MEMOSIO

Final Report Project 2

Vera van Beek: 1687603 | Marloes Lankheet: 1688782
Thomas Levendig: 1681699 | Thijs Reijnders: 1699237

PROJECT INFO

EINDHOVEN UNIVERSITY OF TECHNOLOGY
Department **Eindhoven University of Technology**
Bachelor College Major Industrial Design

FINAL REPORT DFP003
PROJECT 2 DESIGN
Period **2022/2023, Semester A**

Theme **New Futures**

Authors **Vera van Beek:** 1687603
Marloes Lankheet: 1688782
Thomas Levendig: 1681699
Thijs Reijnders: 1699237

Project Coaches **Bastiaan van Hout**
New Futures

Bart Hengeveld
New Futures

Words **+/- 5100**

TABLE OF CONTENT

SUMMARY

In this project, we created MEMOSIO: a project managing tool that can be added to the workplace. As the team looked at how the workstyle of freelancers has changed and will change withing the coming 15 years, we saw a trend in digitalisation, dematerialisation and working from home that would probably extend into the future (Hill et al., 2003; Van Campenhout, L. D. E. et al, 2013). By creating a digital-physical hybrid we want to battle the dependency on digital tools to decrease the amount of cognitive load experienced by freelancers.

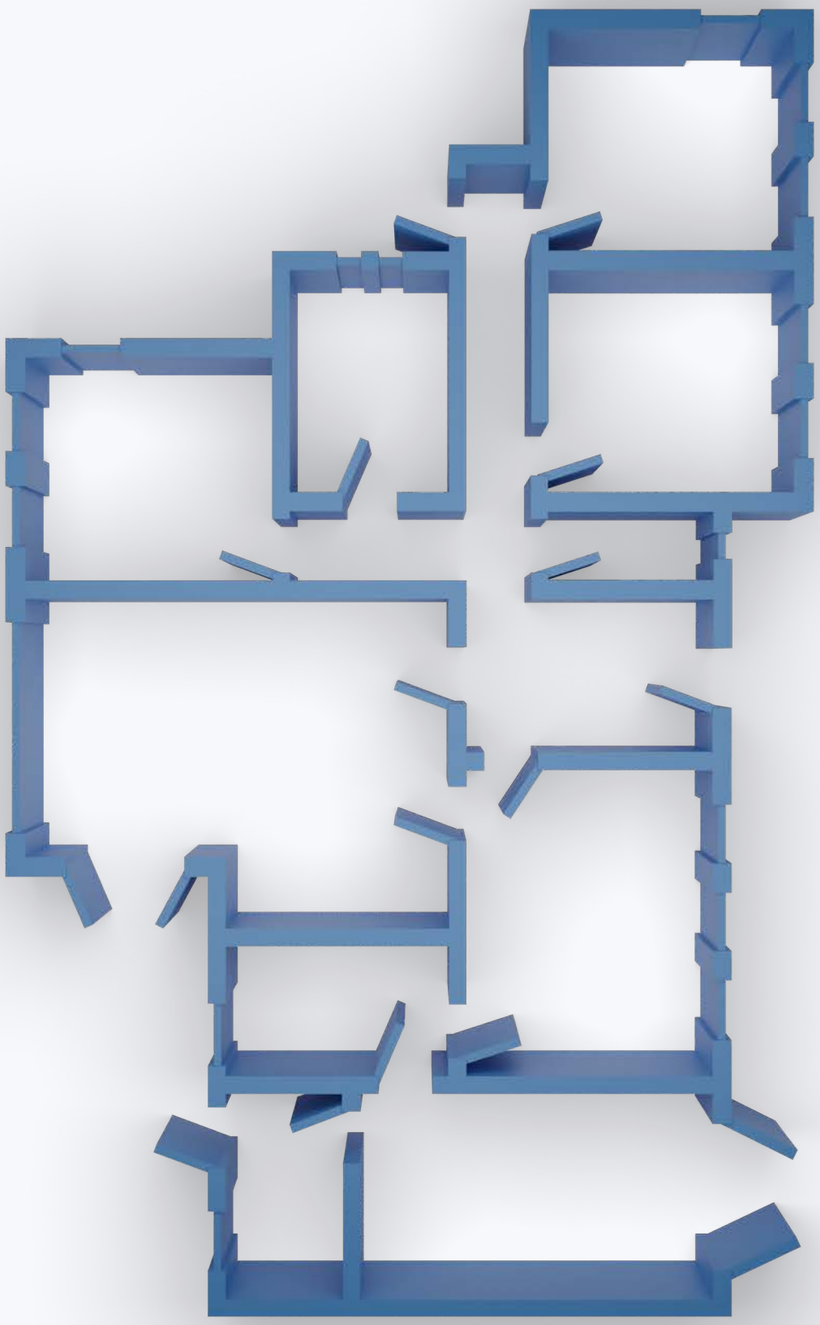
MEMOSIO is a product that can help manage files of projects in a physically sorted manner. These physical storages discs can be transferred to the MEMOSIO controller, which helps open files and interact with them. Using interaction research with different prototypes of this controller, the integration of the storage and the controller with the digital workspace was optimised.

PROJECT GOAL

Design a hybrid physical-digital project management product that battles cognitive overload of freelancers that work from home.

IOT SANDBOX

HOUSE OF THE XAVIER FAMILY



CONTEXT

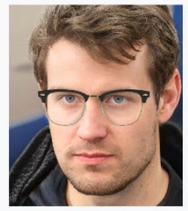
MEMOSIO is specifically designed with the future of work in mind. The initial design case included an IoT sandbox, with a specific user pool: the Xavier Family. The sandbox and this family is a product of a world building brainstorm with fellow students about what a house and a family in 15 years could look like. This worldview included more human-computer interaction and technology that stimulates social contact between family members.

MEMOSIO was developed specifically with Huub Xavier in mind, a freelancing interior designer that generally works from home. A full description of Huub can be seen below.

Huub Xavier - Hansen

Demographics

- 34 Years old (2003)
- Freelance interior designer
- Takes care of his handicapped sister
- Does not work many clients at once, but earns a lot of money on the one's he does.



Behaviors & Habits
(e.g., hobbies, likes, dislikes)

- Plays guitar in a cover band playing 20s music
- Likes to go to parties
- Has the habit of drinking a few too many drinks
- Responsible most of the time.
- Is the glue within the family
- Kind/ Thoughtful
- Huge fan of Harry Styles
- Feels the need to always help others

Pain Points & Frustrations
(e.g., what they're struggling with)

- Struggling with care of sister, kids and provide income.
- Hates when children tell him he's not their father
- Does support Marq in his craft, but hates that he has to earn the most money next to the care of his sister.
- Gets annoyed when Marq starts complaining about how Marq himself is too busy.
- Hard to say "no" to others

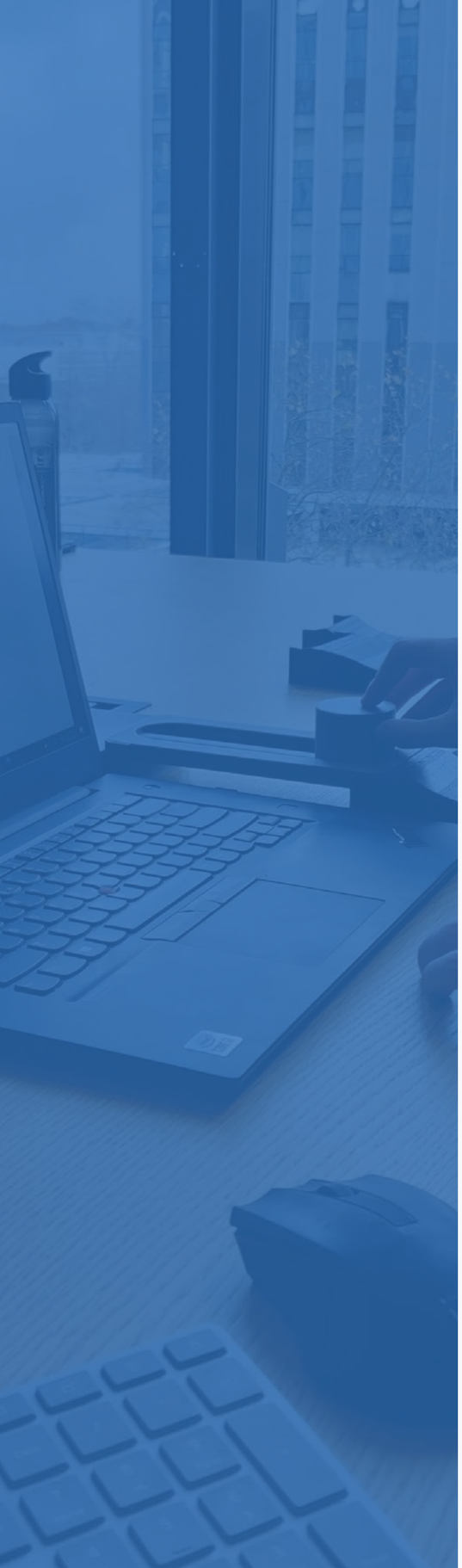
Needs & Goals
(e.g., wants, hopes)

- Huub enjoys spending time with Marq and the kids.
- But also time alone with Marq, preferably in restaurants and bars.
- Huub really wants to play De Zwarte Cross next year with his band.
- Likes to take the dog on far walks
- Wants Marq to provide more of the income so Huub can start to work less.

Pain Points & Frustrations

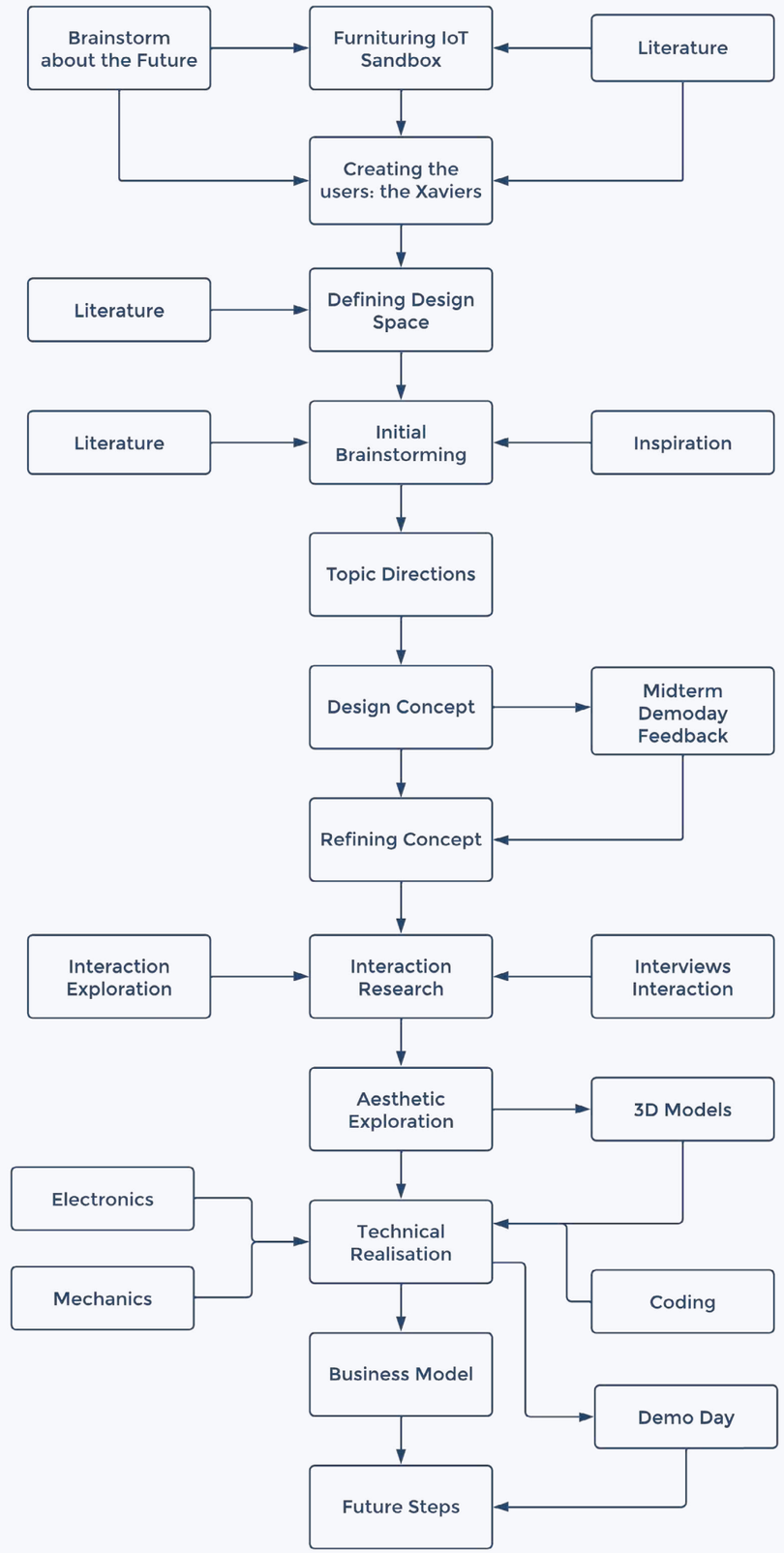
- Improve social interaction & cohesion at home --> through his work as designer

The most important things the team focused on during the development of MEMOSIO was decreasing the chaos in the digital space of freelancers like Huub Xavier. This digital chaos has an impact on the working memory, which is called cognitive load. The efficiency of work and the joy of work were also taken into account, as MEMOSIO should not impact the working experience in a negative manner.



DESIGN PROCESS

The design process of the development of MEMOSIO included research, brainstorming, discussions and decision making, gathering feedback, prototyping, user testing, optimalisation of interactions and final product development.



CHAPTER 1

RESEARCH

CHAPTER 1: Research
In this chapter, research is done on the topics of dematerialisation and cognitive load. Additionally, a benchmark analysis is made, specifically focusing on potential differential advantages that offer opportunities for our own product.

RELATED WORKS

RESEARCH

THE DIGITAL VS THE PHYSICAL WORLD

With the increasing digitalisation and the rise of remote work as a result of COVID-19, more and more tasks primarily performed using physical objects are being adapted by digital tools. This process in which products that act like information carriers move from the physical to the digital world is called dematerialisation (Van Campenhout, L. D. E. et al, 2013). Examples are that CD's are replaced by Spotify playlists, coins by digital cards and notebooks by word documents.

The benefits of dematerialisation lay with the flexible and efficient nature of digital information, that is accessible anywhere and anytime. In contrast, the main downside of dematerialisation is the low level of interaction of dematerialised products that heavily rely on cognition instead of action (Van Campenhout, L. D. E. et al, 2016). This highlights the importance of physical interaction. The familiarity of us humans with the physical world offers opportunities to reduce cognitive load and create more natural interactions that respond to both our perceptual-motor and cognitive skills (Dourish, P., 2001). Instead of choosing between the physical and digital world we are convinced the optimal interaction will result from a physical-digital hybrid that combines the best characteristics of both worlds.

COGNITIVE OVERLOAD

The complexity of existing digital user interfaces challenges human cognition. The mind has limited cognitive resources and is affected by the cognitive demand of certain tasks. The extent to which information has to be processed to execute a certain task determines the cognitive load of an activity. A vital factor that significantly influences cognitive load is the complexity of the design of a task and the tools, features, and interfaces supporting it (Kumar, N., & Kumar, J., 2016)). When the complexity of the task exceeds one's cognitive capacity, cognitive overload occurs, resulting in ineffective information processing, confusion and physiological stress (Schmitt, J. B. et al, 2021).

In this report, we define cognitive overload as the physiological consequences, caused by the limitation of our brain to process information, that occur when confronted with a large set of information, functions or content displayed on digital or physical user interfaces.

In the field of Human Computer Interaction (HCI), cognitive overload is often generated by redundant information, redundant sources of information place and an overload of different modalities, such as visuals and auditory feedback (Feinberg, S., & Murphy, M., 2000). As the concept of file management systems heavily relies on self-made information structures, the cognitive capacity needed to navigate these structures is significant. Hence, to improve the usability of these systems, we are convinced effort should be made to reduce the cognitive load associated with the usage of file management systems.

RELATED WORKS

BENCHMARKS

FILE EXPLORER

Microsoft file explorer is a file management application that allows its user to store, share, organise and access their files in an easy and effective way. The Microsoft file explorer has existed since 1995 and has known many versions since then, all aiming to optimise the usability and effectiveness of the application (Windows Explorer Through the Years, n.d.) . Although already lot of effort has been placed into the optimisation of the application, we see differentiation opportunities in changing the exclusively digital nature of the app into a partially physical one. While the digital nature of the app was predominately created based on the need for flexibility in transfer and use, the increasingly popular trend of working from home, makes way for opportunities for a physical and potentially stationed file management system in home offices. By changing the digital nature of the app we aim to create a richer interaction that instead of only being based on cognition, finds a balance between both action and cognition. Consequently, we aim to improve user engagement with the app and their work environment (Windows Explorer Through The Years., n.d.).

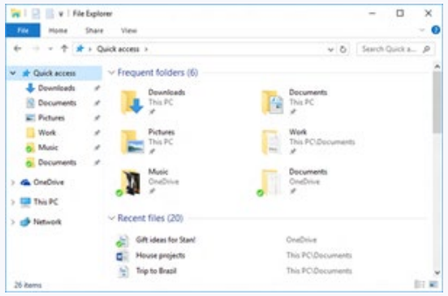


Figure 1: Windows 10 File Explorer

Figure 2: First Windows File Explorer

FLOPPY DISCS

Floppy discs are discs in a plastic enclosure that allow people to store digital data. The discs can be read and written once it is inserted in a floppy disc drive that's connected or integrated into a computer or other device. Although the floppy was very successful for a while, due to increasing competitive rivalry and the introduction of higher capacity storing devices, it disappeared from the market. The popularity it once had is still expressed by the save icon in the shape of a floppy disc, which many applications continue to use. The floppy disc inspired us as it's one of the first products that allowed its users to store, open and close documents on computers using a physical object (Amankwah-Amoah, J., 2016).

Figure 3: 2 Floppy Discs

Figure 4: Inserting Floppy Disc

MEDIABLOCKS

MediaBlocks are tangible user interfaces that are able to transport, save and manipulate digital files. When a file or video tape is saved on it, the object allows the user to open, manipulate or print its content by placing it in the holder connected to the associated device. The possibility to store and manipulate information to an external object offers significant opportunities for our project (Ullmer, B. et al, 1998).

Figure 5: Media Browse Device

Figure 6: Media Sequencer Device

CHAPTER 2

BRAINSTORM

CHAPTER 2: Brainstorm
This chapter explores the possibilities of the design case at hand. Brainstorms about the context of working in the future gave insights into possibilities for the design, and resulted in a more narrow topic and design goal.

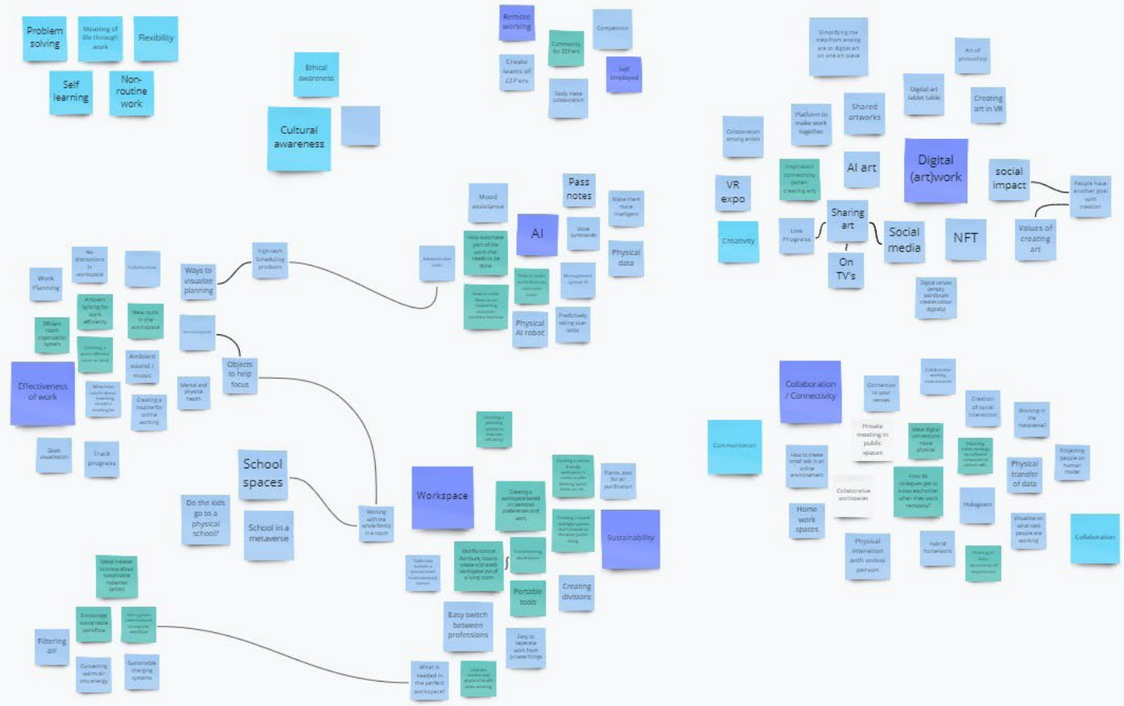
BRAINSTORMING

In 2003, people already saw a positive difference between working from home using the internet compared to working in an office environment (Hill et al., 2003). Ever since, telecommuting has become more and more normalised. Following this trend, in 15 years people will probably be using home offices even more. This especially since the COVID-19 pandemic, which make working from home normalised and more realistic than ever. During the pandemic, a lot of people saw themselves working from home in the future (Barrero et al., 2021). The chosen design space for this project became the home office.
A brainstorm was held to find all interesting topics within the home office / the future of work / freelancers, and to create an idea of design case possibilities.

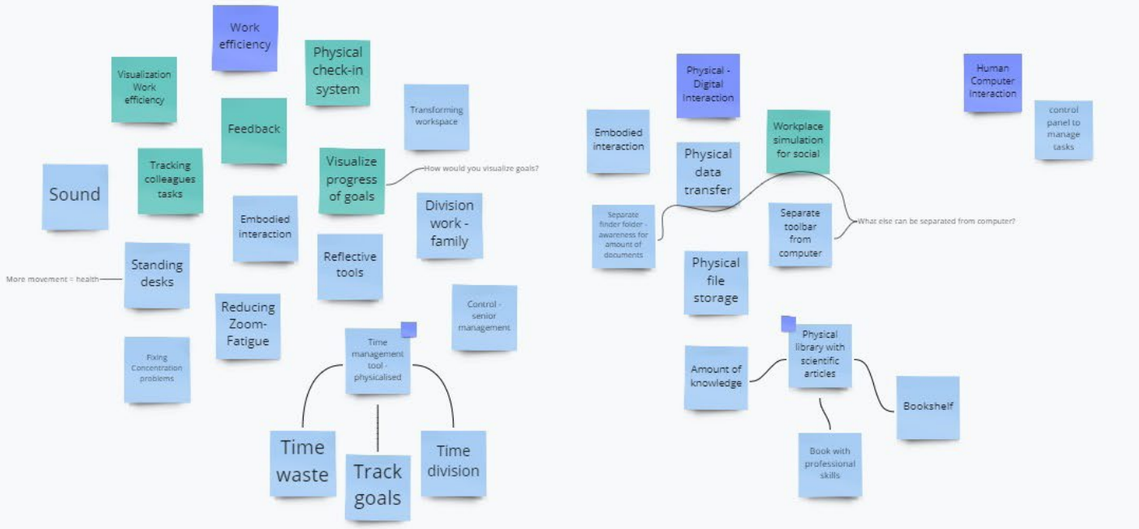
Specific interests was given to the use of AI for jobs in the future, the change in collaboration between people in remote working, the change in the design of a workspace and how the effectiveness of work can be changed using design.

Topics that were found interesting from the initial brainstorming were Embodied Interaction, Physicalisation of Data, and Productivity. We were most inspired by Physicalisation of Data, as this already generated a lot of interesting angles to consider. This is why this became the main topic of the design case moving forward.

27/9 TOPIC BRAINSTORM



29/9 CHOOSING TOPIC BRAINSTORM



POINTS TO KEEP IN MIND

- Professions of the Xavier family
- Self Employees / freelancer
- Future 2037

Selected topics

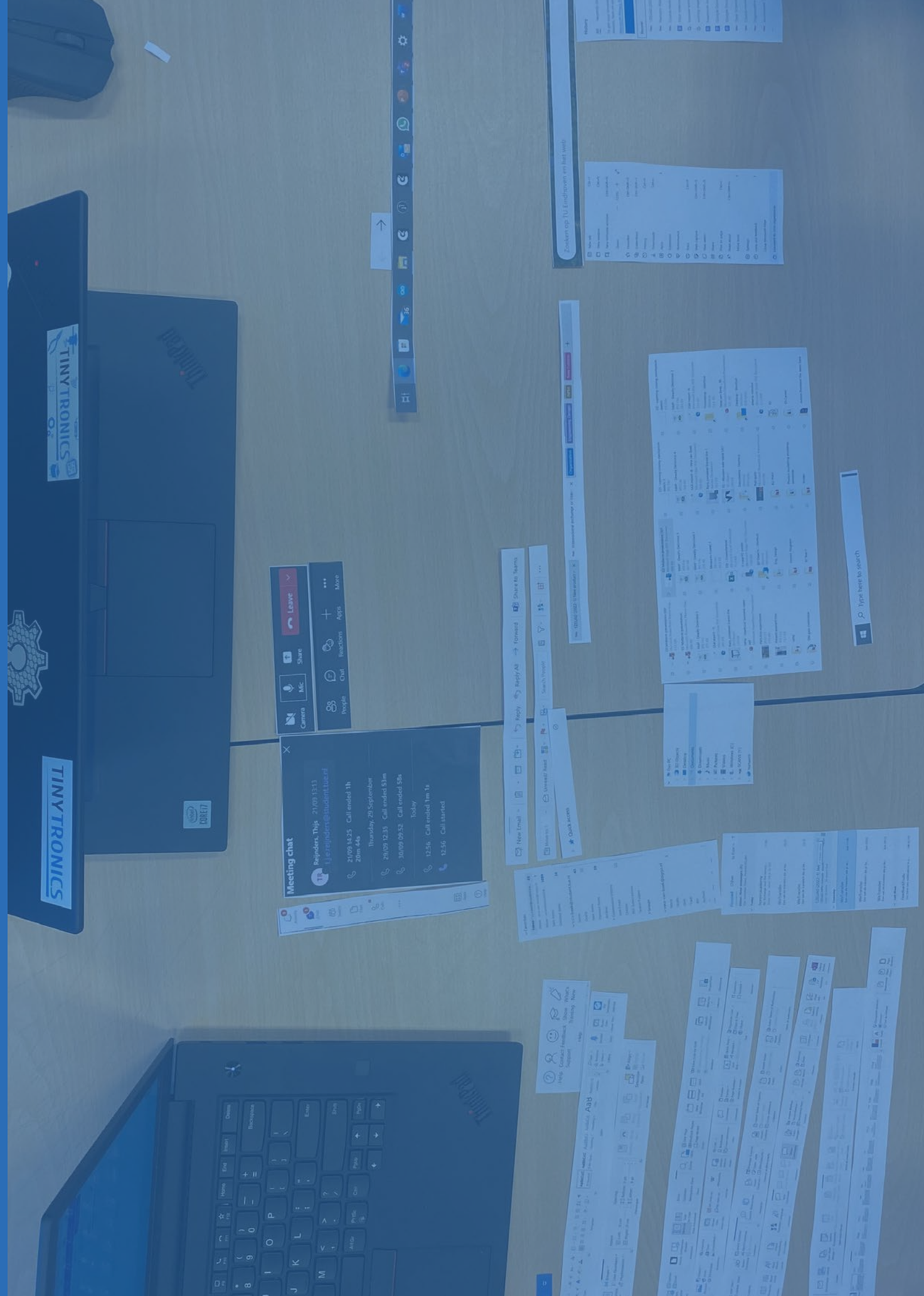
CHAPTER 3

IDEATION

CHAPTER 3: Ideation
This chapter is all about getting to one concept. We use different exploration techniques, where we narrow down more and more to arrive at a single concept and goal. In addition, we also discuss our Midterm DemoDay and the feedback received from that day.

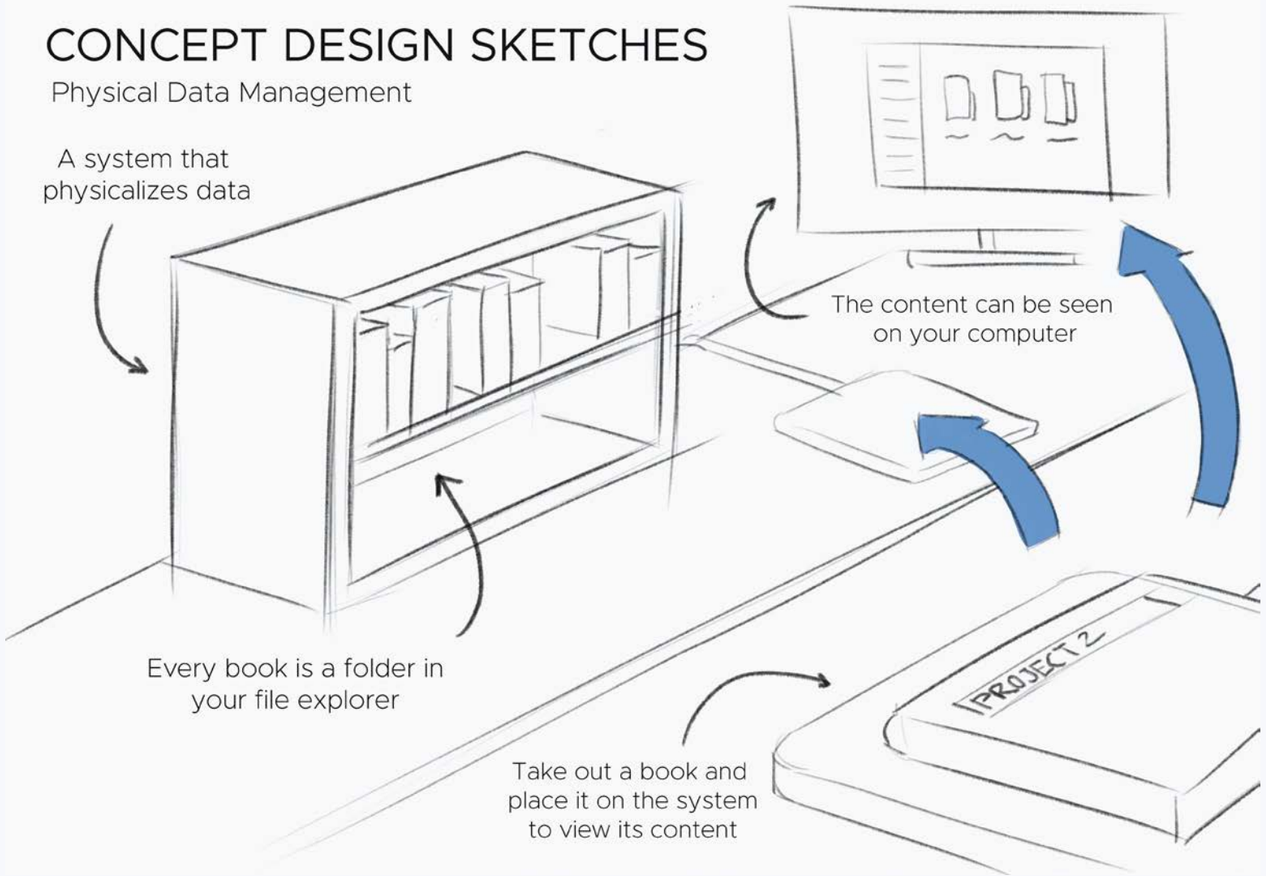
EXPLORATION

The topic chosen was still quite broad. Therefore, we conducted a new brainstorming session to arrive at a more specific goal and concept. During this brainstorming session, we printed out various laptop functions, such as the taskbar and the file explorer. With these printed functions (that can be seen on the right), we created various interactions and considered which functions might be more interesting to have physically rather than digitally. Individually, we considered the various physicalisation possibilities. These options have been worked out in sketches. Some of these sketches are shown on the next few pages. To make a well-considered decision, we used Sinek's Theory. According to his theory, you should be able to answer three questions for each concept you have: What is the relevance of this concept? How are we going to accomplish this? What should we do (Sinek, 2009)? By answering these questions, we were able to make a well-founded choice and arrived at the concept we call "the bookcase".



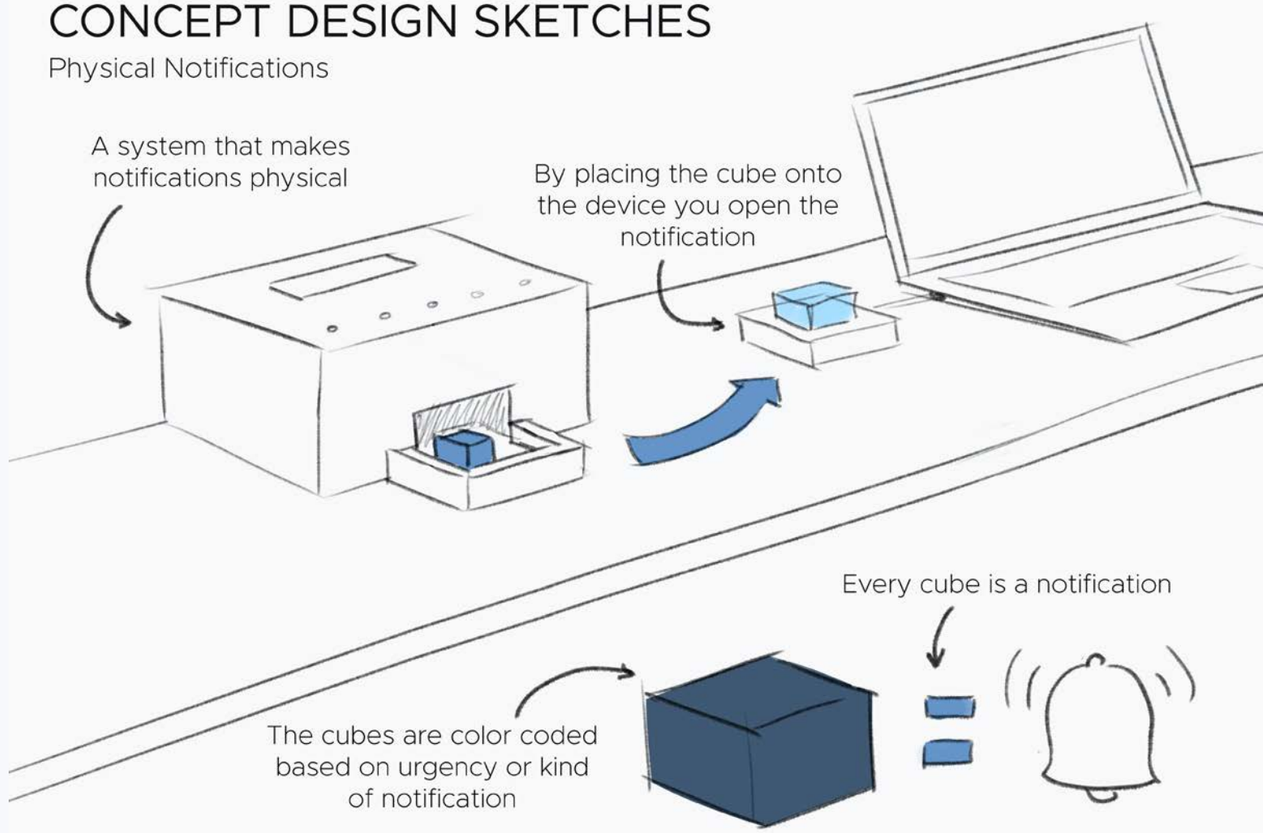
CONCEPT DESIGN SKETCHES

Physical Data Management



CONCEPT DESIGN SKETCHES

Physical Notifications

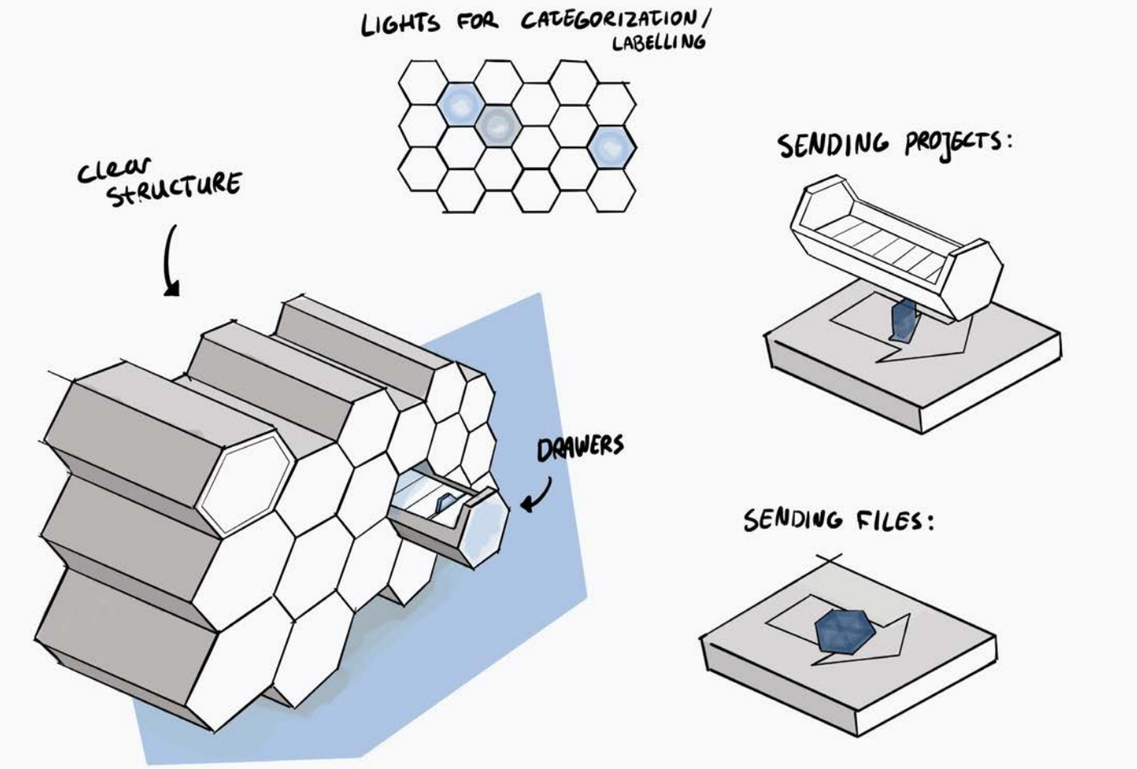


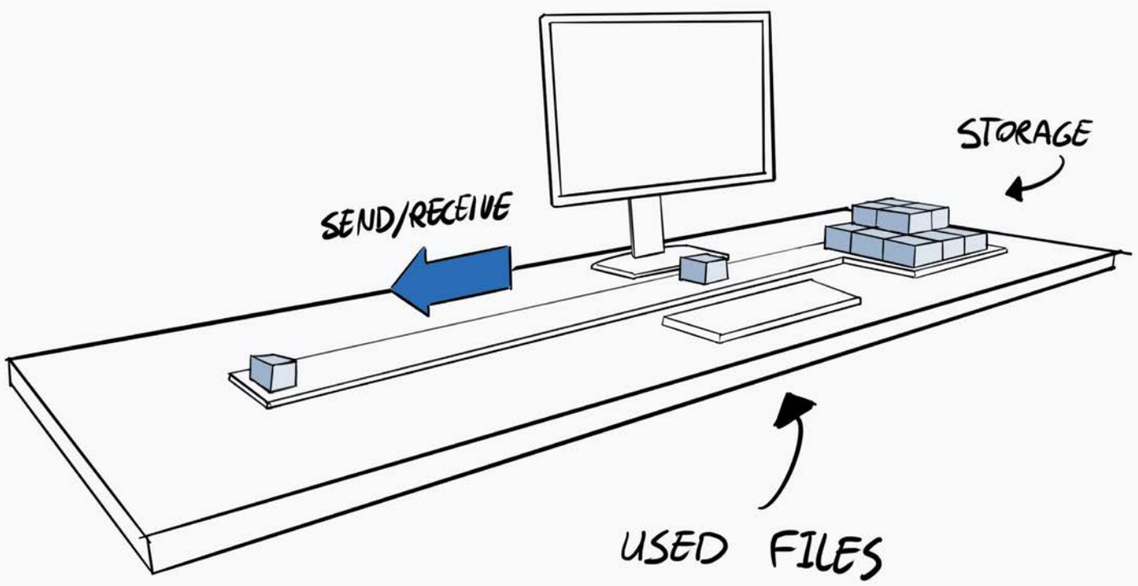
CONCEPT DESIGN SKETCHES

Physical Time Management

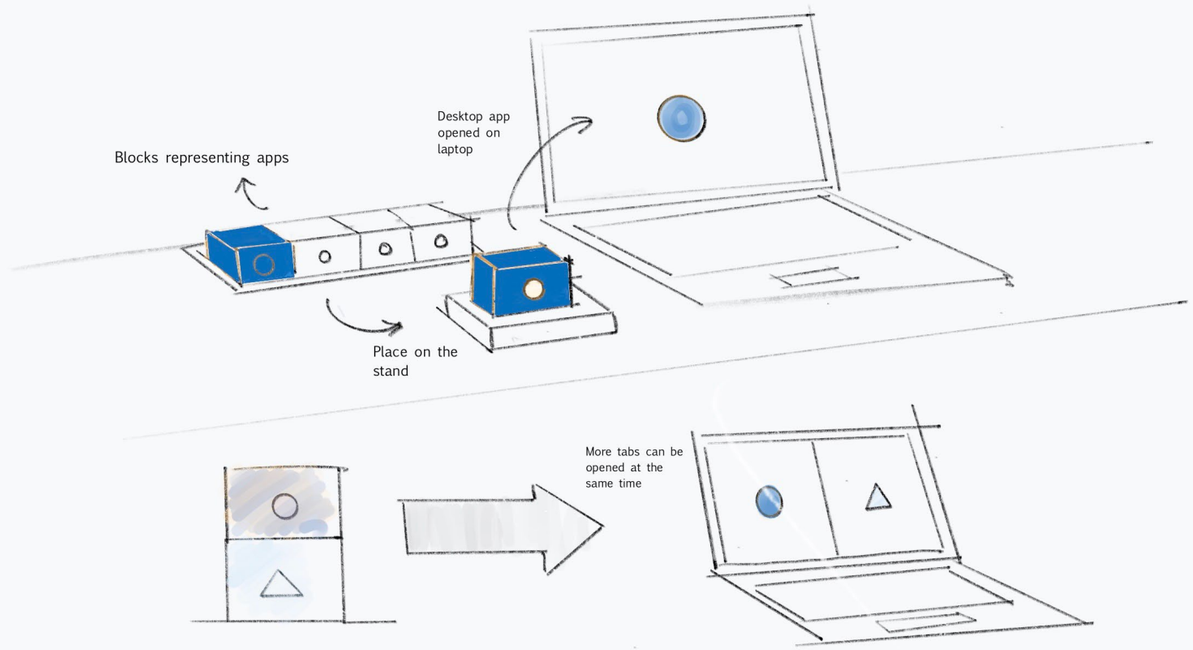
CONCEPT DESIGN SKETCHES

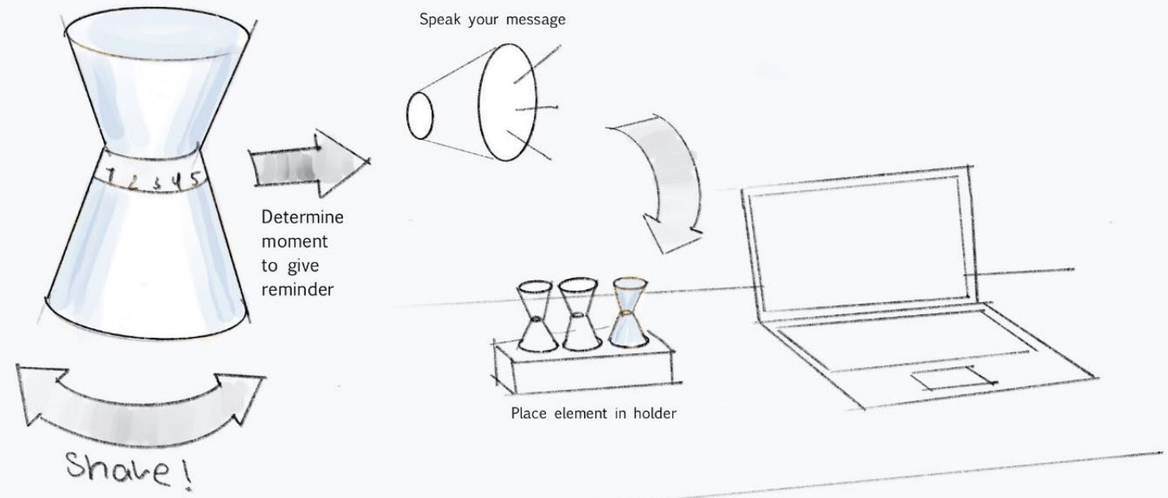
History Scroll Wheel





New version of Desktop



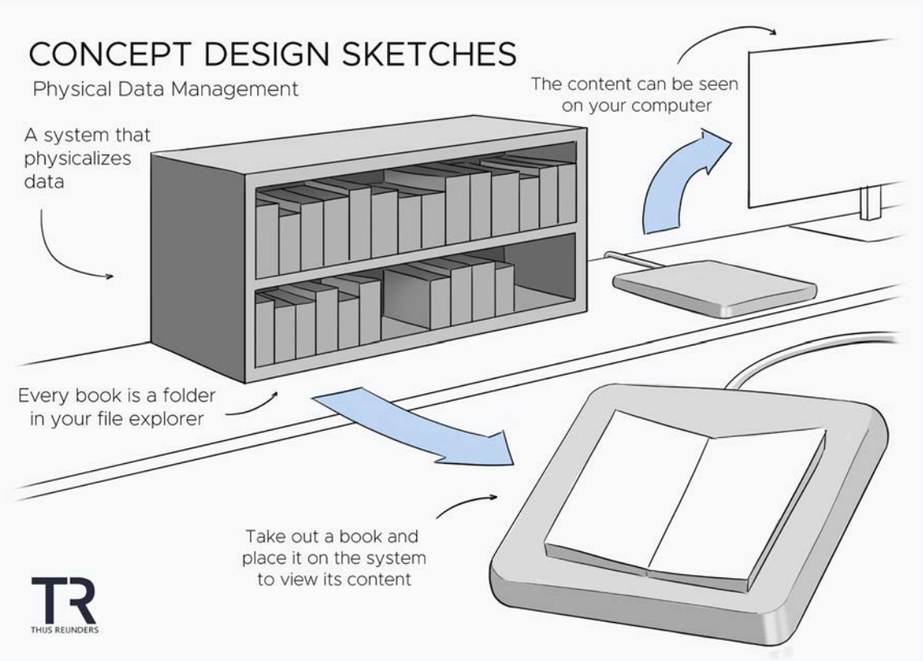


To Do Voice-overs

“THE BOOKSHELF“

“The bookshelf” is a physical storage unit for sorting your data, predominantly focussing on work related files. This means that the data you would normally keep on your computer is now physically present in the form of books in a bookshelf. Each book represents a specific area of expertise or project that is relevant to your work. For example, an interior designer may have a book on colour theory or a book on interior design materials. In this way, we hope to ensure that our users can see at a glance what type of data they have and that the chaos that normally occurs in the computer’s File Explorer is no longer present.

To access a project or expertise area, the user has to take it from the bookshelf and place it on the platform, which must be connected to your computer. We ensure that the physical activity you perform is connected to the feedback on the computer when placing it on the platform and opening the book. When you physically open a book, the folder in your File Explorer is opened.



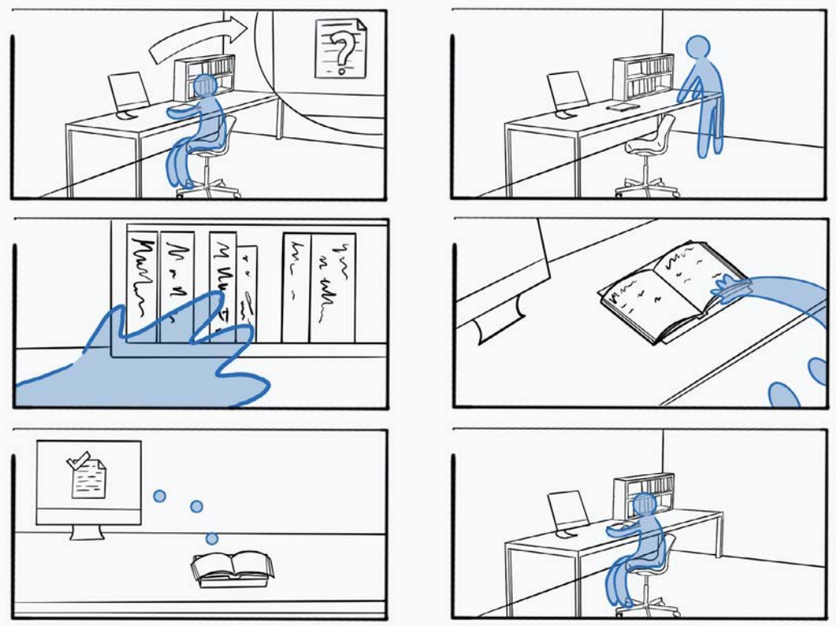
MIDTERM DEMODAY

With the Midterm DemoDay approaching, we began working on the concept right away. Midterm DemoDay was critical to the process and finalization of our concept because it allowed us to receive feedback from coaches who had not yet seen our project. This demonstrated to us whether our concept was clear and perceived as useful and usable by others.

We created a clear sketch as well as a 3D render and a storyboard to show how a user could use the product to make our concept as clear as possible. The visualizations are displayed below.

During our presentation at the Midterm DemoDay, we gained many new insights about our concept. The three most common remarks we received were:

- Does this solve cognitive overload, and if so, how?
- Is the book metaphor interesting enough?
- Have you considered other interactions besides swiping?



CHAPTER 4

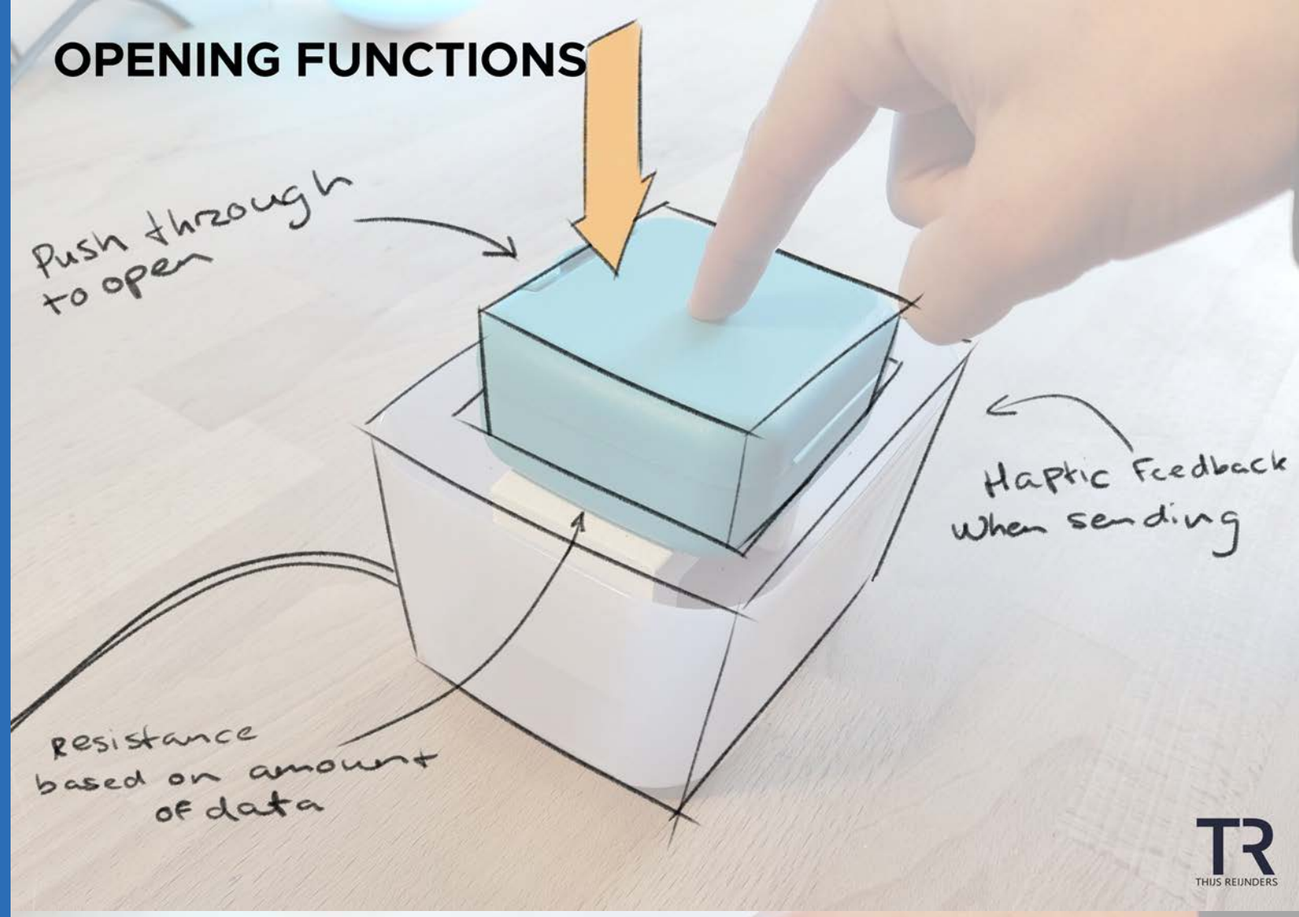
DEVELOPMENT

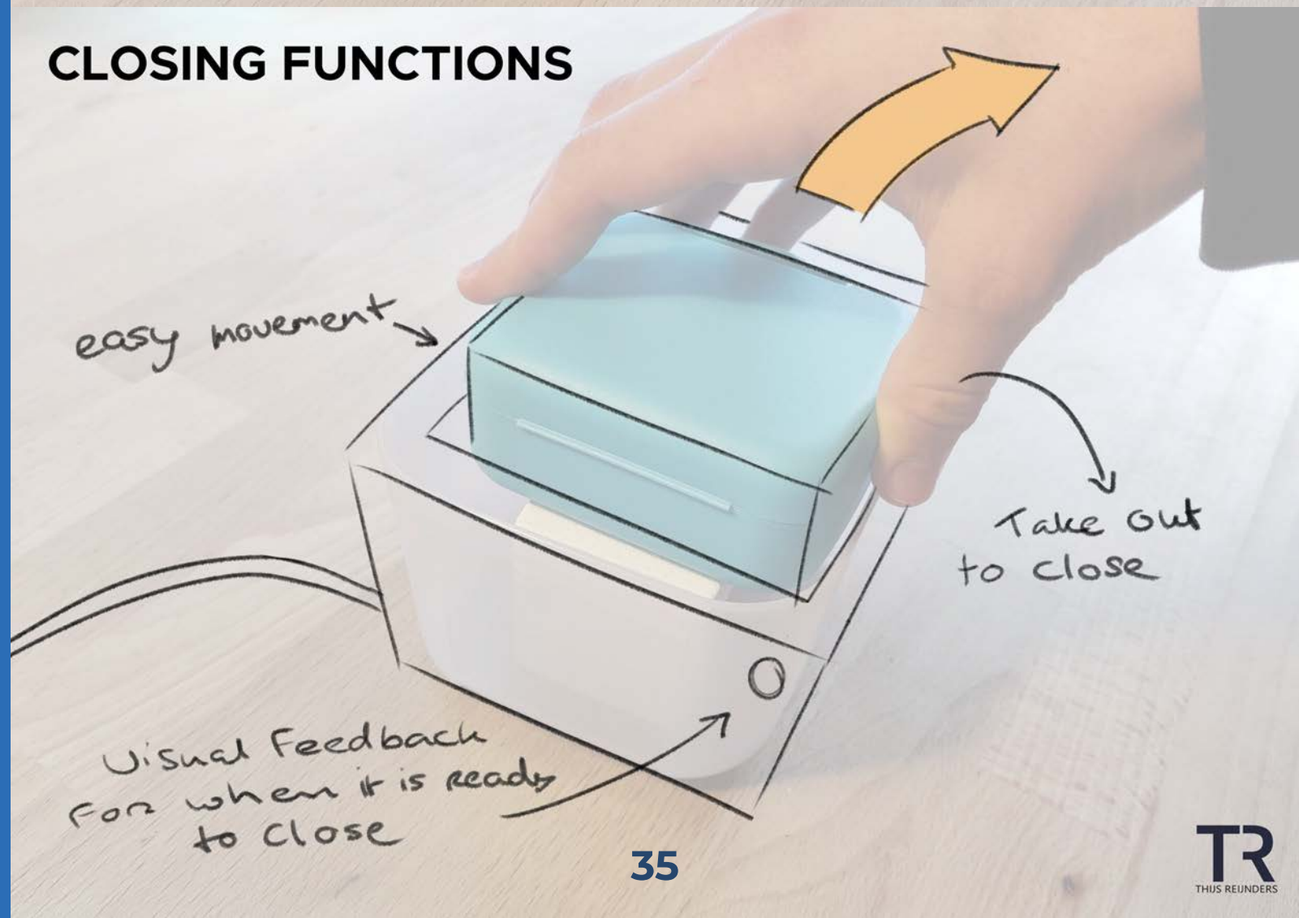
CHAPTER 4: Development
This chapter mainly focuses on interaction research. A multitude of interaction designs was created, prototyped, and tested. From the resulting outcomes, the final interaction with our product MEMOSIO was chosen and a coherent design was created.

RESEARCH - INTERACTION POSSIBILITIES

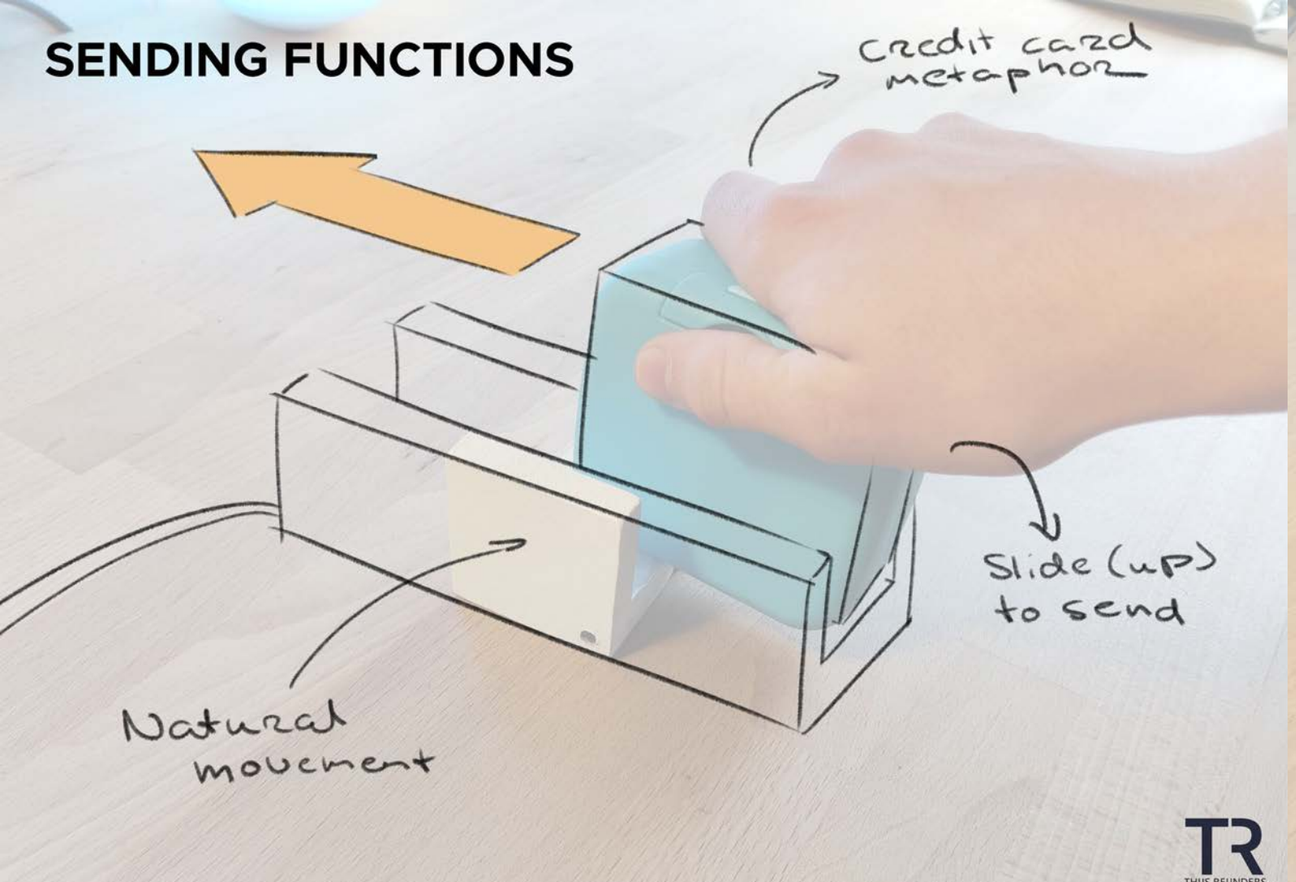
In order to create a digital-physical project management system it was important that the system aligns with both its users' perceptual-motor, and their cognitive skills. At the same time both action and function should be naturally coupled to allow intuitive interaction. Consequently, action and reaction should be unified in aspects like location, time, direction, dynamics, modality and expression (Wensveen, S. a G., Djajadiningrat, J. P., & Overbeeke, C. J. (2004)). To design an interaction in which there is a natural relation between action and function, numerous interaction possibilities were explored, using both sketches and props, to physically interact with. Functions for which a fitting action had to be found were:

- The opening and closing of files
- The sending and receiving of files
- The separation of a single file from a folder, in preparation of sending it
- Fitting UX designs

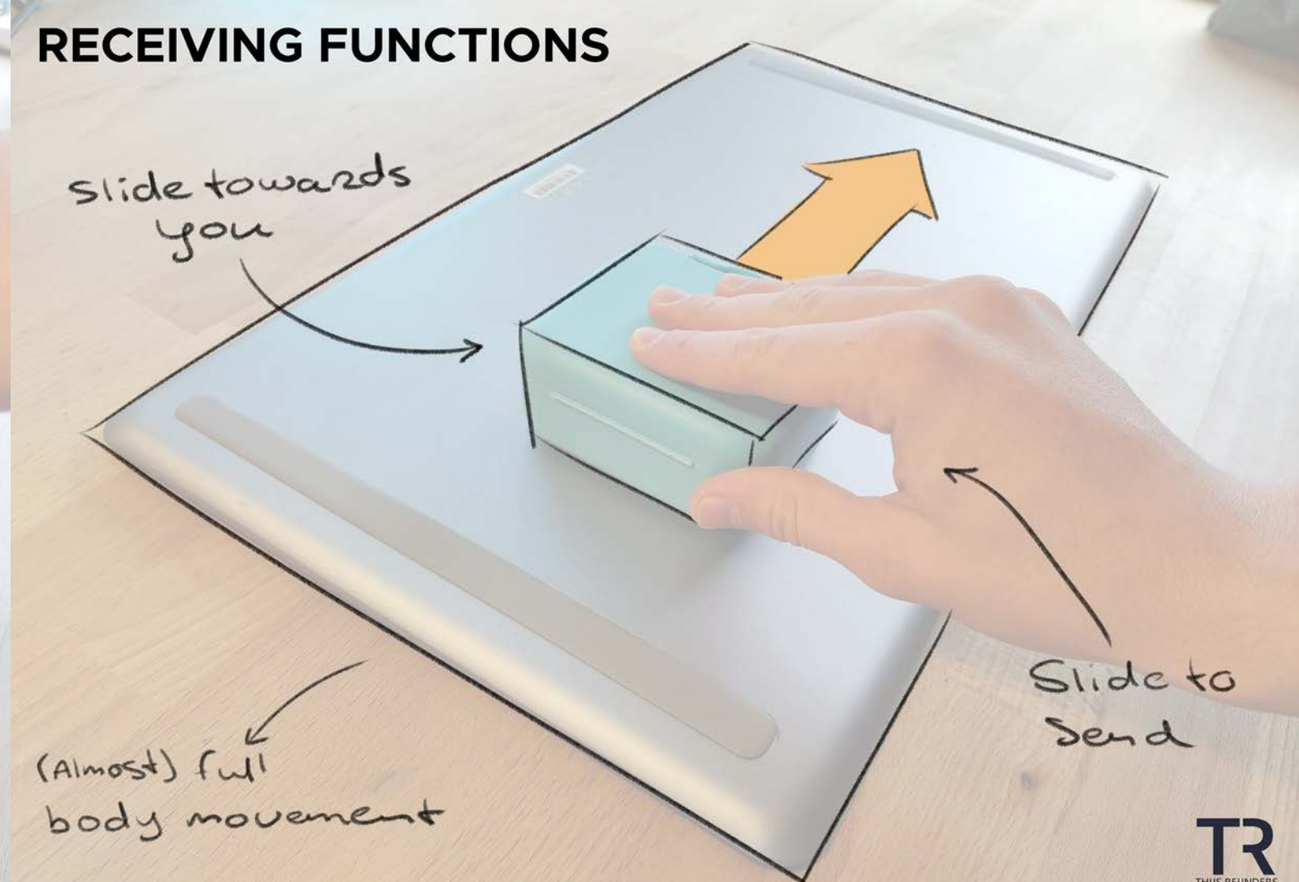




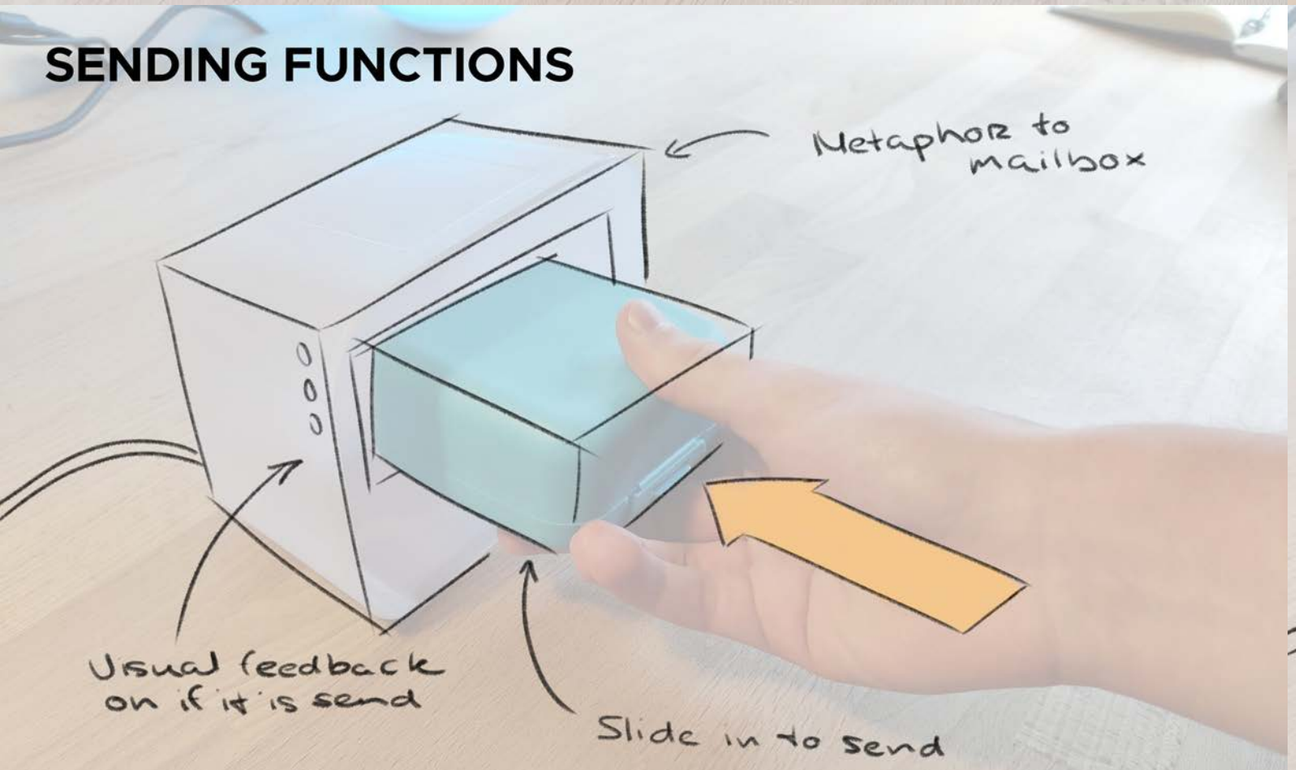
SENDING FUNCTIONS



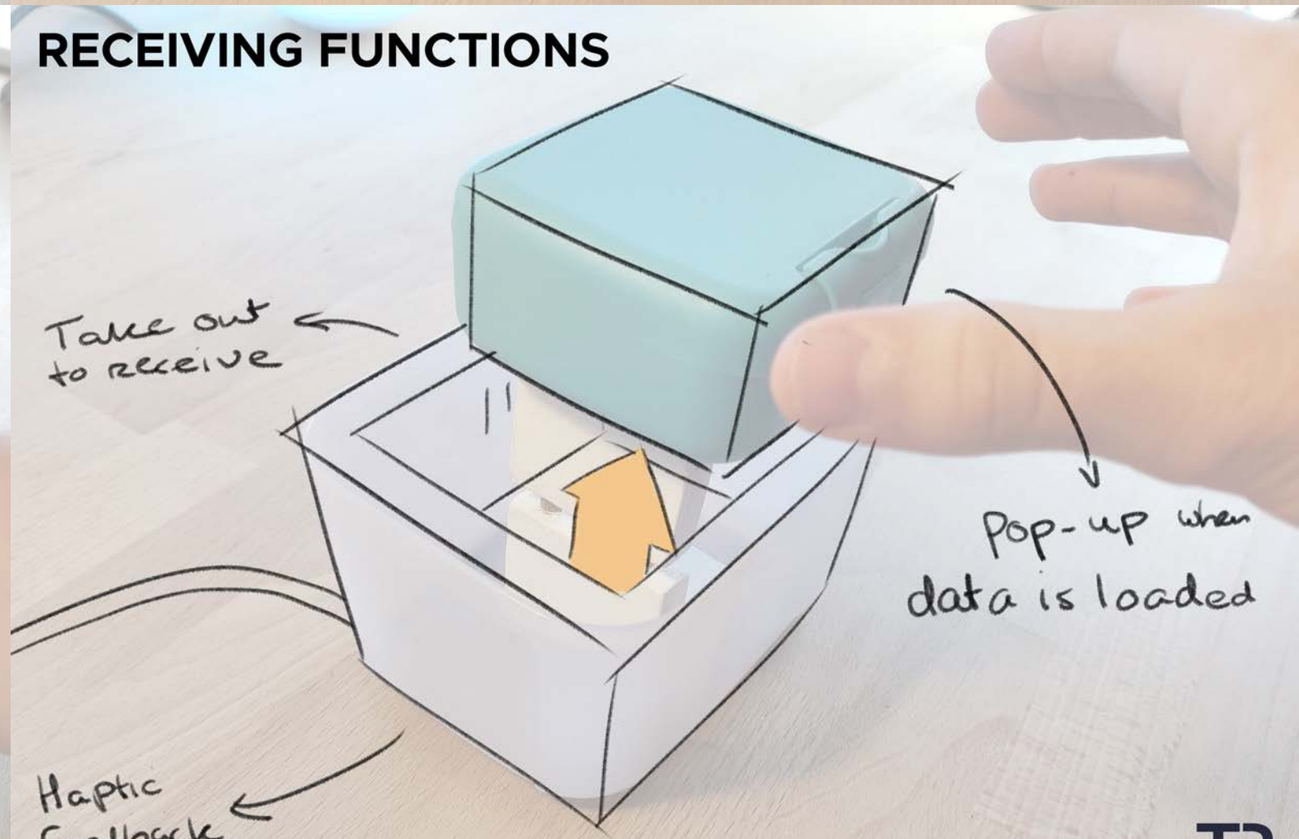
RECEIVING FUNCTIONS



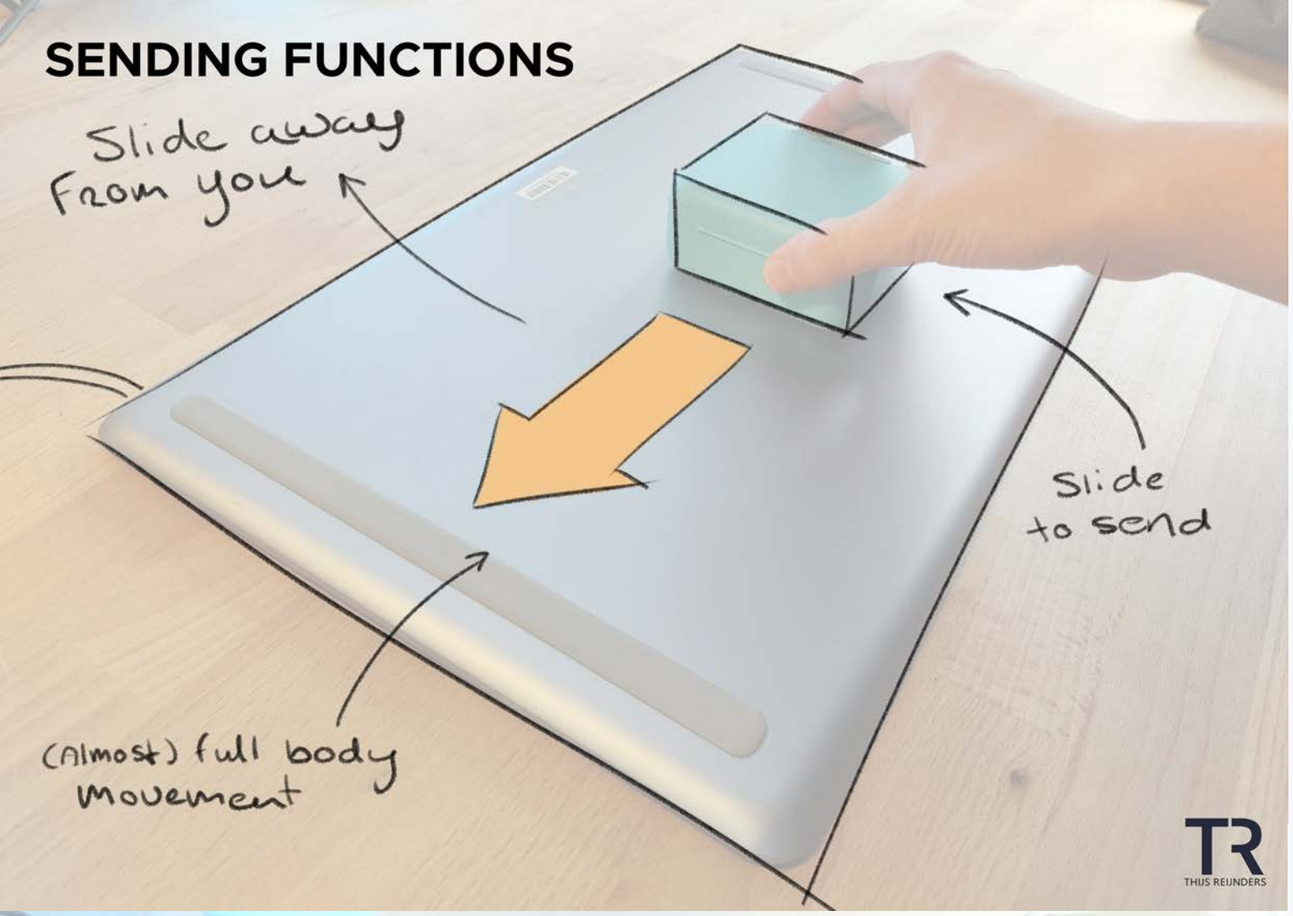
SENDING FUNCTIONS



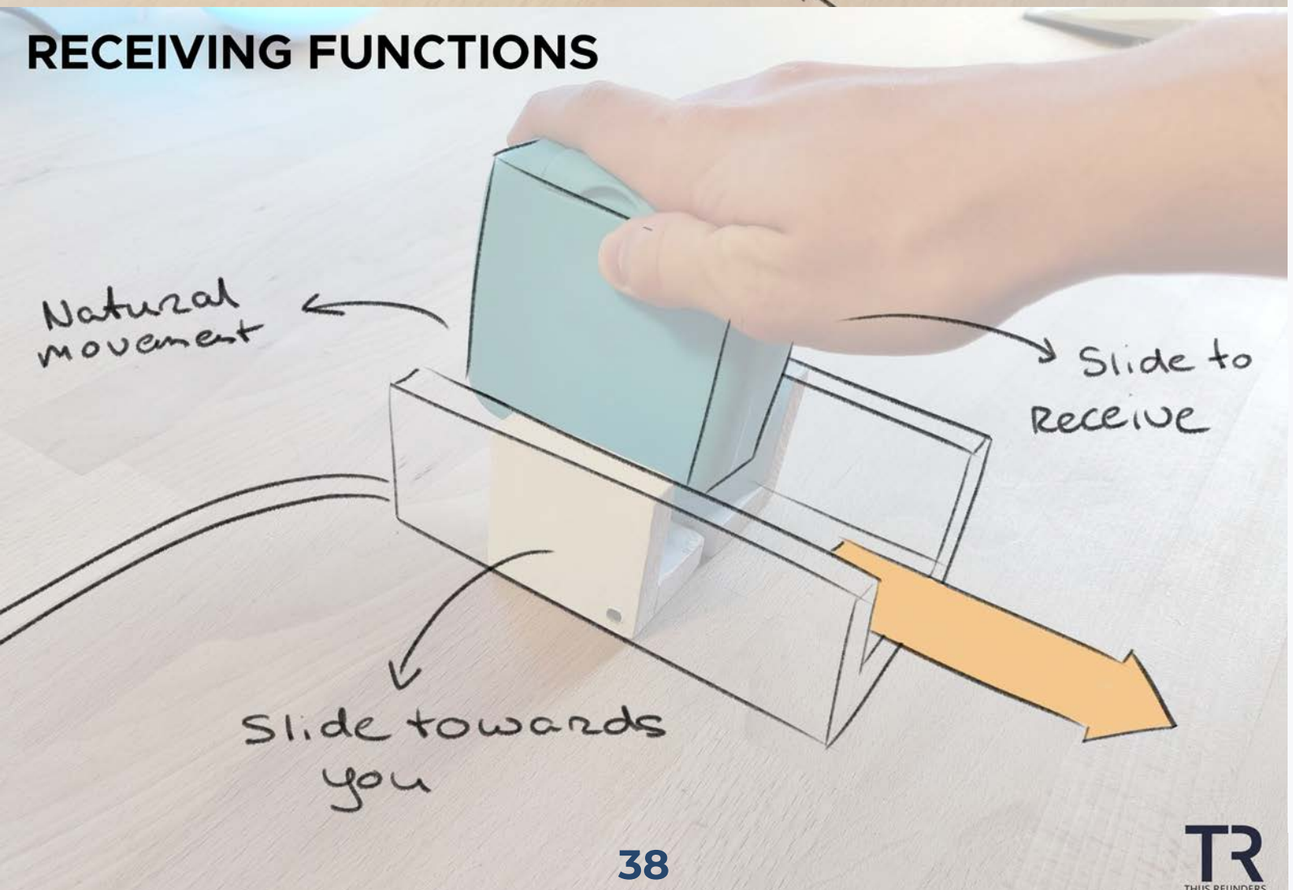
RECEIVING FUNCTIONS



SENDING FUNCTIONS



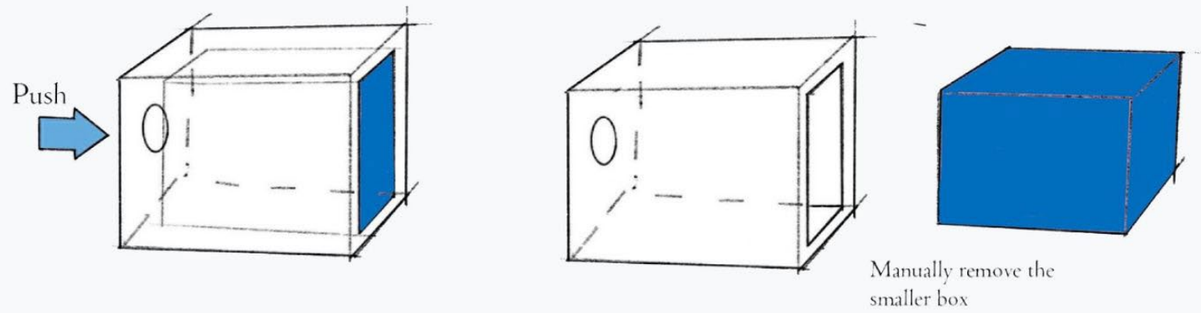
RECEIVING FUNCTIONS



SEPARATING FILES

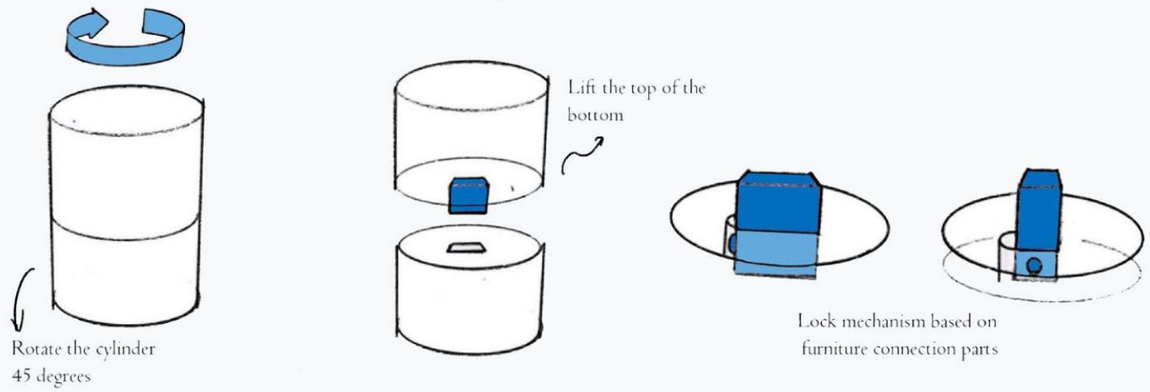
MANUALLY REMOVING THE BOX

The box (having the purpose of a wireless USB) is manually removed from the shell by pushing the smaller cube through the hole



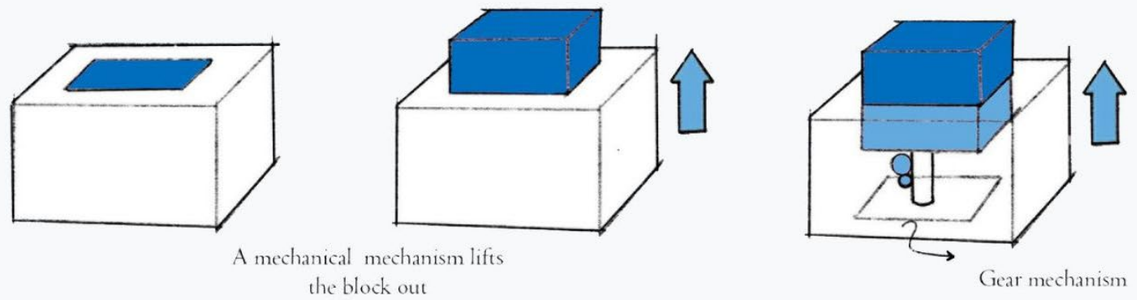
FURNITURE CONNECTION MECHANISM

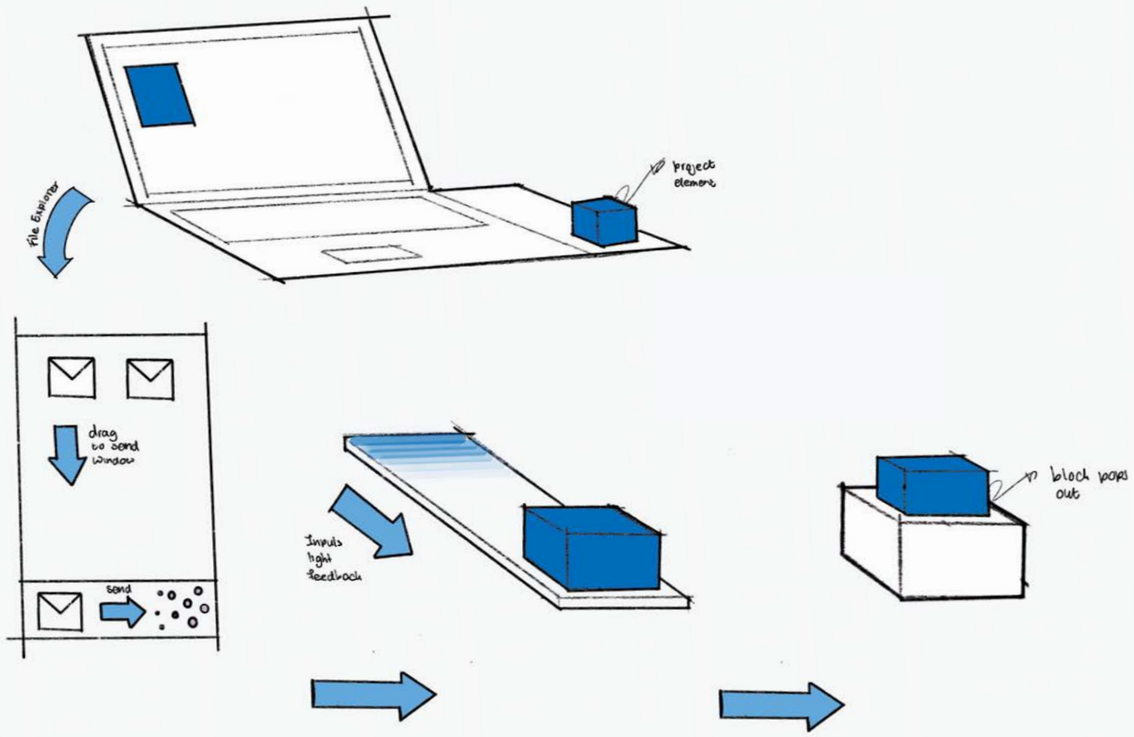
Mechanism based on furniture connection parts that only open when the object is turned in a certain way



GEAR MECHANISM

Gear mechanism drive by a DC motor moves the box up and down when an Arduino program commands it





FUNCTIONALITY - SEPARATING FILES

Concept: To separate a single file from a folder a document was to be dragged to a separate section, where the mail address of the receiver was to be filled in. By pressing on send the document was transferred to a smaller component in the bigger boxed that popped up or was to be taken out or separated from the bigger box. This smaller component was then placed on the sending platform and after executing a specific action sent to the receiver, see the image above.

PROTOTYPING

To correctly evaluate the interaction concepts, being able to physically interact with the objects was of the utmost importance. Hence, of all functionality 2 interaction possibilities were chosen to realise in a 3D print that can be seen below. The following iterations were chosen;

Opening & closing of projects
1. Sliding towards or away from the computer
2. Placing object on a stand

Sending & Receiving files
3. Sliding the object away or toward you
4. Placing it in a mailbox-like element
Separating files

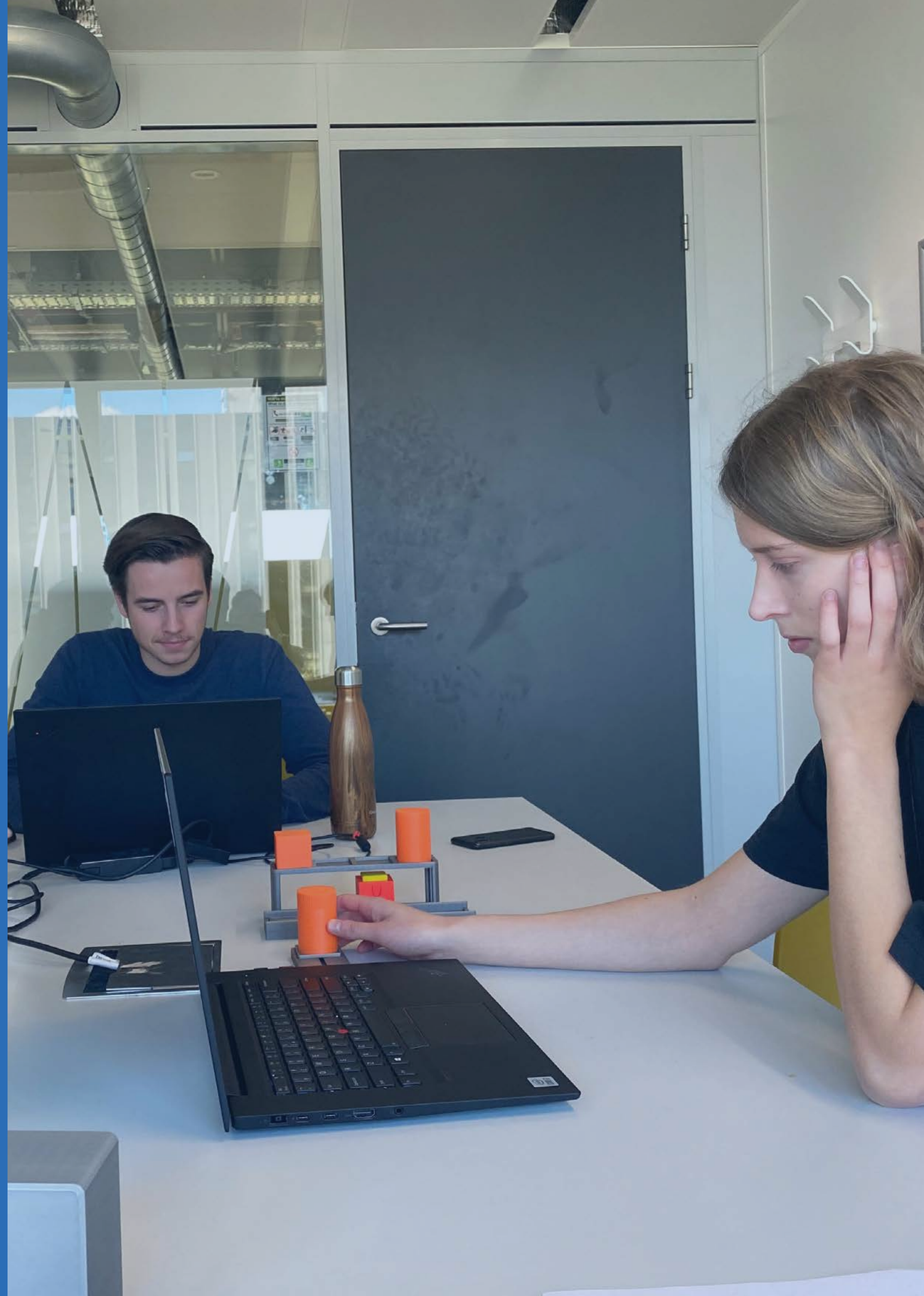
Separating files
5. Unscrew the top from the bottom
6. Take element out of shell

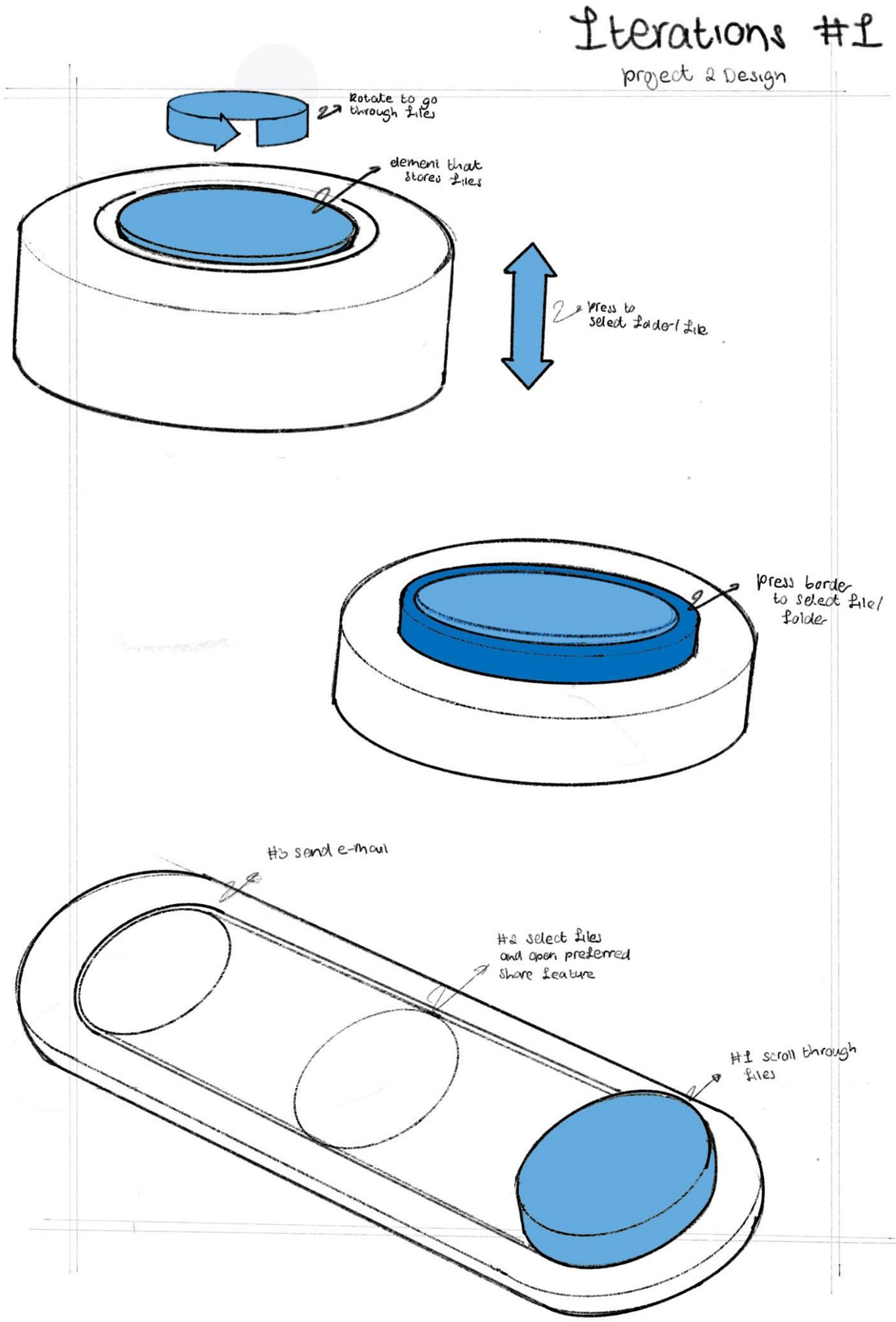
USER TEST

To objectively evaluate the interactions design, discussed priorly, a user test was organised. The goal of the test was to test the effectiveness, desirability, and fluency of the different interaction operatives and resulting reactions that aim to physicalise both file management and exchange. A total of 7 subjects were asked to evaluate the individual interaction operatives while a narrator led them through the entire interaction with the product, including the opening and closing, sending and receiving, and separating of the files. See appendixes A and B for the complete user test plan and consent form.

Key insights of the test were;

- Subjects found it to be more effective when the selecting/separating of the files was done on the computer
- High levels of haptic or visual feedback were experienced to lead to higher satisfaction levels
- The idea of a physical file management system is appreciated but shouldn't take away the efficiency of performing certain tasks. If so it should be rewarded with a rich user experience.
- Physically seeing your projects, provides people with a clear overview of what they are working on. Opportunities are seen in project management
- Find a good balance between actions that are more efficient to execute physically and those that are more efficient doing on the computer.





FINAL INTERACTION

Based on the insights gained from the user test, coach meeting, and our personal findings. The final interaction was defined and based on this a redesign of the product was created.

Final Interaction Design

- Take a disc out of the storage case and place it on the controller. A project window opens on your laptop
- Rotate the controller to scroll through your files
- Push the controller slightly forward to open a file or folder
- Push the controller slightly backward to close a file or folder
- Press the controller down to select a file
- Move the controller half way on the slider to open the application menu and select your application using the same operative on the controller
- Write your message in the normal application you selected. Nothing is changed in the application
- Send the message by sliding the controller all the way to the back

Based on the final interaction design a final design concept was created.

CHAPTER 5

REALIZATION

CHAPTER 5: Realization

This chapter focuses on realizing our concept. We mainly conduct research into the design and the haptic and visual feedback of our product by making prototypes. We also performed a user test with these prototypes.

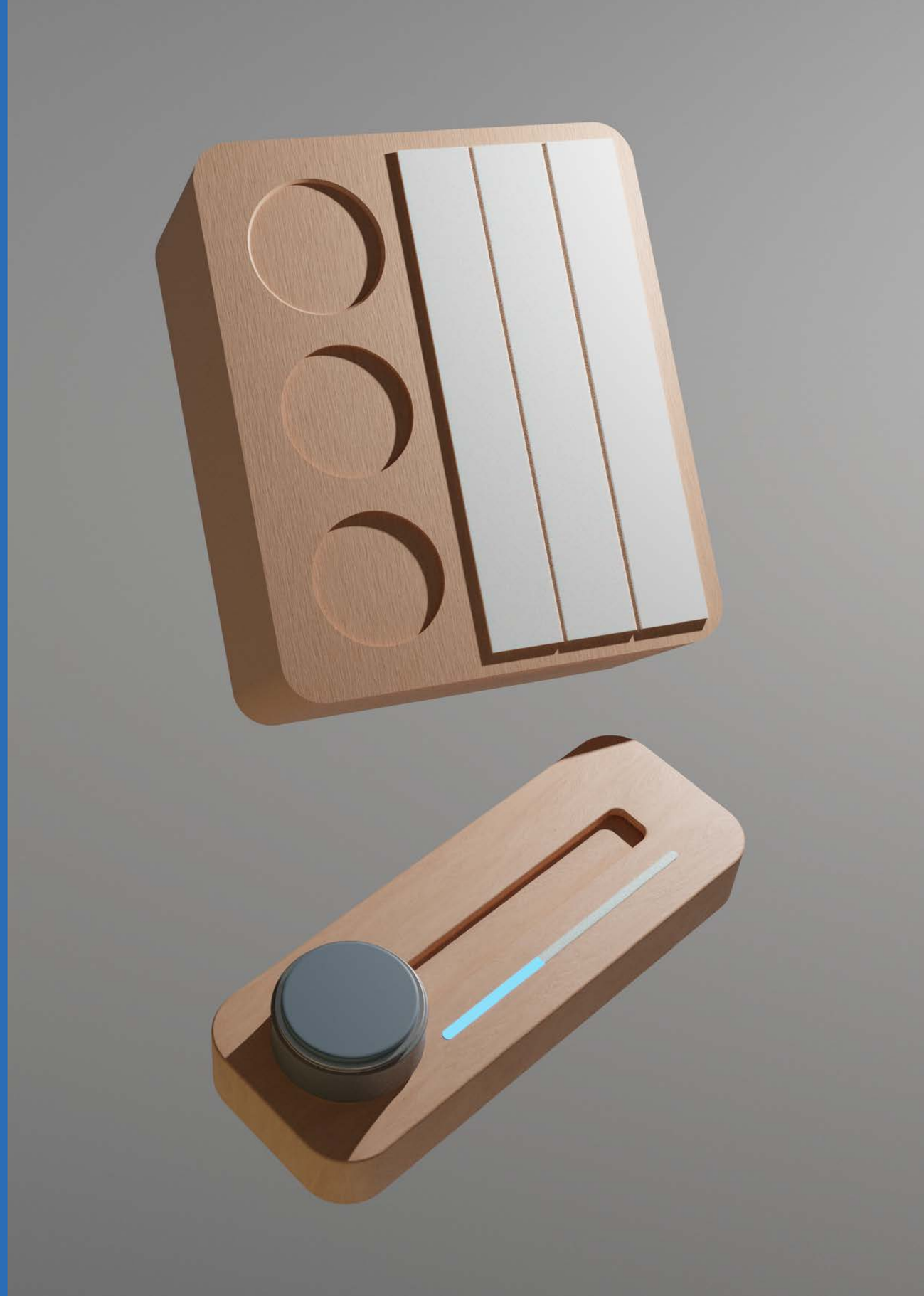
BRAINSTORM

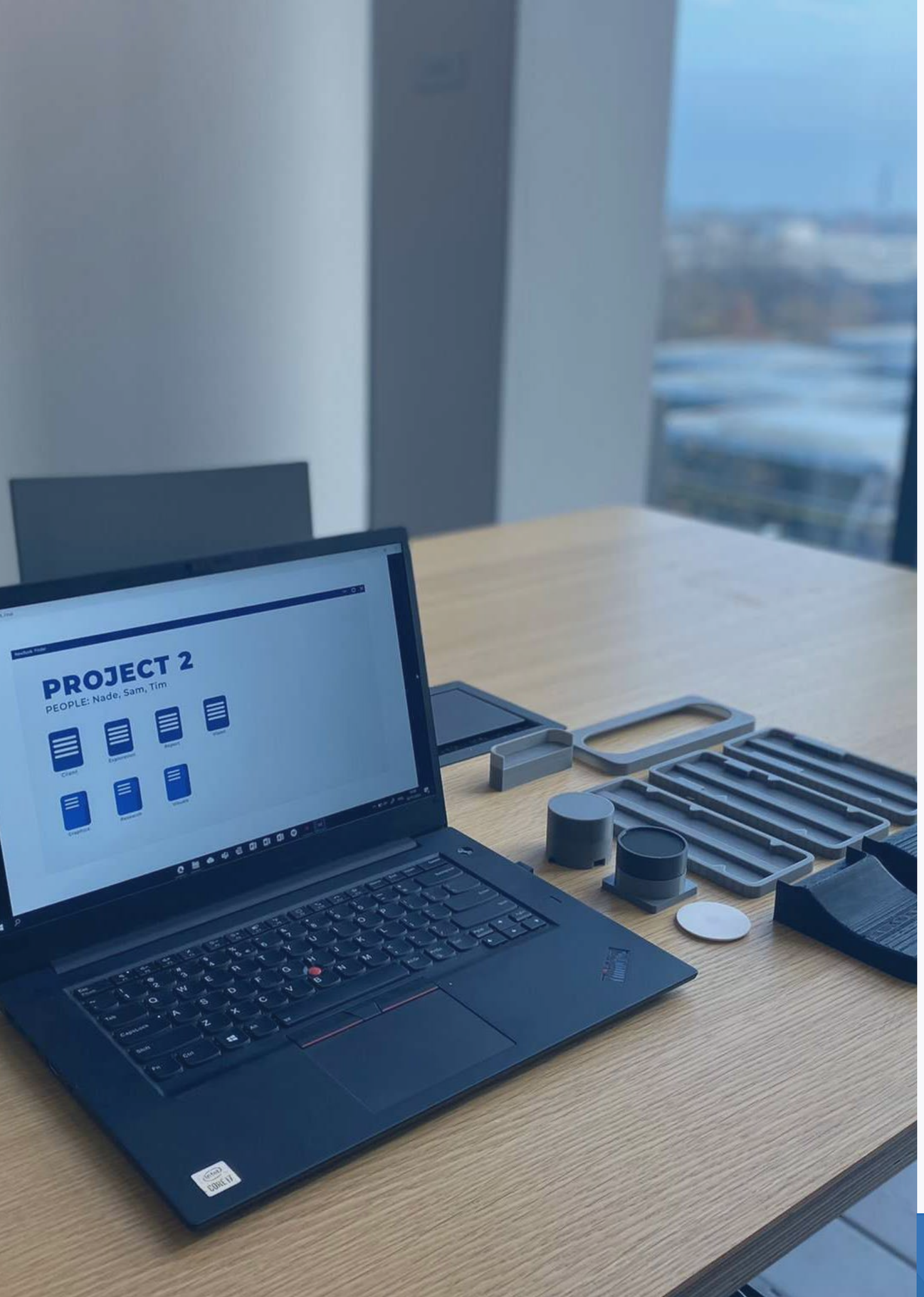
After conducting the first user test and finalizing the interactions for our product, we made it a priority to determine the optimal ways to implement these interactions. We began by researching different electronic components that could potentially be incorporated into the product. We also designed a range of slider mechanisms as potential solutions for executing the interactions in a smooth and efficient manner. It was our goal to find the most effective and efficient methods for implementing the interactions in our final product design, while ensuring that the performed action, and shown reaction correspond well.

Storage of project discs is an essential aspect of utilizing MEMOSIO effectively. It is important to ensure that projects are easily accessible while also minimizing distractions. In order to determine the best storage solution, we have considered the following factors:

1. How many (active) projects do you use?
2. What added functionality can the storing solution have?

In addition to basic storage functionality, there are several other features that may be of interest, such as notifications and planning tools. However, we recognize that having a large number of visible items can be overwhelming and potentially lead to overload. To mitigate this issue, we have limited the number of projects that are visible at the front of the storage to three. These projects can be rearranged based on priority by changing their order. For additional project storage, we have included small drawers that can hold three projects each. This allows users to work on a large number of projects without experiencing overload.





USER TEST

We designed multiple sliders with unique haptic feedback and conducted our own evaluations before organizing a user test to objectively assess the haptic feedback, overall design, and user experience (UX) of the product. At the time of the test, the electronics and coding for the project had not yet been completed, so the UX was tested using a Wizard of Oz setup where corresponding buttons were pressed in response to actions performed by the user. Six participants were guided through the operation by a narrator while viewing the corresponding UX on a laptop. Following the test, the participants were interviewed about their overall interaction with the product and their impressions of the various haptic feedback solutions. See appendixes C and D for the complete user test plan and consent form.

Key insights of the test were:

- The majority of interactions were found to be intuitive, with the remaining interactions being easily learned by users.
- The haptic feedback provided by the rotary encoder and magnetic disc mount received positive feedback from users, contributing to an overall enjoyable experience.
- No clear preference for haptic feedback was identified for the slider, providing the opportunity for the design team to make a decision based on their own considerations.
- The findings indicated that an ergonomic wrist rest may not be necessary, as the slider is not in constant use during interactions.

DESIGN CHOICES

Based on the insights for the user test, and the following group and coach meetings, we have worked out a final concept design. The most important decisions we had to make were the following:

1. What haptic feedback do we want for the slider?
2. Do we include a wrist rest in the design?

During the coach meeting, we discussed the results of the user test regarding the haptic feedback. These results were mostly inconclusive, so we have listed the options to select one ourselves:

1. A small bump for initiating the slider.
2. A small bump for initiating the slider, a small bump for the first step and a decrease in resistance when reaching the final step (where files are send away)
3. A small bump for initiating the slider, and a decrease in resistance when reaching the final step. The first step is noticeable because of the start of the final high-low resistance.

After evaluating the available options, we decided to eliminate the first option due to its lack of differentiation in feedback for different actions. This left options 2 and 3, with the user test indicating a preference for option 3. This option provided feedback that aligned better with users' expectations and was less confusing compared to option 2.

In terms of the wrist rest, the team considered the findings of the user test, which indicated that such a feature was not necessary due to the infrequent use of the slider. As a result, the final design does not include a wrist rest.

CHAPTER 6

FINALIZATION

CHAPTER 6: Finalization

This chapter focuses on creating and explaining our final concept. In this, we discuss what the concept exactly means and how it works in the mechanical and electronical field. Next to that we also describe a business plan made for our product.

FINAL CONCEPT

MEMOSIO is a hybrid physical-digital project management product that aims to reduce the cognitive overload generated by digital interfaces, that rely on cognition instead of action, for freelancers, that work from home, and enhance their working experience. MEMOSIO consists of a storage unit with discs, a controller, and a user interface on the computer.

The product is designed for the user to have as few extra functions or as few distractions while working as possible. The discs are responsible for this. These discs represent the projects on which a freelancer is currently working. By inserting this disc, the project, into the controller, the project opens on the computer. The user interface displays all relevant project information, such as files, contact information, and deadlines. We significantly reduce cognitive load by reducing the amount of information you have to process while working on your project by isolating all of the material you need for this project from the existing file explorer and placing it on a single disc in a virtual project environment.

The controller is used to interact with the project on the computer. By physically interacting with the data, we make your work more enjoyable and increase productivity. The controller has several interaction options, each of which represents a different function. These interactions are detailed further below. The user's interaction with the controller has a direct influence on the user interface; the feedback provided by the user interface is directly related to the action performed, so it is experienced as a connected system.

The storage unit is built in such a way that it reduces cognitive overload. The unit has a capacity of 12 discs or 12 projects. However, the user can only see three projects. These are the three most important projects, for example, those on which the user should be working that week. The user can also arrange them on the storage unit in a specific order to give them a priority. The remaining discs are arranged in the trays. This makes them simple to obtain, but because they are not visible, they cannot distract.

COLLABORATION WITH NET(WORK)

Our product can also be used in combination with NET(WORK), an M1 Future of Work project. This project connects freelancers, provides a clear overview of your existing contact network, and at the same time provides you with suggestions and or opportunities to expand your network. The collaboration between MEMOSIO and NET(WORK) lamp allows you to view and possibly upload the contact information of a contact person in your network to the associated project disc, creating a clear overview of important contact persons in a project. Once you click on a contact person on the lamp, you are redirected to the page for the chosen contact person, providing you with their contact information. By following the instructions on the screen, you can then potentially upload the contact person and their contact information to the associated project disc.

MEMOSIO PLACED IN CONTEXT

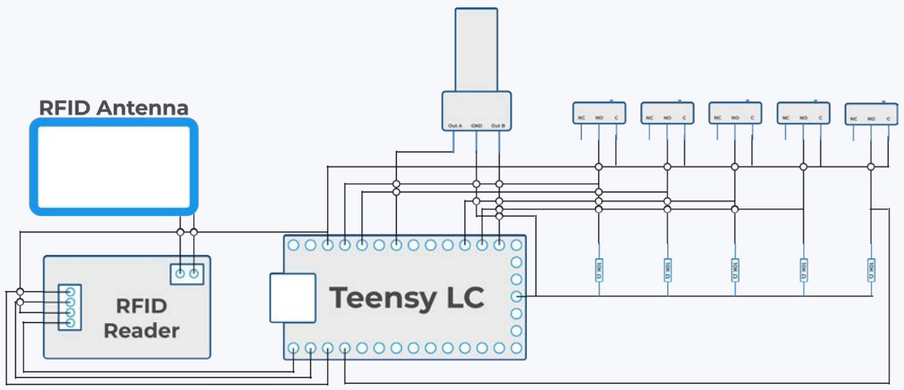
Besides acting like a project manager, MEMOSIO also has a social function. By displaying the projects that you are currently working on, on the priority section on the storage case, family members and other people passing by can see what you are working on. Consequently, the project manager can act like a conversation starter.

When an external client or bureau also possesses a MEMOSIO, the portable nature of the discs, allow freelancers to take their discs to meetings, presentations, and client visits.

ELECTRONICS

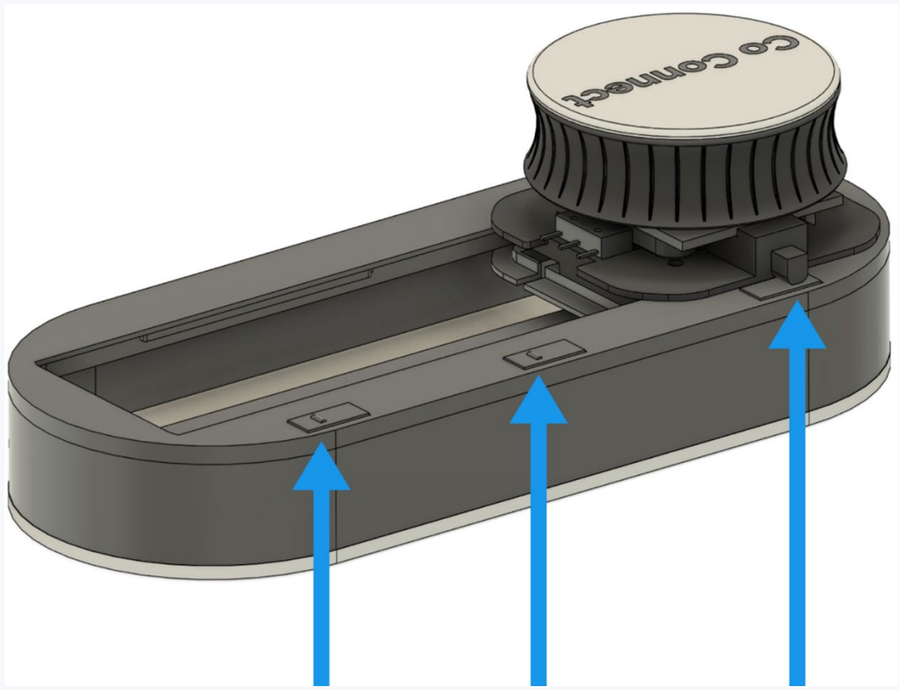
Parts list:
- 1x Teensy LC
- 5x Micro Switch Standard
- 5x 10KΩ Pull-up resistor
- 1x Seeed Studio Grove 125kHz RFID-reader
- 1x Rotary encoder (Kaihl CEN212218D02)
- 6x EM4100 Key Tag (for in the project discs)

After conducting research on various RFID readers, we determined that the PN532 would be the most suitable for our needs due to its extended range of 5-7cm and compatibility with standard Mifare tags, which enable us to read up to 1kb of data from the RFID tag. However, during the prototype development phase, we encountered a problem with the PN532 reader. As a result, we had to redesign our prototype to incorporate an RFID reader from Seeed Studio, along with a separate antenna. This allowed us to position the antenna closer to the tags, effectively resolving the issue.

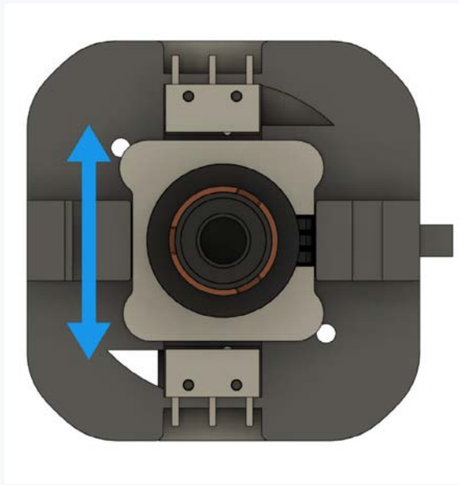


We evaluated several options for measuring the position of the slider, including a linear potentiometer, a rotary encoder with a small wheel at the bottom, and micro switches for each status. We determined that it was not necessary to know the precise position of the slider and decided to implement the simpler approach of using micro switches to indicate three distinct status updates.

MECHANICS



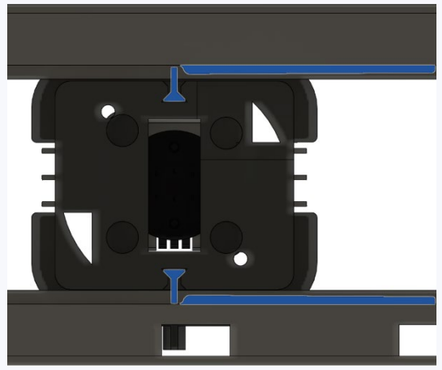
To read out the status of the slider, we have incorporated 3 micro switches. These switches are pressed with a small rounded arm to ensure smooth motion.



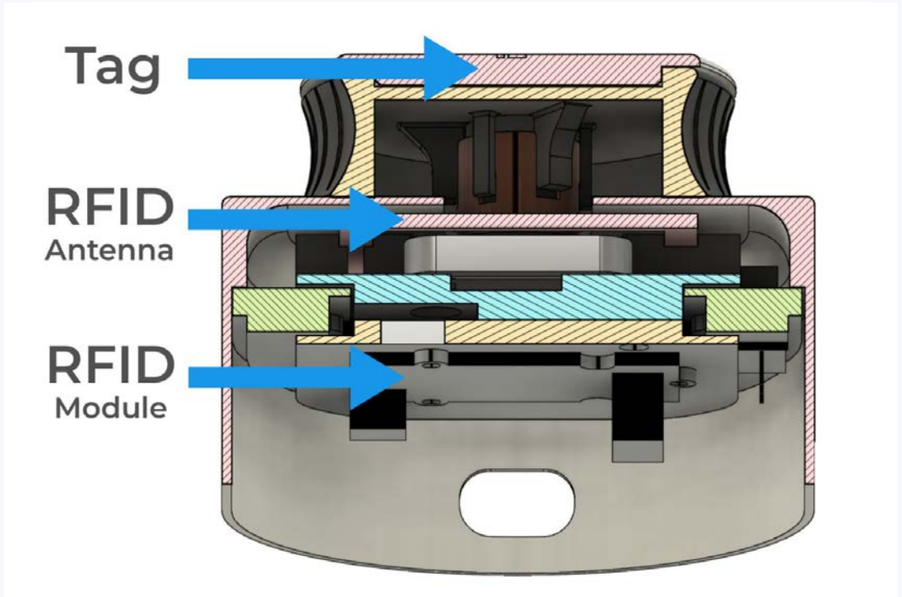
The small click forward and backwards is made possible with the following mechanism. The rotary encoder is mounted on a 3d printed platform (lighter grey part). In the rounded corners of this part, there are 4 neodymium magnets. This allows the platform to move slightly, and automatically return to a neutral position.

MECHANICS

The haptic feedback for the slider is achieved with two small TPU parts, and a feedback ring. The TPU parts are flexible, and cause friction in combination with the feedback ring. In the right image you can see the last part of the feedback, with decreasing resistance as the files are sent away.



In order to read out the RFID tag, trough the rotary encoder, the distance needs to be as low as possible. For this reason we used an RFID module with separate antenna, which is mounted as high as possible.



An Arduino code was developed to read the data provided by the rotary encoder, RFID scanner and micro switches integrated into the controller. Once the status of the controller changes and is detected by the Arduino code, a specific letter is written, which will be read by an Adobe XD program. This input will then trigger a certain action in the UI design. The full code can be seen in appendix E and the explanation of the UI Design in appendix F

BUSINESS MODEL

MEMOSIO follows a simple, Make-Sell business model. To allow for easy customisation of products all sales are directly to the consumers, without resellers. For a product with a large and diverse target audience, this would not be very optimal. However, since our product has a very well defined target group, we would not need the exposure from resellers as much.

The base product is only bought once, and cost estimates are around €60 for the system with basic storage unit and 3 tags. This is based on the average price of a mouse, which uses mostly similar, but slightly more advanced electronics, and on the premise that technology keeps getting more affordable.

To access your data with the tags on multiple devices, you need to use our cloud storage service. The best way to offer this for us, would be with a subscription model, instead of including it in the product price, as providing this service would generate recurring costs for MEMOSIO.

There is also the potential for recurring sales of project tags, but this has not been decided yet. This is mostly dependent on the progress of display technology in the upcoming 15 years and whether it would be reasonable to incorporate displays in the tags to show which project it is by 2037.

CHAPTER 7

REFLECTION

CHAPTER 7: Reflection
In this chapter, we look back at our project. We do this by determining what went well and what could be improved. In addition, we also determine future steps to take in the project.

DISCUSSION

In this report we discussed the development process of the product MEMOSIO a physical-digital project manager. While overall the process completed successfully, there are some points of improvement. Primarily, based on received feedback and internal evaluation, improvements could be made regarding early user involvement. A user test, asking freelancers for their values and needs regarding project management, could have provided us with vital insights to validate the need for our product MEMOSIO. We made some decisions about the workspace of telecommuters which we could have validated with some users to create a stronger case. This could have been done both about the cognitive overload: a test to see how much of an issue it really is, and for the concept: how much could this help solve the issue.

Additionally, the user tests we did do were all of a small scale with only a small number of participants, resulting in subjective results. As the participants were recruited using convenience sampling, there was a validity risk because the participants weren't closely related to the actual user: Huub Xavier. An interview with an actual freelancer would have provided us with more relevant insights for our design case

FUTURE STEPS

With more time, the project could have been taken further. The product is to go through more rigorous testing to improve the prototype's functionalities. Besides, there are some functions included in the current file explorer that cannot be done using MEMOSIO yet, like copying and moving files, or duplicating them, etc. For future versions of MEMOSIO, research should be done to identify opportunities to integrate these functions in the system.

There are some opportunities that were never explored completely; like how the storage system could also be a way of communicating work ethics and work psychology to other family members. The current user interaction with MEMOSIO still requires the usage of a mouse. In the future, possibilities should be explored to integrate the functions of the mouse into the product, so user won't have to switch between the mouse and controller anymore.

After the creation of a better prototype, there is also a marketing plan that could be realised. Production, selling and advertisement are all things to consider if the prototype would be brought onto the market.

CHAPTER 8

REFERENCES

CHAPTER 8: References

In this chapter we noted down all our references used and created our appendix.

REFERENCES

Van Campenhout, L. D. E., Frens, J., Hummels, C., Standaert, A., & Peremans, H. (2016). Touching the dematerialized. Personal and Ubiquitous Computing, 20(1), 147–164. https://doi.org/10.1007/s00779-016-0907-y

Campenhout, van, L. D. E., Frens, J. W., Overbeeke, C. J., Standaert, A., & Peremans, H. (2013). Physical interaction in a dematerialized world. International Journal of Design, 7(1), 1-18.

Dourish, P. (2001). Where the action is - The foundations of embodied interaction. Cambridge, MA: MIT Press.

Feinberg, S., & Murphy, M. (2000). Applying cognitive load theory to the design of Web-based instruction. In IPCC/SIGDOC 2000: Technology and Teamwork - Proceedings, IEEE Professional Communication Society International Professional Communication Conference and ACM Special Interest Group on Documentation Conference (pp. 353–360). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/IPCC.2000.887293

Kumar, N., & Kumar, J. (2016). Measurement of Cognitive Load in HCI Systems Using EEG Power Spectrum: An Experimental Study. Procedia Computer Science, 84. https://doi.org/10.1016/j.procs.2016.04.068

Schmitt, J. B., Breuer, J., & Wulf, T. (2021). From cognitive overload to digital detox: Psychological implications of telework during the COVID-19 pandemic. Computers in Human Behavior, 124. https://doi.org/10.1016/j.chb.2021.106899

Amankwah-Amoah, J. (2016). Competing technologies, competing forces: The rise and fall of the floppy disc, 1971-2010. Technological Forecasting and Social Change, 107. https://doi.org/10.1016/j.techfore.2016.03.019

Figure 3: 3.5” Floppy Disk HD 1.44MB Black. (n.d.). Retro Style Media. https://www.retrostylemedia.co.uk/product/3-5-34-floppy-disk-hd-1-44mb

Figure 4: Maxiphoto, M. (2014, July 25). Hand inserting old floppy disk into a vintage old computer from the. . . iStock. Retrieved January 7, 2023, from https://www.istockphoto.com/nl/foto/hand-inserting-old-floppy-disk-drive-into-vintage-eigthies-computer-gm503180457-44272782

REFERENCES

Ullmer, B., Ishii, H., & Glas, D. (1998). MediaBlocks: Physical containers, transports, and controls for online media. In Proceedings of the 25th annual Conference on Computer Graphics and Interactive Techniques (pp. 379-386). New York: ACM Press.

Figure 2: Windows Explorer Through The Years. (n.d.). https://gekk.info/articles/explorer.html

Figure 1: Microsoft. (n.d.-b). Find and open File Explorer - Microsoft Support. https://support.microsoft.com/en-us/windows/find-and-open-file-explorer-ef370130-1cca-9dc5-e0df-2f7416fe1cb1

Hill, E. Jeffrey., Ferris, M., & Märtinson, V. (2003). Does it matter where you work? A comparison of how three work venues (traditional office, virtual office, and home office) influence aspects of work and personal/family life. Journal of Vocational Behavior, 63(2), 220–241. https://doi.org/10.1016/s0001-8791(03)00042-3

Barrero, J. M., Bloom, N., & Davis, S. J. (2021). Why Working from Home Will Stick. SSRN Electronic Journal, 28731. https://doi.org/10.2139/ssrn.3741644

Sinek, S. (2009). Start with why: how great leaders inspire everyone to take action. Portfolio The Magazine Of The Fine Arts, 1–7.

Wensveen, S. a G., Djajadiningrat, J. P., & Overbeeke, C. J. (2004). Interaction Frogger : a Design Framework. Designing Interactive Systems, 177–184. Retrieved from http://portal.acm.org/citation.cfm?id=1013115.1013140

Figures 5 + 6: Ullmer, B., Ishii, H., & Glas, D. (1998). mediaBlocks. Proceedings of the 25th Annual Conference on Computer Graphics and Interactive Techniques - SIGGRAPH ’98. https://doi.org/10.1145/280814.280940

All none numbered images are from @MEMOSIO - Photo’s take ourselfs

The renders are made by: Thijs Reijnders

APPENDIX: A

USER TEST 1 - TEST PLAN

Goal

To evaluate the effectiveness, desirability and fluency of the user interaction of a selection of interactive and tangible concept designs that aim to physicalise both file management and exchange.

Method

Recruitment

A selection of 8 students from the faculty of industrial design at TU Eindhoven is recruited using convenience sampling. All participants are between the ages of 18 and 25 and are all specialised in the field of design.

Process Overview

In the user test data will be gathered using both observations as a semi-structured interview.

The participants are all asked to try and evaluate 6 variants of the design concept NewBook. Primarily, a random interaction variant is chosen. A narrator explains the general idea of the product concept NewBook, by guiding the participants through the general interaction with the product using the step-by-step explanation. Afterward, at every new interaction variant, one component is changed. Differentiation is made using the following variants; Opening a file by placing the cube on the stand, Opening a file by swiping the cube towards the computer, Sending a file by placing the exchange unit in a slit, Sending a file by swiping the exchange unit up, Selecting the documents to send by interacting with a window that's integrated into the file explorer or Selecting the documents to send by placing the external unit on the sending platform and interacting with the extra window that subsequently appears. For every interaction variant, a semi-structured interview is used in which the subject is asked to evaluate the effectiveness, desirability, and fluency of the interaction.

Execution

1. All participants are given a short summary of the aim of our developing product NewBook.
2. At the start of the user test all participants are asked to follow the instruction of the narrator, who guides them through the entire interaction, see the narrative below.
3. Once the interaction is completed using the guidance of the narrator, the subject is asked if he/she/they understands the interaction and repeat it when felt necessary.
4. One of the 6 variants is chosen, the according setup created, and the subject is asked to individually evaluate the interaction with this variant based on how they experience the usability and enjoyability of the interaction, in a semi-structured interview. Among others the following questions are asked:
   - What are your first thoughts about the interaction you have just had with this design concept?
   - Does the interaction feel natural?
   - Do the actions you're performing align with the result of the action?
   - What sorts of haptic or visual feedback do you think would enrich this specific action?
5. The subject moves on to the following variant and is provided with a new setup. In total the subject is presented with 6 different interaction alternatives and asked to repeat step 3 and 4 for all variants.

Data collection method

In total 3 researchers are working on this user test. All researcher are working on an individual task:

Researcher 1 has the role of the narrator and interviewer and talks the subject through all interaction variants.

Researcher 2 has the role of observer and focuses mainly on the processing time, facial expressions, and other unordinary behaviour that communicate signs of confusion, satisfaction, or other.

Researcher 3 creates all the new variants by making the different setups of the product and manipulates the settings when the wizard of oz method is used

Narrator story for the general walk through the interaction with the NEWBOOK

1. In front of you, you have a storage case. Every individual element represents a folder that contains all your files that are related to a certain project you're working on.
2. You currently want to work on project 2.
3. You take the storage object Project 2 out of the storage case
4. And you place it on the stand
5. When you press the object on the stand a window pops open on your computer displaying all your folders

6. You want to send one of your files to your teammates
7. On your computer you drag your chosen file to the export section in the new file explorer
8. You fill in the email address of the contact person
9. Now you physically separate the file from the folder by taking the top of the element of the cylinder by rotating it halfway and lifting it up
10. This smaller element contains all the info you want to send
11. You place the exchange element on the sending end of the exchange platform
12. You swipe it up and you now have successfully sent the file to the person
13. You attach it again to the bigger element

14. You immediately get a reply back, you see this by a light that starts to blink in the slider
15. You place your storage object for project 2 on the stand
16. You take the exchange component out of the storage object
17. You take your exchange object and place it at the receiving end of the exchange platform
18. You swipe it down and the info in transferred to the smaller element
19. You place the exchange component in the storage object.
20. On the screen you see that the exchange component has one file in the exchange window in the file explorer
21. You open it by clicking on it.
22. You have received the information that you needed and determine you want to keep it in the email folder
23. You drag it to the right folder in your project window.
24. You're now done with working on this project and take the storage object of the stand, the file window on your computer closes.
25. You place the storage object back in the storage case.

APPENDIX: B

USER TEST 1 - INFORMED CONSENT FORM

Introduction:
We are Thomas Levendig, Marloes Lankheet, Thijs Rijenders, and Vera van Beek and are currently doing a project which explores the opportunities to physicalize data management and transfer. The goal of this user test is to evaluate the usability and enjoyability of a selection iteration of our product that aims to physicalize both file management and transfer.

Before participating in this test we ask you to carefully read this information sheet and give us your explicit informed consent to use and store your data, according to the ethical standards for scientific research.

Objective of the research project:
This research project will be led by Thomas Levendig, Marloes Lankheet, Thijs Rijenders, and Vera van Beek and will be supervised by Bart Hengeveld, Berry Eggen and Bastiaan van Hout. The objective of this user test is to evaluate the enjoyability and usability of the perceived user experience of a selection of iterations for a physical file management system.

The legal grounds on which we process your data is consent and we ask you to give us your explicit consent to process your personal data at the bottom of this document.

Procedure:
Participants will be asked to interact with our product and evaluate both the actions the product requires, as well as the response, resulting from the product. They will be asked to follow the guidelines of a narrator, who leads them through the interaction. While interacting with the product, the subjects are asked questions related to their perception of the interaction with the product mainly focusing on the usability and enjoyability of the interaction with the product. The test will approximately take 20 minutes.

Confidentiality:
Confidentiality will be maintained throughout the entire study and data analyses. All data obtained in this user test will be anomized. Data will only be presented in the aggregate and individual user comments will be anonymized prior to presentation. Only the researchers and supervisor will

Data storage:
All data will be safely stored on SURFdrive, a password - protected server, and will be deleted after 6 months after finishing the course.

Potential risks and inconveniences:
Your participation in this test does not involve any physical, mental, legal or economic risks. You do not need to do something or answer any questions you do not wish to. Your participation is completely voluntary. This means you may cancel your participation or skip a certain question at any moment you choose.

Questions or concerns:
If you have any questions or concerns related to this study, please contact Vera van Beek v.c.v.beek@student.tue.nl.

****Scroll down for the consent form****

Consent form for participation by an adult

Through this consent form I agree with the following:

1. I am sufficiently informed about the research through a separate information sheet. I have read the information sheet and have had the opportunity to ask questions. These questions have been answered satisfactorily.
2. I take part in this research project voluntarily. It is clear to me that I can cancel my participation at any moment. I do not have to answer a question against my wish.
3. I give consent to the researchers to store the data collected from me and give them permission to use this information for further scientific reasons while complying with the ethical standards for scientific research
4. I give permission to the researchers to quote my personal data in publications, while anonymity is maintained

Do you agree with the terms above?

YES NO

Name of participant
[Signature:]
[Date:]

Name of researcher: Vera van Beek
Signature:

Date: 30 November 2022

APPENDIX: C

USER TEST 2 - TEST PLAN

Goal

How do subjects experience the usability, effectiveness, and enjoyability of the interaction with different iterations of a physical alternative for file management or transfer?

Subgoals

- Evaluate the quality, coherence, and enjoyability of the action performed by the user on the slider and tool and the resulting reaction in the UX Design.
- Evaluate the naturalness and comfortability of the position of the hand using 3 iterations of ergonomic sliders
- Evaluate the effectiveness and enjoyability of the haptic feedback created by 3 alternative mechanisms integrated into the sliders

Method

Recruitment

A selection of 8 students from the faculty of industrial design at TU Eindhoven is recruited using convenience sampling. All participants are between the ages of 18 and 25 and are all specialised in the field of design.

Process Overview

In general

In the user test, data will be gathered using both observations as a semi-structured interview. The user test can be divided into 3 parts:

- The evaluation of the quality, coherence, and enjoyability of the action performed by the user on the slider and tool and the resulting reaction in the UX Design.
- The evaluation of the naturalness and comfortability of the hand position using 3 iterations of ergonomic sliders
- The evaluation of the effectiveness and enjoyability of the haptic feedback created by 3 alternative mechanisms integrated into the sliders

For every part, participants are provided with 1-3 different concepts and guided through the interaction with the product. Subsequently, the participants are asked to evaluate all concepts individually and provide us with their preferences in a semi-structured interview.

UX design

Primarily, the subjects will be asked to follow the guidelines of a narrator, who will guide them through the interaction, enabling the participants to develop a good understanding of the required interaction with the product. Subsequently, the participants will complete the interaction for the second time and evaluate the quality, coherence, and enjoyability of the required actions and the resulting reactions in the UX Design in a semi-structured interview. Potential questions, asked for every required action, are:

- Does the action you just performed align with your desired result? So does it make sense to rotate the mouse to browse through your files?
- Do you think this reaction aligns with the action you just performed, or do you think another animation of the UX Design would be a more suitable reaction?

Ergonomic sliders

Afterward, the participants are presented with 3 different ergonomic sliders and are asked, in a semi-structured interview, to evaluate the sliders, based on the extent to which they result in a natural and comfortable position of your hand.
The following questions are asked in a semi-structured interview.

- While using this slider do you experience your hand being positioned in a natural position?
- While interacting with the slider do so experience anything that's uncomfortable?
- Do you think you could last in this position for a longer period?
- Would you like to use this slider with your left or right hand?

Mechanisms in sliders

Lastly, using the same sliders, the participants are asked to evaluate the haptic feedback given by the different mechanisms in the slider based on the coherence and enjoyability of the action and the resulting haptic feedback.
The following questions are asked in a semi-structured interview.

- Does the haptic feedback provided by the tool/slider in your opinion align with the actions you perform?
- Is there any haptic, visual or audible feedback you would want to add to the slider?

APPENDIX: D

USER TEST 2 - INFORMED CONSENT FORM

Introduction:
We are Thomas Levendig, Marloes Lankheet, Thijs Rijenders, and Vera van Beek and are currently doing a project which explores the opportunities to physicalize data management and transfer. The goal of this user test is to evaluate the usability, effectiveness, and enjoyability of the interaction with different iterations of a physical alternative for file management or transfer?

Before participating in this test we ask you to carefully read this information sheet and give us your explicit informed consent to use and store your data, according to the ethical standards for scientific research.

Objective of the research project:
This research project will be led by Thomas Levendig, Marloes Lankheet, Thijs Rijenders, and Vera van Beek and will be supervised by Bart Hengeveld, Berry Eggen and Bastiaan van Hout. The objective of this user test is to evaluate the enjoyability and usability of the perceived user experience of a selection of alternatives for a physical file management system.

The legal grounds on which we process your data is consent and we ask you to give us your explicit consent to process your personal data at the bottom of this document.

Procedure:

In general

In the user test, data will be gathered using both observations as a semi-structured interview. The user test can be divided into 3 parts:

- The evaluation of the quality, coherence, and enjoyability of the action performed by the user on the slider and tool and the resulting reaction in the UX Design.
- The evaluation of the naturalness and comfortability of the hand position using 3 iterations of ergonomic sliders
- The evaluation of the effectiveness and enjoyability of the haptic feedback created by 3 alternative mechanisms integrated into the sliders

For every part, participants are provided with 1-3 different concepts and guided through the interaction with the product. Subsequently, the participants are asked to evaluate all concepts individually and provide us with their preferences in a semi-structured interview.

UX design

Primarily, the subjects will be asked to follow the guidelines of a narrator, who will guide them through the interaction, enabling the participants to develop a good understanding of the required interaction with the product. Subsequently, the participants will complete the interaction for the second time and evaluate the quality, coherence, and enjoyability of the required actions and the resulting reactions in the UX Design in a semi-structured interview.

Ergonomic sliders

Afterward, the participants are presented with 3 different ergonomic sliders and are asked, in a semi-structured interview, to evaluate the sliders, based on the extent to which they result in a natural and comfortable position of your hand.

Mechanisms in sliders

Lastly, using the same sliders, the participants are asked to evaluate the haptic feedback given by the different mechanisms in the slider based on the coherence and enjoyability of the action and the resulting haptic feedback. To do so again there will be made us of a semi-structured interview.
The test will approximately take 25 minutes.

Confidentiality:
Confidentiality will be maintained throughout the entire study and data analyses. All data obtained in this user test will be anomized. Data will only be presented in the aggregate and individual user comments will be anonymized prior to presentation. Only the researchers and supervisor will have access to the data.

Data storage:
All data will be safely stored on SURFdrive, a password - protected server, and will be deleted after 6 months after finishing the course.

Potential risks and inconveniences
Your participation in this test does not involve any physical, mental, legal or economic risks. You do not need to do something or answer any questions you do not wish to. Your participation is completely voluntary. This means you may cancel your participation or skip a certain question at any moment you choose.

Questions or concerns:
If you have any questions or concerns related to this study, please contact Vera van Beek v.c.v.beek@student.tue.nl.

****Scroll down for the consent form****

Consent form for participation by an adult

Through this consent form I agree with the following:

1. I am sufficiently informed about the research through a separate information sheet. I have read the information sheet and have had the opportunity to ask questions. These questions have been answered satisfactorily.
2. I take part in this research project voluntarily. It is clear to me that I can cancel my participation at any moment. I do not have to answer a question against my wish.
3. I give consent to the researchers to store the data collected from me and give them permission to use this information for further scientific reasons while complying with the ethical standards for scientific research
4. I give permission to the researchers to quote my personal data in publications, while anonymity is maintained

Do you agree with the terms above?

YES NO

Name of participant
[Signature:]
[Date:]

Name of researcher: Vera van Beek
Signature:

Date: 30 November 2022

APPENDIX: E

CODE MEMOSIO

```
// CODE PRODUCT MEMOSIO
// MEMOSIO is a digital-physical project manager, existing our of discs, a controller, a storage case and a computer program, that aims to enrich the working experience as well as improve productivity
// The purpose of this code is to read the data provided by the rotary encoder, RFID scanner and micro switches integrated into the controller and write a specific number, which will be read by a Adobe XD file and will trigger a certain action in the UX design.
// DFP003 - Project 2
// By Vera van Beek
// 16/12/2022

//Upload libraries
#include <Keyboard.h>
#include <SoftwareSerial.h>

// Variables for the RFID scanner
SoftwareSerial SoftSerial(0, 1);
unsigned char buffer[64];      // buffer array for data receive over serial port
int count = 0;                 // counter for buffer array

//Pins for the rotary encoder
#define CLK 17
#define DT 14
#define SW 20

 //Switch 1 - Home basis
int Lswitch1 = 23;
int buttonStatePrevious_SW1;

//Switch 2 - Applicatie basis
int Lswitch2 = 2;

int buttonStatePrevious_SW2;

//Switch 3 - Send basis
int Lswitch3 = 22;
int buttonStatePrevious_SW3;

//Switch 4 - Open file
int Lswitch4 = 15;
int buttonStatePrevious_SW4;

//Switch 5 - Close file
int Lswitch5 = 16;
int buttonStatePrevious_SW5;

//Variables for clicking of the rotary encoder
//Variables for long and short button press on the rotary encoder
int buttonState = 0;// variable for reading the pushbutton status
int buttonStatePrevious;
unsigned long buttonPressedTime; //Time since the rotary encoder has been pressed
unsigned long buttonPressDuration; //Time the rotary encoder is pressed
unsigned long minButtonLongPressDuration = 3000; //Minimum amount of time the rotary encoder should be pressed to open tab window
unsigned long currentMillis;
unsigned long previousButtonMillis; //Time since the button has been pressed
bool longPress; //Variable that checks if the rotary encoder is pressed for more than 3 seconds or not
boolean cardPresent = false; //Variable that checks if the RFID scanner is already registered or not

//variables for the rotating of the rotaty encoder
int counter = 0;
int SWState;

int SWLastState;
String currentDir ="";


void setup() {
// Set encoder pins as inputs
  pinMode (SW,INPUT_PULLUP);
   pinMode (DT,INPUT_PULLUP);
   pinMode(CLK, INPUT_PULLUP);
```

```
//Set micro switch pins as input
  pinMode(Lswitch1, INPUT);
  pinMode(Lswitch2, INPUT);
  pinMode(Lswitch3, INPUT);
  pinMode(Lswitch4, INPUT);
  pinMode(Lswitch5, INPUT);

SWLastState = digitalRead(SW); // Reads the initial state of the output of the rotary encoder

SoftSerial.begin(9600); // the SoftSerial baud rate

Serial.begin(9600); // Setup serial monitor
}

void loop() {

//Code for rotary encoder - Functionality button long & short pressed
//Read the current time
 currentMillis = millis();

//Read the state of the CLK input of the Rotary Encoder:
 buttonState = digitalRead(CLK);

//Check if CLK is pressed
//If no measurement is running to determine how long the burron is pressed AND
//The button hasn't already been pressed
   if (buttonState == LOW && buttonStatePrevious == HIGH && !longPress) {
     buttonPressedTime = currentMillis;
     buttonStatePrevious = LOW;
     Serial.println("Button pressed");
   }


// Calculate how long the button has been pressed
   buttonPressDuration = currentMillis - buttonPressedTime;

// If the button is pressed AND
// If there is no measurement running to determine how long the button is pressed AND
// If the time the button has been pressed is larger or equal to the time needed for a long press - The button has been pressed long
// Press q to select,
//Tab window opens
      if (buttonState == LOW && !longPress && buttonPressDuration >= minButtonLongPressDuration) {
    longPress = true;
    Serial.println("Button long pressed");
    Keyboard.write('q');
   }

// If the button is released AND
// If the button was pressed before
   if (buttonState == HIGH && buttonStatePrevious == LOW) {
     buttonStatePrevious = HIGH;
     longPress = false;
     Serial.println("Button released");

//If the time the button has been pressed is smaller than the time needed for a long press - The button has been pressed shortly
// Press T to select
// A file or folder is selected
     if (buttonPressDuration < minButtonLongPressDuration) {
       Serial.println("Button pressed shortly");
       Keyboard.write('t');
     }
   }

// store the current timestamp in previousButtonMillis
   previousButtonMillis = currentMillis;


//Code for rotary encoder - Functionality rotating
//read the value if SW and determine if it has been pressed and which direction
SWState = digitalRead(SW);
```

```
// If the previous and the current state of the output SW are different, that means a Pulse has occured
  if (SWState != SWLastState){
// If the output DT state is different to the output SW state, that means the encoder is rotating clockwise. Otherwise the encoder is rotating counter clockwise
    if (digitalRead(DT) != SWState) {
      counter ++;
      currentDir =”CCW - Left”;
      Keyboard.write(‘d’);
    } else {
      counter --;
      currentDir =”CW - Right”;
      Keyboard.write(‘a’);
    }
    Serial.print(“Position: “);
    Serial.print(counter);
    Serial.print(“| Direction: “);
   Serial.println(currentDir);
  }
 delay(10);
   SWLastState = SWState; // Updates the previous state of the output SW with the current state


//Code for micro switches in slider
//Button home basis - When Switch 1 Pressed, Send V to download file
   if(digitalRead(Lswitch1) == HIGH && buttonStatePrevious_SW1 == LOW){
   buttonStatePrevious_SW1 = HIGH;
    Serial.println(“Switch1 Pressed”);
    Keyboard.write(‘i’);
   }

 if(digitalRead(Lswitch1) == LOW && buttonStatePrevious_SW1 == HIGH  ){
  buttonStatePrevious_SW1 = LOW;
    Serial.println(“SWitch1 Released”);
}


//Button Application basis - When Switch 2 Pressed, Send i to initiate sending
   if(digitalRead(Lswitch2) == HIGH && buttonStatePrevious_SW2 == LOW){
   buttonStatePrevious_SW2 = HIGH;
    Serial.println(“Switch2 Pressed”);
    Keyboard.write(‘v’);
   }

  if(digitalRead(Lswitch2) == LOW && buttonStatePrevious_SW2 == HIGH  ){
  buttonStatePrevious_SW2 = LOW;
    Serial.println(“SWitch2 Released”);
}


//Button Send basis - When Switch 3 Pressed, Send z to send
   if(digitalRead(Lswitch3) == HIGH && buttonStatePrevious_SW3 == LOW){
   buttonStatePrevious_SW3 = HIGH;
    Serial.println(“Switch3 Pressed”);
    Keyboard.write(‘z’);
   }

  if(digitalRead(Lswitch3) == LOW && buttonStatePrevious_SW3 == HIGH  ){
  buttonStatePrevious_SW3 = LOW;
    Serial.println(“SWitch3 Released”);
}


//Open and Close button
//Open folder/document, send w to open a file or folder
   if(digitalRead(Lswitch4) == HIGH && buttonStatePrevious_SW4 == LOW){
   buttonStatePrevious_SW4 = HIGH;
    Serial.println(“Switch4 Pressed”);
    Keyboard.write(‘w’);
   }

  if(digitalRead(Lswitch4) == LOW && buttonStatePrevious_SW4 == HIGH  ){
  buttonStatePrevious_SW4 = LOW;
    Serial.println(“SWitch4 Released”);
}


//Close folder/document, send s to close a file or folder
   if(digitalRead(Lswitch5) == HIGH && buttonStatePrevious_SW5 == LOW){
   buttonStatePrevious_SW5 = HIGH;
    Serial.println(“Switch5 Pressed”);
    Keyboard.write(‘s’);
   }
```

```
  if(digitalRead(Lswitch5) == LOW && buttonStatePrevious_SW5 == HIGH  ){
  buttonStatePrevious_SW5 = LOW;
    Serial.println("SWitch5 Released");
}

//Code for the RFID Scanner
// if date is coming from software serial port ==> data is coming from SoftSerial
shield
    if (SoftSerial.available())
    {
        while(SoftSerial.available())              // reading data into char array
        {
            buffer[count++] = SoftSerial.read();      // writing data into array
            if(count == 64)break;

        }
//        Keyboard.write("c"); // write c to open project window
         Serial.write(buffer, count);     // if no data transmission ends, write buffer
to hardware serial port
       clearBufferArray();          // call clearBufferArray function to clear the stored
data from the array
        count = 0;                    // set counter of while loop to zero
    }
    if (Serial.available()) // if data is available on hardware serial port ==> data is
coming from PC or notebook
    SoftSerialt.write(Serial.read());    // write it to the SoftSerial shield
}


void clearBufferArray()                // function to clear buffer array
{
    // clear all index of array with command NULL
    for (int i=0; i<count; i++)
    {
        buffer[i]=NULL;
    }
}
```


//References
//Keyboard and Mouse Control. (n.d.). Arduino Documentation. https://docs.arduino.cc/built-in-examples/usb/KeyboardAndMouseControl
//Engineers, L. M. (2022, July 21). How Rotary Encoder Works and Interface It with Arduino. Last Minute Engineers. https://lastminuteengineers.com/rotary-encoder-arduino-tutorial/
//van Dijk, B. (2019). E15-switch-long-press. Github. Retrieved December 9, 2022, from https://github.com/BasOnTech/Arduino-Beginners-EN/blob/master/E15-switch-long-press/E15-switch-long-press.ino
//Rotary Encoder with Arduino – Examples Included. (n.d.). Diyengineers. Retrieved December 9, 2022, from https://www.diyengineers.com/2021/06/03/arduino-rotary-encoder-how-to-use/
//Zuo, B. (n.d.). Grove - 125KHz RFID Reader - Seeed Wiki. https://wiki.seeedstudio.com/Grove-125KHz_RFID_Reader/

APPENDIX: F

UI DESIGN IN ADOBE XD

The Adobe XD User Interface was part of our prototype. This user interface is entirely based on the palette included with MEMOSIO. The blue color represents trust, responsibility, and loyalty in this color palette, which was chosen based on the meaning that colors can have. These terms are appropriate for our concept.

Because the user interface is simple in design, there is little cognitive overload. This is accomplished by displaying only the most important information. Furthermore, this has been accomplished by not making the icons overly detailed. As a result, there are few distractions when using our user interface.

The animations used in the user interface completely correspond to the action performed on the controller, providing you with instant visual feedback that shows what you are doing. This makes using our product much easier because everything fits together nicely. By connecting all elements of the user interface to the concept of the idea, we create a coherent product.