

Marrina

An adaptable tool for hand washing dishes



Marina

An adaptable tool for hand washing dishes

by Alexandra Carlinger

Degree Project for Bachelor of Fine Arts in Design

Main field of study Industrial Design

Lund University, School of Industrial Design,

Department of Design Sciences

Examiner:

Professor Claus-Christian Eckhardt

Supervisors:

Senior Lecturer Charlotte Sjödel,

Senior Lecturer Jasjit Singh,

Professor Claus-Christian Eckhardt,

Lecturer Anna Persson

Contributor:

Peer Reviewer and Classmate Malin Johansson

Copyright year: 2023

ISRN-number: LUT-DVIDE/EX--23/50623-SE

Before we start,

I'd like to give a special thanks to my family and friends for getting me through some tough times and for cheering me up when I was down. I am eternally grateful to you.

Secondly, I want to thank my teachers and supervisors for all the knowledge and guidance you have shared during the past three years, I will carry it with me in the future.

I also want to thank the guys in the workshop for sharing their expertise and guiding me through the process of making my final prototype.

Lastly, I want to thank my classmates for their feedback and support during these years. It was comforting to talk to people who shared the same struggles. Being able to encourage each other and share joy as well as tips.

Abstract

Hours spent sitting by computers or swiping on phones have taken a toll on people's hands and wrists. Our hands are valuable tools that we often take for granted. We use them to brush our teeth, open doors and wash our dishes. Menial tasks that most of us complete without a second thought. However, if your wrists are worn out for any reason – be it a disease, syndrome, injury or overstrain – these simple tasks can seem just about impossible to complete.

Initial market research showed a lack of variety in ergonomic tools for hand washing dishes. Out of the few that existed, most of them were targeted towards people with rheumatism. Consequently, they were mainly focused on usability and had little to no consideration for appearance. Furthermore, a majority of the tools – which have a relatively short lifespan for hygienic purposes – were made solely out

of plastic. Therefore, designing one or more tools for hand washing dishes that causes less strain on the users wrists and hands – ideally with a clean appearance and more sustainable materials – became the objective.

Further research showed that a level of adaptability in the tool was necessary, since wrist problems can vary greatly from person to person. Additionally, various types of dishes require different brush heads in order to properly reach the areas that need to be cleaned.

The result is Marina, an adaptable tool for hand washing dishes. The handle with two attachment points, different attachable brush heads and silicone sleeves in various sizes allows the users to customize Marina to fit their personal preferences and needs. The level of customizability makes the replacement of worn components quick and easy.

Table of contents

1. Introduction	8 - 17		
1.1 Background	10		
1.2 Initial research	12		
2. Project plan	18 - 27		
2.1 Scenario	20		
2.2 Target group	22		
2.3 Goals	24		
2.4 Time plan	26		
3. Analysis	28 - 45		
3.1 Market analysis	30		
3.2 Ergonomics	38		
3.3 Material analysis	40		
3.4 Functional requirements	44		
3.5 Non-functional requirements	45		
4. Ideation	46 - 83		
4.1 Mood board	48		
		4.2 Finding the concept	50
		4.3 The concept	52
		4.4 Clay model	62
		4.5 Colour, material and finish	68
		4.6 Making a full-scale prototype	74
		5. Result	84 - 95
		5.1 Marina	86
		5.2 Technical drawings	90
		6. Reflection	96 - 103
		6.1 Intended outcome vs. actual outcome	98
		6.2 Intended time plan vs. actual time plan	100
		6.3 Conclusion	102
		6.4 Further development	103
		7. References	104 - 110

1

Introduction



“iPhone Hands“, by Jaysin Trevino, licensed under CC BY 2.0, Cropped and desaturated from original

Background

Since a couple of years back I started feeling pain in my wrists from time to time due to overstrain. I spend a lot of time in front of my computer, scrolling on my phone and tablet or doing repetitive wrist movements while working on DIY projects. Once the pain has set in, the best thing I can do is rest my wrists, but it is difficult since they are necessary for so many tasks I do daily.

Since becoming a student and thus moving out of my parent's house into an apartment without a dishwasher, manual

washing of dishes has become a time consuming task that takes a toll on my often sore wrists.

I also know a few people with different types of wrist problems. Some of them are students like myself and often don't have the possibility of buying a dishwasher.

This is where the idea for my project took root. I wanted to create a tool for hand washing dishes that was less straining on the wrists, since I and others were overall disappointed in the dish brushes and such on the market today.

Initial research

To get a better understanding of what could cause people pain and discomfort when manually washing dishes, I created and sent out a questionnaire. Even though I sent it out in a few different ways, I unfortunately only got 12 answers. However, most of the answers I got were very helpful. In addition to this, I also interviewed and got verbal viewpoints from friends and classmates. These I have also incorporated into my research.

The questions were written in both Swedish and English. To the right are the questions and possible answers in English. If you want to look through the entire questionnaire you can find it through this link:

<https://forms.gle/g9HgUFXVNGWYugiR7>

Question 1*

Do you have any underlying wrist problem?

Yes

No

Question 2

If yes, which one(s)?

Disease or syndrome

Injury

Overstrain

Question 3

If you answered disease/syndrome to question 2, which one(s)?

Free answer

Question 4

If you answered injury to question 2, what type?

Free answer

Question 5*

Do you often experience pain/discomfort in your wrists or hands when manually washing dishes?

Yes

No

Question 6

If yes, which object(s) cause pain or discomfort?

Plates

Bowls

Cutlery

Drinking glasses

Bottles

Cutting boards

Saucepans

Frying pans

Other

Question 7

Out of the objects you checked above, which 3 cause the most pain/discomfort? Rank them 1-3, 1 is the worst. Please include a short explanation of why you find these objects uncomfortable to wash.

Free answer

Question 8

If you have experienced pain/discomfort when washing dishes, do you know of any existing tools for washing dishes that make the process a lot better?

Yes

No

Question 9

If yes, please write their names and/or describe them.

Free answer

Question 10

If you have experienced pain/discomfort when washing dishes, do you know of any existing tools for washing dishes that make the process a lot worse?

Yes

No

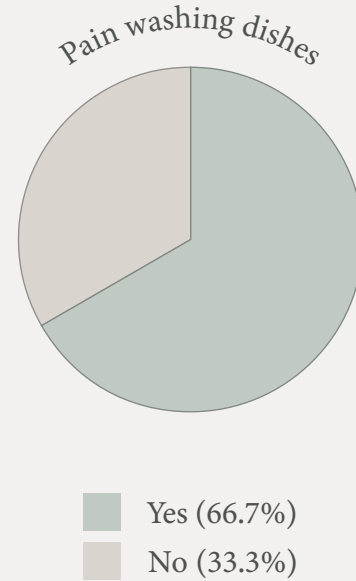
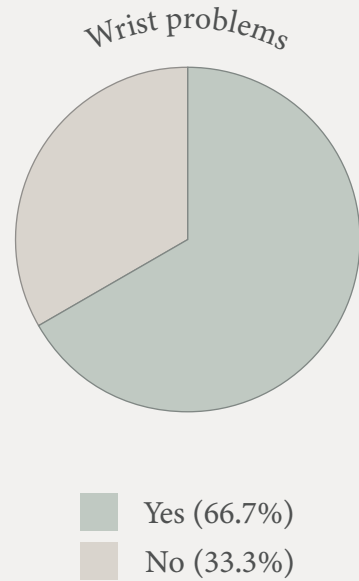
Question 11

If yes, please write their names and/or describe them.

Free answer

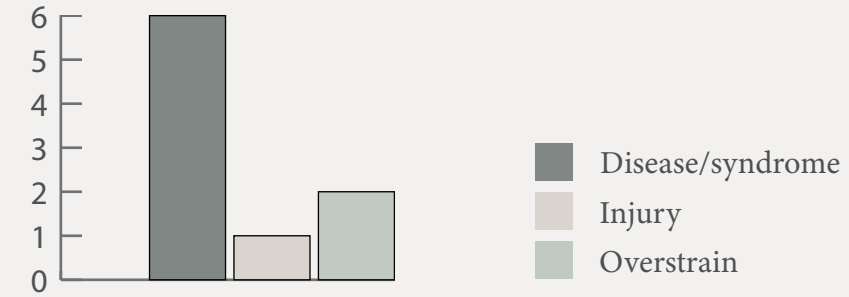
*Obligatory question

Summarized answers



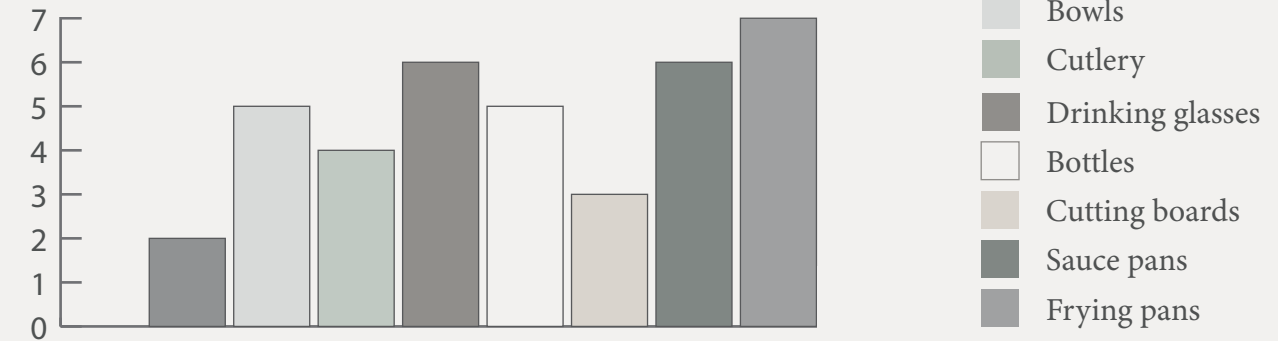
7 people have wrist problems and experience pain/discomfort when manually washing dishes (58,3%). 3 people do not have wrist problems or experience pain/discomfort when manually washing dishes (25%). 1 person has wrist problems but does not experience pain/discomfort when manually washing dishes (8,3%). 1 person does not have wrist problems but does experience pain/discomfort when manually washing dishes (8,3%).

Type of wrist problem



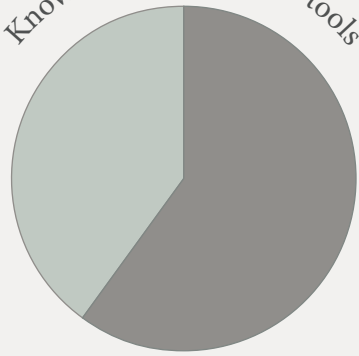
Diseases and syndromes consisted of different types of rheumatism and EDS (Ehlers-Danlos syndromes).

Most painful objects



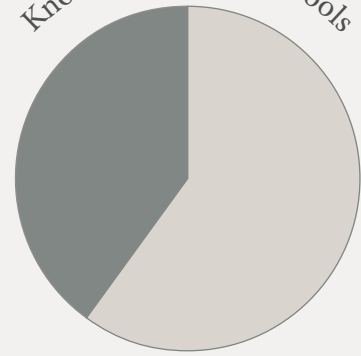
The answers on question 7 in the questionnaire showed that repetitive movements, the weight of the object, the angle of the wrist and the amount of wrist movement required impacted the experience of pain and discomfort for the user.

Knowledge of unhelpful tools



■ Yes (40%)
■ No (60%)

Knowledge of helpful tools



■ Yes (40%)
■ No (60%)

By asking people if they knew of any helpful and unhelpful tools for hand washing dishes on the market, I got an idea of what people liked and disliked with current tools. I used this information in my market research.

The questionnaire helped me to better understand who the target group was and also what they struggled with when hand washing dishes. That knowledge served as a good base for the continuation of my project.

2

Project plan

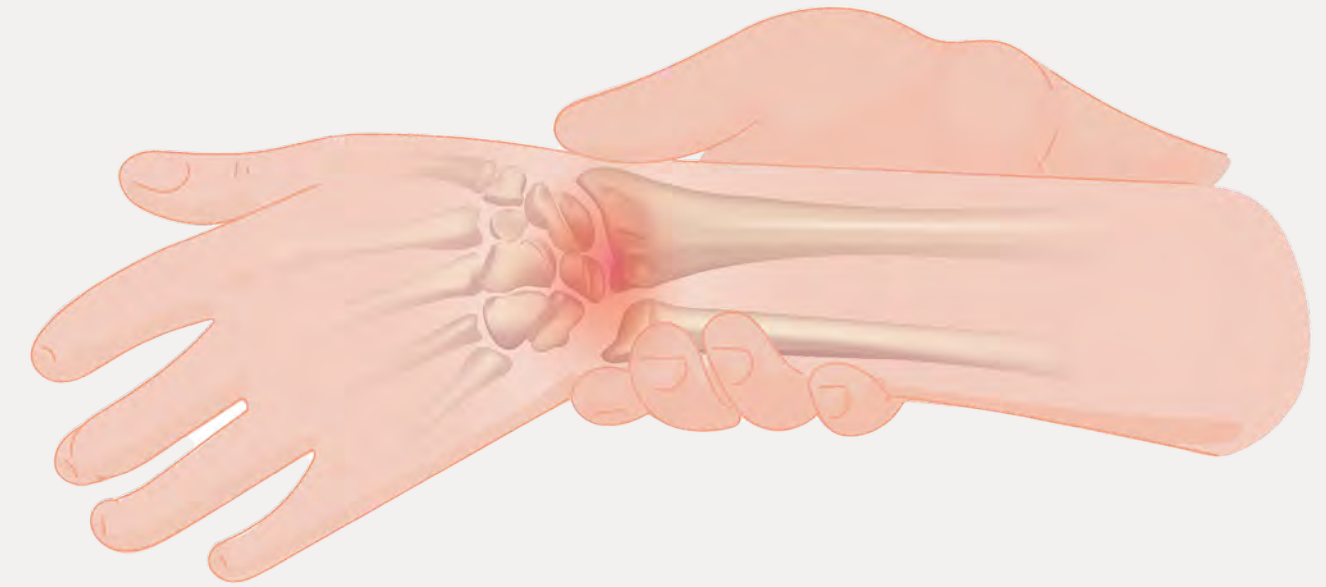


Scenario

The scenario that I am trying to facilitate with my design is the experience of pain or discomfort in the user's hands and wrists during manual washing of dishes due to insufficient tools.

Target group

The intended target group is people with sensitive hands and wrists that easily experience pain and discomfort from repetitive movements. This could be due to an underlying wrist problem, such as a disease, syndrome, injury or overstrain.



“Wrist pain“, by Injurymap, licensed under CC BY 2.0, Background removed from original
<https://www.injurymap.com/free-human-anatomy-illustrations>

Goals

Main goal

I want to design one or more tools that can be used while manually washing dishes that reduces the experience of pain/discomfort in hands and wrists for the user.

Secondary goals

I want to use as many natural, locally sourced, sustainable and recyclable materials as possible for my product, without having to compromise too much on the products functionality and durability.

I want to give the tool a visual appearance that is clean and simplistic, so that it can easily be left out in the kitchen without drawing too much attention.

Time plan



“HAMILTON KHAKI FIELD OFFICER AUTO H70615733“, by Kazuhiro Keino, licensed under CC BY 2.0, Cropped and desaturated from original

Approximated time

1 week

1 week

3 days

1 week

1 day

3 days

2 weeks

1 week

During the entire project

Task

Literature and analysis study of existing tools for hand washing dishes on the market.

Literature and analysis study of existing and alternative environmentally friendly materials for tools for hand washing dishes.

Create a questionnaire to get a more detailed understanding of what people experience as strain/pain during hand washing dishes.

Interview different groups/individuals about the troubles they experience while washing dishes through the questionnaire.

Compile result from the questionnaire.

Sketch different materials and solutions.

Create and develop models before and during user tests.

Create full-scale prototype before final presentation.

Write documentation.

3

Analysis

Market analysis

From the answers gathered from the questionnaire, along with my own market research, I compiled an image board of different tools for hand washing dishes on the market. I then roughly divided them into three categories: sustainable, clean appearance and gentle on wrists. While an existing tool may fulfill two of the criteria, none fit all of them. The intention was that my design would fit all three categories. I also looked at different types of dishbrushes on the market and tried to identify their positive and less positive features.



Brush head

- + Good shape
- + Good placement of bristles for cleaning
- + Scraper for dried food
- Not replaceable head

Handle

- + Good texture on handle for better grip
- + Possibility to hang
- Bad angle that forces wrist into a straining position
- Small diameter = bad grip
- Hard edges, uncomfortable to grip
- Too short grip area, not suitable for larger hands
- Hard material on grip area

Dimple between handle and brush head

- + Place to put finger for more force
- Placed so that the angle is still straining

Material and appearance

- Unsustainable materials
- Cheap appearance
- Strong colors

*Pros and cons that I found with this dish brush specifically, but several points could be true for similar products



"Diskborste Classic 1-P 12110" from KRON

Brush head

- + Good placement of bristles for cleaning
- No scraper for dried food

Handle

- + Centered in the palm of your hand
- Bad angle for wrist
- Too small grip area for people with larger hands
- "Sharp" edge close to grip area
- Smooth texture, could become slippery

Material and appearance

- + Natural materials
- + Clean appearance
- + Simple construction
- Material is not water resistant without coating



*Pros and cons that I found with this dish brush specifically, but several points could be true for similar products

"Grytborste" from Granit

Brush head

- + Good shape
- + Good placement of bristles for cleaning
- + Replaceable brush head
- (+/-) unsure if it has a scraper

Handle

- + Good texture on handle for better grip
- + Possibility to hang
- Bad angle that forces wrist into a straining position
- Bigger diameter than some, but not that big
- Hard edges, uncomfortable to grip
- Too short grip area, not suitable for larger hands
- Hard material on grip area

Suction cups

- + Dish brush can be placed on smooth surfaces in order to make it possible to hold the object being washed with two hands, or if you only have one hand/arm that you can use.

Material and appearance

- Unsustainable materials
- Cheap appearance
- Strong colors

*Pros and cons that I found with this dish brush specifically. Not many similar products available on the market.



"Diskborste med sugkoppar" from Swereco

Ergonomics

From being in contact with Certec, as well as doing my own research, I learned some characteristics for a more ergonomic handle. The wrist should be straight in a neutral position, as to not strain the wrist. It is good to have a non-slip material on the gripping surface and slight contour to lessen the force required to hold the handle. The recommended handle diameter and length varies a bit from source to source¹²³, but a generally agreed upon span is 30-40 mm in diameter and 100-150 mm in length. It is also good to give the user the possibility to fasten the tool to a surface to make it possible to hold the object being washed with two hands, or if you only have one

hand/arm that you can use. Rheumatic tools have a high focus on ergonomics and usability. Therefore, they are a good inspiration functionality-wise.

-
1. Canadian Centre for Occupational Health and Safety. (2015, October 1). *Hand Tool Ergonomics - Tool Design*. Canadian Centre for Occupational Health and Safety. <https://www.ccohs.ca/oshanswers/ergonomics/handtools/tooldesign.html> (2023-03-02)
 2. Humantech Ergonomics. (2015, June 23). *Get a Grip: Three Things to Know about "Ergonomic" Handles* [Video]. YouTube. <https://www.youtube.com/watch?app=desktop&v=P0ljvzSOnd8> (2023-02-27)
 3. Mafouo, Martha. (2014, January). *Ergonomiska principer avseende arbete med rak handled och handgrepp - En litteraturstudie*. Lunds Universitet. <https://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=4731012&fileOId=4731043> (2023-05-01)



Material analysis

Handle

The main material of the handle needs to hold up to wear and tear, and so needs to be sturdy. It needs to at least somewhat be able to withstand water and humidity, while at the same time be sustainable and environmentally friendly. Some sort of organic/wood material seemed a good fit. My research has led me to bamboo and birch, two materials that are commonly used in dish brushes currently on the market.

Bamboo is a strong, fast growing, low maintenance renewable grass with versatile applications. However, as with all materials, it has its downside. Several species of bamboo are classified as "invasive weeds" in some parts of the world. Furthermore, buying and shipping bamboo to a country where it is not native can be expensive⁴. Additionally, in order to get a larger, usable block of material you need to form a plywood from its thin stems.

Due to its many positive attributes, bamboo has become a popular material in recent years.

There are some species of bamboo that can grow in colder climates⁵, but there exists a native wood material that could be more suitable for the production of my tool

in Sweden, European beech.

Beech has similar enough mechanical properties to bamboo for the intended application. It has good hardness, workability and machines well. Beech is also easy to glue and finish. The European beech tree is widely available across Europe, and is very economically priced. This contributes to its high popularity among woodworkers. European beech is not listed as a threatened species⁶, but for a more sustainable product it is important to only use wood that comes from beech trees that are grown and cut down in a legal and sustainable way, as to not damage the wildlife⁷.

Since beech wood is a solid material, usable blocks of material can be cut directly from its trunk without needing to create a plywood. European beech tree is native to Sweden⁸ and can be locally sourced. Consequently, the distance the wood needs to be transported to produce the product in Sweden is reduced, giving it a major advantage to bamboo which would most likely need to be imported as already cut pieces.

The wood pieces needed are relatively small, thus

it might be possible to manufacture some of the dish brushes from beechwood off-cuts that would otherwise be thrown away or burned.

Beech, like most wood materials, is sensitive to water and humidity. Thus it is important to take care of the material and let it dry properly after coming in contact with water. Coating the wood with a natural, food-safe and water resistant finish would prolong the products lifespan without being harmful to the user or the environment.

There are a number of alternatives that can be considered. Mineral oil minimizes cracks and warps and has good water repelling properties. It is a traditional and common food safe finish. However it is a by-product from the petroleum industry, and not a sustainable product⁹.

Tung oil is derived from the seeds of tung trees and is entirely natural and eco-friendly. It has good waterproof properties, is easy to apply and is non-toxic. In addition, Tung oil is resistant to various acids and alcohols. The oil requires numerous coats and takes a long time to properly cure. However, it does not require regular maintenance, making it very suitable for commercial products¹⁰.

Linseed oil, which is derived from flaxseed, is another eco-friendly option. It requires less coats than Tung oil, however, the necessary wait time between coats is significantly longer. Linseed oil has a number of other disadvantages compared to Tung oil. It requires regular maintenance, yellows over time and supports mildew growth¹¹. Making it less than suitable for the intended use.

Grip

The grip material needs to have a high coefficient of friction and be soft and pliable when gripped to reduce the strain on the wrist. Therefore, I wanted a separate material on the grip surface. This also needs to be resistant to wear and tear but not strong since it is just a thin covering for the handle. A rubber or rubber like material seems ideal.

Synthetic rubber is made from crude oil and is consequently not an eco-friendly alternative¹². Natural rubber from plantations is comparably more environmentally friendly but has its own issues with for example deforestation, loss of biodiversity and pollution¹³.

Silicone has many of the same properties as rubber, but is made mainly from silica (sand). It does also include some hydro-carbons that typically are derived from non-renewable natural gas or oil, which is not ideal. It would be preferred to use silicone that is made with renewable hydro-carbons, if available at a reasonable cost. Silicone has a very long life span and is not toxic. It does not biodegrade, which is a problem, but on the other hand it also does not contribute to micro plastic pollution, which is becoming a serious environmental issue. The recyclability of silicone is not great but that is compensated for by its long service life. One great feature of silicone is how it can be made into many different consistencies. It can be soft like a gel or hard like a rock and anything in between¹⁴.

Fastener

The fastener needs to be strong for its size and be flexible so that it can expand when being removed or replaced. A metal or alloy seems best for this application and the one that best fits the requirements is brass.

Brass is easy to machine, corrosion resistant and has the correct mechanical properties. It is a relatively affordable material and the amount used will be very small. Its long life and its outstanding recyclability, it does not lose any properties when re-forged, make it a good choice from an environmental perspective¹⁵.

An alternative material for the fastener is stainless steel. It has excellent mechanical properties and is also corrosion resistant, but generally not as much as brass, since it is still susceptible to corrosion at some degree¹⁶.

Brush

The brush material needs to be flexible and sturdy but not too hard, so as to not scratch the surfaces of the items being washed. There are many different animal hairs that are used, but it would be better to avoid non-vegan materials.

Sisal is a natural fibre from the leaves of agave plants and is widely used in many products including brushes. It is renewable and is grown with little water and no fertilizers or pesticides are needed¹⁷. Jute would be an alternative. Its environmental impact is also very good,

if fertilizes and pesticides can be avoided¹⁸, but its fibres are too soft for this application so Sisal seems a better fit.

4. Miller, James. (n.d.). *Is Bamboo Eco-Friendly? Pros and Cons of this Renewable Resource*. The Roundup. <https://theroundup.org/is-bamboo-eco-friendly/> (2023-05-01)

5. Hornaday, Fred. (2022, October 10). *15 Cold Hardy Bamboos for Snowy Climates*. Bambu Batu. <https://bambubatu.com/cold-hardy-bamboo/> (2023-05-01)

6. Meier, Eric. (n.d.). *European Beech*. The Wood Database. <https://www.wood-database.com/european-beech/> (2023-05-01)

7. Nguyen, Quynh. (n.d.). *How Sustainable Is Beechwood? Here Are the Facts*. Impactful Ninja. <https://impactful.ninja/how-sustainable-is-beechwood/> (2023-05-01)

8. Holden Forests & Gardens. (n.d.). *European Beech*. Holden Forests & Gardens. <https://holdenfg.org/nature-profiles/european-beech/> (2023-05-01)

9. Foodsafe Lubes. (2021, July 21). *What is Food Grade Mineral Oil?*. Foodsafe Lubes. <https://foodsafelubes.com.au/what-is-food-grade-mineral-oil/> (2023-05-01)

10. Parker, Walter. (2023, April 3). *Tung Oil Advantages and Disadvantages – All You Need To Know!*. Woodworkly. <https://woodworkly.com/tung-oil-advantages-and-disadvantages/> (2023-05-01)

11. Parker, Walter. (2022, October 22). *Linseed Oil Advantages and Disadvantages – All You Need To Know!*. Woodworkly. <https://woodworkly.com/linseed-oil-advantages-and-disadvantages/> (2023-05-01)

12. Aquasealrubber. (2020, September 10). *The Synthetic Rubber Production Process*. Aquasealrubber. <https://www.aquasealrubber.co.uk/articles/the-synthetic-rubber-production-process/> (2023-05-01)

13. Brown, Ethan. (2022, January 7). *What Are the Environmental and Economic Issues Facing Rubber Production?*. PBS. <https://www.pbs.org/wnet/peril-and-promise/2022/01/what-are-the-environmental-and-economic-issues-facing-rubber-production/> (2023-05-01)

14. Mindseteco. (n.d.). *Are Silicone Products Sustainable And Eco-Friendly*. Mindseteco. <https://mindseteco.co/is-silicone-environmentally-friendly/> (2023-05-01)

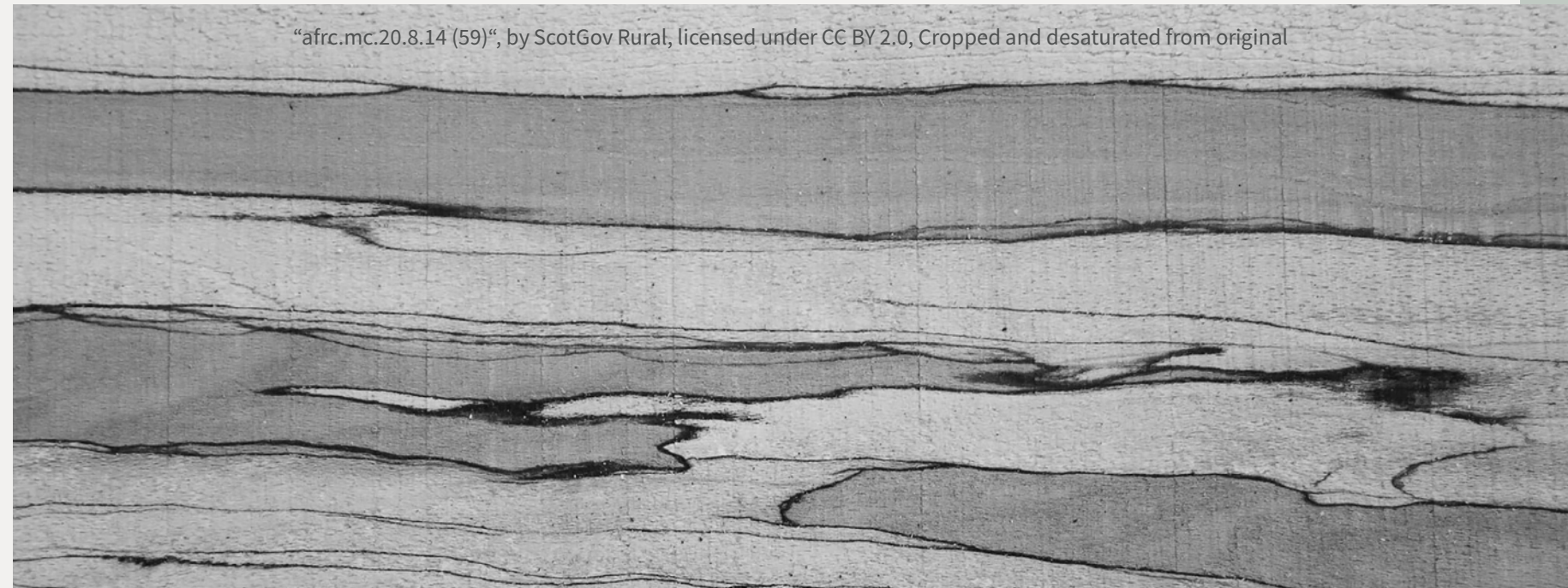
15. Rotax Metals. (2023, April 14). *Everything You Need To Know About: Brass*. Rotax Metals. <https://rotaxmetals.net/everything-you-need-to-know-about-brass/> (2023-05-01)

16. Rotax Metals. (2018, December 17). *Brass vs Stainless Steel—Which One Should You Use for Your Project?*. Rotax Metals. <https://rotaxmetals.net/brass-vs-stainless-steel-which-one-should-you-use-for-your-project/> (2023-05-01)

17. Goonvean Fibres. (n.d.). *Our Top 10 Fibres & Powders for Eco-Friendly Products*. Goonvean Fibres. <https://goonveanfibres.com/news-insights/news/our-top-10-fibres-powders-for-eco-friendly-products/> (2023-05-01)

18. Yarns and Fibres. (2020, October 23). *What are the environmental impacts of jute?*. Yarns and Fibres. <https://www.yarnsandfibres.com/textile-resources/natural-fibers/plant-cellulosic-fibers-natural-fibers/jute/sustainability-jute/what-are-the-environmental-impacts-of-jute/> (2023-05-01)

“afrc.mc.20.8.14 (59)“, by ScotGov Rural, licensed under CC BY 2.0, Cropped and desaturated from original



Functional requirements

Usability

- Self-explanatory
- Easy to understand

Good, firm grip

- Sturdy dimensions
- Good friction, non-slip

Adaptability

- Multiple attachments for different use
- Multiple attachment points

Multi directional use

- Multiple attachment points
- Bidextrous
- Neutral grip shapes
- Can be held in many positions

Easy to switch attachments

- Minimum force required
- Robust, not fiddly

Non-functional requirements

Sustainability

- Ecological materials
- Separable and recyclable materials
- Long functional lifetime for handle
- Replaceable wear parts (attachments)
- Adaptable for evolving needs
- Minimal resource use
- Easy and resource lean manufacturing

Appearance

- Simple and clean appearance
- Soft and organic feel
- Scandinavian design
- Honest design
- Neutral colours
- Natural materials
- Solid materials

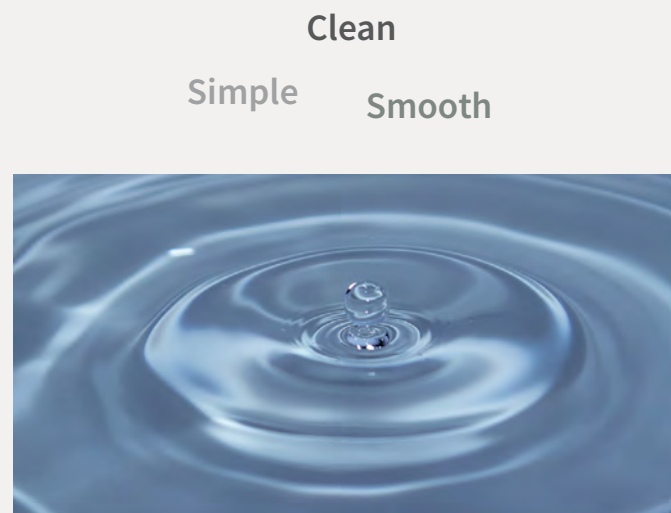
4

Ideation

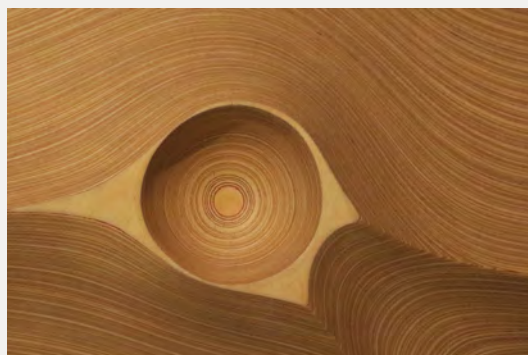
Mood board



Sturdy
Marine Reliable



Clean
Simple Smooth



Conformable Soft curves
Bend



Scandinavian Nature
Light

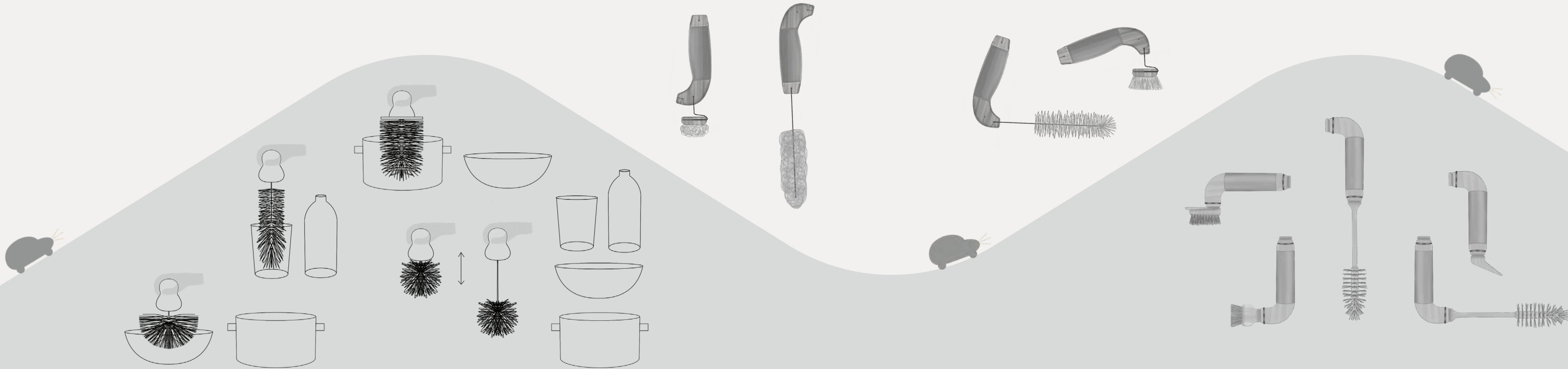


Finding the concept

A somewhat bumpy road

Then I had the idea of having different attachment points for the brush heads so that the user had the possibility to vary their grip.

I liked the idea, but I needed to come up with an easier way to attach the brush heads to the handle, so that it was less straining and fiddly.

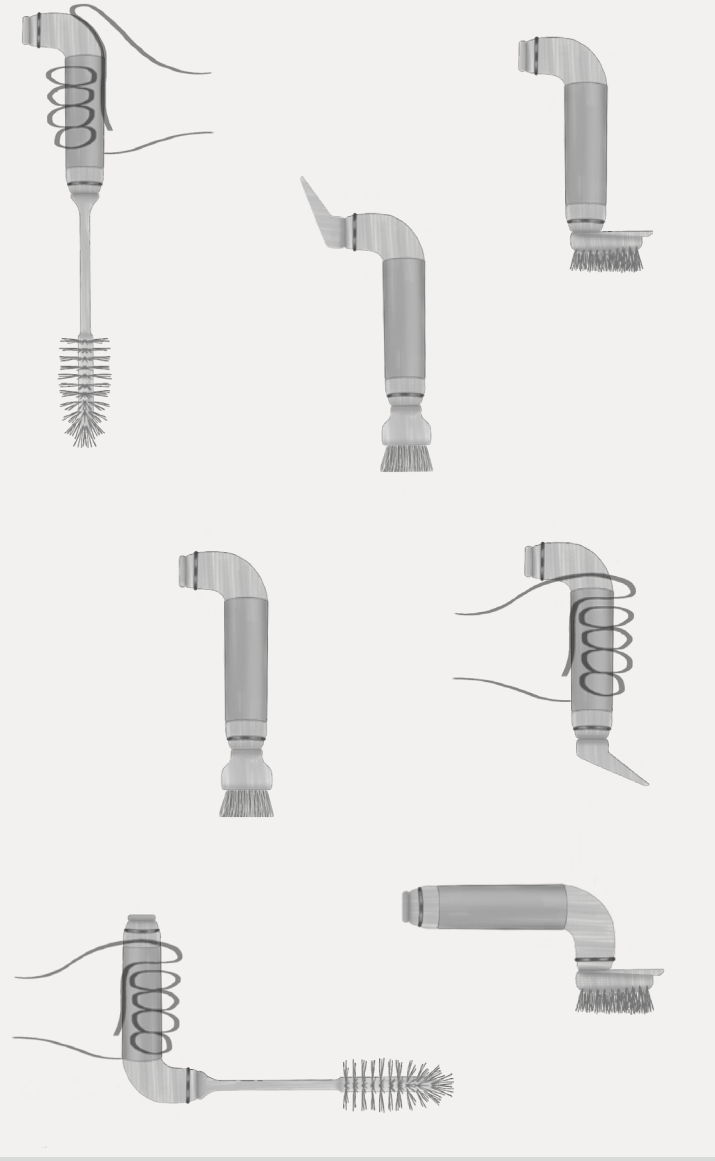


Based on the types of dishes people answered were the most painful to clean, I started to sketch different shapes of brush heads that could be used for various dishes. In the beginning I thought that I could find one type of handle that would be comfortable for everyone, but soon realized that the handle also needed to be at least somewhat adaptable.

I realized that two attachment points were enough to give the user several different ways to hold the handle. It also made it possible for me to make the fastening sturdier and easier to use. In order to make the angle of the heads better I had to make the bend 90 degrees. I also removed the slight contour from the handle to facilitate more grip options.

The concept

Mix and match



The chosen concept is a dish brush with interchangeable heads. The handle has two attachment points where you can insert one of the four dish brush heads depending on the users preference and the type of object that needs to be cleaned. The attachment points have a poka-yoke solution that makes it impossible to insert the brush heads

incorrectly. The uniform shape of the handle makes it possible to hold the dish brush in different ways and it works for both right and left handed people. To give the handle a slight contour, the silicone has a malleable texture that shapes itself after the users hand. In order to fit a wider range of hand sizes, the silicone tube comes in five different thicknesses.

The family consists of a handle, a bottle brush, a round brush, a scraper and a more standard brush head. The bottle brush is intended for tall and narrow objects. The round brush is good for plates and smaller objects. The scraper helps remove stubborn, dried food. The standard brush head has both bristles and a scraper and is good for general dishes.

The family

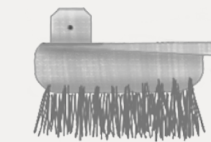
Handle



Scraper

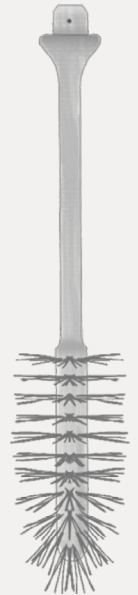


Round brush

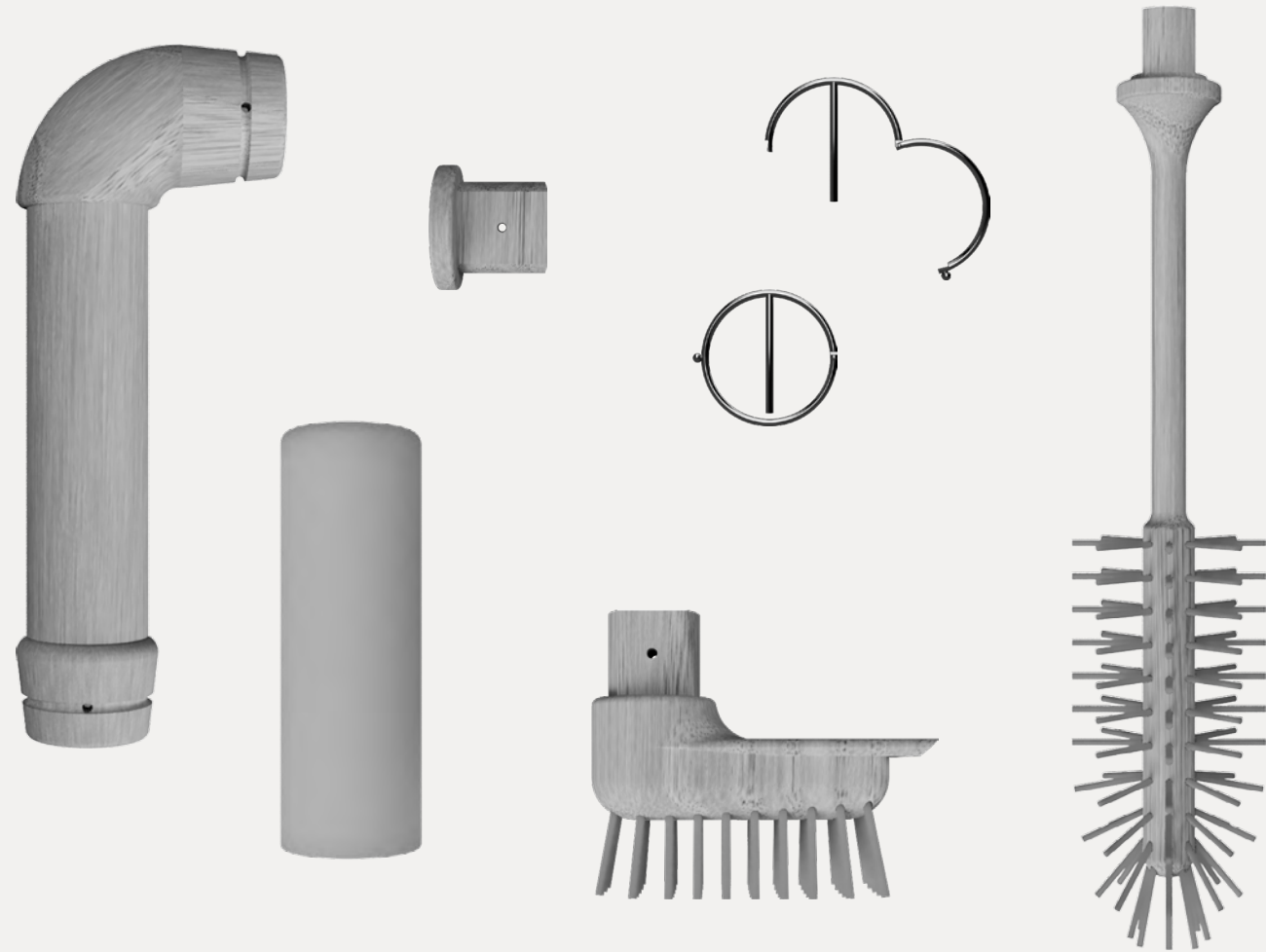


Regular brush

Bottle brush

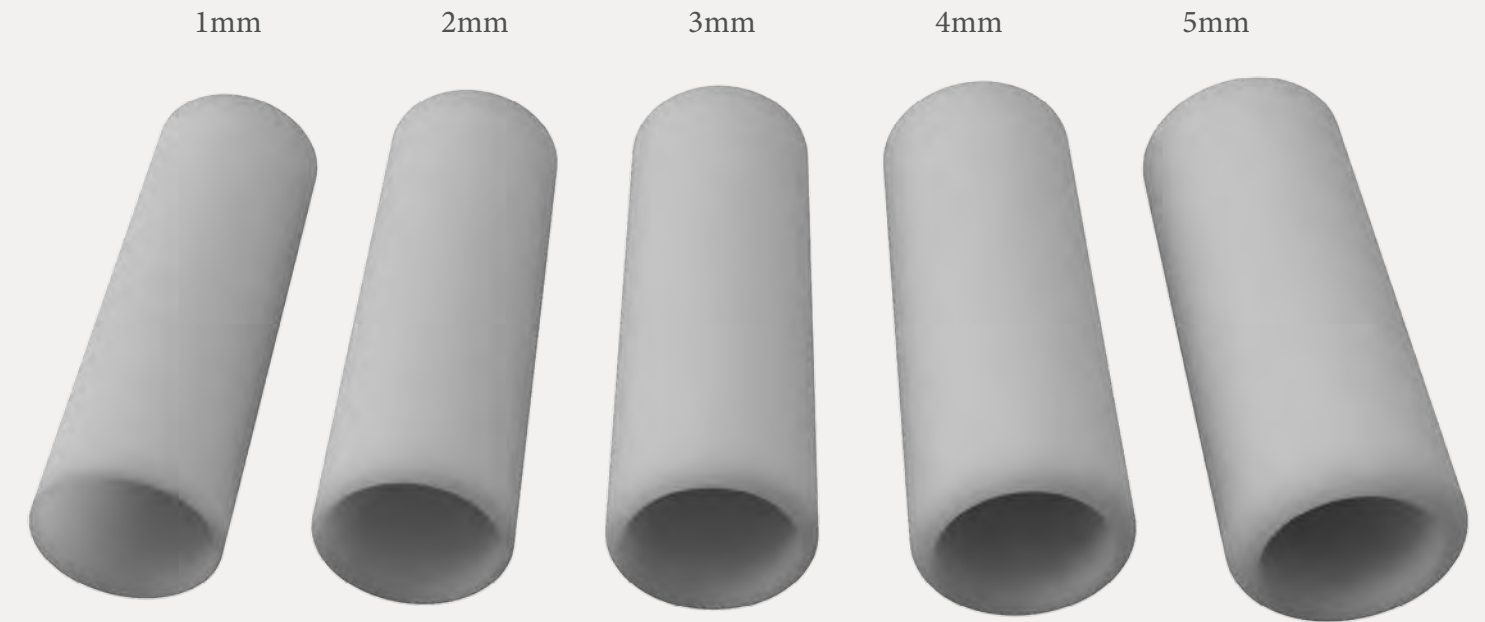


Starter kit

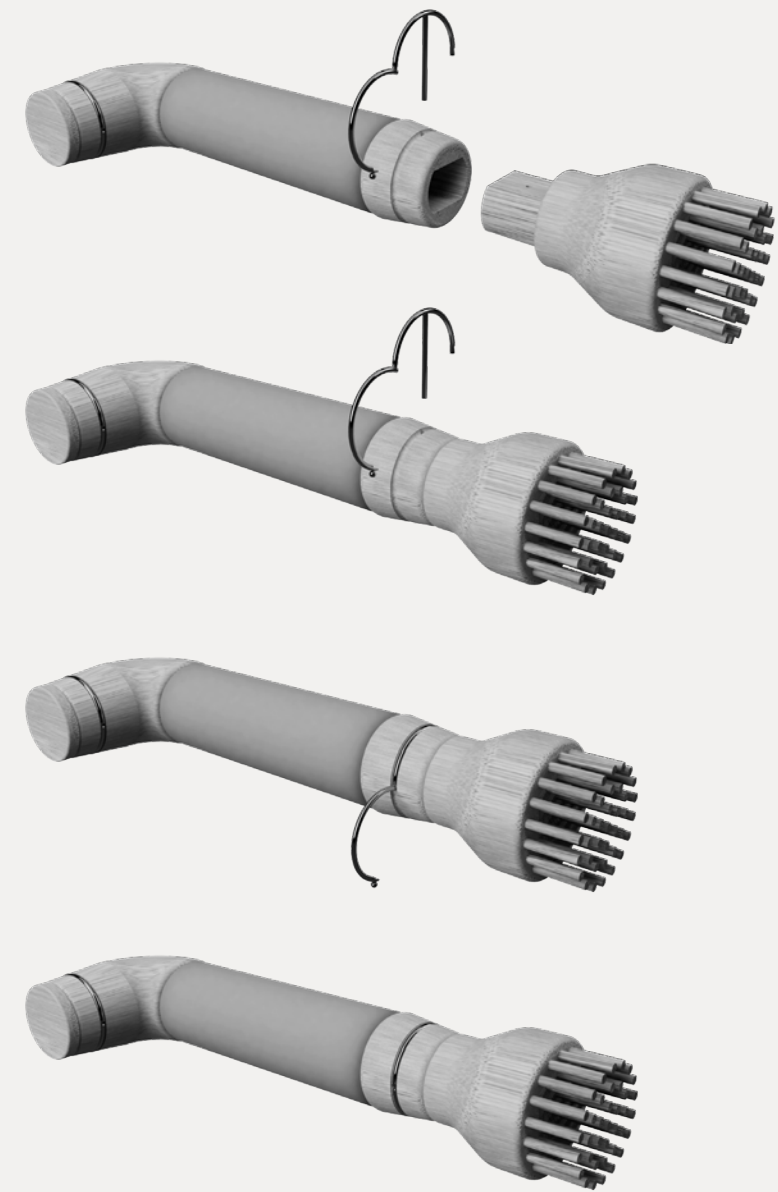


The starter kit consists of one handle, one 2mm thick silicone tube, two fasteners, one plug, one regular brush and one bottle brush. I chose this combination since it covers most dish situations. It will also be possible to buy each piece separately if something needs replacing or if you want to construct your own starter kit. With this solution, it makes it possible to replace only the parts that are too worn or stained instead of throwing the entire dish brush away.

The silicone tubes will be available in five different thicknesses: 1mm, 2mm, 3mm, 4mm and 5mm. I chose to have different thicknesses to give the user possibility to adapt the handle thickness to better fit their hand size. The five sizes are selected to cover the span of recommended handle diameter. For example, if the user opts to not have any silicone on the handle, the diameter will be the minimum recommended size, 30 mm. With the thickest silicone tube on the handle diameter is the maximum recommended size, 40 mm.



Here is an image sequence detailing how to attach the brush heads. You begin with removing the fastener, then you insert the head of your choosing. You then put the fastener back in its place and lock it.



Clay model

What I realized

Poka-yoke solution

Mistake-proofing
Lining up the holes

Measurements

Shorten handle
Shorten bottle brush

Tolerances

Tight tolerances
Prevent wiggle

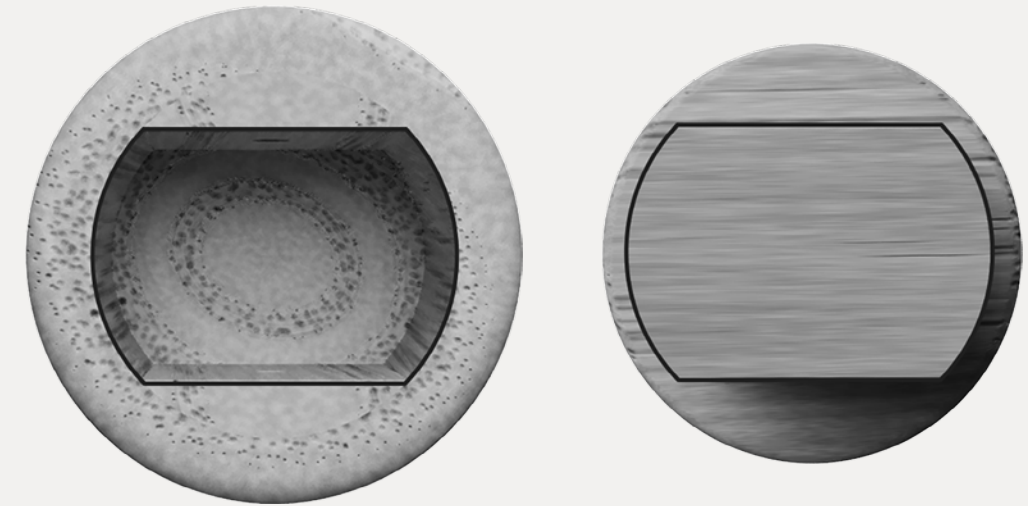




Poka-yoke solution

"A poka-yoke is a mechanism that is put in place to prevent human error. The purpose of a poka-yoke is to inhibit, correct or highlight an error as it occurs."

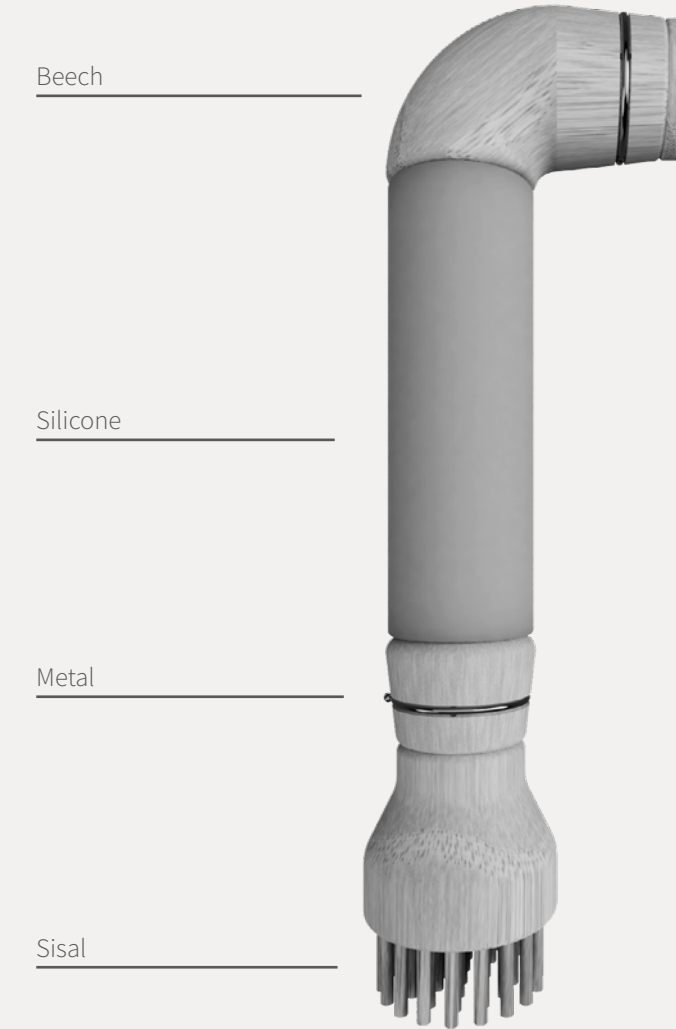
- Diann Daniel, 2021, *Poka-yoke*, Techtargget.com



This is the poka-yoke solution that I came up with for my dish brush. It ensures that the brush heads can only be inserted in a way where the holes line up correctly, making it easier to insert the fastener.

Colour, material and finish

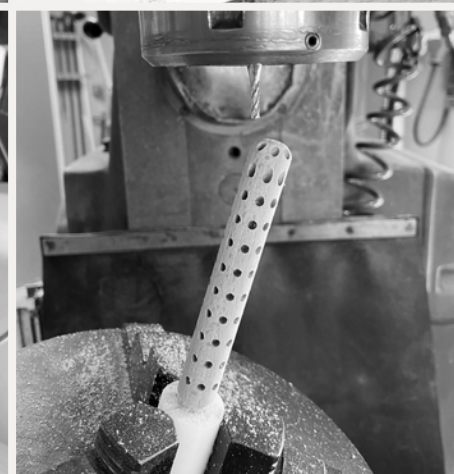
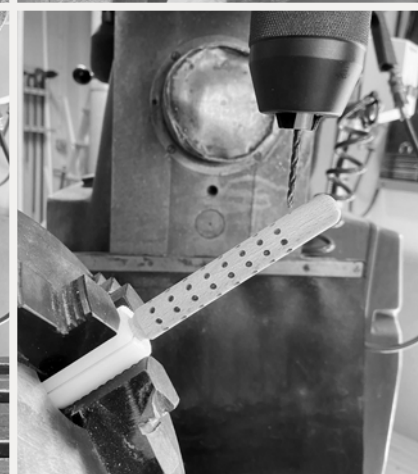
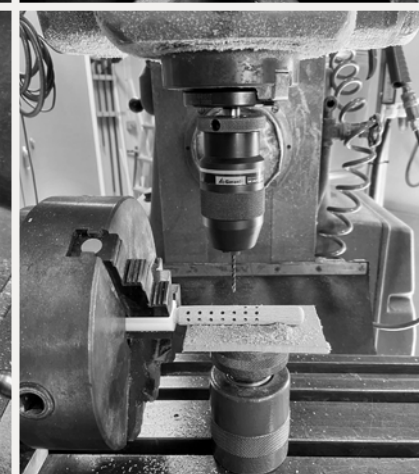
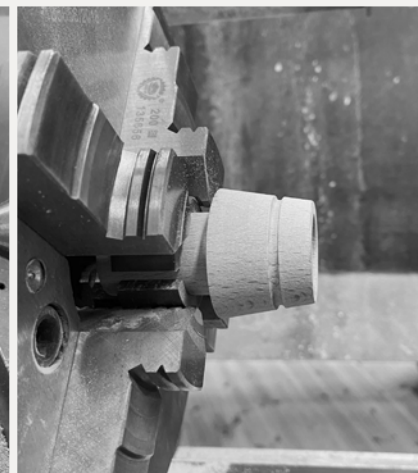
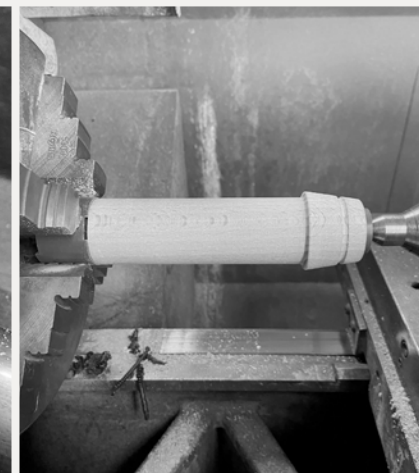
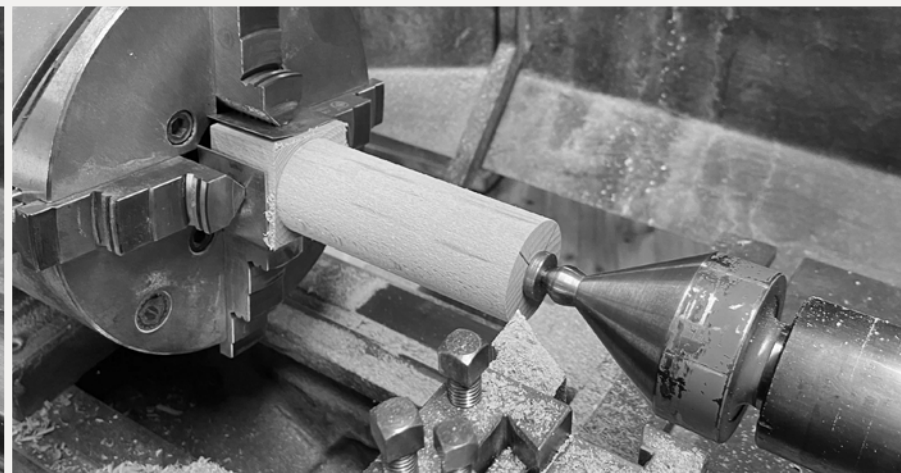
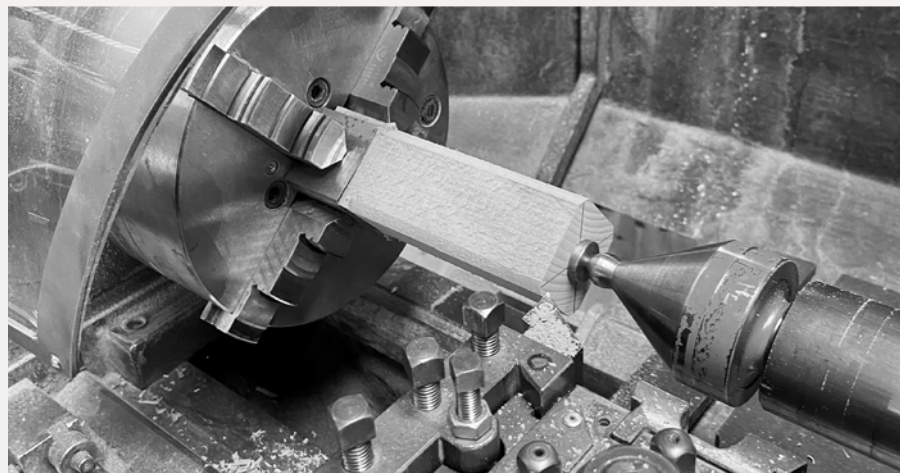
I looked at some alternative CMF versions for my dish brush before deciding on a few that I liked the most. I decided to not do any colour variants for the bristles and instead looked at different wood finishes, silicone colours and alternative metal appearances.





These are the alternatives I chose. I decided to only have one wood option – the unstained beech variant – since having multiple wood options would entail that all of the brush heads also needed to be produced in those wood finishes. This would result in an unnecessary amount of product variants. To give the customer a bit of adaptability on the dish brush's appearance, I decided to have the fastener available in both brass and stainless steel. Additionally, there will be a few color variants for the silicone as well: white, light gray and neutral brown.

Making a full-scale prototype





After consulting with the guys in the workshop, we decided that the easiest way to construct the handle for the prototype would be to make it in eight separate parts and then glue them together. This construction was based on the resources we had in the workshop. Ideally, if the product was to be produced, it would be possible to make the handle in fewer pieces. Thus, less glue would be needed, which is good because the glue could potentially weaken over time.

When all of the parts were made, I started to glue them all together. But then...

...this happened



The smallest tasks can prove to be the most difficult

One piece got stuck half way in. I tried to push it in, I tried to pull it out, but it would not budge. The workshop had closed for the day just minutes before, so I could not ask them for help either. Eventually I had to give up and filled the gap with a mixture of wood shavings and glue.



This is what the prototype looks like so far. Unfortunately, since I greatly underestimated the time it would take to create a full-scale model in the workshop, I did not manage to finish all of the parts before the deadline. But I intend to make them before the exhibition.





I have discussed it with the guys in the workshop and the base for the two remaining heads should be possible to make using the CNC machine. Like with the bend for the handle, the two brush heads will need to be split into two parts in order to make the CNC process quicker and easier. I will then glue the halves together and add the finishing touches.

5

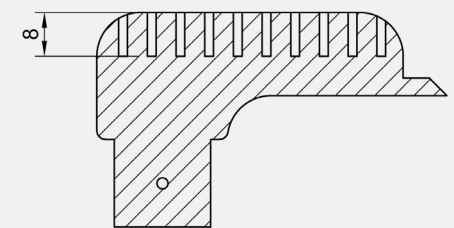
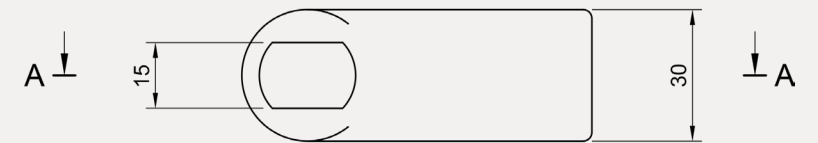
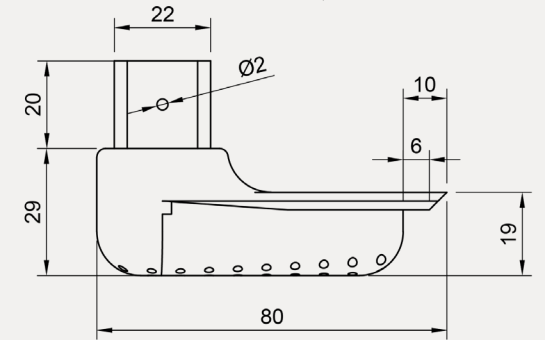
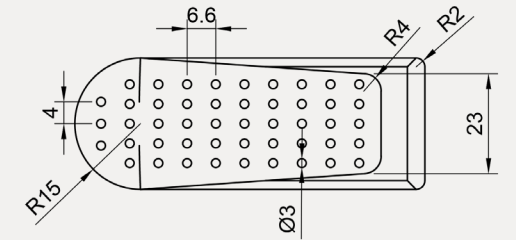
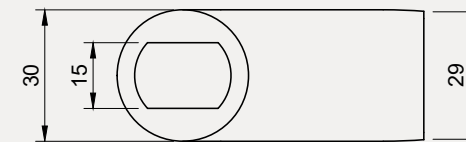
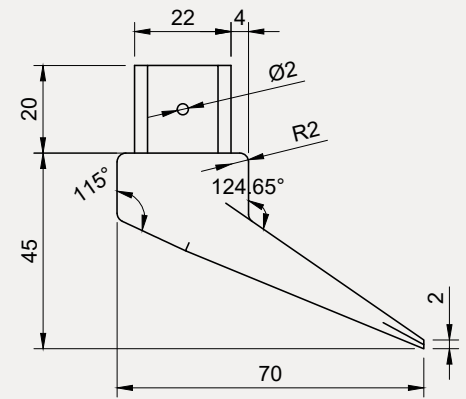
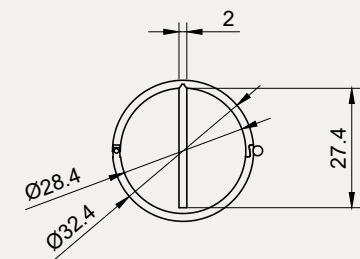
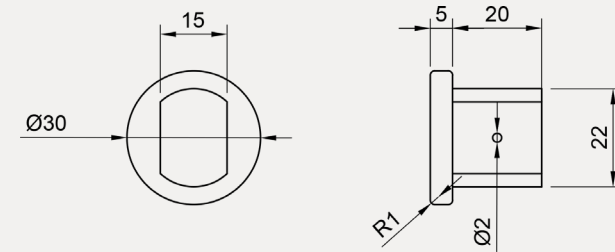
Result

Marina

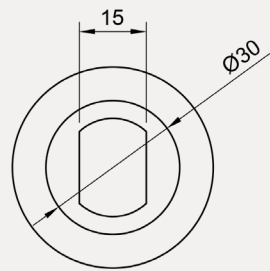
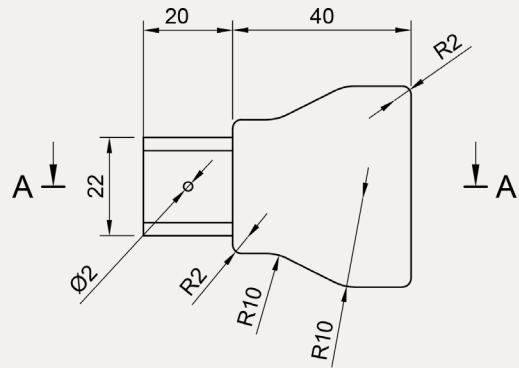
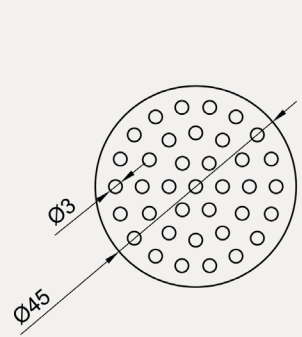




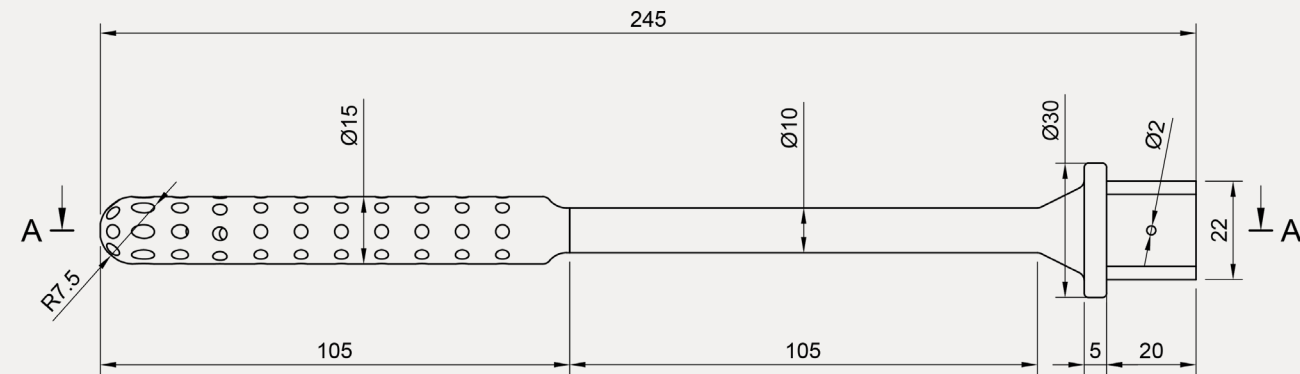
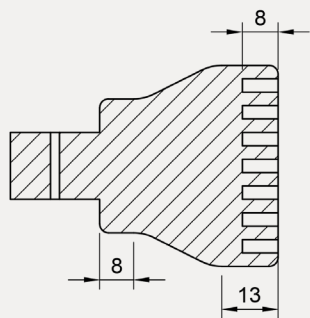
Technical drawings



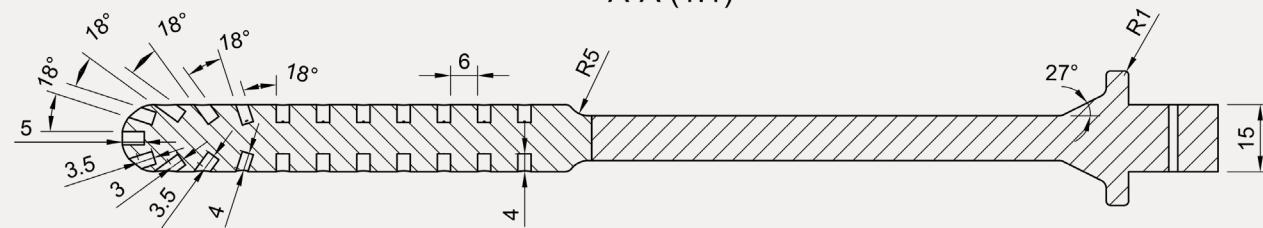
A-A (1:1)

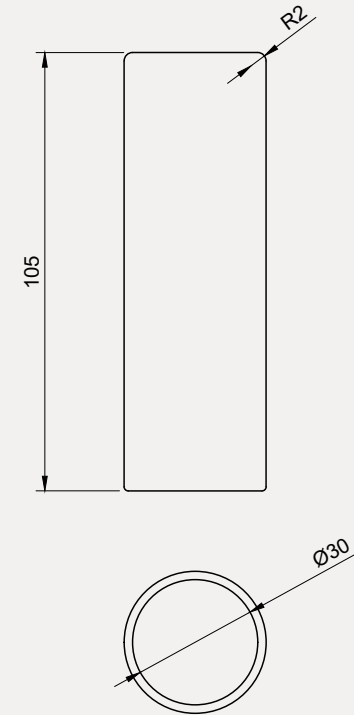
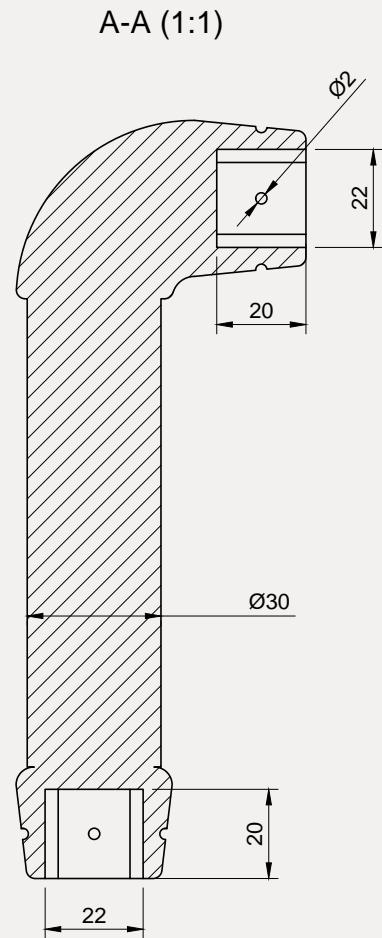
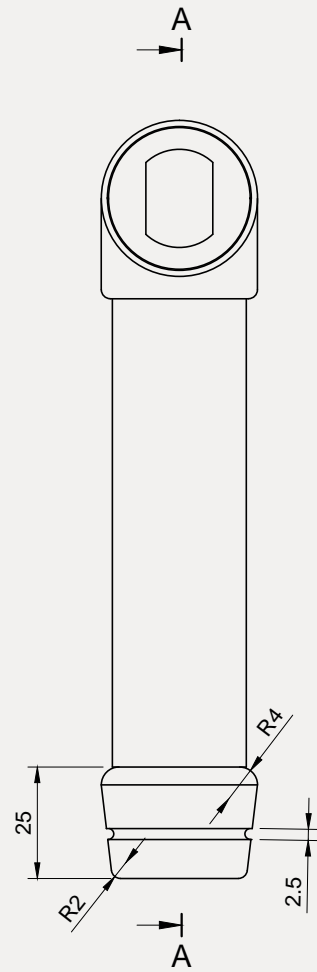
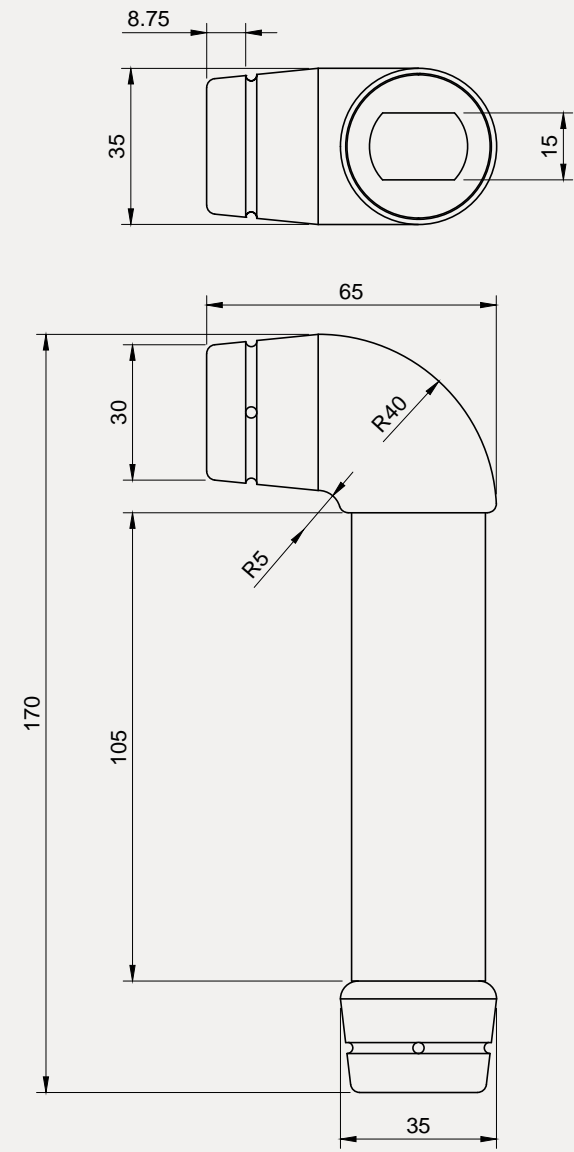


A-A (1:1)



A-A (1:1)





6

Reflection

Intended outcome vs. actual outcome

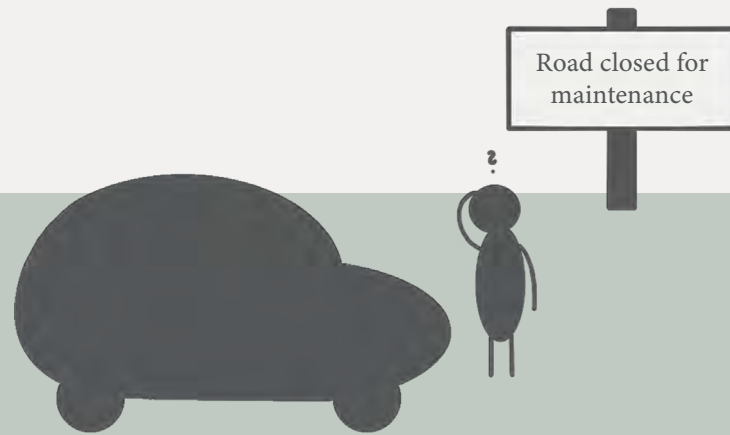
While creating my full-scale prototype I made some changes to my design, mainly measurements and chamfers. After some user tests and additional research, I came to the conclusion that 40 mm was too thick. So, one big change I made was reducing the handle diameter to 30 mm instead of 40 mm. I also wanted to add a bit more adaptability and later in the project decided to give the user a few different silicone sleeve thicknesses to choose from. That way they can adapt the handle thickness to their liking.



Intended time plan vs. actual time plan

Procrastination rears its ugly head

Due to some things happening in my personal life, certain aspects of my project took longer than I originally expected.



Approximated time

1 week

1 week

3 days

1 week

1 day

3 days

2 weeks

1 week

During the entire project

Not as much as wanted →

3-4 weeks

At the end

Task

Literature and analysis study of existing tools for hand washing dishes on the market.

Literature and analysis study of existing and alternative environmentally friendly materials for tools for hand washing dishes.

Create a questionnaire to get a more detailed understanding of what people experience as strain/pain during hand washing dishes.

Interview different groups/individuals about the troubles they experience while washing dishes through the questionnaire.

Compile result from the questionnaire.

Sketch different materials and solutions.

Create and develop models before and during user tests.

Create full-scale prototype before final presentation.

Write documentation.

Conclusion

From this project I have realized a lot of valuable lessons that I will carry with me into my future projects. For one, I now understand how many different kinds of wrist problems there are and how much they vary from person to person. Making it hard, if not impossible, to create one solution that fits everyone.

I also realize the importance of making full-size prototypes early on in the process, since that is when you notice problems in functionality, look and feel.

Another thing I realized is the complexity in making material choices in today's society.

It was very overwhelming at times to find the information, process it and be sure that it is the right choice on balance. The choices we make can have various consequences that are unknown to the average person and not readily apparent from the final product. Looking at my brush, you will not be able to see how the wood was sourced, so a lot of it depends on trust for the producer. Trust that is hard earned, but easy to lose.

Further development

Further development could be to fine tune the overall measurements in order to find an even better balance between functionality and appearance.

I would also like to add more functions, such as an alternative head with a sponge and some way to hang or store the tool between uses.

Additionally, I want to develop accessories to the tool. For example, an attachment with suction cups for hand free use or a rotational plate that could hold and position heavy objects during washing.

7

References

Literature

Aquasealrubber. (2020, September 10). *The Synthetic Rubber Production Process. Aquasealrubber.* <https://www.aquasealrubber.co.uk/articles/the-synthetic-rubber-production-process/> (2023-05-01)

Brown, Ethan. (2022, January 7). *What Are the Environmental and Economic Issues Facing Rubber Production?* PBS. <https://www.pbs.org/wnet/peril-and-promise/2022/01/what-are-the-environmental-and-economic-issues-facing-rubber-production/> (2023-05-01)

Canadian Centre for Occupational Health and Safety. (2015, October 1). *Hand Tool Ergonomics - Tool Design.* Canadian Centre for Occupational Health and Safety. <https://www.ccohs.ca/oshanswers/ergonomics/handtools/toolde-sign.html> (2023-03-02)

Daniel, Diann. (2021, October). *Poka-yoke.* TechTarget. <https://www.techtarget.com/searcherp/definition/poka-yoke> (2023-05-01)

Foodsafe Lubes. (2021, July 21). *What is Food Grade Mineral Oil?* Foodsafe Lubes. <https://foodsafelubes.com.au/what-is-food-grade-mineral-oil/> (2023-05-01)

Goonvean Fibres. (n.d.). *Our Top 10 Fibres & Powders for Eco-Friendly Products.* Goonvean Fibres. <https://goonveanfibres.com/news-insights/news/our-top-10-fibres-powders-for-eco-friendly-products/> (2023-05-01)

Holden Forests & Gardens. (n.d.). *European Beech. Holden Forests & Gardens.* <https://holdenfg.org/nature-profiles/european-beech/> (2023-05-01)

Hornaday, Fred. (2022, October 10). *15 Cold Hardy Bamboos for Snowy Climates.* Bambu Batu. <https://bambubatu.com/cold-hardy-bamboo/> (2023-05-01)

Humantech Ergonomics. (2015, June 23). *Get a Grip: Three Things to Know about "Ergonomic" Handles* [Video]. YouTube. <https://www.youtube.com/watch?app=desktop&v=P0ljvzSOnd8> (2023-02-27)

Mafouo, Martha. (2014, January). *Ergonomiska principer avseende arbete med rak handled och handgrepp - En litteraturstudie.* Lunds Universitet. <https://lup.lub.lu.se/luur/download?func=downloadFile&recordOID=4731012&fileOID=4731043> (2023-05-01)

Meier, Eric. (n.d.). *European Beech.* The Wood Database. <https://www.wood-database.com/european-beech/> (2023-05-01)

Miller, James. (n.d.). *Is Bamboo Eco-Friendly? Pros and Cons of this Renewable Resource.* The Roundup. <https://theroundup.org/is-bamboo-eco-friendly/> (2023-05-01)

Mindseteco. (n.d.). *Are Silicone Products Sustainable And Eco-Friendly.* Mindseteco. <https://mindseteco.co/is-silicone-environmentally-friendly/> (2023-05-01)

Nguyen, Quynh. (n.d.). *How Sustainable Is Beechwood? Here Are the Facts.* Impactful Ninja. <https://impactful.ninja/how-sustainable-is-beechwood/> (2023-05-01)

Parker, Walter. (2022, October 22). *Linseed Oil Advantages and Disadvantages – All You Need To Know!* Woodworkly. <https://woodworkly.com/linseed-oil-advantages-and-disadvantages/> (2023-05-01)

Parker, Walter. (2023, April 3). *Tung Oil Advantages and Disadvantages – All You Need To Know!* Woodworkly. <https://woodworkly.com/tung-oil-advantages-and-disadvantages/> (2023-05-01)

Rotax Metals. (2018, December 17). *Brass vs Stainless Steel—Which One Should You Use for Your Project?* Rotax Metals. <https://rotaxmetals.net/brass-vs-stainless-steel-which-one-should-you-use-for-your-project/> (2023-05-01)

Rotax Metals. (2023, April 14). *Everything You Need To Know About: Brass.* Rotax Metals. <https://rotaxmetals.net/everything-you-need-to-know-about-brass/> (2023-05-01)

Yarns and Fibres. (2020, October 23). *What are the environmental impacts of jute?* Yarns and Fibres. <https://www.yarnsandfibres.com/textile-resources/natural-fibers/plant-cellulosic-fibers-natural-fibers/jute/sustainability-jute/what-are-the-environmental-impacts-of-jute/> (2023-05-01)

Images

"iPhone Hands", by Jaysin Trevino, licensed under CC BY 2.0, Cropped and desaturated from original, <https://www.flickr.com/photos/orijinal/4841996359/in/photolist-8nSuPR-8euAu2-amrtgP>

"Washing the dishes- Cleaning Cutlery", by Ryan Lee, licensed under CC BY 2.0, Desaturated from original, <https://www.flickr.com/photos/190784293@N05/50861784428/>

"Wrist pain", by Injurymap, licensed under CC BY 2.0, Background removed from original, <https://www.flickr.com/photos/157210824@N06/46770332995/in/photolist-2efWbxD>

"HAMILTON KHAKI FIELD OFFICER AUTO H70615733", by Kazuhiro Keino, licensed under CC BY 2.0, Cropped and desaturated from original, <https://www.flickr.com/photos/djkeino/8257742382/in/photolist-dzH67E-eG-2fea-dzH5NA-dzH5zm-dzBBjt-dzBAbv-dzH51j-dzH6Hb-dzH6U9-eG8KTQ>

"Natural Dish Sponge", by COOKUT, Background removed from original, <https://www.formahouse.co.uk/brand/cookut/home/homeware/natural-dish-sponge>

"Eco-Friendly Natural Kitchen Washing Up Sponge Plant-Based Biodegradable Non-odor Loofah Dish Sponge", by junxince-shui, Background removed from original, https://www.joom.com/sv/products/5f6d93df6f51370106d487f7?variant_id=5f6d93df6f51370406d487fc

"Dish brush with coconut bristles", by Nova Concept, Background removed from original, <https://www.novaconcept.se/produkt/dish-brush-with-coconut-bristles/>

"Redecker Horsehair and Beechwood 13-3/4 inch Bottle Brush, Durable Wooden Handle, Dense Natural Bristles, Easily Cleans Vases, Pitchers, Mugs and More, Made in Germany", by Redecker, Background removed from original, <https://www.amazon.com/REDECKER-Horsehair-Beechwood-Bristles-Pitchers/dp/B002HORIN4?th=1>

"Grytborste", by Granit, Background removed from original, <https://www.granit.com/se/grytborste-374238/#tab-label-description-tab>

"Dish Washing Brush, stainless steel handle with natural brush", by Küchenprofi, Background removed from original, <https://www.kuchenprofusa.com/collections/prep-serve-clean/products/classic-dish-washing-brush-stainless-steel-handle-with-natural-bristles>

"HeavyDutyScrubSponges|5pcsDual-SidedDishwashingSpongeforKitchen | Scrubbing Dish Sponge I", by Quanwujin ping, Background removed from original, https://www.joom.com/sv/products/6357b42420218401bf97402e?variant_id=6357b42420218456bf974031

"Home Kitchen Clean Washed Pot Brush Long Handle Brush", by Duska, Background removed from original, <https://www.joom.com/sv/products/63bfc69ef29e3901b87b293a>

"Full Circle FOMO Dispensing Foam Brush", by Williams Sonoma, Background removed from original, <https://www.mydomaine.com/prettiest-cleaning-tools-6361054>

"SOAP DISPENSING DISH BRUSH MID GREY", by BRABANTIA, Background removed from original, <https://brabantia.com.au/collecting-waste/brabantia-soap-dispensing-dish-brush-mgr/>

"OXO Good Grips diskborste med tvålhållare", by OXO Good Grips, Background removed from original, https://oxogoodgrip.se/hushall/diska_stada/oxo-soap-pump-palm-brush

"Garneck 4 st disksvamp med handtag skrubba svamp rengöringsborste för kök handfat badrum (vit, svart)", by Garneck, Background removed from original, <https://www.amazon.se/Garneck-disksvamp-handtag-skrubba-reng%C3%B6ringsborste/dp/B08M3HXPW1>

"Rotfruktsborste med sugkoppar", by Swereco, Background removed from original, <https://www.swereco.com/hjalpmedel-i-hemmet/kok-maltid/koksredskap/rotfruktsborste-med-sugkoppar-132350>

"Diskborste med sugkoppar", by Swereco, Background removed from original, <https://www.swereco.com/hjalpmedel-i-hemmet/kok-maltid/koksredskap/diskborste-med-sugkoppar-132170>

"Libman Kitchen Scrub Brush Kit Cleaning Brushes for Household Use Dish Brush Kitchen Brushes for Dishes Scrubbing Brush Long Handle Scrub Brush 3 Different Brushes Included", by Libman, Background removed from original, https://www.amazon.com/Libman-1567-Kitchen-Scrub-Brush/dp/B0B3Y67KF2?source=ps-sl-shoppingads-lpcontext&ref_=fplfs&smid=ATVPDKIKX0DER&th=1

"Diskborste Classic 1-P 12110", by Kron, Background removed from original, <https://www.k-rauta.se/produkt/diskborste-classic-1-p-12110/7312070121107>

"Osthyvel", by Clas Ohlson, Background removed from original, <https://www.clasohlson.com/se/Osthyvel/p/Pr341124000>

"Kniv, tandad, blad 260 mm, ergonomiskt handtag", by Bakers, Background removed from original, <https://bakers.se/catalog/products/kniv-tandad-blad-260-mm-ergonomiskt-handtag-11264>

"afrc.mc.20.8.14 (59)", by ScotGov Rural, licensed under CC BY 2.0, Cropped and desaturated from original, <https://www.flickr.com/photos/scotgovrural/14987299471/in/photolist-oQnPZ2>

"Magic!", by Samanvay Karambhe, licensed under CC BY 2.0, <https://www.flickr.com/photos/skarambhe/8484216206/in/photolist-dVHPTL>

"Smooth", by Annelieke B, licensed under CC BY-SA 2.0, <https://www.flickr.com/photos/anneliekeb/14258174552/in/photolist-nHWSxJ>

"Roker pier 10/5/15", by Dave43251 mages, licensed under CC BY-SA 2.0, <https://www.flickr.com/photos/wakeywonderer/16898465414/in/photolist-rK-g42Y>

"Smooth & Silvered", by Orin Zebest, licensed under CC BY 2.0, <https://www.flickr.com/photos/orinrobertjohn/316760669/in/photolist-tZtUR>

"6Q3A1369", by Ilkka Jukarainen, licensed under CC BY-SA 2.0, <https://www.flickr.com/photos/130333033@N08/48888736641/in/photolist-2hu8y9r>

"Ferdig bøyd plexiglass, test", by Espen Klem, licensed under CC BY 2.0, <https://www.flickr.com/photos/eklem/5581235887/in/photolist-9vchYX>

"Heart", by Johnathan Nightingale, licensed under CC BY-SA 2.0, <https://www.flickr.com/photos/johnath/5376628385/in/photolist-9c7Cip-5jQDxs-6cN-HWT>

