

The Turning Point

When Efficiency
Becomes Experience.




Designing for Meaningful Interactions and Longevity in Kitchen Appliances.

Introducing '**The Turning Point**': a conceptual design for the Future Frankfurter Kitchen of 2040. Reducing e-waste and hidden environmental impact caused by premature replacement of electronic kitchen appliances, by making cooking an active, experience-based ritual.

MSc. Graduation Thesis
April 2026

B.A.M. Koppert
Integrated Product Design
Faculty of Industrial Design Engineering
Delft University of Technology

 **Babette
Koppert**

Chair
Dr.ir. M.C. Dekker
Human Factors
Human-Centered Design (HCD)

Mentor
Ir. C.P.J.M. (Caroline) Kroon
Design for Sustainability
Sustainable Design Engineering (SDE)

Company mentor
Markus Orthey
De'Longhi Braun Household

"Things designed to be breakable are easier to repair. Rather than being tough and rigid, they gracefully absorb excess force. When they become old, they break down and are reborn into new forms."

~ Japanese Pavilion, Osaka World Expo 2025

Foreword

Dear reader,

At the start of this project, the incentive was to make our owned products more sustainable and future ready. I thought the problem was solvable by simply making products repairable. I saw a message on LinkedIn saying: "If you're not designing for repair, you're designing for landfill.". However when I started my research, I found that perfectly repairable products are not repaired because people lack 'Willingness to Repair' and products are discarded even before it needs repairing: 'premature replacement'. I discovered that the problem was bigger than I thought, rooted in our society and economy. This 'rabbit hole' is not something to be solved within an individual graduation project over half a year, but it confirmed that our responsibility as designers is significant when designing and shaping our future on this planet. I want sustainability not only to become the responsible choice for an utopian world, but I want it to be the logical one.

With the introduction of new EU regulations, the demand for sustainable products is becoming a reality and part of a societal change. Companies should respond to this development and contribute to it.

I am passionate about sustainable domestic products, and the project has sparked countless interesting conversations with those involved and others. I hope that The Turning Point will encourage more conversations like that among my readers.

Enjoy!

Babette Koppert

Delft, April 2026



Summary

The amount of products we own combined with the ease of obsolescence, result in a huge environmental impact. Our attitude towards products is unsustainable and designers have a responsibility to guide consumers toward more meaningful and lasting relationships with the products we buy.

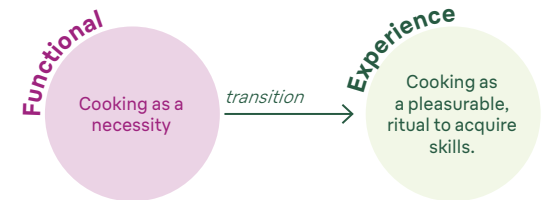
Since the kitchen appliance market is highly saturated, focus on functionality and affordability makes it hard to compete. There is an opportunity in adding other types of value (emotional, social, epistemic and conditional) to Braun kitchen appliances, to be front runner for the transition in kitchen context and product ownership.

The choice to cook often results in a trade-off between time, cost, and health. The mega-trends show that health, sustainability, self expression and community become increasingly important. Therefore cooking will transition from a functional activity to an experience-based one. The purpose of cooking will be to acquire skills or to connect with oneself and others.

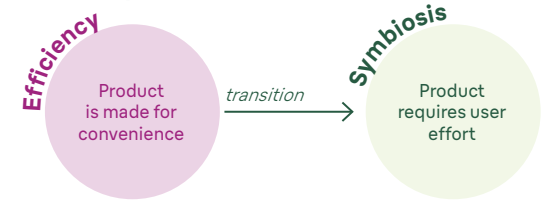
The conceptual design, **'The Turning Point'**, transforms the cooking process into a satisfying and enjoyable experience. Users can choose between hand-pulling and foot-pumping movements, which are converted by a visible mechanism into a rotational driver for kitchen appliances. This replaces all electric rotating motors in the kitchen. The interaction between user and product requires effort from the user, thereby strengthening their relationship. Direct feedback makes people feel in control, and they value the end result more when they have put in the effort themselves.

The future persona will put time and effort in their kitchen appliance and associates the product with a positive experience. The investment and positive association lead to more product attachment. Care and maintenance feel natural and satisfy the user. Their daily movements contribute to a healthy lifestyle.

Shift of kitchen context



Shift of product interaction



The report is structured based on the Vision in Product Design method (ViP). The current context is compared to the future context of 2040, which is used to create a design vision. The Turning Point is a showcase that embodies communicates this vision.



Terminology/ Abbreviations

Epistemic Value The epistemic value of products is one of five key consumption values that shape consumer decisions to retain or replace a product. It refers to the product arousing curiosity, providing novelty or the need for a change of pace, breathing new life in an owned product (Sun et al., 2025)

Lifespan: The active lifetime of a product comes to an end when it is no longer in use, regardless of who owns it, and it often enters a period of hibernation (Murakami et al., 2010).

Premature replacement: The actual lifetime of many consumer electronics is often much shorter than the potential lifetime, since consumers dispose of many consumer electronics quickly and prematurely, while they are still functioning well (Mugge, 2024).

Product longevity: A product's ability to remain functional, useful and desirable over a long period of time.

Symbiosis: "A relationship between two types of animal or plant in which each provides for the other the conditions necessary for its continued existence" (Cambridge Dictionary, n.d.).

Ambient exercise: "Ambient Exercise refers to the implicit exercise that people undertake in the course of their everyday duties" (Wan et al., 2009).

RPM: Rotations Per Minute

Acknowledgment

As a designer, working on an project individually is challenging. As creativity flows through connection with others, my project is a culmination of inspiration from interesting conversations I have had. Above all, I would like to express my gratitude for the enthusiasm of my supervisory team.

During the research phase, Marijke Dekker sent me interesting articles related to my topic, showing genuine interest. Also your detailed feedback on the report was highly appreciated.

I was really happy with Caroline Kroon as my coach. I think your coaching style, which focuses on guidance throughout the process, is far more valuable than focusing solely on the end result. I could always drop by when I needed to bounce ideas around.

Markus Orthey taught me not to forget that a designer's enjoyment is a huge driver in the development of a project. I want to thank you for the opportunity to do this graduation for Braun and for welcoming me in the office to take a look behind the scenes at a well-known brand.

I would like to thank my parents for their support and sincere interest in my project. They supported me throughout my time as a student, and especially over the last couple of weeks when I was able to make use of their time and car. :)

Thanks to Bas for helping me unstress (*Figure 1*); to Carmen for the pep-talks when my confidence needed a boost; to Bastiaan,



Figure 1. Bas helping me capture the final prototype.

Lianne & Mick for creating an ambience that we were a design studio together while doing our graduation projects simultaneously (*Figure 2*); thanks to Lianne for the coffee and to Finn, Isabella & Willem for the coffee breaks; thanks to the pleasant ambience at the PMB and to kind employees maintaining our faculty.

Thanks to Marie-Claire for always finding time when I was in need for advice.

And last but definitely not least: My prototype would never have turned out as it did without my uncle Kees, who took the challenge to help me in his workshop in Antwerp, when the faculty's workshop said that my plan was not allowed in their workshop.

Figure 2. Our self-claimed 'office' at IDE Faculty.



Table of Contents

- Foreword 6
- Summary 7
- Terminology/ Abbreviations 8
- Acknowledgment 9
- 1 Introduction 12**
 - 1.1 Project introduction 12
 - 1.2 Problem definition 12
 - 1.3 Scope..... 13
 - 1.4 Context..... 13
 - 1.5 Research objectives..... 14
 - 1.6 Approach..... 14
- Current context 16**
- 2 The kitchen as we know it now 17**
 - 2.1 Origin of the kitchen 17
 - 2.2 Why people cook 19
 - 2.3 The process of cooking..... 20
 - 2.4 Current products 20
- 3 Company Context 21**
 - 3.1 Braun Household..... 21
 - 3.2 Current repair ecosystem 22
 - 3.3 Barriers & incentives..... 23
- 4 Product lifetime 24**
 - 4.1 Obsolescence..... 24
 - 4.2 Product values..... 25
- 5 Overconsumption society 28**
- 6 Current context: Take-aways 31**
- Future context 32**
- 7 Circular Economy 33**
- 8 Strategies to extend product lifetime 36**
 - 8.1 Shared ownership..... 36
 - 8.2 Maintaining product Integrity 36
 - 8.3 Slow design..... 38
 - 8.4 Eco-effectiveness..... 39
- 9 Megatrends 40**

- 10 Persona 41**
- 11 Movement in the kitchen 44**
- 12 Future context: Take-aways 45**
- Design Vision 46**
- 13 Shift of intention 47**
 - 13.1 Shift of kitchen context 47
 - 13.2 Shift of product interaction 47
 - 13.3 Analogy..... 50
- 14 Product investment 51**
- 15 Look & Feel 53**
 - 15.1 Placement 54
- 16 Design challenge 56**
 - 16.1 Design guidelines..... 56
- Showcase: The Turning Point 57**
- 17 Design summary 60**
 - 17.1 Human powered motor 63
- 18 Design experience 66**
- 19 Design details 68**
 - 19.1 Mechanism..... 69
- 20 Concept development 70**
- 21 Showcase validation 78**
 - 21.1 Reflecting on product values 78
 - 21.2 Limitations & Recommendations 78
- Conclusion 80**
- 22 Innovation timeline 82**
- 23 References 83**
- Appendix 91**

1 Introduction

1.1 Project introduction

In Western Europe, the average person owned 9.4 electronic devices in 2023 (Fleck, 2024). As a result, Europe generated 17.6 kg of e-waste per capita in 2022, with a significant portion coming from common household equipment (Baldé et al., 2024). Although academic research in areas such as repairability and circular product design has progressed substantially, its real-world application has not kept pace. Besides, even products that are technically repairable may still be discarded prematurely. For example, 58% of replaced TVs and 16% of replaced washing machines were still functioning at the time of replacement (Mugge, 2024).

Company 'Braun Household' (official name De'Longhi Braun Household) creates domestic appliances based on the principles such as "Good design is simple, useful and built to last" and "Better by design" (Braun Household, n.d.). These values offer an opportunity to align academic insights on product longevity with commercial product development. However, achieving this requires balancing theoretical ideals with real user behaviour and business constraints, creating both a design challenge and an opportunity to make a meaningful impact.

As product designers, we play a crucial role in shaping a sustainable future. The products we create must not only meet functional needs but also align with the environmental and social demands of our time and the future.

Yet, many everyday products fail to live up to this expectation.

1.2 Problem definition

Academic researchers have developed strategies to reduce premature replacement. For example increasing epistemic value: using novelty, curiosity and changing pace to make a product interesting for a longer period of time (Sun et al., 2025) and to improve willingness to repair (Roskladka et al., 2023). These approaches are still in development and have not been translated to a tangible example yet. As a result, there is a gap between academic strategies, commercial relevance, and how users actually interact with their products in everyday life. The challenge is to bridge the gap, offering Braun research-based inspiration for designing more durable, emotionally engaging products in the future.

The current knowledge on enhancing the product-user relationship is analysed and the most promising is used to create a tangible prototype of a kitchen appliance. This prototype is used to validate the selection of academic sustainability strategies with Braun and Braun product owners.

Ultimately, this project aims to reduce premature product replacement by designing consumer electronics that people are more curious about, emotionally connected to, and motivated to maintain/repair.

1.3 Scope

The main focus is on desirability of the product, but feasibility and viability will also be considered.

The main market of Braun is Western Europe, therefore, this will also be the focus including the regulations of the European Union. The Western European area includes a.o. the countries: Belgium, France, Germany, Great Britain, Greece, Italy, Luxembourg, Netherlands, Portugal, Spain (EEA, n.d.). The target group is focused on home cooks in Western Europe.

1.4 Context

The Frankfurter Kitchen

The design should fit into the 'Frankfurter Kitchen' of the future. But what exactly does that mean? In 1926, the Austrian architect and activist Margarete Schütte-Lihotzky designed an efficient, ergonomic kitchen for affordable housing, as part of the "New Frankfurt" design project. Standardising houses and their kitchens enabled them to be built quickly during the housing crisis caused by war and inflation (MoMa, 2010). Margarete mapped out people's journeys through the

Project aim

Understanding and tackling the premature replacement of appliances to slow down environmental damage and e-waste.

Design statement

Design a tangible prototype to explore and validate how sustainability strategies such as epistemic value and willingness to repair can encourage a more meaningful and lasting relationship between users and kitchen consumer electronics.

Figure 3. E- waste (Adapted from Amrecycling, n.d)



kitchen area and designed the layout based on efficiency, hygiene and workflow. The idea was that the kitchen would free women's time and energies for work, education and leisure by rethinking the purpose of the kitchen in the home. It was the first mass-produced built-in kitchen and it is still the base for the kitchen as we know it now (Šeruga, 2024).

Braun will present the 'Frankfurter Kitchen of the Future' during the World Design Capital Frankfurt RheinMain 2026 (Figure 4) at the Museum Angewandte Kunst (MAK) in Frankfurt, November 2026. For this future kitchen concept, the main question is: **What is the role of the kitchen and our appliances going to be in our future homes?**

1.5 Research objectives

Main Research Objective

MRO. How can strategies for enhancing epistemic value and willingness to repair be translated into the design of household electronics to reduce premature product replacement?

Sub-Objectives

RO1. What is the role of cooking and appliances in our current kitchen environment?

RO2. What are user considerations for replacement or retention of products?

RO3. What is the role of cooking and the kitchen in the future society of 2050?

RO4. What is the desired interaction between user and kitchen appliance in the future context of 2050?

RO5. What are the tensions and trade-offs between academic sustainability strategies and commercial design constraints in the development of long-lasting consumer products?

1.6 Approach

I will start this project by taking a step back to look at the broader context of the problem. With the **problem framing** method, I will

Figure 4. Frankfurt is the World Design Capital in 2026. (WDO, n.d.)

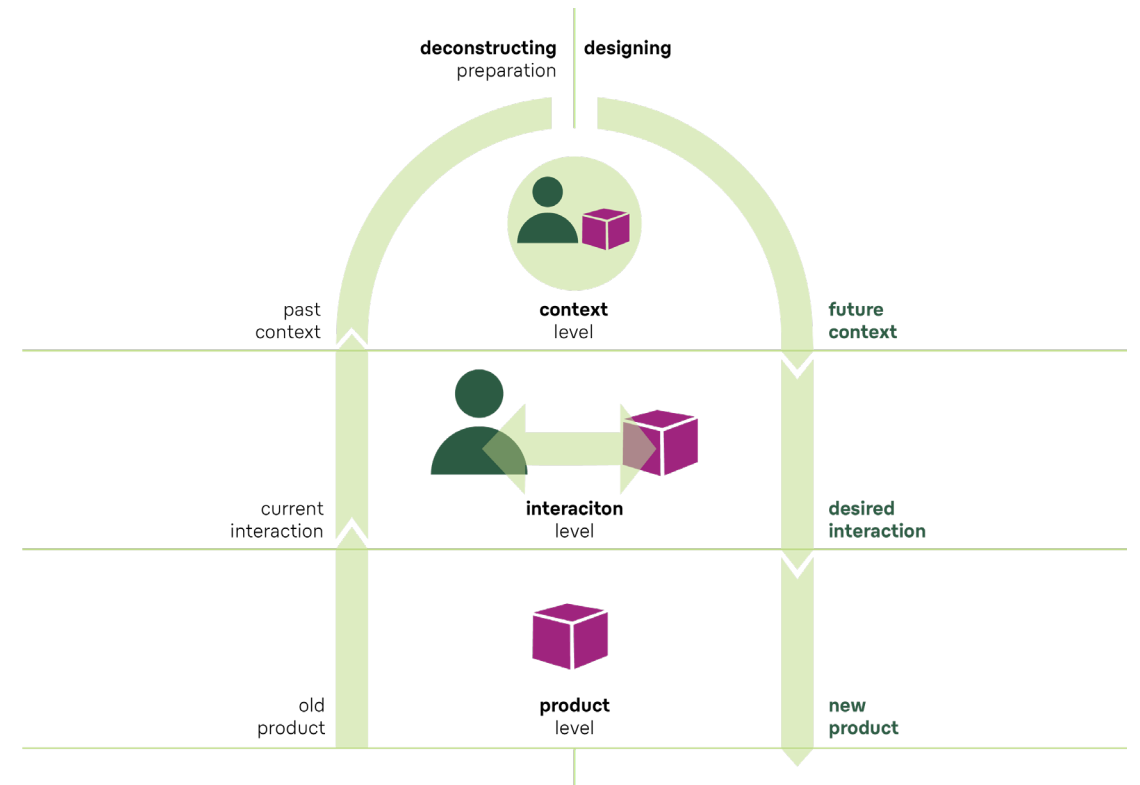


Figure 5. ViP method is used to create value and meaning to a design by describing the future context. (Image made by author)

break down the root causes and redefine the problem to set a focus for a meaningful design direction that increases the likelihood of achieving the desired outcome.

Vision in Product design (ViP) is a method for creating meaningful products by designing for a desired future. In order to change our relationship with products in the future, it is necessary to know the context it will be placed in (Figure 5, Van Dijk & Hekkert, 2020). This report is structured into sections that describe the current and future contexts, as well as the design vision created by comparing the two. Next, the showcase is elaborated on, followed by a conclusion.

As product designers, our relationship with these products often differs from that of the majority of users. To reduce bias this project will follow a **User-Centred Design approach** (Van Boeijen et al., 2020), so continuous

interaction with users will reflect on the clarity of the conveyed message.

The project will follow a structured process consisting of the following phases: exploration, analysis, creation, prototyping, validation, iteration, and documentation. Although presented linearly, the process will include multiple iterative design cycles, making use of prototypes and **Research through Design** (RtD) to explore and validate insights in context.

The final deliverable will be a tangible prototype intended for exhibition at Braun's Future Frankfurter Kitchen, part of the World Design capital. The designed product aims to encourage visitors to reconsider how they interact with (and ultimately value) their everyday products.

Find the full project brief in *Appendix A*.

NOW

Current context

Cooking has always been central in human evolution, and the development of the kitchen and its tools reflects societal changes. This chapter explores how kitchens and appliances have evolved in today's Western society and how our attitudes toward products leads to environmental issues. It also considers the role Braun plays within this context.

Figure 6. *The Frankfurt Kitchen: view toward the window (MoMa, 1926)*

2 The kitchen as we know it now

2.1 Origin of the kitchen

The start

When the Homo Erectus started using tools to process their food two million years ago, there was no way back to their old habits. According to Harvard anthropologist Richard Wrangham (2010), their bodies lost the ability to process raw foods. They became more intelligent and started to experiment with methods to detoxify poisonous plants, making them easier to chew and digest. By doing so, the number of edible plant species increased rapidly, which made it easier to find areas to settle.

Fast forward to the 12th century, humans started making constructions to place ingredients above the fire. The brickwork constructions were moved inside, which became the central spot of food, light, heat and safety. The smoke led to the development of chimneys in the 16th century, marking the beginning of the fixed kitchen in the home. (Lopes Ramos, 2016).

In 1735, Francois Cuvilliés designed the first kitchen stove, which was fuelled by wood. Because of air pollution concerns, this changed to coal and gas later (Lopes Ramos, 2016). During the Industrial Revolution 1760 to 1840, the upper class began separating

their kitchens from living areas since this was the place for servants, while common families continued sharing one room with a stove.

In 1899, feminist Wilhelmina Drucker proposed collectivizing domestic services, but industry and designers showed little interest in making housework more convenient for woman. By 1890, heavy and impractical cleaning machines like vacuums emerged (Oldenziel & Berendsen, 2001), which could only be used by trained staff. These products were the foundation for modern housekeeping devices.

Appliances for functional cooking

Max Braun founded the design company 'Braun' in 1921, initially focusing on radios before expanding into household appliances ten years later (Braun, 2021).

In 1923, electricity was for the first time used in a household appliance. The iron was connected to the electricity source used for lights on the ceiling. The dedicated sockets in the wall as we know them now, replaced the sockets on the ceiling to power electronic products (Oldenziel & Berendsen, 2001). The standardised Frankfurter kitchen design provided the lower classes with electricity, gas and running water, setting new technical and hygiene standards, *see '1.4 Context' on page 13.*



2 mln. B.C.

The start

Homo Erectus starts using tools to process food.



ca. 1850

Separate kitchens

Separate kitchens show wealth and status.



16th century

Fixed kitchen

Chimneys allow for indoor cooking.



1890

Professional tools

Appliances are only for trained professionals.

In 1938, the first supermarket opened in Osnabrück, Germany, inspired by the U.S. concept of 'Piggly Wiggly,' allowing customers to select their own groceries (Berliner Zeitung, 2017).

The invention of the microwave in 1967 changed cooking habits and introduced pre-heated food. Its popularity grew rapidly when the government set radiation standards that reduced public concerns about health issues. Although 90% of U.S. homes owned a microwave in 2001 (Liegey, 2017), it never fully replaced other heating methods, since the same quality of food was not achieved (Cavolt et al., 2017).

In the 1970s, the U.S. government recommended reducing fat intake due to a rise in heart disease and strokes. However, as people replaced fats with carbohydrates, obesity rates increased, leading to what became known as the "Obesity Epidemic," which eventually spread to Europe (Aubrey, 2014). Simultaneously, ingredients from different cultures were combined to create unique flavours. According to the Escoffier School of Culinary Arts (2022): "Fusion food has a complex history whose origins can't be easily pinpointed. It has likely been around for centuries, as long as humans have been exchanging facets of their culture".

At the same time, the kitchen appliance

market expanded rapidly, taking over daily movement. As open-plan kitchens became fashionable, technology and designer cookware gained popularity and were proudly displayed as symbols of wealth. Household appliances also contributed to women's emancipation around the 1960s, since the availability of household appliances allowed more women to work (Coen-Pirani et al., 2010).

Digitalisation

The introduction of social media in 2005 has transformed the internet from a way to exchange digital information, into an everyday necessity. The internet's roots can be traced back to the NSFNET in 1987 that was the basis for the first social media platform in 1997. Blogging became popular in 1999, and Facebook took over in 2008 (Maryville University, 2021).

Food was always a popular interest area for Instagram and when video uploading was made possible, recipes were shared on a large scale in different languages. Abigail Abesamis Demarest (2020) wrote about the changing role of Instagram during COVID-19: "The type of content we consume and create on Instagram has seen a drastic change in light of the coronavirus pandemic. Everybody turned into a home cook and Instagram has transformed into an alternate type of Food

Network in everybody's handheld device. Instagram users search for inspiration and accessible recipes that you don't need a culinary degree to make." Instagram and other social media platforms stimulated the popularity of fusion cooking, combining ingredients and method from multiple cultures into one dish.

Smart devices entered homes around 2017. The expensive smart systems are becoming more budget friendly and available to end users. There are still a lot of opportunities regarding availability of smart tools in homes, like Artificial Intelligence (Hart, 2022).

Concluding

Eating and cooking has always been an important social event for human interactions. Either the kitchen or the dining room was the heart of a residence.

In the past, new ingredients and cooking methods were adapted by upper class first. After these 'early adopters', the innovations sometimes became accepted by the majority, depending on availability, accessibility, and feasibility.

The first cooking appliances were inspired by industrial machinery. The function of the machines used in factories or shops were simplified to be used in households, resulting in appliances based on efficiency.

2.2 Why people cook

Cooking is associated with health, social and economical advantages. Preparing meals at home allows individuals to have more control over their nutrition and hygiene. On a personal level, cooking can be a source of relaxation or enjoyment. It is sometimes pursued as a hobby, and provides a sense of pride and satisfaction, particularly when investing effort and 'love' into a meal made from scratch ingredients. The older generation sees using microwaves to heat convenience food as lazy or cheating, as it would reduce the ability of traditional cooking skills.

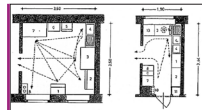
The choice to cook often results in a trade-off between time, cost, and health. The most commonly cited barrier is lack of time, especially among employed women. Economically, the inability to afford scratch or fresh ingredients (such as fruits, vegetables, meat, or fish) is a major constraint, especially for lower-income families. Affordability was identified as a far bigger concern than physical access to food. Furthermore, barriers related to lack of confidence or enjoyment discouraged people to cook.

(Wolfson et al., 2016)

1921

Start of Braun

Company Braun is established by Max Braun.



1926

Frankfurter kitchen

An unified kitchen based on ergonomics and efficiency.

1923

Electric appliances

The first domestic iron uses ceiling sockets of light bulbs.



1950s

Convenient food

Fast food brands like McDonalds gain popularity.



1955

Dieter Rams

Dieter Rams's team changes design at Braun.



1953

Appliances for all

Kitchen appliances are commercialised.



1960s

Open Kitchens

Criticism about isolated kitchens.



1970s

Obese epidemic

Eating habits cause international health issue.

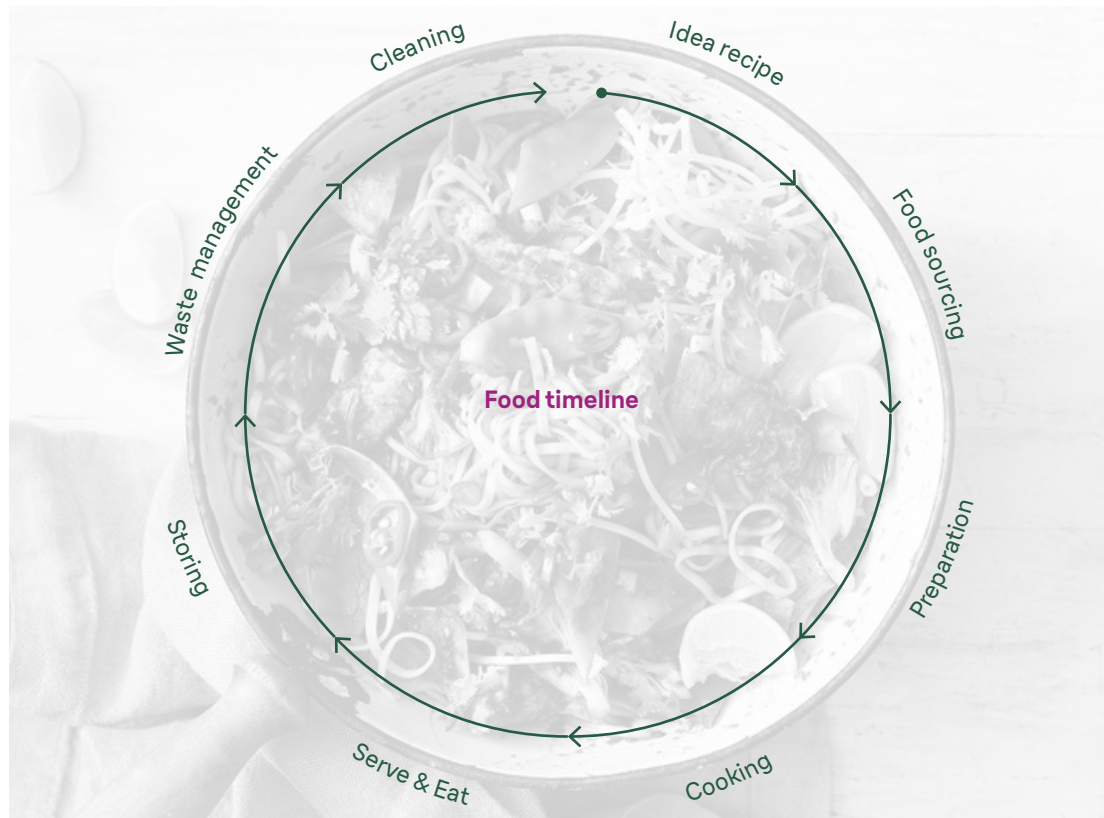


Figure 7. Visualisation of the steps in the cooking process. [Background image adapted from taste, n.d.]

2.3 The process of cooking

The actions of preparing food involves more than just cooking. The steps are visualised in Figure 7. Kitchen appliances support a user in any of these steps. The 'preparation' and 'cooking' step of food can be categorised into the following four main categories:

1. **Thermal:** Changing temperature (heating and cooling)
2. **Mechanical:** Changing the size and shape of the raw material using mechanical force (milling, grinding, chopping, and juicing)
3. **Chemical:** Changing chemical characteristics by treating with water, acids, and alkalis (leaching and marinating)
4. **Biotechnological:** Encouraging biochemical activity (fermenting)

These methods each influence the nutritional value differently. Boiling and milling makes food easier to digest, but can lead to substantial nutrient losses, while others, such as steaming, fermentation and genetic modification, preserve or even actively enhance nutritional value. (Moyo, 2024)

2.4 Current products

Appliances supporting the cooking process have been focussing on minimising human effort. A lot of activities can be done by pressing a button. Most actions in the kitchen have been replaced by an electrical appliance, often with a similar functionality made specific for a certain action, although the components (e.g. a rotating motor) overlap.

3 Company Context

3.1 Braun Household

Braun GmbH is divided into two main groups: Procter & Gamble and De'Longhi. In 2012, the household appliances division, along with the licensing rights, was transferred to the Italian company De'Longhi S.p.A.

BRAUN

Figure 8. Braun logo, recognisable by the capital 'A' (Braun, 2021)

Braun Household is committed to three core principles: **“Good design is simple, useful and built to last”**. These originate from the ten principles of famous designer Dieter Rams, who was Head of Design at Braun from 1961 to 1995. See Figure 10. His team created iconic products for Braun that are still a source of inspiration for the company and many other designers.

At that time, the company was family-owned by Artur and Erwin, the sons of the founder, Max Braun.

Braun Household has a wide range of product lines, having a product for each market segment. For example the MultQuick 9 including all accessories is sold on the Braun website for €189,99 and the Braun MultiQuick 1 is €39,99 (Braun Household, n.d.). The main focus is quality, which is build on four pillars: safety, functionality, reliability and packaging.

A lot of Rams' design ideas correspond with current visions about futuristic design, making him way ahead of his time. In documentary “Rams” from 2018, Dieter Rams “regrets contributing to culture of overconsumption” says documentary director Gary Hustwit (Jordahn, 2019). The topic of this thesis therefore corresponds to his design vision, so his principles will be of guidance during this project: “Weniger aber besser”.

Figure 9. Overview of the current product portfolio of Braun Household. (Braun Household, n.d.)



Dieter Rams: 10 principles of good design

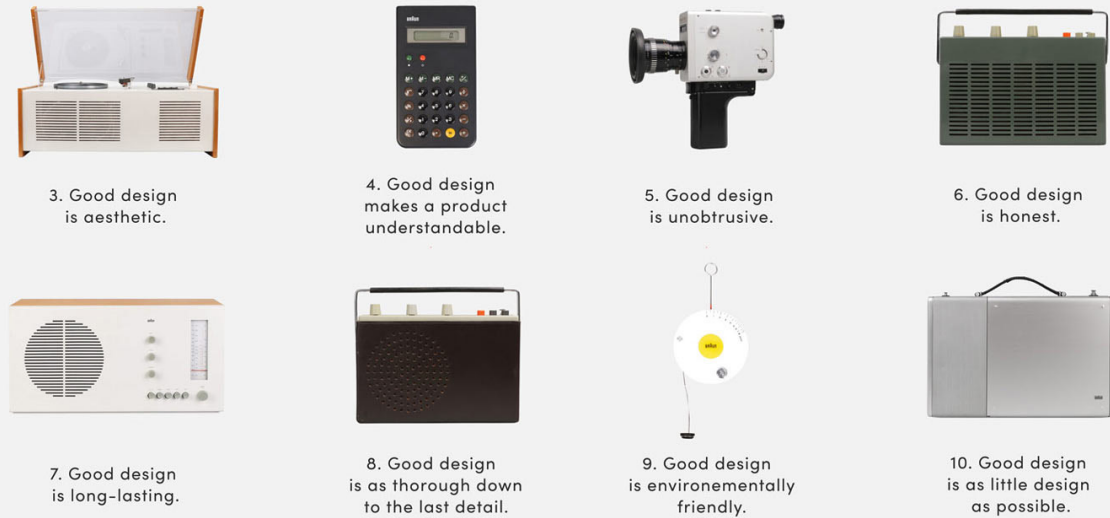


Figure 10. The ten design principles of Dieter Rams, famous for his designs for Braun. (Only Once, 2024)

3.2 Current repair ecosystem

Braun has a repair service for products that are within the guarantee period, with a receipt. For products that lack one of these, there is nothing Braun can do. For a small selection of products more information is available, such as spare parts and tips on care and maintenance. This accounts mostly razors, non of the products are part of the household division. Razors can also be registered with BraunCare+ to extend the warranty period.

Some household products have supporting videos showing the use and cleaning. Although these videos provide visual explanations and do not contain any language, they are not available on the website of other languages, such as the Dutch site.

Other third party websites sell spare parts and accessories for household products. As an example, for the immersion blenders a variety of attachments is available, but if a part (e.g. button) of the main motor needs replacement, the whole immersion blender motor unit needs to be replaced because of safety and financial reasons.

Customers outside the warranty period who do not want to repair the product themselves could go to a repair café. However, these volunteers are not trained to work on Braun products. There is a lot of uncertainty involved, which causes many customers to opt for the easy option of buying a replacement. This replacement comes with new accessories, rendering the perfectly functioning older ones unnecessary waste.

3.3 Barriers & incentives

Because of Braun's large scale, the various divisions in multiple operating countries, it is difficult to make all information available from every product to every country. The Braun care division has already set some steps in an online service infrastructure (service.braun.com), which could serve as inspiration.

The highly saturated kitchen appliance market offers such cheap products that people don't expect them to be of good quality. In the Netherlands in November 2025, a Philips immersion blender can be bought at HEMA for €19,99 and at Action for € 8,49. The question is whether Braun wants to compete with these alternatives, or add another value to their customers (see '4.2 Product values' on page 25).

The European Union is working on regulations

to make products more repairable by forcing companies to change the design, and make information and spare parts available. For example fridges and dishwashers already have some first regulations, and the electric toothbrush should have a replaceable battery by 2027. Regulations for other product categories like household appliances are not in development yet, but expected to follow quickly considering the EU's target to be circular in 2050 (see '7 Circular Economy' on page 33). Last century, Braun responded perfectly to society's desires. The question now is what future societies will need, and how Braun can meet those needs, being the front runner instead of having to catch-up on regulations.

This report will show that the high quality of product is just one of many values a product can have, giving Braun many opportunities for their brand.

Figure 11. It was an honour to meet Dieter Rams at the Museum Angewandte Kunst (MAK) in Frankfurt. (Entken, 2023)



4 Product lifetime

Product longevity is defined as a product's ability to remain functional, useful and desirable over a long period of time. It incorporates durability, repairability and adaptability to changing user needs. Product longevity is a key principle in the transition to a circular economy.

In this report, the 'product lifetime' is defined as the duration of existence of the product in question, regardless of whether it is still in use.

Murakami distinguishes several terms to describe the different states of a product within its lifetime (2010):

- **Service lifespan:** the period during which the product is functional and can be put to use, including the time spent in distribution for the next user.
- **Possession span:** the total time a consumer owns the product, regardless of whether it is still functional.
- **Duration of use:** the actual time the owner actively uses the product.
- **Dead-storage period:** the gap between possession span and duration of use: the period during which a product is owned but not used.
- **Designed lifetime:** the lifetime that a manufacturer intends its product to remain functional, shaped through design, after-sale service and other factors.

- **Desired lifetime:** defined as the average time that consumers want products to last.

According to the European Environment Agency (2024) the product lifetime of small household appliances such as vacuum cleaners, microwave ovens, steam irons, food processors, fryers, and coffee machines, was 9 years and 1 month in 2023. This is five months longer than in 2019, an average yearly increase of 1,2%. In *Figure 12*, the lifetime of a selection of appliances is compared. The main reasons for replacing small household appliances was for reliability reasons e.g. "it was not working well anymore (and I didn't want to repair it.)", "It was completely out of use" or "it should have been repaired but the costs were too high".

4.1 Obsolescence

The designed lifetime and desired lifetime of consumers do often not align. Many consumers dispose of their consumer electronics prematurely and while they are still functioning well. We call this **premature obsolescence**. Several types of product obsolescence can explain why consumers replace products. **Quality obsolescence** occurs when the performance declines due to wear and tear or malfunctioning parts, such as a broken motor in an immersion blender. **Technological obsolescence** happens when

new innovations offer improved functionality, like the ActiveBlade of the Braun MultiQuick 9. **Economic obsolescence** arises when products are replaced by more cost-efficient alternatives, such as eco-friendly appliances. **Aesthetic obsolescence** relates to changes in appearance caused by use or shifting trends, for example white appliances turning yellow over time or evolving shape preferences. **Psychological obsolescence** reflects the symbolic value of products, such as replacing an item to stay up to date with peers. In many cases, product replacement results from a combination of these different forms of obsolescence. (Van den Berge et al., 2023)

In other cases, the designed lifetime is shorter than the desired lifetime. This is called **planned obsolescence**, a business strategy in which the manufacturer plans and builds the product in such a way that the consumer will feel the need to purchase new products and services in the future, when the manufacturer brings out replacements for the old ones. (Kramer, 2012)

In specific cases, early replacement of a product within its service lifespan can be an eco-effective strategy. Domestic appliances with large electricity consumption such as refrigerators and tumble dryers may sometimes be better replaced with an energy-efficient alternative. As extending the lifespan of products and parts is not always desirable, we should strive to achieve the **product's optimal lifetime** of a product rather than its longevity. See *Figure 13*.

Sometimes the product gets redistributed within the service lifespan through online or offline platforms like marketplaces, but it often goes into waste within the service lifespan.

This raises the question: When is a product considered broken? Is it when it is no longer able to do the job, or when the user is no longer satisfied?

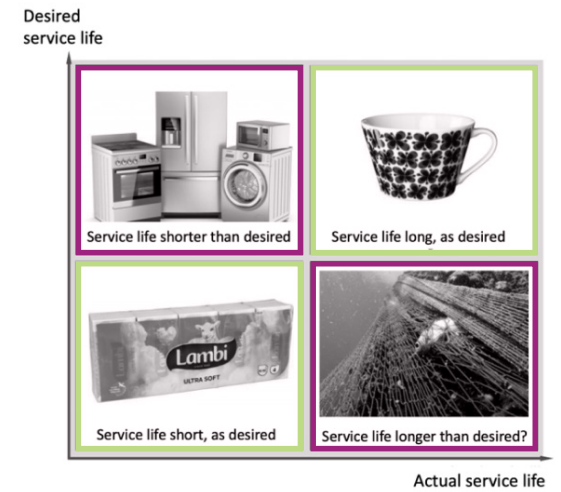


Figure 13. Extending the lifespan of products and parts is not always desirable. (Carlsson et al., 2021)

4.2 Product values

When consumers decide whether to keep or replace a product, there is a trade off between the owned and the new product. They do not only consider the price of the new product, but also the mental cost of letting go of the old one. During ownership, the user constantly assigns the 'mental book value' to the product. Replacing it feels costly when this value remains high but less so when it's lower, for example due to malfunction, wear, hygiene issues, or a pricier new alternative. See *Figure 14* (Van den Berge et al., 2021).

But product replacement is not only based on rational decision making. Other values influence the trade-offs that consumers make during the decision to either retain an owned product or replace it with a new one. These values are briefly explained (Van den Berge et al., 2021) and see examples in *Appendix C*.

Functional value

Looking at the marketing of Braun, functionality is the main selling point. The product pages on the website mainly show the new features of a new product model

Lifespan of selected household appliances (years) and increase in 2019-2023 (%)

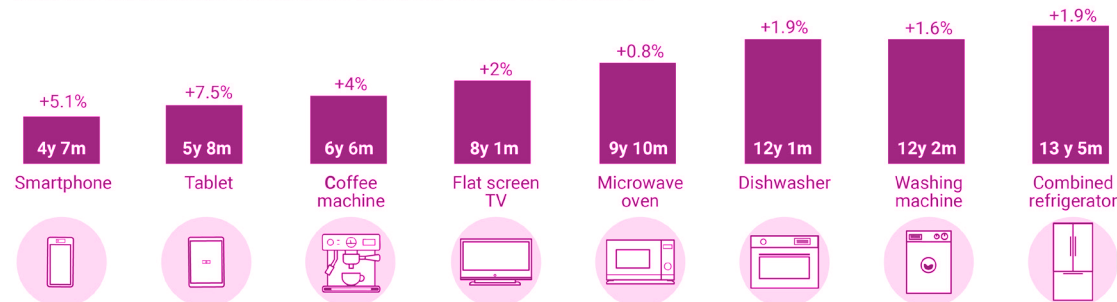


Figure 12. The lifespan of selected household appliances has increased from 2019 - 2023. (Adapted from European Environment Agency, 2024)

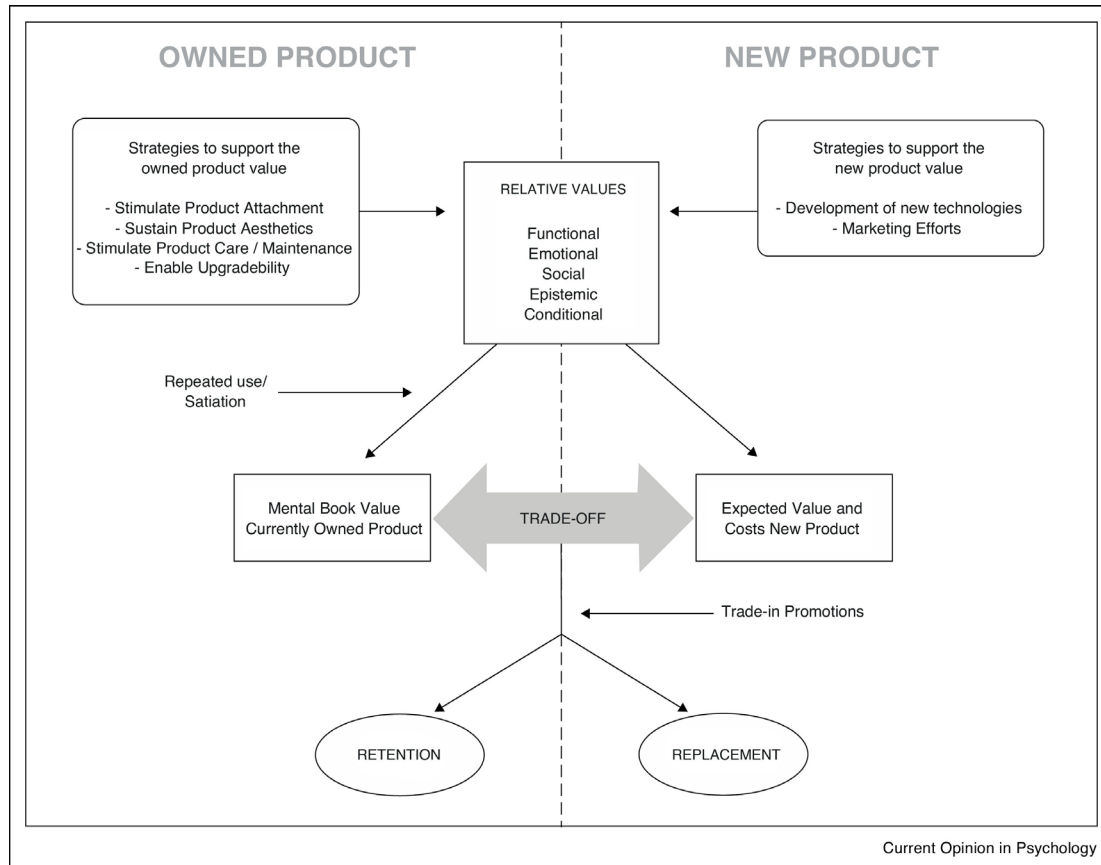


Figure 14. Psychological process of product replacement. (Van den Berge et al., 2021)

[see Figure 15]. Braun is known for reliable, functional products, focussed on simplicity, durability, and ease of use, aligned with Dieter Rams’ “less, but better.”

Emotional value

The user feels emotional value when the appliance makes the user feel happy, proud, or excited. Braun has been contacted by users that have owned their Braun kitchen product since their wedding a long time ago. This time builds trust between the user and the product and in this example, the product holds the memory of the wedding. The product could also hold a memory of moment, person, achievement. This connection creates an emotional bond between user and product. Emotional value can also be delivered through

a product’s aesthetics, though wear and tear can decrease this aesthetic value over time. The product could also express the owners’ identity. Proudly presenting this identity links to the next value: social value.

Social value

Social value refers to a product’s associations and the sense of belonging it provides to a group. When the open kitchens became the norm (find earlier in the history timeline), kitchen appliances could be seen by guests, increasing the social value of the products put on display. A big and bright KitchenAid stand mixer is seen on baking shows, making it a “must have” for passionate bakers and making it part of the kitchen interior. Product retention can be stimulated by upgradability,

nudging a consumer to adapt a product to keep up with a group. This argumentation contributes to overconsumption, which is the norm in our current society.

Epistemic value

Generally, the value of a product decreases with the amount of time it is being used, even if the performance stays the same. When a product provides novelty, arouses curiosity or satisfies the need for a change of pace, this increases the epistemic value. This novelty and curiosity is perceived high when a new product is bought.

The highest level of attachment is often within 1 year (epistemic value) or after 20 years (emotional value).

(Schifferstein & Zwartkuis-Pelgrim, 2008)

There are nine strategies that increase epistemic value in a product, of which some examples are: software updates, monthly interactions (e.g. subscriptions) or upgrades. All epistemic strategies can be found in Appendix D. (Sun et al., 2025)

An example for Braun could be to stimulate owners of an immersion blender to use it for

an unexpected new activity, such as making soap or plant fertilizer, giving the product a sense of novelty after a period of time.

Conditional value

Conditional value is the influence that specific circumstances or situations have on consumer decisions regarding product retention or replacement. Braun uses this value by giving moment-specific discounts, such as autumn sale, Black Friday, or Christmas, stimulating users to buy the product. This value contributes in retaining a product when it is received as a gift, bought as a mark of an achievement or when it is inherited. Modularity and upgradeability can enhance conditional value by allowing a consumer to adapt the product to specific circumstances.

The product value and the trade-off between retention or replacement is always a combination between multiple values and considerations. These product values are not static and can change over time. (Sneth et al., 1991)

Cheap competitors make it harder for a qualitative product company to compete. So a product company should give one of these additional values for a product in order to compete with cheap alternatives.

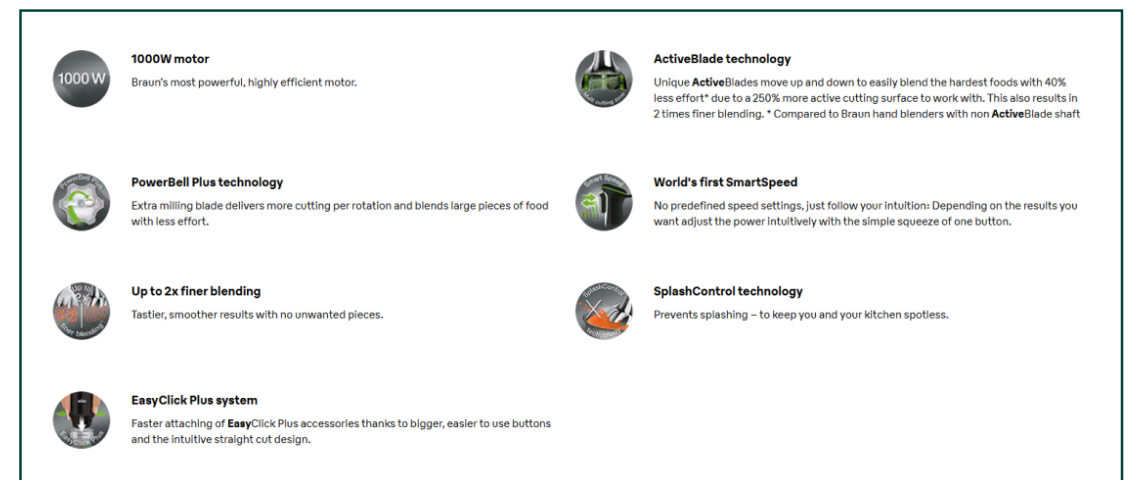


Figure 15. The values that Braun highlights on the product page of the Braun Multiquick 9 are all functional values. (Braun, n.d.)

5 Overconsumption society

The force that drives our current consumption culture is convenience (Bakker et al., 2022). Ordering a new Braun appliance from the website is made as easy as possible and within 3-5 business days, the new product is delivered at your doorstep. In the Netherlands this is even 2-4 business days. (Braun, n.d.)

For decades, overconsumption has been the norm in many Western societies, with increasingly pressing environmental issues as a result (Kuijjer & Laschke, 2024). Our current economy is based on growth. Wealth and economic growth are directly proportional to each other according to economic models. Some economists have started to question if our current economical system will sustain, since the earth and its resources are not taken into consideration in these economic models. Hans Stegeman wrote in his doctoral thesis that it is impossible for us to solve climate and environmental problems within the current economic system (Wittebrood, 2025). The core issue for sustainable production and consumption is volume, not durability (Berg & Hebrok, 2024). When someone buys a new kitchen appliance, that purchase counts as economic growth for that year. However, if the person keeps the same appliance for

many years, it doesn't contribute to economic growth, even though holding onto products longer is better for the environment. In other words:

What's good for the economy (more new purchases) often conflicts with what's good for the planet (longer product lifetimes).

The somewhat radical discussion whether our current economical system based on growth will sustain in the future, is not within the scope of this project. However, it is important to note that it might fundamentally change the future kitchen context. Ideas about de-growth and post-growth have existed for decades, acknowledging that the planet is a stakeholder with its own demands. It's becoming more likely that the focus on economic growth as the accumulation of money will shift toward collective well-being, with greater awareness of the planet's ecological limits. The link between technology and overconsumption can be explained using three principles: accumulation, acceleration and stacking (Kuijjer & Laschke, 2024).

Figure 16. Busy shopping mall (Mayooreasan, 2024)



Figure 17. A smartwatch telling the user 'Time to stand' and counting steps, making sure a person moves enough (Adapted from Chesser, 2015)

Accumulation

Once a new capability is introduced (e.g., flying), it quickly becomes part of everyday life, changing how people behave, what skills they use, and how they manage their time. These changes are hard to reverse, as people naturally choose what is easier, more effective, and more enjoyable.

Acceleration

The rapid of technological development creates a snowball effect, speeding up the integration of technology in daily life. Because technology develops faster than humans can adapt, the balance between what people do and what technology does becomes uneven.

Stacking

When humans started delegating tasks to technologies, more activities could be performed simultaneously and quicker. Therefore, more living (and more consumption) can be squeezed into less time and space. For example, with the introduction of faster transportation options, people now live further away from work, so travel time has stayed about the same (Kuijjer & Laschke, 2024).



Figure 18. An electric salt and pepper mill. What problem does it solve? (Kinghoff, n.d.)



Figure 19. The activity of kneading is replaced by a kitchen mixer saving effort. Now we use other products to stimulate human activity. (Adapted from Spetnitskaya (2018), Horeca.com (2024) and Freitas (2018))

A perfect example of such a product that is a result from overconsumption society is an electric salt & pepper mill (Figure 18). When the product is flipped, the mill automatically turns on together with an blue LED light. The product has six batteries, and does not work when one is empty. The product does not have a power on button, meaning it is always on 'stand-by' and using small portions of electricity. One benefit is that the design is inclusive for people with one hand, but for other users, the environmental impact is significantly higher than most manual salt and pepper mills since the product lifetime shortens.

The habit of owning every product 'in case you need it' is a questionable social normality to sustain. Research shows that "many specialized kitchen appliances, are seldom used but still owned by most affluent households." Similarly in the car industry, private cars stand idle 95% of the time. Some initiatives are moving towards shared ownership. (Kuijjer & Laschke, 2024).

Movement

People go to the gym by car to cycle on a stationary bike or row on an indoor rower without covering any distance. Instead of lifting grocery bags we rather lift a dumbbell up and down repeatedly. When moving was a natural part of daily life, people were not counting if they did 10.000 steps (Figure 17). We created products to minimise effort and then we made products that makes sure we get enough daily activity. (Figure 19)

We created products to take over our daily actions, and then we created products that encourage people to be more active.

The strategy of replacing every human action with an electronic product has brought many advantages, such as earlier mentioned inclusivity and feminism. However, the strategy must be criticised in the long term. Companies that manufacture kitchen products and still follow this strategy are introducing electric pasta machines and electric salt and pepper sets, which not only contribute to an unsustainable future, a cluttered kitchen but also result in insufficient physical activity in daily life.

6 Current context: Take-aways

In the last decades, food has always been a necessity to get nutrients. Braun perfectly stepped into the market of providing society with appliances that made their life easier and more efficient. The products were based on convenience, time efficiency and minimal effort. This led to a societal change, among others contributing to the feminist movement.

RO1. What is the role of cooking and appliances in our current kitchen environment?

Currently, there is a high competition on kitchen appliances, that mostly still focus on functional value. In order to compete to the highly saturated market, an opportunity lies in adding and combining product values other than functional that benefit both Braun, the user and the environment. With the transition towards a more sustainable economy, the role of the kitchen and its appliances will change. Cooking is already no longer a necessity and when we cook, most of the process is taken over by electric appliances for convenience. The choice to cook often resulting in a trade-off between time, cost, and health. The following chapter will dive into the question of the role of cooking in the future society.

RO2. What are user considerations for replacement or retention of products?

Product replacement is not only based on rational decision making. Functional, emotional, social, epistemic and conditional values influence the trade-off between the owned and the new product.

The user feels a strong emotional connection to the product is there is meaning or memories linked to the product, however this is difficult for manufactures to influence. The highest levels of attachment are registered for recently acquired products (<1 year) and for products owned for more than 20 years.

Due to societal change and environmental demands, it is likely that we will transition from easily and prematurely replacing products to retaining them. Extending the lifetime of products aligns with Dieter Rams' principles: Good design makes a product understandable, is honest, long-lasting and environmentally friendly (Design principle 4, 6, 7 and 9).

Last century, Braun responded perfectly to society's desires. The question now is what future societies will need, and how Braun can meet those needs, being the front runner instead of having to catch-up on regulations.

2040

Future context

Last chapter showed that kitchen products perfectly reflected the drivers of society in the past century. Kitchen appliances reflect the focus on functionality and convenience, that was central to this period of time.

To find out what the drivers are of the use of kitchen appliances in the future, the future context of the kitchen, a prediction of the future society and its kitchen context will be described based on trends and literature.

Figure 20. A question mark from the steam in a pan. (Image generated by Canva AI, 2026)

7 Circular Economy

The European Union has set a target of being circular in 2050 (2024). What does this mean for the kitchen and for Braun?

The current life cycle of a product is linear: we extract materials from our planet, use them to produce products, use the products and then throw them away, often when they are still fulfilling their purpose. It has become clear that the current linear system must be transformed into a 'circular economy'. The goal of a circular economy is to retain as much of this value for as long as possible. The 'Butterfly Diagram' in *Figure 21* by the Ellen MacArthur Foundation visualises how products should maintain their highest possible values. The smaller the loop, the more value can be retained with minimal additional resources. In the biological cycle (left), nutrients from biodegradable materials are returned to the

Earth to regenerate nature. In the technical cycle (right), products and materials are kept in circulation through processes such as reuse, repair, remanufacturing and recycling.

The '9R Framework' of *Figure 22* explains the nine corresponding circularity strategies to reduce the consumption of natural resources and materials, and minimise the production of waste. They can be ordered for priority according to their levels of circularity (Kirchherr, 2017).

In recent years, more and more products have made claims about being (partially) recycled. However, this does not mean that it can be placed directly in the recycled loop of the butterfly diagram. For a product to be considered circular, it must be made from 'post-consumer recycled material' (PCR).

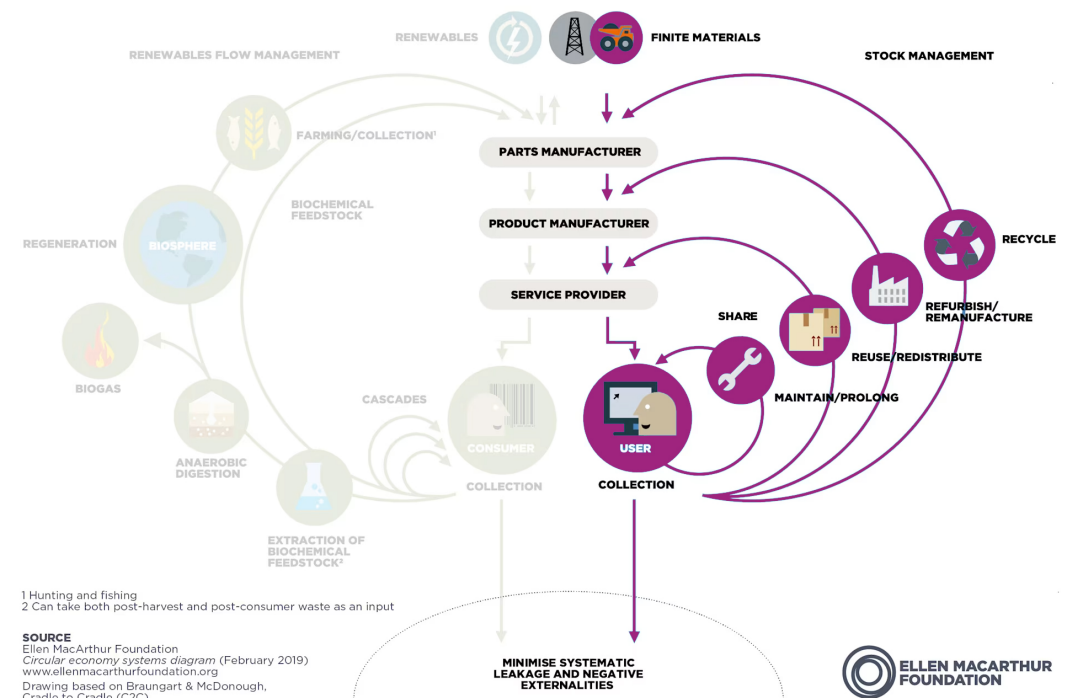


Figure 21. The technical cycle of the Butterfly Diagram for products that are used rather than consumed. (Adapted from Ellen MacArthur Foundation, 2019)

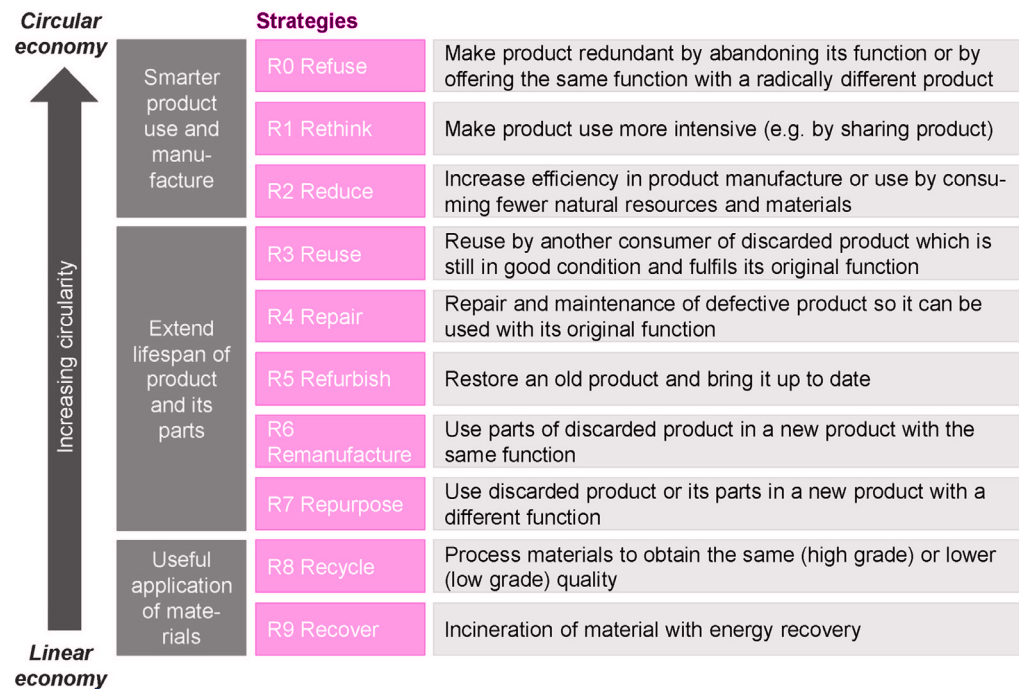


Figure 22. The 9R Framework showing strategies to reduce consumption. (Adapted from Kirchherr, 2017)

Some product parts of Braun appliances contain recycled plastics, such as the motor unit of the Multiquick 5 Hand Blender (immersion blender), which is made from 28% recycled plastic (not specified what it is recycled from or if it is PCR). Which means the other material is finite, extracted materials. They are sold to consumers, used, sometimes redistributed to a new owner and then discarded as waste. Within the product warranty period, there is a possibility for the product to enter one of the loops of the butterfly diagram in Figure 21 and retain some of its value. However, the majority of products will follow the linear process.

As a kitchen appliance provider, Braun should aim to retain as much value as possible in its products, thereby contributing to a circular economy.

Product impact

Products do not only have environmental

impact when discarded as waste. The biggest impact of a product occurs during mining and production, which is 86%. Babette Porcelijn called this **hidden impact** (2018). The impact during product usage, the electricity and data usage together, produce 10% of the product's total impact, see Figure 23.

To reduce our impact, it is important to implement the R strategies on our ownership of stuff.

"86% of the impact occurs during mining and production, while electricity and data usage together account for only 10% of the impact."

(Porcelijn, 2018)

EU legislation

As part of the aim to be circular in 2050, the European Union strives to reduce waste and

strengthen the repair sector by simplifying and reducing the cost of repairing goods. The parliament adopted the directive on the **"right to repair"** for consumers. A selection of relevant EU directives and regulations can be found in Appendix B. This chapter will conclude their relevance for Braun and this project.

The current regulations do not yet apply to the product categories sold by Braun Household. However, it is likely that the rules already in force for other product categories, such as washing machines, fridges and smartphones, will soon be applied to the 'household appliances' category. Therefore, companies are advised to prepare for these requirements in order to avoid falling behind in the future.

The main effect for Braun is to provide and support information on self-repair and repair services, as well as spare parts and tools for a reasonable price. By giving every product a unique product passport, transparency about the supply chain is provided. This information can be found by users that already lost the packaging.

The **Repairability Index** is a numerical scoring system (typically on a scale from 0 to 10) that assesses how repairable a product is. The goal is to inform consumers at the point of purchase about how easy (or difficult) it will be to repair the product in the future. The score is calculated based on the availability of technical documents; the ease of disassembly; availability of spare parts; price of spare parts; and specific criteria dependent on product category. This French initiative is already in use for some products, and Belgium will introduce a similar index. The European Union is developing an EU-standardized label, and the amount of product categories will gradually expand (Right to Repair Europe, 2024).

Regulations on repairability are a realistic near future. Why wait for the regulations to be implemented and not be the front runner of this development?

Consumers tend to choose electronic appliances based on their power (watts), assuming that higher power equals better performance. However, higher input power does not necessarily result in better cleaning performance. Instead, it results in increased noise levels, quicker overheating of the system, and heating of the surrounding air. For vacuum cleaners, the EU has set a legal limit on watts (Wierda & Zanuttini, 2025).

Although one might assume that innovation of kitchen appliances lies in higher watts, this leads to products using unnecessary energy or even break because of overheating.

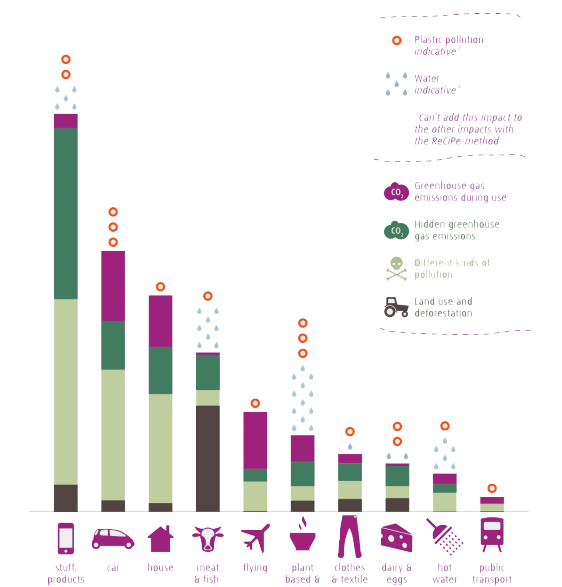


Figure 23. Top 10 categories with the most environmental impact, with possessions the biggest polluter. (Adapted from Porcelijn, 2018)

8 Strategies to extend product lifetime

There are multiple strategies for extending product lifetime aiming to create more sustainable products. While not all strategies are likely to be applied to kitchen appliances, inspiration can be taken from them.

8.1 Shared ownership

When ownership is shared, one pays for the function of a product rather than the ownership of the product. A lot of materials degrade over time, regardless of the amount of use cycles. Shared ownership minimises the **dead-storage period**, which is when the product is owned but not used.

We all know the laundromat, where one pays for the functionality rather than the object, leaving the care and maintenance the responsibility of the provider, making it easier to be informed about the maintenance of the appliances.

Another example is the library, where books are returned once they have served their purpose. Many books are purchased, but only used once since we rarely read a book more often. Inspired by this is concept is the 'Library of things', a rental of appliances such as drills and other household equipment that have a large dead storage period and are yet owned by a large share of households.

On the contrary, shared ownership of some products is a reason for low product care (Ackermann et al., 2018). Abandoned scooters and bicycles in urban areas are a perfect example of 'don't be gentle, its a rental'.

8.2 Maintaining product Integrity

Product Integrity is a measure for how true a product remains to its original, factory fresh configuration. Every step in changing the product, for example with repair or refurbishment, energy is added. Ordered on product integrity, six strategies are formulated.

Design for attachment and trust

"Product attachment is defined as the strength of the emotional bond a consumer experiences with a specific product." (Mugge et al., 2008). The product triggers the persons positive emotions. "...people cherish their relationship with the object and want to preserve the object" (Mugge et al., 2008). When a person feels attached to a product, they are more likely to handle the product with care, to repair it when it breaks down, and to postpone its replacement. Attachment and trust is not the equally important for every product. Experiencing positive emotions when you use a product, this doesn't automatically mean that you will behave in a protective way. Products with higher product attachment are less likely to be prematurely replaced.

Product attachment is strongest for products that have been owned for less than a year and for those that have been owned for more than 20 years: "For new products, enjoyment may be the main driver of attachment, whereas for old products memories may be more important." (Schifferstein & Zwartkruis-Pelgrim, 2008).

It is important to note that a person can be attached to a product functionality rather than that specific product. An example is somebody who really likes their e-reader, and bought four of them in case one breaks down. In this case, the person is more attached to having an e-reader to read rather than being attached to a product. The spare e-readers have a long dead-storage period and their production has already made most of the impact.

Berg and Hebrok argue that businesses can stimulate emotional attachments to extend product lifespans. However, they emphasize that emotional durability cannot simply be manufactured. While design strategies and storytelling can strengthen brand loyalty and influence purchasing decisions, it is the actual longevity and product usage that truly foster emotional attachment. The relationship and experiences built over time are what

ultimately foster emotional attachment. (2024)

Design for durability

Designing for a long lifespan and for durability go hand in hand. This includes the technical reliability, but also reliability perception influences the lifetime of a product. A copying machine is a good example to explain this. Originally, an engineer had to come and fix a re-occurring paper jam every few months, leading the machine to be out of use a few days. This lead users to accept the machine coming to a standstill once a week as long as it took them only a few seconds to handle the failure themselves (Bakker et al., 2022, p. 103).

The quality department of Braun tests products intensively to ensure product durability. The focus on safety, functionality, packaging and reliability cause the immersion

blender to be rigid. Doing quality test, the product housing has to be cut in half to be able to look inside.

The Japanese Pavilion state in the Osaka World Expo 2025: "Things designed to be breakable are easier to repair. Rather than being tough and rigid, they gracefully absorb excess force. When they become old, they break down and are reborn into new forms.". It is key to find a balance between a product that does not break easily, but can also be fixed when a failure happens.

Some materials are chosen for their ability to age gracefully. The use of **patina** is a strategy that allows visible degradation over time, giving the product character.

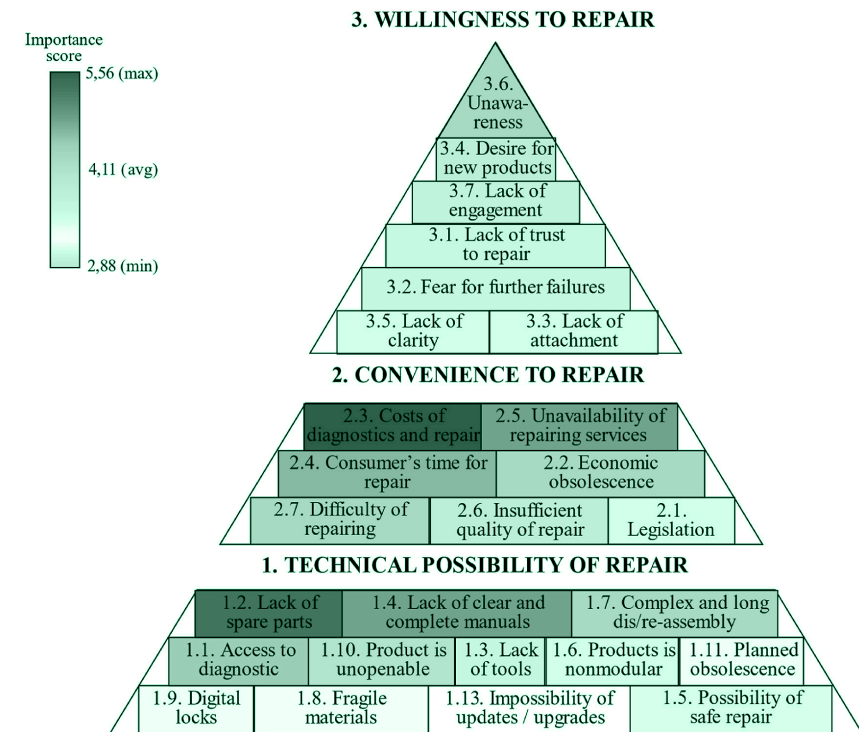


Figure 24. Consumer barriers to repair a washing machine, classified within three categories and ordered by importance. (Adapted from Roskladka et al., 2023)

Design for standardisation and compatibility

The Braun MultiQuick is a great example of a modular system, where the motor unit is compatible with multiple accessories of various product lines. However, renewing the design from rounded to straight made them not compatible anymore.

Regulations by governments has lead to standardisation of sockets and more recently USB-C cables. An example of a brand using standardisation as a selling point is Bosch, offering a battery that is compatible with multiple appliances, such as drills, vacuums and gardening equipment. These batteries can be easily switched, enabling replacement and exchange, and adding the benefit of continuous use without having to wait for the battery to charge.

Design for ease of maintenance and repair

For some products, like cars, we do regular check-ups and maintenance. When our bodies are malfunctioning we go to a doctor, psychiatrist or physiotherapist to ensure longevity. The general perception on kitchen products is different. Why?

Research shows that barriers to repairability fall into three categories, with the most significant being willingness to repair (Figure 24). Even when a product is technically repairable, consumers often choose not to repair it (Roskladka et al., 2023). The willingness to repair is depended on among others: unawareness, lack of trust/clarity/attachment or fear for further failures. The term 'fixophobia' has recently emerged to describe consumers' reluctance to repair items.

This creates a paradox:

Why design products to be repairable if people rarely repair them? At the same time, people's perceptions of repair will not change if those who try

to repair their products cannot do so successfully.

EU legislations and theoretical knowledge allow companies to make products that are repairable. However, it is not the technical possibility or convenience that discourages consumers to repair their products. The main barrier for reparation is willingness to repair (Roskladka, 2023).

Design for adaptability and upgradability

Design could allow possibilities to change the product over time like some strollers, adapting the size of the child. Because of the rapid pace of technological development, upgradability allows products to be adjusted to technologies that do not even exist yet. Fairphone is a familiar example that allows for upgrades of parts of the product.

Design for dis- and reassembly

Allowing products to be taken apart and assembled again is necessary not only for the previous three strategies, but also to enable parts of the product to be transformed into something different.

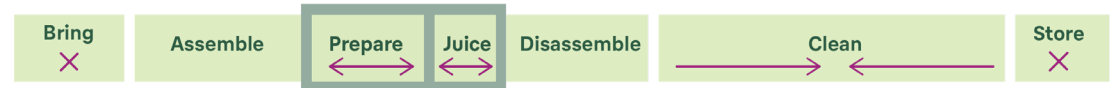
Since electronic appliances are protected from water and dust, they are rigid and very difficult to disassemble and reassemble, if not impossible. They are designed with an attractive casing that hides the inner workings of the product, creating a 'black box'. These casings are so common that even non-electrical products are sometimes designed to conceal their functionality. Some kitchen products where disassembled to find the difficulty of disassembly (Appendix E).

As said earlier, Braun products are made to be assembled quickly. These fusion methods are irreversible, making it impossible to disassemble most parts of the product.

8.3 Slow design

Slow design is a philosophy that promotes

Current time distribution of an electric centrifugal juicer



Vision for a new slow design juicer



Figure 25. Time spent using an existing electric juicer versus a slow-design juicer. [Adapted from Grosse-Hering et al., 2013]

product attachment by focusing on well-being for individuals, society, and the natural environment. Interacting with the product creates a 'mindful' experience, which does not necessarily require more time, but stimulates the user to spend more time on 'meaningful' parts of the interaction and less on those that are not. Figure 25 shows a comparison of a vision for a slow-design juicer with an existing electric juicer (Grosse-Hering et al., 2013). This example illustrates the time distribution of the juicing process. For an electric juicer, actual juicing takes up only a small part of the total user interaction, although this should be the most rewarding and satisfying part of the process. The product makes juice quickly, but cleaning and repairing the product is often more of a hassle. Slow design chooses to slow down at the joyful moment of the interaction, making the interaction more meaningful and creating more attachment between user and product, and reducing cleaning time.

Taking time for the joyful movement of the interaction, taking time for what matters.

In this research of people making juice, users valued making juice for others because they had put in the effort, which made them value the result more.

8.4 Eco-effectiveness

When it comes to strategies for extending the lifetime of products, a distinction can be made between eco-efficiency and eco-effectiveness. **Eco-efficiency** involves making minor sustainable improvements to an existing product to make it less harmful than the original version. **Eco-effectiveness**, on the other hand, involves rethinking how a product fits into the bigger picture. Simply said: Doing Good vs. Less Bad (Hauschild, 2015).

Using the eco-efficiency strategy to create a more sustainable, energy-efficient product could also have an unintended result. The **Jevons' paradox** states that technological improvement can lead to increased production of the more efficient product. William Stanley Jevons', economist in the 19th century, observed that the increased efficiency of coal engines led to higher overall consumption of coal, iron, and other resources, rather than saving them because they were used more frequently. (Alcott, 2005)

In the kitchen of 2040, we should take a step back and look at the overall eco-effectiveness of our kitchen products, not only making our current products more eco-efficient.

9 Megatrends

ZukunftsInstitut defined twelve multi-layered, multidimensional megatrends that will last for several decades and impacts all areas of society globally (2023).

In this chapter, four of the megatrends will be implemented on the future kitchen context (Figure 26).

Health



Health will shape all aspects of life being the central goal to achieve a high quality of life. The focus will be on prevention rather than curing diseases. The kitchen will facilitate this fundamental value. The demand for products and services to support longevity continues to grow. Up to 60 percent of consumers across markets report that healthy aging is a “top” or “very important” priority (Pione et al., 2025).

The life expectancy of a human being is for 80 percent influenced by lifestyle and environment. (National Academy of Sciences, 2015). In the blue zones, five regions spread across the globe with a high concentration of people who live to be 100 or older, the environment supports citizens to not only eat healthy, also natural movement was part of their daily lives. Every 20 minutes, they performed an activity such as gardening, kneading their own bread, and using hand-operated tools; their houses were not full of conveniences. Once energy consumption exceeds a certain level, the correlation between it and well-being indicators such as health, education, culture and general satisfaction appears to diminish (Kuijjer & Laschke, 2025).

Individualisation



The trend **individualisation** describes how people will focus on self-expression and value freedom of choice to become unique. At the same time, new types of communities are forming, showing that individuality and togetherness can grow side by side. The focus is moving away from the traditional idea



Figure 26. All megatrends defined by ZukunftsInstitut (Adapted from ZukunftsInstitut, 2023).

of individualisation. Instead, there is now a stronger focus on finding meaning, support and direction within the community.

Neo Ecology



The megatrend **Neo-Ecology** expresses how sustainability fundamentally realigns society, economy and companies. The awareness of humanity's role in the ecosystem increases. “As a megatrend, eco-intelligence is increasingly shaping the strategies of companies, political institutions, and society as a whole.”

Urbanisation



A growing number of the population will live in cities. Due to this **urbanisation** trend, cities are more than just places to live. They are complex, dynamic systems that encourage creativity, solve global problems, shape the economy, and play an increasingly important political role. Food will be available everywhere and the need to cook everyday is no longer a reality. As cities grow, rural areas are regaining interest as places to live as well. The future is not just in cities, but in a balance between city and countryside. This means connecting these two living spaces.

10 Persona

As designers, we shape the future. We design for personas and since design can nudge people into certain behaviours, we could also choose for which persona we want to design. This chapter describes two personas, based on research by Kuijjer and Laschke, that are shaped by the same megatrends yet respond to them very differently. (Figure 28) The **Techno-Hedonist** is driven by convenience, control and endless choice, which reinforce today's overconsumption society. In contrast, the **Eco-Harmonist** is more in balance with planetary boundaries and is therefore more desired for a sustainable future. For this reason, the **Eco-Harmonist** will likely be interested in a sustainable kitchen. This is not the main interest of the **techno-hedonist**, so the challenge is to let the **techno-hedonist** make a sustainable choice by responding to their values.

Techno-Hedonist

The challenge is to move the **techno-hedonists** to appreciate the values of the **eco-harmonist** and helping people choosing for a more conscious and sustainable way of living.

The **techno-hedonist** is “a self-interested individual motivated by optimizing pleasure and preferences, with a desire to shape the world to (usually) their personal preferences”. This persona has three core values:

- **Convenience** - save time and hassle, leading to efficiency and improved productivity.
- **Control** - deriving pleasure from controlling devices, although the power eventually ends up at tech companies.
- **Endless choice** - maximizing pleasure and hyper-personalized experiences.

The **techno-hedonist** will always look for new technologies to keep them shortly satisfied, without leading to improved well-being. Research indicates that excessive consumption is associated with various negative social and emotional effects (Kuijjer & Laschke, 2024). This persona lives in a society where economic growth remains the main driver of wealth and well-being, leading to accumulation, acceleration and

stacking of technologies, harming see ‘5 *Overconsumption society*’ on page 28. In this society, product innovation will continue developing innovative technologies without knowing whether it is necessary.

If designers keep assuming that people want their problems solved through new technology, they reinforce the **techno-hedonist** stereotype and add to the growing resource intensity of everyday life. This becomes a self-fulfilling prophecy, as technologies not only meet needs but also shape people's habits, expectations, and desires.

Eco-Harmonist

The other persona is the **Eco-Harmonist**, a persona aligning with the megatrends on page 40. The **Eco-Harmonist** values learning new skills and is willing to invest

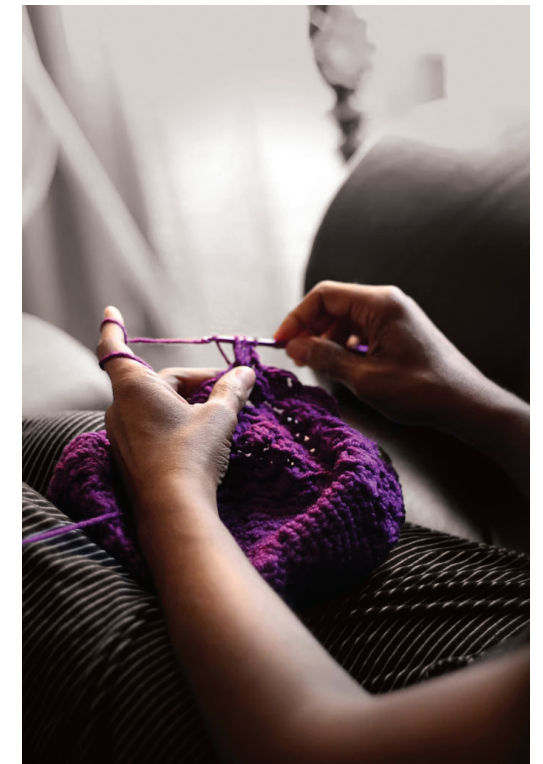
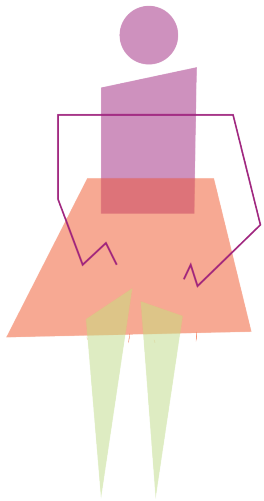


Figure 27. Knitting has transformed from a necessity to a hobby. Will cooking become the same? (Adapted from Imani, 2018)



TECHNO HEDONIST GROWTH ECONOMY

Endless innovation

Values

Convenience, control & endless choice

Goals

always be up to date with the newest hype/trend/gadget.

Wants to buy a fancy car, automatic closing curtains and the newest air purifier.

ECO HARMONIST POSTGROWTH ECONOMY

Respects ecological limits

Values

Learning new skills and is willing to invest time and effort in doing so.

Goals

Seeking for experiences that improve quality of life.

Takes the bicycle to work and wants to be outside.

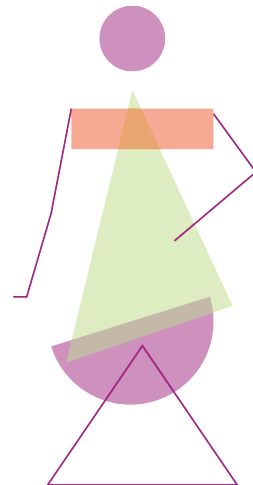


Figure 28. Infographic of two personas: the techno-hedonist and the eco-harmonist. (Image by the author)

time and effort in doing so, instead of making life easier. Activities in our current society that align with this vision are hobbies like knitting (Figure 27) and road cycling, that used to be daily necessities and are no longer relevant. The outcome of these actions can be easily replaced by alternatives using less time and effort (by buying sweater in a shop or travel by car). In most cases, the supplies to knit a sweater are more expensive than buying one in a store. But people perform

the activities for the pleasure of the activity itself and to improve their skills, adding value to the satisfaction of the end result. Although activities such as knitting; making pasta and grinding spices with a mortar are clear examples, the desired activity does not necessarily have to be a nostalgic act of craftsmanship. A novel craft can fulfil this purpose as well.

Beside the health benefits of staying active,

research shows that lower consumption rates align with better mental health and that low-intensity physical activity, including household chores, is beneficial for sleep architecture and linked to reduced stress and increased energy (Zapalac et al., 2024).

This Eco-Harmonist invests time in care for others, self, objects and natural surrounding, improving personal and community well-being (Figure 29). Sharing becomes more natural, not only for tangible items but also for work. Work sharing allows for a four-day working week and more time for essential and meaningful activities. "More time is spent on basic living provisions such as growing food, cooking, cleaning, DIY, and caring, as well as on learning and teaching the skills required to perform them." (Kuijjer & Laschke, 2025).

We can link this persona directly to the four megatrends:

- **Health** - The Eco-Harmonist's commitment to acquiring skills and

do activities to strive to the 'good life' aligns with the trend of growing interest in healthy living. This commitment is perfectly in line with the health benefits seen in the 'Blue Zones', where natural movement, such as gardening and kneading bread, is part of daily life.

- **Individualisation** - The persona gains satisfaction from successful collaboration within a local community. People are seen as creative individuals who are also concerned with cooperation and the larger whole.
- **Neo-Ecology** - The Eco-Harmonist lives in harmony with nature and strives to shape everyday life to be more in line with planetary limit. The collective well-being and ecological limits are prioritized over economic growth.
- **Urbanisation** - The social relations and activities of an Eco-Harmonist become more local, living and sharing within a community.

Figure 29. Vision board for the Eco-Harmonist persona, that invests time in care for others, self, objects and natural surrounding. (Image by the author)



11 Movement in the kitchen

The previous chapters have shown that the trend in health is shifting from treating symptoms to preventing health issues. It has also highlighted that the Eco-Harmonist persona is motivated to invest in their own health and physical activity. But the Techno-Hedonist wants convenience, control, and endless choice. What if we could use their values to make them move by satisfying these needs, while unconsciously benefiting the planet as well?

An emerging concept, sometimes referred to as **ambient exercise**, describes the movement embedded in functional daily activities that naturally supports a healthy lifestyle. Today, many appliances reduce physical effort in tasks such as laundry, dish washing, grocery shopping, and cooking. While this saves time, that time is now invested in exercise, such as the gym. For example, rowing machines maximise air resistance to create high effort without actually moving through space. But why do we minimise our natural energy use only to spend it somewhere else, instead of commuting by bicycle? (Figure 30)

Bringing movement back into the kitchen, making daily life naturally healthy again.

Integrating movement into daily tasks is far more efficient and sustainable than separating activity from routine. Using the body during everyday activities not only saves energy but also provides continuous health benefits. Bringing joyful, functional movement into the kitchen can support this principle, making everyday actions both meaningful and physically beneficial.

Studies show that activities involving the hands contribute to better sleep, and regular physical activity is one of the most effective ways to reduce the risk of developing dementia. By embedding exercise into daily routines, such as cooking or food preparation, people can achieve health benefits without needing to invest time going to the gym.

Figure 30. A stationary airbike in a busy city with commuting people. (Antoni Shkraba Studio [2020] and adapted from ArtMassa [2020]; images combined using ChatGPT [OpenAI], 2026.



12 Future context: Take-aways

Sustainability will be an important factor in the future society. It will not only be imposed by governments and institutions, but the consumer interest in living in harmony with nature will grow as well.

RO3. What is the role of cooking and the kitchen in the future society of 2050?

Health will be a growing interest in the future. Nutrients will allow people to focus on prevention rather than curing diseases. Healthy cooking will become an investment of time, effort and money. The kitchen will be social heart, place for community and to destimulate in a fast paced world. Cooking will be an activity of self care, creating a ritualistic moment. Individualisation will make the kitchen a space for personal expression while also supporting new forms of community for shared cooking and food culture. Driven by the Neo-Ecology trend, the kitchen will become a place for environmentally responsible behaviour, with awareness of resource use and waste. Urbanisation will lead to adaptable kitchen spaces to suit different needs, while strengthening connection between urban and rural food systems. Overall, the kitchen will serve as a place where health, identity, sustainability, and new living realities come together.

Products are not designed solely for a 'lazy' persona. The product nudges the user to invest time in caring for others, themselves, their possessions and their natural surroundings, thereby improving their own well-being and that of their community. They value learning new skills and seek experiences over material possessions. Daily activity in the kitchen is encouraged, contributing to a healthy lifestyle.

Although the current group of Eco-Harmonists is relatively small and often stereotyped as extreme or "back-to-nature" idealists, ongoing megatrends predict a growing shift toward their values. More people will begin to recognise the importance of caring for both the planet and themselves, gradually moving toward behaviours that align with the Eco-Harmonist persona. The design will support and encourage this shift, helping people to choose for this more conscious and sustainable way of living. The concept should nudge the Techno-Hedonist to move from overconsumption society and make sustainable choices. Adding values that align with the Techno-Hedonist: control and convenience, helps them taking the right steps.

This proactive attitude towards upcoming (European) regulations considering repair and sustainability strengthens Braun's brand identity of 'Design for what Matters'.

Design Vision

This chapter compares the current and future context from the previous sections and formulates design guidelines for future kitchen products based on the transition of the context and the product interaction.

Figure 31. Happy couple dancing in a kitchen. (Adapted from Freeplik, n.d.)

13 Shift of intention

13.1 Shift of kitchen context



Current kitchen context: The kitchen and its appliances reflected a society where cooking is a necessity in order to get nutrients. The kitchen including its appliances serve a functionality aiming for time efficiency and comfort.

Future kitchen context: The kitchen becomes a facilitator of home cooks that consider cooking as their hobby. The intention of cooking becomes acquiring skills or connecting with self and others.

13.2 Shift of product interaction



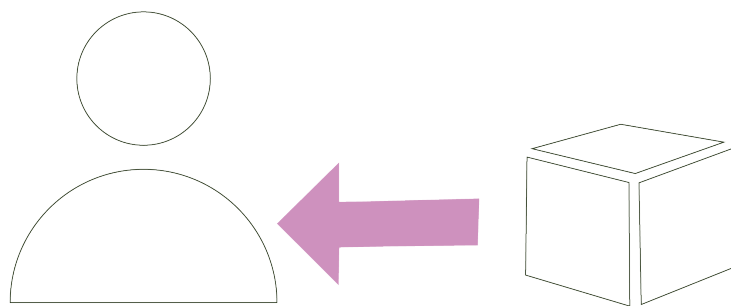
Current product interaction: The market is highly saturated with products that serve a specific function. The product should almost invisibly serve the user in a cooking activity. Caring, cleaning or maintaining the product is a burden, since the user expects the object to serve them, not the other way around.

Future product interaction: The user puts time and effort in the product, resulting in receiving a pleasurable experience. They invest in the product creating attachment. Care and maintenance are naturally and satisfy the user.

CURRENT

USER - PRODUCT RELATIONSHIP

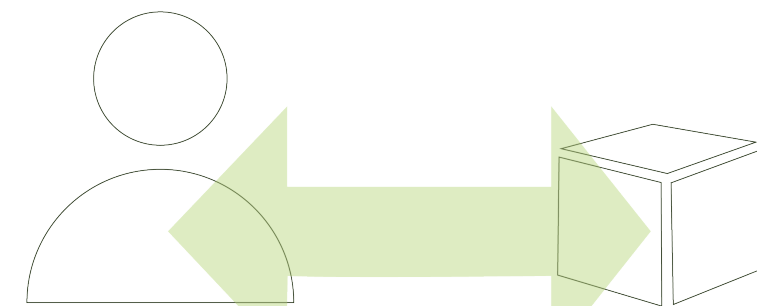
Products are designed for convenience, minimising time and effort.	Product as a functional tool	Product facilitates an experience	The user gets included in the use of the product, enhancing the cooking experience.
Products are rigid, protecting them from water and dust, but making them hard to repair.	Black box	Open	The product's working is visible and intuitive, enabling the user to care for it.
Products reflect a society that values convenience, making daily life unhealthy.	The lazy user	Active habits	Mobility and activity are encouraged by involving the user in the action.
Every manual kitchen task is replaced with an electrical alternative.	Hidden impact & e-waste	Manual	Implementing technology when necessary, appreciating human effort.
Products are competing for the minimal available counter or cupboard space.	Kitchen full of products	De-cluttered	Products are made taking their environment in consideration.
The product does the cooking for the user and notifies them when it is finished.	Disconnected	Control	The user sees direct result of their own action, making them owner of the process.



one-way relationship

FUTURE

USER - PRODUCT RELATIONSHIP



two-way relationship

Figure 32. Comparison of the current and future user-product relationship. (Image by the author)

13.3 Analogy

The desired relationship between a product and its user can be compared to a pet and its owner (Figure 33). The user feels **responsibility** for a product as they would feel for their pet. In this example, the pet is unique, has a personality, changes over time; and effort is invested to improve the relationship.

A relationship is both ways: the user not only receives but also invests, just as a human-to-pet relationship.

For care between humans, research shows that consumers feel like better caregivers when they put more effort into care-giving tasks than when they use products that reduce the effort required to perform such tasks (Garcia-Rada, et al., 2021).

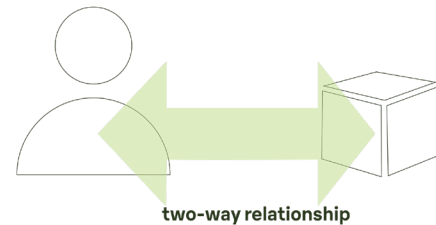


Figure 33. A loving relationship between user and pet. (Adapted from Katt, 2020)



14 Product investment

There are multiple ways a user can invest in a product. A simple example is investment of money: a high product price leads to consumers expecting a better quality. As a long lifetime is expected from high-quality products, consumers are willing to do their part by investing money and effort in product care activities. In contrary, high prices on spare parts lead to decrease of product care (Ackermann et al., 2018).

Increasing the product price is not always a desired solution to increase the relationship between user and product. An investment can also be made by spending time and effort. Products can be assembled, customised or produced by the user, which gives the product personality and creates memories. Knitting a sweater is an example of how investing time and effort in creating a product can lead to a stronger product-user relationship. Besides such investments made at the **creating** of the product, there are two other categories of investment opportunities: **caring** and **using**, each with some examples in the infographic of Figure 34. See Appendix G.

When a product is associated with **activities of pleasure and fun**, by representing a hobby or providing social experiences, users are more motivated to take care of the product. On the contrary, products that are annoying or do not provide fun are usually taken care of less. (Ackermann, 2018). The activities of investments should

therefore not only build skills but also be an activity of pleasure and fun.

The kitchen appliances that allow us to easily incorporate fun and exercise are those with a rotating motor. The infographic of Figure 35 categorises kitchen appliances according to their main function. Appliances on the left, such as the kettle, rice cooker, toaster and induction plate, rely primarily on converting electricity into heat. On the right are rotation-based appliances, such as mixers, immersion blenders and juicers, which are driven by electric motors and perform mechanical work. These functions could, in principle, be performed by human power, taking inspiration from movements that are now performed in the gym. The area where the two circles overlap contains hybrid appliances, such as the milk frother, air fryer, and coffee machine, which combine heating and rotational mechanisms. Devices such as scales and microwaves are positioned outside the circles as they operate on fundamentally different principles.

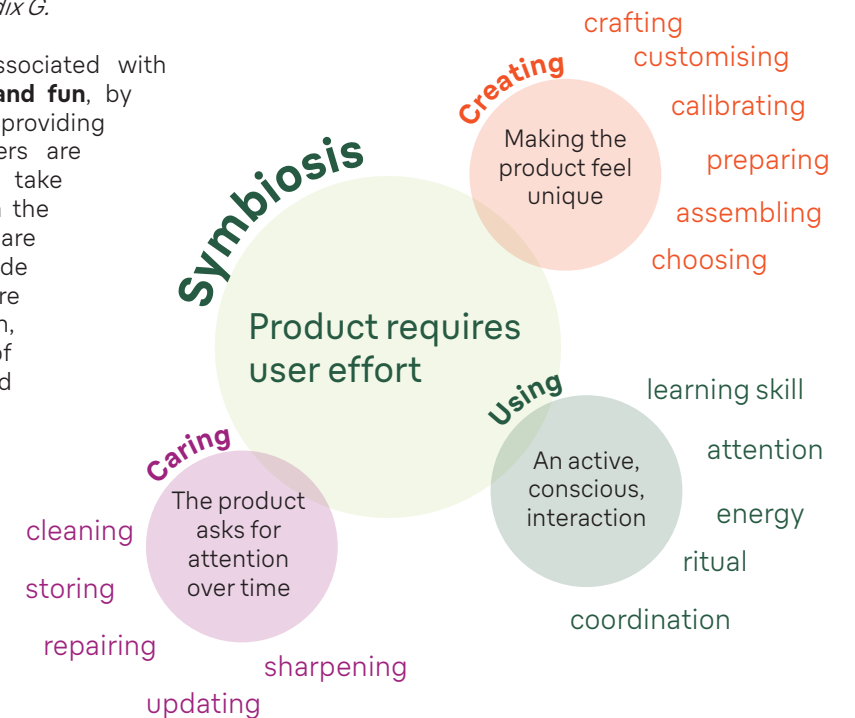


Figure 34. Different types of product investment that lead to symbiosis between user and product. (Image by author)

15 Look & Feel

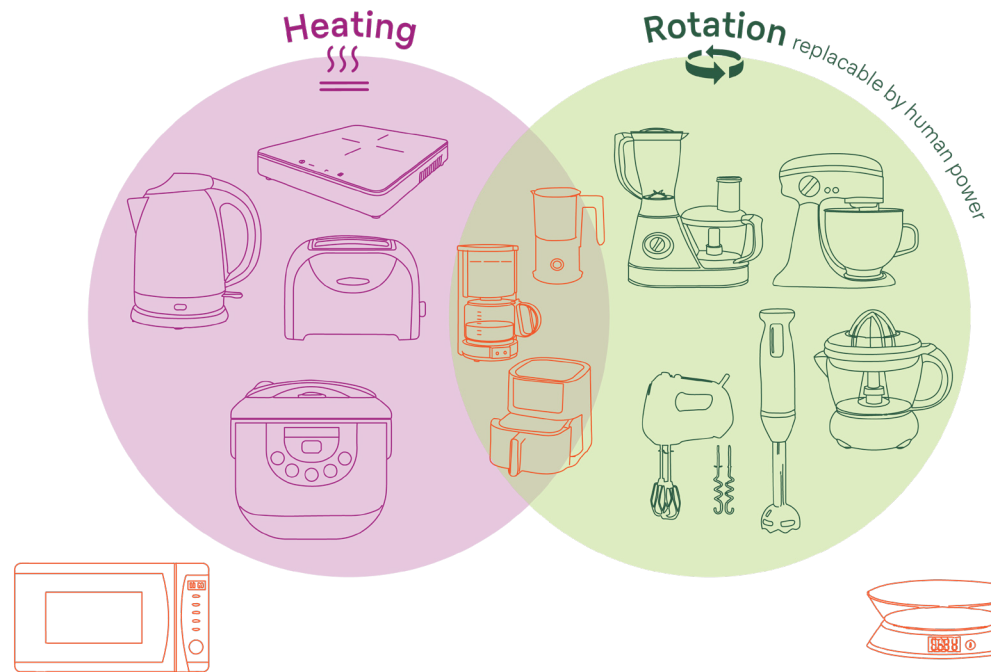


Figure 35. Global distribution of functionalities electronic kitchen appliances. (Image by the author)

The infographic shows a number of rotating appliances, of which there are many more examples. Considering that people will cook less in future context, they will need these appliances less. "Depending on the individual, a blender can go months unused. Therefore, environmental effects of a blender are mainly due to material extraction, manufacturing, distributing, and disposal." (Hawthorne & Ameta, 2012). Given the high environmental impact of producing electric motors and the precious materials they contain, kitchens should have one rotating driver for all appliances. Making the driver mechanical allows the user to actively participate in the process, which aligns with the slow design strategy for product longevity. Because of the symbiose between the product and its user, the user will feel more attached to the product, learn skills and experience health benefits by their ambient exercise.

This is an eco-effective strategy rather than an eco-efficient one, because it considers what is necessary for the whole kitchen, rather than making a single existing product more sustainable.

Because there is no electricity involved in the product, the product does not have to be a 'black box' to save the electronics from water and dust in sake of safety. Opening up the black box will make the product more understandable, repairable and make the user feel more in control of their owned product.



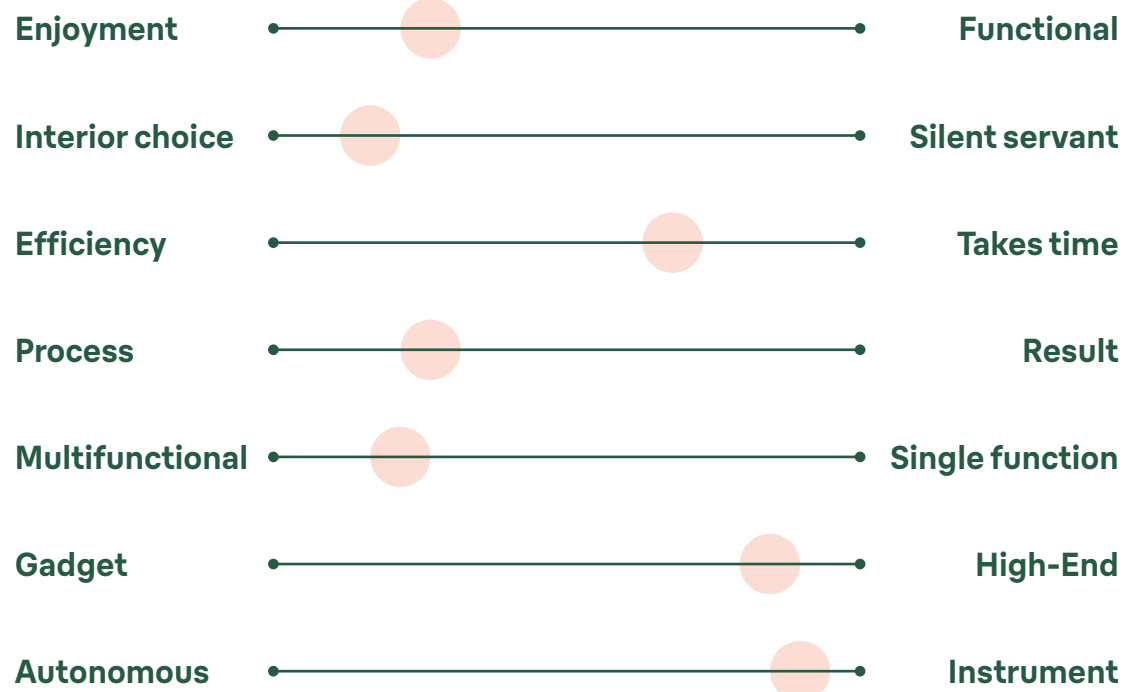
Figure 36. Inspirational collage for colour, material and finish (CMF). (Image by the author)

15.1 Placement

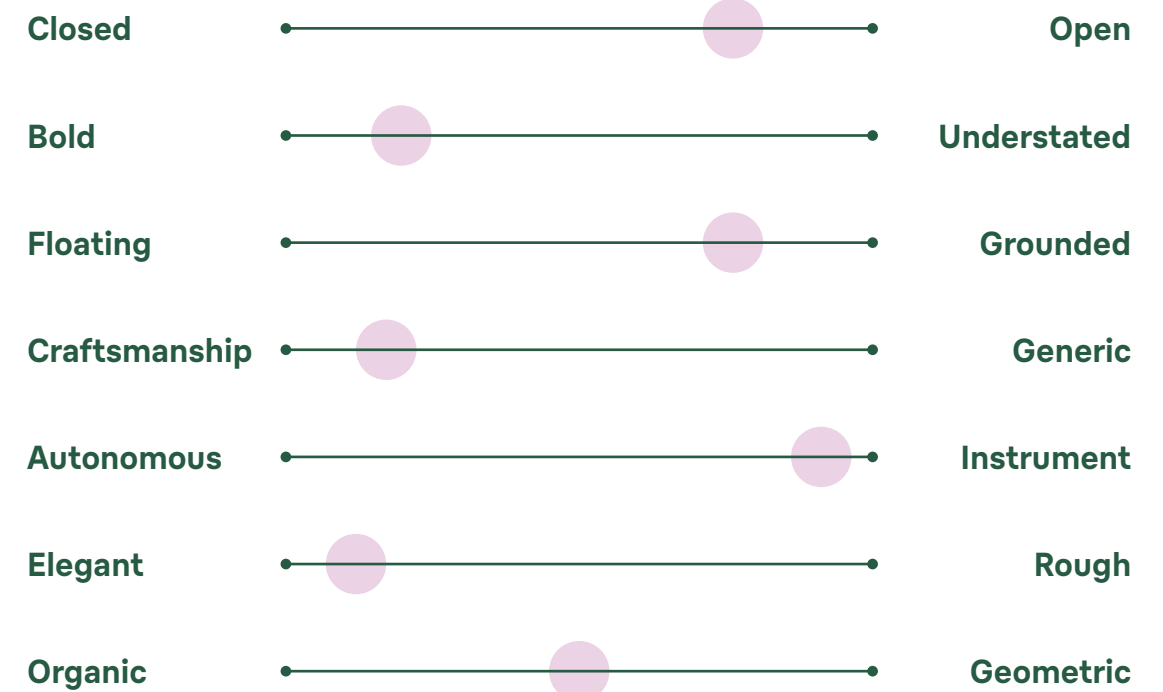
The choices for placement are visualised using a set of axes, with each end representing two contrasting terms. These axes are based on the insights and values identified in the previous chapters. A coloured dot indicates where the product is positioned within these tension fields.

This visualisation makes abstract design decisions concrete and helps to guide the design process. It also provides a clear overview of the trade-offs that have been made. Product placement compared to the current market is placed in *Appendix I*.

Function



Aesthetics



16 Design challenge

RO4. What is the desired interaction between user and kitchen appliance in the future context of 2050?

In the future, cooking will transition from a functional activity to an experience-based one. People are focusing on health and valuing experiences over material possessions. The purpose of cooking will be to acquire skills or to connect with oneself and others.

The user invests time and effort in the product, forming a positive association with it. The product and its user engage in a mutual relationship, investing energy and receiving energy in return, just like human interactions. This investment and positive association leads to more attachment to the product. Care and maintenance therefore naturally satisfy the user. The user values learning new skills and is willing to invest time and effort in doing so, instead of making everything in life evolve around efficiency.

RO5. What are the tensions and trade-offs between academic sustainability strategies and commercial design constraints in the development of long-lasting consumer products?

The current commercial design constraints are that the whole economy is based on growth, which is a linear model where sustainability is hard to implement. Now that the future context is described, academic sustainability strategies better fit in the future. There was simply a mismatch between the current commercial needs and the future context. Societal changes might lead to new, more sustainable commercial needs.

Designing products based on an eco-effective strategy rather than an eco-efficient one creates new opportunities and helps us move away from the mindset of always designing for higher power, cheaper and faster.

16.1 Design guidelines

- 1. Being in Control:** The product must provide a direct, visible, and tangible relation between user action and its effect on the ingredients, ensuring immediate feedback during use.
- 2. Human Participation:** The product must be powered by human force and engage large muscle groups to stimulate daily physical activity during cooking.
- 3. Multifunctional Rotation:** The product must use one central rotational drive system compatible with multiple kitchen functions replacing electric motors.
- 4. Opening up the Black Box:** The product's mechanism must be visible and understandable, enabling intuitive comprehension, disassembly, and repair.
- 5. Lasting aesthetics:** The product must be made from durable, preferably natural materials that age aesthetically (develop patina) and be designed to function as both a utilitarian and decorative object.
- 6. Non-Electric:** The product must function entirely without electricity to minimize e-waste and hidden environmental impact.
- 7. Satisfying the Senses:** The product must provide pleasurable sensory feedback (e.g., sound, resistance, tactility) during operation.
- 8. Requires Skill:** The product must allow performance improvement through practice, enabling the user to grow in skill and personalize outcomes.
- 9. Cleaning and Maintaining:** The product must be easy to disassemble, clean, and maintain, encouraging upkeep as part of the ritual.
- 10. Take Time for What Matters (Slow Design):** The product must not optimize for maximum speed, but instead allow time investment in the preparation process, increasing appreciation of both process and outcome.



Showcase: The Turning Point

In this section, conceptual design the 'Turning Point' is introduced. This prototype is made to showcase the design vision, sparking inspiration and conversation. The product experience and recommendations are documented. The prototype details can be found in the appendix.

Figure 37. Showcase prototype: 'The Turning Point'. (Photograph by the author)



Figure 38. Showcase prototype in current kitchen context (Photograph by the author)

17 Design summary

The previous Frankfurter Kitchen brought gas, electricity and water to the house in a static fixed kitchen. The next Frankfurter Kitchen will bring daily movements into the home, in a world where we use our minds over our bodies, making daily movement natural again, instead of only moving when going to the gym.

Conceptual design, **'The Turning Point'**, transforms the cooking process into a satisfying and enjoyable experience. Users can choose between various movements, which are converted by a mechanism into a universal rotational driver for kitchen appliances. This replaces all electric rotating motors in the kitchen.

Using the Turning Point is like playing an **instrument** rather than using a servant:

enjoyable and active, building skills over time. Direct haptic, visual and auditory feedback gives users a sense of control over the cooking process. Active participation gives the cooking outcome higher value. The interaction between user and product requires effort from the user, thereby strengthening the relationship between them. Craftsmanship and movement is brought into the kitchen, where users develop skills through repeated use.

The product is designed to fit into the unique interior of your home, making it a personal item.

Users invest direct energy in the product while learning skills. Active use makes the product feel like an instrument: an interplay between user and product..

The product is open and simple yet elegant, made of natural, lasting materials. The open mechanism makes errors easy to diagnose and fix.

Symbiosis

Product requires user effort

Creating

Making the product feel unique

Using

An active, conscious, interaction

Caring

The product asks for attention over time

The Turning Point

From efficiency to experience

Actively participating in the cooking process.



Figure 39. Interaction between the user and The Turning Point (Van Adrichem, 2026a)

17.1 Human powered motor

The actual product in 2040 may vary in shape and size, adapting to different needs and interior preferences. The showcase's aesthetics represent craftsmanship, openness and experience, and it is both grounded and elegant.

Instead of using an electric motor that is activated by pressing a button, the user provides the power that drives the mechanism.

In the design of the showcase, the mechanism is part of the aesthetics (see *Figure 40*), allowing the user to understand and control the rotation, giving direct visual feedback on their own input movement. The freewheel provides auditory feedback by making a ticking sound. The combination of visual, auditory and haptic feedback creates a multi-sensory experience, moving away from the minimal interaction of simply pressing a button and letting an electric motor process the food.

Various kitchen activities require different tools. Therefore, the mechanism can be adjusted to suit the cooking activity. The number of rotations per minute, and therefore the torque, can be changed using the compatible adapters. The user becomes skilled in using the right tool for the right activity, which is comparable to using gear in a workshop.

A flywheel is connected to the axis to distribute a pulsing rotation caused by a pulling or pumping motion into a continuous rotation. Weights are placed around the outer edge of the flywheel disk. A glass cover reveals the satisfying rotation while protecting the flywheel for safety reasons (see *Figure 41*).

The product is designed as a standalone piece of furniture, combining practicality with interior design. The mechanism is not integrated into the kitchen itself, since kitchens in 2040 could have various aesthetics and might not be fixed in place like the old Frankfurter Kitchen. For a functional design, the mechanism could be integrated into other kitchen components.



Figure 40. The mechanism is part of the aesthetics. (Photograph by the author)



Figure 41. The flywheel allows a continuous rotation. (Photograph by the author)

Sustainability

A product with a long product lifetime.

The product is designed to last. Durable, long-lasting materials ensure its longevity, while the user's personal investment in using the product builds a strong relationship, encouraging them to keep and care for it over time.

The product does not use electricity; however, the reduced amount of emissions and precious materials required during production provides an even greater environmental benefit. Instead of multiple appliances each containing their own motor, a single manually driven mechanism replaces electric motors across the kitchen.

The active interplay between user and product further strengthens this relationship, leading to better care, maintenance, and an extended product lifespan.

The metal gears are less likely to overheat and deform. The accessible mechanism is easy to diagnose and repairable.

Modularity

One motor for all appliances, on display as a furniture piece.

The showcase uses existing recognisable rotating kitchen appliances to connect with the universal plug (Figure 42). The true concept in 2040, would not use these products. There will be an universally accepted and regulated connector. The products will be made of lasting materials, using different sizes of bowls and different sizes of attachments that can be mixed and matched or the desired functionality.

For the showcase, connectors are used to connect existing products with the Turning Point, so that they do not have to buy new ones. Besides, when demonstrating the concept with existing products, people directly understood that The Turning Point was used as an universal plug for all kitchen appliances, replacing electric motors. When showing the concept with different types of tools, it was perceived as a new product rather than a replacement.

The tools can be on display, replacing stacked kitchen cabinets full of cables and plugs.



Figure 42. An universal connector fits to all rotating kitchen tools. (Photograph by the Author)



Figure 43. The user chooses which movement will lead to the rotation: pulling or pumping. (Van Adrichem, 2026b)

Movement

Encourage daily movement without it becoming tiring exercise. Get energized by giving energy

The Turning Point can be used by foot or hand, left or right (Figure 43). Larger muscle groups are engaged to achieve higher power and to convey the story better of bringing movement to the kitchen, without users getting tired.

Replacing only the rotary motors in the kitchen with human movement will not provide all the exercise needed to stay healthy, but this showcase is an inspiration for incorporating movement into multiple everyday products.

The movement is enjoyable and satisfying. By actively participating in the preparation process, the end result is perceived higher.

Control

The mechanism visible, embraced and appreciated, making it easy to maintain.

The product has an open design with no hidden components. It does not use any electricity, which means that it does not have to be designed as a black box to protect the electrical circuit from water. Users know their product inside out, making them more in control and more resilient.

Unlike pressing a button, the user's actions have an immediate effect on the product's output. The user will learn to 'play' the product, just like an instrument, and will get better at it over time, developing skills.

Enjoy the cooking experience, don't let the appliances do it for you.

18 Design experience

Cooking as a satisfying, enjoyable experience, in symbiosis with the product.

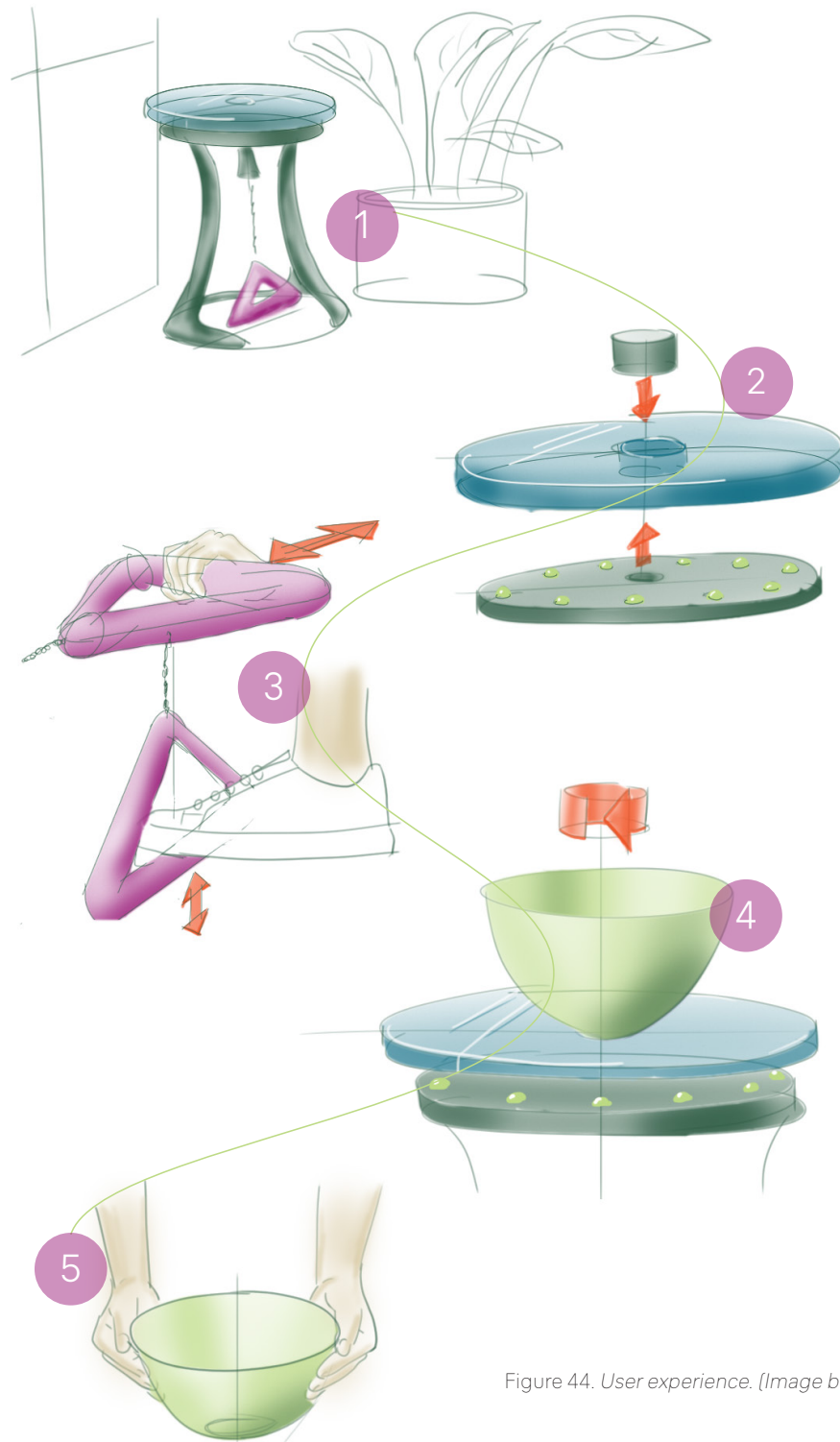


Figure 44. User experience. (Image by the author)

1. Interior piece

The product naturally blends into the home. Its calm materials and open construction make it feel like a sculptural object rather than a machine.

2. Set-up

The user attaches the desired RPM and chooses between pulsing or continuous rotation by attaching the flywheel. The setup becomes part of the ritual.

3. Pulling or pumping

The user chooses their preferred movement. The interaction feels physical, deliberate, and engaging.

4. Rotational drive

The axis in the centre of the tabletop starts rotating. The direct sensory feedback makes the transformation of ingredients visible and satisfying.

5. Attached

The user appreciates the end result because of the invested effort. The preparation becomes more than a task, it becomes an accomplishment. The user improves skills over time and achieves symbiosis with the product, taking care of it and repairing it when broken.



Figure 45. Prototype used to juice an orange in context. (Photographs by the author)

19 Design details

The design looks like a piece of art and craftsmanship, emphasising that cooking is a form of art as well.



The **top surface** is a flat working area made of glass, both protecting and revealing the flywheel.

The **flywheel** distributes the energy of the pulsing movement to make the pulsing rotation continuous.

The **base** is open, components are embraced and appreciated, making it easy to maintain.

The **mechanism** converts linear motion to vertical rotation, using a freewheel and bevel gears.

The **handle** can be used both by foot (pumping) or hand (pulling) motion, leaving the choice to the user.

Figure 46. Full prototype (Photograph by the author)

19.1 Mechanism

The mechanism converts linear motion from large muscle groups of the user into a vertical rotation. An infographic is made in Figure 47.

The mechanism of the showcase is made

to let people understand that their input can lead to a vertical rotation. For an actual product, multiple mechanical systems and user movements could result to a rotation. Ergonomics, minimal resistance, gear ratio's, flywheel weights and sizes should be considered.

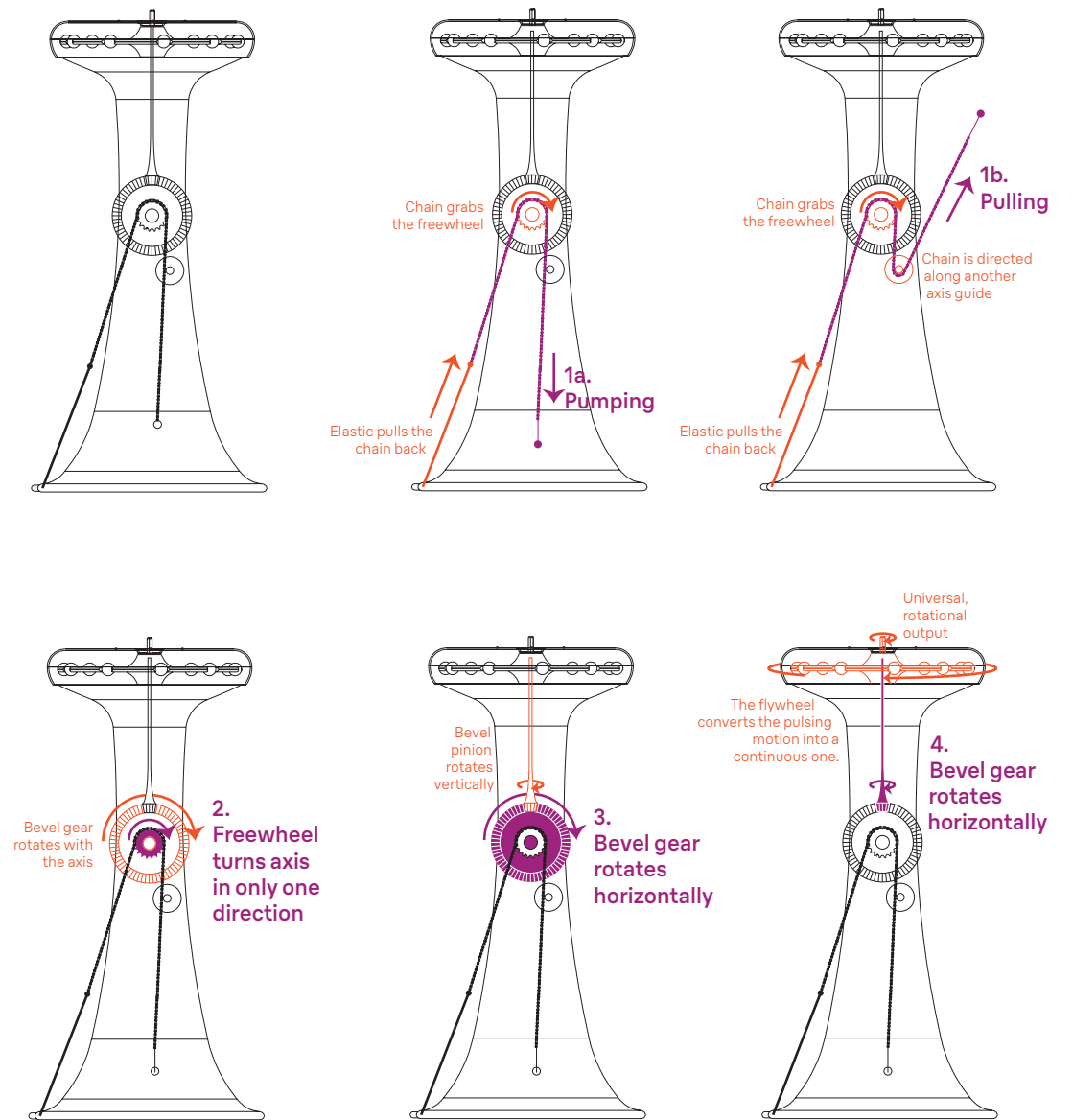


Figure 47. Visualisation of the mechanism. Input in purple, result in orange. (Image by the author)

20 Concept development

The design of the showcase has evolved significantly over time. This chapter illustrates the key steps of the iterative process. *All photographs and renders in this chapter are made by the author.*



1

1. Direct user feedback

Making a pull-mechanism that fits on existing Braun attachments. Finding out that users find it satisfying to see direct feedback on their efforts.

Searching for a solution to stay balanced when pulling a string in another direction.

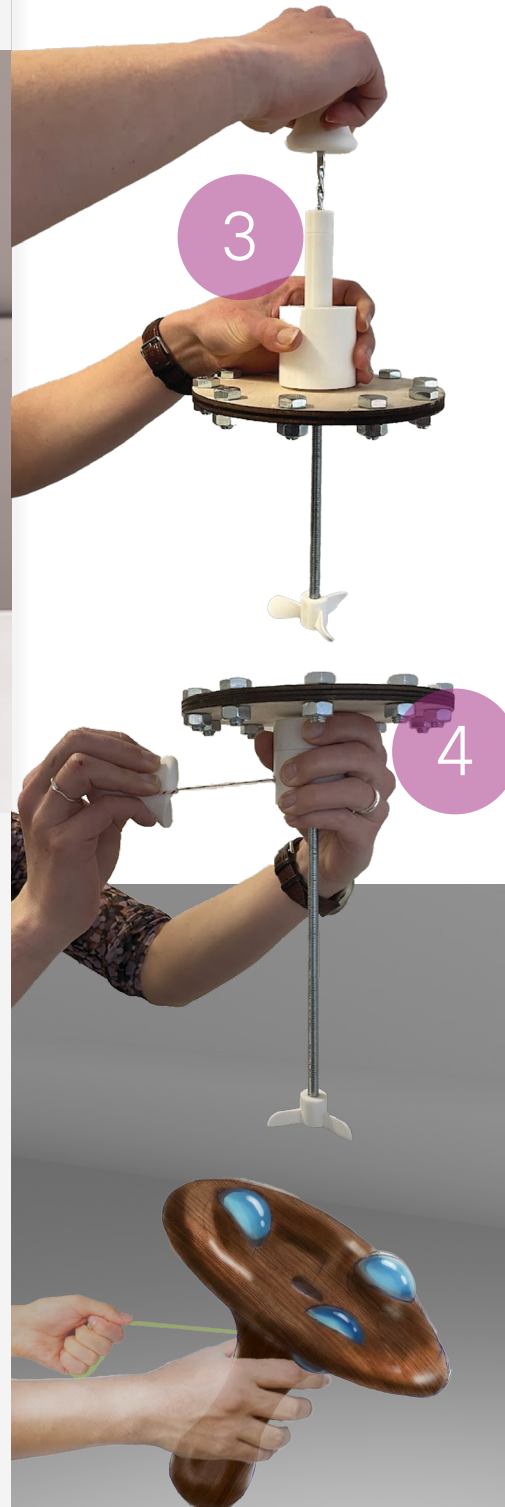
2. Adding a flywheel

Adding mass as a flywheel to allow a continuous rotation, not only pulsing. Testing various ergonomic shapes *Appendix H*.

Try being more conceptual.



2



3

4

3. Push mechanism

This mechanism exerts force in the opposite direction to gravity, so that the user does not have to compensate with their own strength and thereby lose balance and power.

4. Gyroscopic effect

Discovering that the flywheel and gyroscopic effects result in stability, making the product seem as if it has its own will. Trying out different sizes and masses of flywheels.

5. Storytelling more conceptual

Finding out that the product does not reflect the story yet. People associated the product with existing kitchen gadgets. The modularity with various rotational functions and the choice of movement should be emphasised more. This product is still perceived as addition to existing products, rather than altering the way we use kitchen products altogether.

5



6. Scaling the product

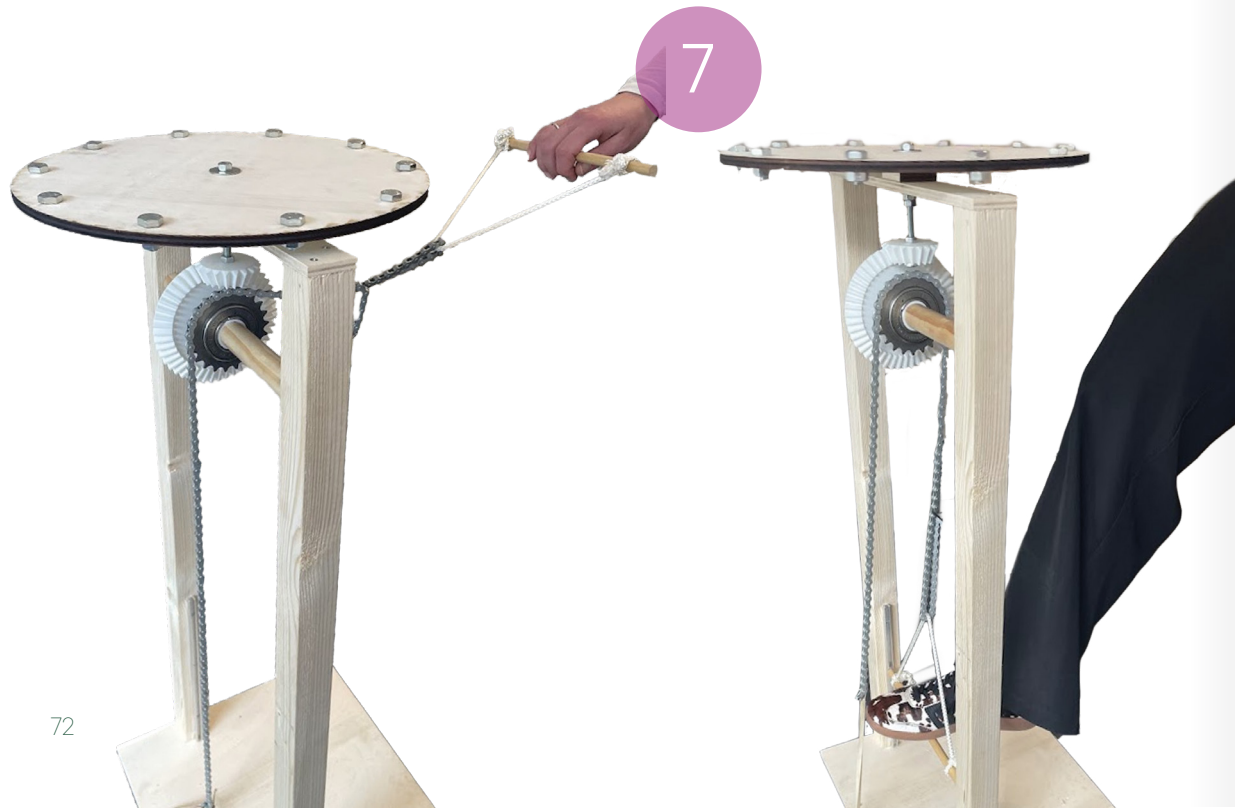
The idea is to create a more radical eye-catcher to convey the story more clearly. This involves emphasising bigger body movements and making the compatibility with all motor driven appliances clearer.



7. Functional prototype

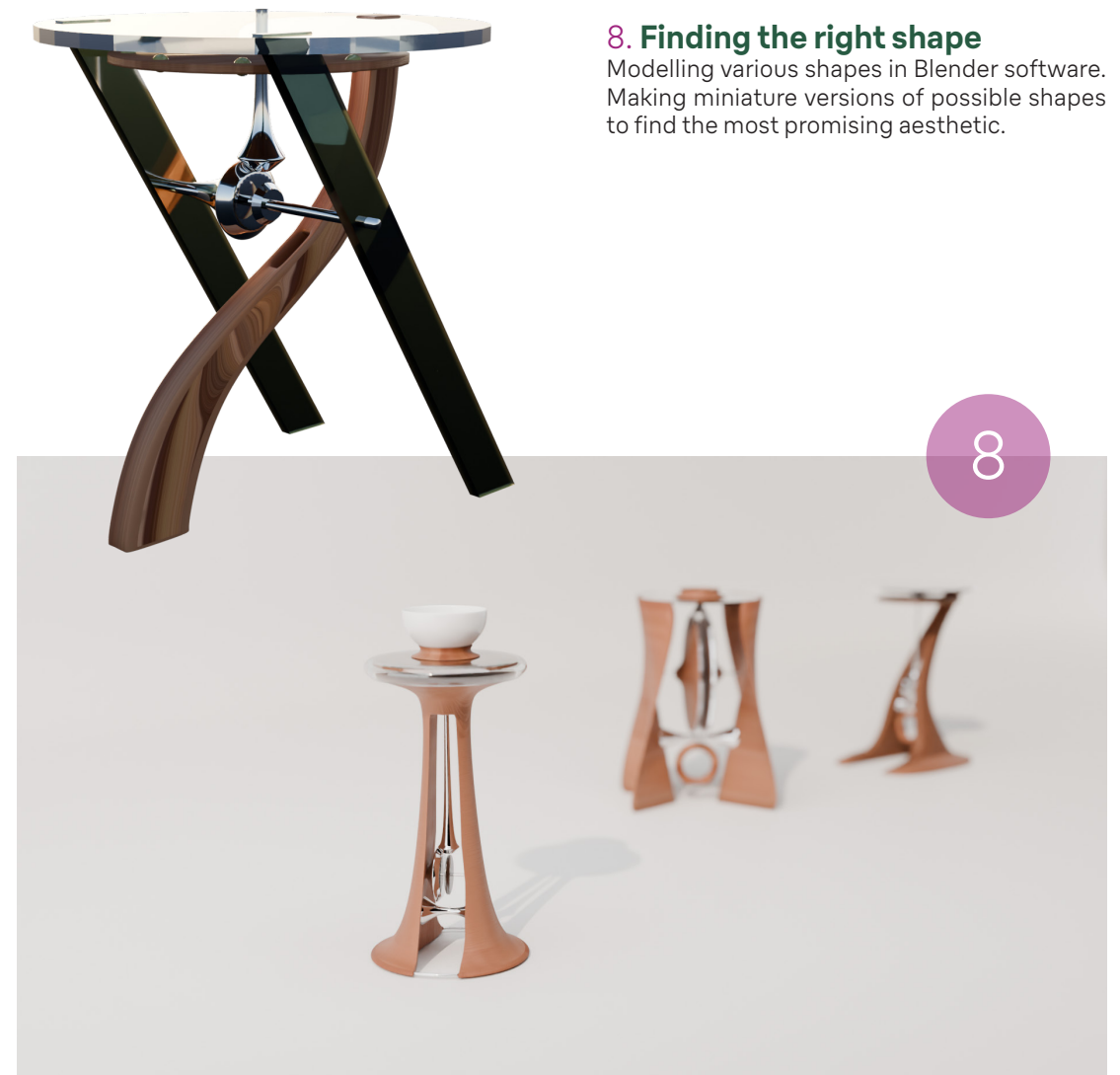
Creating a functional prototype to determine and validate the necessary elements and their placement. It has become clear that stability and support for the vertical axis are needed, as well as an additional horizontal axis positioned lower down in the product to

prevent the product to pivot. Also the position of the leg in relation to the product could be specified. Some calculations of the energy distribution can be found in *Appendix I*.



8. Finding the right shape

Modelling various shapes in Blender software. Making miniature versions of possible shapes to find the most promising aesthetic.





9

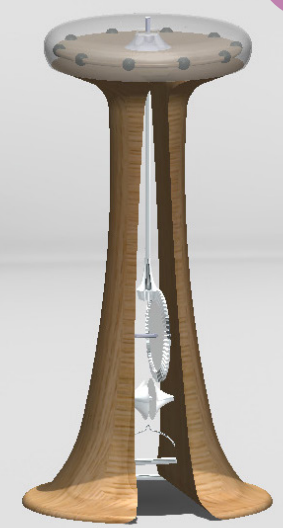
9. Defining final shape

Selecting an aesthetic based on the collages, the design drivers and the global part placement, making renders in Blender.

10. Detailing

Modelling the product in SolidWorks for the right dimensions. Making technical drawings and prepare for prototyping *Appendix L*.

10

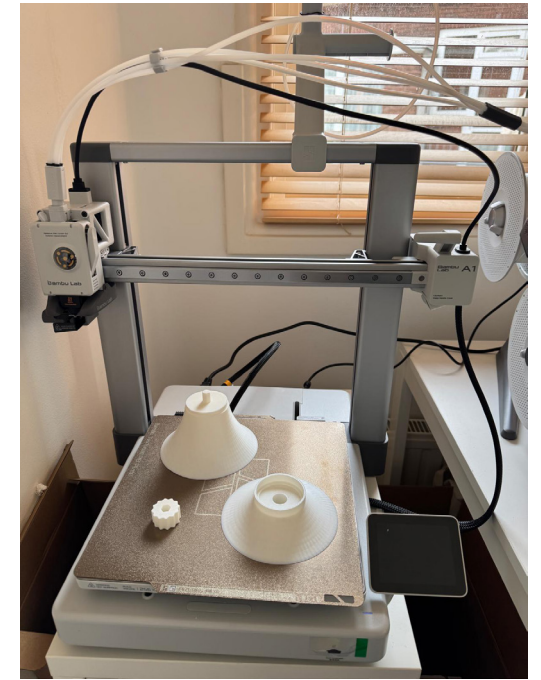




11. Prototyping

A prototype is made to support the design vision of the Frankfurter Kitchen of the Future. The prototype is made as a showcase in the context of the (MAK) museum. The prototype focuses on conveying the story rather than being optimised for daily use or production feasibility. This shape serves as inspiration for implementation of the design guidelines on [page 56](#).

During the prototyping, a lot of design decisions have been reviewed and some have been modified for feasibility. The recommendations contain a list of improvements for the current prototype. The materials for the prototype have cost €421,60. The Bill of Materials including costs can be found in the table in [Appendix K](#). For more details on the prototype, see [Appendix L](#).

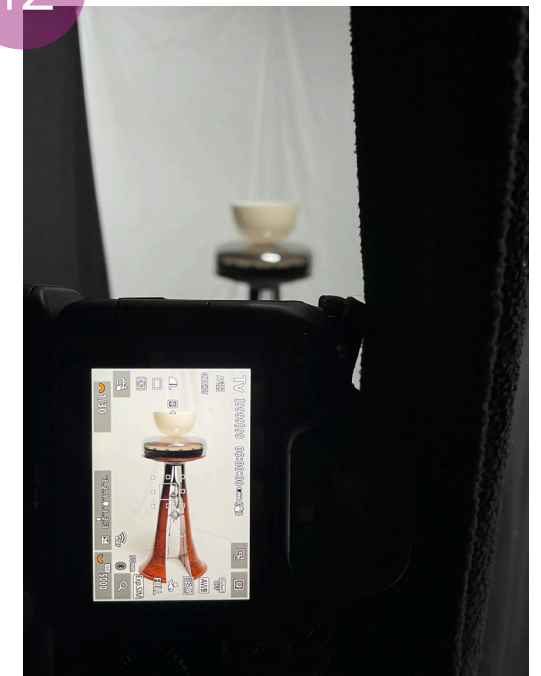


12. Finalising

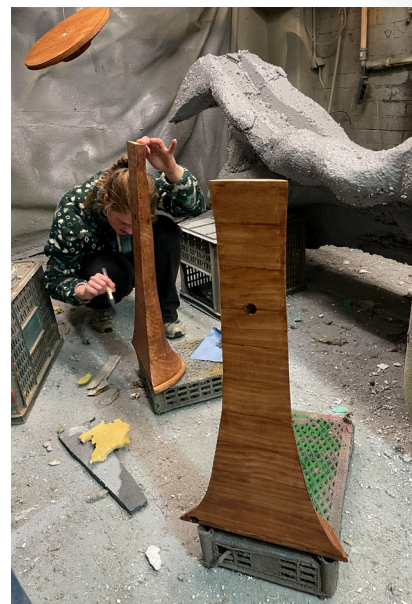
Product pictures in studio and context setting are made for understandability of the product. The current kitchen is used as the product context, although the kitchen in 2040 presumably is less fixed in space.

More behind the scenes during the finalising can be found in [Appendix M](#).

12



11



21 Showcase validation

21.1 Reflecting on product values

The product values influencing the trade-offs that consumers make during the decision to either retain an owned product or replace were explained in *see '4.2 Product values' on page 25*. Each of these values is reflected in the product concept 'The Turning Point'!

Functional

The product powers rotating kitchen tools mechanically, without electricity, making it independent of a power socket and movable. It also combines multiple food processing functions in one central mechanical driver powered by human energy. This reduces energy use and increases durability and reliability by reducing the number of electronic components, while offering direct control over speed and intensity (RPM selection). The product combines functionality with enjoyment, making it FUNctional.



Figure 48. The showcase in kitchen context (Photograph by author)

Emotional

Because the user physically powers the mechanism, cooking becomes embodied and effort-based. This creates satisfaction, pride, and a sense of accomplishment. The interplay with direct feedback and the visible mechanics increase perceived authenticity and craftsmanship.

Social

Cooking for others is seen as an expression of appreciation. The end result is more highly valued when time and effort have been invested in the process. It can become a conversation piece in the kitchen, especially because of its furniture-like aesthetics and visible mechanics. With an developing trend of sustainable living and healthy lifestyles, this is something to be shared.

Epistemic

The product invites experimentation, improving skills over time. The symbiosis that the product-user interaction form, results in the appreciation of the activity.

Conditional

The product is relevant in specific contexts, such as: Off-grid or low-energy households, and during periods of instability where we cannot rely on electricity. It is also ideal for people seeking a healthier lifestyle or more physical experiences, and for those who want to reduce their screen time, increasing taking time for the joyful part of living (slow design).

21.2 Limitations & Recommendations

Change RPM

For the product to replace all electric rotational motors in the kitchen, the mechanism should be further developed. The user should be given the ability to change the ratio of rotations per minute (RPM) and torque. Possibly by stacking multiple planetary gears composing their desired

outcome. This system is used in existing electronic applications.

Pulsing vs. continuous

The optimal mechanic solution for the rotary system should be developed, reducing friction and improving energy efficiency. The attachment and detachment of the flywheel is something for further research, taking inspiration from a lot of existing products with similar systems. The possibility of gradual release of the energy should be considered. For example by connecting or disconnecting



Figure 49. Planetary gear. (Eldoctore, 2014)

the flywheel, making switching between a continuous or pulsing rotation possible. It could have three settings:

1. **Pulsing rotation** - flywheel disconnected
2. **Continuous rotation** - flywheel connected
3. **Pulsing rotation with extra power** - building up speed with flywheel before release.

The flywheel itself should be made of a more stiff material than 9mm popular wood, which is used in the showcase. This material deforms too easily making the weight not evenly distributed.

Adding cut-outs to the flywheel makes the flywheel see-through while rotating. This phenomenon could be used to see the mechanism and own feet during use.

Stability of handle while pumping

The handle which the user holds to pull or pump is very simply designed and not tested for ergonomic satisfaction, so an iteration is recommended. Also the handle should be guided vertically to improve stability while pumping.

Healthy lifestyle

The movement brought in the kitchen will not ensure a healthy lifestyle on its own, it is an addition to other daily activities and does not fully replace the need to exercise. The Turning Point should be one of many products that encourage daily movement.

Concept variation

The future kitchen will presumably not look like the rectangular modules we know now, descended from the Frankfurter Kitchen. It will presumably be a movable furniture piece that can be relocated throughout the house. Just as the centralised mechanical driver, products with a heating element will be compressed to using the heating element in the stove, decreasing the number of separate electronic heating appliances in the kitchen. The application of the concept in different types of future kitchen contexts could be further developed.

Also the possibility to use the concept for other household activities than food preparation is a possible exploration.

User-product relationship over time

Whether the concept results in a more meaningful relationship between user and product is now based on theoretical knowledge. In order to conclude that people will take better care of a design as The Turning Point than they do of existing kitchen appliances, research should be conducted with users taking into account a factor that could not be investigated in this thesis: time.

Conclusion

This final chapter reflects on the outcomes of the graduation project and evaluates how the developed design addresses the initial challenge of reducing premature product replacement in the kitchen.

The design vision redefines cooking from a purely functional necessity into a meaningful, experience-based ritual. The future kitchen will be defined by active engagement, skill development, and personal investment rather than speed, efficiency, and convenience. The vision emphasises a shift towards active participation, where the user becomes an integral part of the cooking process, creating a symbiotic relationship between user and product. By transforming appliances from 'silent servants' into 'instruments', the design encourages users to invest time and effort in them. This strengthens the relationship between user and product, which increases the product's lifetime.

The showcase, 'The Turning Point', translates this vision by showcasing a tangible, mechanical alternative to the electronic 'black box'. The prototype uses visible mechanics to convert human motion to power kitchen tools. The showcase is optimised for museum storytelling rather than immediate daily use, and it challenges the norm for kitchen electronics by showing that its tasks can be completed by users themselves, benefiting from this ambient exercise. People are encouraged to think about the irony of minimizing time and physical effort in the kitchen only to spend that energy later in a gym. They should question whether the desire for maximum efficiency has removed the joy and ritual from cooking. And reflect on the excessive number of similar electronic devices in your kitchen that lead to huge piles of e-waste.

The design bridges the gap between two contrasting personas. For the Eco-Harmonist, the concept aligns naturally with values of sustainability, skill-building, and meaningful engagement. For the Techno-Hedonist, the challenge lies in reframing effort and interaction as desirable experiences rather than inefficiencies. By emphasising control, sensory feedback, and personal mastery, the design appeals even to those driven by convenience.

Besides the elimination of multiple, similar electric motors, the improved relationship

between user and product is key in designing sustainable kitchen tools. Instead of mindless consumption, the product demands active participation, creating a sense of ownership and responsibility. This shift reduces the likelihood of premature replacement, and highlights that the true environmental impact of products lies not only in their repair and disposal, but in their creation. Designing for longer, more meaningful relationships is therefore essential in reducing both visible e-waste and hidden impact.

Kitchen design has always responded to societal needs. In 1926, Margarete Schütte-Lihotzky designed the Frankfurter Kitchen to maximise efficiency and free up time for work and education. A century later, our society has changed, facing new challenges around health, sustainability, and connection. It is time to rethink the kitchen, seeing it not as a factory for food production, but as a space for well-being.

Cooking is an enjoyable, ritualistic process that should encourage user involvement, rather than being dominated by appliances. Act in harmony with your tools to foster meaningful interaction and a lasting attachment. Take time for what truly matters.

In future product design, I will critically consider the use of new technologies, evaluating whether they truly benefit the user and the planet.

Figure 50. World Design Capital at the MAK Museum. (Adapted from Kuhlmann 2026)

22 Innovation timeline

The product is a conceptual design for the Frankfurter kitchen of 2040. Its goal is to inspire short-term product development. Possible inspiration directions are mentioned, however any other sustainable inspiration taken from the concept is appreciated.

Short term

In the short term, people should not be encouraged to dispose of their current owned product to get a longer lasting one, but retain them as long as possible. Regulations will encourage products to be repaired more easily, but safety and electronic devices in a kitchen environment remain a safety concern.

The group of products that actively involve the user in making cooking an experience, such as mortars, manual pasta makers and ritualistic coffee machines will grow. Products will evolve in small steps, including more elements that encourage an active role.

It is possible that companies want to implement technologies such as AI in every domestic activity and appliance, just as happened with the introduction of electricity. Designers have a responsibility to ensure that AI is only used for products that offer significant benefits.

Braun will shift its focus from efficiency to experience, bringing its silent servants to the foreground.

Long term

When people cook in 2040, they perform an experience-based ritual, allowing themselves to take time for this activity. The movable kitchen consists of two main energy drivers: one for mechanical processing of food, and one for temperature regulation, eliminating the high amount of heating elements found in kitchen appliances today. The kitchen could be shaped around a modular 'Turning Point', 'Heating Point' and 'Water Point'.

A mechanical rotary driver as 'The Turning Point' can have various shapes according to people's personal interests and the shape of their cooking environment. For example, built-in their movable kitchen or as a separate unit.

Braun focuses on selling or renting experiences rather than objects. When a product is bought, the consumer thinks about the responsibility of owning and maintaining an appliance.

23 References

During the documentation of this work, I used DeepL Write & Translate to help formulating my findings. In addition, I have occasionally used ChatGPT as a tool to structure my thoughts and to make Figure 30. After using these tools, I thoroughly reviewed and edited the content as needed, taking full responsibility for the final outcome.

- Ackermann, L., Mugge, R., & Schoormans, J. (2018). Consumers' perspective on product care: An exploratory study of motivators, ability factors, and triggers. *Journal of Cleaner Production*, 183, 380-391. <https://doi.org/10.1016/j.jclepro.2018.02.099>
- Alcott, B. (2005). Jevons' paradox. *Ecological economics*, 54(1), 9-21. <https://doi.org/10.1016/j.ecolecon.2005.03.020>
- Alzheimer's Society (n.d.). Physical activity and the risk of dementia. Retrieved February 21, 2026, from <https://www.alzheimers.org.uk/about-dementia/managing-the-risk-of-dementia/reduce-your-risk-of-dementia/physical-activity>
- Am Recycling (n.d.). *E-waste* [Photograph]. <https://amrecycling.nl/werkgebieden/e-waste/>
- Antoni Shkraba Studio (2020). *Man vent kerel sport*. [Photograph] Pexels. <https://www.pexels.com/nl-nl/foto/man-vent-kerel-sport-5878673/>
- ArtMassa (2020). *Vele mensen die in het stadscentrum in Wenen lopen*. [Photograph] Adapted from iStockPhoto. <https://www.istockphoto.com/nl/foto/vele-mensen-die-in-het-stadscentrum-in-wenen-lopen-gm1204988402-346931588>
- Aubrey, A. (2014, March 28). *Why We Got Fatter During The Fat-Free Food Boom*. NPR. <https://www.npr.org/sections/thesalt/2014/03/28/295332576/why-we-got-fatter-during-the-fat-free-food-boom>
- Bakker, CA., den Hollander, MC., van Hinte, E., & Zijlstra, Y. (2022). *Products that last: Product design for circular business models*. (2nd ed.). Bis Publishers.
- Baldé, C. P., Kuehr, R., Yamamoto, T., McDonald, R., D'Angelo, E., Althaf, S., Bel, G., Deubzer, O., Fernandez-Cubillo, E., Forti, V., Gray, V., Herat, S., Honda, S., Iattoni, G., Khatriwal, D. S., Luda di Cortemiglia, V., Lobuntsova, Y., Nnorom, I., Pralat, N., & Wagner, M. (2024). *Global E-waste Monitor 2024*. United Nations University (UNU), International Telecommunication Union (ITU) and United Nations Institute for Training and Research (UNITAR). Geneva/Bonn
- Cambridge Dictionary (n.d.). *Meaning of symbiosis in English*. Retrieved November 24, 2025, from <https://dictionary.cambridge.org/dictionary/english/symbiosis>
- Chesser, L. (2015). *Young Indian man wearing Apple Watch* [Photograph]. Adapted from <https://unsplash.com/photos/person-clicking-apple-watch-smartwatch-rCOWMC8qf8A>
- Berg, L. L., & Hebrok, M. (2024). Holding on or letting go: Conflicting narratives of product longevity. *Resources, Conservation and Recycling*, 210, 107834. <https://doi.org/10.1016/j.resconrec.2024.107834>
- Berliner Zeitung. (2017, October 9). *Erster Supermarkt der Welt: Das Piggly-Wiggly-Konzept*. Berliner Zeitung. <https://www.berliner-zeitung.de/politikgesellschaft/erster-supermarkt-der-welt->

das-piggly-wiggly-konzept-li.13128

- Braun. (2021). *Design and Craftsmanship*. Timeline. <https://uk.braun.com/en-gb/design-and-craftsmanship/timeline>
- Braun Household (n.d.). *Good design is* [Screenshot]. Braun Household. <https://www.braunhousehold.com/en-us/braun-100-years>
- Braun Household (n.d.). Staafmixers. Retrieved November 14, 2025, from https://www.braunhousehold.com/nl-nl/producten/voedselbereiding/staafmixer/c/hand_blenders
- Carlsson, S., Mallalieu, A., Almfelt, L., & Malmqvist, J. (2021). Design for longevity-a framework to support the designing of a product's optimal lifetime. *Proceedings of the Design Society, 1*, 1003-1012. <https://doi.org/10.1017/pds.2021.100>
- Cavolt, J., Dean, K., White, M., & Salita, H. (2017). *Impact on American Society – The Microwave*. <https://historyoftech.mcclurken.org/microwave/the-impact/>
- Coen-Pirani, D., León, A., & Lugauer, S. (2010). The effect of household appliances on female labor force participation: Evidence from microdata. *Labour Economics, 17*(3), 503-513. <https://doi.org/10.1016/j.labeco.2009.04.008>
- Directive - EU - 2024/1799 - EN - EUR-Lex. (n.d.). <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024L1799>
- EEA (n.d.). *Western Europe*. Retrieved November 10, 2025, from <https://www.eea.europa.eu/help/glossary/gemet-environmental-thesaurus/western-europe>
- Entken, D. (2023). *Group picture with Dieter Rams*. [Photograph].
- Eldoctore (2014). *Planetary reducer from metallic gear on white background* [Image]. iStock. <https://www.istockphoto.com/nl/foto/planetary-reducer-from-metallic-gear-on-white-background-gm503889417-44249122?searchscope=image%2Cfilm>
- Ellen MacArthur Foundation (2022). The technical cycle of the butterfly diagram. <https://www.ellenmacarthurfoundation.org/articles/the-technical-cycle-of-the-butterfly-diagram>
- Escoffier School of Culinary Arts. (2022). *What is fusion cuisine?* <https://www.escoffier.edu/blog/world-food-drink/whats-the-status-of-fusioncuisine/>
- European Commission. (2022). *Recycled plastic packaging in contact with food*. EUR-Lex. <https://eur-lex.europa.eu/EN/legal-content/summary/recycled-plastic-packaging-in-contact-with-food.html>
- European Environment Agency (2024). *Evolution in average lifespans of household appliances*. <https://www.eea.europa.eu/en/circularity/sectoral-modules/product-lifespans/evolution-in-average-lifespans-of-household-appliances>
- European Parliament (2024, May 17). *How the EU wants to achieve a circular economy by 2050*. <https://www.europarl.europa.eu/topics/en/article/20210128STO96607/how-the-eu-wants-to-achieve-a-circular-economy-by-2050>

- Fleck, A. (2024). *Overconsumption: The Growing Desire for Ever More Devices*. Statista TU Delft. <https://www.statista.com/chart/32691/average-number-of-devices-and-connections-per-capita/>
- Freepik (n.d.) *Cheerful Greyhaired Seniors enjoying dancing tango after cooking dinner kitchen* [Photograph]. Retrieved January 29, 2026 from https://www.freepik.com/premium-ai-image/cheerful-greyhaired-seniors-enjoying-dancing-tango-after-cooking-dinner-kitchen_54650575.htm
- Freitas, V. (2018). *Topless man using rowing machine* [Photograph]. Unsplash <https://unsplash.com/photos/topless-man-using-rowing-machine-KkYWWpurqBE>
- Garcia-Rada, X., Steffel, M., Williams, E. F., & Norton, M. I. (2022). Consumers value effort over ease when caring for close others. *Journal of Consumer Research, 48*(6), 970-990. <https://doi.org/10.1093/jcr/ucab039>
- Grosse-Hering, b., Mason, J., Aliakseyeu, D., Bakker, C., Desmet, P. (2013). Slow Design for Meaningful Interactions. *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 3431-3440). <https://doi.org/10.1145/2470654.2466472>
- Hauschild, M. Z. (2015). Better-but is it good enough? On the need to consider both eco-efficiency and eco-effectiveness to gauge industrial sustainability. *Procedia CIRP, 29*, 1-7. <https://doi.org/10.1016/j.procir.2015.02.126>
- Hawthorne, B.D. & Ameta, G. (2012) LCA Study and Comparison of Two Multispeed Blenders. *International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, 2*, 997-1002. <https://doi.org/10.1115/DETC2011-48612>
- Horeca.com(2024). *Deeg kneden met een keukenmachine, planeetmenger of deegmenger* [Photograph]. <https://www.horeca.com/nl/blog/190/deeg-kneden-met-een-keukenmachine-planeetmenger-of-deegmenger>
- Ihr Braun Shop (n.d.). *Versandoptionen* Retrieved October 1, 2025, from <https://shop.braun.de/c/informationen/versandbedingungen/>
- Imani (2018). *Woman sewing purple textile* [Photograph]. Unsplash. Adapted from https://unsplash.com/photos/woman-sewing-purple-textile-_TuldedBPwQ
- Jordahn, S. (2019, March 5). *Dieter Rams "regrets contributing to culture of overconsumption" says documentary director*. Dezeen. <https://www.dezeen.com/2019/03/05/dieter-rams-documentary-gary-hustwit-interview/>
- Katt, S. (2020). *Snijd Zwarte Vrouw Kussen Hond Op Bed* [Photograph]. Pexels. <https://www.pexels.com/nl-nl/foto/snijd-zwarte-vrouw-kussen-hond-op-bed-5256106/>
- Kinghoff (n.d.) *Kinghoff Set van 2 Zwaartekracht Peper- en Zoutmolens*. Bol. Retrieved November 15, 2025 from <https://www.bol.com/be/nl/p/kinghoff-set-van-2-zwaartekracht-peper-en-zoutmolens-elektrisch-keramisch-maalmechanisme-led-verlichting-matte-zwart/9300000066987800/>
- Kirchherr, J., Reike, D., & Hekkert, M. (2017). *The 9R Framework* [Image]. Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, conservation and recycling, 127*, 221-

232. <https://doi.org/10.1016/j.resconrec.2017.09.005>

- Kramer, K.-L. (2012). Sustainability, User Experience, and Design. *User Experience in the Age of Sustainability*. pp 1-30. <https://doi.org/10.1016/B978-0-12-387795-6.00001-9>
- Kuhlmann, B. (2026). WDC Hub Museum Angewandte Kunst [Photograph]. Museum Angewandte Kunst. <https://www.museumangewandtekunst.de/en/visit/exhibitions/wdc-hub/>
- Kuijjer, L. & Laschke, M. (2024). Designing for a Post-Growth Society through the Eco-Harmonist. A Critical Examination of the Role of HCL and Technology Design. *NordiCHI '24: Proceedings of the 13th Nordic Conference on Human-Computer Interaction* Article 69 Association for Computing Machinery, Inc.. <https://doi.org/10.1145/3679318.3685405>
- Liegey, P. R. (2017, August 14). *Microwave oven regression model: U.S. Bureau of Labor Statistics*. <https://www.bls.gov/cpi/quality-adjustment/microwave-ovens.htm>
- Lopes Ramos, A. (2016, May 20). *A brief history of the kitchen. John Desmond Ltd*. <https://www.johndesmond.com/blog/design/a-brief-history-of-the-kitchen/>
- Mayoosan, J. (2024). *a black and white photo of a shopping mall* [Photograph]. <https://unsplash.com/photos/a-black-and-white-photo-of-a-shopping-mall--Ld5xooHVyo>
- MoMa (1926). *The Frankfurt Kitchen: view toward the window* [Photograph]. Counter Space. https://www.moma.org/interactives/exhibitions/2010/counter_space/the_frankfurt_kitchen/
- MoMa (2010). *the frankfurt kitchen*. Counter Space. https://www.moma.org/interactives/exhibitions/2010/counter_space/the_frankfurt_kitchen/
- Moyo, H. N. (2024). The Impact of Food Processing Techniques on Nutrient Retention and Bioavailability. *International Research Journal of Engineering and Technology*, 8(2), 435-460. https://www.researchgate.net/publication/384146758_The_Impact_of_Food_Processing_Techniques_on_Nutrient_Retention_and_Bioavailability
- Mugge, R., Schoormans, J. P., & Schifferstein, H. N. (2008). Product attachment: Design strategies to stimulate the emotional bonding to products. *Product experience* (pp. 425-440). Elsevier. <https://doi.org/10.1016/B978-008045089-6.50020-4>
- Mugge, R. (2024). *The other side of early obsolescence: we need to change the way we value what we own*. Euroconsumers. <https://www.euroconsumers.org/opinions/the-other-side-of-early-obsolescence-we-need-to-change-the-way-we-value-what-we-own/>
- Murakami, S., et al. (2010) Lifespan of Commodities, Part I: The Creation of a Database and Its Review. *Journal of Industrial Ecology Vol. 14 (4)*, pp 598-612. <https://doi.org/10.1111/j.1530-9290.2010.00250.x>
- National Academy of Sciences (2015, May 8). *Lessons from the Blue Zones*. National Library of Medicine. <https://www.ncbi.nlm.nih.gov/books/NBK298903/>
- Oldenziel, R., & Berendsen, M. (2001). *Techniek in Nederland in de twintigste eeuw*. DBNL. https://www.dbnl.org/tekst/lint011tech04_01/lint011tech04_01_0002.php#005
- Only Once (2022). *Dieter Rams 10 principles of good Design* [Image]. <https://onlyonceshop.com/blog/>

dieter-rams-10-principles-of-good-design

- Pione, A., Medalsy, J., Weaver, K., & Rickert, S. (2025, May 29) *The \$2 trillion global wellness market gets a millennial and Gen Z glow-up*. McKinsey & Company. <https://www.mckinsey.com/industries/consumer-packaged-goods/our-insights/future-of-wellness-trends>
- Porcellijn, B. (2018). *The impact top 10 of the average Dutch person*. My Hidden Impact <https://myhiddenimpact.com/en/top-10>
- RCPhotostock (n.d.). *Frankfurt skyline at night in black and white colors* [Photograph]. Freepik. Retrieved from https://www.freepik.com/premium-photo/frankfurt-skyline-night-black-white-colors_29754288.htm
- Regulation - 2023/1542 - EN - EUR-Lex. (n.d.). <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023R1542>
- Regulation - EU - 2024/1781 - EN - EUR-Lex. (n.d.). <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1781>
- Right to Repair Europe (2024). Current State of EU Right to Repair. Brussels. <https://repair.eu/wp-content/uploads/2024/10/Current-State-of-EU-Right-to-Repair-Right-to-Repair-Europe.pdf>
- Roskladka, N., Jaegler, A., & Miragliotta, G. (2023). From “right to repair” to “willingness to repair”: Exploring consumer’s perspective to product lifecycle extension. *Journal of Cleaner Production*, 432, 139705. <https://doi.org/10.1016/j.jclepro.2023.139705>
- Schifferstein, H. N. J., & Zwartkruis-Pelgrim, E. P. H. (2008). Consumer-product attachment: Measurement and design implications. *International Journal of Design*, 2(3), 1-14.
- Šeruga, K. (2024, November 12). *'That damned kitchen!' How the inventor of the fitted kitchen came to see it as a curse*. The Guardian. <https://www.theguardian.com/artanddesign/2024/nov/12/damned-kitchen-inventor-fitted-frankfurt-margarete-schutte-lihotzky>
- Sheth, J. N., Newman, B. I., & Gross, B. L. (1991). Why we buy what we buy: A theory of consumption values. *Journal of business research*, 22(2), 159-170. [https://doi.org/10.1016/0148-2963\(91\)90050-8](https://doi.org/10.1016/0148-2963(91)90050-8)
- Spetnitskaya, N. (2018). *Person making dough beside brown wooden rolling pin* [Photograph]. Unsplash. <https://unsplash.com/photos/person-making-dough-beside-brown-wooden-rolling-pin-tOYiQxF9-Ys>
- Sun, H., Granato, G., & Mugge, R. (2025). Design Strategies to Strengthen Epistemic Value in Consumer Electronics and Prolong Product Lifetime. In L. Nhu Laursen, & A. Kornmaaler Hansen (Eds.), *Proceedings of the 6th Product Lifetimes and the Environment Conference (PLATE2025)* Article 10369 [Proceedings of the 6th Product Lifetimes and the Environment Conference (PLATE2025); No. 6]. Aalborg University. <https://doi.org/10.54337/plate2025-10369>
- Taste (n.d.). Top 100 easy dinner recipes [Photograph]. Retrieved November 12, 2025 from <https://www.taste.com.au/quick-easy/galleries/top-100-easy-dinner-recipes/biccuul7>
- Van Adrichem, A. (2026a). *Interaction between the user and The Turning Point*. [Photograph]. Personal

archive.

- Van Adrichem, A. (2026b). *The user chooses which movement will lead to the rotation: pulling or pumping*. [Photograph]. Personal archive.
- Van Boeijen, A.G.C., Daalhuizen & J.J., Zijlstra, J.J.M. (Eds.), (2020, Rev. ed.). *Delft Design Guide*. Amsterdam: BISPublishers
- Van den Berge, R., Magnier, L., & Mugge, R. (2021). Too good to go? Consumers' replacement behaviour and potential strategies for stimulating product retention. *Current opinion in psychology*, 39, 66-71. <https://doi.org/10.1016/j.copsyc.2020.07.014>
- Van den Berge, R., Magnier, L., & Mugge, R. (2023). Until death do us part? In-depth insights into Dutch consumers' considerations about product lifetimes and lifetime extension. *Journal of Industrial Ecology*, 27, 908-922. <https://doi.org/10.1111/jiec.13372>
- Van Dijk, M. & Hekkert, P. (2020). *VIP Vision in Design*. Bis Publishers
- Wan, J., O'Grady, M. J. & O'Hare, G. M. P. (2009). Implicit interaction : a modality for ambient exercise monitoring. *Human-Computer Interaction*. <http://dx.doi.org/10.1007/978-3-642-03658-3>
- Wittebrood, W. (2025, July 7). Hans Stegeman (Triodos): 'Maatwerkafspraken met Shell en BP? Dat was een dom idee' Change Inc. <https://www.change.inc/transities/leiderschap-transitie/hans-stegeman-triodos-bank-duurzaamheid-economie-groene-groei>
- WDO (n.d.). About WDC 2026 [Image]. <https://wdc2026.org/en/about-wdc-2026>
- Wierda, L. & Zanuttini, A. (2025). Ecodesign impact accounting overview report. *Van Holsteijn en Kemna BV for European Commission*. <https://circabc.europa.eu/ui/group/418195ae-4919-45fa-a959-3b695c9aab28/library/e2a752ef-c365-41df-8e50-98376e6ca756/details>
- Wolfson, J. A., Bleich, S. N., Smith, K. C., & Frattaroli, S. (2016). What does cooking mean to you?: Perceptions of cooking and factors related to cooking behavior. *Appetite*, 97, 146-154. <https://doi.org/10.1016/j.appet.2015.11.030>
- Wrangham, R. W. (2010). *Catching fire: How Cooking Made Us Human*. Basic Books (AZ)
- Zapalac, K., Miller, M., Champagne, F. A., Schnyer, D. M., & Baird, B. (2024). The effects of physical activity on sleep architecture and mood in naturalistic environments. *Scientific Reports*, 14(1), 5637. <https://www.nature.com/articles/s41598-024-56332-7>
- Zukunftsinstitut (2023, December 19). The Megatrends. <https://www.zukunftsinstitut.de/zukunftsthemen/dossier/megatrends-en>

24 List of Figures

- Figure 1. Bas helping me capture the final prototype.
- Figure 2. Our self-claimed 'office' at IDE Faculty.
- Figure 3. E- waste [Adapted from Amrecycling, n.d]
- Figure 4. Frankfurt is the World Design Capital in 2026. (WDO, n.d.)
- Figure 5. ViP method is used to create value and meaning to a design by describing the future context. (Image made by author)
- Figure 6. The Frankfurt Kitchen: view toward the window (MoMa, 1926)
- Figure 7. Visualisation of the steps in the cooking process. (Background image adapted from taste, n.d.)
- Figure 8. Braun logo, recognisable by the capital 'A'. (Braun, 2021)
- Figure 9. Overview of the current product portfolio of Braun Household. (Braun Household, n.d.)
- Figure 10. The ten design principles of Dieter Rams, famous for his designs for Braun. (Only Once, 2024)
- Figure 11. It was an honour to meet Dieter Rams at the Museum Angewandte Kunst (MAK) in Frankfurt. (Entken, 2023)
- Figure 12. The lifespan of selected household appliances has increased from 2019 - 2023. (Adapted from European Environment Agency, 2024)
- Figure 13. Extending the lifespan of products and parts is not always desirable. (Carlsson et al., 2021)
- Figure 14. Psychological process of product replacement. (Van den Berge et al., 2021)
- Figure 15. The values that Braun highlights on the product page of the Braun Multiquick 9 are all functional values. (Braun, n.d.)
- Figure 16. Busy shopping mall (Mayoorezan, 2024)
- Figure 17. A smartwatch telling the user 'Time to stand' and counting steps, making sure a person moves enough (Adapted from Chesser, 2015)
- Figure 18. An electric salt and pepper mill. What problem does it solve? (Kinghoff, n.d.)
- Figure 19. The activity of kneading is replaced by a kitchen mixer saving effort. Now we use other products to stimulate human activity. (Adapted from Spetnitskaya (2018), Horeca.com (2024) and Freitas (2018))
- Figure 20. A question mark from the steam in a pan. (Image generated by Canva AI, 2026)
- Figure 21. The technical cycle of the Butterfly Diagram for products that are used rather than consumed. (Adapted from Ellen MacArthur Foundation, 2019)
- Figure 22. The 9R Framework showing strategies to reduce consumption. (Adapted from Kirchherr, 2017)
- Figure 23. Top 10 categories with the most environmental impact, with possessions the biggest polluter. (Adapted from Porcelijn, 2018)
- Figure 24. Consumer barriers to repair a washing machine, classified within three categories and ordered by importance. (Adapted from Roskladka et al., 2023)
- Figure 25. Time spent using an existing electric juicer versus a slow-design juicer. (Adapted from Grosse-Hering et al., 2013)
- Figure 26. All megatrends defined by Zukunftsinstitut (Adapted from Zukunftsinstitut, 2023).
- Figure 27. Knitting has transformed from a necessity to a hobby. Will cooking become the same? (Adapted from Imani, 2018)
- Figure 28. Infographic of two personas: the techno-hedonist and the eco-harmonist. (Image by the author)
- Figure 29. Vision board for the Eco-Harmonist persona, that invests time in care for others, self, objects and natural surrounding. (Image by the author)
- Figure 30. A stationary airbike in a busy city with commuting people. (Antoni Shkraba Studio (2020) and adapted from ArtMassa (2020); images combined using ChatGPT (OpenAI), 2026.
- Figure 31. Happy couple dancing in a kitchen. (Adapted from Freeplik, n.d.)
- Figure 32. Comparison of the current and future user-product relationship. (Image by the author)
- Figure 33. A loving relationship between user and pet. (Adapted from Katt, 2020)



- Figure 34. Different types of product investment that lead to symbiosis between user and product. (Image by author)
- Figure 35. Global distribution of functionalities electronic kitchen appliances. (Image by the author)
- Figure 36. Inspirational collage for colour, material and finish (CMF). (Image by the author)
- Figure 37. Showcase prototype: 'The Turning Point'. (Photograph by the author)
- Figure 38. Showcase prototype in current kitchen context (Photograph by the author)
- Figure 39. Interaction between the user and The Turning Point (Van Adrichem, 2026a)
- Figure 40. The mechanism is part of the aesthetics. (Photograph by the author)
- Figure 41. The flywheel allows a continuous rotation. (Photograph by the author)
- Figure 42. An universal connector fits to all rotating kitchen tools. (Photograph by the Author)
- Figure 43. The user chooses which movement will lead to the rotation: pulling or pumping. (Van Adrichem, 2026b)
- Figure 44. User experience. (Image by the author)
- Figure 45. Prototype used to juice an orange in context. (Photographs by the author)
- Figure 46. Full prototype (Photograph by the author)
- Figure 47. Visualisation of the mechanism. Input in purple, result in orange. (Image by the author)
- Figure 48. The showcase in kitchen context (Photograph by author)
- Figure 49. Planetary gear. (Eldoctore, 2014)
- Figure 50. World Design Capital at the MAK Museum. (Adapted from Kuhlmann 2026)

Appendix

25 List of appendices

Appendix A. Project Brief	93
Appendix B. EU directives and regulations.....	97
Appendix C. Product values	98
Appendix D. Epistemic value strategies.....	99
Appendix E. Opening the 'black box' of kitchen appliances	100
Appendix F. Brainstorm sessions.....	101
Appendix G. Examples of investment of effort in three phases.....	103
Appendix H. Ergonomic handheld shapes.....	106
Appendix I. C-Box market placement	107
Appendix J. Functional prototype	108
Appendix K. Bill of Materials (BOM)	109
Appendix L. Prototype specifications and technical drawings.....	110
Appendix M. Behind the scenes: capturing prototype	121

Appendix A. Project Brief



Personal Project Brief – IDE Master Graduation Project

Name student **Babette Koppert** Student number **5,019,370**

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT
Complete all fields, keep information clear, specific and concise

Project title Create a lasting relationship between a Braun kitchen appliance and its user to prevent premature replacement.

Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

Introduction

Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

As product designers, we play a crucial role in shaping a sustainable future. The products we create must not only meet functional needs but also align with the environmental and social demands of our time. Yet, many everyday products fail to live up to this expectation.

In Western Europe, the average person owned 9.4 electronic devices in 2023 (Fleck, 2024). As a result, Europe generated 17.6 kg of e-waste per capita in 2022, with a significant portion coming from common household equipment (Baldé et al., 2024). Although academic research in areas such as repairability and circular product design has progressed substantially, its real-world application has not kept pace. Besides, even products that are technically repairable may still be discarded prematurely. For example, 58% of replaced TVs and 16% of replaced washing machines were still functioning at the time of replacement (Mugge, 2024).

Company 'Braun Household' sells domestic appliances based on the principles such as "Good design is simple, useful and built to last" and "Better by design" (Braun Household, n.d.). These values offer an opportunity to align academic insights on product longevity with commercial product development. However, achieving this requires balancing theoretical ideals with real user behaviour and business constraints, creating both a design challenge and an opportunity to make a meaningful impact.

Baldé, C. P., Kuehr, R., Yamamoto, T., McDonald, R., D'Angelo, E., Althaf, S., Bel, G., Deubzer, O., Fernandez-Cubillo, E., Forti, V., Gray, V., Herat, S., Honda, S., Iattoni, G., Khatriwal, D. S., Luda di Cortemiglia, V., Lobuntsova, Y., Nnorom, I., Pralat, N., & Wagner, M. (2024). *Global E-waste Monitor 2024*. United Nations University (UNU), International Telecommunication Union (ITU) and United Nations Institute for Training and Research (UNITAR). Geneva/Bonn

Braun Household (n.d.). *Good design is* [Screenshot]. Braun Household. <https://www.braunhousehold.com/en-us/braun-100-years>

Fleck, A. (2024). *Overconsumption: The Growing Desire for Ever More Devices*. Statista TU Delft. <https://www.statista.com/chart/32691/average-number-of-devices-and-connections-per-capita/>

Mugge, R. (2024). *The other side of early obsolescence: we need to change the way we value what we own*. Euroconsumers. <https://www.euroconsumers.org/opinions/the-other-side-of-early-obsolescence-we-need-to-change-the-way-we-value-what-we-own/>

→ space available for images / figures on next page

introduction (continued): space for images

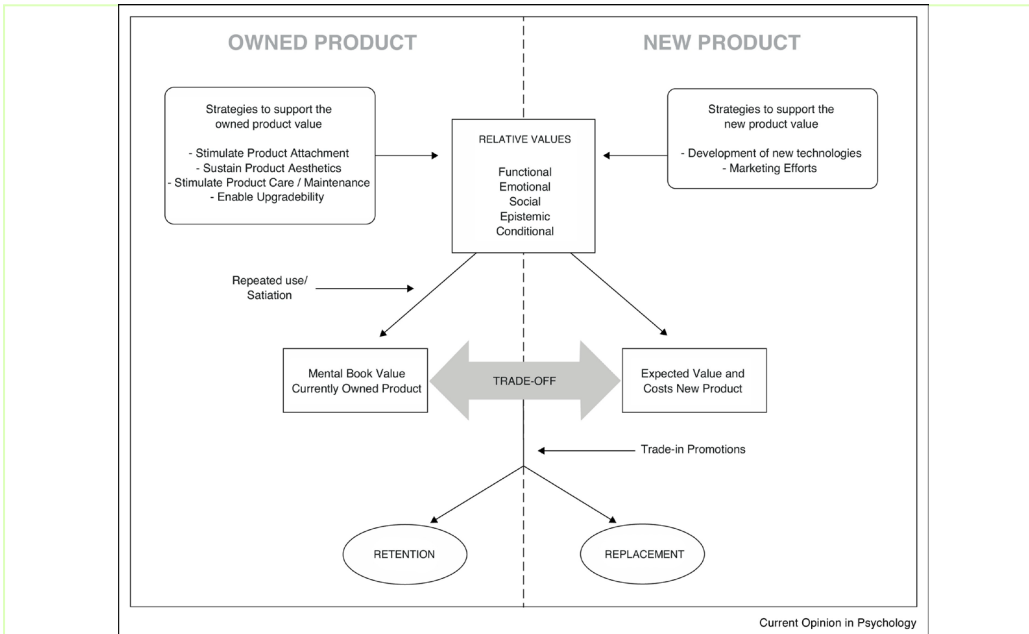


image / figure 1 Psychological process of product replacement (Van den Berge, 2021)

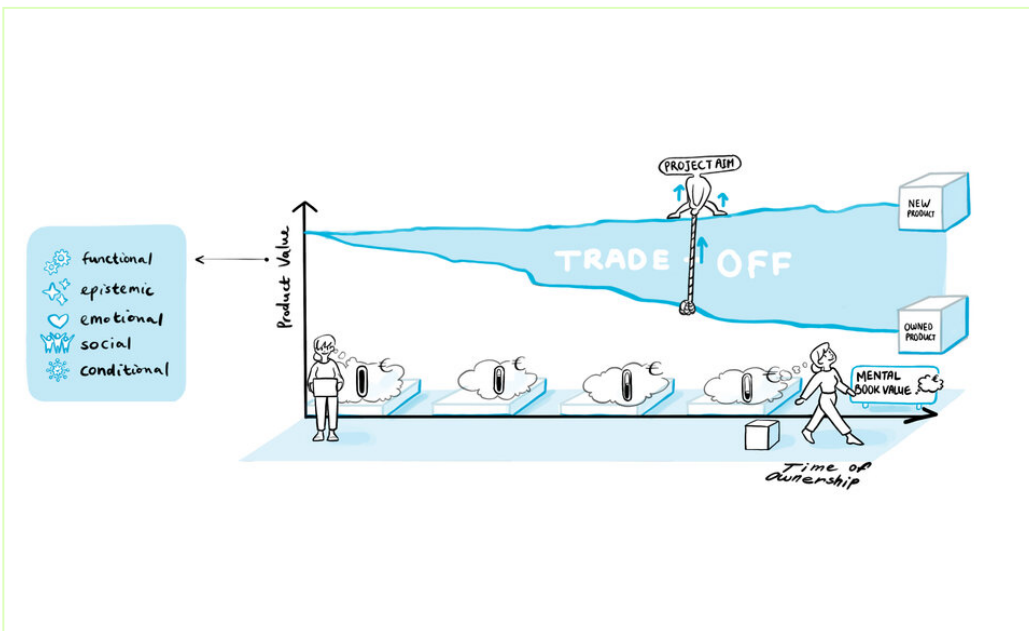


image / figure 2 Encourage longer usage and potentially slow the rate of electronic consumption (Mugge, n.d.)

Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice. (max 200 words)

Academic researchers have developed strategies to reduce premature replacement. For example increasing epistemic value: using novelty, curiosity and changing pace to make a product interesting for a longer period of time (Sun et al., 2025) and to improve willingness to repair (Roskladka et al., 2023). These approaches are still in development and have not been translated to a tangible example yet. As a result, there is a gap between academic strategies, commercial relevance, and how users actually interact with their products in everyday life. The challenge is to bridge the gap, offering Braun research-based inspiration for designing more durable, emotionally engaging products in the future.

The current knowledge will be mapped out and the most promising will be used to create a tangible prototype of a kitchen appliance. This prototype will be used to validate the selection of academic sustainability strategies with Braun and Braun product owners. The main focus is on desirability, but feasibility and viability will also be considered.

Ultimately, this project aims to contribute to reducing premature product replacement by designing consumer electronics that people are more curious about, emotionally connected to, and motivated to maintain/repair.

Roskladka, N., Jaeger, A., & Miragliotta, G. (2023). From "right to repair" to "willingness to repair": Exploring consumer's perspective to product lifecycle extension. *Journal of Cleaner Production*, 412, 139705.
 Sun, H., Granato, G., & Mugge, R. (2025, June). Design Strategies to Strengthen Epistemic Value in Consumer Electronics and Prolong Product Lifetime. In *Proceedings of the 6th Product Lifetimes and the Environment Conference (PLATE2025)* (No. 6).

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for. Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence) As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:

Design a tangible prototype to explore and validate how sustainability strategies such as epistemic value and willingness to repair can encourage a more meaningful and lasting relationship between users and kitchen consumer electronics.

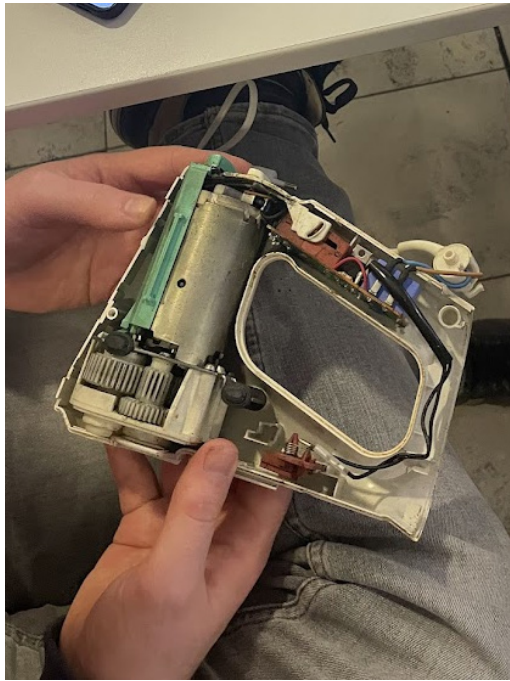
Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)

Strategies to strengthen longlasting product-user-relationships in consumer electronics have been developed by academic designers. These strategies will be mapped out and the most promising strategy for Braun will be further explored and translated into a tangible prototype. As product designers, our relationship with these products often differs from that of the majority of users. To reduce bias this project will follow a User-Centered Design approach (van Boeijen et al., 2020), so continuous interaction with users will guide each phase of the design journey. The project will follow a structured process consisting of the following phases: exploration, analysis, creation, prototyping, validation, iteration, and documentation. Although presented linearly, the process will include multiple iterative design cycles, making use of prototypes and Research through Design (RtD) to explore and validate insights in context.

The final deliverable will be a tangible prototype intended for exhibition at Braun's Future Frankfurter Kitchen, part of the World Design Capital. The designed product aims to encourage visitors to reconsider how they interact with (and ultimately value) their everyday products.

van Boeijen, A.G.C., Daalhuizen & J.J., Zijlstra, J.J.M. (Eds.), (2020, Rev. ed.). *Delft Design Guide*. Amsterdam: BISPublishers

Appendix E. Opening the 'black box' of kitchen appliances

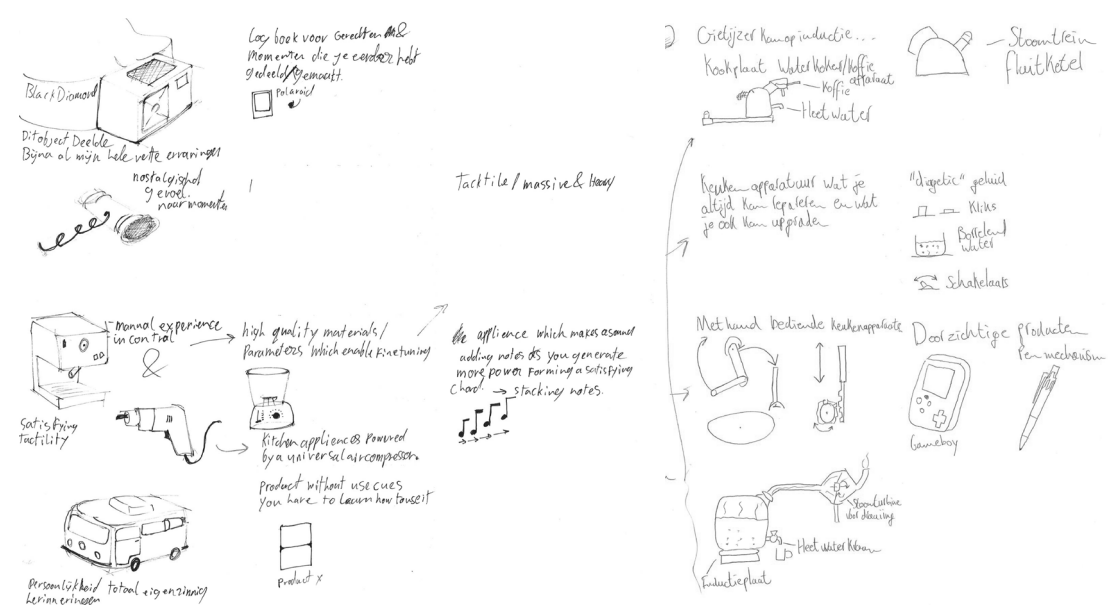
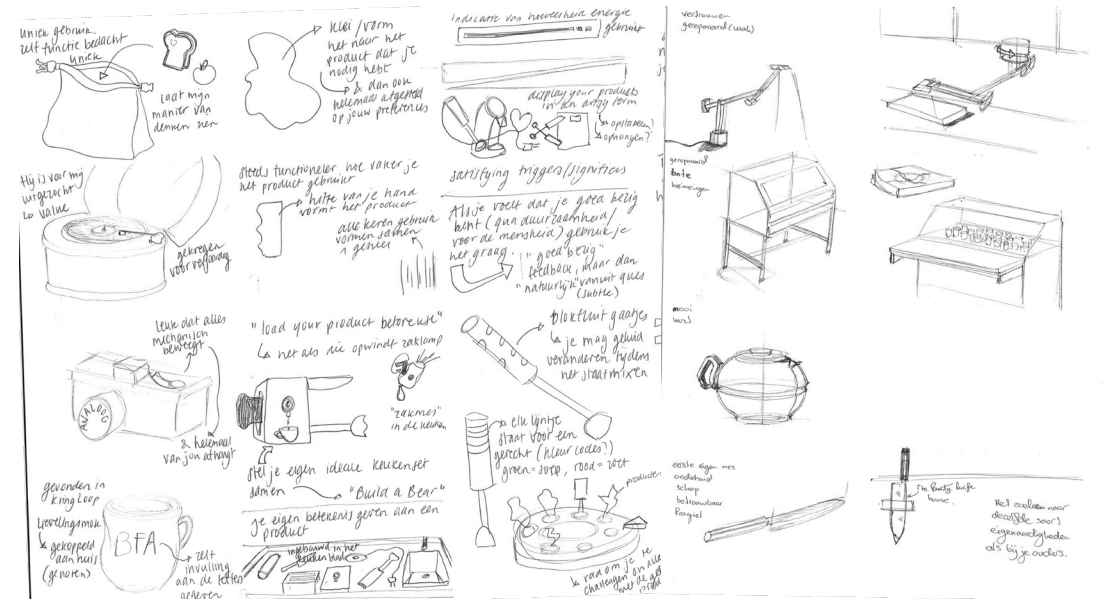


During this project, various Braun appliances were disassembled. The hand mixer (top left) was repaired, but the immersion blenders (top right) had to be cut open in order to reach the inside. When Braun does quality tests, their have no other option to reach the components then to cut the product open.

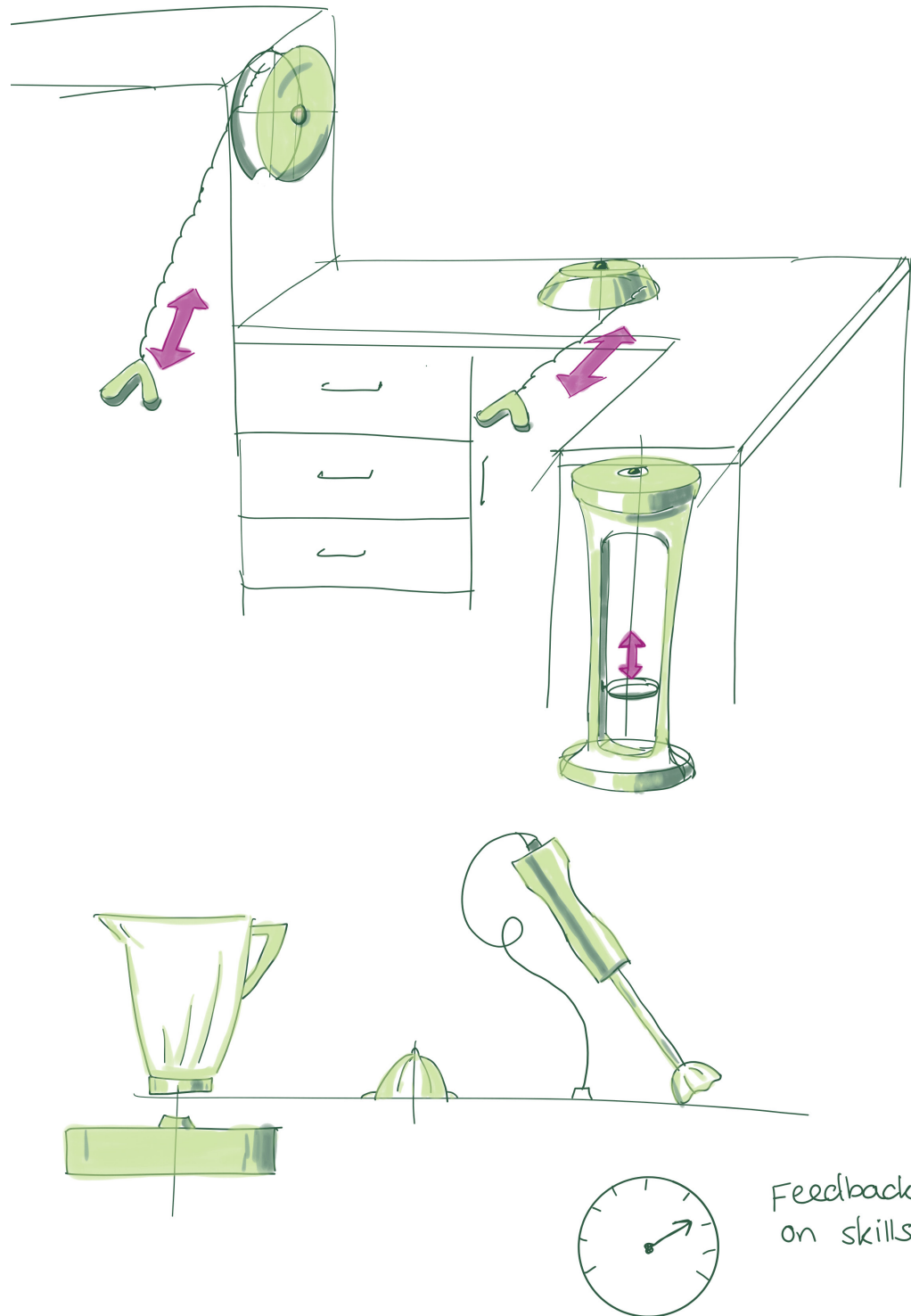
Designers often create the shape of the housing and its interactive elements, while neglecting the design of the inside. On the bottom left, an IKEA hand mixer has been cut open. Although this product does not require electricity, it is designed as a black box, not allowing disassembly.

Appendix F. Brainstorm sessions

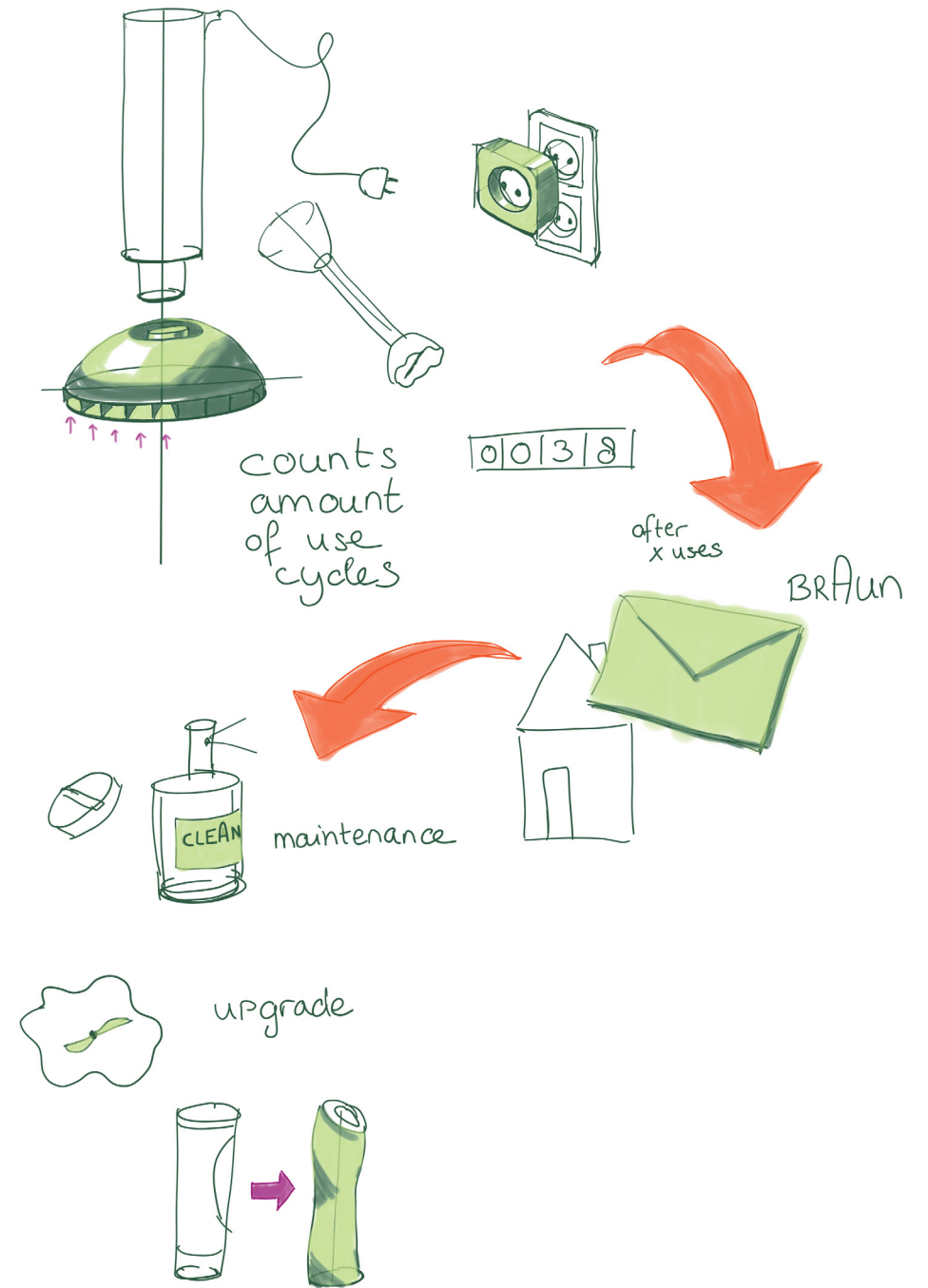
Apart from multiple non-structured brainstorm sessions, three structured brainstorm sessions have been prepared and executed during the ideation phase of the project.



Investment while using the product:
A conscious, active interaction



Investment while caring for the product:
The product asks for attention over time



Appendix H. Ergonomic handheld shapes



1. Most comfortable shape



2. Nice to be able to pull



3. Not entire hand fits



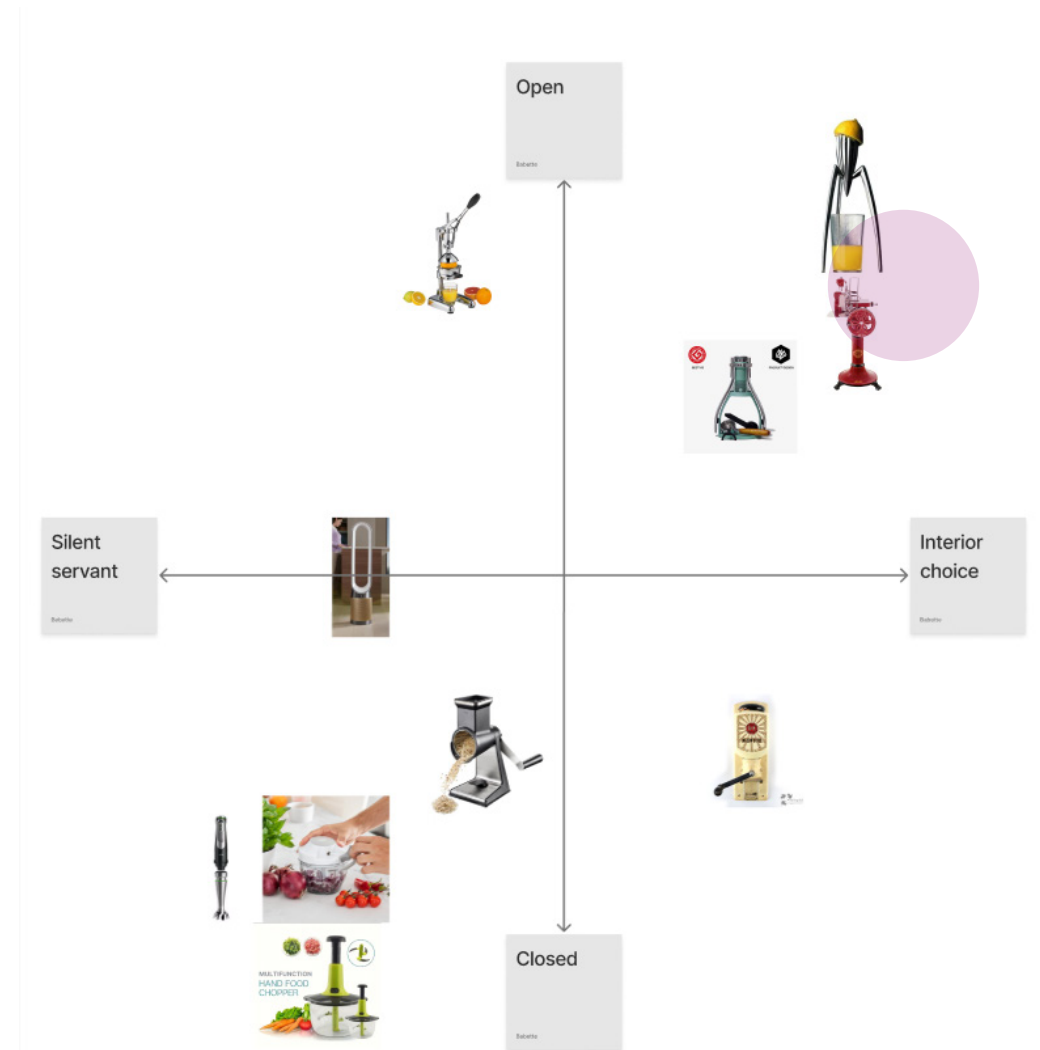
4. Not possible to switch between hands.

Appendix I. C-Box market placement

In the C-Box various domestic products are placed on the axes. The vertical axis says something about the openness of the aesthetic shape. It shows a clear distinction of products that are manually driven, revealing the mechanism, or an open design but with

a closed bottom where the electronics are hidden.

The purple dot is where the product should be placed based on earlier findings.



Appendix J. Functional prototype

A functional prototype was made to simulate the interaction and to determine the required mechanical elements, which is necessary when designing the shape of the product by imitating the interaction.

Bevel gears

In the functional prototype, bevel gears change the direction of the rotation from a horizontal to a vertical rotation. These gears have a ratio of 48:20 teeth = 12:5.

$$\text{Bevel gear ratio} = \frac{\text{driven}}{\text{drive}} = \frac{12}{5}$$

Every time the handle is pulled/pumped (27 cm), the freewheel rotates the axis 1 time. The vertical bevel gear is fixed to this axis. This means that if we pull 50 times per minute (50 RPM), the output RPM is:

$$\text{Output RPM} = \frac{12}{5} \times 50 = 120\text{RPM}$$

Flywheel

The basic working principle of a flywheel is that it absorbs rotational energy and when it is by keeping spinning. In this project, the flywheel is used as stabiliser to get a continuous rotation, not as energy storage. The energy that can be stored in a flywheel will increase with the increase in weight, size, and angular velocity. The impact of these variables can be derived from these formula's:

$$E_k = \frac{1}{2} I \omega^2$$

$$I_{\text{solid disk}} = \frac{1}{2} m r^2$$

$$I_{\text{open disk}} = m r^2$$

$$I_{\text{point mass}} = \sum m r^2$$

The kinetic energy (E_k in J) is depended on

the moment of inertia (I in $\text{kg}\cdot\text{m}^2$) and angular velocity ω (Rad/s). The moment of inertia is depended on mass (m in kg) and radius of the disk (r in m) squared. From this formula we can conclude that it is more effective to increase the radius of the flywheel, than to add more mass.

On the functional prototype, ten weights were placed with a radius of 0,177m from the centre. One weight (nut and bolt) is a point mass of 0,0326 kg. For now, the weight of the plywood disk is neglected. The moment of inertia is therefore:

$$I_{\text{weights}} = 10 \times 0,0326 \times 0,177^2 \approx 0,0102$$

To calculate the kinetic energy, we use an 120 RPM.

$$\omega = \frac{2\pi \times \text{rpm}}{60}$$

This RPM can be adjusted by simply adjusting the gear ratio of the gears.

$$\omega = \frac{2\pi \times 120}{60} = 12,57 \text{ Rad/s}$$

$$E_k = \frac{1}{2} 0,0102 \times 12,57^2 \approx 0,806 \text{ J}$$

This knowledge gives two main insights:

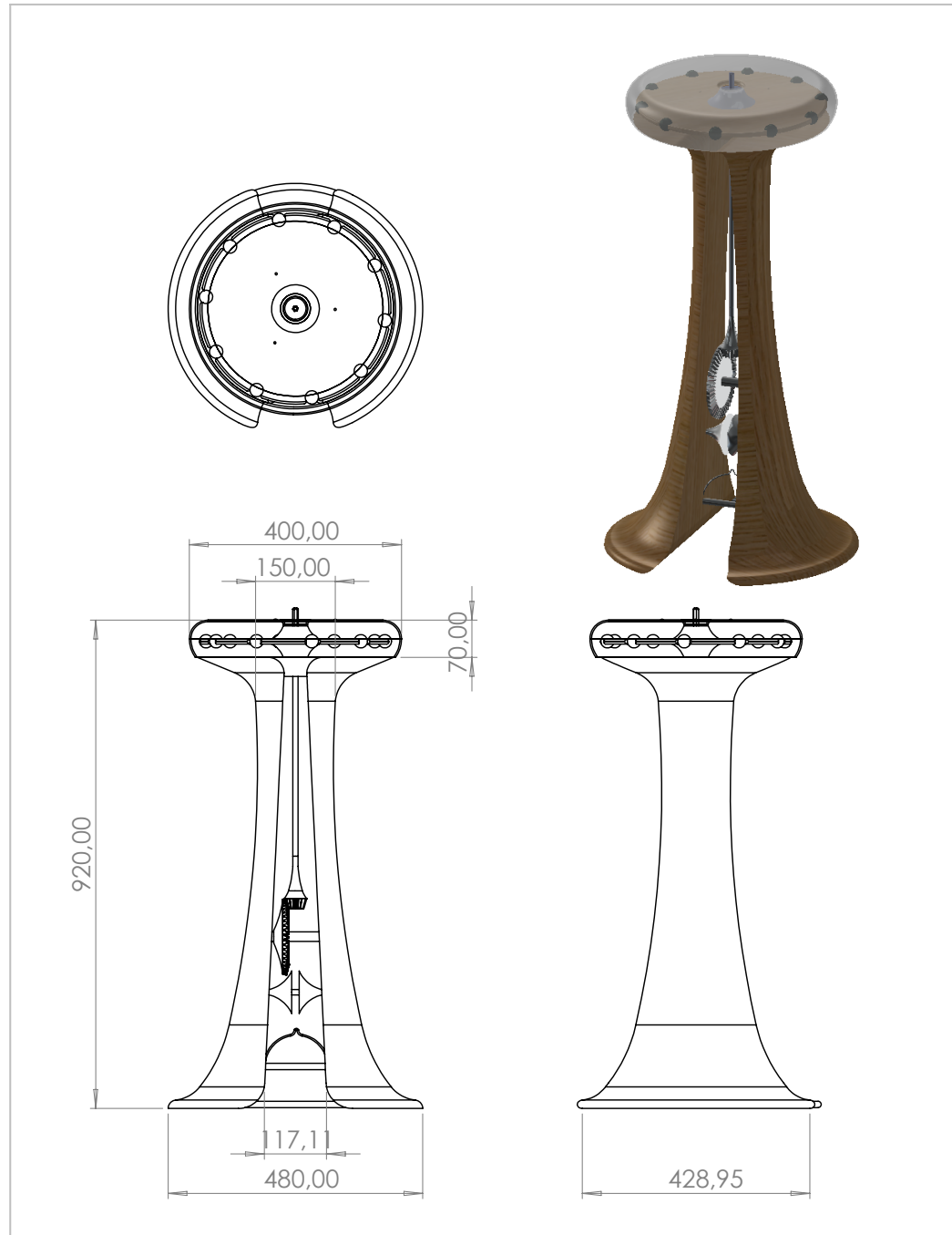
1. It confirms that the flywheel is only used to distribute energy created by pulling or pumping, to make a pulsing rotation more continuous.

2. In future iterations, higher gear ratios, heavier weights and a big radius should be included in the design in order to create the desired circumstances for various appliances.

Appendix K. Bill of Materials (BOM)

Main	Main part	Amount	Size	Material	Production	Waar	Shop	Costs
1	Main Base							
1.1	Wood	2	7,5 x 15 x 245 cm	Radiata Pine	https://nl.pinterest.co	Alter Ego	Buurman en Bu	€ 67,00
1.2	Pipe bottem	2	D12mm	Aluminium	Bending	PMB	PMB shop	€ 5,00
1.3	Top ring to tight fit the glass cover	1	414mm	Multiplex Poplar	Lasercut	PMB	PMB shop	€ 13,04
1.4	Top wood Circles	4	D200; D320; D380; D420mm	Pine	Band saw	PMB	Gamma	€ 36,99
1.5	Bearings top and bottom ase for axis	2	D8, D22, 7mm	Bearing	-	Alter Ego	Hornbach	€ 2,85
2	Glass cover							
2.1	Glass cover	1	D420mm	Glass	Lamp shade	Kosilamp	Kosilamp	€ 149,00
3	Flywheel							
3.1	Disk	1	D380 mm, 9mm	Multiplex Poplar	Lasercut	PMB	PMB shop	€ 18,20
3.2	Weights	10	D25mm	Marble	Push in place	Alter Ego	Intertoys	€ 2,58
3.3	Bearing Top Cover + connection	1	D90 - 410mm	PLA	3D print	At home	Bambulab	€ 25,00
3.4	Bearing Bottom Cover	1	D90 - 460mm	PLA	3D print	At home	Bambulab	€ 0,00
3.5	Kogeltaatslager	1	D25, D42, 11mm	Bearing	-	At home	123kogellager	€ 4,39
3.6	Kogeltaatslager pressure nut around ax	1	D8, D19, 7mm	Bearing	-	At home	123kogellager	€ 6,87
3.7	Inslagmoer (T-Nut)	2	M8	Metal	-	Alter Ego	Hornbach	€ 2,75
4	Gears							
4.1	Bevel pinion	1	D10mm; D43mm; H19, 7mm	PLA	3D print	At home	Bambulab	€ 0,00
4.2	Bevel gear	1	D178mm; 8mm	PLA	3D print	At home	Bambulab	€ 0,00
4.3	Freewheel	1	Dbinnen22,2mm; Dbuiten60mm		-	Alter Ego	Decathlon	€ 13,95
4	Finish	1	-	Chrome finish	Spray paint	Alter Ego	Gamma	€ 12,79
4	Finish	1	-	Primer	Spray Paint	Alter Ego	Gamma	€ 12,79
4.5	Rotating Axis	1	8mm	Steel	-	Alter Ego	PMB Shop	€ 7,32
4.6	Bearings top and bottom ase for axis	2	D8, D22, 7mm	Bearing	-	Alter Ego	Hornbach	€ 2,85
4.7	Linear Axis	1	M8	Steel	-	Alter Ego	Hornbach	€ 1,30
4.8	Linear Axis buis	1	10mm	Aluminium chrome	-	Alter Ego	Hornbach	€ 2,45
5	Hinge							
5.1	Hinge axis	1	D4mm; 130mm	steel	-	PMB	PMB Shop	€ 0,00
5.2	Hinge cover	2	D80 - D8mm	PLA	3D print	Alter Ego	Bambulab	€ 0,00
5.3	Touwrol Polyamide	1	D40; 200mm	Polyamide	-	Alter Ego	Hornbach	€ 2,95
6	Handle							
6.1	Aluminium pipe	1	12mm	aluminium	Bending; colour	PMB	PMB	€ 0,00
6.2	Rope	1	300mm	PP	-	Hornbach	Hornbach	€ 8,95
6.3	Bicycle Chain	1	260mm	Steel	-	Gamma	Gamma	€ 11,99
6.4	Elastic rope	1	D4mm; 400mm	latex/Poly	-	Gamma	Gamma	€ 10,59
7	Planetary Gears							
7.1	Cover	1	tbd	Wood	Lathe			
7.2	Gears	4	tbd	PLA	3D print	At Home	Bambulab	
								€ 421,60

Appendix L. Prototype specifications and technical drawings



	units	mm	scale	1:10	quantity	1	date	31/03/2026	remark	<<remarks>>
material			mass	gr						
author	Babette Koppert		group	<<group>>		 Delft University of Technology				
name	Full Prototype				format	A4	drawing no.	1		

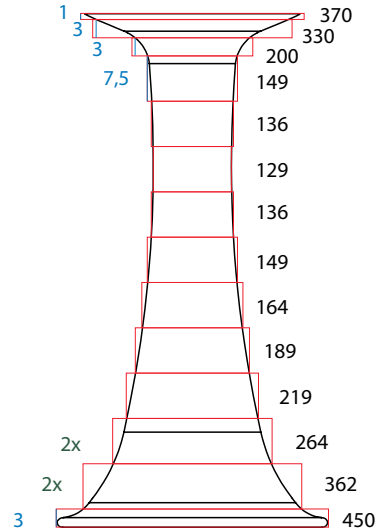
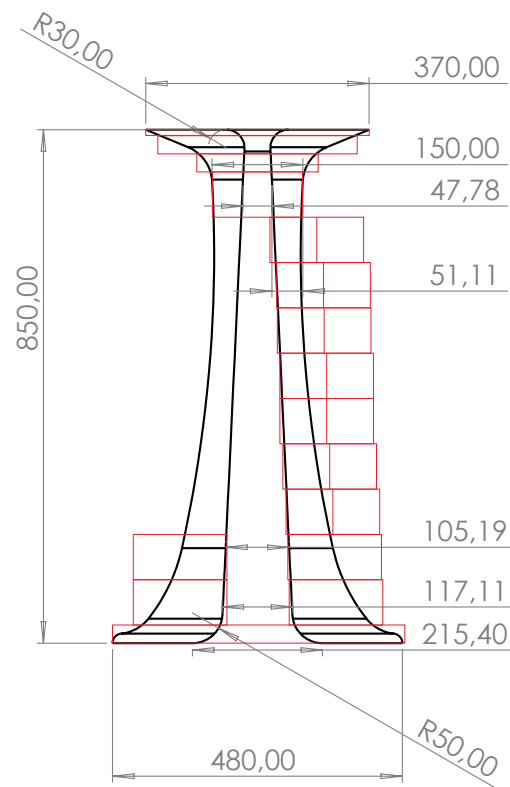
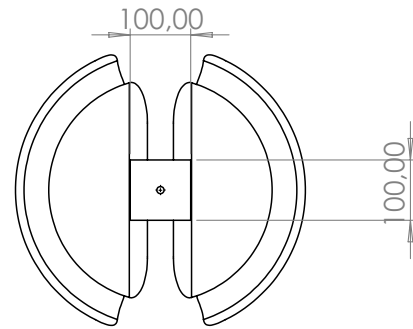
Full prototype

The prototype is 920 mm in height, making it a similar height to a existing countertop.

The last iteration on the aesthetics was made with the assignment to not think about the manufacturing of the product, since this had too much influence on the previous aesthetic. However, the organic elements do not make the prototype easy to produce.

During the prototyping, a lot of design decisions have been reviewed and some have been modified for feasibility. For example the whole mechanism has been moved up vertically to ensure stability of the bevel pinion axis, also, to give the leg more space.

Apart from the wooden base, the other elements are rigid but also easy to disassemble, allowing future modifications to be made.



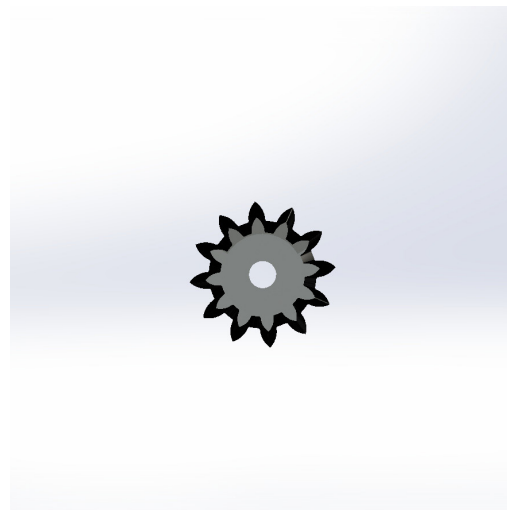
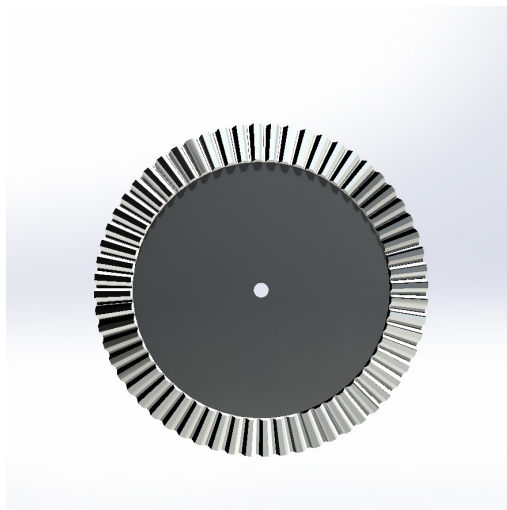
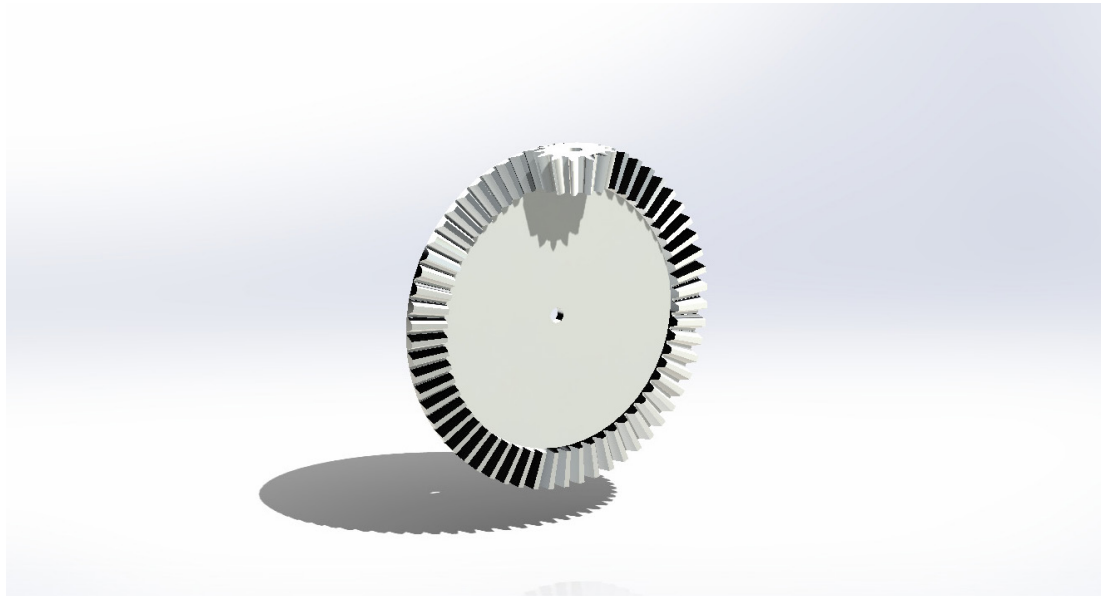
Base - Radiata Pine Wood

The base is made from wooden blocks cut out of beams of 75 mm by 150 mm by 2450mm. In this drawing, the size of the blocks is determined. The wooden blocks are stacked, glued and bolted. With a lot of sanding and wood filling, the stack became a cohered shape.

The wood is finished with two layers of 3/2 mixed oak interior stain and mahogany varnish, topped by two layers of transparent varnish.



	units	mm	scale	1:10	quantity	1	date	18/03/2026	remark	<<remarks>>	
material			mass	gr							
author	Babette Koppert		group	<<group>>							
name			1. Base			format	A4				
						drawing no.	2				



Bevel Gear
 60 teeth
 Module 3
 Pressure Angle: 20
 Face Width: 20 mm
 Hub Diameter: 200 mm
 Nominal shaft diameter 8mm

Bevel Pinion
 12 teeth
 Module 3
 Pressure Angle: 20
 Face Width: 20 mm
 Hub Diameter: 75 mm
 Nominal shaft diameter 8mm

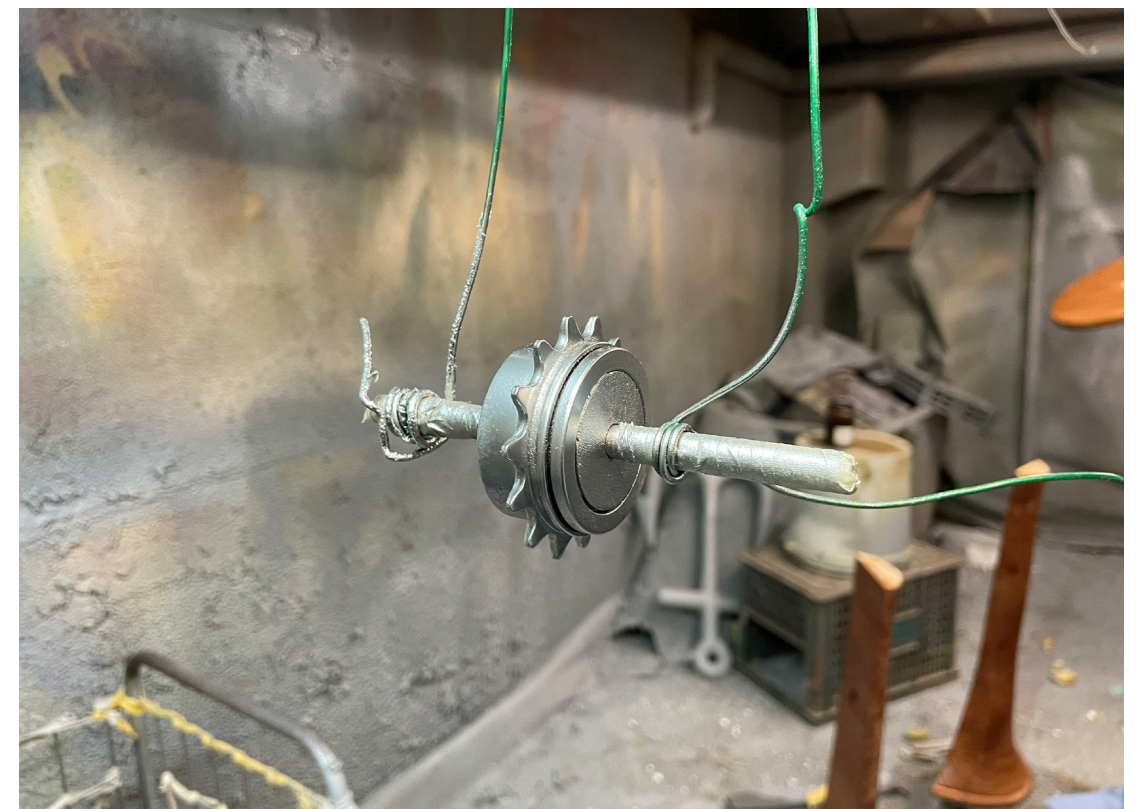
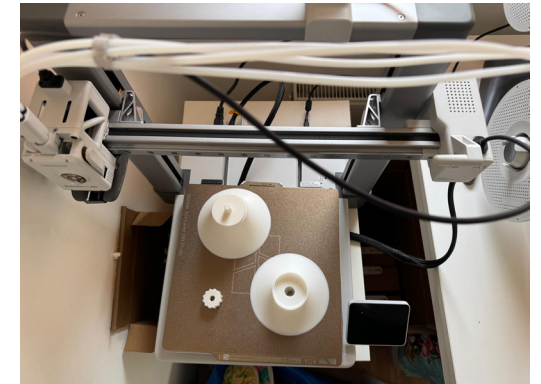
Mechanism - PLA & Aluminium

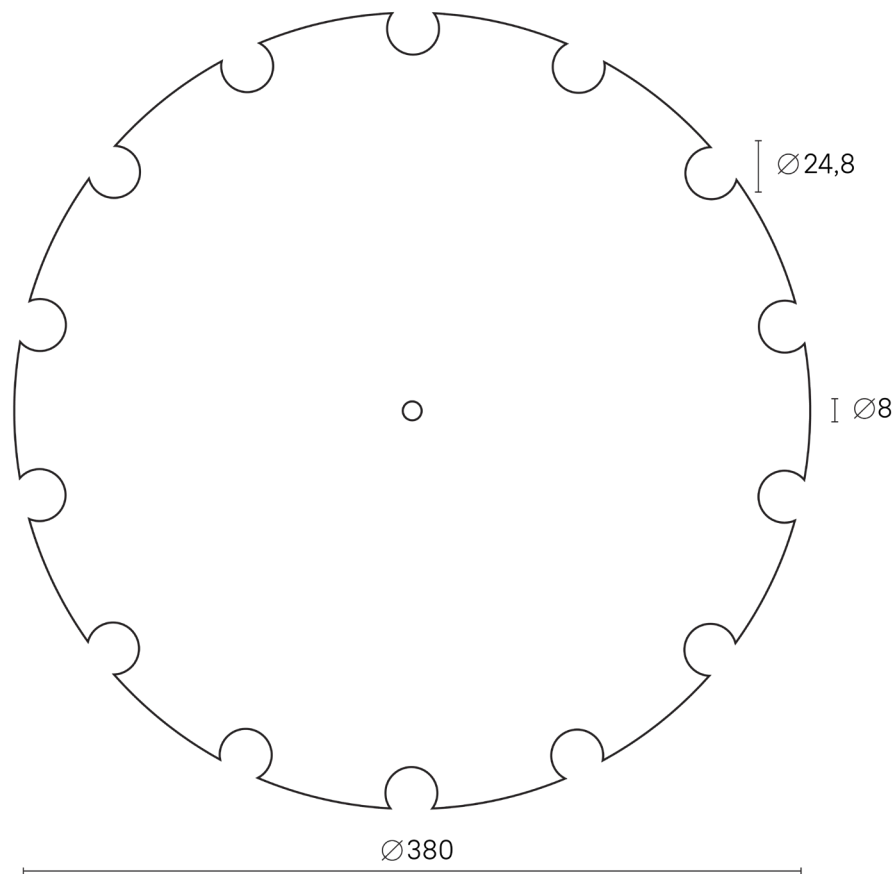
A combination of 3D printed parts and metal parts are used to make the mechanism. By spray painting them in the same chrome colour, the mechanism becomes cohered and the material difference is less obvious.

For the final product, the plastic gears would be replaced by metal ones, however, for the demonstration prototype the printed gears are sufficient.

The gears are printed in two parts: the gear itself and the conic cover. The two parts are glued to each other. A bicycle chain and single speed freewheel with 14 teeth are used to convert the linear motion to a rotational axis. A elastic rope on the other side of the freewheel pulls the handle back into place.

A threaded rod is used as the linear axis, since it allows the components to be disassembled.





measurements in mm

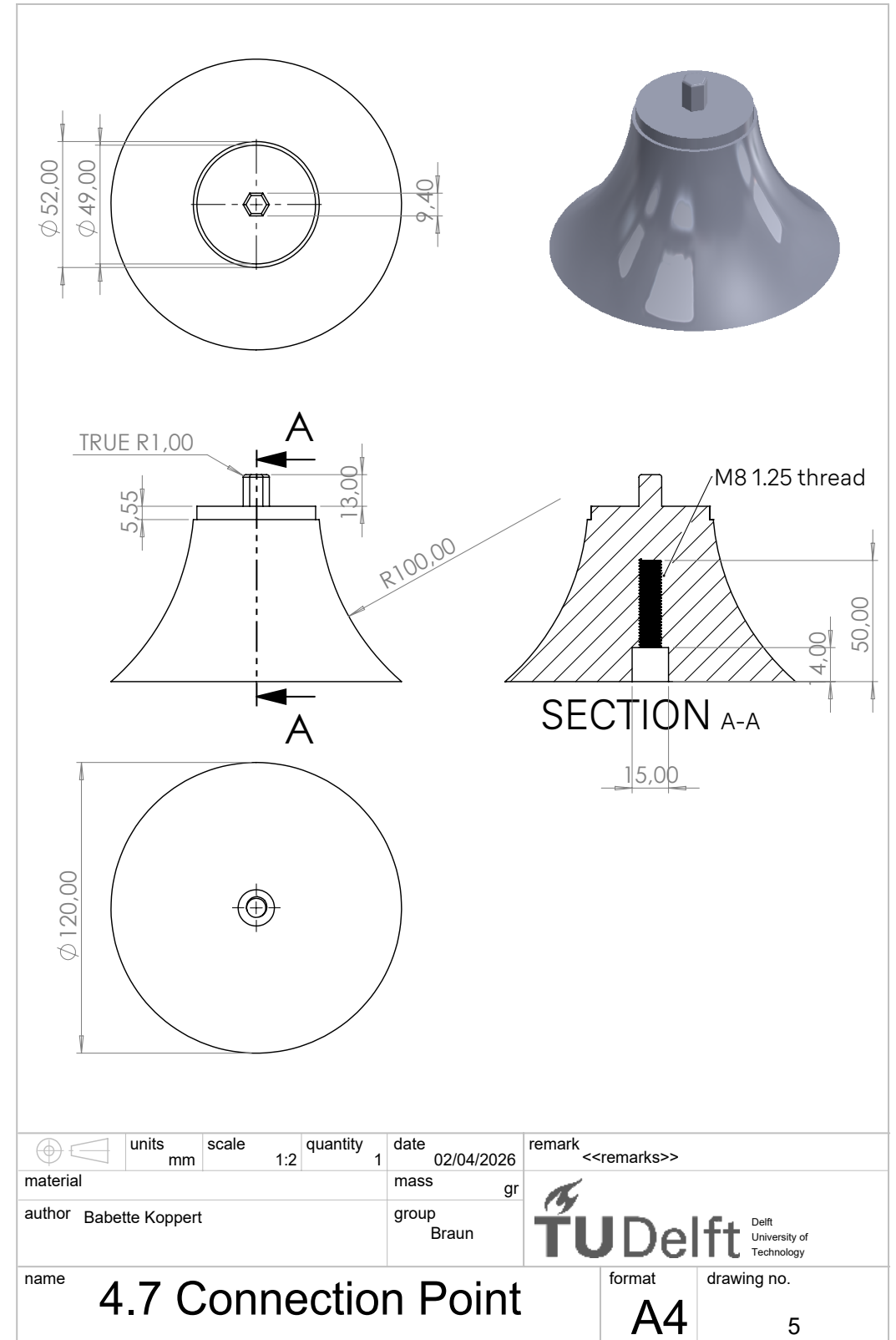
Flywheel

In the prototype, the flywheel is laser cut from popular multiplex 9 mm. In the prototype, the wood shows some bending. A harder type of wood or other stiffer material is recommended for a more stable flywheel.

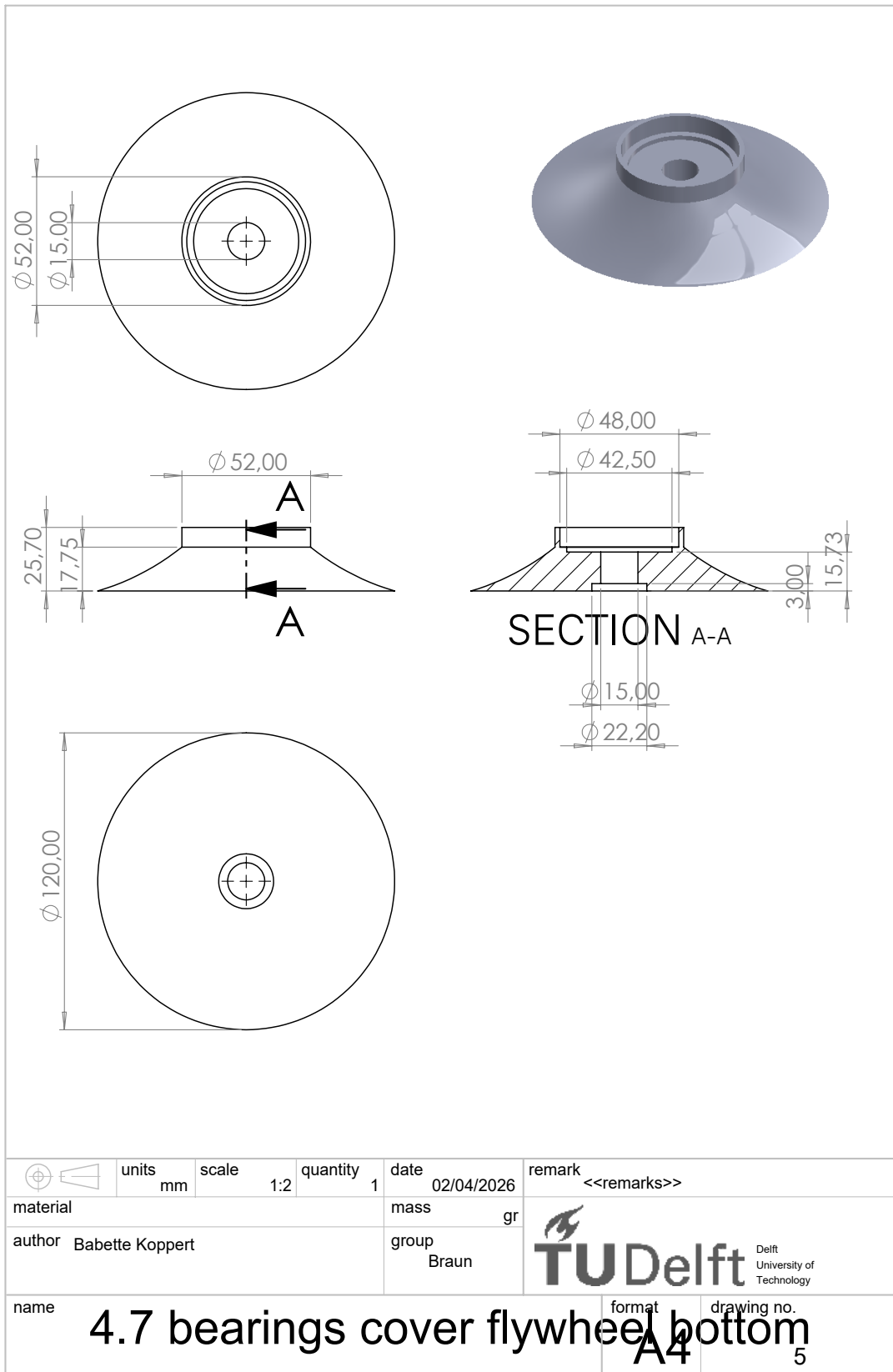
Using 14 marbles as weights combine aesthetics and functionality. The ones used in the prototype are from playing marbles.

A T-nut is used to attach the flywheel to the linear axis.

The flywheel has parts on the top and bottom for extra support when rotating and to cover the thread and nuts. Part 4.7 Connection point (next page) is the connector for other kitchen products.



	units mm	scale 1:2	quantity 1	date 02/04/2026	remark <<remarks>>
material	mass gr	 <small>Delft University of Technology</small>			
author Babette Koppert	group Braun				
name 4.7 Connection Point	format A4	drawing no. 5			



Appendix M. Behind the scenes: capturing prototype



*Thanks for reading 'The Turning Point: When efficiency becomes experience.'
I wish you plenty of inspiring conversations about the kitchen of the future.*

Enjoy your meals!

In 2040, cooking has shifted from a purely functional necessity into a meaningful, experience-based ritual. The future kitchen will be defined by active engagement, skill development, and personal investment rather than speed, efficiency, and convenience.

Take time for what matters.