ALIGN

A sustainable cleaning tool for model makers

Master Thesis in Industrial Design
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Abstract

People who make models as their hobbies at home often generate more trash clutters than others. Once they start the modeling process, they often end up having small debris, sanding dust, and spilled paints on their desks. These tiny clutters will reduce their concentration and enthusiasm for the model-building process. It is quite difficult to collect them and get rid of them.

Therefore, I designed ALIGN, a household desk cleaning product for amateur model makers. It includes a double-sided brush and a dustpan with two high walls. The double-sided brush helps gather both solid pieces and liquid waste into the dustpan. For the dustpan part, users can attach the high walls to the edge of desks to prevent trash from falling to the floor. After the desk cleaning process, users can hang the brush and dustpan together on walls to save space.

Align is made of recyclable raw material with simple forming technologies. One of my main goals is to design a simple hand tool that requires low energy consumption to produce and is easy to recycle. And more importantly, the cleaning process should be simple and natural.

Keywords

Cleaning tool, sustainability, home workspace, model making

Table of content

Chapter 1

Introduction

Background

The increasing need of having working space at home

In the past decade, the amount of distance jobs has increased significantly due to the fast development of online communicating technologies and rising demands for job flexibilities. More and more people choose to work remotely because it can reduce commute time and provide a more flexible working schedule. According to Global Workplace Analytics' analysis of 2018 ACS data (Analytics, 2020), the amount of distance work at home has grown 173% from 2005 to 2018 in world-wide. In 2019, a report from Eurostat (Employed persons working from home as a percentage of the total employment, by sex, age and professional status (%) - Eurostat, 2020) shows that 31.3% of employed Swedish people sometimes working at home, which is the highest number among the European countries.

In 2020, the world is under the coronavirus crisis. In this special situation, the European Center for Disease Prevention and Control(ECDC)(2020) has encouraged the public to keep a social distance. In order to reduce the transmission of coronavirus, many social activities have been postponed and we tend to spend a lot more time at home to lower the risk of getting infected.

No matter we are remote workers or not, we seek a temporary working space at home more than ever before. The need for working space in the home environment keeps rising over the past decade and increases dramatically in 2020. Based on this fact, I would like to choose the home working space as my initial focus area.

Sustainability in mind

Sustainability as a global goal

| Low energy and water consumption processes | Corporate Sustainability Management System | Materials from Recycling | Processes without hazardous chemicals | Traditional materials with low environmental impact | Ethical practices along the supply chain | Materials from responsibly managed forests |

(Riri, n.d.)

In recent years, public awareness of sustainability is rising quickly. Sustainability is defined as 'the balanced use of social, environmental and economic capital, so as not to compromise the ability of future generations to survive and thrive.' (Sherin, 2013) In product design field, sustainable thinking has become a must. Industrial designers should have responsibilities for eliminating negative environmental impacts by selecting eco-friendly materials and minimalized the energy consumption of the manufacturing process.

Project goal

The project aims to explore existing problems in the home working space and then design a household product to improve the home working experience. The product should be made of sustainable material and manufactured by simple technology.

Methodology

Questionaire

Online research

Interview

Sketch

Prototype

Chapter 2

Research

Questionnaire

explore the working space at home

At the starting point, I decided to make short anonymous questionnaires to understand the working space at home. I reached 14 people and asked 3 questions in order to explore the locations of working spaces at home, the usages of working spaces, and the problems in working space.
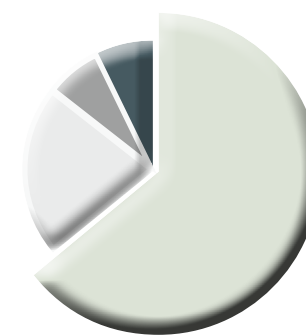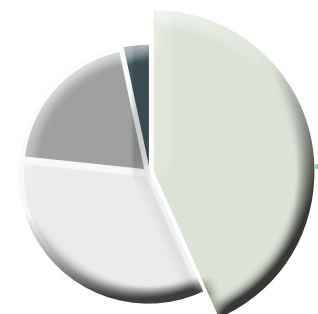
Where do you usually work at home?

Desk	9
Couch	3
Armchair	1
Window bed	1
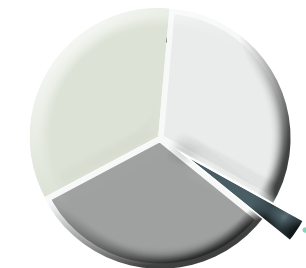
Do you have other use of your working space at home?

Entertainment	12
Having food	13
Hobbies	12
No, I have deticatded spaces	1

What problem do you have in your home working space?

Messy working space	13
Home distrations	10
Limited working space	6
Lack of tools	1

Summary of answers

Understand the working space at home

1 Location of working space at home

Compared to traditional working space in offices, the location of the workspace at home is much more flexible. 36% of people mentioned that they prefer to work in comfortable places, such as couch, armchair and window bed. However, 64% of people still prefer to set up their working space around the table.

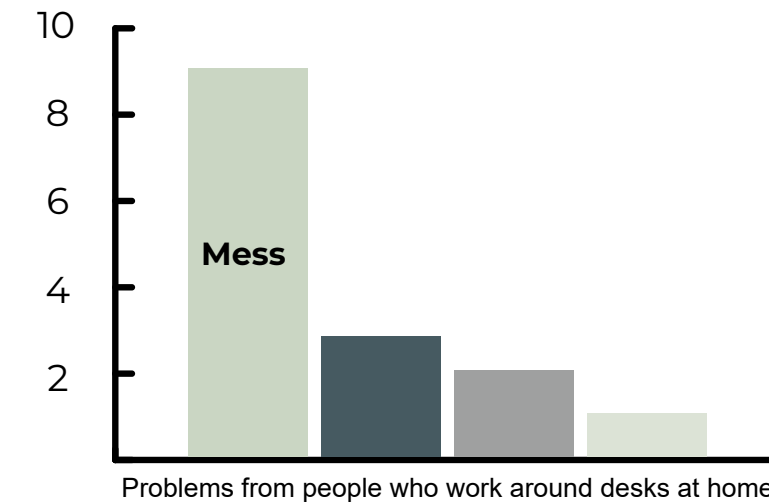**2 Usage of working space at home**

Only 2% of people have dedicated working space at home. Most people tend to use their home workspaces for different activities, such as eating food, doing hobbies and having entertainment

3 Problems

There are quite many problems in the home working space, which are the mess problem, home distractions, limited space, and lack of tools. The most common problems are having messy working space(mentioned by 13 people) and home distractions(mentioned by 10 people).

Messy desk

The problem in home working space

Problems from people who work around desks at home

Based on the summary of the questionnaire answers, I found messy working space and home distractions are the biggest problems in working space at home. I also found most people work around their desks at home and they use their desk space for different tasks. To be more specific for people who work around desks, I figured out that these people all (9 of 9) mentioned the messy working space problem is the primary issue they want to solve. Therefore, I would like to explore the messy desk problem at home.

Online research

Understand the messy desk problem at home

What

cause desk mess problem?

Why

do we need to solve the mess problem?

How

can I solve desk mess problem through product design?

What cause desk mess problem?

(Horgan et al., 2019)

(Horgan et al., 2019)

According to one article(Horgan, Herzog and Dyszlewski, 2020), messy desks are described as being dirty, untidy, disorganized, and cluttered.

"A messy desk typically contains a lot more things than you actually need." (This is How a Messy Desk Affects Your Brain – Kwik Learning, 2020) According to my questionnaire answers, people mentioned that they use their desk space for different tasks rather than using it as a dedicated working space. As a result, we often place many objects on desk surfaces. If we don't organize our stuff and clean up desks at home regularly, we are very likely to have messy working desks.

The need of tidiness

Why do we need to solve the mess problem?

The tidiness of the working space mainly influences people's emotions and productivity.

One study about the psychology of home working space shows that clutter will cause extreme fatigue and stress in mental aspects.(Saxbe and Repetti, 2009) This is because clutter will distract us visually and signal to our brains that our works are not completed. In mental aspects, a messy working space will give us negative feelings.

A messy home working environment will also lead to having low productivity. As a cleaning service company mentioned, messy workspace will reduce people's persistence in completing tasks. (8 Reasons Why Cleaning is Important in the Workplace – Owens Management, 2020) When a desk is messy and occupied by clutters, the available space on desks will be reduced and limited. A messy desk will also prevent us from locating tools and files quickly, which slows down our working pace. (Why Mess Causes Stress: 8 Reasons, 8 Remedies, 2020) In contrast, A study shows that the tidiness of working space will reduce errors and improve accuracy, which contributes to high productivity. (Horgan, Herzog and Dyszlewski, 2020)

Therefore, we strongly need to have a tidy working space since it can decrease negative emotions and make us more concentrated on works and be productive at home.

Solution

How can I solve desk mess problem through product design?

for desk mess
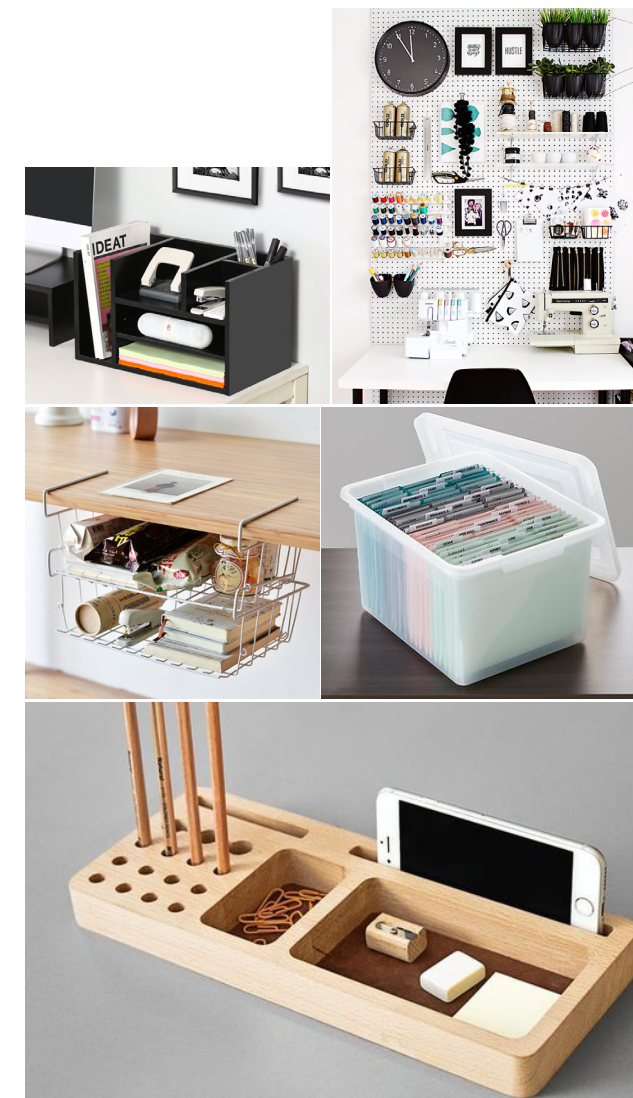
After understanding the importance of having tidy working space at home, I did observations of existing products that can solve messy desk problems. Based on my observation, these products can be categorized into two functions: organizing and cleaning.

STEP 1
Organizing

Products for organizing working space are quite similar in the way they all provide an extra storage place for gathering and hiding clutters. By organizing things around our workspaces, we will create more free spaces and fewer distractions.

STEP 2
Cleaning

Products for cleaning process aims at removing unwanted substances. We have various cleaning tools for different cleaning tasks, depending on the type of trash to deal with. The cleaning process usually comes after the organizing step.

Organizing or cleaning?

Looking into the current market, it is shown that in order to deal with messy workspace, we need both organizing and cleaning products

Organizing and cleaning are related to each other, however, the clutters they deal with are diverse. Organizing is more about sorting stuff that we want to keep and gather in orders, while cleaning is for getting rid of the trash and completely remove them away from desks. Both steps are necessary and should not be mixed up.

Moving forward, I think it is important to choose one direction to focus on. I was more interested in the cleaning tools since they have various cleaning functions. It will be interesting to combine some of the features in one product so that users don't need to have various cleaning tools for different cleaning tasks. In the following part of my research, I would like to dig deep into the cleaning process.

Interview

Desk cleaning

I decided to conduct an interview for collecting personal experience about the desk cleaning process at home. I choose to hold semi-structured interviews so that I can receive extended responses from my interviewees. The interview questions should be open-ended in order to get descriptive answers. (Muratovski, 2016)

My interview questions are:

Do you have a working space at home and where is it located at your home?

What type of activties do you do at your working space at home?

- **How often do you usually clean your working space?**

- **What type of trash or waste do you usually find at your home working space?**

- **What type of products do you use to clean your working space?**

- **Are you satisield with you current cleaning tools ?**

Interview answers
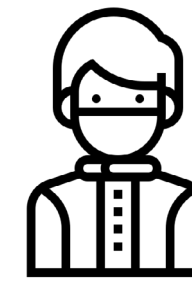
Student	Model hobbist	Remote worker
27	33	32
Cleaning frequency		
Once a week	Every time before starting modeling and after finishing models	Twice-three times a week
Cleaning targets		
Postics Spilled drinks Food debris	sanding powder, spilled paint Model debris erassor bits	Printed paper docs Postics Hair
Tools for cleaning		
Mini trash bin Wiping cloth Tissues	Mini vacumm cleaning brush Model packaging（for collecting sanding dust） Wiping cloth Tissues	Vacumm cleaner Trash bin Tissues

Interview summary

I reached to three participants with different occupational backgrounds for my interviews. Each interview takes 20 minutes of a skype meeting.

According to the interview result, I found people all appreciate having a clean and tidy working space at home. They all clean their desks weekly while the model maker has the highest cleaning frequency. The model maker mentioned that he has to free up desk space before starting modeling and every time he finished his modeling task, he needs to remove all the trashes on desks and keep all the tools and model parts back in orders.

Three interviewees listed quite a lot of trash on their desks, which can be categorized into two groups: solid trash and liquid trash. The model-maker has the highest difficulty of cleaning since the trash he needs to get rid of is tiny and hard to pick, which are sanding powder, spilled paints, and model debris.

Tools that people used for cleaning messy desks usually consist of two parts, a cleaning part to remove trash and a bin part to collect trash. People also prefer to have small cleaning products that can be placed within arms' reach.

Target group

Amateur model makers

Based on the summary of the interview, I found people require different levels of tidiness in their home working spaces. The model-maker has the highest demand for cleaning tools since they need to clean the desk space very frequently. What's more, they need to deal with some specific trash coming from the modeling process, which is tiny and hard to pick. Therefore, I would like to narrow my targets to model makers

Looking into the hobby modeling community, models are generally considered as "physical representations of an object and maintains accurate relationships between all of its aspects." (Scale model, 2020) In today's model making communities, we have different model categories, such as Scale-model, miniature model, RC models, and so on. The materials of models contain wood, metal, resin, plastic and etc.

Professional model makers usually do the modeling works in dedicated workshops or studios, while most of the amateur model makers build their hobby models around their home desks. Since amateur model makers have limited tools and desk space at home, the models they build are mainly small scale model kits. Therefore, I decided to choose amateur scale-model makers as the target group for my design.

(nozakuboy, 2017)

Observation

an amateur model maker's desk

Amateur model makers have storage shelves to organize their tools and model parts. Organizing is not a big problem for amateur model makers.

The modeling process will generate lots of tiny trash on desks., which leads to the messy desk problem.

Cleaning challenge

For amateur model makers

From my observation, amateur model makers have more problems in the cleaning process rather than the organizing process. Amateur model makers usually build models around desks at home, which means they don't work at a dedicated workspace for modeling tasks only. During the modeling process, the model waste will quickly occupy the desk space. and reduce the available workspace. Therefore, amateur model makers have to clean their desk surfaces constantly as a long-term habit. In this case, the cleaning process should be done regularly with minimal efforts and consciousness. Cleaning tools should be designed in a way that is easy to operate with enough affordances

Type of trash

For amateur model makers, these are the three main types of waste they need to remove from their desk working space, which are model debris, sanding dust, and spilled paint. The first two waste is tiny solid waste and the third one is liquid. They are quite tiny and impossible to pick by hands, which is much more difficult to clean than other trashes.

Solid		Liquid
(Cheboksary, n.d.)	(FineScale Modeler, 2014)	(CHAT: NO POINT CRYING OVER SPILT PAINT, 2017)
Model debris	Sanding dust	Spilled paint

Cutting is an essential step in the modeling process. Model-makers cut model parts from the runner and will generate quite a lot of model debris.

After assembling different model parts together, model-makers need to sand models in order to get smooth surfaces. Therefore, sanding dust is quite common on model-makers' desks.

Some model makers also mentioned the spilled paint problem when they paint models and accidentally knock over the paint bottles.

Product analysis

Currenet cleaning products

	Debris	Sanding dust	Spilled paint
Dust pan set	✓	✓	✗
Desktop bin	✓	✓	✗
Wiping cloth	✓	✓	✓
Squeegee	✗	✗	✓
Housework vacumm	✓	✓	✗
Mini vacumm	✓	✓	✗

I looked into the current market and made this competitive analysis of different cleaning products. I tried to analyze whether each product is suitable for cleaning model debris, sanding dust, and spilled paints or not. Most of the cleaning tools can deal with either solid waste or liquid waste. This triggered me to think about dividing the cleaning tool into two parts, one for cleaning small solid trash and the other one for cleaning liquid waste.

Product analysis

Pros and Cons

Hand tools	Dust pan set	Pros: small volume, portable, can be washed Cons: when trying to brush debris and dust into a dustpan, a part of dust will be stuck in the gap between the dustpan entrance and table surface
	Desktop bin	Pros: small volume, can be reached in arms Cons: quite hard to pick up small debris and sanding dust and throw them into the bin
	Wiping cloth	Pros: universal cleaning usages Cons: need be washed quite often which will interrupt the concentration of modeling process
	Squeegee	Pros: good to control the flow of liquid on a flat surface Cons: have high frictions when clean a dry surface
Electronic tools	Housework vacumm	Pros: provide enough suction for remove debris and sanding dust. Cons: need be charged, size is quite big for desk cleaning, might accidentally suck small model pieces in it
	Mini vacumm	Pros: Effective on cleaning small trash, small volume Cons: need to be charged, e-waste, not enough suction

Current household cleaning products have different pros and cons. These products can be divided into hand tools and electronic tools.

Electronic tools (vacuum machines) have stronger performances of cleaning solid waste but are incapable of removing liquid waste. They are made of lots of components and will end up with e-waste problems.

Hand tools are simple to use and can be produced with simple forming technologies. Non-electronic cleaning products usually consist of two parts, one cleaning part (brush, squeegee, wipe cloth, etc) and one part for collecting trash(trash can, the scoop part of the dustpan, etc).

For amateur model makers, both types of cleaning products have several common demands: space-saving and reachable on the desk surface; able to deal with both solid and liquid waste.

Marketing mapping

Sustainability

Recyclable

Short lifecycle

Long lasting

Unrecyclable
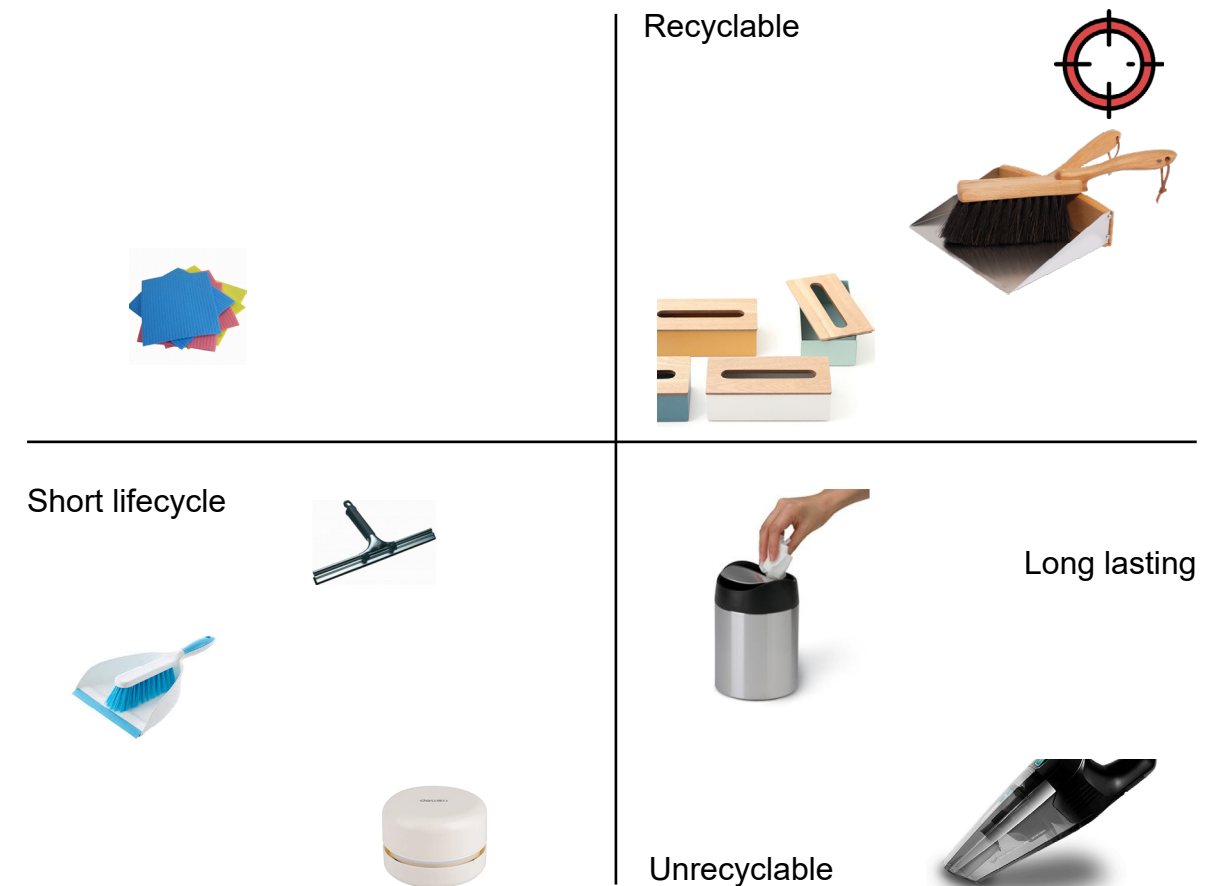
Electronic cleaning products consist of lots of parts, which can not be recycled as a single unit. By contrast, non-electronic cleaning products can be produced by simple forming technologies with sustainable raw materials. As a result, they can be recycled in cost- and energy-efficient ways.

With sustainability in my mind, I would like to design a non-electronic cleaning tool. It should be recyclable and long-lasting.

Final brief

Product features

Develop a household desk cleaning product for amateur scale-model makers.

It should be designed in a way that is convenient to clean small debris, sanding dust and spilled paints from the modeling process.

It should be small and reachable so that it won't occupy a lot of space in the working space.

It should be designed as a simple product with sustainable material.

Chapter 3

Design part

Design elements

cleaning part and trash container part

According to my research, I would like to design a hand tool set for cleaning messy desk space at home. This toolset should consist of two parts, a cleaning part, and a trash container part.

The cleaning part could be a combination of cleaning brush and squeegee so that it can be used to sweep both solid trash and liquid waste(model debris, sanding dust, and spilled paints on desk surfaces) and gather them in one small area. Later, these gathered trash will be collected by the trash container part.

I had a clear idea about the features of the cleaning part. By contrast, I do not have concrete ideas about the trash container part. Therefore, I decided to explore more possibilities for trash containers.
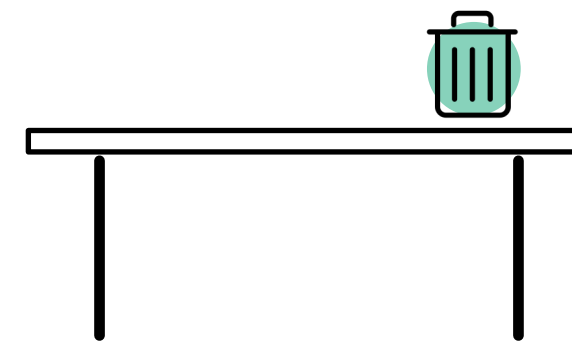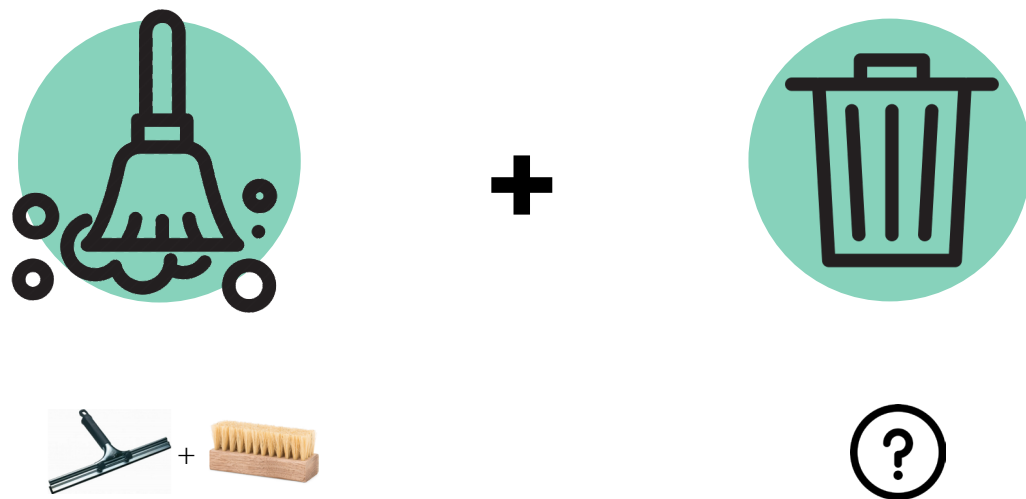
On the table

Under the table
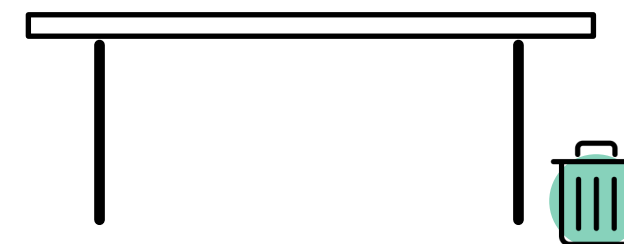
Nearby the table

Trash bin

what problem i should sovle by trush bin ?

In the current market, there are three ways of placing trash bins, including on the table, under the table, and nearby the table. There is a height difference between the trash bin entrance and the desk surface. For normal trashes, users usually pick up them and throw them into trash bins. For model makers, the model waste they need to deal with it is too tiny to pick up. Therefore, they need to use cleaning tools to sweep these wastes into trash bins. In this case, in order to collect all these wastes, the trash bin should be placed in the same height as the desk surface, so there will be no waste escaping from the gap.

Initial Idea
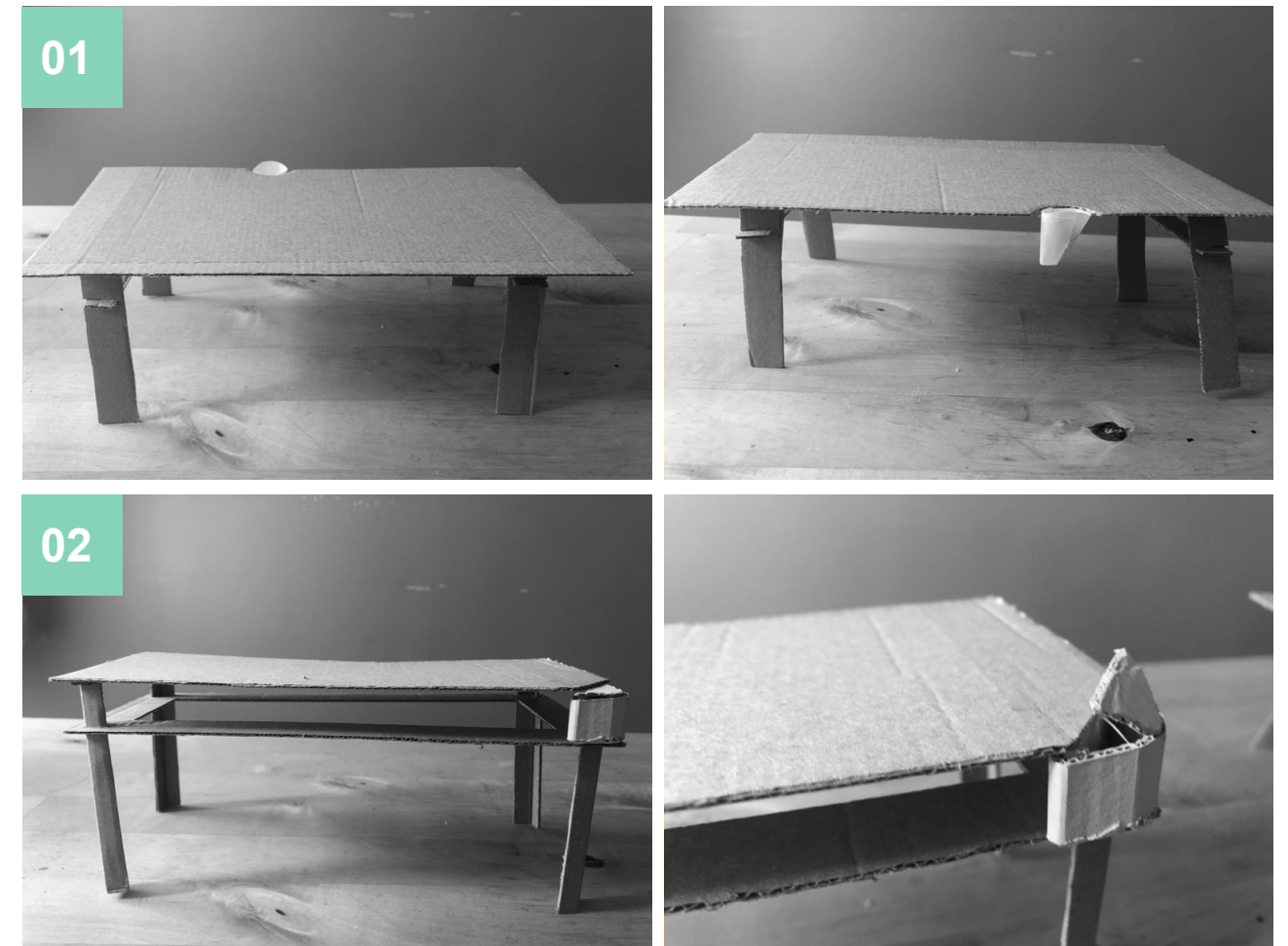
Design a desk with trash bin part
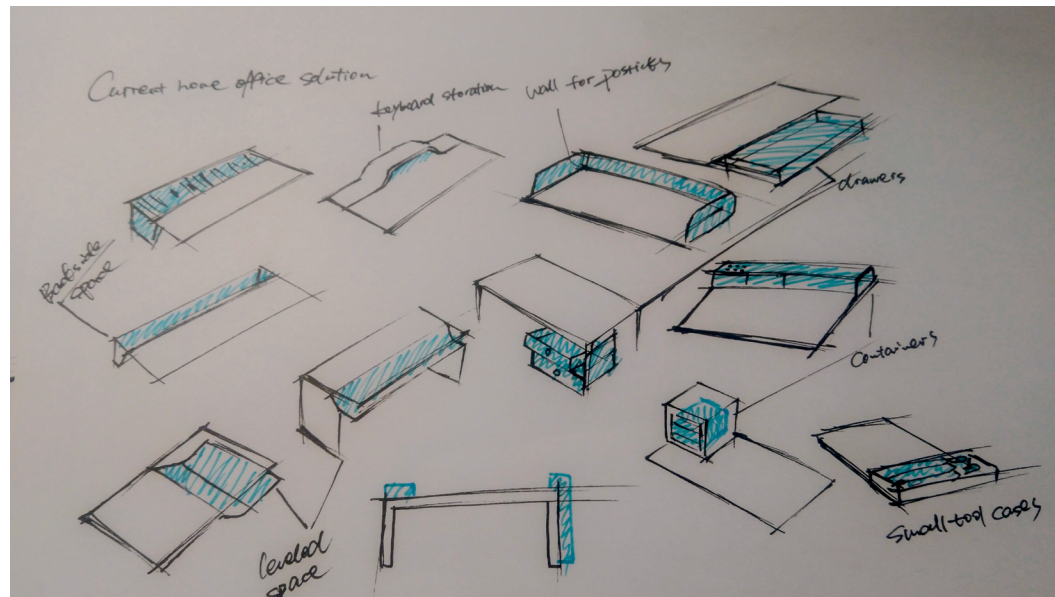
Various desk designs aim at providing sufficient and invisible storage for organizing stuff and maximizing the available working space. This inspired me to think about combining a desk and a trash bin together in order to save desk space.


Mock ups

1:10 scale cardboard models

01

02

I made two cardboard mock-ups for this concept. I cut a part of the desk surface for placing a trash bin so that the entrance of the trash bin is on the same level as the desk surface. In that case, I need to design a specific desk with a trash bin, which seems overdesigned to solve the simple cleaning problem.
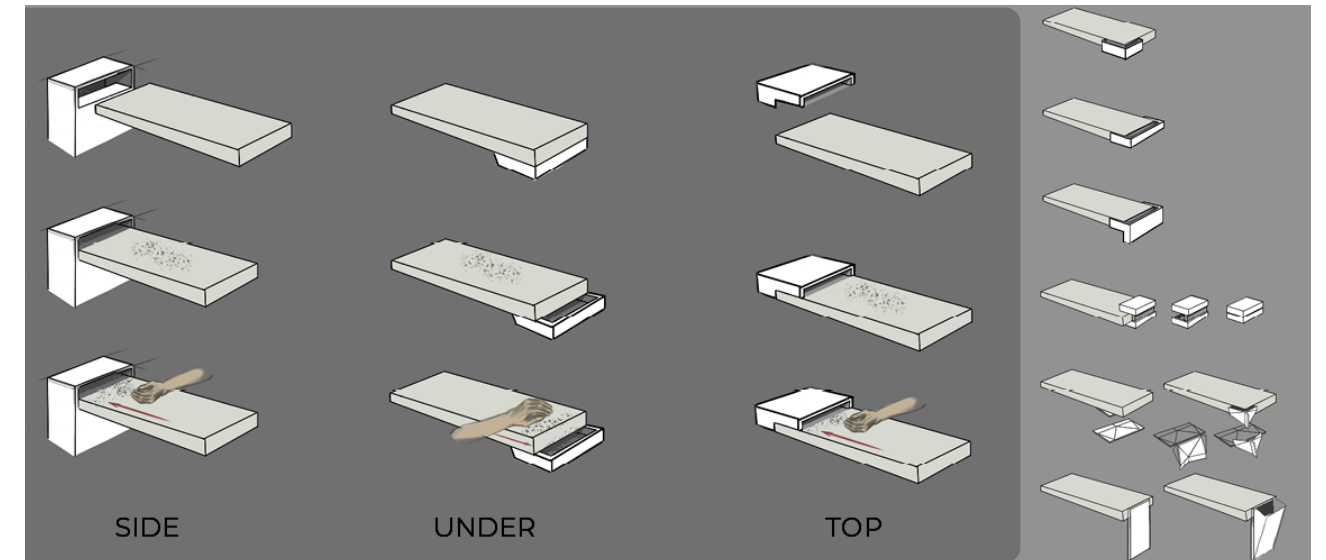
Desk edges

Since the initial concept is abandoned, I would like to explore other ways of combining trash bin parts and desks. By observing the placement of desks at home working space, I found that part of desk edges are seldom used by users. Therefore, the trash bin part can be located at these free edges.
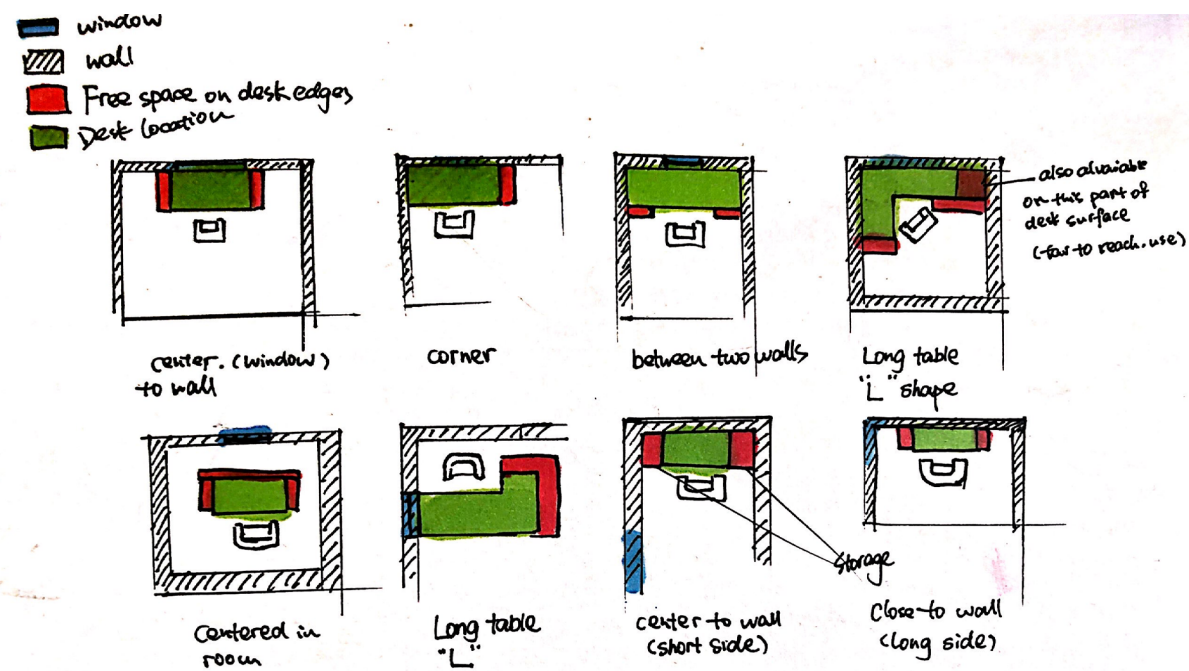

# Idea shift

Design a small accessory for cleaning

Moving forward, I decided to design a small trash bin as a desk accessory. I made several sketches to explore how this part can be placed on desk edges. I prefer to have the trash bin accessory placed on the side edges of desks.

The trash bin accessory should be attached to the desk edges during the desk cleaning process. After the cleaning process, users should be able to detach the trash bin accessory and empty it.


Ideal placement on desks
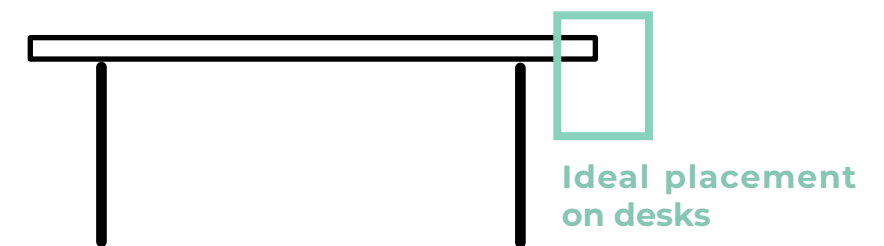
Mock up

1:1 scale cardboard models
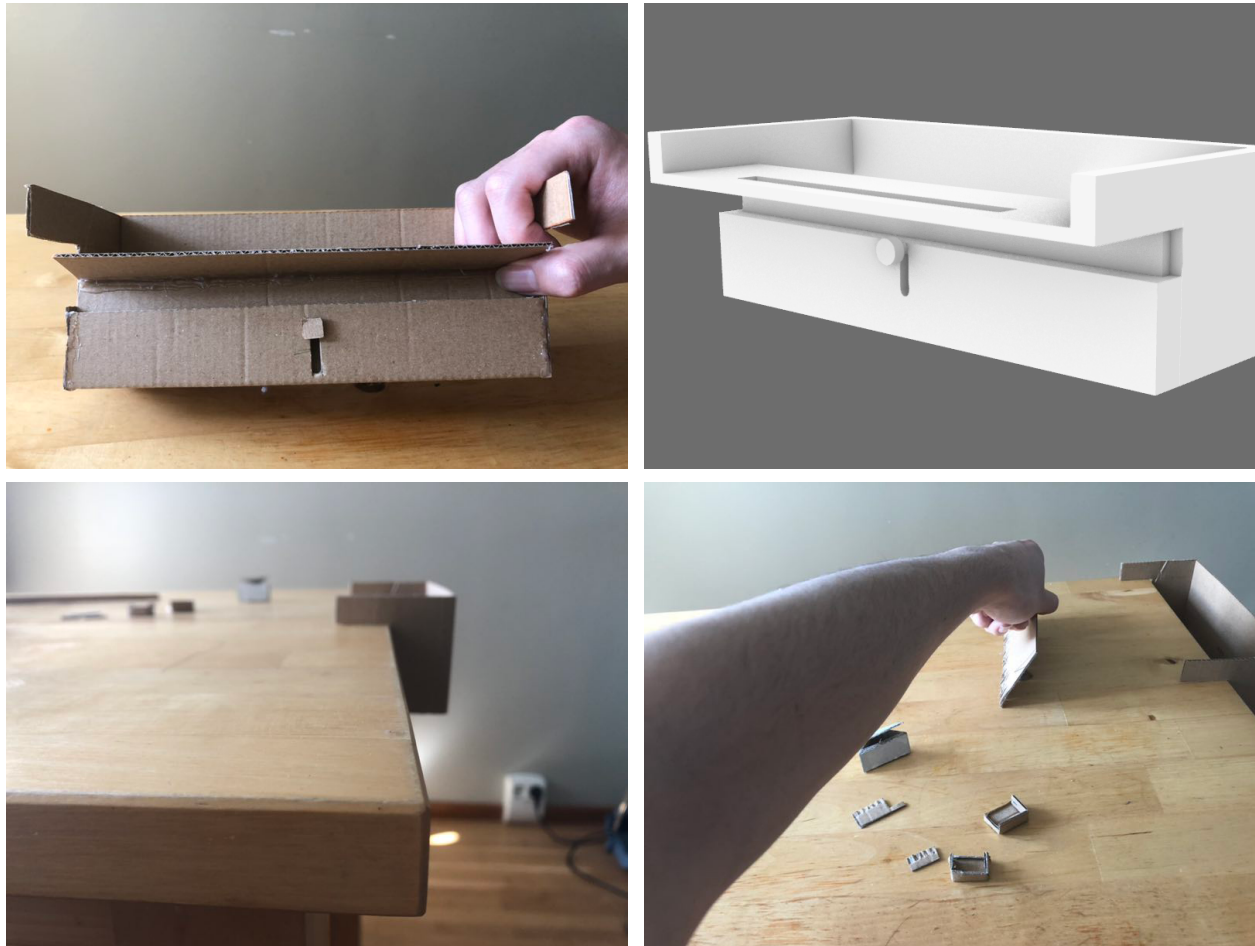
In this stage, I was thinking that the trash bin should stay on the side corner of the table, the place where users seldom reach. I also considered that it is better to have two high walls at the trash bin entrance so that debris and sanding dust will be guided into the bin without falling downwards to the floor

Noticed that the thickness of desk surfaces is different (normally from 1.6cm to 2.8cm for indoor desks). The best attachment between the table and the trash bin is to have an adjustable clamping system so that the trash bin accessory can be attached to different desks.
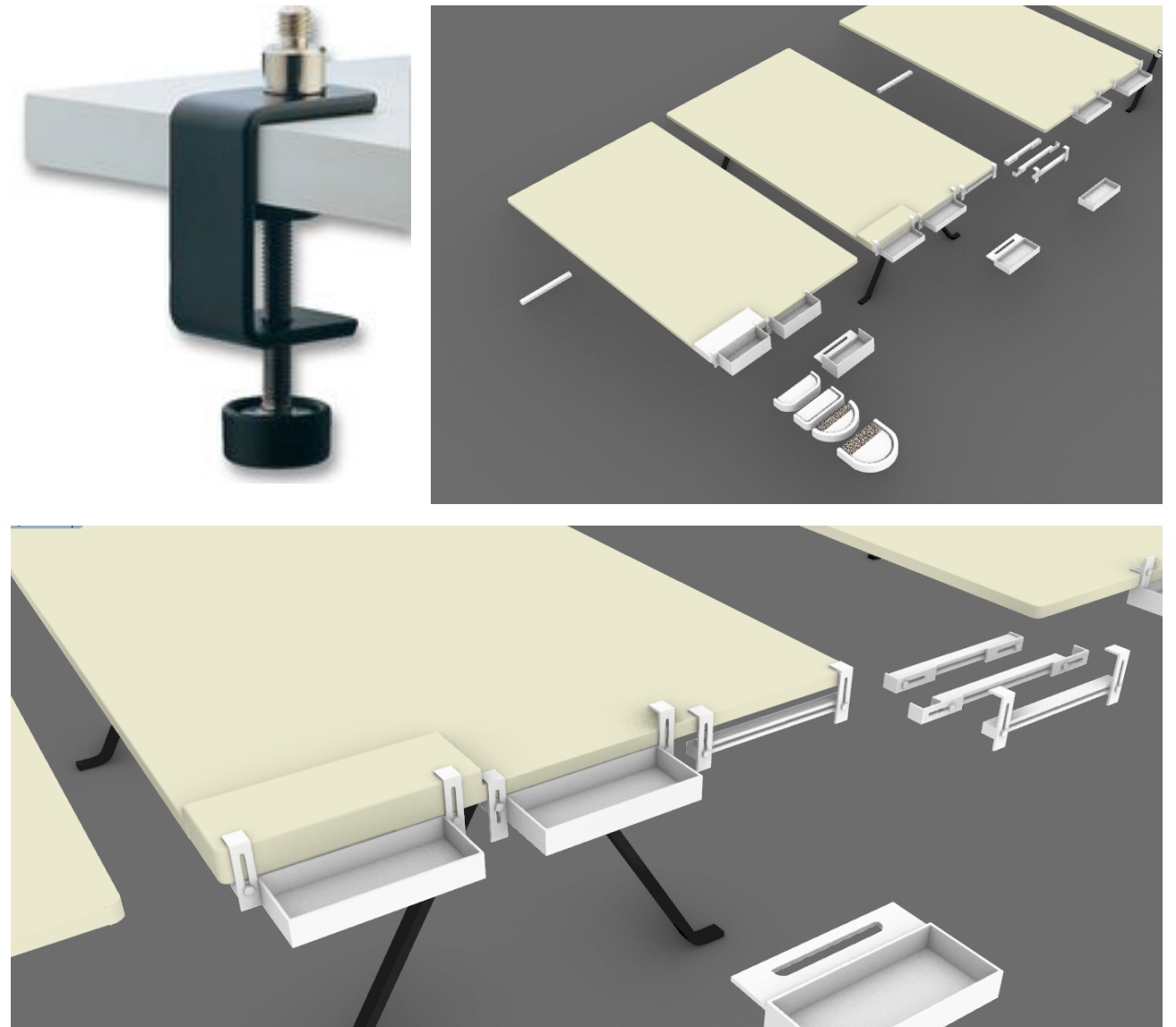

I made more 3d models to explore different ways of clamping. I realized that having a clamping system is quite complicated. Users need to detach the trash bin part once they want to empty it. Afterward, they have to attach the bin to the desk again. This means that users need to adjust the clamp many times, which could be annoying for them.

What's more, if the debris and dust are far away (on the other side of the table), users need to sweep the waste a long way to the trash bin entrance, which is not convenient.

How

can I simplify the trash bin accessory?

Does it have to be fixed on desk?
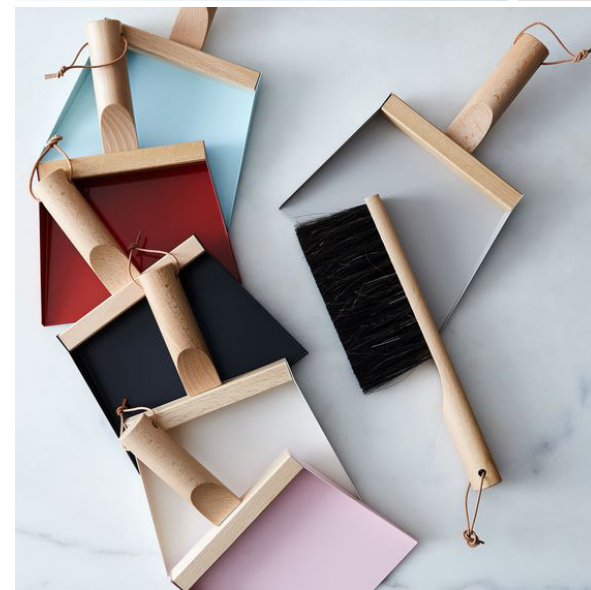
Mood board

I found the simplest way of collecting desk trash is to have a scoop. A scoop can be simply hung on the wall when it is not used. It doesn't need to be fixed on a desk surface all the time.

Current dustpan products show good combinations of cleaning parts and trash container parts. Therefore, I decide to redesign the dustpan for amateur model makers.
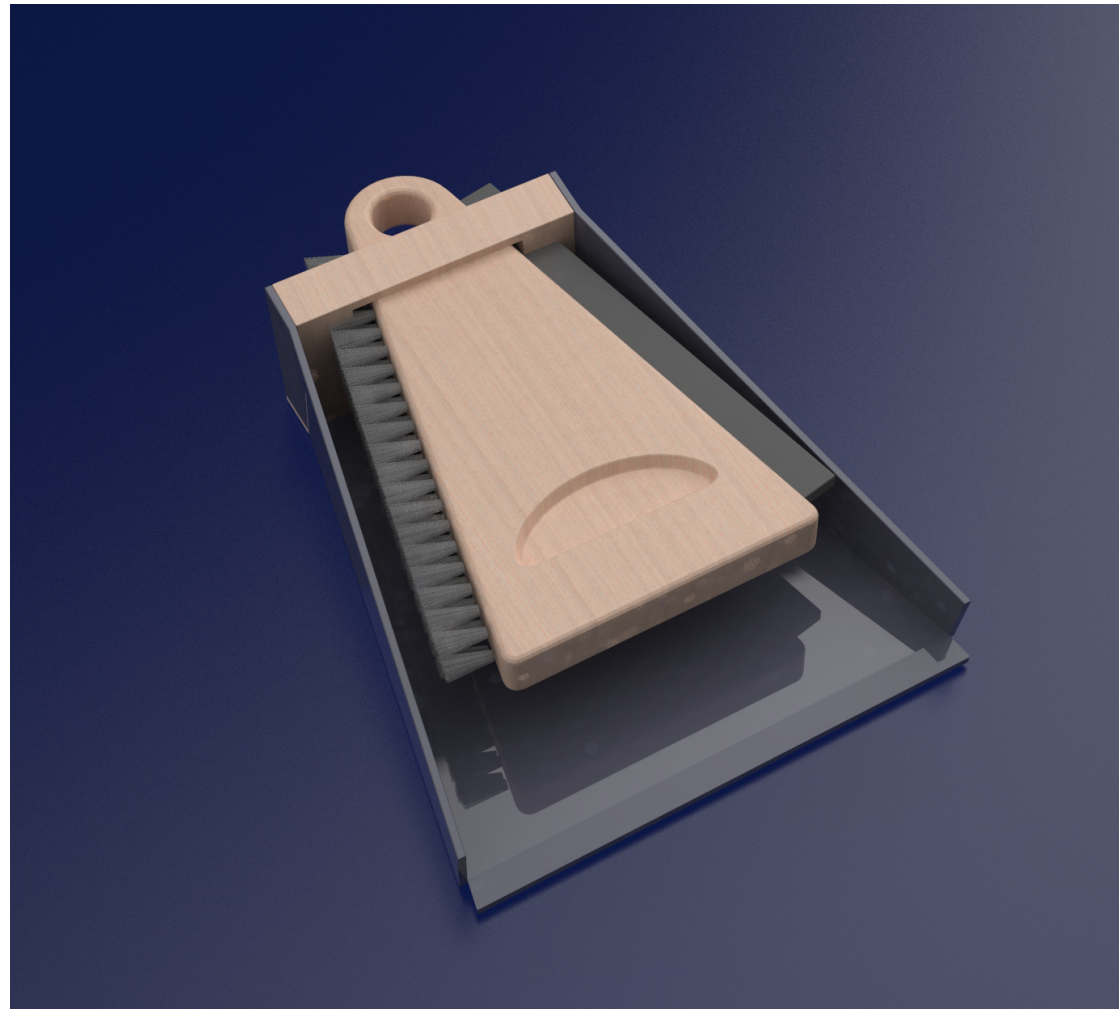
Sketch

I tried to sketch different shapes of the cleaning parts and the scoop parts for my dustpan design
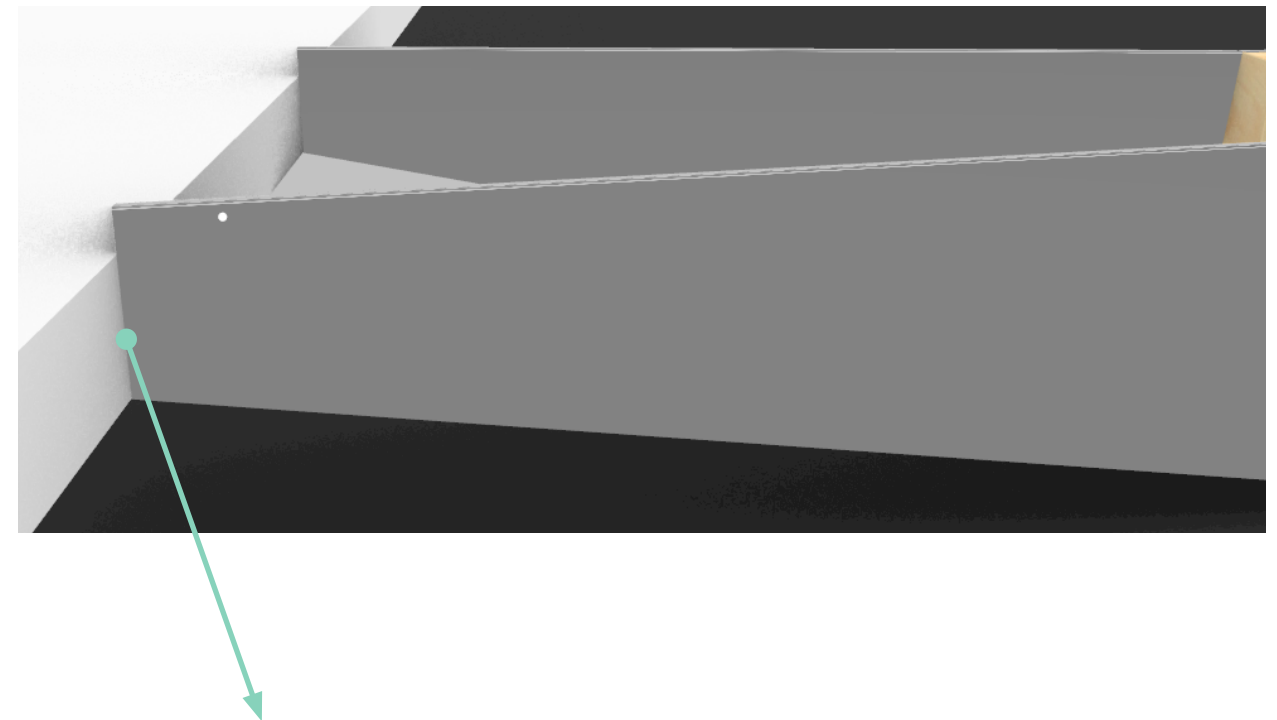

Mock up

1:1 scale cardboard models

Functional 3D Model

I made a 3d model to visualize my thoughts. As a dustpan style product, the cleaning part and the scoop part should fit nicely. The hole on the top is for hanging purposes.
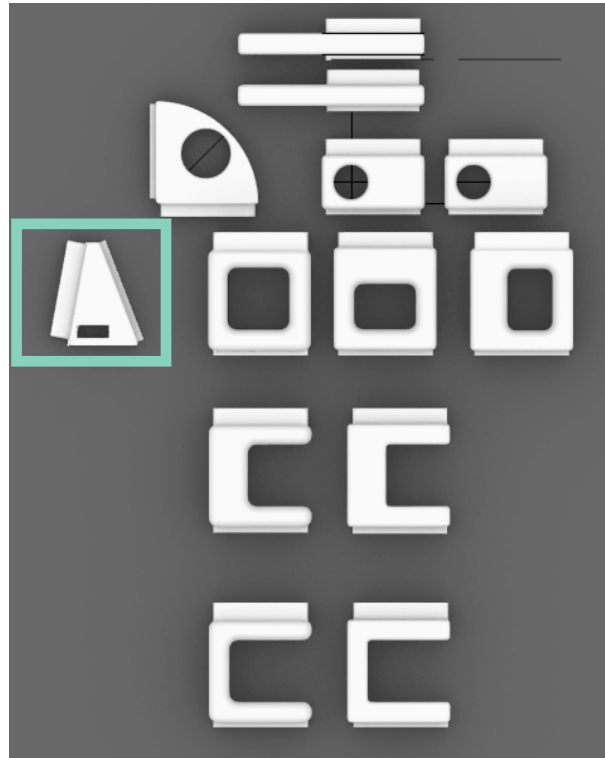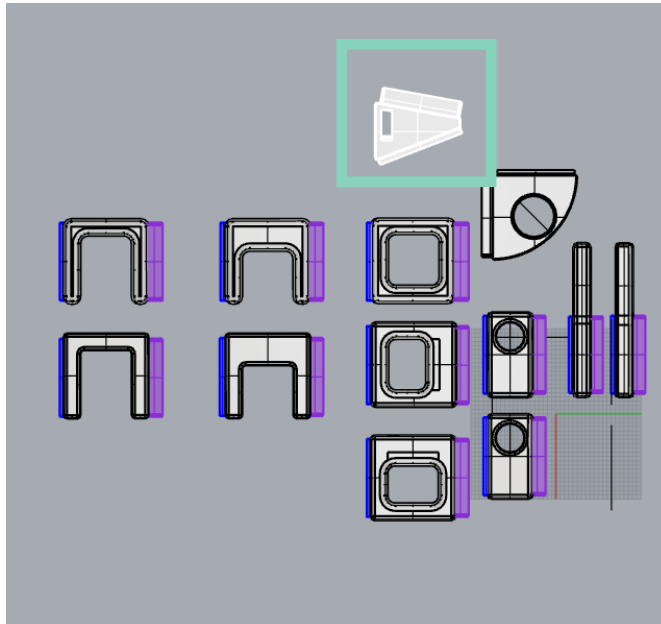
# Design details

High walls

The scoop part has two high walls in the front. Each wall is 3 cm high in the front, which is longer than the thickness of most desk surfaces. In this way, model waste won't fall to the floor through gaps. These high walls also help users to attach the scoop part to the desk edges stably.

Double sided brush

A double-sided brush could be a simple design solution for the cleaning part. One side can be used to clean solid trash and the other side is to clean liquid waste.

I also find out the shape of the double-sided brush should be mirrored so that both left-handed and right-handed people can use it. The trapezoid brush is the most comfortable one to hold and sweep on desks.
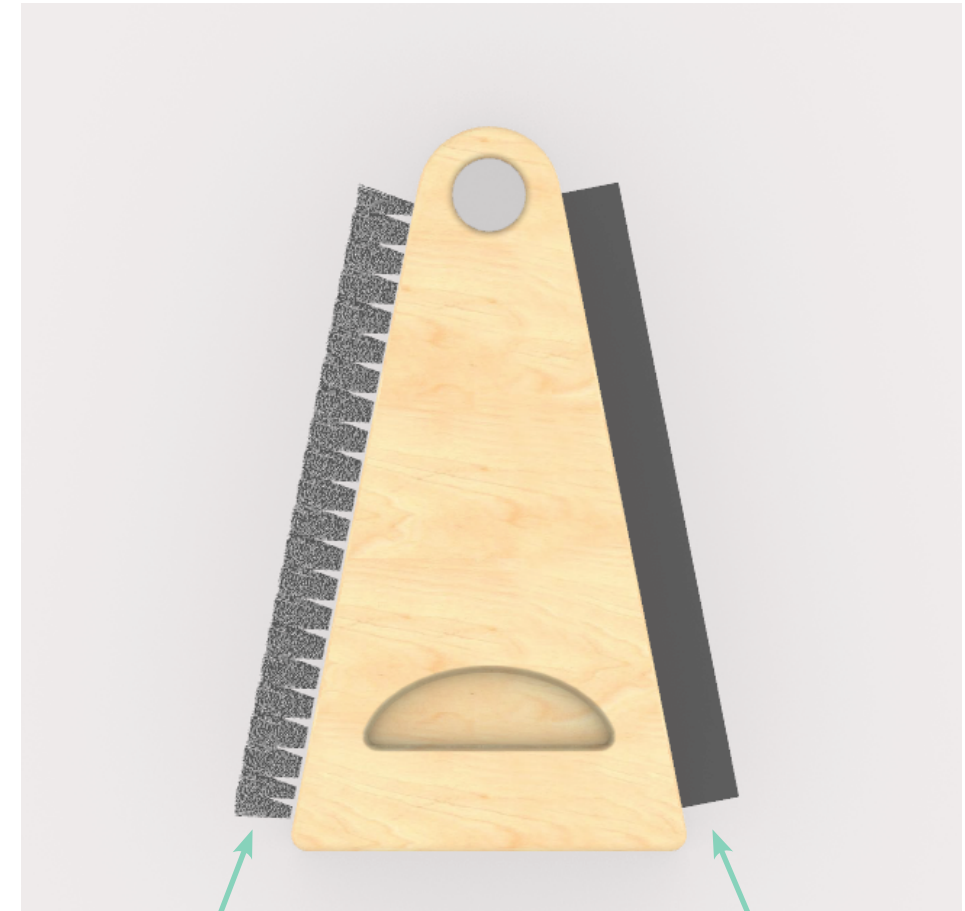

Material

(Tamiya, n.d.)

(Boresko, n.d.)

In order to clean the model debris and sanding dust, I choose to use organic conductive fibers with PBT resin fiber for the brush bristle part. (Inspired by Tamiya 74078 Model Cleaning Brush) This brush bristle can eliminate static electricity to prevent dust build-up on modelers' desks.

I choose to use silicone straps instead of rubber straps for wiping away spilled paints. Silicone lasts longer and can be manufactured without petroleum, which is more sustainable compared to rubber.

Problem analysis

The wood handle part is longer than the brush bristle part, which makes it impossible to reach desk corners.
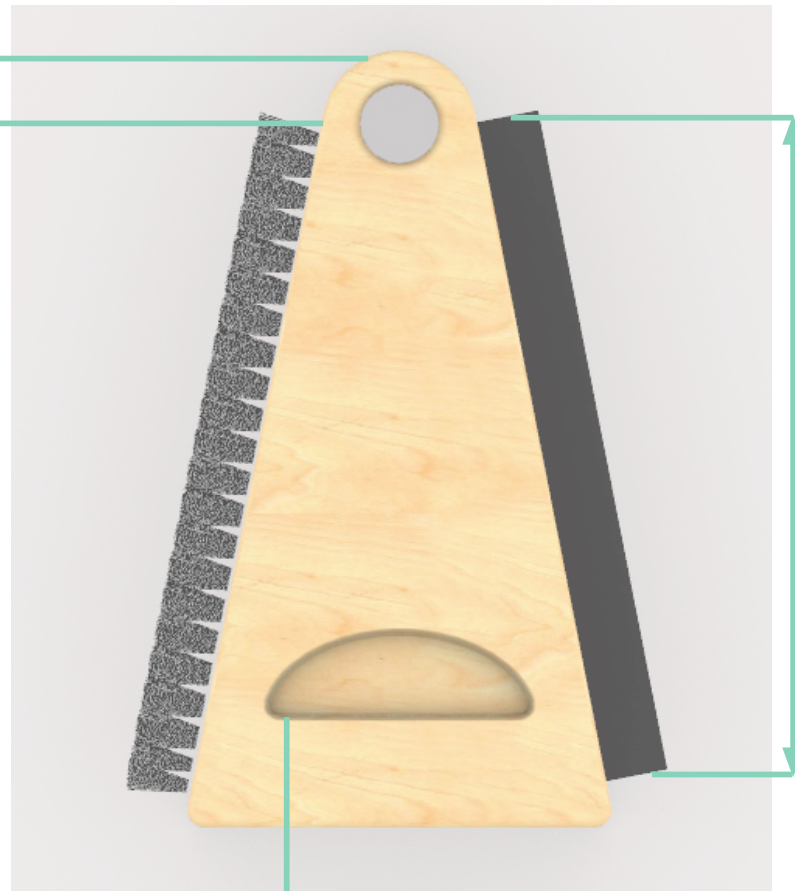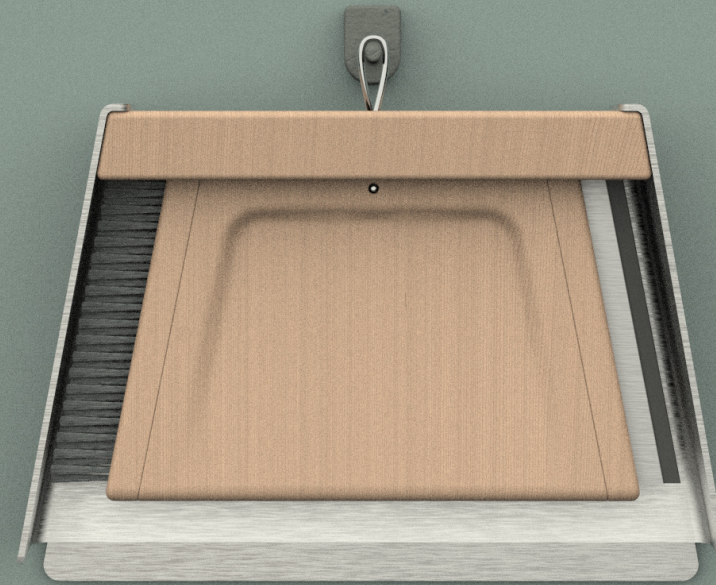
The length of the double-sided brush I made is 20cm length, which is too bulky for desk usage.

The handle part should be smooth and have enough affordances to tell users how to hold it.
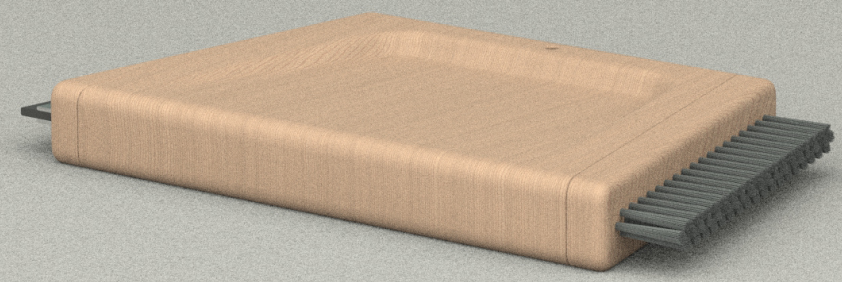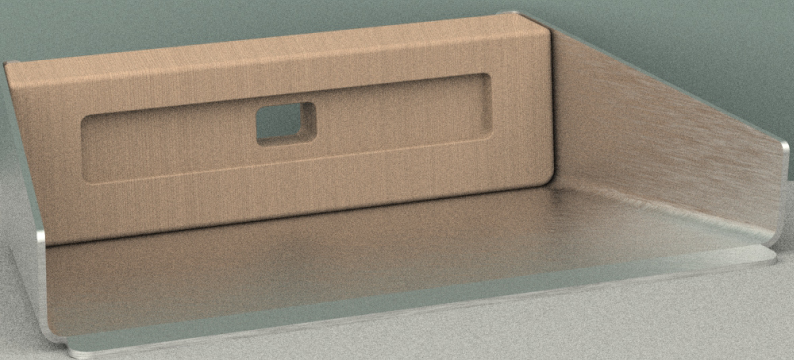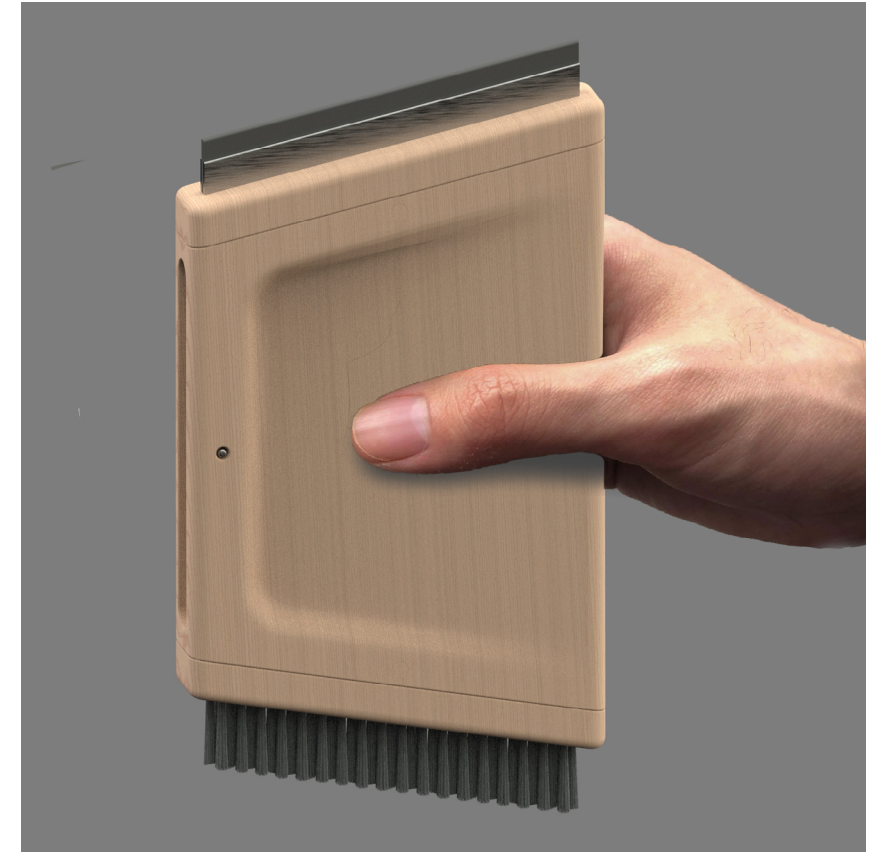
Second prototype

After realizing the problems in my previous design, I made a few changes to improve my design. This prototype is close to the final design.

Final design
ALIGN
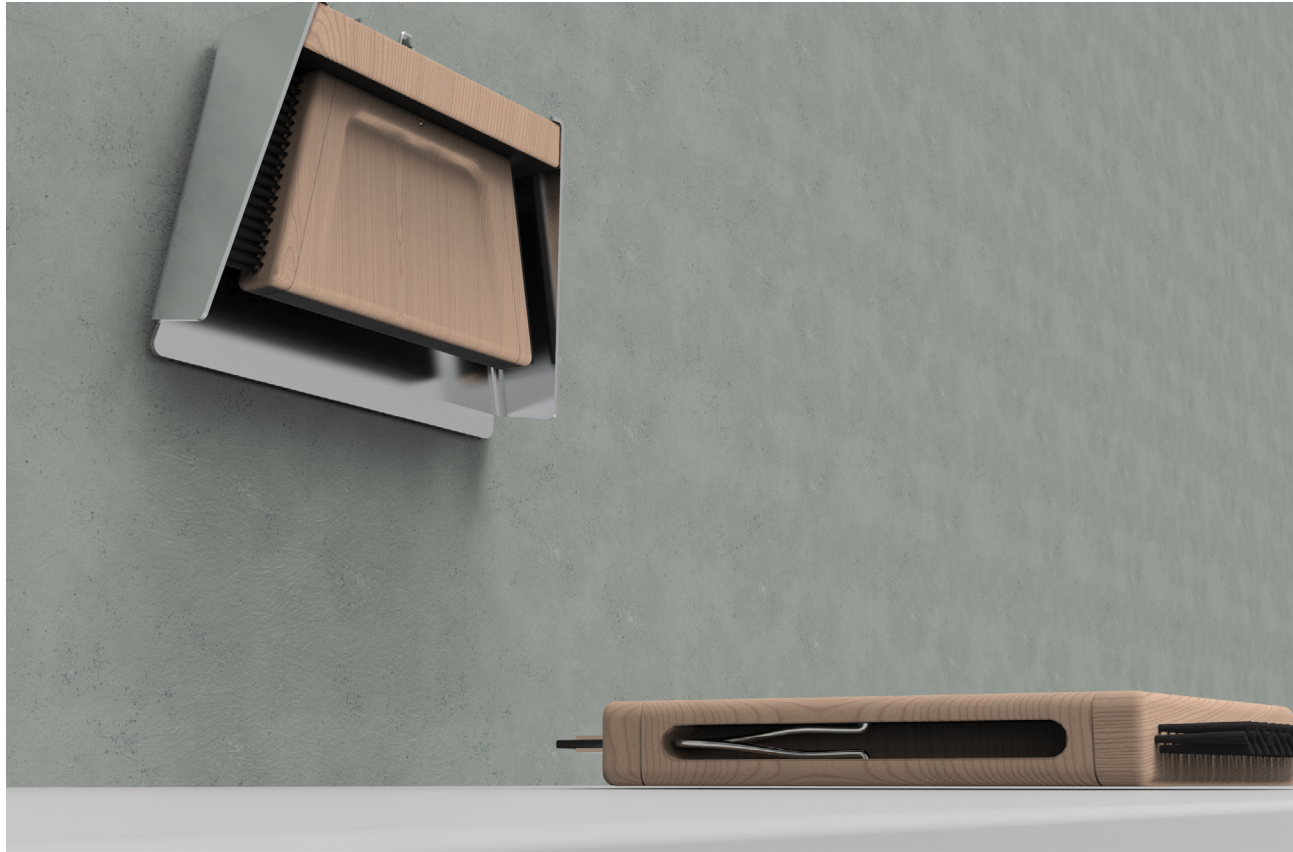
Handle

The concave surfaces of the double-sided brush tell users to hold the brush properly.

Rotatable hook

The hook part is for hanging purpose. When users need to use the double-sided brush for cleaning, the hook can be rotated and hidden.

High walls
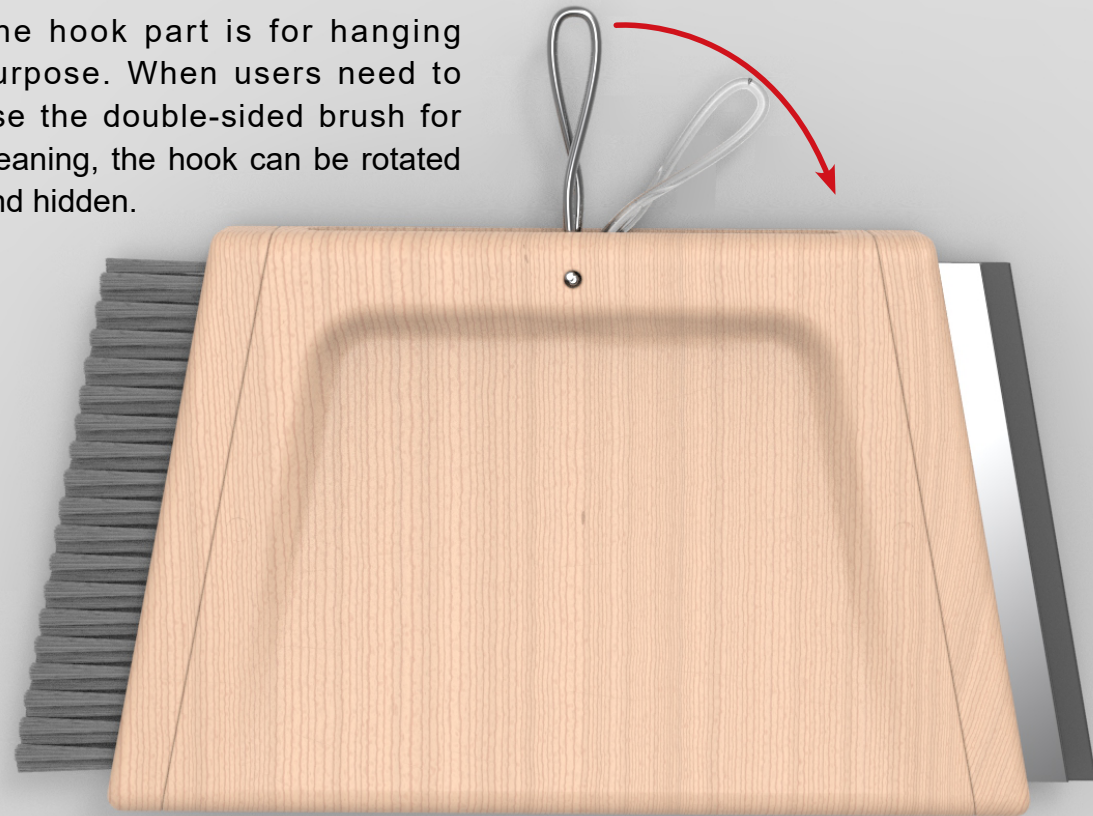
Preventing debris and dust falling through gaps
Giving stable attachment to desk edges

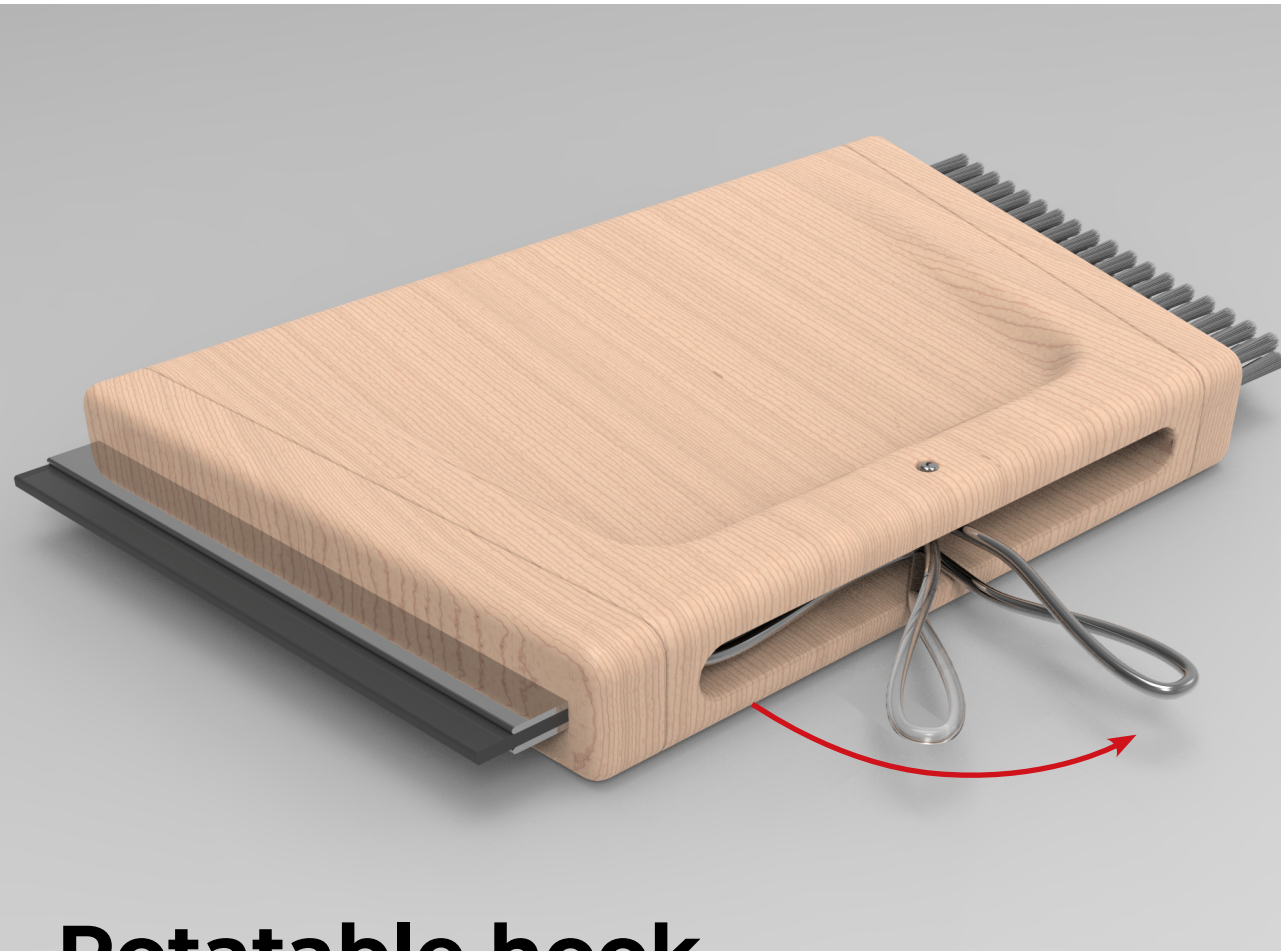# Combination

The double-sided brush can be stacked into the scoop part. These two parts can be hung together on walls for storage.
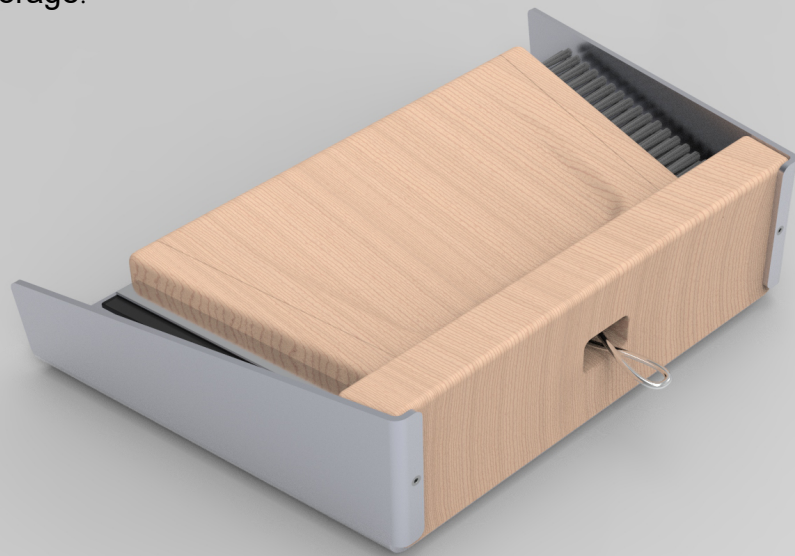
Exploded view
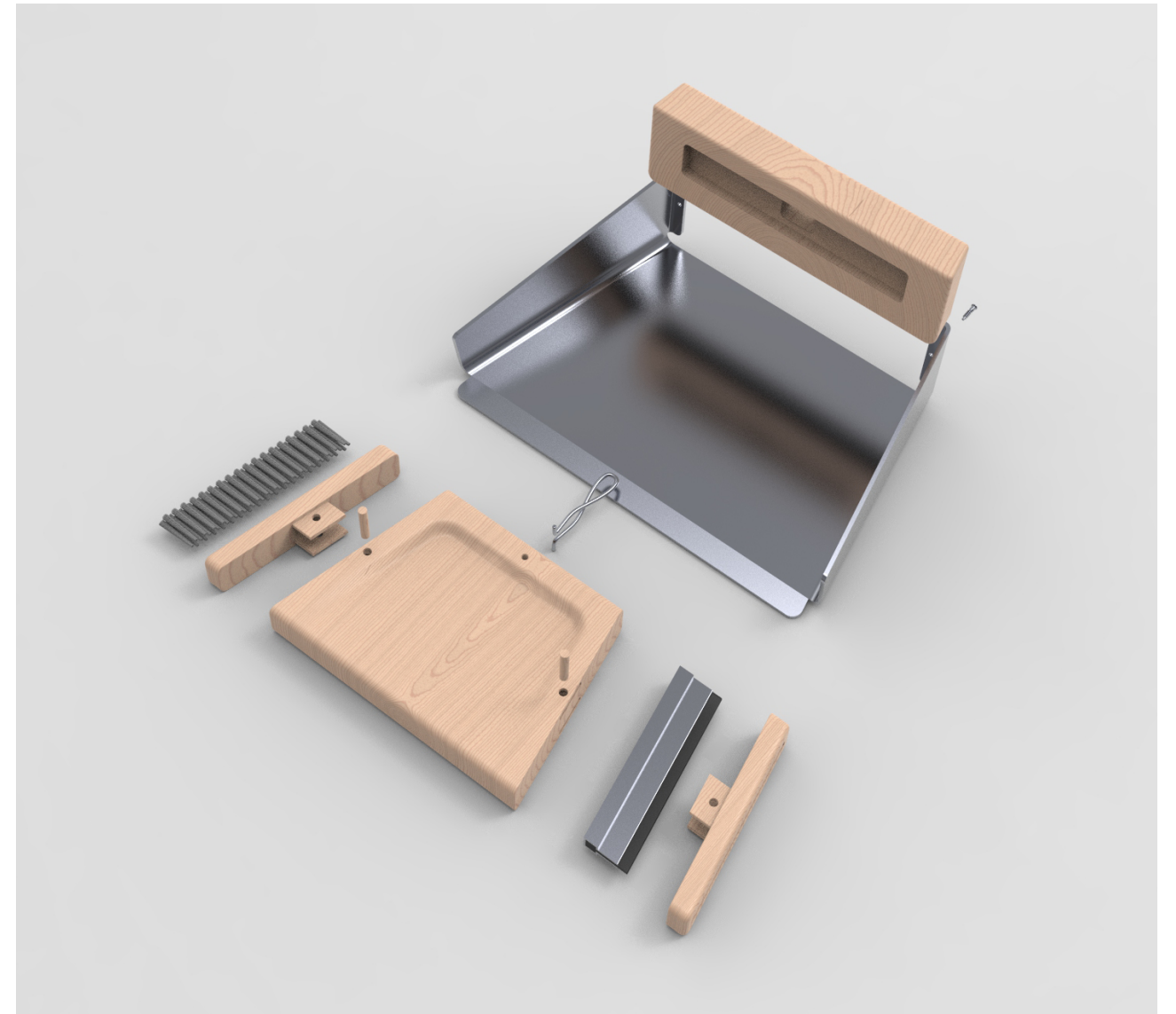
The materials of the product are mainly stainless steel and wood. With sustainable thinking in my mind, I tried to avoid using glue, magnets, and other chemicals. I use wood plugs and screws to assemble all the components in my design.
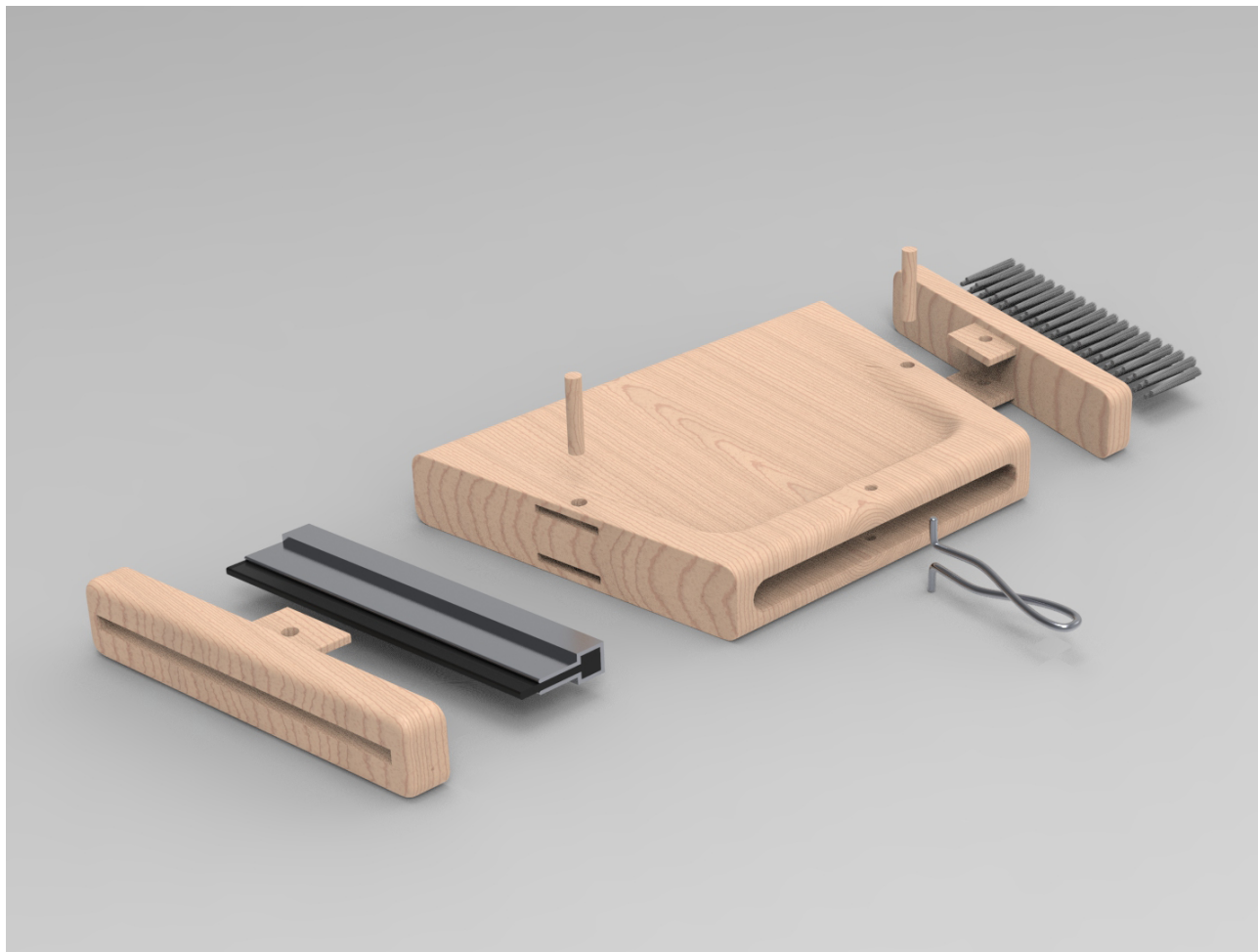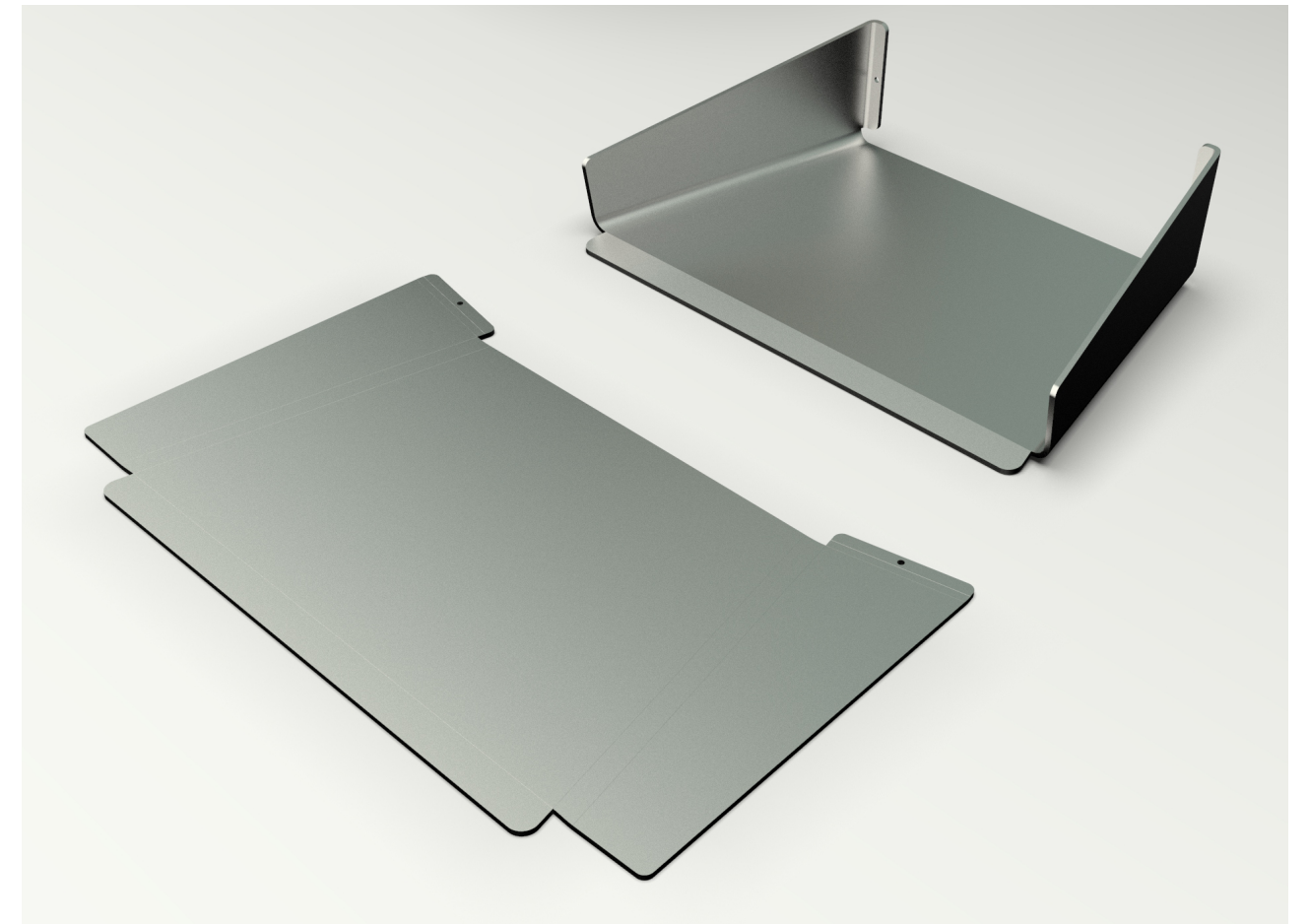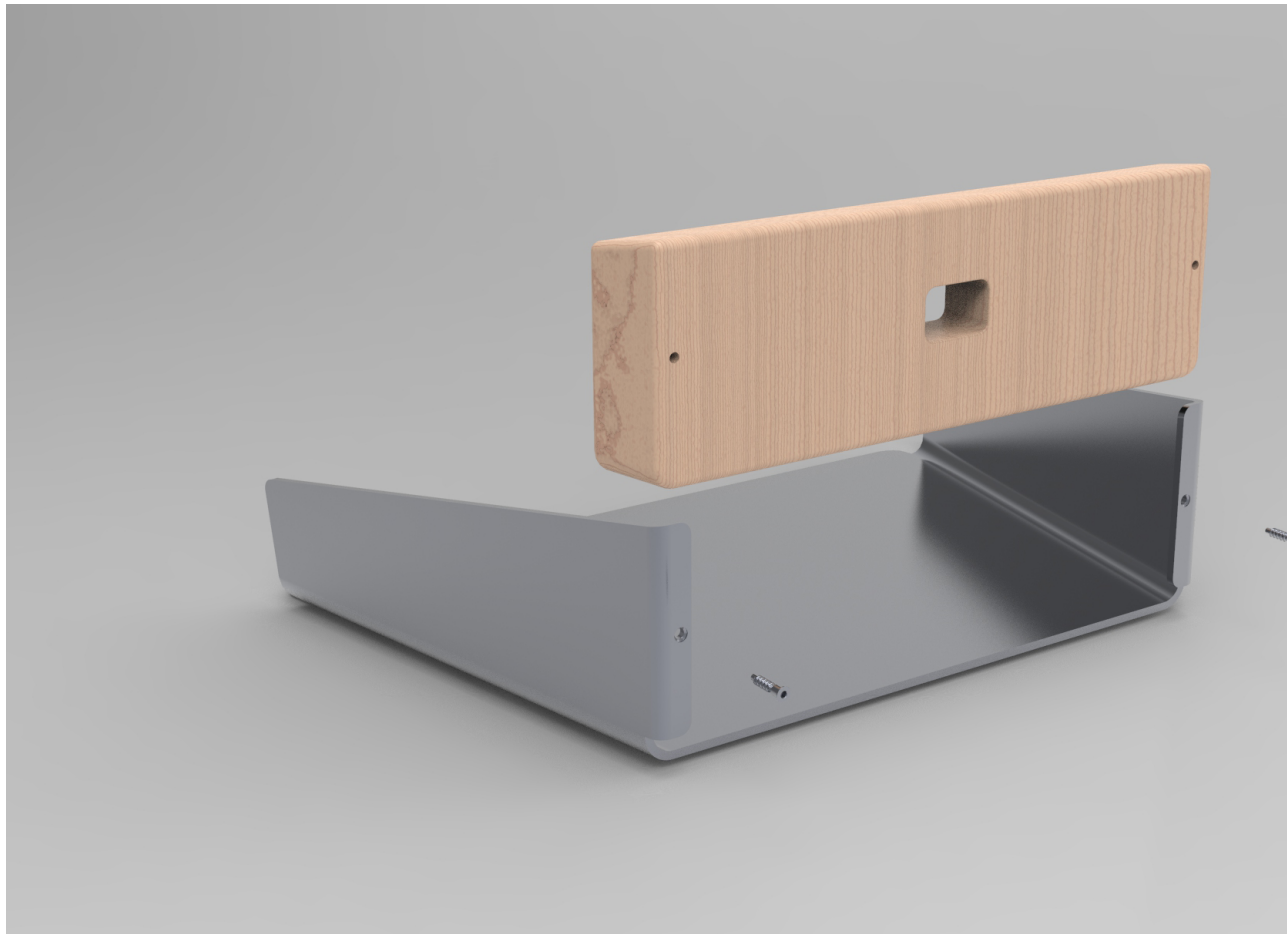
I would like to use sheet metal folding to produce the dustpan part. The metal sheet I used is 2mm thick stainless steel. For mass productions, metal sheets can be produced by a simple stamping process. which is a cheap and quick forming method with low energy consumption.

(Amedee, 2019)

Dimension

115mm
18mm
45mm
5mm
9mm
R2.00
152mm

10mm
190mm
4mm

20mm
100mm
9mm

152mm
20mm
163mm
145mm
190mm
R5mm

118mm
15mm
R3mm
13mm
7mm
R3mm
30mm
56mm
R5mm

132mm
R3mm
27mm
128mm
47mm

Sustainability

Low energy and water consumption processes

Materials from Recycling

Processes without hazardous chemicals

Traditional materials with low environmental impact

Sustainability is highly emphasized in the design. ALIGN consists of two main materials: birch wood and stainless steel. Both materials are recyclable and easy to process. The birch parts can be produced by cutting machines while the stainless metal parts can be manufactured by stamping and sheet metal folding. Therefore, the production process of ALIGN will not consume a lot of energy.
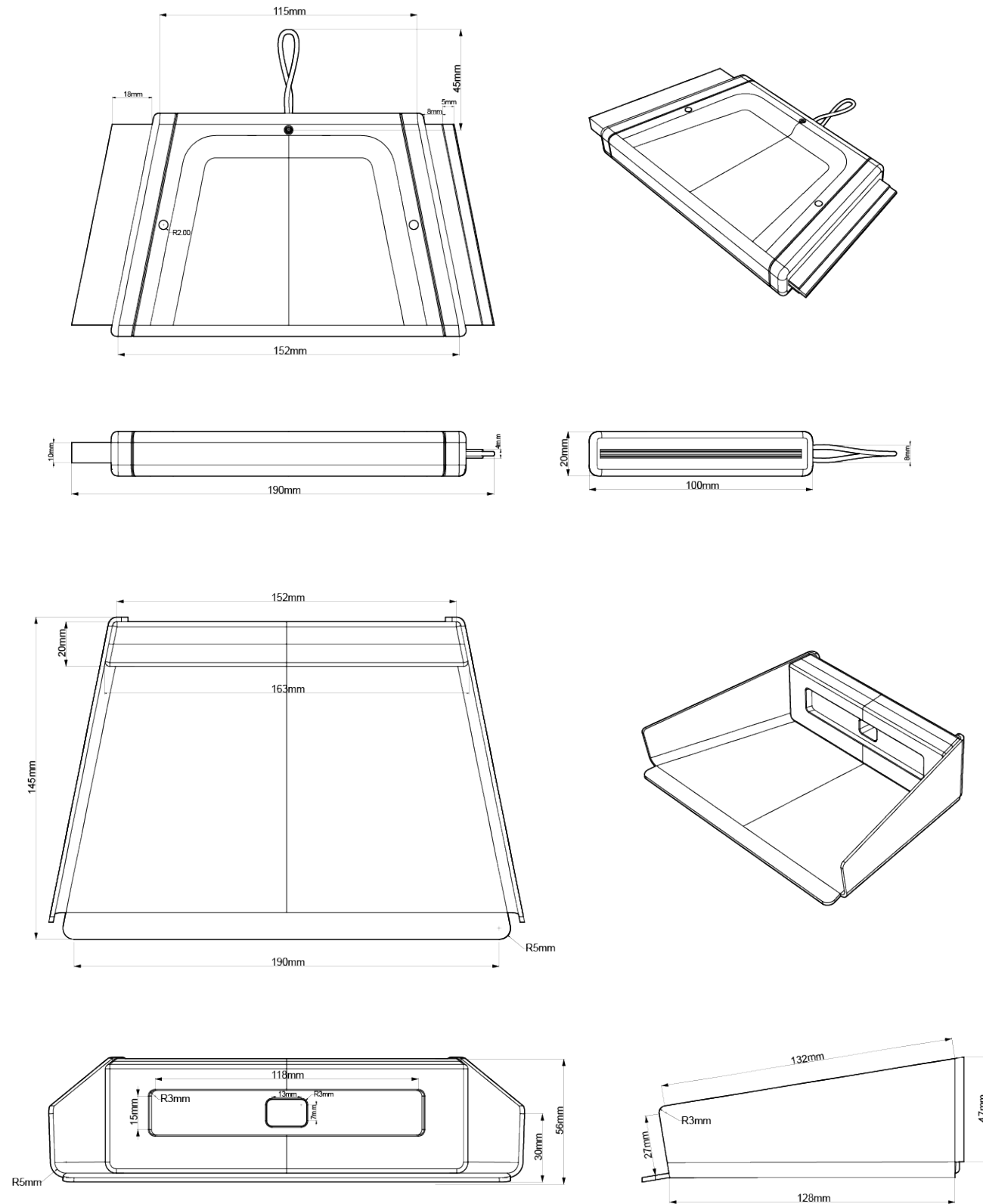
Besides, the brush bristle part and the silicone strap part are separable and replaceable. Users can replace these small wear parts and keep the rest durable parts to extend the lifespan of ALIGN.

Last but not least, all the components are assembled without hazardous chemicals. I chose to use wood plugs and screws instead of using glue and magnets.

Reflection

In the research part

I was intended to do some literature reviews to find the problem of home working space. When I did searches on google scholar, LUB, and other platforms, I could not find many relevant and convincing articles. Many of them are posted in blogs which are quite subjective. Therefore I decided to do my own questionnaires and interviews. However, under the coronavirus situation, it was much more difficult to reach people. As a result, the majority of my researches was carried out through online communication, which is less reliable than face-to-face communication. In general, the number of my research samples was very small, which might make the research part seem subjective.

In the design part

Under the coronavirus situation, I can't use the wood workshop for making quick wood models which I am quite familiar with. Instead, I made many cardboard mock-ups to visualize my concepts quickly. These cardboard models can present the basic shape and size of products, while they are not suitable for showing small details. For the last cardboard prototype I made, I spent quite a lot of time on the calculation on the dimension of the models before building prototypes. To build a 3D model in cardboard, it is necessary to unfold the object to get a planar representation. I should also leave space for folding. Overall, I think cardboard is not an efficient way to present complicated and detailed models. However, it can visualize rough ideas quickly.

Design possiblities

Until now, this product is only aimed at amateur model makers at home environments. In the future development of my products, I should also think about other using scenarios, such as workshops and offices. What's more, I probably need to simplify the components for real production.

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