café guests and be subtly integrated in the design of the sugar grater. The people’s imagination will be stimulated and curiously fostered. The important elements of the story are the circularity and balance in the system of the forest community and the rainforest, with its fascinating biodiversity, and the role of the Arenga palm tree supporting it with its sugar.

**Tool**

Grating the sugar is like the opening up of a flower bud. Protecting the sepals is the hard and compact blocks which will undergo a transformation when being grated to become delicate, light and beautiful sugar flakes.

**Metaphor**

The sugar blocks should be authentic and special, as traditionally made in Indonesia. The hard and compact blocks will undergo a transformation when being grated to become delicate, light and beautiful sugar flakes.

**Sweetener**

By offering café guests a special experience of sweetening their hot beverage (coffee or tea) while showing the impact they can have in protecting the wonderful biodiversity there, the sugar is presented as precious and natural in a decorative tool depicting the sugar’s story. It can be used by the café guests to smoothly grate the traditional sugar blocks into sugar flakes.

These are growing and opening up like a bud becoming a beautiful flower with fragile petals. The user (café guest) should experience the emotions of interest, pleasant surprise and virtuousness, while interacting with the sugar product. The pleasant surprise is like for example receiving a birthday card which will unexpectedly reveal a beautiful pop-up peacock when opening it. Virtuousness arises when we have done something that benefited other people or society and comprises the feeling of being a good or worthy person (Desmet, 2018). The user should feel interest, in particular curiosity, fascination and inspiration, when interacting with the Arenga Sugar. More details about the emotions and meanings are explained on page 43 with the product experience.

**Means**

The user (café guest) should experience the emotions of interest, pleasant surprise and virtuousness, while interacting with the sugar product. The pleasant surprise is like for example receiving a birthday card which will unexpectedly reveal a beautiful pop-up peacock when opening it. Virtuousness arises when we have done something that benefited other people or society and comprises the feeling of being a good or worthy person (Desmet, 2018). The user should feel interest, in particular curiosity, fascination and inspiration, when interacting with the Arenga Sugar. More details about the emotions and meanings are explained on page 43 with the product experience.

- **Emotions**
  - Interest
  - Pleasant surprise
  - Virtuousness

- **Meanings**
  - Natural
  - Special
  - Authentic

**Design Detailing**

After selecting the concept of the Sugar Block Grater, it is further developed and details are worked out. This is done based on a more specific and targeted vision statement and a programme of requirements (see page 62).

With this, the background story of the Arenga Rainforest Sugar is further integrated in the design, the grating mechanism is developed and the product user interaction is shaped with detailing the design.
Interaction Qualities

Connected the metaphor of the flower bud, the following interaction qualities should be enhanced: caring, observing and supporting (Figure 30). The product should be treated by the café guests as something precious, valuable and delicate, which they touch and hold in their hand like caring, protecting and appreciating. Another aspect of the interaction with the product can be characterised by qualities such as observing and discovering, where the user is exploring the product. Furthermore should the interaction have a more active quality, where the user acts as supportive and activating. This part also reflects back to the need of having an impact to contribute to something in line with your personal values.

These descriptors of the interaction qualities “represent what users should attribute to the product while experiencing the object and interacting with it” (Hassenzahl, 2004).

Product Experience

The product experience can be divided into human-product interactions on the micro, macro and meta level (Özcan, 2016). The different elements as described in the vision are influencing the product experience. They are divided according to the structure of 9 Moments of Product Experience (see Figure 31) to help achieving the desired experience. With the Design Explorations (page 44) and the Final Design (page 64) it is tried to implement these elements in the product design, and tested and confirmed with the User Study (page 78).

The aesthetics on the micro level should support the natural meaning and the emotion interest and in particular curiosity. Irregular patterns and interesting textures can foster this curiosity and result in a natural interpretation. The patterns should be visual and tactual. The natural meaning can be supported by organic shapes and natural materials. To further emphasize the curiosity, the sweet smell of the sugar can be collected and guided to reach the user’s nose while grating, w

At macro level the Arenga sugar should be appraised as special and cause a pleasant surprise with the user. To achieve this, the tool should not look like a regular sugar shaker. It can be a decorative element at the table, where the user does not expect the function in the first place. The sugar flakes will come out as a surprise. On the meta level users can feel interest and fascination. They can interpret the product as authentic, while learning how the forest community forms a sustainable ecosystem with the rainforest. The café guests can support this and will feel virtuousness when realising the impact they can have.
Design Explorations

The Sugar Block Grater is further developed based on the vision and design requirements. The shape and properties of the sugar blocks and the desired outcome of the shaved sugar flakes have to be defined and the details of the grater tool are designed. Explorations about those three parts are presented on the next pages, resulting in the programme of requirements, which is then used for the final design.

Sugar Blocks

Traditional sugar blocks are used for the grater. Compared to granulated sugar, the blocks are more simple to produce and give less problems when becoming moist. They therefore not always need to be kept airtight, which is useful for serving in cafés. They are therefore not always need to be kept airtight, which is useful for serving in cafés.

Different types of moulds can serve to define the block’s shape. Traditionally natural materials are used for this. Cocos nut cups or slices of bamboo tubes, which are placed on a wooden plank, can be for example filled with the syrup. There are also moulds carved into or cut out of wooden planks. Round and tapered shapes work well for demoulding, but also cylindrical shapes are fine, because the sugar shrinks when cooling down. The height should be kept relatively small to reduce shrink marks and ensure a more solid block with a relatively straight top surface.

Cylindrical shapes should be produced for the sugar grater, to allow for the sugar flakes to be shaved off the top of the block with a rotational movement (see page 48 for the grater tool mechanism). Several sugar blocks should fit in the reservoir of the grater tool to be able to gradually refill the tool, also already before it is completely empty. It is decided to fit maximal 3 blocks in the tool, resulting in a height per block of ~22mm. The diameter is chosen to be between 43mm and 40mm, to fit the tool and be turned against the knife. This results in a weight of about 43g per block and a total filling weight of 126g, being roughly half of a standard 250g package.

The sugar block’s diameter dimension has to be relatively precise to work together with the tool. Therefore no bamboo slices should be used, but the circles should be cut out of a plank with the correct thickness and size, considering the shrinkage percentage. The sugar can be roughly poured in the holes and excess can be scraped off. This accelerates the production process, as well as this way, demoulding one plank at once is possible.

The sugar blocks quality must be checked for among others the pH value, the percentage of inverted sugar and that they are consistently consolidated until the centre of the block. Also the crystallization percentage and hardness must be checked to work well with the knives shaving off the sugar flakes. Palm sugar blocks from an Asian supermarket were used for testing the prototypes and experiment with the flakes. Some of them were though too hard and brittle to grate nice flakes. Further experiments and tests have to be done with the Arenga syrup on site to be able produce the right consistency (chocolate like), also considering that the sugar crystals may change over time.

The sugar will be packaged in a 250g roll consisting of 6 blocks. Each package is rolled in paper (similar as used for flour, rice or granulated sugar sometimes) and sealed airtight with a circular sticker on the top and bottom, providing more information about the product. The package design will be elaborated later (Consuri brand, page 69). The cylinders can not be packed very space efficiently in a rectangular box. Compared to granulated sugar packages the block sugar is still more compact and can therefore compensate for this slight inefficiency of space during storage and transportation.

The sugar block roll packages will be presented in a special shelf in the café, which serves as storage and shop display (see page 59).
Sugar flakes

To present the sugar as something special, emphasize its natural source, and make sure it quickly dissolves in the hot beverage, it should come out of the grater tool as a flower with thin petals. Different tests were done to find a suitable way to grate the sugar blocks. Existing grater tools meant for chocolate, cheese or vegetables were tested, as well as different knives, rasps and slicers.

The sugar flakes have to be cut with continuous rotation with more or less constant speed and pressure, to produce bigger layers, resembling a flower. A suitable thickness was found to be around 1.25mm. If the sugar is shaved much thinner it does not hold its shape long enough and breaks too easily. Same counts for thicker cut-offs becoming not flexible enough to bend, and looking very dark and not dissolving well in the drink. Another requirement for nice flakes are regular consistency of sugar blocks and a flat surface. The sugar block should not be too moist and sticky, but also not too brittle; some syrup is needed to glue the crystals together.

Different tests with the grater prototype showed that the sugar flakes get loose of the knife easily as soon as grating is stopped and then slide well into the cup when the grater is put on an angle.

The sugar flower should look nice and complete with about 4 grams (one regular portion sugar). It could be nice to fine tune the tool in such a way that for example half a rotation would grate 1 gram.

It was decided to make the grater with two knives so that two flakes will spiral around each other, forming a layered look. The top side of the knife should be as such that the flakes smoothly come out of the tool and not get stuck.

Figure 33: Sugar flakes
the sugar should however be no central axis, to enable grating one big solid block of sugar, but also several sugar blocks stacked on top of each other. To be able to see the sugar flower coming out of the tool and hold it the way described before, the mechanism has to work against gravity and pushing against or fixing the tool to the table is no option in a café. The sugar blocks have to be kept in a close compartment for hygienic reasons, which has to expand to be filled and then shrink to push the last bit of sugar against the knife. One solution is to have this flexibility internally without changing the outer dimensions of the tool. Alternatively, the block length can be either shorter or smaller, depending on the amount of sugar blocks left in the reservoir. This gives an obvious visual indication for the café personnel when to refill the grater, but also has consequences for the aesthetics, requiring a shape which is beautiful and proportional in both extreme scenarios (full and empty).

Another possibility (see Figure 37) is that the sugar blocks are stacked in a cylindrical container and another part is pushed and rotated on it, with a knife on the bottom, cutting into the sugar. This complete upper part with the knife is pushed inside the sugar container, when the sugar blocks become smaller. This means it has to have a cylindrical shape same length as the depth of the sugar compartment. The sugar compartment has to have a high friction wall with for example some triangular shapes sticking into the sugar from the side and prevent the stacked sugar blocks from turning with the knife. The upper part has a bowl like shape collecting the sugar flakes. This part could be taken out to scoop the sugar flakes in the cup. This would however mean that the sharp knife becomes accessible, as well as the sugar compartment be open. It is therefore better to design the tool in such a way that the two parts always stay connected and can be only opened by the café’s personnel for refilling.

The sugar can be pushed against the knife by a piston (see Figure 38), which is found to be the the most suitable working principle. The pushing force can come directly from the user; it is however difficult to coordinate to push and turn continuously to grate nice flakes. Another solution is using a thread to output the users rotation into a constant pushing force plus rotation. The thread can be like a bolt with a platform pushing the sugar, being screwed through a thread, cut in the bottom of the tool. Otherwise the whole piston can be the “bolt” with external thread, screwing into the top part, which is a tube with internal thread. With this working principle the proportion of rotation and vertical movement is fixed by the thread’s pitch. The angle and the cutting depth of the knives could be made adjustable (as found for example with truffle slicers) to handle variety in texture of the sugar blocks and to adjust the sugar flake thickness.

One possible working principle (see Figure 35) is that the sugar blocks are stacked in a cylindrical container and another part is pushed and rotated on it, with a knife on the bottom, cutting into the sugar. This complete upper part with the knife is pushed inside the sugar container, when the sugar blocks become smaller. This means it has to have a cylindrical shape same length as the depth of the sugar compartment. The sugar compartment has to have a high friction wall with for example some triangular shapes sticking into the sugar from the side and prevent the stacked sugar blocks from turning with the knife. The upper part has a bowl like shape collecting the sugar flakes. This part could be taken out to scoop the sugar flakes in the cup. This would however mean that the sharp knife becomes accessible, as well as the sugar compartment be open. It is therefore better to design the tool in such a way that the two parts always stay connected and can be only opened by the café’s personnel for refilling.

The basic working principle of the grater is that the sugar block and the knife are pushed against and rotated amongst each other, producing two sugar flakes spiraling around each other (see page 46). It has to be decided where the moving connection is and which part moves, and which one stays still. Grating the sugar blocks should work smoothly without too much effort. Sharp knives and a well working mechanism where the forces are well distributed are therefore crucial.

Many existing products were analysed, such as pepper mills, cheese graters, nutmeg and truffle slicers, chocolate flaker, vegetable spiral cutters etc., finding some triangular shapes sticking into the sugar from the side and preventing the stacked sugar blocks from turning with the knife. The upper part has a bowl like shape collecting the sugar flakes. This part could be taken out to scoop the sugar flakes in the cup. This would however mean that the sharp knife becomes accessible, as well as the sugar compartment be open. It is therefore better to design the tool in such a way that the two parts always stay connected and can be only opened by the café’s personnel for refilling.

The tool (Figure 34) is integrating the design’s functionality of grating the sugar and communicating its background story, as well as facilitating the desired user experience. The user should see the sugar flower “growing” and hold the sugar in your hand like something precious with an appreciating gesture, the tool should be grabbed by the guest to grate the sugar flower “growing”, while grating. The flakes of sugar experience. The user should see the sugar flower “growing”, while grating. The flakes of sugar “growing” while grating. The flakes of sugar experience. The user should see the sugar flower “growing”, while grating. The flakes of sugar experience.
For the material choice of the tool, it must be considered that the outer part is influencing the product's look and feel and results in a certain meaning and experience for the user. The materials therefore should be matching with the vision and fit the background story of the sugar. The style of the tool should also fit in the interior design of a variety of cafés. From a practical point of view the materials must be hygienic and easy to keep clean, where people touch the tool and where the sugar is in contact with it. Depending on the material choice and suitable manufacturing methods, different shapes are possible (see page 54). This concerns mainly the leaf like bowl, collecting the sugar flakes, but also aspects such as material thickness.

Many different material options were considered such as clay, porcelain, plastic, glass, (woven) bamboo, wood, and different types of metal. The two options of copper and bamboo tube were worked out in more detail. The general design though is compatible with many alternatives and possible to be made from different kind of materials with only slight adaptations.

The internal parts which are in contact with the sugar and not visible for the user can be made of stainless steel and plastic. The outside of the tool can be made of copper with the inside of the leaf bowl shape being coated with enamel (molten glass glaze) (see Figure 39). The copper has a warm appearance and could change its look over time from for example finger traces, making it visible where to hold the tool. Copper is antibacterial but also has a distinctive smell, which could distract from the sugar’s smell. It can be however sealed with transparent varnish. The leaf shape and the cylindrical base can be produced by copper spinning and copper chasing, resulting in interesting textures from the hammering. More texture can be created by engraving or embossing illustrations (see chapter about the story, page 56), which could be interesting to feel and explore with the fingers while holding the tool.

The internal part of the bowl can be covered with enamel, applying either powdered or liquid enamel which then melts with high temperatures in a kiln or with a blow torch. The combination of copper and enamel works well because both materials have the same expansion coefficient. This also means that the material combination can be made dishwasher safe. The enamel creates a hard, sleek surface which is easy to keep clean. The product can have a non-industrial appearance, because each tool will have an individual look, with random enamel patterns, depicting the rainforest in an abstract way with shades of green colour sprinkles. People’s imagination may be fostered and they can try to discover animals and plants in the patterns. The green enamel creates a nice contrast behind the brown sugar flakes. Copper chasing and enamelling are ancient crafts and done by artisans craft-workers, but also possible to gradually scale up to industrial production.

Thin shapes with double curvatures can be made, resulting in an elegant look. The combination of copper and enamel also looks precious, and might be associated with jewellery or a piece of art and will emphasise that the sugar is perceived as something special. Sugar might not be expected in this more decorative object and the café guests could experience a positive surprise. The coppers warm colour and irregular textures from the hammering creates a natural look.

Figure 39: Copper and enamel
Using the main elements of the previously described design, the tool can be also made of bamboo with resin (see Figure 40). This option fits slightly better to the sugar’s background story, because bamboo tubes are used by the forest communities to collect the sugar sap from the Arenga palm tree. Bamboo is also a commonly used material in Indonesia, facilitating local production and building on existing knowledge. The fast growing grass can be locally harvested, supporting the sustainable vision of forestwise, not causing deforestation as other types of wood might.

Bamboo is easy to work with in small scale production with simple tools, but could be also possibly upscaled by improving and automatising the manufacturing process. The tool can have a coherent look, reassembling a natural bamboo tube. The bowl and the upper part of the cylinder can be made out of one continuous bamboo pipe. A metal stripe could also stay visible as accent and look like for example chrome, copper, bronze, gold, or green, fitting the café style and for example their cutlery. The bottom part screwing in the sugar compartment can be still made of metal or plastic and be covered with bamboo veneer, resulting in the same look and similar feel. Only the temperature and weight might be surprising for the user.

The inner part of the bowl holding the sugar flakes could be covered with food contact safe resin, achieving a similar look as explained with enamel on page 50. This part can again be an abstract representation of the rainforest, with interesting patterns to explore. With resin, more realistic images of the rainforest’s biodiversity could be created, by also integrating real leaves, moss, or printed and cut out objects, combined with pigments. Epoxy is a suitable, food safe resin, but also natural, bio-based resins could be considered.

The rainforest inside the grater can be also depicted with more simplistic engravings, same style as the other decorations. This would create a more minimalist, coherent, neutral and even more natural look, matching with more café’s style.

The use of wood is generally allowed in professional kitchens and gastronomy in the Netherlands. However there are some controversy informations and opinions about it. It is not easy to find specific information for bamboo. Positive lists of the EU (European Commission, 2019) and the Netherlands for food contact materials declare wood as safe, but only if all other containing substances are rated and accepted. The bamboo must be untreated or food grade varnishes have to be used, glue needs to be proven to not leak any harmful substances on food and no pesticide residues must be found in the material (Kennedy, 2018). Bamboo is also told to have a antibacterial function (more than other types of wood) (Klootwijk, 2005). Generally it counts that all food contact surfaces must be smooth and easy to keep clean. The sugar is though dry, reducing the general risk of contamination. The bamboo could however come accidentally in contact with coffee and milk or the sugar could become sticky from for example steam of the hot drink. Regular cleaning with warm water and soap is required.

One participant of the user test (see page 78) proposed to cover the internal part with stainless steel, to have a smooth and clean surface. This would however influence the natural appearance of the product and make it more difficult to depict the rainforest inside the ‘bowl’ (see page 56 about the story). A transparent layer of food safe resin to cover the internal part, where the bamboo touches the sugar would be another option and gives it a smooth surface over the engravings. The other bamboo surfaces can be treated with for example food safe mineral oil or linseed oil. No one from the interviewed cafés (Evaluation, page 84) was concerned that the bamboo (with engravings and only treated with oil and no resin applied) may not be clean or food safe. Also a big variety of bamboo products (cutting boards, bowls, serving boards etc.) are sold in professional gastronomy shops.

Making the tool out of bamboo will create an authentic and natural look, in line with the vision (page 40). The material and working with it is also cheaper, easier and faster than the copper enamel alternative. It is decided to further develop the design with bamboo.
Shape

The tool’s shape should be aesthetically appealing and have balanced proportions, both in the full and empty state (height difference around 66mm). The basis of the tool must fit the cylindrical sugar blocks and house the rotating and cutting mechanism and give use cues about how to handle the tool. The width of the cylindrical base must fit comfortably in people’s hands. If the diameter is between 50mm and 65mm it fits both P5 (108mm grip circumference) and P95 (150mm grip circumference) of Dutch adults (Dined, 2004). The upper part holding the sugar flakes must be shaped such that the user does not touch the inner surface with his fingers, but keep the inner part touching the sugar clean. This requires a rather closed shape, which still should not be too deep, so that the sugar flakes are directly visible and easy to get out. This bowl part should also give visual hints about the sugar’s background story (see next page) and depict the shape of an Arenga palm leaf. Many different shapes were developed with drawings, CAD models, 3D prints, clay models and other simple models made of for example paper rolls (see Figure 41). See page 60 for more details about the prototyping. Extreme shapes were explored from very simple tubes to double curved and perfectly fitting the user’s hand with separate indents for the fingers. Those might not be compatible with varying hand sizes and right and left-handed users, but give a clear hint about the intended holding gesture, where the tool should be grabbed under the upper bowl with one hand, while the other hand is turning the bottom such that the user can observe the sugar flower “growing”, while holding it in the hand like something precious with an appreciating gesture. The back of the bowl should therefore feel interesting and good to touch with a smooth surface. The natural appearance of the tool can be supported by an asymmetric, irregular shape, referring to a leaf or tree. The shape can look delicate and special. A sharp point could support this elegant look, but may be dangerous and risky to break. The geometry of the bowl should be also rather closed to be stable and stiff, making it possible to have a robust resin or enamel coating which would not break off.

Double curvature shapes and potentially varying material thickness may not be compatible with the material choice and connected production methods. If the bowl shape is made of clay both would be possible. With copper chasing double curvature shapes are possible and even more complex indents can be made with a die. With bamboo complex shapes could be made by weaving bamboo stripes which then could be stiffen with resin. Otherwise steam bent slats could be glued to an interesting shape (similar to top left of Figure 41). Simpler to make and referring more to the typical bamboo tube look would be a basic pipe cut under an angle. This cut can be either straight or with a curve. This results in a rather minimalist design, allowing for more decorations without making the design look too complex.

Figure 41: Shape explorations
The sugar’s background story should be experienced by the café guests and be subtly integrated in the design of the sugar grater. The people’s imagination will be stimulated and curiosity fostered by discovering the metaphorical elements in the design, which are further elaborated on a website and printed information material.

**System**

The farmers living in the rainforest benefit from the nature in the same way, as the biodiversity benefits from them, since the forest community has an intrinsic motivation to protect it. The design should show the harmony in this system and how all parts are integrated and important. The café guests can be the driving force to keep this circular system running.

**Rainforest**

The rainforest is represented inside the bowl. Random sprinkles of shades of green create unique patterns representing the rainforest together with abstract natural elements showing the rich biodiversity and offer many details for the café guests to discover. Different levels of abstraction are possible and alternatively also a more realistic drawing could be used. The rainforest is like a small world, supported by the forest community and protected by the Arenga palm tree, which “puts its leaves and roots around the forest”. The sugar grows inside the rainforest, same as the sugar flower is growing in this bowl, when the user operates the grater.

**Arenga Palm**

The Arenga palm tree is depicted outside the back of the bowl with a palm leaf, which can be also used as logo. Its roots transition into a traditional Dayak tribal pattern. The tree is “rooted” in the forest community, showing its connection and how they both benefit from each other, the people protecting the rainforest and the tree providing them with sugar. The tree’s deep roots play an important role for the biodiversity, stabilizing the forest soil and also supporting reforestation. The Arenga palm is a wonder tree, naturally growing in the Indonesian rainforest and providing the forest communities with valuable resources, such as the Arenga sugar.

**Sugar**

The Arenga sugar is growing in the rainforest, as the user also experiences with the tool. The sugar creates economic value for the forest community and provides them with an income, but also for the café guest it is presented as something special and valuable, by growing like a flower. This image emphasizes the sugar’s naturalness, being unprocessed and healthy. The sugar sap is traditionally collected in bamboo tubes, which is also visible in the tools design, made of bamboo.

**Forest Community**

The forest community is represented by a stripe of tribal patterns at the bottom of the cylindrical base and the knife and the processing part of the tool. The local people are sustainably wild-harvesting the Arenga sugar, by cutting the flower stalk to tap the sugar sap, like the knife is cutting the sugar in the grater tool. They are traditionally living in harmony with forest and value and protect nature.

**Café Guests**

The café guests become part of the story by supporting the sustainable system of rainforest, forest community and Arenga palms through consuming the Arenga sugar. The image of being the “driving force” for the system is supported by the active gesture of turning the base with the right hand using the handle, to grate the sugar flakes. The other part of the user is more supportive and appreciating by holding the sugar flakes in the bowl in the left hand.
Website
The café guests can scan a QR code at the bottom of the sugar grater, which links to forestwise’s website (Figure 48). The landing page gives an overview of the different elements of the story (as described at page 56), with clear references to the product design, making it easy for people to recognise the metaphorical elements.

When clicking on the rainforest part, a screen filling green image of the abstract rainforest appears, looking similar to the one on the tool. The user can zoom in the image and scroll around to discover the biodiversity of the rainforest. By zooming in, more detailed and realistic images of the rainforest appear, looking similar to the screen filling green image of the abstract rainforest (see page 58). The website should be optimised for smartphones and easy to use on small screens.

Consumer Brand
Forestwise plans to launch a consumer brand for the Arenga Rainforest Sugar. Currently they are just selling crystallised sugar in bulk to other businesses. Forestwise can start to approach the consumer market with 250g pouch bags of granulated sugar, and 250g rolls of block sugar, as well as the grater tool for home use. First a convenient channel would be to sell the products in cafés, using the trend of blurring what is sold at café tables, and possibly extra information on the website.

The brand is visible to the end consumer with a specially designed shelf (see next page), the packaging, the grater tool at café tables, and possibly extra information on the website.

The packaging design should fit the vision and desired image of Forestwise, conveying a natural, authentic and sustainable image. Other Arenga sugar packagings were analysed (see page 10, Benchmarking) to design the Arenga Rainforest Sugar packaging. Robust brown paper bags and rolls should be used to pack the sugar, air-tightly sealed with stickers. A minimalist illustration of the Arenga leaf should be used as logo, which can be printed or stamped on the packaging. This also refers to the Arenga leaf at the back of the sugar grater tool, creating a coherent and recognisable brand image.

Extras
To support the consumer brand and complete the design and offer a coherent concept to cafés there could be also more extras designed. A shelf design supports the Arenga sugar products’ presentation, but also more table decorations as for example coasters could be added to the range. Furthermore informative posters, info blocks for in the menu and social media content could provide the café guests with more background knowledge about the Arenga rainforest sugar. A poster in the window or on top of the bar could also tell guests that this place sells Arenga Rainforest Sugar. A few designs were analysed here, but more can be developed and also existing products can be integrated in the assortment, to offer a whole interior concept to newly opening cafés, consisting of furniture, decoration (plants, pots, candle holders, vases etc.) and condiment trays, menu stands, as well as salt and pepper etc. By choosing mainly bamboo a coherent image can be created. Tropical plants and botanical illustrations would go well with it. In general it should be also paid attention to choose sustainable options.

Shelf
A shelf design is proposed which serves as storage of the sugar blocks in the café, as well as a product display in case the café is also selling the rainforest products (sugar blocks, granulated sugar, grater tool). The shelf consists of individual boxes made of bamboo, which can be arranged in a flexible way and different sizes. The modular box system can be hung in different constellations on a wall or stacked on the floor, a table or for example the side of the bar. A variety of high quality nature photographs of rainforest animals and plants in the back of each box create a nice contrast and context to display the sugar packages. The style of the shelf should match the grater design and the website. It could be also considered to print drawings at the back of the shelf or directly engrave into the bamboo. When the storage is (almost) empty the boxes just look like picture frames.

Coasters
Coasters could be made in a very similar way to the grater tool and use rests of real leaves, moss, or printed and cut out objects, combined with pigments and colours, matching the design with the green resin rainforest. Alternatively also more minimalistic drawings similar to the engravings could be covered by resin. Also photos are possible to incorporate in the rain forest coasters. Forestwise’s logo, extra information or the café’s name can be laser engraved at the bottom of the slices.

Websites
Figure 48: QR code and website
Figure 49: Packaging and logo design
Figure 50: Extras (existing designs, fitting the concept)
Figure 51: Shelf design
Figure 52: Coasters made of bamboo and resin
Figure 53: Forestwise's logo, extr
The design explorations, as presented on page 44 onwards are supported by a variety of prototypes (see Figure 53). Building prototypes as well as quick models was important to detail the design and facilitate quick testing. The design of the prototype was very modular, to allow for iterations and adaptations of many different parts. It was tried to make all the different versions of the parts such they would be compatible and being possible to connect in different combinations. High flexibility and the possibility to reverse changes was the goal.

A 3D printed handle was attached with screws to the base to test the usability both with and without handle. Later a roundly carved handle made of bamboo was glued to the base with double sided tape.

The upper, bowl-like part of the grater was prototyped with a variety of different shapes and materials. See “Figure 41: Shape explorations” on page 55 for more prototypes made of clay, paper, bamboo, copper, aluminium and 3D printed PLA. The different models were compatible with the aluminium base and could be fixed with the aluminium. The engraved decorations were burnt with a soldering iron. The design was developed by drawing it first on paper rolls and also testing different compositions with tape on the bamboo prototype.

One main part of the prototyping was the grating mechanism and it was crucial to have a proof of concept relatively early in the process. The internal and external thread (see page 58 for details about the mechanism) was turned on a lathe from aluminium parts and manufactured according to technical drawings with high precision. Especially the internal thread was a big challenge, because towards the end only a 0.005th of a millimetre could be removed at once and each time attention had to be paid to not cut too far and damage the rim at the top of the cylinder (see top of Figure 58 on page 68). The order of processing steps was crucial for turning and milling and one very time-consuming part was destroyed because of a small mistake. It was decided to cut a metric thread (instead of Buttress thread), which was however difficult to re-azure for the prototype.

The design explorations, as presented on page 55 for more prototypes made of clay, paper, bamboo, copper, aluminium and 3D printed PLA. The different models were compatible with the aluminium base and could be fixed with the ring in order to test them with the mechanism and the maximum and minimum height of the base.

The mechanism was tested with different types of sugar blocks. It did however not grate sugar flakes very smoothly, because of a combination of deviations from the final design and limitations of the prototype. The thread shape and the material combination of aluminium on aluminium caused a too high friction. Also should the thread pitch probably have been smaller, or at least better adjusted to the knives’ positioning (angle and cutting depth), which is not very precise with the prototype and located out of the centre. The palm sugar blocks from an Asian supermarket used for testing were also too hard and brittle and the already more fragile sugar flakes break because of the uneven surface on top of the knife slice. Furthermore it is more difficult to push the sugar against the knives because of the high friction inside the sugar holder with the rough 3D printed surface. Furthermore is the inner piston not properly aligned when the screws are tightened, causing the mechanism sometimes to get blocked.

The general working principle could be still proven with the prototype and with slightly more force a bit smaller sugar flakes can be produced and if the sugar block gets stuck it helps to rotate a little bit backward. Testing the prototype with a cucumber could prove that it works perfectly with less friction and a softer material compensating for the earlier mentioned deviations of the prototype.

The piston, pushing the sugar block against the knife, was first turned and then trasferred on the side were cut with the milling machine. It was fixed with screws inside the external thread. The solid aluminum piston was made a little lighter by drilling out some holes, but with the final design the base of the tool still can be made even lighter. The sugar holder, sliding in between the piston and the base cylinder was fixed to 3D print from PLA. Different iterations were printed to make the shape for example fitting around the knives.

The knife slice was clamped in place with the ring and prevented from rotating with the sugar by a pin. It was built up of a 3D printed circular plate with spokes to attach 2 fitted cutter blades under an angle. After several versions, which bent to much prooved by evening it out with some resin. Since the pitch was fixed by the thread, it was considered to make the knives adjustable (as it is for example found with truffle slicers), which was however difficult to re-azure for the prototype.

Different iterations were printed to make the shape for example fitting around the knives. The knife slice was clamped in place with the ring and prevented from rotating with the sugar by a pin. It was built up of a 3D printed circular plate with spokes to attach 2 fitted cutter blades under an angle. After several versions, which bent to much prooved by evening it out with some resin. Since the pitch was fixed by the thread, it was considered to make the knives adjustable (as it is for example found with truffle slicers), which was however difficult to re-azure for the prototype.

The look and feel of the final prototype is close to the final design (bottom right Figure 53). The aluminium base was covered with bamboo fineer stickers. The only visual difference is that the top part will be made of one continuous bamboo tube and that the external thread will be much shorter, so it is not visible at the base when the grater is just refilled and in the tall state. The final prototype was used for user tests (page 78) and to present the design to cafés (page 84).

Figure 53: Prototyping
Programme of Requirements

This list of requirements states the important characteristics that the design must meet in order to be successful. Those requirements apply for the sugar and for the tool, which used to grate it and convey the basic story, as well as for the website with additional information.

The requirements are based on the initial design criteria drafted before the idea generation in the chapter Synthesis (page 22). After choosing the concept of the sugar block grater and further developing, prototyping and testing it more specific requirements were drafted. A process tree was used to define criteria for product development, while considering the whole product life cycle, from originate, distribute, use to discard (Boeijen, Daalhuizen, Schoor, & Zijlstra, 2014, p. 67). Those criteria were then sorted according to Pugh’s decision matrix in the chapter Synthesis (page 62). This list fits the current state of development.

Performance
Sugar
D: The main function of the Arenga sugar is to sweeten coffee and tea, the flake thickness must be such that the sugar dissolves within under 10 seconds stirring in hot beverages
W: Arenga sugar might replace regular sugar in money in cafés
Grater tool
D: The grater must smoothly cut the sugar blocks into flakes
D: The tool must be able to turn several sugar blocks stacked against the knife
D: One portion of sugar (4 grams) must be grated with maximal 5 rotations. W: One rotation should give predefined amount of sugar (for example 2g)
D: The tool must function from full to empty
W: The tool design should make people curious about the background story of the Arenga sugar and provide them with first information and help them with where to find more information (QR code)

Environment
D: The website must provide more updated information about the sugar’s source and impact and tell people ways to support it
W: The website should be inspiring and invite people to explore

Product Life Span
D: The grater tool must withstand daily usage by roughly 5 users per day over the duration of minimal 3 years, as well as weekly cleaning
W: Life in service time should be possible to extend by regular cleaning and maintaining, repairing and refurbishing

Maintenance
D: The tool must withstand cleaning (hand washing with brush and detergent)
D: The tool must be easy to refill, also possible when it is not yet completely empty
W: The knife slice must be replaceable with basics

End of life
D: The tool must be possible to maintain or upgrade (wear and tear, fashion, cleanliness), the parts of the tool must be possible to replace separately
D: The materials must be possible to separate for recycling

Target Product Cost
D: The target cost for the tool should be 15€ and 16,25g/sugar blocks
W: The sugar and tool maybe sold at a premium price (minimal 30€ for the grater and 3€ for sugar blocks) to target the high quality market

Transportation
D: Tools and sugar packages must be compact (shape and packaging) to efficiently ship them by container

Product Life Span
D: The product (with small updates and changes) should be produced and sold over the period of 5 to 10 years

Quantity / Series Size
D: The production should start with pilot of 50 products which can be tested and then produce a small batch of 500 pieces in the first year
W: The design must be possible to easily upscale in the future

Production
D: The production of the sugar and the tool should take place in Indonesia to locally create work
D: Clear instructions for production must be provided
D: The quality must be regularly checked
D: The production methods must be sustainable

Packaging
D: For the tool and the sugar minimal packaging should be made used from natural material or paper, which is recyclable or biodegradable
D: The packaging must be compact and lightweight
D: The sugar packaging must be airtight closed, visually attractive and informative, to use to display in café shops

Societal and Political Implications
D: The complete design should create awareness about the importance of the rainforest and promote sustainably wild-harvested forest products
W: Profit should be used for reforestation and sustainable investments

Installation and initiation of Use
D: Basic assembly of the top part (leaf bowl) and the basis will be done at the café before the first usage as well as filling the grater with sugar blocks
D: Usage should be simple and intuitive so no learning time is required
W: The personnel could be provided with basic information to tell guests about the Arenga sugar

Standards, Rules and Regulations
D: The sugar and the tool have to comply with food safety regulations applicable in the Netherlands and other relevant product import norms (for example CE)
D: The sugar packaging must be airtight and sealable
D: The tool must look natural and special
W: The tool should be aesthetically appealing and serve as a decorative element on the table
W: The tool should match many cafés’ style

Materials
D: The materials used must have a natural look and feel
D: The materials must be sustainably sourced

Ergonomics
D: Café guests must be able to understand that it is sugar to be used to sweeten coffee and tea and how to use the product and get some hints of the story (cognitive ergonomics)
D: The product must be possible to comfortably used by P5 to P95 of Dutch adults (anthropometrics). It must be held in one hand (diameter tool between 50 and 65mm), easy to lift (weight total sugar and tool not more than 500g) and grate easily (force needed to grate the sugar must not exceed 10N)

Safety
D: There must be no risk to cut fingers for guests and when refilling and the tool has to comply with General Product Safety Directive 2001/95/EU.
D: Replacement parts for the tool must be possible to maintain
D: The product should be produced responsibly with a fair wage to all workers and with minimal environmental impact

Product Policy
D: The product should be produced with full life cycle, from originate, distribute, use to discard
W: Profit should be used for reforestation and sustainable investments
D: The complete design should create awareness about the importance of the rainforest and promote sustainably wild-harvested forest products
W: Profit should be used for reforestation and sustainable investments

Installation and initiation of Use
D: Basic assembly of the top part (leaf bowl) and the basis will be done at the café before the first usage as well as filling the grater with sugar blocks
D: Usage should be simple and intuitive so no learning time is required
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Standards, Rules and Regulations
D: The sugar and the tool have to comply with food safety regulations applicable in the Netherlands and other relevant product import norms (for example CE)
Final Design

In this chapter the final design is presented, forming the outcome of this graduation project. The design consists of the physical grater with its mechanism, transforming the sugar blocks into sugar flake flowers. The tool lets coffee bar guests experience the Arenga Rainforest Sugar’s story. The different parts of the design are explained in detail in this chapter and evaluated in the next chapter.

Usage

The tool to serve the Arenga Rainforest Sugar in coffee bars is used by café guests to grate traditional hard sugar blocks into beautiful sugar flakes, to sweeten their hot drinks, such as coffee and tea. The context of use for the sugar grater are cafés in the Netherlands. The focus lies on small speciality coffee bars with hip guests, offering a range of tasty, healthy and sustainable products with a transparent story (see “Product Context” on page 8, “Target Group” on page 26 and Evaluation context on page 84). It enhances the experience of the Arenga Rainforest Sugar and facilitates a new way of serving sugar.

A scenario (Figure 54) of the usage of the product gives an overview of the design in a similar way as a user would discover the Arenga Rainforest Sugar grater in a café. The guests first enter the café, sit down, check the menu and order at the waiter. The first interaction with the Arenga Rainforest Sugar could be either discovering the extra flyer or the info box about the sugar in the menu or realising the grater standing on the table, which looks interesting, natural and special.

When the drink is served, the guest might look for sugar to add. The word “SUGAR”, engraved at the front of the tool on the table should give a hint, but the whole product might be unknown and surprising for the user. Grabbing the grater and reading the whole text ‘Arenga Rainforest Sugar’ and looking at the other engraved illustrations gives an idea about the source of this special sugar. The grater feels a bit heavy and the engravings are interesting to touch with the fingertips. Looking inside the top of the grater, small sugar flakes on the knives are visible and the nice smell might be noticed.

The cylindrical shape, the parting line between the bamboo and the metal base, and the handle give the user the hint to use the tool similar to a pepper mill. Starting to turn the base and looking inside the top, it is visible how the sugar flakes come out there, growing and looking like a flower. One rotation grates around 2 grams of sugar and two rotations results in a nice sugar flower with several layers of petals. The caramel flavour of the sugar can be smelled and the sugar’s appearance should be a pleasant surprise for the user.

To add the sugar then to the drink the user tilts the grater and lets the sugar flower slide into the cup. The flakes shortly float on top of the milk foam and then slowly dissolve and sink. After stirring the drink, the user tastes and checks if the drink is sweet enough. The whole experience with the sugar stimulates interest and fascination with the user.

While enjoying the drink the café guest looks again at the illustrations on the grater and maybe reads extra informations with the menu. When using the grater before, the guest also noticed the QR code at the bottom of the tool, which he scans now with his phone to check-out the website. Understanding the deeper meaning of the product and the background and impact of the Arenga Rainforest Sugar creates a good feeling about contributing to it.

Final Design

Figure 54: Scenario
The user experiences the Arenga Rainforest sugar as something special with this grater design. It facilitates a new way of serving this sugar with many metaphorical layers and subtleties with aesthetics, emotions and meanings, as aimed for with the vision statement (page 40).

The guests are stimulated to be active and are supported to create something themselves (the sugar flower), which should make them more aware of the sugar, treat it consciously and see it as something valuable. The big (not compact) sugar flakes in the shape of a fragile flower support this association with something precious. Furthermore, the user can observe the sugar flower “growing” while holding the sugar in his hand with an appreciating gesture (see “Interaction Qualities” on page 42).

Not only the flower shape and colour of the sugar, but also the look and feel of grater support the natural appearance of the sugar.

The flakes are shaved off traditional sugar blocks, supporting the authentic image. This special shape and texture of the Arenga sugar help to differentiate it from regular brown sugar and makes its unique story more clear for the user.

For more details regarding the sugar blocks and flakes used in the final design see the description with the design explorations (page 44 and page 46).

The Arenga Rainforest Sugar should be experienced as natural, special and authentic with emotions such as curiosity, pleasant surprise, fascination and virtuousness. The message of a healthy, sustainable and transparent product should be also conveyed by the grater and its usage.

Outside

The outside of the grater has a coherent look and feel with an integrated shape. The bamboo dominates the tool’s appearance with engravings as decoration and some shiny metal as accent.

Bamboo tube

One bamboo tube covers the upper part of the mechanism and forms a scoop on top of the tool (see Figure 55). The material choice of bamboo is in line with the natural experience of the sugar and supports the sugars story, since the farmers also use bamboo tubes to collect the sugar sap from the Arenga trees. For more reasons for the material selection of bamboo see page 53.

The part can be made of a dried, continuous bamboo tube, having roughly the right measurements (inner diameter maximal 52mm and outer diameter minimal 60mm). The tube is cut under an angle and both sides can be used, reducing waste material. In case there are cracks in the material, they should be broken and glued (with food grade glue) before sanding the surfaces smooth according to the measurements. Inside a step is created, making the bottom of the tube wider to slide over the mechanism (see “Assembly” on page 72). The bamboo is treated with odourless, food grade oil.

Decoration

Decorations on the bamboo complete the look of the tool and communicate the sugar’s background story to the café guest (see more about the “Story” on page 74)

The text “ARENGA RAINFOREST SUGAR” is engraved in capital letters on a spiral line around the grater. The most important message “SUGAR” is shown on the front, just underneath where the sugar flower comes out. The line however begins at the top back of the grater, saying “ARENGA”, as explanation above the Arenga palm leaf logo. Following the line down and passing the “SUGAR” text, illustrations show where the sugar comes from. The process is illustrated from rainforest and Arenga palm tree, harvesting the sap, boiling it, and moulding it in cylindrical blocks. Following the line all the way down leads to the handle at the bottom, which continuous the spiral with its rotation around the base and depicts a finger print to show the user’s role. At the bottom a QR code is engraved.

The engraved illustrations and text can be carved or burnt in the bamboo. Manual carving or pyrography is though very time consuming. A heated metal stamp could burn the engravings in the bamboo. Otherwise a 4 axis cylinder CNC engraving machine with laser or other cutting or burning tools could be used. This would also allow for adapting the decorations according to cafes’ branding. A high enough contrast should be created for good readability.

From further away it looks though nice if the decorations are more subtle.

Figure 55: Tool design

Figure 56: Engraved decorations
Mechanism

The grating mechanism (see Figure 57) is explained in this chapter with all its parts. It consists of one cylinder with external and one with internal thread, a knife, a ring, a sugar holder, a piston with an extra pushing plate and a handle. How those parts are assembled is also presented in this chapter.

The basic working principle is that the sugar blocks are stacked inside the grater and pushed and rotated against the knife, shaving off the sugar flakes. In Figure 57, only one sugar block is shown, but up to 3 sugar blocks can be stacked on top of each other. In this case, when the grater is just refilled, is the bottom part almost screwed out completely. When the base is rotated with (the handle) it screws into the upper part. The piston pushes the sugar upwards with the metal plate with spikes sticking in the bottom sugar block, transmitting the rotation to the sugar. The piston also rotates the sugar holder, to ensure that the upper sugar blocks also rotate. They are clamped in the sugar holder, which has triangular profiles at the inner wall to create high friction against rotation. The two cylinders have a right-hand thread, which is intuitive for most users. The external and internal thread should screw smoothly to transmit the rotation and vertical force from the user with as little friction as possible. A buttress thread, where the load-bearing thread face is perpendicular to the screw axis, is suitable because shear forces are prevented. It can be easily machined on a lathe with a buttress thread tool.

Figure 57: Parts of the grating mechanism

Figure 58: Section view of thread internal (top) and thread external (bottom)

Threaded Cylinders

The two cylinders have a right-hand thread, which is intuitive for most users. The external and internal thread should screw smoothly to transmit the rotation and vertical force from the user with as little friction as possible. A buttress thread, where the load-bearing thread face is perpendicular to the screw axis, is suitable because shear forces are prevented. It can be easily machined on a lathe with a buttress thread tool.

The two parts of the thread should be made out of two different materials, ideally one metal and one self-lubricating plastic. The bottom part with the external cylinder is made from metal (preferably stainless steel or alternatively brass) to have a low centre of gravity and ensure stable standing of the grater. The upper part with the internal thread can be made of POM, nylon or for example iglidur® (from igus.com), a self-lubricating food-safe, high-performance polymer. A thin metal sheet should be placed on the top rim of this plastic part to create a good bearing with the sugar holder, rotating on there.

The thread’s pitch has to be in accordance with the flake thickness and the angle and cutting depth of the knife. A pitch of 2.5mm was found to be slightly too much, although other factors have to be tested first before being able to draw a final conclusion.

The external thread should be as short as possible to have it not visible when the grater has its maximum expansion and being just refilled with 3 new sugar blocks. On the other hand, it must be long enough to overlap when screwed completely in the internal thread, when the last sugar block is about to be used up. The internal thread however can not go all the way up because the thread cutting tool needs some free run on top before the rim, which can be however minimal with a computer controlled lathe.

Knife

The circular knife is made out of one piece of stainless steel. The two blades are die-cut, bent downwards and afterwards hardened and sharpened. The part has to be stiff and strong enough to withstand the pressure of the sugar block, with the blades going all the way to the centre. The blades are facing downwards and sticking in the sugar block and therefore safe and not possible to touch for the user. The top surface of the knife slice is flat and allows the sugar flakes to smoothly come out of the grater without getting stuck or breaking. The optimum angle and cutting depth for the blades should be still tested. With a pitch of 2.5mm it was expected that each blade should stick out 1.25mm, but this could not be confirmed yet.

Ring

A metal ring finishes off the mechanism on top and holds the knife slice in place. It is fixed to the upper cylinder with a bayonet quick closure, an L-shaped cut-out, which can be pushed and rotated over a pin. The bamboo tube is being slid over this ring and also held in place by it. The ring has a rounded edge towards the inside (with an asymmetric fillet) to create a smooth transition between the ring and the bamboo, where the sugar flakes can slide over. The ring should be made of stainless steel to have the same appearance as the bottom cylinder with the external thread, to create a coherent look, when they are both visible.
Sugar Holder

The sugar holder encapsulates the blocks and rotates them. It is a cylindrical shape with triangular profiles sticking inwards, but not going all the way up, because otherwise they would be cut by the knives. The rim on top has to have a smooth surface and as little friction as possible to rotate on the upper cylinder.

This part might be a bit challenging to produce on a small scale. In the beginning 3D printing could be suitable, although smooth surface properties are required for the mechanism to work well. When the product is upscaled, injection moulding might be considered, possibly starting with a low investment 3D printed mould. Alternatively would be aluminium extrusion an option with some postprocessing turning and then a food grade surface treatment.

Piston

In the centre of the mechanism and fixed to the lower base of the grater is the piston, which pushes the sugar against the knife. It can be milled out of a thick pipe since it has a hollow centre to reduce material and weight. On the outside it has triangular grooves to transmit the rotation to the sugar holder and allow it to slide inside the holder and push the sugar blocks all the way through. The piston has to be as long as the 3 sugar blocks together to compensate and push the sugar when the grater is full, as well as when it is almost empty. On top of the piston is a slice which is flexibly fixed on pins and with springs around to prevent the mechanism from getting stuck, but allow the knives to cut around hard parts in the sugar. On the slice are small thorns which are punched and bent up to stick in the sugar block. Extra distance keeper at the sides next to the blades ensure that the thorns do not damage the knife.

Handle

The handle at the base of the grater enables the user to rotate continuously with one or more fingers, without having to change the hand position about each half turn. The extra arm of the handle increases the user’s finger force. The handle has an indent and engraved index finger print to show which direction to turn. It is carved out of one piece of laminated glued bamboo. It is decided to add the handle to the mechanism, because people can still not use it if they prefer, but it makes the usage more clear and also dedicates a special part of the design to the user, representing the impact of the café guest by making the “system turn” (see more with the “Story” on page 74).

Assembly

The grater consists of two sub-assemblies, screwed into each other. In the bottom assembly, the cylinder with external thread is connected to the bamboo handle and the piston inside with bolts. The sugar holder is illustrated in Figure 64 (left) with the bottom assembly, because those parts rotate together. The sugar holder is connected to the top cylinder and only slides into the bottom. When assembling the upper part, the sugar holder is inserted from the top, where it sits on a rim of the upper cylinder. The knife is then placed on the top of the upper cylinder and clamped in place with the ring, prevented from rotating by two pins. The knife is easy to replace if it becomes blunt. The whole upper assembly is slid into the bamboo tube. Some grooves in the ring prevent the bamboo from turning. All connections between parts are made against the grating direction, to ensure the tool does not accidentally fall apart while the café guest is using it.

First assembly requires that all parts are clean and that no dangerous residues of lubricants and oils or dust can end up in the food. How the (dis-) assembly works in practice is further elaborated on page 72, where it is explained how the café personnel can refill and clean the grater.

Figure 61: Sugar holder
Figure 62: Piston
Figure 63: Handle
Figure 64: Assembly
Usage for Personnel

The grater can be easily refilled and cleaned by the personnel of the café.

Refilling

The grater adapts its height to the amount of sugar blocks inside. The overall height and how much of the stainless steel is visible at the base of the tool give clear feedback to the personnel about the filling state of each grater. Quickly looking at all tables is sufficient to determine which graters need to be refilled (see Figure 65).

New sugar blocks can be pushed inside the sugar holder from the bottom. The triangular profiles on the sugar holder cut in the side of the sugar blocks to rotate them while grating. The sugar holder can be filled almost completely, leaving a few millimetres free at the bottom (depending on the material choice of the sugar holder and piston to transmit the rotation). The tool can then be closed again by screwing the base in the top. After a few rotations the bottom of the sugar holder slides into its gap in the base and starts being rotated. The grater is now ready for use.

To open the tool, the base can be completely screwed out, in the opposite direction as grating. The old sugar block stays on top inside the sugar holder, pressed against the knife. This left-over sugar will be used up first after refilling, guaranteeing continuous material flow, where no bits of sugar remain in the grater for too long. This allows that all sugar will be used without waste. Only the little bits stuck between the thorns at the piston slice may require removal.

Notice the sugar is (almost) empty.

Figure 65: Refilling

Cleaning

The grater should be cleaned regularly. It has to be opened and all leftover sugar collected. This can be reused to refill the graters afterwards or serve as ingredient for cakes or other recipes. It is safe to reuse this sugar, as guests are not able to touch the it inside the grater.

It is possible to disassemble all parts for cleaning. The two bamboo parts can be separated from the mechanism by sliding off the tube towards the top and unscrewing the handle. The bamboo should be washed by hand with warm water, soap and brush with food-safe oil about once per month. All other parts of the mechanism can be disassembled by removing the ring. The metal and plastic parts are dishwasher-safe.

After drying, all parts can be assembled again and the grater can be refilled with sugar and closed.

New sugar blocks can be pushed inside the sugar holder from the bottom. The triangular profiles on the sugar holder cut in the side of the sugar blocks to rotate them while grating. The sugar holder can be filled almost completely, leaving a few millimetres free at the bottom (depending on the material choice of the sugar holder and piston to transmit the rotation). The tool can then be closed again by screwing the base in the top. After a few rotations the bottom of the sugar holder slides into its gap in the base and starts being rotated. The grater is now ready for use.

It is possible to refill the sugar blocks already before it is completely empty, without creating waste. This allows for smoother work-flows and regular procedures for refilling all graters. The grater can be filled with around 125g of sugar, resulting in more than 30 portions of 4g.

Opening

The grater adapts its height to the amount of sugar blocks inside. The overall height and how much of the stainless steel is visible at the base of the tool give clear feedback to the personnel about the filling state of each grater. Quickly looking at all tables is sufficient to determine which graters need to be refilled (see Figure 65).

Close

To open the tool, the base can be completely screwed out, in the opposite direction as grating. The old sugar block stays on top inside the sugar holder, pressed against the knife. This left-over sugar will be used up first after refilling, guaranteeing continuous material flow, where no bits of sugar remain in the grater for too long. This allows that all sugar will be used without waste. Only the little bits stuck between the thorns at the piston slice may require removal.

Figure 66: Cleaning
Story

The goal is to let the café guests experience the background story of the Arenga Rainforest Sugar. Storytelling elements are integrated on different layers. The first and most obvious one is the text. Next come the illustrations (explained on page 67), then the general appearance of the grater, the sugar, and the experience of using the grater. Metaphorical elements subtly communicate the story. Extra layers and details can be discovered by the user, stimulating their imagination. Explanation can be found in the information material on the table and on the website. The story is deeply integrated in the final design. Some focus points have shifted and the implementation has slightly changed compared to how the story is explained with the design explorations on page 56. The main elements remain the same.

It is important to communicate that the sugar comes from the rainforest. This is shown with the sugar flower growing inside the rainforest illustration. In this illustration also an Arenga palm tree is depicted in its actual habitat.

Also the small process engravings emphasize the rainforest origin of the sugar and the role of the forest community. These processing illustrations are located around the grating mechanism, where the processing takes place in the tool. This links the decoration to the function of the tool.

The Arenga palm leaf, depicted at the back close to the processing illustrations, symbolises the important role of the tree for the rainforest and the local community, providing them with a sustainable income. The leaf engraving invites the user to put its protecting hand around the rainforest, depicted inside.

The spiral line is circulating around the grater and connecting all the elements to represent this balanced eco-system, where everything is connected. Both the rainforest and the people benefit from each other through the Arenga palm tree. The circular motion of the spiral is continued in the grating rotation actuated by the café guest, who keeps this system running. The handle gives the user an explicit part in the design, serving as metaphorical element for the story and showing the users contribution.

Information Material

On the table, some basic information material about the Arenga Rainforest Sugar can be provided. Depending on the café’s preference it can be either a separate flyer, which is inside or next to the menu, or an info box integrated and printed in the menu.

The information material consists of a short text, roughly explaining the sugar’s source and mentioning the sugar’s health benefits, such as the low glycemix index and the nutrients. A drawing of how the grater is held with the sugar flower coming out is used to illustrate it.

Extra information can also be provided at the shelf (see with the design explorations on page 59), where the café displays the Arenga Rainforest Sugar.

Website

The website can be reached by scanning the QR code on the bottom of the tool. Next to the QR code is also the web-address written. The website is optimised for mobile phone usage. It is designed in the same style as the bamboo grater with its decorations. The sugar’s background story is explained in more detail and illustrated with visual references, clearly linking to the metaphorical elements on the physical grater design. Next to drawings, explaining the process, there should be also video and photo material of the people harvesting and processing the sugar. The character of the website should be explorative and provide different layers of information for the user to discover, but summarise the main information in one quick overview.

A future addition could be some Augmented Reality features, where the user points with the phone camera on a certain element of the grater and gets extra information about this part blended in.
The business model for the Arenga sugar is drafted for selling the sugar products to cafés (business to business), who then sell the products to end consumers. The sugar will be offered in the café with the drinks, as well as sold to the end consumers together with the grater for home use. To reach the cafés, existing distribution channels should be used to introduce the Arenga Rainforest Sugar via local, small scale coffee roasters. Later the selling channels could possibly be extended to sell to delicatessen and ecological shops etc.

The Business Model Canvas (by Osterwalder and Pigneur, source Boeijen, Daalhuizen, Schoor, & Zijlstra, 2014, p. 105) is filled in for the rainforest sugar and tool (see Figure 70), to define the value creation and value capture for the Forestwise sugar consumer brand.

Key partners are cafés, coffee suppliers, sugar production, and tool production and repair.

The internal key activities consist of organising the sugar and grater tool production, checking its quality, delivering the sugar blocks to cafés, and providing them with the grater tool and background information about the rainforest products.

The value proposition forms the raison d'être for the Forestwise sugar consumer brand and consists of providing Dutch café guests with a tasty, sustainable and healthy sugar experience with a good story.

External aspects such as customer relationships is rather distant and consists of arranging delivery of the sugar (consumable) and making sure the cafés have (well maintained) grater tools (service). Channels for this relationships will be mainly coffee suppliers, but also social media, website and email. The targeted customer segment are hip cafés and their guests (see page 26, Target group).

The key resources are the Arenga Rainforest Sugar, an Indonesian network and the possibility to provide a transparent tracking system.

The price can be justified by the added value, consisting of the experience, decoration, design, health, taste, and a unique and sustainable product story. It is suggested to sell the sugar blocks for 3€/250g and the tool for 30€ to the end consumer. Cafés only pay for the sugar and get the tool provided for free. For a sugar portion of 4g it would cost the café around 0.05€ per drink, plus labour costs.

Product Category Life Cycle

The sugar grater will start off with the introduction phase after the first model is developed, tested (pilot with 50 pieces), and manufactured. This phase should be kept at a small scale (around 500 pieces) to manage the risk and stay flexible for adaptations and preparation for upscaling production.

**Figure 70: Business Model Canvas for Forestwise’s sugar brand**

![Figure 70: Business Model Canvas for Forestwise’s sugar brand](image-url)
Evaluation

The design is evaluated with input from users and cafés. Evaluation criteria are user perception, suitability for its context of use and sustainability.

User study

Research Goal

The goal of the user study is to evaluate the concept by validating assumptions and find points which need to be improved.

Setup

The setup for the user study was like a café and participants were served a cup of coffee. They were asked to use the Arenga Rainforest Sugar grater to add sugar to their drink and act naturally and not think out loud. The stimulus material was a functional prototype, with almost realistic look. Some limitations in the working of the prototype were solved by interfering once during the test. The prototype was not suited to grate flower like flakes, but rather smaller pieces, and required more force than the final design would. After the user started grating, the flower shaped flakes were therefore showed with an image and quickly explained. Also some more sugar flakes were added inside the top part of the grater to test how the user would scoop the sugar from there in the cup. The participants were female and three were left-handed.

Results

All participants initially looked inside the cup, afterwards some checked the bottom side of the tool, expecting a sugar outlet there. Some participants also thought the sugar would be inserted on the top. Most participants expected granulated sugar. One started to shake the tool since he expected the sugar would then come out through the gaps between the blades. Most of the participants however noticed directly the handle and started rotating the bottom base. Associations with pepper mills and a clear parting line between the bamboo and the metal helped for the usage. The rotation direction was directly done right by 11 participants, 3 were hesitant and went a bit back and forth. The 1 left-handed first screwed out the base. He only changed the rotation direction when noticing the threads came out. Although most participants rotated the grater in the right direction, some were answering in the questionnaire that it was not very clear. The handle was used by half of the participants, most of them with index finger and thumb. Other participants did not use the handle, but grabbed the bottom part with their whole hand. Nevertheless it seemed that the handle was not in the way for those people and still made it clear to them that the bottom part should be rotated. The shape of the handle and the engraved finger print also served as hint for the rotation direction. Some participants ticked with a finger on the side of the grater to make the sugar move slowly with only a small angle, to be able to carefully determine the quantity. 4 of the 16 participants used their spoon to scoop the sugar in their cup. A few people were observed to leave some sugar flakes in the cup. The sugar came loose well and slid easily through the bamboo tube. Some participants lacked with a finger on the side of the grater to make the sugar move slowly with only a small angle, to be able to carefully determine the quantity. 4 of the 16 participants used their spoon to scoop the sugar in their cup. A few people were observed to leave some sugar flakes in the cup. The sugar came loose well and slid easily through the bamboo tube. Some participants lacked with a finger on the side of the grater to make the sugar move slowly with only a small angle, to be able to carefully determine the quantity. 4 of the 16 participants used their spoon to scoop the sugar in their cup. A few people were observed to leave some sugar flakes in the cup. The sugar came loose well and slid easily through the bamboo tube. Some participants lacked with a finger on the side of the grater to make the sugar move slowly with only a small angle, to be able to carefully determine the quantity. 4 of the 16 participants used their spoon to scoop the sugar in their cup. 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Grater

The general appearance of the grater was rated as slightly more decorative than functional (mean 4.38/7, 4 would be neutral). Some participants explained this with “Because it looks lovely as a piece of nature with you in the table, but it also has a small handle that makes you think about the functionality of the product.” It is more like a decoration compared to a normal one, but it is still quite clear that it is used as a grater., and “I think it has both characteristics, functionality is achieved by the shredding process that includes an aesthetic value for the outcome.” Three rather critical reactions on the appearance of the grater were “Appropriate to the context of a coffee place, however not really my style.” “bulky”, and “Might need to become a bit more modern in appearance.” Furthermore the appearance was commented positively by the example words:

- “It does look novel and organic.”
- “Very natural, decorative. Looks like it will fit in many contexts. Seems attractive to serve food in (trustworthy).”
- “It makes me perceive the sugar I am using and don’t know the exact amount of sugar and don’t know how much sugar I would need compared to my normal amount I use.”
- “So that I know how much is necessary. Right now I think I took a lot, because I did not expect it to sweeten it so much as my drink got really sweet.”
- “A weight indication although would not help everyone since the Arenga sugar is a bit less sweet and one participant said: “I don’t know how much sugar I would need to know my normal amount I use”.
- “It looks like super pretty and looks natural and raw, having the flakes feels fancy.”
- “It seems like quality sugar”.
- “It feels very raw, not processed. Makes me think that it’s healthier”.
- “It has a natural appearance and I like the sugar flower.”
- “Natural was rated for the sugar with a mean of 4.57 of 5. The meaning ‘special’ was rated with 4.47 as well as ‘authentic’ with 4.37. Regarding the emotions about the sugar, participants agreed to “Curiosity” with 4.47 as well as “authentic”, “Natural” was rated for the sugar with a mean of 5.93, rated on a 7-point scale. Liked the sugar very much over at all (1) to very much (7). (Likings of the smell of the sugar was rated as 4.31 (close to neutral) and the taste as 5.14. While grating only 5 participants (31.3%) noticed the smell of the sugar, and 6 participants (42.9%) noticed the taste of the sugar in their drink.

Comments were:

- “The colour is super pretty and looks natural and raw, having the flakes feels fancy.”
- “It seems like quality sugar”.
- “It feels very raw, not processed. Makes me think that it’s healthier”.
- “It has a natural appearance and I like the sugar flower.”
- “Natural was rated for the sugar with a mean of 4.57 of 5. The meaning ‘special’ was rated with 4.47 as well as ‘authentic’ with 4.37. Regarding the emotions about the sugar, participants agreed to “Curiosity” with 4.47 as well as “authentic”, “Natural” was rated for the sugar with a mean of 5.93, rated on a 7-point scale. Liked the sugar very much over at all (1) to very much (7). (Likings of the smell of the sugar was rated as 4.31 (close to neutral) and the taste as 5.14. While grating only 5 participants (31.3%) noticed the smell of the sugar, and 6 participants (42.9%) noticed the taste of the sugar in their drink.

Story

Most users seemed to understand the main message, the sugar originates from. Many answered the question about the source of the sugar correctly, for example:

- “from some forest of course”,
- “Some kind of exotic rainforest”,
- “From forest rainforest, but don’t know exactly where it is.”
- “From the Arenga rainforest, it clearly states it is collected from rainforest, but don’t know exactly where it is.”
- “From somewhere from Southeast Asia”,
- “probably Asia due to the bamboo”,
- “From preserved places in which a sustainable process is done and there is a sustainable process of rainforest products.”

Several participants expected that “Arenaga Rainforest” would be a term and also googled it. Some wrong associations were with sugar cane and Latin America. The question about how it does make the participant feel, knowing where the sugar comes from, was answered with:

- “I feel that it is good that it is organic.”
- “More appreciate.”
- “I feel a bit more sustainable and healthy.”
- “I like to be aware about the origin of what I am eating”.
- “I am consuming a new natural product, hopefully helping out the people making it.”
- “Good! I like consuming food that sustains local economies.”
- “In the sense that you know the product is not taking advantage of the communities”
- “Curious to know more about the product.”

80
81
Some concerns were mentioned how-ever and the sugar was not thought to be sustainable by 3 participants (18.8%), be-cause “I don’t get any info. about that.” and “I don’t generally use my phone when in cafes.” 14 participants (87.5%) noticed the QR code on the bottom of the grater during the user test, but only 6 participants (37.5%) would have scanned it. Explanations were “I never do, I’m not used to. I would have preferred to google the name or find their FB page.”, “I don’t generally use my phone when in cafes.”, “I would not scan the code and read online, I would like to read it on the table itself. Also I am with my friend. I would prefer that both of us don’t use our phones.” and “I noticed it in the end, so I think it needs to be in another place to catch more the attention to be more engaging and make me scan the code.”

Others said to scan it “Because I believe it is an interesting thing to learn about, also the design is inviting you to.”, “It’s an interesting product, so I would like to see what I would say.” and “It helps you explore the product for the first time.”.

Discussion

The results of the user test should not be generalised as such, since the study was only conducted with a small amount of participants (16 students) and probably does not perfectly represent the average café guest. Some participants also did not like to put sugar in their coffee and normally drink it without. Additional context factors need to be considered. In a café people might be for example more sceptical and first check the decorations and explanations better. Only the grater was tested with its decorations and no extra information material was used. The users did not receive any specific background infor-mation about the Arenta Rainforest Sugar. This probably contributed to the relative low rating for feeling of “virtuousness”, be-cause they did not completely understand the bigger picture and their impact yet. Limitations of the prototype also influenced the results. Some participants were hesitant because they were afraid to break the prototype. Some were insecure whether it was really a working prototype and one test person just pretended to use it. The perception of the handle was influ-enced by the quality of the prototype. The handle was perceived as fragile, especially since a lot of force was required, which would not be the case with the final design. The parting line in the bamboo tube, consisting of two parts in the prototype made it furthermore less clear, which part of the grater would rotate. The perception of the hygiene and cleanliness might be also in fluenced by the quality of the prototype. The solid aluminium block inside of the grater prototype made the base more heavy than the final design, causing a different equilibrium position. This might have influenced how and where people would hold the grater. Same counts for the engravings; the palm leaf at the back side of the grater was intended to be explored with the fingers while holding the tool up-side down, grating. The engravings though were not very deep in the prototype and the users did not hold the tool the intended orientation. Interfering during the test, where the prototype did not grate nice flakes, inter-rupted the user and did not let them use the product completely naturally.

The smell of the sugar was probably not noticed by many because of the overruling smell of the relatively fresh linseed oil on the bamboo, which did not neutralise yet. Using the grater upside down did not guide the smell of the sugar towards the user’s face as intended.

Conclusion

It can be concluded from the user test that the grater and the sugar were ap-praised as very positive and interesting.

However it was not clear to the users that the sugar flakes should come out at the top of the grater. Solutions should be developed to motivate the users holding the grater upright while grating because this way they can observe the sugar flow-er growing. Explanatory illustrations and explanations on the table could be helpful. This information material could challenge the users to create a perfect sugar flower. This can be only done holding the grater in the intended orientation. More pronounced engravings with deeper indents at the back of the tool could support this by guiding the finger position, as well as a more rounded and ergonomic shape fitting the hand.

Another solution should be found for in-dicating the portion size and for what hap-pens in case people grate too much sugar. Overall it seems that the vision is achieved and the users perceive the prod-uct as natural, special and authentic. They confirm emotions such as curiosity and pleasant surprise and. The main message of the sugar can be conveyed. People understand that the sugar comes from the rainforest and is produced under fair condi-tions by local communities in a sustainable way. This results in the perception of a natural and healthy product. It should be paid attention to ensure that really nobody associates the sugar with deforestation.

The general attractiveness of the grat-er’s appearance and the fact that it was rated as decorative also confirms the idea to use the grater as table decoration. It might also draw attention of people not even using sugar.

More conclusions from the user test are translated to recommendations on page 88.
Context

For a successful design it is important that it matches with its context of use and is in line with the practice. In order to evaluate the design it was presented to more than 15 different coffee places in Den Haag with the prototype and some visualisations. Coffee owners, managers, baristas and waiters were interviewed and asked feedback on the design. The reactions were in general very positive, many assumptions could be confirmed and useful points of attention could be found to refine the design. An overview of the conclusions from the interviews and potentially interested cafes in Den Haag are presented in Figure 72.

The interviews could ascertain what kind of cafes would be interested in serving the Arenga Rainforest Sugar with the grater. It was found that big places, restaurants and more classic places were not so much interested and found the design too complicated and too novel to offer their guests. On the other side small speciality coffee bars could see the added value in the tool. Bamboo was seen as a suitable material for home use or as a gift. Also other potential uses of the sugar were mentioned such as for desserts, baking and cocktails.

Premium prices are easy to justify for specialty coffee bars and accepted by their guests. The higher price for the Arenga Rainforest Sugar was seen as worth the product. The business model where the cafes buy the sugar blocks and get the tools provided as long as they offer the Arenga Rainforest Sugar could be confirmed by the interested cafes. They perceived the risk as relative small to try out the new sugar product. They are positive about how their guests react on the new product and how it performs in practice. Practically issues were not many mentioned and the design was perceived as well thought through. The only concern was rain, when left outdoors. Bamboo was seen as a suitable material choice, although maybe the inside of the tool where the sugar flower touches could be made more smooth for easy cleaning. Furthermore it is convenient that the tool can be disassembled for regular cleaning with soap and warm water. Refilling was only seen as a burden by some cafes currently using sugar sachets. It was though mentioned that those cause a lot of waste because many of the returned, not used sugar bags are dirty and not reusable anymore. It is convenient that it is possible to refill before the sugar grater has to be refilled and that is is possible to refill before it is completely empty. They were not concerned about having to refill the tool too often, since sugar consumption is relatively low in general, but difficult to estimate. Many cafes also sell products and were interested to also offer the Arenga Rainforest Sugar assortment in their shop. Many interviewees could well imagine the product for home use or as a gift. Also other potential uses of the sugar were mentioned such as for desserts, baking and cocktails.

The look of the tool was perceived as attractive and matching with the cafes’ interior design. It fits well to the bright wood and plants which are often used. One place mentioned to prefer a more minimalistic design (with less decoration) and two others asked for customisation for the cafes’ theme. The presentation of the Arenga Rainforest Sugar was perceived as matching with the story behind. The grater was considered being suitable to promote the cafes sustainability efforts. The general idea of how the story is integrated in the tool was seen as very creative and well thought through. Especially the aspect of seeing the sugar flower growing inside the rainforest was intriguing.
The first incentive for the design of the grater was to promote the sustainable Arenga Rainforest Sugar with end consumers. All aspects of the design must be in line with the sustainability background of the sugar and the general mission of Forestwise. The “Ecodesign checklist” from the Delft Design Guide (Boeijen, Daalhuizen, Schoor, & Zijlstra, 2014, p. 65) helped to evaluate the design on the conceptual, product component, product structure and product system level.

Conceptual Level

The concept of the grater for Arenga Rainforest Sugar blocks for cafés fulfills the social need of more sustainable and transparent products, which are consumed with more awareness. The design supports the sustainable business model of wild-harvesting from the rainforest and this way protecting biodiversity, while also improving the livelihood of the local people in Indonesia. For the café guests it fulfills the need of having a positive impact by letting them experience the story and contribute to it. The design furthermore makes a healthier alternative more attractive. The main function of the tool, serving the sugar, is done effectively and efficiently within the requirements of the context. The functions of storing and grating the sugar are integrated and also combined with storytelling and table decoration. The proposal of a modular shelf system for cafés as storage and display with information and decoration also highly integrates functions.

Product Component Level

The supply of the materials and production of the parts are determining the impact of the components.

The outer part is made of bamboo, which is a deforestation free and renewable material, locally growing at the location of production. Production waste is minimal because both sides of the bamboo tubes, cut in an angle, can be used and parts of the tubes which do not have the right dimensions can be for example processed into coasters. Bamboo is used for the bigger parts of the product, which may be seen as less “necessary”, since it is a low impact material.

The mechanism is made of a minimal amount of parts and material is tried to be reduced. When selecting the specific materials, recycled metals and recycled or renewable (bio-based) plastics should be preferred. Waste material can be reduced, by machining the cylinders and piston out of pipes instead of solid material. The knife is punched out of stainless steel sheets with minimum waste, and the left parts between the circles can be recycled.

The sugar blocks production requires slightly less boiling and energy than making granulated sugar.

Product Structure Level

The distribution of the grater and the production of the parts are determining the impact of the components.

The outer part is made of bamboo, which is a deforestation free and renewable material, locally growing at the location of production. Production waste is minimal because both sides of the bamboo tubes, cut in an angle, can be used and parts of the tubes which do not have the right dimensions can be for example processed into coasters. Bamboo is used for the bigger parts of the product, which may be seen as less “necessary”, since it is a low impact material.

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Product System Level

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The sugar blocks production requires slightly less boiling and energy than making granulated sugar.
Conclusion

To conclude this report it is reflected on the project outcome and recommendations are given for further development of the design.

The project’s aim was to develop a suitable way to serve the Arenga Rainforest Sugar in Dutch cafés. The starting point was granulated, brown Arenga sugar.

The Material Driven Design approach stimulated not to take the starting material as given but to play with texture, shape and process, for finding a more suitable material concept. This also generated a complete understanding of the Arenga sugar. The idea to use traditional sugar blocks and let the user transform them into beautiful sugar flakes was stimulated by this approach. This helps to distinguish the Arenga sugar from other brown sugars.

The final design proposal presents the sugar to café guests in an attractive way as special and natural. The proposal fulfils the design goal. As aimed for with the vision, it lets café guests experience the background story of the Arenga sugar. The idea to use traditional sugar blocks and let the user transform them into beautiful sugar flakes was stimulated by this approach. This helps to distinguish the Arenga sugar from other brown sugars.

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Recommendations

The project was conducted in limited time and by one person with a specific skill-set. It is recommended to further investigate and develop some aspects.

Information material (flyer, info box and website) should be developed by a communication designer. In the future it might be also considered to implement augmented reality to elaborate on the story.

A solution should be found to motivate users to hold the grater in the intended orientation and observe the sugar flower growing.

The knife angle, position and cutting depth have to be refined and fine tuned together with the thread’s pitch. The amount of rotations and indications for portion sizes should be also defined. To find a suitable consistency, the sugar block production should be tested together with the details of the grating mechanism.

For user tests on a bigger scale, an adapted prototype should be built with the earlier mentioned improvements.

It is advised to use the Programme of Requirements (page 62) and the proposals of this report for further development and at the same time stay critical and update it with new insights.

Personal Reflection

The project was a great opportunity to combine my interests in sustainability, nature, food, new materials and prototyping.

I tried to be open to experiment with different methods, approaches and focus points. It was a valuable experience to manage my own project. I was able to integrate what I have learned from my studies during the past 5 years. The project helped me to gain more confidence in my way of working as a designer.

Consciously, I tackled the assignment quite broadly in order to cover the bigger picture. This holistic approach and the resulting complexity made it sometimes challenging for me to clearly communicate my project. Also writing this report was quite difficult and I struggled to convey all the thoughts behind the different parts of the design in a logical and convincing way.

This was my first design project with a truly iterative process. It was good to already select a concept at the midterm which allowed for another iteration to detail this design. My clear planning and keeping track of my progress helped me through the project, but it was also good to be open and leave some room for changes.

It was a pleasure to be able to contribute to Forestwise’s work and help them promoting their wild-harvested sugar. It would be a great honour if my design proposal would be implemented in the future.

Working 4 days a week on the project stretched it out over a longer period of time. I could keep some challenges in the back of my mind during the other days and this helped me to zoom in and out on the project. I was highly motivated throughout the whole process and really enjoyed working on the project. I was able to select focus points according to my ambitions and interests, in consequence I can identify well with my project. Working individually was challenging and regularly discussing with stakeholders, fellow students and friends helped me to reflect on my work.

I am proud of the outcome of this project and am happy that my final design got such positive feedback from users and cafés.

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The project’s feasibility is proven with small tests, a variety of prototypes, and a final user test with a high-fidelity prototype. The working principle could be confirmed. Different scales of production are possible with only minor changes in the design. The different parts of the concept are discussed with the stakeholders to confirm that it can be done.

The viability of the product is elaborated with a business model (page 76). The product is expected to survive on a longer term because it builds on the sustainable model of wild-harvesting. The product matches Forestwise’s mission with being sustainable on different levels (page 86). It also takes future trends into account. Furthermore, possibilities are incorporated in the design to adapt and improve it in the future. Cafés indicated to be open to try the new design because of the low risk and perceived added value.

The product’s desirability is indicated by all stakeholders seeing the new design in the future. Cafés indicated to be open to try the new design because of the low risk and perceived added value.

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Appendix

Content

User Study
Details, questions and results of product evaluation with users.

Project Brief
The project brief as accepted by the board of examiners.
User Study

Consent Form

Consent form for participation in user test

Dear participant,

This study is part of my graduation project at the faculty of Industrial Design Engineering at TU Delft. The goal of the research is to evaluate my product design. You cannot do anything wrong, don’t feel observed or under pressure, because if “mistakes” happen it only shows which aspects of the design need to be improved. I ask you to interact naturally with the product. You do not have to say out loud what you think, you may share your thoughts afterwards, when filling in a questionnaire.

The test will take about 30 minutes and consists of two parts: first using the product and second filling in a questionnaire.

Your participation in this test is completely voluntary. If you do not feel comfortable during the test and do not want to continue, you are free to withdraw at any time.

I will observe you discreetly while interacting with the product and take notes. If you agree, I would also like to film in case I miss some details which I would like to review later. The film material will not be shared anywhere and only used by me to evaluate the product design.

My observations of you and your answers to the questionnaire will be treated confidentially and will be presented in my graduation report anonymised.

❑ I agree to being filmed during the test
❑ I have carefully read the above description, asked any questions I had and am aware of my rights. I hereby voluntarily agree to participate in this study.

Name participant ________________________________
Date ________________________________
Signature participant ________________________________

Thanks for participating in my test!

Instructions

Imagine you go to your favourite café with your best friend to have a cappuccino and maybe some cake. You enter the café, find a table and order at the waiter. Please pretend you want to add sugar to your cappuccino, even if you would normally drink it without.

Please take a seat and wait for your cappuccino to be served. Then add sugar to your drink.

Please consider that the design you are using is only a prototype and I will show you later how the final design should look like. I may interfere once because of limitations of the prototype.

Visualisations

The following photos of how the sugar flower should look like were presented to the participant after he/she started grating. After using the product, this visualisations of the final design were shown to the participants to show them the differences between the prototype and let them fill in the questionnaire considering the final design instead of the prototype.

Questionnaire

To find the original questionnaire used for the study please check tinyurl.com/arengasugar

❑ I agree to being filmed during the test
❑ I have carefully read the above description, asked any questions I had and am aware of my rights. I hereby voluntarily agree to participate in this study.

Name participant ________________________________
Date ________________________________
Signature participant ________________________________
### Observations

The following points were noticed while observing how the participants used the product. Reviewing the film recordings of the test helped to notice all the details.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Looking, understanding</th>
<th>Sliding sugar</th>
<th>Sliding sugar</th>
<th>Rotating direction</th>
<th>Rotating speed</th>
<th>Sliding, using handle</th>
<th>Biting</th>
<th>Holding the tool</th>
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<td>yes, first looks down, looks inside tool before and looks inside tool after</td>
<td>yes, directly used</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

### Participant Observations

<table>
<thead>
<tr>
<th>Participant</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>- First looks down in tool before and after</td>
</tr>
<tr>
<td>2</td>
<td>- First grabs handle, looks inside tool before and after</td>
</tr>
<tr>
<td>3</td>
<td>- First grabs handle, looks inside tool before and after</td>
</tr>
<tr>
<td>4</td>
<td>- First grabs handle, looks inside tool before and after</td>
</tr>
<tr>
<td>5</td>
<td>- First grabs handle, looks inside tool before and after</td>
</tr>
<tr>
<td>6</td>
<td>- First grabs handle, looks inside tool before and after</td>
</tr>
<tr>
<td>7</td>
<td>- First grabs handle, looks inside tool before and after</td>
</tr>
<tr>
<td>8</td>
<td>- First grabs handle, looks inside tool before and after</td>
</tr>
<tr>
<td>9</td>
<td>- First grabs handle, looks inside tool before and after</td>
</tr>
<tr>
<td>10</td>
<td>- First grabs handle, looks inside tool before and after</td>
</tr>
<tr>
<td>11</td>
<td>- First grabs handle, looks inside tool before and after</td>
</tr>
<tr>
<td>12</td>
<td>- First grabs handle, looks inside tool before and after</td>
</tr>
<tr>
<td>13</td>
<td>- First grabs handle, looks inside tool before and after</td>
</tr>
<tr>
<td>14</td>
<td>- First grabs handle, looks inside tool before and after</td>
</tr>
<tr>
<td>15</td>
<td>- First grabs handle, looks inside tool before and after</td>
</tr>
<tr>
<td>16</td>
<td>- First grabs handle, looks inside tool before and after</td>
</tr>
<tr>
<td>17</td>
<td>- First grabs handle, looks inside tool before and after</td>
</tr>
</tbody>
</table>

### Additional Notes

- **Participant 7** noticed that the tool did not rotate smoothly and had some friction issues.
- **Participant 11** commented on the tool’s design, suggesting improvements for better handling.
- **Participant 15** expressed concern about the tool’s stability during use.
- **Participant 16** noted the tool’s ease of cleaning and maintenance.

---

**Design Considerations**

The tool seems to require significant improvements in terms of user comfort and ease of use. The design should prioritize smoother rotation and easier handling to enhance user satisfaction.
**Appearance**

Participant  | What did you think when you first noticed the grater?  | What do you think of the appearance of the grater?  | What do you think of the appearance of the product?  | What's your opinion about the handle? Did you feel it was comfortable when using it?  | What's your opinion about the decorations? Did you feel it was an elegant something for my coffee?
---|---|---|---|---|---
Thijs | I was used to the wood and I thought that it was a natural something for my coffee. | It looks natural. | It makes me perceive the sugar I am grinding as healthier, really my style. | I really like it. It reminds me to tropical climates. | It does look novel and organic.
Radek | I was not sure where the sugar came out of. | It is more like a decoration composed in a normal one, but it is still quite clear that it is used for the sugar. | It carries both qualities together. Wooden body makes it decorative and seeing the result of the sugar you produce inside it is a functional. | It's a bit too small. I can break it if I want to break it. | I need a cover for my coffee.
Nyckle | I didn't notice the handle very well. The wooden body makes the decoration seem and seeing the result of the sugar you produce inside it is a functional. | It is a bit too small for my coffee. I can break it if I want to break it. | It's a bit too small. I can break it if I want to break it. | I like the shape how you hold it. | It was more like a grater for sugar.
Liz | I was not sure where the sugar came out of. | It is a bit too small. I can break it if I want to break it. | It was more like a grater for sugar. | It's not so handy to hold. | It was more like a grater for sugar.
Vysali | It was not sure where the sugar came out of. | It is a bit too small. I can break it if I want to break it. | It was more like a grater for sugar. | It's not so handy to hold. | It was more like a grater for sugar.
Thijs | I was not sure where the sugar came out of. | It is a bit too small. I can break it if I want to break it. | It was more like a grater for sugar. | It's not so handy to hold. | It was more like a grater for sugar.
David | I was not sure where the sugar came out of. | It is a bit too small. I can break it if I want to break it. | It was more like a grater for sugar. | It's not so handy to hold. | It was more like a grater for sugar.
Andrea | I was not sure where the sugar came out of. | It is a bit too small. I can break it if I want to break it. | It was more like a grater for sugar. | It's not so handy to hold. | It was more like a grater for sugar.
Daniel | I was not sure where the sugar came out of. | It is a bit too small. I can break it if I want to break it. | It was more like a grater for sugar. | It's not so handy to hold. | It was more like a grater for sugar.
Melanie | I was not sure where the sugar came out of. | It is a bit too small. I can break it if I want to break it. | It was more like a grater for sugar. | It's not so handy to hold. | It was more like a grater for sugar.

---

**Usability**

Participant  | Was it intuitive for you how to hold the tool? Which orientation? Which hand? | Was it clear in what direction you had to turn in order to grate? | What's your opinion about the handle? Did you feel it was comfortable when using it?  | Was it clear in what direction you had to turn in order to grate? | Was it clear in what direction you had to turn in order to grate?  | What's your opinion about the decorations? Did you feel it was an elegant something for my coffee?
---|---|---|---|---|---|---
Thijs | I did not like the orientation. I thought it was hard to turn it around. | It was clear in what direction you had to turn, it was just not intuitive. | I like the shape how you hold it. | I really like it. It reminds me to tropical climates. | It does look novel and organic. | It looks natural.
Radek | I did not know the function of the flower-style pattern is not very obvious. Probably with more different color or shape. | There is a handle with a fingerprint on one side, which should be a clear indicator, but the product is not so obvious. Probably with more different color or shape. | It's good. | It's a bit too small. | I really like it. It reminds me to tropical climates. | It looks natural.
Nyckle | I did not know the orientation. I thought it was hard to turn it around. | There is a handle with a fingerprint on one side, which should be a clear indicator, but the product is not so obvious. Probably with more different color or shape. | It's good. | It's a bit too small. | I really like it. It reminds me to tropical climates. | It looks natural.
Liz | I did not know the orientation. I thought it was hard to turn it around. | There is a handle with a fingerprint on one side, which should be a clear indicator, but the product is not so obvious. Probably with more different color or shape. | It's good. | It's a bit too small. | I really like it. It reminds me to tropical climates. | It looks natural.
Vysali | I did not know the orientation. I thought it was hard to turn it around. | There is a handle with a fingerprint on one side, which should be a clear indicator, but the product is not so obvious. Probably with more different color or shape. | It's good. | It's a bit too small. | I really like it. It reminds me to tropical climates. | It looks natural.
Thijs | I did not know the orientation. I thought it was hard to turn it around. | There is a handle with a fingerprint on one side, which should be a clear indicator, but the product is not so obvious. Probably with more different color or shape. | It's good. | It's a bit too small. | I really like it. It reminds me to tropical climates. | It looks natural.
David | I did not know the orientation. I thought it was hard to turn it around. | There is a handle with a fingerprint on one side, which should be a clear indicator, but the product is not so obvious. Probably with more different color or shape. | It's good. | It's a bit too small. | I really like it. It reminds me to tropical climates. | It looks natural.
Andrea | I did not know the orientation. I thought it was hard to turn it around. | There is a handle with a fingerprint on one side, which should be a clear indicator, but the product is not so obvious. Probably with more different color or shape. | It's good. | It's a bit too small. | I really like it. It reminds me to tropical climates. | It looks natural.
Daniel | I did not know the orientation. I thought it was hard to turn it around. | There is a handle with a fingerprint on one side, which should be a clear indicator, but the product is not so obvious. Probably with more different color or shape. | It's good. | It's a bit too small. | I really like it. It reminds me to tropical climates. | It looks natural.
Melanie | I did not know the orientation. I thought it was hard to turn it around. | There is a handle with a fingerprint on one side, which should be a clear indicator, but the product is not so obvious. Probably with more different color or shape. | It's good. | It's a bit too small. | I really like it. It reminds me to tropical climates. | It looks natural.

---

**Participant**  | What did you think when you first noticed the grater?  | What do you think of the appearance of the grater?  | What do you think of the appearance of the product?  | What's your opinion about the handle? Did you feel it was comfortable when using it?  | What's your opinion about the decorations? Did you feel it was an elegant something for my coffee?
---|---|---|---|---|---
Thijs | Was it intuitive for you how to hold the tool? Which orientation? Which hand? | Was it clear in what direction you had to turn in order to grate? | What's your opinion about the handle? Did you feel it was comfortable when using it?  | Was it clear in what direction you had to turn in order to grate? | Was it clear in what direction you had to turn in order to grate?  | What's your opinion about the decorations? Did you feel it was an elegant something for my coffee?
---|---|---|---|---|---|---
Thijs | Was it intuitive for you how to hold the tool? Which orientation? Which hand? | Was it clear in what direction you had to turn in order to grate? | What's your opinion about the handle? Did you feel it was comfortable when using it?  | Was it clear in what direction you had to turn in order to grate? | Was it clear in what direction you had to turn in order to grate?  | What's your opinion about the decorations? Did you feel it was an elegant something for my coffee?
---|---|---|---|---|---|---
Thijs | Was it intuitive for you how to hold the tool? Which orientation? Which hand? | Was it clear in what direction you had to turn in order to grate? | What's your opinion about the handle? Did you feel it was comfortable when using it?  | Was it clear in what direction you had to turn in order to grate? | Was it clear in what direction you had to turn in order to grate?  | What's your opinion about the decorations? Did you feel it was an elegant something for my coffee?
Emotions

Participant | What emotions did you feel while looking at the grater? | Can you explain why? | What meanings do you associate with the SUGAR? | How did you feel about the SUGAR? | Do you want to add any other emotions? | Do you want to add any other meanings? | Can you explain why?
--- | --- | --- | --- | --- | --- | --- | ---
| 1 | Calmness | | | | | | 
| 2 | Curiosity, Fascination, Virtuousness | | | | | | 
| 3 | Curiosity, Fascination | | | | | | 
| 4 | Fascination | | | | | | 
| 5 | Virtue | | | | | | 
| 6 | | | | | | | 
| 7 | | | | | | | 
| 8 | | | | | | | 
| 9 | | | | | | | 
| 10 | | | | | | | 

Meanings

Participant | What meanings do you associate with your first impressions regarding the grater? | Can you explain why? | What meanings would you associate with the SUGAR? | How did you feel about the SUGAR? | Do you want to add any other meanings? | Can you explain why?
--- | --- | --- | --- | --- | --- | ---
| 1 | Natural, Authentic, Special | | | | | 
| 2 | Natural, Authentic, Special | | | | | 
| 3 | Natural, Authentic, Special | | | | | 
| 4 | Natural, Authentic, Special | | | | | 
| 5 | Natural, Authentic, Special | | | | | 
| 6 | Natural, Authentic, Special | | | | | 
| 7 | Natural, Authentic, Special | | | | | 
| 8 | Natural, Authentic, Special | | | | | 
| 9 | Natural, Authentic, Special | | | | | 
| 10 | Natural, Authentic, Special | | | | | 

Natural: pleasant surprise, its material is quite natural. The shape is
Fascination: looking at the grater?
Virtuousness: looking at the grater?
Curiosity: feeling of home, smoothness and finishing.
Fascination: looking at the grater?
Virtuousness: looking at the grater?
Curiosity: looking at the grater?
Fascination: looking at the grater?
Virtuousness: looking at the grater?
Curiosity: feeling of home, smoothness and finishing.
### Sugar

**Participant 2 when tasting the sugar:**

"It's awesome! What is it?"

---

### Portion Size

| Participant | How many turns would you have done for one portion of sugar? | Would you like to know how much Arenga sugar you took? | Where would you integrate an indication for the quantity of sugar?
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3 No, I already had an estimate</td>
<td>True: conferring</td>
<td>True: portion size in the handle at the bottom</td>
</tr>
<tr>
<td>2</td>
<td>4 Yes</td>
<td>Depends on the product and sometimes control it</td>
<td>True: portion size in the handle at the bottom</td>
</tr>
<tr>
<td>5</td>
<td>2 No</td>
<td>I need to keep track of the amount I have</td>
<td>True: portion size on the cylindrical body</td>
</tr>
<tr>
<td>10</td>
<td>3 No</td>
<td>I should just take an estimated amount of sugar and don't know the exact amount of grams</td>
<td>True: portion size on the cylindrical body</td>
</tr>
<tr>
<td>15</td>
<td>3 No</td>
<td>I need to keep track of the amount I have</td>
<td>True: portion size on the cylindrical body</td>
</tr>
<tr>
<td>20</td>
<td>2 Yes</td>
<td>I want to see how much sugar I am consuming</td>
<td>True: portion size in the handle at the bottom</td>
</tr>
</tbody>
</table>

---

**Participant:**

Did you notice the shape of the Arenga sugar?

Did you notice the texture of the Arenga sugar?

Did you notice the taste of the Arenga sugar?

Do you like the shape of the Arenga sugar?

How do you measure the Arenga sugar?

Do you prefer to have it when in need, or while grating?

Did you notice the Arenga sugar colour?

Do you notice the Arenga sugar smell?

Do you notice the Arenga sugar form that is not small particles?

Do you notice the Arenga sugar taste any different compared to normal sugar?

Do you notice the Arenga sugar texture, form and the Arenga sugar taste of the Arenga sugar?
**Participant**

Where do you think the sugar comes from? What did you imagine the background story of the sugar to be?

<table>
<thead>
<tr>
<th>Participant</th>
<th>Story QR Code General Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>Yes</td>
</tr>
<tr>
<td>6</td>
<td>Yes</td>
</tr>
<tr>
<td>7</td>
<td>Yes</td>
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<tr>
<td>8</td>
<td>Yes</td>
</tr>
<tr>
<td>9</td>
<td>Yes</td>
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<tr>
<td>10</td>
<td>Yes</td>
</tr>
<tr>
<td>11</td>
<td>Yes</td>
</tr>
<tr>
<td>12</td>
<td>Yes</td>
</tr>
<tr>
<td>13</td>
<td>Yes</td>
</tr>
<tr>
<td>14</td>
<td>Yes</td>
</tr>
<tr>
<td>15</td>
<td>Yes</td>
</tr>
<tr>
<td>16</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Did you notice the QR code at the bottom of the grinder? Would you have scanned it?

<table>
<thead>
<tr>
<th>Participant</th>
<th>QR Code</th>
<th>Why</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No</td>
<td>As my previous answer explains.</td>
</tr>
<tr>
<td>2</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>7</td>
<td>Yes</td>
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<td>8</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>9</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>10</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>11</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>12</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>13</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>14</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>15</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>16</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Would you like to know more about the story of the sugar? Where would you like the information to be?

<table>
<thead>
<tr>
<th>Participant</th>
<th>General comments and tips for improvements</th>
<th>Please share your thoughts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 point</td>
<td>Would prefer that both of us don’t use our phones/phones. I would like to read it on the table itself. Also I am with my friend. I would like to read it on the tablet. I would like to use my phone when in cafes.</td>
</tr>
<tr>
<td>2</td>
<td>2 points</td>
<td>I like the idea behind it and really want to know more about the sugar.</td>
</tr>
<tr>
<td>3</td>
<td>3 points</td>
<td>I think the first interaction with the product is important. I would not scan the QR code, but I was interested by it.</td>
</tr>
<tr>
<td>4</td>
<td>4 points</td>
<td>Try AR for the story.</td>
</tr>
<tr>
<td>5</td>
<td>5 points</td>
<td>Good product, even if it’s a bit old fashioned. I like the QR code and the fact that it’s available.</td>
</tr>
<tr>
<td>6</td>
<td>6 points</td>
<td>Innovative product but I would love to know more about the sugar. It’s very engaging and makes me scan the code.</td>
</tr>
<tr>
<td>7</td>
<td>7 points</td>
<td>Interesting product, so I would like to see what I will get.</td>
</tr>
<tr>
<td>8</td>
<td>8 points</td>
<td>I don’t think it is a QR code.</td>
</tr>
<tr>
<td>9</td>
<td>9 points</td>
<td>Because I believe it is an interesting thing to learn about, also the design is inviting you to know how it works exactly.</td>
</tr>
<tr>
<td>10</td>
<td>10 points</td>
<td>To know how it works exactly, or to learn more about the sugar.</td>
</tr>
<tr>
<td>11</td>
<td>11 points</td>
<td>For me, it is an interesting product. I would like to learn more about it.</td>
</tr>
<tr>
<td>12</td>
<td>12 points</td>
<td>It’s an interesting product, so I would like to see what I will get.</td>
</tr>
<tr>
<td>13</td>
<td>13 points</td>
<td>Sometimes I do not want to use my smartphone in cafes (especially if I’m with someone).</td>
</tr>
<tr>
<td>14</td>
<td>14 points</td>
<td>More engaged and make me scan the code.</td>
</tr>
<tr>
<td>15</td>
<td>15 points</td>
<td>I would be curious to see at which webpage the product is connected to.</td>
</tr>
<tr>
<td>16</td>
<td>16 points</td>
<td>It’s likely that you addressed the factors of colour, type and size of typeface, as well as making it attract you and make you curious to explore. It would be more about the sugar</td>
</tr>
</tbody>
</table>

**General Comments**

- I like the idea behind it and really want to know more about the sugar.
- I think the first interaction with the product is important. I would not scan the QR code, but I was interested by it.
- Try AR for the story.
- Good product, even if it’s a bit old fashioned. I like the QR code and the fact that it’s available.
- Innovative product but I would love to know more about the sugar. It’s very engaging and makes me scan the code.
- Interesting product, so I would like to see what I will get.
- I don’t think it is a QR code.
- Because I believe it is an interesting thing to learn about, also the design is inviting you to know how it works exactly, or to learn more about the sugar.
- It’s an interesting product, so I would like to see what I will get.
- Sometimes I do not want to use my smartphone in cafes (especially if I’m with someone).
- It’s likely that you addressed the factors of colour, type and size of typeface, as well as making it attract you and make you curious to explore.
- More about the sugar.
**Project Brief**

On the following pages the project brief is presented, which got accepted by the board of examiners after some adaptations were made and explanatory text (page 111) was added.

---

**STUDENT DATA & MASTER PROGRAMME**

Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy". Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1!

**chair dept. / section:**

**mentor dept. / section:**

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v.

---

**SUPERVISION TEAM**

Fill in the required data for the supervisory team members. Please check the instructions on the right!

---

This document contains the agreements made between student and supervisory team about the student’s IDE Master Graduation Project. This document can also include the involvement of an external organization, however, it does not cover any legal employment relationship that the student and the client might agree upon. Next to that, this document facilitates the required procedural checks.

- The student defines the team, what he/she is going to do and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student’s registration and study progress.
- IDE’s Board of Examiners confirms if the student is allowed to start the Graduation Project.

---

**IDE Master Graduation**

**Project team, Procedural checks and personal Project Brief**

---

**IDE TU Delft - E&SA Department /// Graduation project brief & study overview /// 2018-01 v30**

Page 1 of 7
Designing with Arenga sugar from Indonesian rainforest

This project is about developing a sustainable sugar-based product. The Wild Bunch and the Wild Bunch (www.thewildbunch.network) received the permission to harvest Arenga sugar from the Indonesian rainforest, and it has the potential to be sold in the Netherlands. The sugar is harvested from the Arenga palm tree, which naturally grows in the rainforest and requires this biodiverse surrounding. Rainforest sugar is made from the sap which can be tapped twice a day a thin layer can be sliced from the end of the stalk on which male flowers are growing. If done properly, the sap drips down the thin tube of this type, by “heating” some of the raw energy in the Arenga sap, the sugar is then cooked and ultimately made into sugar from it. The Arenga sugar has a light caramel-like flavor and is not as sweet as a sugar cane for sale. It is not only unique but also the incredibly renewable, manufacturing process and the perceived health benefits. (Stichting Masarang International, n.d.)

The project focused on the sugar products. The sugar is harvested from the Arenga palm tree, its naturally grown in the rainforest and requires this biodiverse surrounding. The arenga palm tree is a sapling that can be tapped twice a day and in vast quantities. Twice a day a thin layer can be sliced from the end of the stalk on which male flowers are growing. If done properly, the sap drips down the thin tube of this type, by “heating” some of the raw energy in the Arenga sap, the sugar is then cooked and ultimately made into sugar from it. The Arenga sugar has a light caramel-like flavor and is not as sweet as sugar cane for sale. It is not only unique but also the incredibly renewable, manufacturing process and the perceived health benefits. (Stichting Masarang International, n.d.)

The project is focused on designing products with the Arenga palm tree-based sugar. The sugar is harvested in a sustainable way from palm trees in Indonesia. The project is about commercializing the Arenga sugar and applying it in innovative product ideas. The project is paired with the rainforest, people, technology, business and sustainability in art and culture, which is also represented by the supervisory team.

Chair: Dr. ir. Willemien M. Vliegenthart - Director of Food Design Lab (People), Design

Bakker: Bahar Barati (Technology, materials, design)

Company: Stichting Masarang International (n.d.)


REFERENCES


The final design should be a sustainable solution, which is aligned with the background of the assignment and my intention to graduate with the annotation "Technology in Sustainable Development". I plan to apply parts of the Material Driven Design method (Karana et al. 2015) and treat the sustainability into account. I plan to apply parts of the Material Driven Design method (Karana et al. 2015) and treat the sustainability into account. I aim to develop a product that not only turns the Arenga sugar into a sustainable product, but also promotes the variety of advantages of the Arenga sugar, to increase the impact of the sustainable sugar in the Netherlands.


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Assignments: To design a product concept using Arenga sugar as a material, as part of the project in the context of sustainable design, and in line with the proposal of the assignment. The product concept should be developed using the Material Driven Design methodology and should aim to promote the sustainability of the product concept. The product should be designed with consideration for the environment, health, and social sustainability.
Explanatory text for board of examiners

In the first half of the project I want to take a broad approach and do many (not so much in depth) steps. In the second half I plan to do more in-depth steps to make sure that the final product is producible. The main focus will be the design of the product itself, made of or for the rainforest sugar. I plan to start on 25 February 2019 and work 4 days per week on the project. In the planning above I decided to take friday free (for part-time work, applying for jobs, and other activities), but the specific day in the week could still change.

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My motivation for this project is to be able to combine Sustainability, Food Design and Material Driven Design. I want to deepen the knowledge and experience gained from the elective courses Sustainable innovation into Practice, Food & Eating Design, and Material Driven Design. I can personally very well identify with the topic of the project, which in the first place may not seem a very typical product design project. I want to take as many different aspects into account and integrate them in my design. I am already very enthusiastic about the project and am looking forward to get started with it!

In case your project brief needs final comments, please add any information you think is relevant.

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