OMNIS

GAMING FOR ALL

PRODUCT REPORT

Aalborg University
Spring 2022

Industrial Design
MSc04 ID7

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ABSTRACT

This project represents the development process of a gaming tool meant for people with cerebral palsy that are private from various activities due to their incapacity of using one side of their body. The purpose of this product is to enforce people with incapacity in one hand, with a tool that can give them the possibility to experience social gaming at the same level with healthy people.

E-sport is a growing trend among teenagers, that creates communities of gamers all around the world and promotes a social activity that bonds people, from their earlier stages in life. The result of this project is a 2-in-1 gaming mouse made for all which presents a solution to social inclusion.

TITLE	OMNIS
THEME	GAMING AND DISSABILITES
PROJECT PERIOD	01-02/2022 - 25-05/2022
MAIN SUPERVISOR	MARIO BARROS
CO-SUPERVISOR	JØRGEN KEPLER
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INTRO

Gaming is becomming a huge pivot around socializing in the youth of Denmark, if you do not play the right games or play at all, young people can feel like they're kept out of the social circles. Some people don't get the choice of participating in the gaming community, as they have dissabilities that prevent them to do so. The dissabilities aimed to help in this project, are all the dissabilities that only allows the person to use one hand while playing. These could be dissabilites such as cerebral palsy which has been a focus in the project, birth defect, lost limbs and much more.

The main game the product has been designed for is the game Counter-Strike: Global Offensive. It's a game which has massively increased ever since its release back in 2012, which amounts to over 900 000 daily unique players. It is a game series that has changed very little ever since the release of the first game all the way back in year 2000. By designing for a game that doesn't recieve any major changes, the product ensures to not beccome obsolete for a long time. Counter-Strike: Global Offensive is a simple first person shooter game, where the main objective is to either plant the bomb or prevent the bomb for exploding.

INTRODUCING OMNIS

Omnis aims to bring together two devices in one, adding the possibility of playing Counter Strike and other FPS games by using only one hand, by cerebral palsy users from level 1 to 3 and other audience with incapacity of using one hand. The product name “Omnis” means in latin “all” and implies the products’ value for giving the possibility of gaming for all.
The striking color of the logo represent the gaming trend that use a bright colour palette and is seen at popular gaming companies in their devices (mice, keyboards, headsets, laptops etc.), while the logo shape from the flash implies the performance that can be achieved using this device, respectively by everyone.

The E-sports (electronic sports) subject is a popular activity nowadays, growing in Denmark and around the world. Billions of users are gaming every day, and one in every three boarding schools has now E-sport as a subject.

People with disabilities aspire for the same possibilities as ordinary people. However, as much as they want to outcome their condition that they were born with, there is a limitation to remain in an ordinary field and blend among the healthy people crowd or idea. Therefore, they want to reach an ordinary look or status in all the life aspects, but not exceeding it with tools that look "special", "different" or that make them and their disability be even more seen.

AMBIDEXTROUS DESIGN

The product is designed with an ambidextrous design, meaning it can be used equally by both hands. This had become a design choice to include as many people as possible with the fewest possible resources.

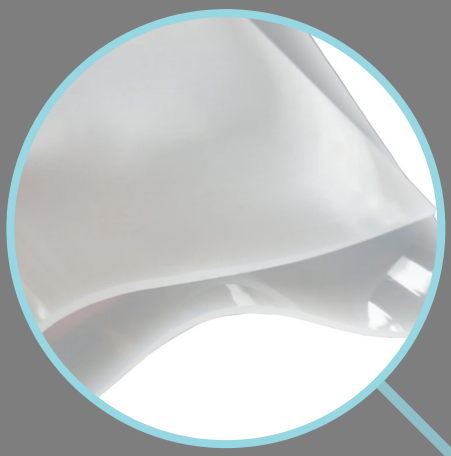
It makes sense, to make one product for both hands as the device is made for people with dissabilities, so there will be as many people who needs a left handed, as right handed device.

The expenses of making an ambidextrous design are greatly reduced, compared with making a device for each hand or only for the right hand. This way the only extra expense is from extra injection molding cavities and one extra PCB.

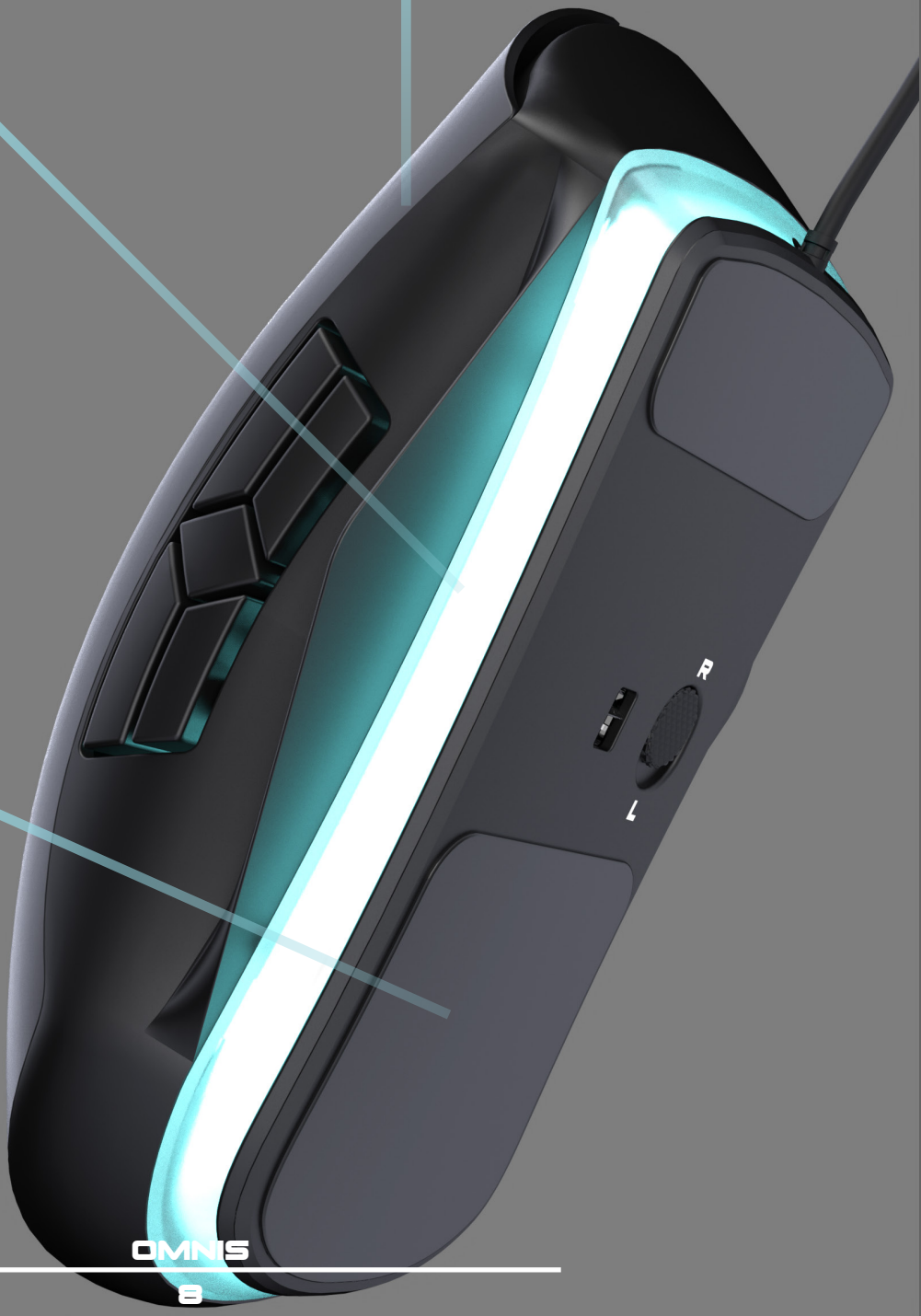
MATERIALS

ABS PLASTIC

TRANSLUCENT SILICONE RUBBER



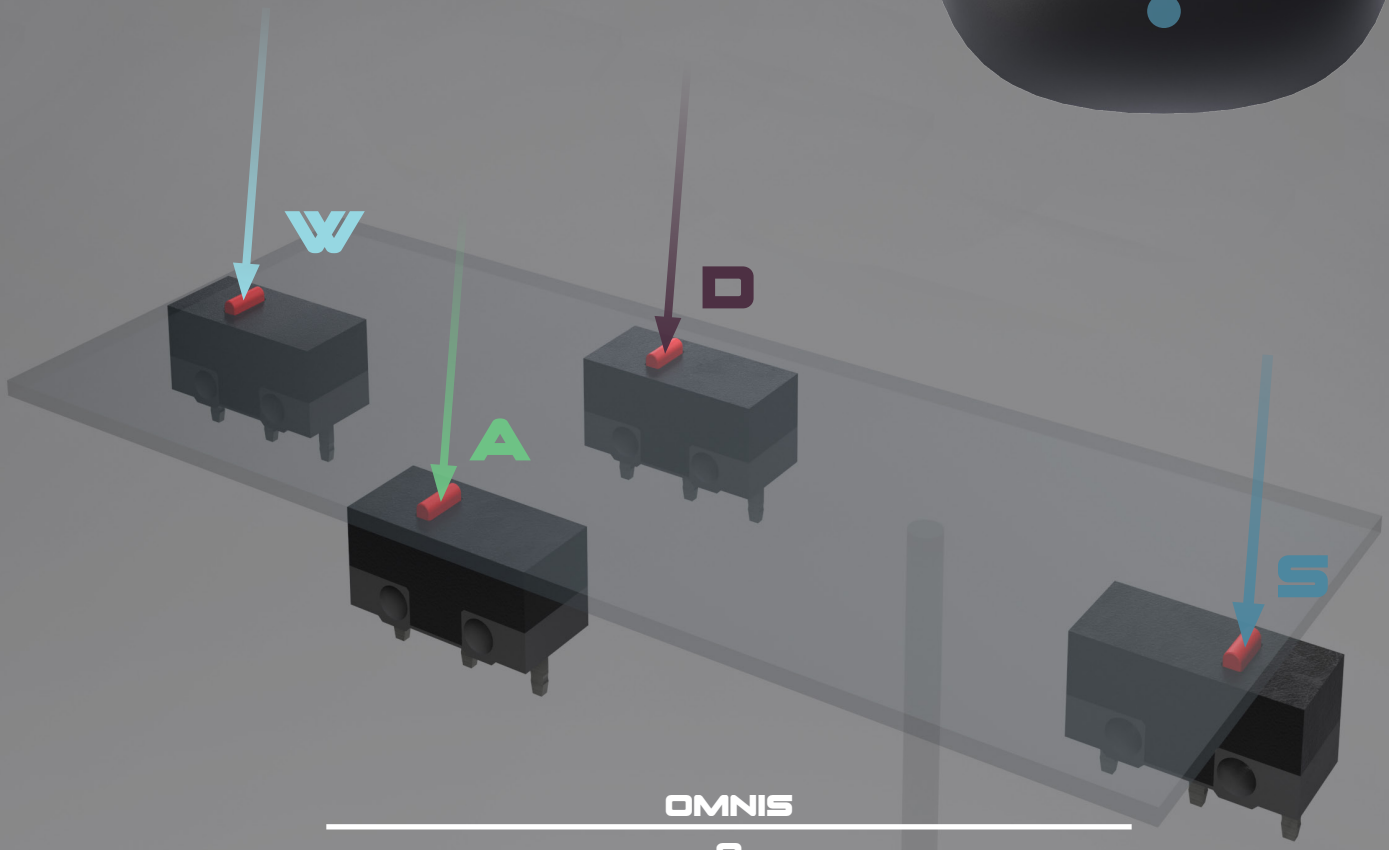
PTFE PLASTIC



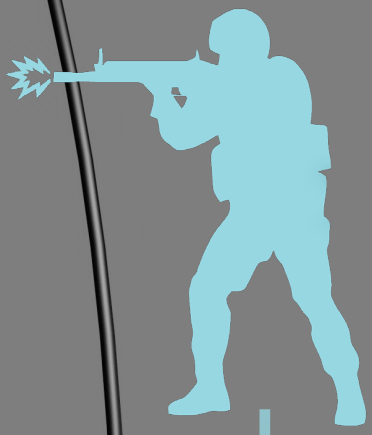
HOW IT WORKS

THE MAIN MECHANIC

The product is build with a pressureplate mechanism. It is with this mechanism, you move inside the game. It is designed to allow switching between the WASD keys as effortless as possible,
while it allows using the other movement depended features, such as crouch, slow walk, shoot etc. at the same time. It works by pressing with the palm, thumb and or pinky finger, where the colored dots shows, to get the desired output.



3 TOP BUTTONS

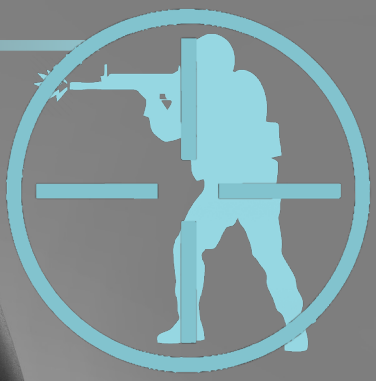


SHOOTING

It is one of the most important features, as it's one of the main objectives in the game to shoot eachother. The product is designed so this feature is easily accesible at all times.

JUMPING

Jumping is used to get on higher surfaces that can't be accessed by walking, it is important it is easy to use in collaboration with the movement mechanic.



SCOPING

Scoping is a feature that is only available on some weapons, however, it is an important feature to reach a high level in the game. The feature is designed to be available together with the shooting button.

5 THUMB BUTTONS

SLOW WALKING

Slow walking is the feature that provides movement in the game without being heard. The feature is depended on movement, therefore the product is designed to be reachable with the thumb while using the moving mechanism.

CROUCHING

Crouching is the feature that is used to improve the aiming accuracy and to get into small places. This feature is also dependend on movement, so therefore the button is also placed accesibly while moving in game.

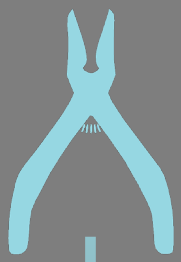
WEAPON SWAP

The feature used to swap around the weapons in the players possession.

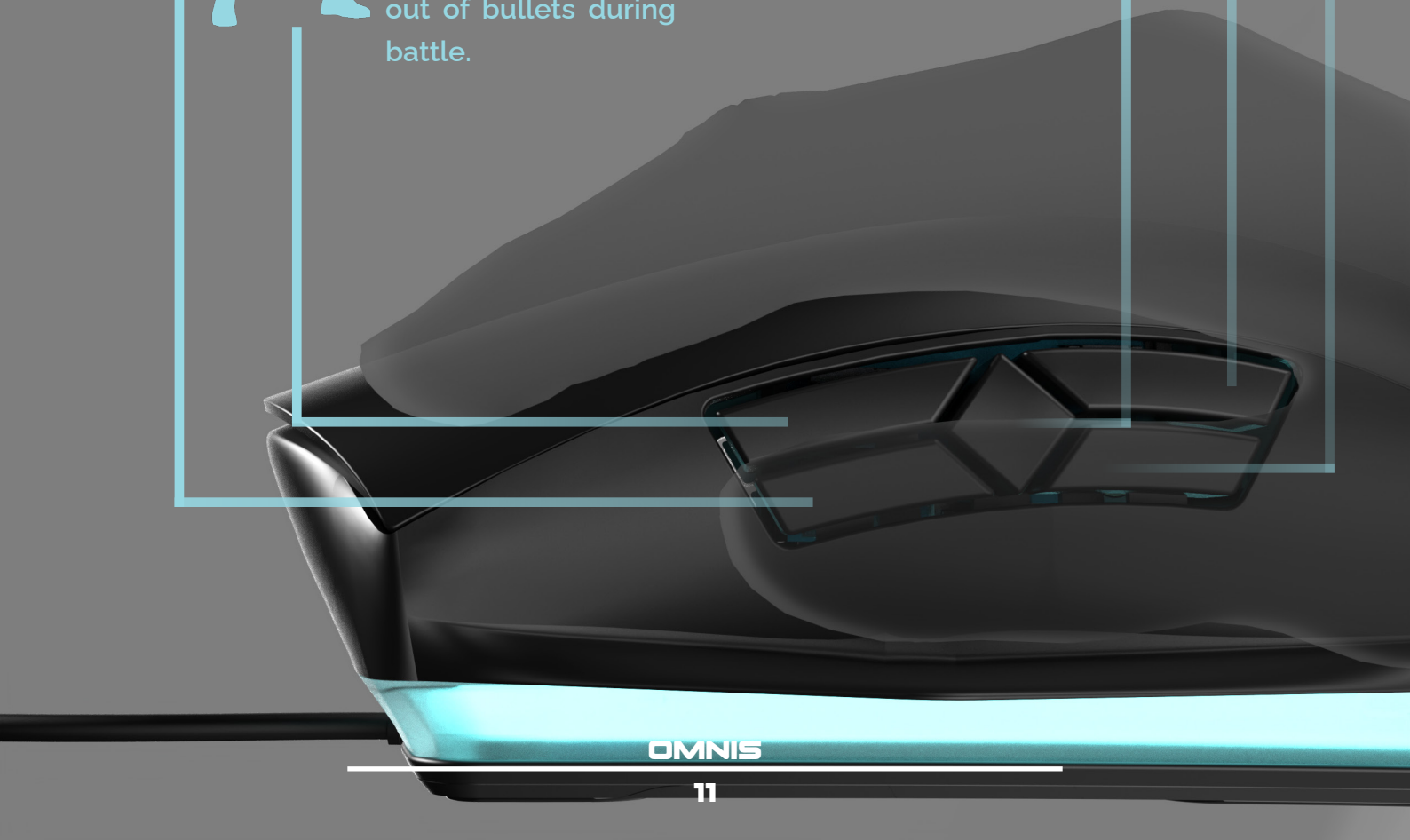
RELOADING

The feature used to make sure to not run out of bullets during battle.

DEFUSING



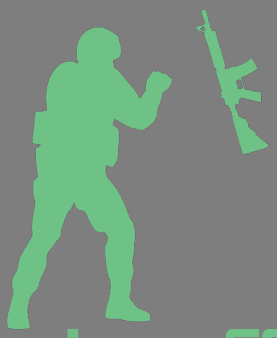
The feature to defuse the bomb and win the round.



BUYING

Opens a menu, where weapons can be purchased. This feature is only used in the very start of the round.

The “defuse” feature is the only feature that is never used simultaneously with any other features, which is why this button can be used as a gateway to the less used funtions, as it will not have an effect on the game.

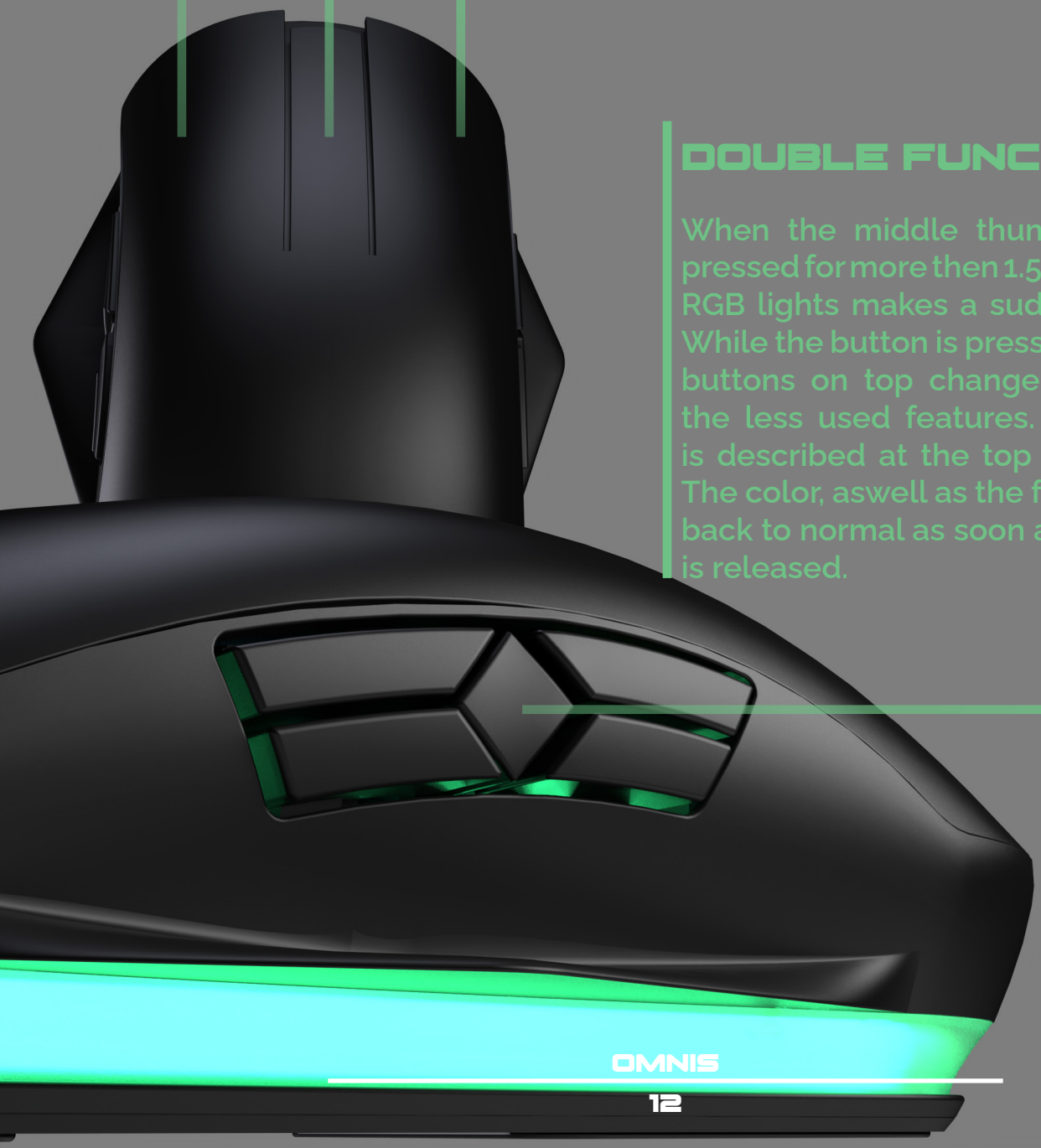


DROPPING WEAPONS

This feature is mostly used to give weapons to teammates that can not afford to buy themselves.

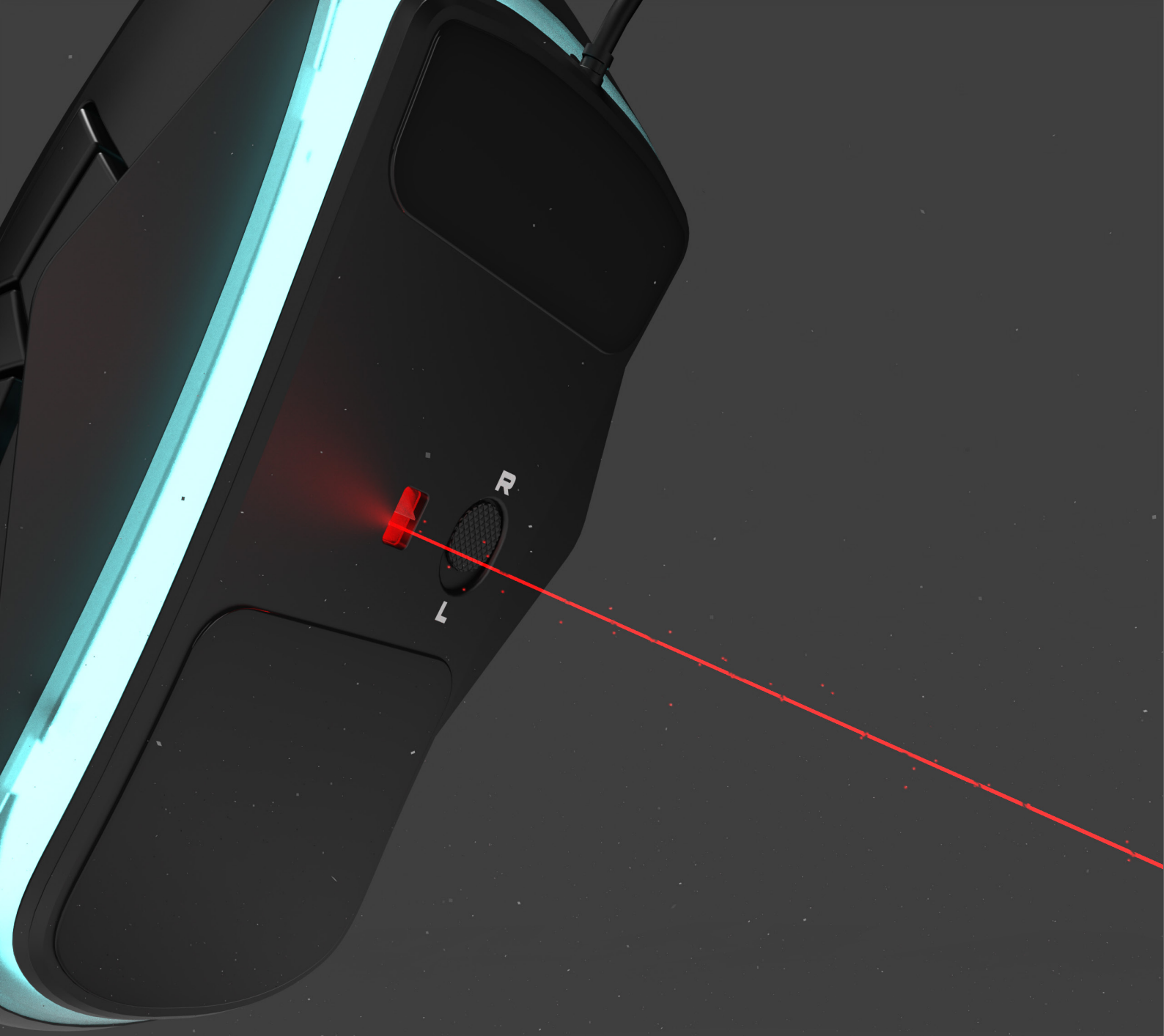
SCOREBOARD

This feature shows a table telling the amount of kills, assists and deaths of each player.



DOUBLE FUNCTION

When the middle thumb button is pressed for more then 1.5 seconds, the RGB lights makes a sudden change. While the button is pressed, the three buttons on top change function, to the less used features. The change is described at the top of the page. The color, aswell as the fuctions goes back to normal as soon as the button is released.

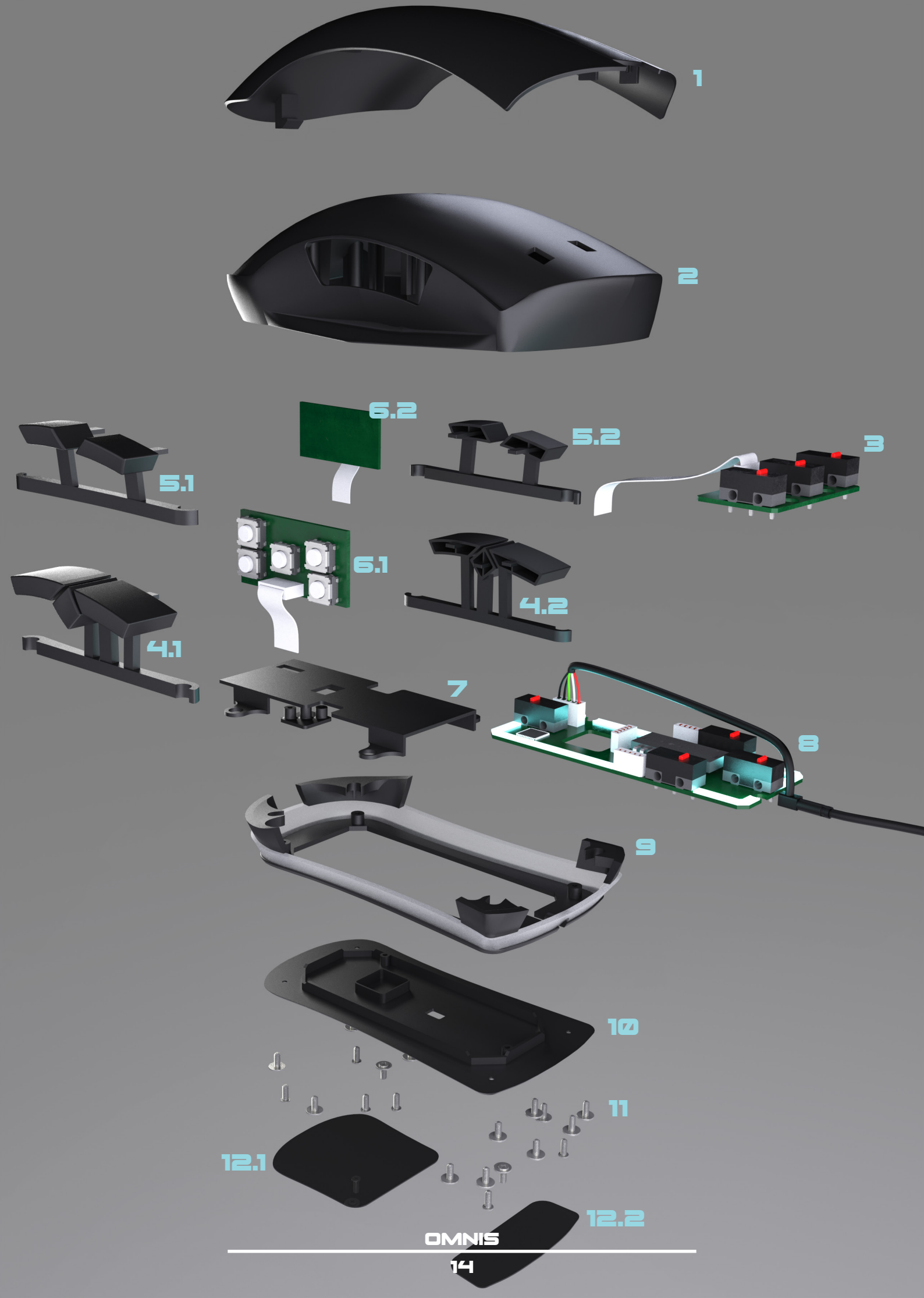


OPTICAL MOUSE SENSOR

The optical mouse sensor controls the players orientation in the game. It has been chosen because it delivers a high speed, high accuracy and high resolution gaming experience, so the user can count on a reliable performance.

RIGHT/LEFT HAND SWITCH

The switch underneath turns the device from a righthanded device, into a lefthanded device. The buttons on the left side of the device gets disabled, while the buttons on the righthand side activate. At the same time the functions are mirrored, that way an equal performance can be delivered for both hands.


1
2
6.2
5.2
3
5.1
6.1
4.2
4.1
7
8
9
10
11
12.1
12.2

BILL OF MATERIALS & UNIT COST

7x Huano swicthes: 2.45DKK Total

10x panasonic switches: 3.50 DKK Total

Injection moldings: 123.79 DKK

PCB 4x: 11.49 DKK

Screws 23x: 1 DKK

Micro controller: 0.70 DKK

Optical mouse sensor: 1 DKK

PTFE Mouse Skates: 1.11 DKK

LED 0.23 DKK

TOTAL UNIT PRICE (APP 46)

159.68 DKK

ASSEMBLY INSTRUCTIONS

STEPS

1. (1) and (2) are being clicked on top of each other and assembled with a single screw (11).

2. (3) are being assembled inside (2) with four screws (11).

3. (4.1) are being assembled into (2), (5.1) added afterwards, so they share the same screw tower. Same goes for (4.2) and (5.2).

4. (6.1) and (6.2) will be slided into place, so they align with (4) and (5) and locked with a screw each (11).

5. (7) will be added on top of the same screw tower as (4) and (5) and locks all the mentioned into place with 4 screws (11).

6. (8) will be assembled onto (10) with 2 screws (11).

7. (9) will be assembled onto (2) with 4 screws (11).

8. The connection straps from (3), (6.1) and (6.2) will be connected to (8). Then (9) are asssemled with (10) with 4 screws (11). Leaving only (12) disconnected from the rest.

9. Two screws (11) are added to two holes underneath (10), connecting (10) and (7) together.

10. A protective layer is removed from (12.1) and (12.2), revealing a sticky side, (12) is put underneath (10) to hide the last visible screws (11).

BUSINESS CASE

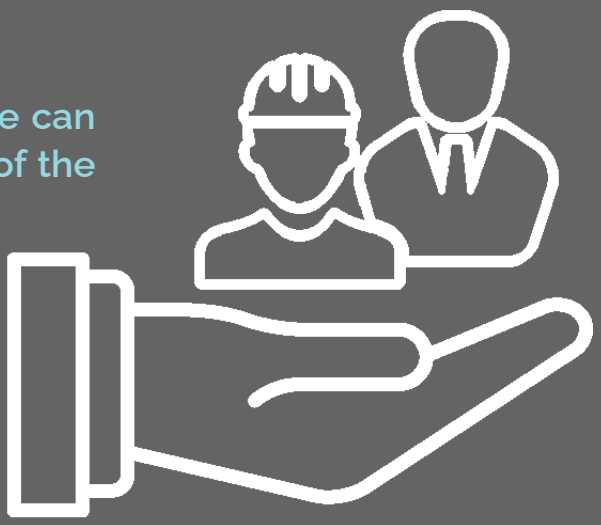
POTENTIAL BUSINESS STRATEGIES

START UP

One of the business strategies for the project could be a startup business, it's a strategy with big risk, but also a lot to gain.

PROS

By creating a company from the product, one can remain in full control over the development of the product, market decisions and so on.



All the profit gained in the project goes to the team, if there're no partnered businesses or investers to share the profit with.

CONS

If the product doesn't sell, the initial investment overcome the revenue and the break even point never comes.

All the investments are on the participants of the team, unless investors are brought in.

A lot of missing knowledge of how to run a business, quality control, software development etc. all have to be outsourced.

SELLING THE CONCEPT

Another business strategy could be to sell the concept, to a company that has the resources to finalize the product. There have been found three possible ways with this strategy, first one being selling the concept for one large one time payment, which obviously stops the cashflow immediately, as the concept would be owned by the other business.

Second way, would be to sell the concept with royalties, the team would recieve money depending on how much the product sells, this way gaining income, for an unknown period of time.

The third would be the favourable direction, it would be selling the concept with royalties and being assigned in the company as a consultant on the project during the development period. This way a stable income will be gained during the development and gain royalties after the partnership is over.

PROS

All risk is on the partnered company.

Resources and conncetions are already established within the companies, can therefore finalize the product faster and cheaper.

Known brands, that have much bigger opportunity to reach a much larger audience, that goes world wide.

CONS

Most profit goes to the partnered company.

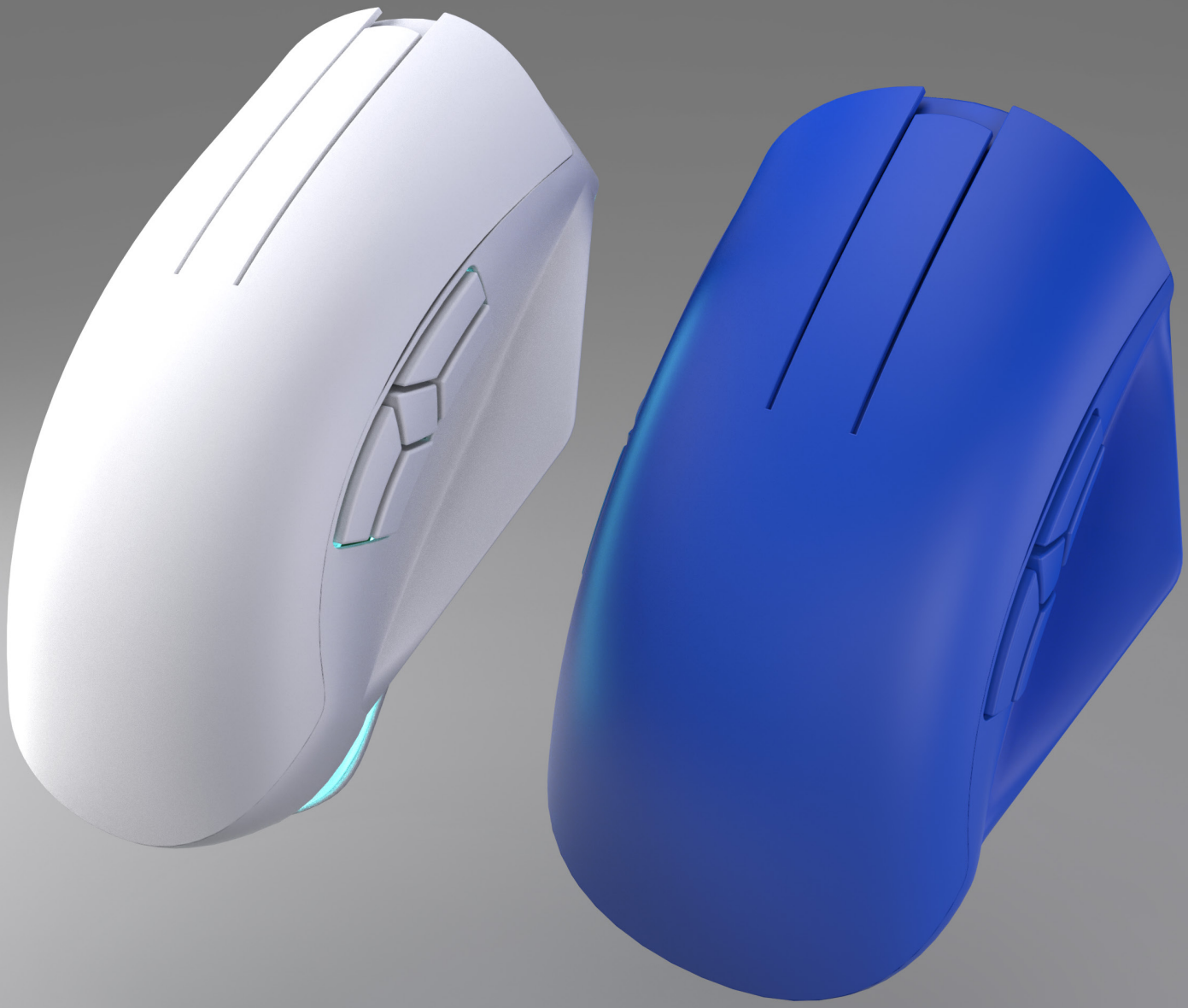
Losing most to all creative decisions for the project.

COMPANIES

Potential partners with resources to realise the concept could be as following:

MARKET EXPANSION

There are serval ways to expand the reach for the product on the market. First of all the cheapest way of doing this would be through a varied collection of accesible colours. This helps reaching people who are not interested in just having a regular black product. This is a cheap way of making variations of the product as the only expense is changing the material and a change of the packaging cover.



Another way of expanding the reach on the marked, could be to make a wireless version, this is however more expensive, as it requires extra parts, such as battery, extra software development and changes to some of the plastic parts. But it could be beneficial, as the target users isn't necersarily in a perfect health condition, so the opportunity of removing restrains from wires, might be compelling for the users.

CASHFLOW

FULL INVESTMENT:

159675 DKK

INCLUDES:
Electrical components, Injection molds, manufacturing, PCB & PCB assembly, product assembly & shipping.

RETAIL PRICE VAT INCLUDED: 1500 DKK

VAT EXCLUDED 1125 DKK

BREAK EVEN:

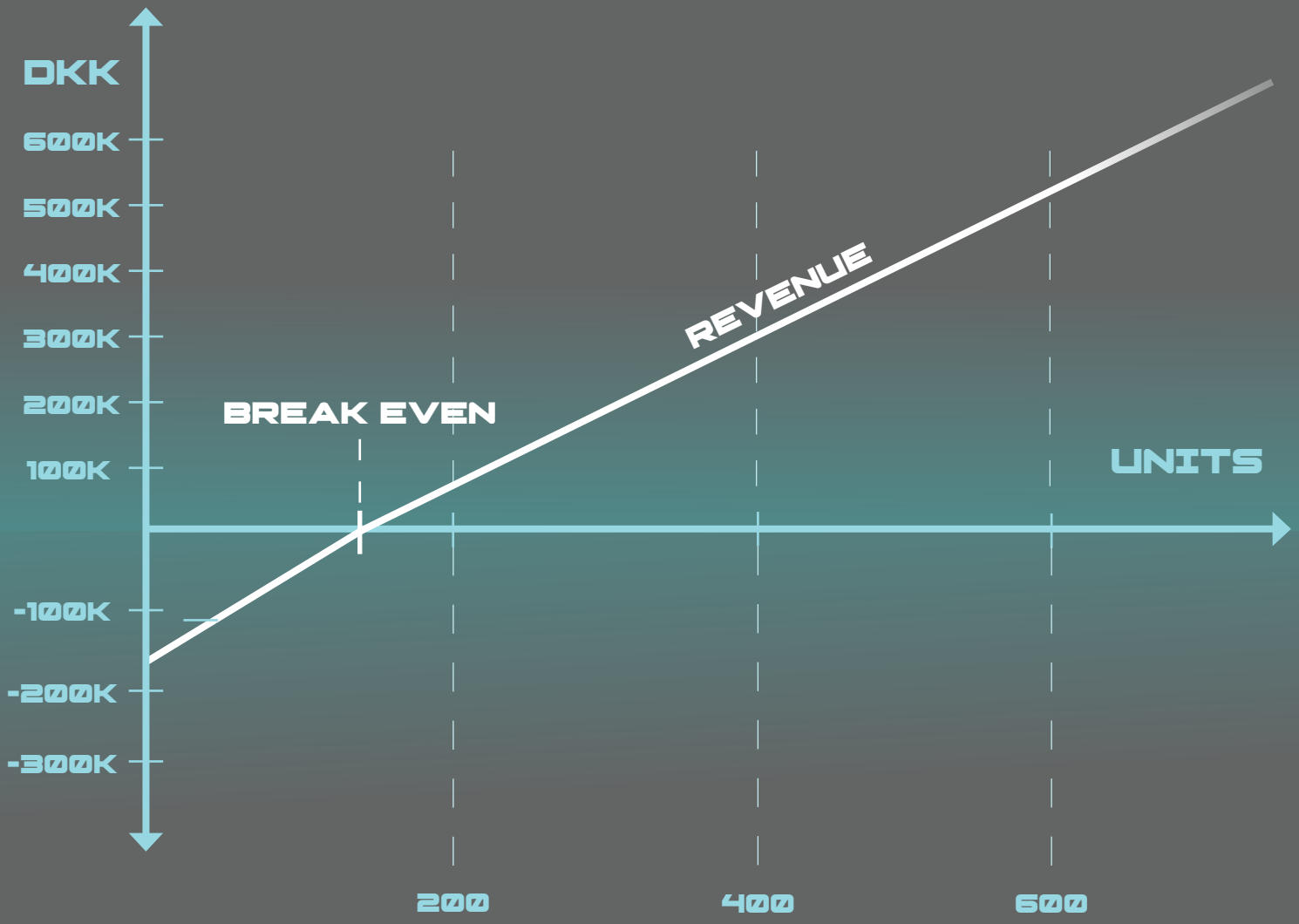
142 UNITS

Estimated investment of 159445 DKK will be earned back after 142 sold units with a profit of 1125 DKK each unit.

PRODUCTION COST

The investment and unit prices are explained in appendix no 46.

CASHFLOW GRAPH



PROFIT

The revenue from the 1000 units produced, would result in a profit of approx. 965000 DKK, given all the units are sold.

The profit could be used for further development of new improved variations of the product.

There are likelyhood of some overlooked business expenses, not noted during the analysis, which would increase the investment and unit price, therefore also lessen the profit.

AALBORG UNIVERSITET

ARCHTECTURE AND DESIGN

SPRING 2022

INDUSTRIAL DESIGN

MSc04 ID7

OMNIS

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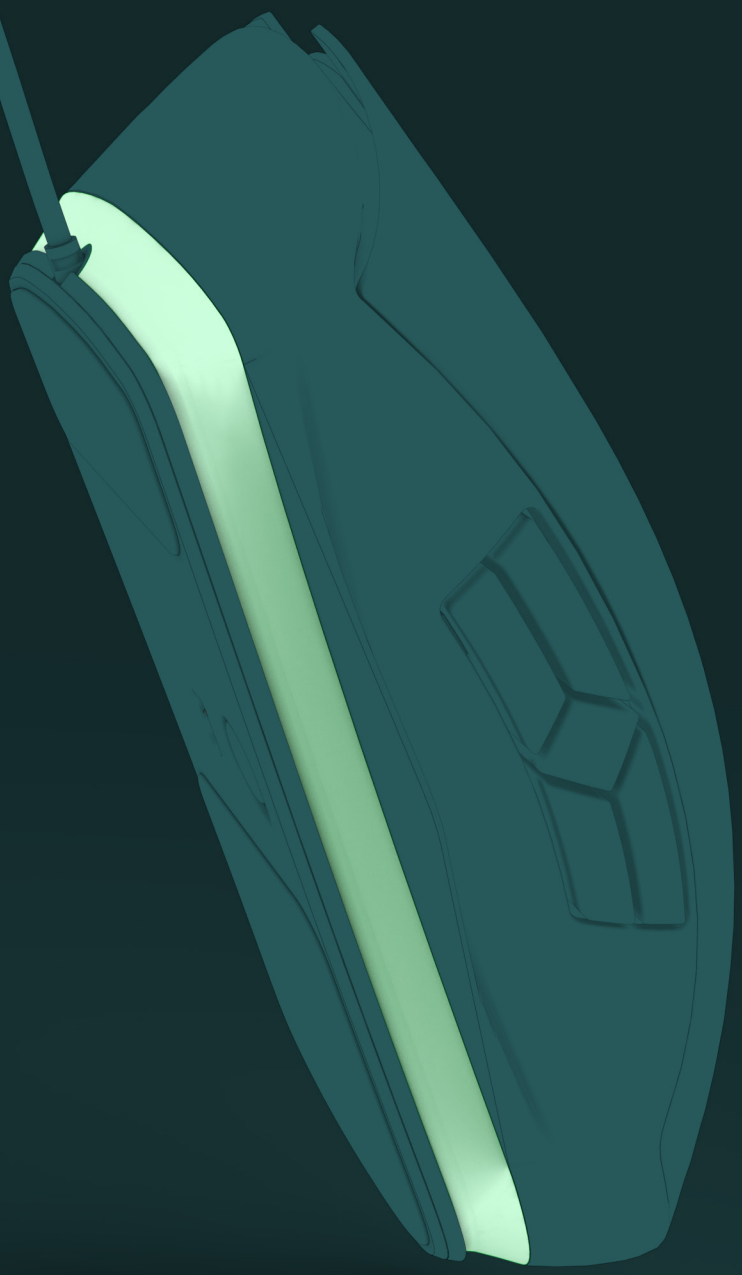

PROCESS REPORT

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AALBORG UNIVERSITET

AALBORG UNIVERSITY | MSC04-ID07 | INDUSTRIAL DESIGN | SPRING 2022

THE TEAM

DIANA ASMARANDEI RASMUS OLESEN

TITLE
OMNIS

REPORT
PROCESS

THEME
GAMING FOR ALL

PROJECT THEME
MASTER THESIS

PROJECT PERIOD
1.02.2022 - 25.05.2022

SUPERVISOR
MÁRIO BARROS

TECHNICAL SUPERVISOR
JØRGEN ASBØLL KEPLER

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PREPHASE & ACKNOWLEDGEMENTS

This project serves as Master Thesis in the specialization of Industrial Design and was developed by the team MSc04-ID07 at Aalborg University. It consists of two reports, the process and the product report together with an appendix and technical drawings part. This project had a time span of 4 months in which it was developed by a two-members team. The work was independent from external collaborations, and thus the subject was chosen and explored by the team alone.

Thanks to the supervisor guiding this projects' process, Mário Barros, and to the co-supervisor for the insights on the product development, Jørgen Asbøll Kepler. A great help was also the feedback got from all the users who tested the prototype in development and provided information.

ABSTRACT

This project represents the development process of a gaming tool meant for people with cerebral palsy that are private from various activities due to their incapacity of using one side of their body. The purpose of this product is to enforce people with incapacity in one hand, with a tool that can give them the possibility to experience social gaming at the same level with healthy people.

E-sport is a growing trend among teenagers, that creates communities of gamers all around the world and promotes a social activity that bonds people, from their earlier stages in life. The result of this project is a 2-in-1 gaming mouse made for all which presents a solution to social inclusion.

READING GUIDE

The project is supposed to be red starting with the product report, process report, appendix and technical drawings.

1. Product report: It shows the final product within illustrations and in-depth details about its features.
2. Process report: Represents the development process of the product, with the steps in cronological order and describes the methodology used, product goals and reasoning.
3. Appendix: Worksheets which were the base for the process report, including references, experimentation and other details.
4. Technical drawings: illustrate the dimensions and specifications of the product assembly and its components.

The process report is divided into 5 sections, starting with framing, concept development, detailing, implementation and epilog. Each section has a different flash color that keeps track of the chapters order, which are shown in the table of contents and on each page of the report further on.

The references are listed at the end of the report, into the Harvard method. Also, the sources are shown in a short version in the report text together with the information from where it belongs.

The illustrations references are listed after the text references, and indicated with a number below each figure in the report.

All information from the appendix is also refered to in the report with the appendix number.

INTRODUCTION

The E-sports (electronic sports) subject is a popular activity nowadays, growing in Denmark and around the world. Billions of users are gaming every day, and one in every three boarding schools has E-sport as a subject. Gaming is an activity that not only entertains an individual while improving abilities and skills such as distributive attention and rapidity, but it also creates a community where people with the same passion perform and belong to a social group.

More and more teenagers are attracted in the gaming universe, which is rich in game options but poor in devices that can help physically challenged customers. People with disabilities are a target group affected by the mentioned limited market options. While these people suffer from physical inabilities to perform ordinary activities, they also involve social exclusion from communities of people bound by a hobby.

This project is focusing on the cerebral palsy disability, and the range of users that have incapacity in their physical movement in on their hands and fingers in one side of their body, in the context of one of the most popular games in E-sport, which is Counter Strike. The game is played with two devices, keyboard and mouse. While the players must use their both hands, they also have to press different keys or buttons in the same time. Hereby, the purpose of this project is creating a tool that will give the affected users the ability to play like ordinary people by unifying the keyboard and the mouse and to deliver an easier way to play, without key or devices combinations.

The main challenge is of technological nature, that is bringing together two devices that will work like one, and into a convenient user interaction. By removing one of the devices and improving another, a dual solution is created together with a complete gaming experience that facilitates inclusion into the society.

”

I don’t feel my disability as much when I am playing.
It makes me happy to be included.

-

Jonas

”

ill 1. Gaming workspace suggestion

1 FRAMING

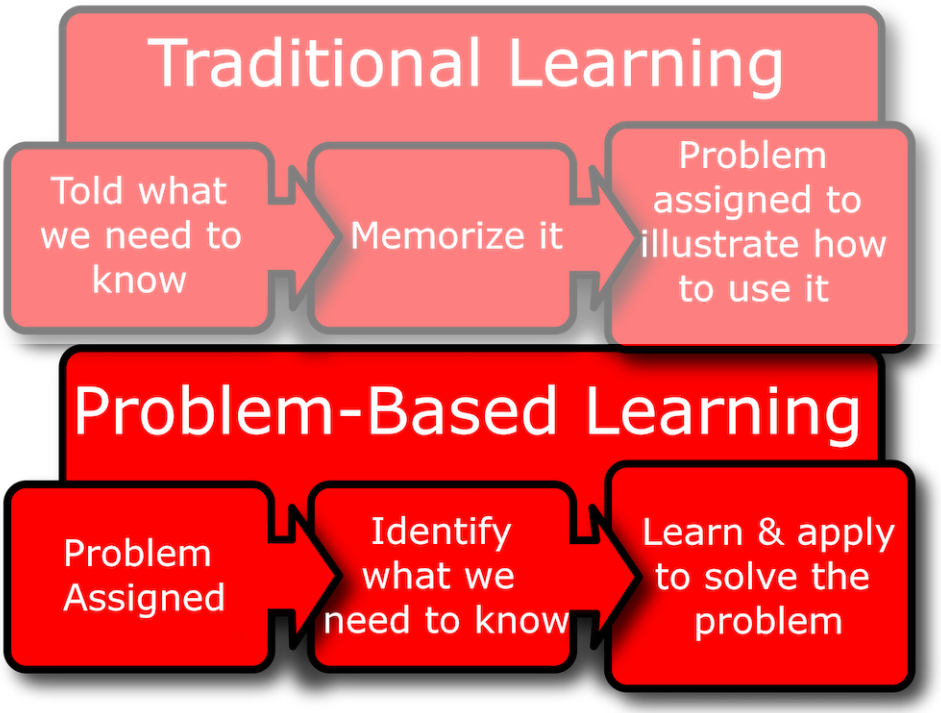
The first and biggest chapter, framing, represents the base of this project's development. Through research about target users, context, techologies and market, a direction was found, to later sum-up and find a first set of requirements for creating the new product.

Here it is introduced the reasoning behind the choices that have been made in every chapter. Starting with the approach, it is unfolded the problem that powered this project, and a need for a solution is established. The goal is to find a solution to the problem, and there is implicit a set of solutions that can solve the problem in various ways.

Therefore, the first chapter takes the first step into finding a direction and discovering which type of solutions can fit the current situation best.

The project view is expanded into solutions existing on the market and types of users that needs a solution, with a goal in finding the 'missing piece' which the solution for the project's chosen problem.

The project potential is then validated with statistics into the subject and trends that are growing. There are main decision factors for the project that are discussed and analyzed into chapters 2, 3 and 4 with the purpose to narrow down the project focus into a specific solution that can later be expanded again. Last chapter is the resulting design brief filled with requirements specific for each of the topics discussed, that will define the product in the beginning and will help start the conceptual phase, more specific with the ideation.



ill 2. PBL learning principle

1.1 APPROACH

The project process began with the problems that disabled users develop nowadays, as times and trends change. Since it is a Project Based Learning (PBL) education, the focus was mainly on a specific problem that needs a solution. After discovering the problem, all the process was formed around it and narrowed down to a specific area of interest. A direction was chosen to work on, the categories that needed attention were taken separately and researched in-depth towards the creation of this Master Thesys proposal. It was therefore an on-going learning process about specific users, market domain, technology on a specific area of interest, design, aesthetics and ergonomy. Hereby, a framing of all the aspects resulted from the starting phase in this approach, which contributed as a sum-up of requirements to follow in the process.

1.1.1 UNDERSTANDING THE PROBLEM

ill 3. Jonas, cerebral palsy user

It all started when one of the team members who is passioned about gaming, saw a video with a teenager named Jonas that was also passioned about gaming but couldn't play at a full extent because he had cerebral palsy in an advanced stage ("E-sport som frirum," 2021). The problem is that people with disabilities are in general excluded from most activities, due to their incapapcity to do things as healthy people perform. Therefore, this group of users needs special equipment to cope with the challenges in their daily lives.

They are however ambitious people, that would do anything to reach a healthy person's level and to feel included in the society. Due to this, most of the people with disabilities built their own gaming set-up for example, that is suitable for one game at least. There are very limited options for people with disabilities on the market and hence they have to create a set-up alone, or be limited by the market choices.

1.1.2 DIRECTION

Finding a disability to work with, and choosing of the target users

A research has been made in the physical disabilities field in order to find out what body parts are affected by common disabilities and also, how these are affecting hands in particular (WS 01). The following list contains the most common disabilities extending to the hands.

HAND DISORDERS

01 CARPAL TUNNEL SYNDROME

Description: A pinched nerve in the wrist
Symptoms: Pain, numbness, and tingling in the hand
Users age: Between 40 and 60
Treatment: Yes

ill 4. Carpal tunnel syndrome

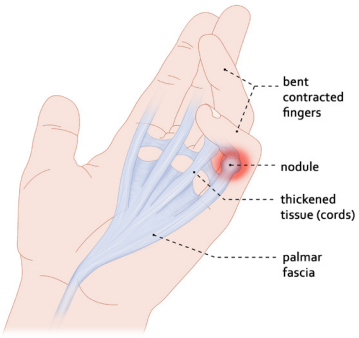
02 TRIGGER FINGER

Description: Inflammation in the sheath surrounding the finger's tendon
Symptoms: Pain
Users age: 40-50 y.o.
Treatment: Yes

ill 5. Trigger finger

03 DUPUYTREN'S DISEASE

Description: Fingers pulled in towards the palm by skin thickening
Symptoms: Reduced movement
Users age: After 50
Treatment: Yes



ill 6. Dupuytren's disease

04 ARTHRITIS

Description: Inflmmation of one or more joints in the hands or other parts of body (osteoarthritis and rheumatoid arthritis for hands)
Symptoms: Pain and stiffness
Users age: old users
Treatment: No

ill 7. Arthritis

05 GANGLION CYSTS

Description: Lumps that develop mostly in the hand wrist, or other parts of the body
Symptoms: Movement difficulty
Users age: 20-40
Treatment: Yes

ill 8. Ganglion cysts

06 CEREBRAL PALSY

Description: A problem in the brain that causes loss of motor functions in one or more parts of the body
Symptoms: Reduced motor movements and coordination problems
Users age: Any age
Treatment: No

ill 9. Cerebral palsy

07 STROKE

Description: Blood clogs in the vessels stop the circulation of oxygen to the brain
Symptoms: Body affected, with stiffness in hands (spasticity)
Users age: Old people
Treatment: Yes

ill 10. Stroke

08 MUSCULAR DYSTROPHY

Description: Disease affecting the body muscles, not able to grow
Symptoms: Weak muscles
Users age: Any age
Treatment: No

ill 11. Muscular dystrophy

CONCLUSION

The disability topic is very wide. Therefore, it needed to be narrowed down to not only what users cannot do, but with an emphasis on what they can do. This way, we can focus on what works for a person with disability and develop a solution for that part. The emphasis is mostly on disabilities that affect the hands. The chosen the disability will have as target criteria the young people group (between age 10-50), with focus on untreatable disabilities that affect the hands, to an extent where it becomes painful or impossible to use an ordinary computer gaming set-up.

1.1.3 PROJECT POTENTIAL

To map out the project potential in the area of gaming for teenagers, there have been analyzed trends that are increasing all over Denmark. The research was done to find out if and where could be a need for this project, and prove e-sport in boarding schools is a rising trend. (WS 02)

ill 12. Participants with disability in an E-sport camp at the boarding school

BOARDING SCHOOLS WITH E-SPORT SUBJECT

"Egmont højskole" is a school that used to be a school for handicapped, but has developed to be a school everyone can be a part of. They don't have e-sport as a subject, but it is an activity done in their sparetime.
They are working a lot with people with cerebral palsy.

Hardsyssel efterskole is a boarding school mixed with normally functioning students and a few handicapped at the age around 15-16, which also recently opened e-sport as a subject.

Rydhave efterskole is a boarding school mixed with normally functioning students and a few handicapped at the age around 15-16, which also recently opened e-sport as a subject. (WS 02)

STATISTICS

„Every third boarding school in Denmark now has E-sport as a subject

„96% of all boys of age between 13 and 19 play computer games, while 49% plays daily

„70% of all girls of age between 13 and 19 play computer, while 5% plays daily.

(Melgaard, 2019)

CONCLUSION

Through the research on the gaming trend among boarding schools in Denmark implementing e-sport as a subject, it has been found that gaming has a big impact for teenagers, where almost all male users practice gaming and half of them do it on a daily basis.

1.2 MARKET RESEARCH

In this chapter will be analyzed the variants people with disabilities have on the market for gaming and e-sport activities, but also what types of people can benefit from a new design. What have been found in the research resuted from internet search, in-store research and gaming events for people with disabilities attendance by the team. The purpose of the market research is to find out how and what types of users can we help with a new gaming device.

> *Online, you can't see the fact that I am in a wheelchair. All you see is another avatar in the game, playing, doing exactly the same thing you're doing.*
>
> -
>
> *Richard 'Zeus' Jacobs*

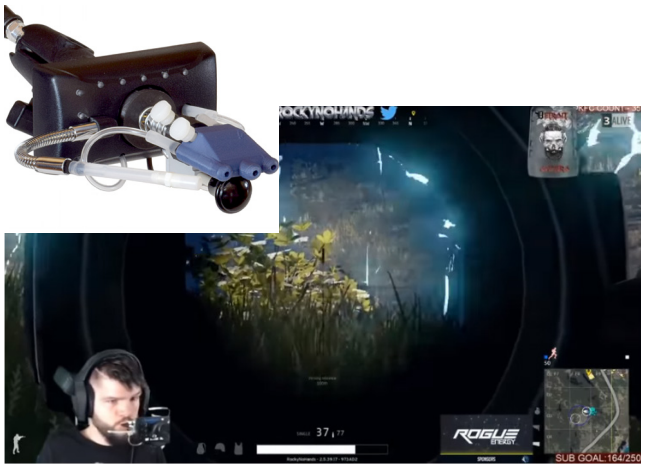
1.2.1 PRODUCTS ANALYSIS

Here it has been conducted a market research on the competitors that already have products for people with disabilities on the market. These were summed up on key categories that helped us understand where could this project come in and contribute. There was found a big variety of gaming devices specially for the parts of users that function still well. From mouth to feet devices, these devices work for most of the game types. However, there was only found one device for first person shooter games, which is the Counter Strike or Call of Duty type.

01 QUADSTICK

The Quadstick is a mouth operated joystick made specifically for quadriplegics. It converts the sensor inputs into outputs through Bluetooth.

There are three versions: the QuadStick FPS, the Singleton, and the Original. The FPS is the highest-end version. It has four sip and puff sensors and a lip position sensor that can be assigned any game controller axis or button. The other two versions are less expensive, and the mouth sensor has strong centering springs which may not be the best choice for those with reduced lip strength. (Silman, 2020)



ill 13. Quadstick gameplay

02 XBOX ADAPTIVE CONTROLLER

This controller was designed by Microsoft specifically for accessibility. It has two large black buttons on its surface, and ports in the back that correspond to all the buttons on a regular controller which works through switches.

Adaptive joysticks can be connected through a USB port. All of the buttons are mappable using the Xbox Accessories app. It can also attach to a large variety of mounts. While the controller was made for Xbox, there are ways to connect it to the Nintendo Switch and PlayStation.

ill 14. Xbox adaptive controller

03 THE 3D RUDDER

The 3dRudder is made specifically for virtual reality gaming, allowing for a full range of motions using only feet. It allows for full-motion control by turning, pressing, and rotating feet.
It additionaly be matched up with the Xbox Adaptive Controller for adaptive gaming and with any gamepad/playstation.

ill 15. 3D Rudder

04 LOGITECH ADAPTIVE GAMING KIT

Logitech, a company that makes peripherals for electronic gaming, created an adaptive gaming kit catered to the Xbox Adaptive controller.

It has 12 plug and play triggers that are light touch, pressure-sensitive, and feature both small and large buttons. The triggers and buttons can be labeled, they can be arranged by the users on the wheelchair in any order they like. It also comes with a game board, plus hook and loop ties.

ill 16. Logitech adaptive gaming kit

05 AXIS CONTROLLERS

Blue Tip Gaming is a company that makes high-end equipment for gamers. The Axis controller line is designed with adaptive gaming in mind.

It features everything in one compact space, including large colored buttons and numerous joysticks. They're especially useful for gamers with limited wrist and finger function.

ill 17. Axis controllers

CONCLUSION

The research made on gaming peripherals for disabled users showed gaming equipment specific for different parts of the users' body that are working (mouth, hands, feet etc.). However, these devices don't work for one of the most prefered teenager games, which is Counter Strike. Therefore, the project focuses on this gaming area that is not exploited yet.

1.2.2 MARKET POTENTIAL

In order to understand how big our market potential would be and see if the product idea can be validated, a research has been made regarding the gaming market on Counter Strike Global Offensive (CSGO), but also on the Cerebral Palsy (CP) population around Denmark that we could help.

Therefore, in this sub-chapter will be presented statistics from latest years with evidence of people playing computer games including CSGO and numbers of the CP born every year in Denmark. On the other hand, there were considered people with other disabilities as well that could benefit from the same game set-up in other terms.

Moreover, healthy people were also included to the possible market users with diverse reasons of use of the new gaming concept which could be: more comfort, multitasking, freedom for the other hand, or one button assigned for one function; these would be only few advantages that healthy people would consider for being part in this market too.

ill 18. Gaming market

THE CREBRAL PALSY USERS

In Denmark, the frequency is 2.4 / 1000 live births, which means that there are 120 - 150 new cases annually. The incidence is higher among premature and twins. In Denmark, about 10,000 people live with CP (sundhed.dk, n.d.).

If there are 10,000 people with CP, then deducting from the research paper made on children with CP where level 1 CP represents the same amount as the sum of all the other levels (Carnahan et al., 2007), it means that there are about 5,000 people with CP level 1 in Denmark.

Since our mouse has focused on the users with CP level 1 and there is a slight difference between level 1-2 and 2-3, the bigger gap starting from level 4 and 5, then our mouse could be sold to almost 7,000 CP people in Denmark.

POTENTIAL USERS

OTHER DISABILITIES
As mentioned in the description of this chapter, there have been found also other categories of users that can benefit from the mouse, for example: people with one missing limp or defects at one hand, arthritis users that cannot coordinate both hands, or muscular dystrophy users who use pressure better instead of rapid finger movements.

HEALTHY
Even healthy users can be included in this market; some prefer to use one hand for gaming and the other one for e.g., eating, drinking or other parallel tasks. On the other hand, having only one button assigned for one function on the same device would make it more easier for them to play. It helps to coordinate movements and access the functions easy, rather than combining different keys on the keyboard to access only one game function. This means it would be more comfortable for the healhy users to use only one gaming device instead of two, as well.

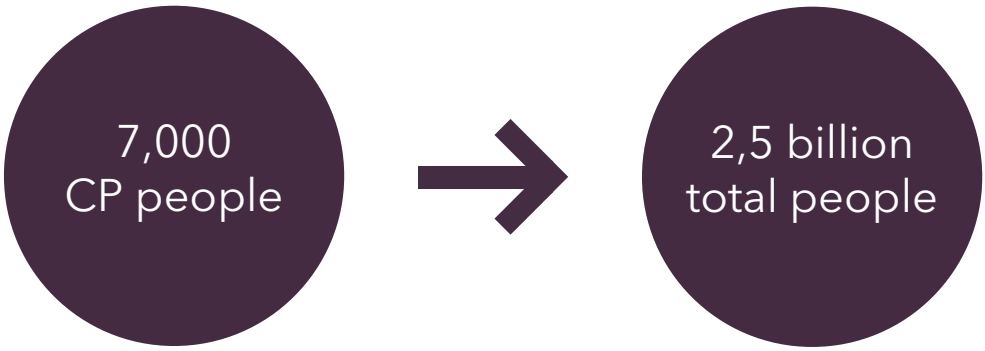
GAMING IN DENMARK

E-sports area is an important and dominant aspect in Denamrk that is continuously growing. The trend is increasing, and even for such a small country, Denmark is very active in the esports world. The biggest e-sport star is also Danish, suggesting the gaming culture is very popular here. (denmark.net, n.d.)

As gamers play competitive as well, they also win different prizes in money. The winnings from e-sports competitors in Denmark was reaching as much as 5.06 millions USD, showing that is a huge gaming competition market. (statista.com, n.d.).

GAMING WORLDWIDE

A statistic has been made in 2020 sugesting that 2.5 billion people are gaming. This means that over 1/3 of the world's total population is gaming – and it is increasing. This creates a large gaming industry with an annual revenue of 115 billion US dollars (Gamesparks.com, n.d.).



ill 19. Gaming context

REFLECTION

Here will be included two different aspects that needed attention regarding the mouse design – **problem solving purpose and updating purpose.**

1. The research concluded that there are more people than expected to make use of a one hand device. From the main focus that is cerebral palsy, to various hand disabilities that people are not only born with but also get injured from accidents at some point in life, all these are **problems that need a solution**.

2. On the other hand, there are also the passionate gamers that even if they have both healthy hands to play with, they can still benefit from a one hand device, perhaps to enhance multitasking skills and allowing to have a hand free to use for other tasks or just for comfort. This does not have to be a solution, but rather an **updated product** for those who have different wishes at their gaming station or want to get more out of the experience (doing more things at the same time).

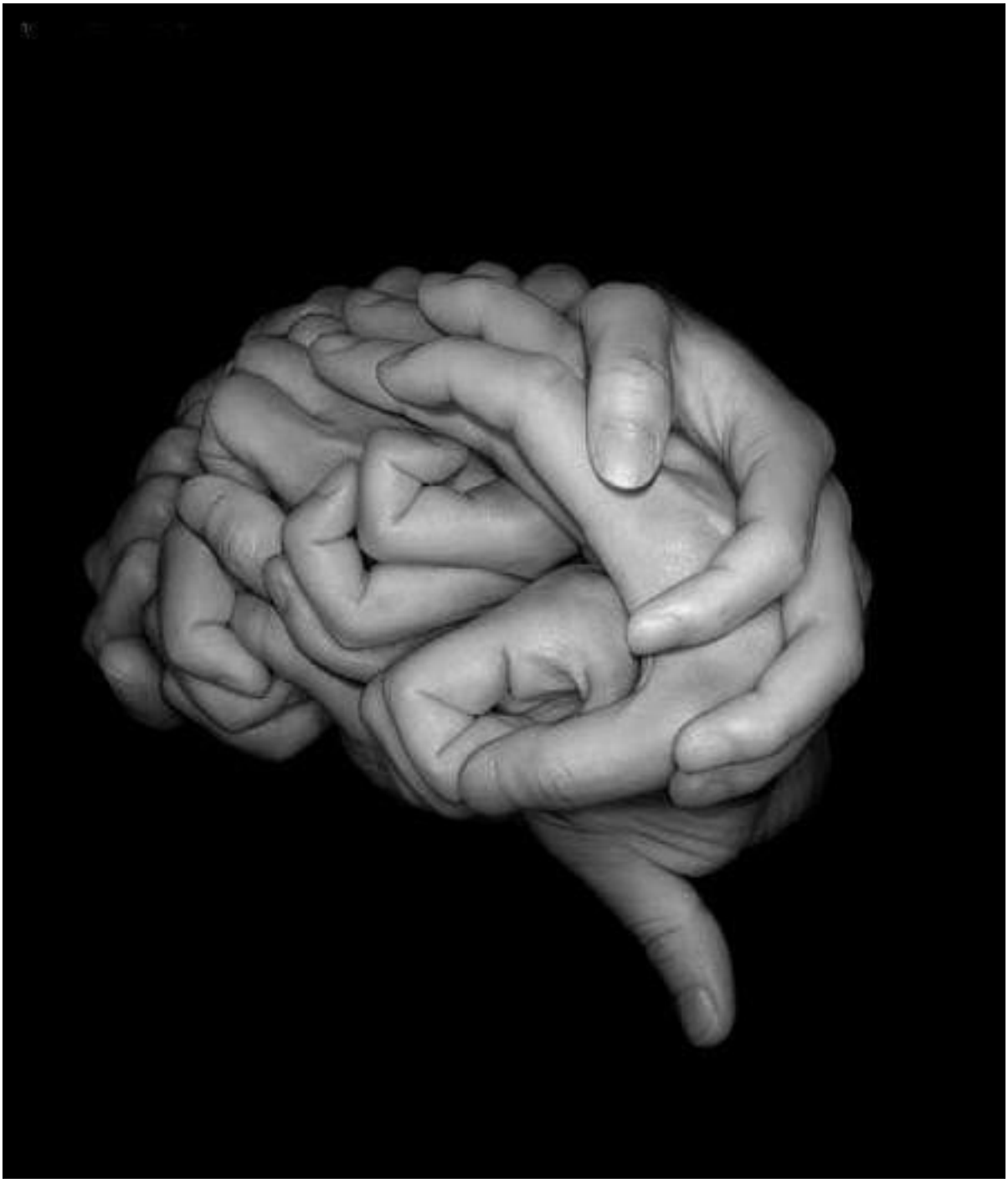
Even though the numbers are clear, and a new one-hand device for gaming might get sold very well, it is important to be aware that in order to pay for a product there must be a good ratio between product value and price. Manufacturing of such product might result in very high costs. The question is, will the price be too high for the value that a special product gives to a person with disabilities that would do anything to be a little more 'part of the community'?

CONCLUSION

Considering the CP users, the other disabled users and the healthy users, there could be a market range starting from at least 7,000 people to possibly 2,5 billion people worldwide taking advantage of our product. Each type of user can have a benefit, from being a big one (like a neccessity) to being just a level-up in their gaming preferences.

1.2.3 TARGET USERS

As concluded in the previous chapters, there are many categories of disabilities that we can help with a new gaming device. However, people with untreatable disabilities (and people that are born with them) could get the most out of this project. Therefore, the focus is set on the cerebral palsy disability, which affects children since they are born and they live with the disability their whole life. What a person with cerebral palsy can benefit from, are products that will ameliorate the effects of this disability in society, and the effects that sepparates him from a healthy individual. Hereby, different products can give them power to rise at the level of a healthy person and do anything they want, things they couldn't do alone. Cerebral palsy will be discussed in the next pages along with its levels of affecting the brain and body, to understand in-depth details about how much each level affects users and in between which areas can this project contribute. (App 09, 10)

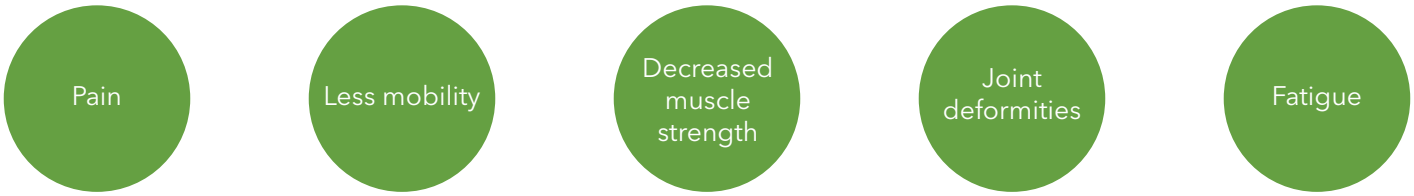


ill 20. Cerebral palsy connection between brain and hands

THE CEREBRAL PALSY

Cerebral Palsy (CP) is a type of disability affecting the brain in the initial stages of life. This results in mobility impairment, meaning that the ability to control muscles and movements is affected when one has cerebral palsy. Depending on which areas of the brain are affected, it causes difficulty moving, using hands and arms, eating, or speaking. Over time, there may be misalignments of joints and bones due to tightness and imbalance in the muscles. ("Hvad er cerebral parese?," 2022)

The consequences of having cerebral palsy differ from person to person. Cerebral palsy is commonly considered as a non-progressive brain injury that in most cases is congenital (90%) or that occurs at birth or shortly thereafter (10%). However, there are common late effects that may appear, like:



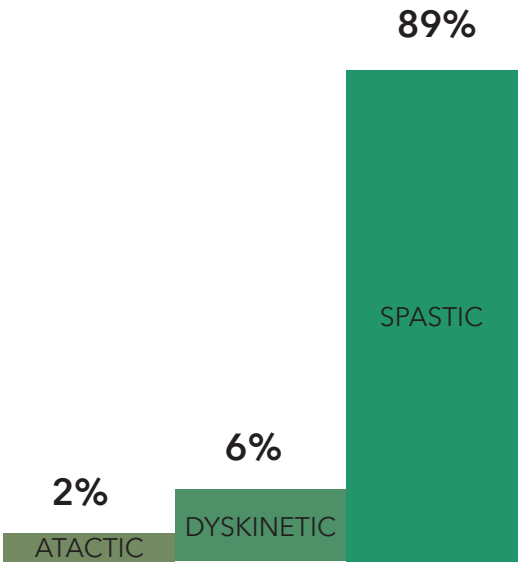
("Konsekvenser og senfølger," 2021)

TYPES OF CEREBRAL PALSY

Based on the physical symptoms, cerebral palsy can be divided into three types, each with its own characteristics:

1. Atactic cerebral palsy (approximately 2 percent)
2. Dyskinetic cerebral palsy (approximately 6 percent)
3. Spastic cerebral palsy (approximately 89 percent)

All three types of cerebral palsy have common characteristics such as mobility problems. However, the spastic cerebral palsy is the most common type and, unlike the other two, is characterized by the person having very slack muscles and a general slow-developed spasticity. ("Typer af cerebral parese," 2022)

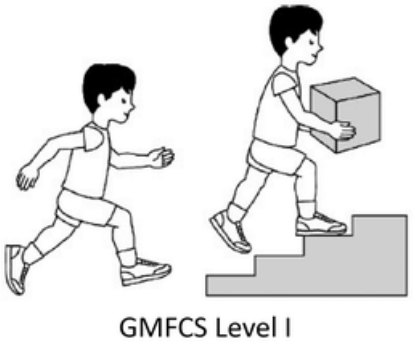


DEGREES OF CEREBRAL PALSY (LEVELS)

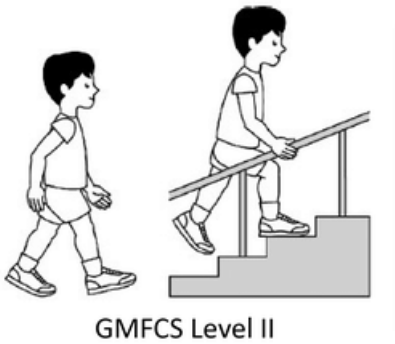
When professionals have to describe the individual's degree of cerebral palsy, e.g. the level of physical function, they use a number of divisions. One of the most widely used is the GMFCS (Gross Motor Function Classification Scale). GMFCS is a scale for motor function level. The scale divides 0-18 year olds with cerebral palsy into five groups according to their ability to walk, sit and move. Children and adolescents in GMFCS 1 have the best level of functioning, while GMFCS 5 includes the least functioning, who lack gait function. There are large variations within each level. ("Grader af cerebral parese," 2021)

FUNCTIONALITY LEVEL 1

A person with CP functionality level 1 is able to do most of the daily activities. They are usually effected by minor spasm in one side of their body (arm and leg), but are still able to use it in some degree. They are able to master functions like running and jumping; however speed, balance and coordination are limited.



ill 21. Cerebral palsy of level 1



ill 22. Cerebral palsy level 2

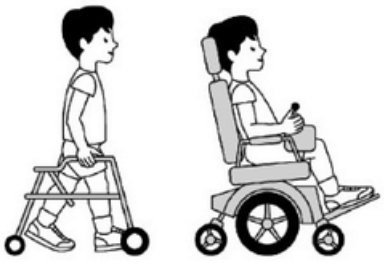
FUNCTIONALITY LEVEL 2

A person with CP functionality level 2 are able to walk, but struggle when there is uneven terrain, slopes, long distance, requirements of speed and bad weather. They have problems with speech and one of the sides of their body is heavily limited. However the other side (both arm and leg) are close to fully functional.

ill 23. Cerebral palsy level 3

FUNCTIONALITY LEVEL 3

The functionality level 3 is very similar to level 2, where the limits are extended to a larger degree, so there are more scenarios where users with level 3 would need a form of assistance to walk.



GMFCS Level IV

ill 24. Cerebral palsy level 4

GMFCS Level V

ill 25. Cerebral palsy level 5

FUNCTIONALITY LEVEL 4

A person with CP functionality level 4 doesn't have the ability to walk, because the spasms is too strong and taking up too much of the persons body. So they have to get help to the most daily activities. However they usually have an arm they can use to a fairly high level and are able to use a normal computer mouse with the arm.

FUNCTIONALITY LEVEL 5

At functionality level 5 the spasms are survere and are affecting both sides of the body. So the person needs to be transported in a wheel chair in all situations. The person isn't able to sit by themselves and in most cases need mechanical assistance to sit for themselves.

LEVELS INCIDENCE

A study made in 2007 over a total of 359 children (Carnahan et al., 2007) illustrated the averages of cerebral palsy GMFCS levels in the graph below (with blue). The result was a majority of cerebral palsy patients having level 1, being followed equally by the rest of the levels (2, 3, 4 and 5) with the same ratios. In this paper was included also the MACS scale evaluating the manual ability and hands coordination. Both scales (GMFCS and MACS) were used together to categorize patients in the study and resulted the next numbers:

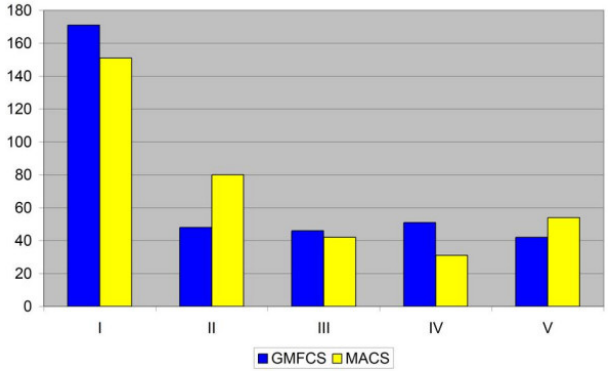
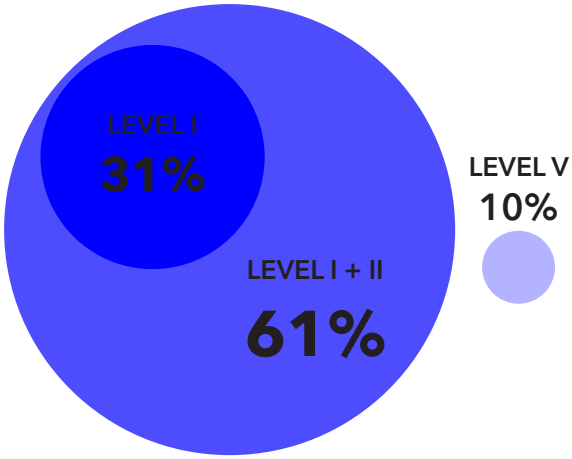


fig x.



1.2.4 MARKET RESEARCH REFLECTION

As a conclusion, cerebral palsy is a spread disability over Denmark that affects people from the initial stage of life. Even if it does not worsen in time, every individual is born with some degree of cerebral palsy. From the graph shown in the levels incidence study it can be seen there is a big gap between users with level 1 and the rest of the other levels. This means that the most people with CP can use normally one side of the body.

Hereby, the project borders were defined in helping the cerebral palsy group, with a relevance to focus on the levels that can use at least one hand (level 1, possible until level 3). The levels showed in the degrees of CP chapter there are two gaps between levels. Level 1 is the least recognizable form of cerebral palsy, and people born with this form can easily be spotted as healthy users if there is not a detailed check on the hands or so. Then it is a small gap between level 1 and level 2/3, as there can be complications when walking or more severe cases where hands are visibly affected. Levels 2 and 3 are similar and they have slight differences. From 3 to 4 there is a big gap, as an individual with level 4 cannot use any of his limps, nor speak or eat properly. Same is the level 5, where the whole body is imobilized and the user needs full support. Therefore it was clear what areas of CP can use a gaming device in normal parameters and was decided to use as target group the levels 1, 2 and 3.

However, each person with CP is different and this means they cannot be always categorized in one specific level, the majority being in between two levels.

Other users can benefit as second market from a special gaming device. In Denmark there is a trend in gaming that is growing among competitors but also among enterntainment levels in boarding schools, as social activities that bring people together. E-sport is becoming a big trend all over the world, and many players are updating their gaming devices with a purpose to excell.

If people with disabilities would have the same oportunity to play like healthy users, they would take any device that gives them the power to reach the same competitive gaming levels, or even only to be able to play to a minimal extent.

The same situation applies to people with other similar disabilities, that could benefit from our project at least from a minimum extent. People with muscular dystrophy, arthritis, missing limps or fingers are part of a potential market that can benefit from a special gaming device for one hand.

Most of the gaming resources for people with disabilites were listed in the products analysis chapter and they were only focused on specific games, that should be played normally with a joystick and that serves as replacement, or that should be combined with one. Moreover, they were complicated in design and accesibility.

There is a need in the E-sports world for a simple product that comes in one piece, without the need to be paired with other devices or too complicated to be used, where one of the most popular games, Counter Strike, is also adressed for people that cannot use both hands to play it.

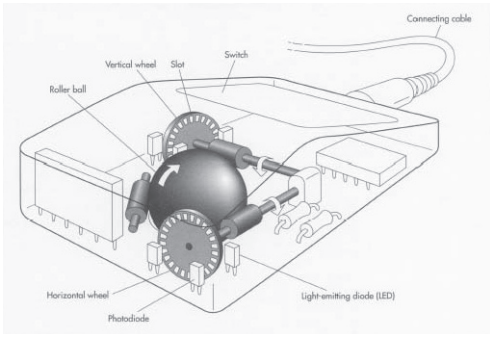
1.3 TECHNOLOGY RESEARCH

Here will be listed and discussed mice technologies but also other computer interaction products on the market. Since the product should be something new and relevant to the user field we refer to, the device could be on one hand very innovative like nothing seen before, while to the other extreme it could just be a different mouse. The research made in this chapter has as purpose to get inspiration by thinking out of the box while fitting the best solution to our case. Here are considered all the gaming devices on the market that refer to all the users, no matter the aesthetics or functions of the devices. At the end of the research, it is concluded how a special gaming device should look like and what functions are the most important in the device that follow the cerebral palsy group requirements.

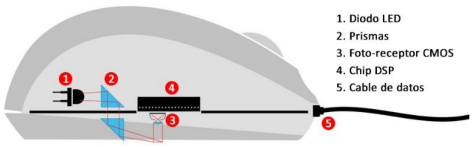
1.3.1 MICE TYPES

First, a research has been made on mice types that have a very broad range of applications. The mouse is taken as a first example of a gaming device (among others), as the simplest and most popular peripheral on the market. Starting with the basic mouse, and reaching to the most performant mice for gaming, there are a lot of categories to list and analyze. Mice are therefore split in two categories, that refer to connection with the computer and movement. Thus, 3 main types of mice will be shown and discussed below. (App 03)

WIRED MOUSE



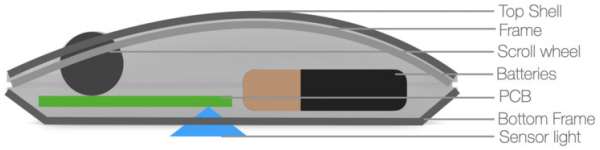
ill 26. Wired mouse with ball



ill 27. Wired mouse with sensor

BALL MOUSE

SENSOR MOUSE



ill 28. Wireless mouse with sensor

BLUETOOTH MOUSE

01 WIRED MOUSE WITH BALL

It is the oldest type of mouse, the one that was first made and used for browsing purposes and in a non-performant way.
Nowadays, it is not seen anymore because the ball was replaced with a sensor that makes the movement more smooth and quicker, that delivers the best results on the computer.

02 WIRED MOUSE WITH SENSOR

It is a mouse widely used. Its wire makes the computer response faster while the sensor give a better movement. It is used mostly for performance purposes in gaming where speed is needed. The sensor can also have a lightning purpose that changes colours along with buttons pressed in the game, or just for identity.

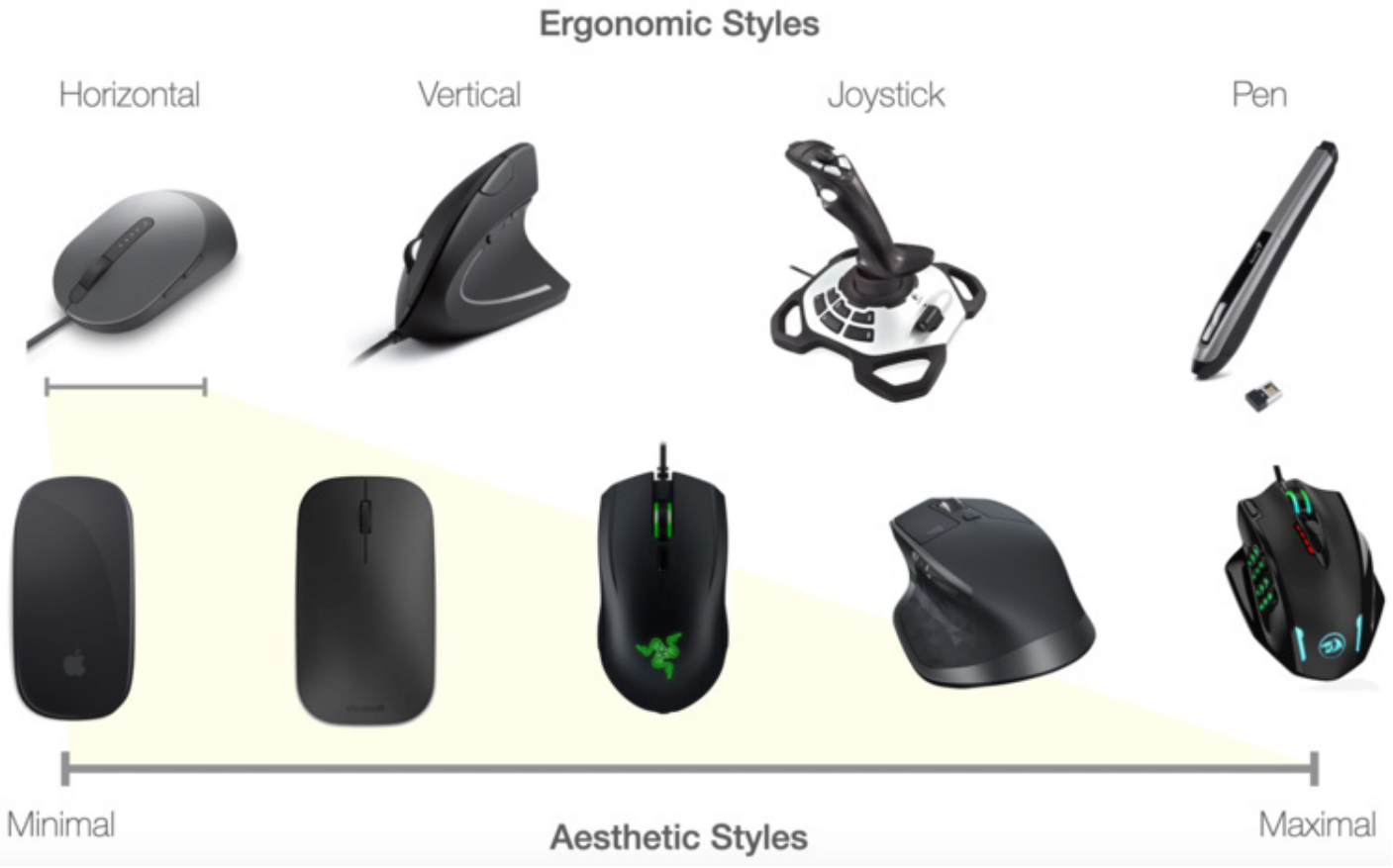
03 WIRELESS MOUSE WITH SENSOR

Like the mouse mentioned previously, the wireless mouse with sensor is also very popular. Its advantages would be the freedom of movement it gives due to wireless connection. This one is only working through bluetooth connection between mouse and computer, plugging in the mouse USB. This type of mouse is used for daily tasks on the computer and gaming as well, but it doesn't have a response as good as the wired one.

CONCLUSION

The wired mouse with sensor is the best choice for gaming. Since the new technologies develop only mice with sensors for a well known reason of moving smoothly on the computer, it is a clear choice to consider for this project as well. Moreover, having a wire will facilitate a good and fast response in games like CSGO that require fast movements.

AESTHETICS AND ERGONOMY IN MICE



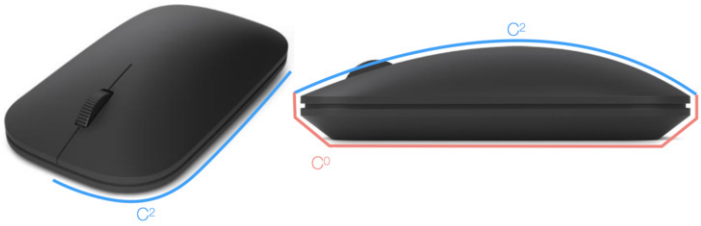
ill 29. Ergonomic and aesthetic styles in mice

Another topic to discuss is the aesthetics along with the ergonomy part of a mouse. Depending on the purpose they are used for, mice have from simple to overcomplicated looks in terms of design and shape. From easy to use and nice feeling in the hand to performant fast mice, they all adapt with a specific look and feel that define their usage target. In terms of gaming, they stand for the maximal aesthetic style, while in the middle category can be reached also good ergonomy for the hand (comfort while playing with such a mouse). Therefore, the best mouse for cool gaming looks and performance combined with ergonomy for the hand, is in between a minimal and maximal style.

MOUSE SHAPING

Considering the shapes that a mouse can take, the topic was categorized by edges in connection with the design language these give to the mouse.

The edges are degrees of curvature in mice expression, categorized from C0 to C2 and above ("Teardown | Computer Mouse," n.d.). While C1 is the most used curvature in mice design, the other 2 are more recognisable in terms of their usage purpose:



ill 30. Mouse shaping

C0 - stands for sharp corners which show precision (e.g., in gaming, fast pace, performance tasks)

C2 and above - stands for high curvature which evokes simplicity and elegance (e.g., daily tasks, slow motion, relaxed usage)

CONCLUSION

The research on mice enabled in-depth understanding of the types, styles and ways of evolving mice technology over decades. Moreover, it synthetises criteria as the ergonomic and aesthetic aspects in mice building through expression. The next step will follow in discovering different devices used for human – computer interaction for gaming and not only, to expand the project focus and learn how other technologies work.

1.3.2 OTHER HUMAN-COMPUTER INTERACTION

Here we expand once again our field of research and look 'outside the box' to get inspiration of not only gaming devices, but any kind of human-computer interaction. Following the Double Diamond model, this part of the project is intended to expand the area of interest, researching all solutions on the market to later sum-up with one choice of techology that can define a new gaming device suitable for the people with CP. (App 07)

01 WII CONTROLLER

The Wii Remote uses a Broadcom Bluetooth chip to wirelessly send a constant stream of position, acceleration, and button-state data to the Wii console. The chip also contains a microprocessor and RAM/ROM memory for managing the Bluetooth interface and converting voltage data from the accelerometers into digitized data.

ill 31. Wii controller

02 NINTENDO POWER GLOVE

Made back in 1989, the glove used ultrasonic sound (transmitter/speaker on the glove and reciever/microphone on the TV) to calculate the hands placement (time to reach the mircophone and direction from the sound was used to calculate). This peripheral was an innovative design meant to make movement easier, however it worked very poorly.

ill 32. Nintendo glove

03 VR HEADSET

Based on virtual reality, this type of computer interaction has gyroscopic sensors, accelerators, and magnetometers in headsets to determine how you move and track your interactions within a virtual space.

ill 33. VR headset

04 GEST

Hand device that uses a combination of accelerometers, gyroscopes, and magnetometers sensors to understand what the user is trying to do and then transmits them to a computer or mobile device over Bluetooth (Introducing Gest, 2016).

ill 34. Gest, the hand and finger sensors

05 THE KEYBOARD

Represents a large palette of keys and switches that each is entitled to a letter, number or symbol. Their individual or combined press is accessing different functions on the computer, depending on the task performed (writing, gaming etc.).

ill 35. Keyboard

06 THE TOUCHPAD

Touchpads use relative motion, similar to a computer mouse. Relative motion enables you to move your finger or stylus across the surface and a cursor will move on the screen.

ill 36. Touchpad

07 PLAYSTATION/XBOX CONTROLLER

Uses a combination of analog sticks and switches, to be able to control a game with both hands.

ill 37. PlayStation

08 GOOGLE HOME

Uses voice commands/recognition to do a task on the computer according to what's being said by the user.

ill 38. Google home set

CONCLUSION

Extracting information from the research on human-computer interaction made above, more ideas energed on what technologies potentially be implemented in a new device. However, most of these products are lacking in the precision which is very important in shooter games, especially in CSGO. Therefore, the project will open up, considering these technologies along with normal gaming mice technologies that will be tested through the ideation stages.

1.4 THE GAME

In this chapter will be discussed the game which was chosen to be the target for a new gaming tool. Along with the game description will be also described how it is played and also why it was chosen.

First, statistics of the game popularity will be shown. Here it can be seen the reason of choice for this game. Not only due to its constant availability on the market, but also due its classic concept it became a trend in the e-sports world and it is a trend continuously growing among gamers nowadays.

Counter Strike - Global Offensive has a medium complexity, however to play it there is needed a set-up made from 2 devices. Therefore, the game structure and accessibility of functions are analyzed further, to understand what is the gaming scenario now. Moreover, it is challenged the way it can be possibly changed and transposed into a new, easier game set-up for the people with cerebral palsy from our target.

Lastly, the performance parameters which separate a purely enterntaiment activity from a competitive one, are discussed. Pictures showing the performance were collected from one of the team members game play, who is playing at a high level CSGO.

The research made into the game will help facilitate the project development in the next stages of ideation, prototyping and experiments with setting up limits of parameters that need to be followed in order to satisfy specific requirements that will be summed up in the project framing.

1.4.1 COUNTER-STRIKE GLOBAL OFFENSIVE

Counter-Strike Global Offensive is one of the worlds most played multiplayer first person shooter games and is the worlds most viewed tactical shooter game. It is the newest version of the game franchise "Counter-Strike" which has existed since year 2000.

ill 39. Counter Strike - Global Offensive

STATISTICS

At the time of January 2022, Counter-Strike has an average of over 600.000 players online at all times and at the popular hours there're almost 1.000.000 online players. Where the game just came out back in August 2012, the average online player base was just around 15.000 players, which is an active player increase of 4000% since the game launch. ("Counter-Strike: Global Offensive - Steam Charts," n.d.). The player base amounts of 35 million players every single month ("Counter Strike," 2020).

GAME OBJECTIVE

The game is, as said, a first person shooter, where the objective of the game is to either plant a bomb on one of the two bomb sites if you are on the terrorist side, or defend the bomb sites if you are on the counter-terrorist side with the weapons you buy at the start of each round. One game consists of 30 rounds, so when 15 rounds have been played, teams switch from or to the terrorist or counter-terrorist site, the opposite of where it started playing. Then the game continues until a team reaches 16 rounds and the winner team is found.

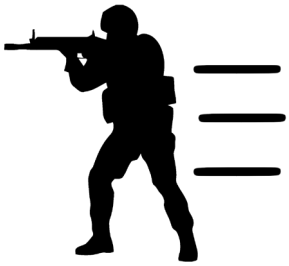
GAME DECISION

Counter Strike is a game franchise that has only changed three times in 22 years since it has existed. Compared to games which constantly change and update, this one was very stable and that's why it remained among the top game choices until today. Therefore, due this reason together with its current and rising popularity, it's the game chosen in this project to design a special tool for.

1.4.2 GAME STRUCTURE

The controls are described with the automatically set controls which is determined by the game developers. The features in the game will be here ranked by relevancy when playing in three tiers. Hence, the game features are divided into 3 tiers to clarify their need in the game, which are mandatory and which are extra to have. Tier 1, being the most important, has only basic functions in the game. Tier 2, important for a complete game experience, has functions without which it could be possible only to play in a small extent. Tier 3, are extra functions that change the game from enterntainment to competitive level, however not being necessay to have a good game experience. (App 4, 12)

TIER 1



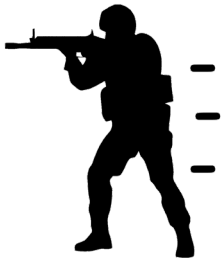
RUN

The ability to run around the map is one of the main features and probably the most important. This feature is important to be accesible at almost all times and should be used simultaneously with shooting.

SHOOT

Shooting is another one of the main features. This is a feature that should be accesible at all times during the game and is important it can be accessed while running.

TIER 2



WALK

Walking is a feature to hide the audio of the footsteps for the enemy, it is done by holding the SHIFT key.
It is use very often and should be possible to do at the same time as moving around.

CROUCH

Crouching is a feature that is important to get in some smaller places and elevate higher when jumping. It is a feature important to be able to use at the same time as walking and jumping.

SWITCH WEAPONS

Switching weapons is a feature that allows using other weapons your character has on him. It is a feature which is often used in more intense situations in the game. It should therefore be easily accesible, but is a feature that is not necessary to be reachable while shooting.

JUMP

Jumping is a feature used to get on higher floor levels that can't be accessed by running onto. This feature should be able to be acessed simultaneously with the running and crouching feature.

RELOAD

Reloading is a feature that is used when running out of munition or it is not enough for the next fight. It is a feature that shouldn't be reachable at the same time with shooting.

SCOPING

Scoping is a feature used quite often, when certain weapons are able to scope. The use of the feature shouldn't interrupt the running feature.

DROP WEAPON

Dropping weapons is a feature that doesn't gets used very often. It is done to give teammates weapons, if they can't afford them by themselves. It is a feature that shouldn't be reachable while shooting.

BUYING

Buying is a feature only possible in the very start of each round, where it can be bought what ever it is needed for the upcomming round. Since it is only used once every round, it doesn't need to be very accesible.

DEFUSING AND PICKING UP WEAPONS

Defusing or picking up weapons are two features accessed in the same time. Non of the features are used constantly, thus they don't need to be used simultaneously with other features.

OTHER FUNCTIONS

Scoreboard is also a feature used to watch the individual statistics of players and the rounds of the game. It is a feature not required to play, but it is nice to have.

Inspecting weapon is another function mostly made to show off weapon skins you have purchased for the game. It doesn't do anything important for the game and stands only for aesthetics of the weapons.

ill 40. Inspecting weapon in CSGO

CONCLUSION

Through listing the game features and categorizing them into priority/non-priority tiers, they were better understood together with the fact of which features should be focused on first when going to the ideation rounds. Then, the focus on the following iterations will only be on the important game fuctions shown above (Tier 1/2). The features may vary in importance after what game mode is played in the game. At this point the list is organized after the game mode "deathmatch" which is what will be used for the user experiments.

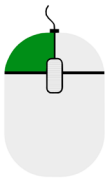
1.4.3 THE TRADITIONAL WAY

From understanding the game features, the next chapter will show how the functions should be accessed with the current gaming set-up used for Counter Strike - Global Offensive. Therefore, here will be shown through illustrations what keys or keys combinations must be pressed to activate functions in the game and play the classic way of CSGO.

TIER 1 FEATURES

RUN

WASD keys



AIM AND SHOOT

Left mouse click and mouse sensor

TIER 2 FEATURES

CROUCH

Ctrl key

RELOAD

R key

JUMP

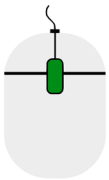
Space bar

SLOW WALK

Shift key

SWITCH WEAPONS

1-5 or mouse wheel



TIER 3 FEATURES

DEFUSE OR PICK UP WEAPONS

E key

DROPPING WEAPONS

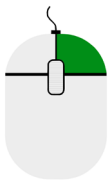
R key

BUYING

B key

SCOPE

Right mouse click



CONCLUSION

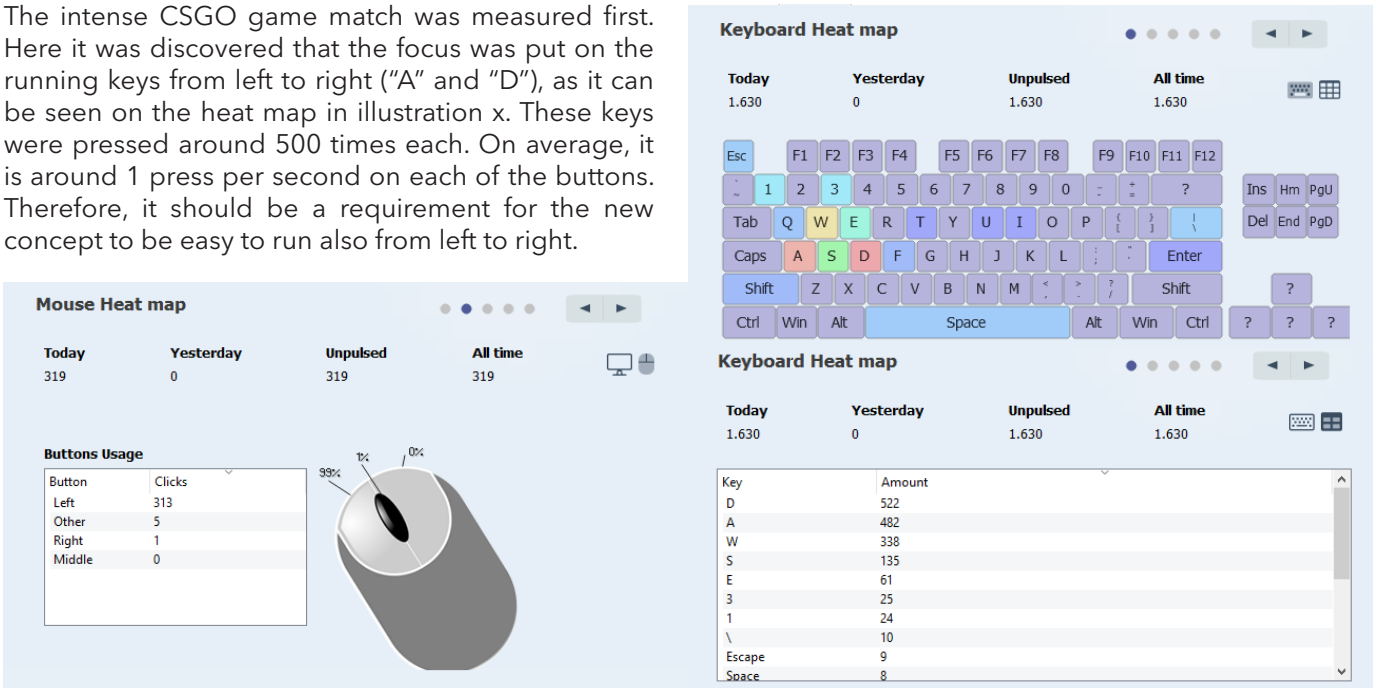
It can be seen in the illustrations above that the gaming set-up for CSGO consists on two devices: the keyboard and the mouse. Both must be used together simultaneosly to be able to not only press fucntions, but also combine them so it creates a game play. It cannot be played one without another. Moreover, the keyboard has keys that must be combined to create more than half of the functions. Therefore, it can be seen that the mouse is the most easy tool to access the game through, as it has direct buttons for the functions, and no need of key combinations. It is a handy tool. The downside of it, is that it cannot create a game play alone. This fact pushes the project in the direction to explore what solutions can be added to a potential tool that operates like a mouse and unfold further possibilities.

1.4.4 PERFORMANCE PARAMETERS

Here there are mesaured CSGO performance parameters that can reveal an approximate number of key presses that must be achieved during two types of game sessions. First, it is measured the performance of a 10 minutes game match which is haracterized by high intensity. Secondly, it is measured the average gaming mode of 45 minutes that uses more functions on a lower pace. Finally, the results of both games are compared and there is set a goal of key pressings that must be achieved by the new device which will be created during this project (App 14). The parameters were measured with a mouse and keyboard tracking software on the computer where the game was tested.

01 INTENSE GAME MODE

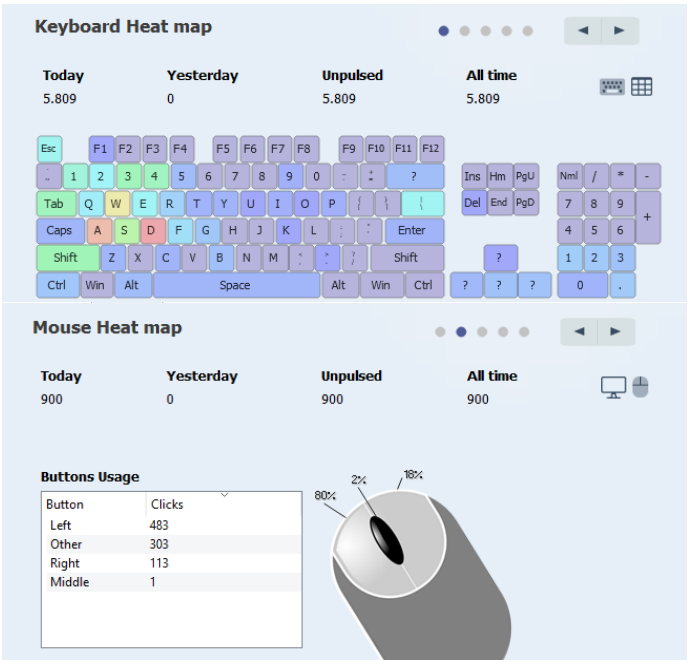
The intense CSGO game match was measured first. Here it was discovered that the focus was put on the running keys from left to right ("A" and "D"), as it can be seen on the heat map in illustration x. These keys were pressed around 500 times each. On average, it is around 1 press per second on each of the buttons. Therefore, it should be a requirement for the new concept to be easy to run also from left to right.



ill 41. Performance data of an intense game match

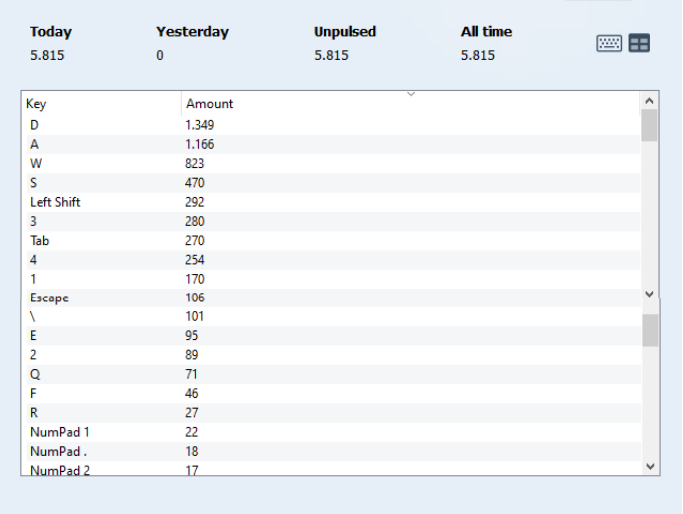
02 COMPETITIVE GAME

The first pictures show a heatmap (ill 42) and statistics (illu x) of the buttons that were pressed and the frequency of these buttons during an average game play (45 minutes) and at a high level of gaming (in the top 1% in Denmark). The competitive game mode, which is a game of 30 rounds format, it's a format where the intensity fluctuates a lot during a round. Hence, there are rarely two rounds played the same way in a row. This means there will be moments in the game where the frequency of pressed buttons is very low and other times where it will be much higher. However, this experiment aims to collect and deliver an average performance to keep in mind for the new product list of requirements.



ill 42. Performance data of a competitive game match

The most pressed buttons in this mode were the keys for running, again mostly the left and right run ("A" and "D" keys), which were pressed 1166 and 1349 times during the game. This amount of key pressings would mean around 40 to 50 presses each round. (out of 30 rounds in one 45 minutes competitive game).

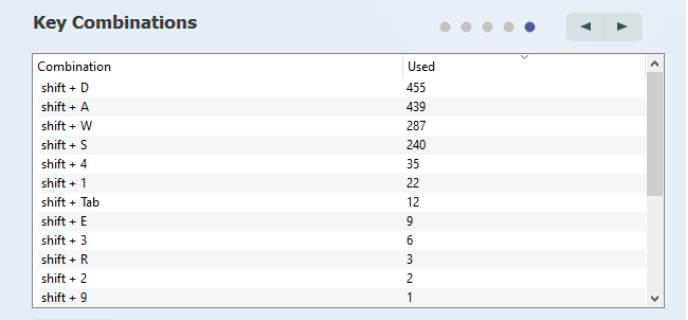


Today	Yesterday	Unpulsed	All time
5.815	0	5.815	5.815

Key	Amount
D	1.349
A	1.166
W	823
S	470
Left Shift	292
3	280
Tab	270
4	254
1	170
Escape	106
\	101
E	95
2	89
Q	71
F	46
R	27
NumPad 1	22
NumPad .	18
NumPad 2	17

ill 43. Keys pressed in a competitive game match

Last picture (illu x) shows a total of key combinations that have been pressed and their frequency during the same game. The numbers show a new requirement that must be taken into consideration, which is that it should be possible to use the function "walk" in the same time with the function "change weapons", "run", "reload" and "jump".



Key Combinations

Combination	Used
shift + D	455
shift + A	439
shift + W	287
shift + S	240
shift + 4	35
shift + 1	22
shift + Tab	12
shift + E	9
shift + 3	6
shift + R	3
shift + 2	2
shift + 9	1

ill 44. Key combinations of a competitive game match

CONCLUSION

The competitive game of 45 minutes shows a balanced average of the pressed buttons intensity and frequency. However, in this game mode there are times where no buttons are pressed as well, so the measurements are not always accurate and they do not show parameters of the keys pressed at intense moments. Whereas, the 10 minutes match gives a better understanding of intensity and frequency for buttons pressed in intense moments, since there is action all the time.

From the measurements above and following calculations of parameters, in a competitive 45 minutes game there are pressed around 1,5 to 2 buttons per second. On the other side, the intense game plays shows moments where the buttons are pressed up to 3 or even 4 times per second. In the next chapter there will be created a list of requirements that states all these parameters, together with a sum-up of the whole chapter 1 in the project framing.

1.5 FRAMING SUM-UP

This chapter has as purpose to collect all the data from the whole chapter 1 into the project framing and into the method called a design brief. Here will be visually represented the project requirements, vision and mission along with the project description and target group.

DESIGN BRIEF 1.0 (WS 05)

COUNTER STRIKE - GLOBAL OFFENSIVE GAMING DEVICE FOR PEOPLE WITH CEREBRAL PALSY

Description: A device that can be easily used by one hand or part of one hand and fingers, convenient for users with coordination problems, hard movement of muscles or joints. The device will contain all game functions in the same place, being handy to play with one body part. It will contain the basic inside components like a usual mouse, but with a different exterior structure.

REQUIREMENTS

Ergonomic -
good hand comfort

ill 45. Ergonomic icon with a shape fitting the hand

Multifunctional –
to be able to use multiple functions with one device

ill 46. Multifunctional icon with a hand controlling more objects

Lightweight -
easy to grab and move

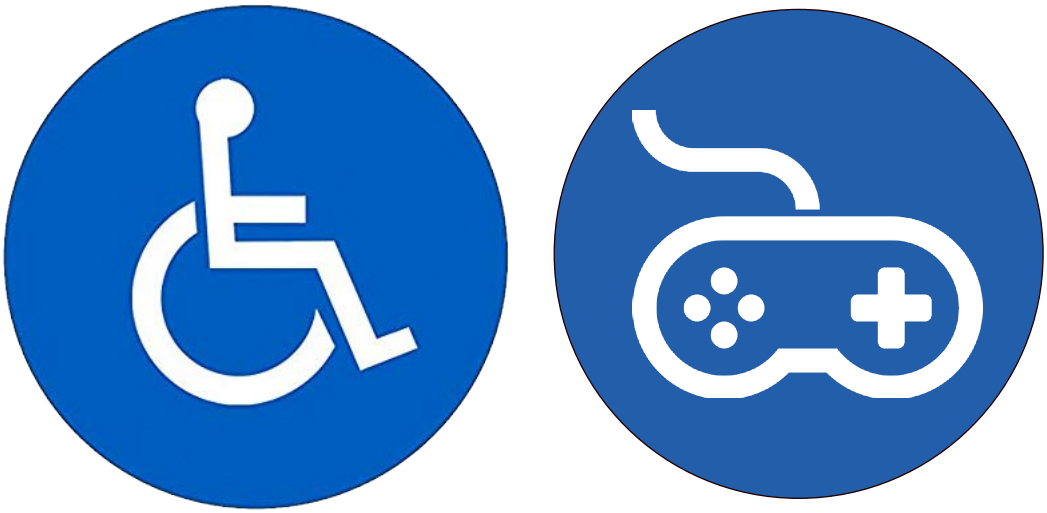
ill 47. Lightweight icon with hand holding a feather

VISION

Given by the quote we first heard from a user with cerebral palsy in an advanced stage
- "I don't feel my disability as much when I am playing. [...] It makes me happy to be included" -
This project's vision is **to include people with cerebral palsy in the society, giving them the power to escape their disabilities and do activities that makes their every day better even just for a couple of hours.**

MISSION

Help people with cerebral palsy and other disabilities to participate in a popular entertainment activity, the E-sport, where they should not only be able to enjoy playing by themselves, but also compete with ordinary users and have satisfaction by performance.



ill 48. Connection between a person with disabilities and gaming controller

PROBLEM FORMULATION

More and more people with disabilities want to live a normal life but cannot be included in ordinary entertainment activities, which the gaming community is part of, due lack of easy and accessible equipment for disabilities cases. (App 11)

TARGET GROUP

People with cerebral palsy from level 1 to 3 that like gaming and can use at least one hand. The focus is on cerebral palsy but also on disabilities that has the same output: at least one healthy hand.

CONTEXT

The game Counter Strike - Global Offesive is the context where the gaming will happen between target user and gaming device.

2 CONCEPT DEVELOPMENT

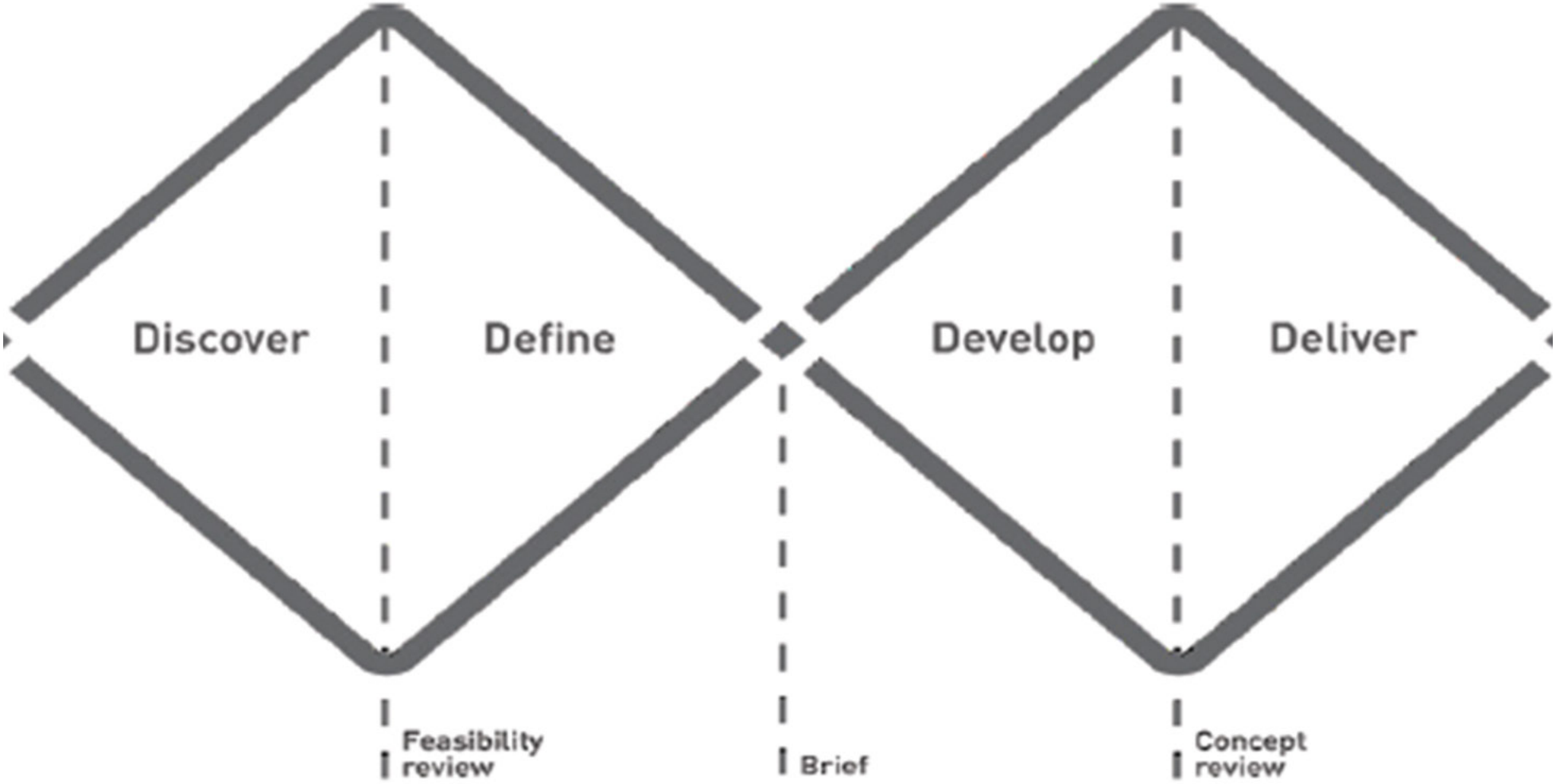
The whole conceptual process was based on mixed methodology where concept development was combined with research. By following the Double Diamond method there were achieved rich solutions filled with ideas and experiments, but also with feedback and further research implementation.

In total, there have been made three concepts following ideation rounds and mock-ups (quick and dirty). These methods helped with understanding of how the real prototype would look like, how it would feel in the hand and what parameters are crucial for a good design. The three concepts were made in a way that can express from crazy ideas to simple and something in between.

The first prototype, based on a non-traditional idea, was the most unusual to deal with. For this one the approach was to think outside of the box and try to focus on the requirements that a person with disabilities could have. Hence, a 2-in-1 idea of a device was created and for this concept it meant an arm support connected to a mouse base. The functional principle was of a joystick on top of a mouse, that each has independent movements. Nevertheless, their connection also leads to the challenge of 2 different movements in the same time that are not meant to happen.

The next concept, was a more relaxed prototype which kept some of the features in the first 2-in-1 arm support joystick and mouse base. This one was a hand support ergonomically made that had the goal of a comfortable shape for the hand. However, the challenge was the look of this hand support. It was interesting, yet not recognisable for the users that have tested it. And for every new product appearance, users need more time to get use to it - if they even choose to. Here it is first shown a challenge that is about the learning curve, and how fast do people get used to such a new device, or if they do.

Finally, the last concept was the most recognisable prototype, that kept the 2-in-1 idea of device, but adjusted to what customers prefer in terms of interaction. This idea was validated by 100% of the tested users, that they will still prefer a device that looks or feels like something they used before. This is how the 2-in-1 mouse idea was born, and it had the most iterations and changes compared to the previous concept versions. It was therefore adjusted until the final version was reached, in what we would call **"the mouse for all"**.



ill 49. The Double Diamond Method

2.1 INTERVIEWS

A first step was taken before ideation into meeting different types of people with cerebral palsy from the target group. Thus, before starting sketching tools for hands, the action was to know how the hands from different levels of cerebral palsy work. There were conducted interviews with three users that volunteer to show their hands and to tell about how is to live with a specific degree of cerebral palsy. The interviewed persons were with level 1, 2 and 4 CP.
The goal of completing this additional stage, was seeing real cases and understanding directly from the source how the hands are affected in different levels of CP. Moreover, better understanding was achieved in what and whom this project can offer. (App 43)

ill 50. Björn Nielsen, user with cerebral palsy level 1

ill 51. Jonathan Svendsen, user with cerebral palsy level 2

ill 52. Michael Thyregod, user with cerebral palsy level 4

" It took me many years to learn to tie my shoes, because that's an activity where you use the fingertips a lot. "

" When we're talking about computer games - especially shooter games, I have a very hard time […] because it happens too fast for me. "

" My limited feeling and the spasms I have, that make me cramp in the left hand, leg etc. makes it just way too hard to compete. "

Lene (mother): " […] it's very limited what you actually can play when you can only use one of your hands. "

Lene (mother): " He uses some special kind of equipment made by Microsoft/Xbox, but it's not very optimal because you can't play a lot of games with it. "

Lene (mother): " […] socially it would be really great to have something to help people like Jonathan (himself) to participate. "

Caretaker: " His gaming setup works fine; we do, however, think it could be working much better if it was designed for it. The setup he uses now is something his dad put together. "

Caretaker: " He cannot use a normal mouse; it is too mobile as equipment, so the spasms would make him throw it away. "

Caretaker: "When he is playing the game, the spasms seem to calm down."

CONCLUSION

These were only few quotes to represent the real struggle these patients have from cerebral palsy, no matter the disability degree. Starting with unabilities like moving the fingertips of one of the hands, or performing fast tasks with it, coordinating hands or focusing on a task, to being almost completely unable to move and coordoante both hands, these effects show exactly what a gaming device for cerebral palsy should focus on. They all have struggles with their hands and these people cannot always be categorized in levels. Most of the times they are between levels and each person has different needs in real life. Therefore, the main points were understood better then in theory and taken into consideration for the next step which is sketching a device for these people in need.

2.2 IDEATION

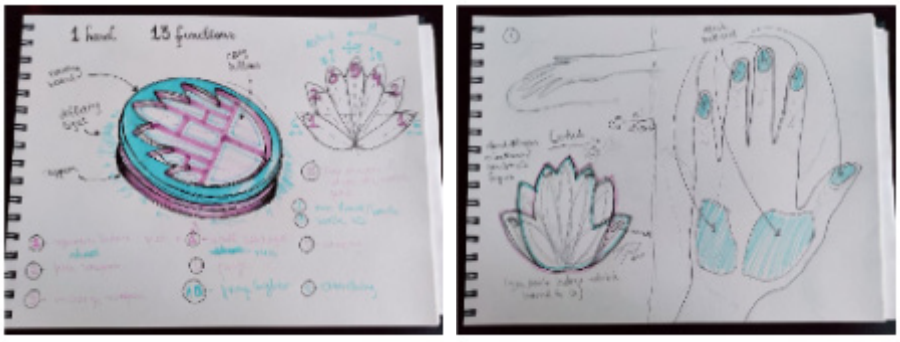
In the first chapter of the concept development the project begins with quick ideas that can implement the set of requirements. There is made one round, where different ideas are sketched regarding the technology or target user strengths. Then, the methods clustering was used to separate sketches in categories such as: touchpad, mouse or joystick techology for the hand, and pressure access for feet. From these ideas, pros and cons were analyzed and the winning concept technology was taken further in the next ideation round. Further in the process, more detailed sketches were made with the winning concept in mind, with ideating a scenario of gaming as well. The goal of this chapter was achieved by having a visual idea of what will be further on built into mock-ups materials.

2.2.1 FIRST ROUND

It starts with a broad view on the market, including all levels of cerebral palsy and other forms of hand disability. All the sketches are based as principle on a one hand interaction.

01 TOUCHPAD

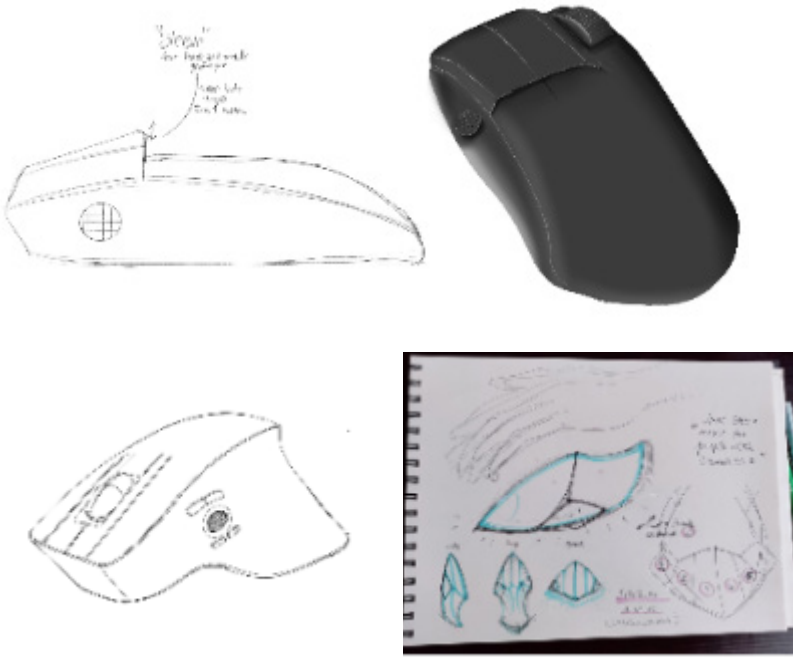
The goal of the first ideas were to reduce fast finger movements and introduce a platform for pressure (the touchpad) where it is easier to play in a manner that does not involve fine motor skills, yet it takes advantage of the disability strengths.



ill 53. Touchpad sketches

02 MICE

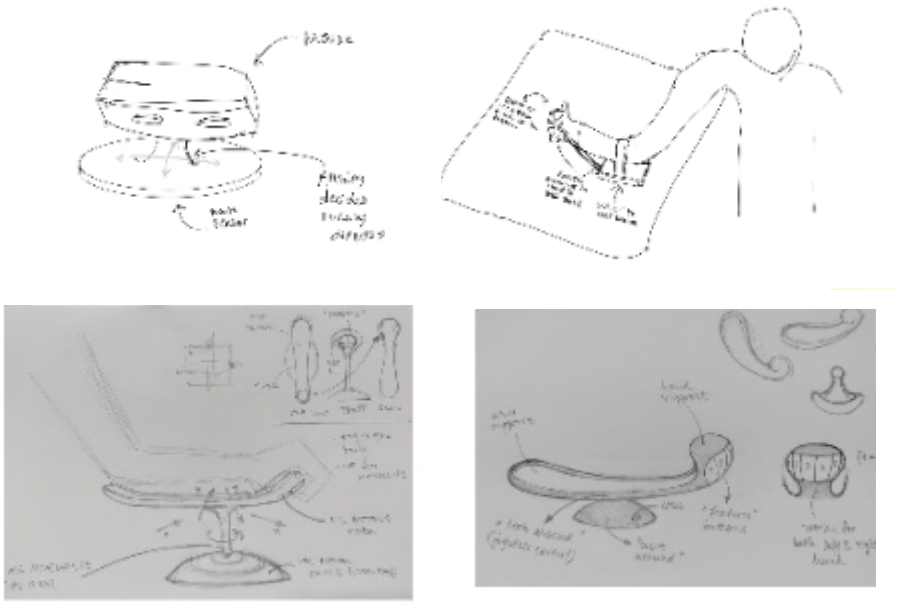
This category includes mouse technology and concepts close to the mouse shape. The buttons are assigned and placed differently, with the purpose to reach easy with the part of the hand which is functioning better.



ill 54. Mice sketches

03 JOYSTICK

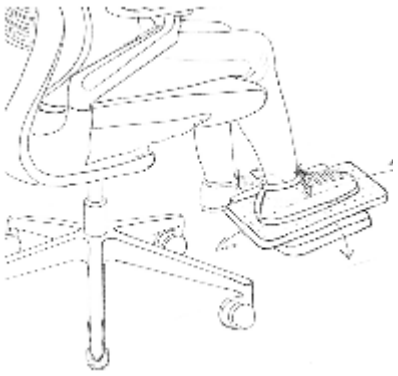
The joystick technology wsa an inspiration for how people with disabilities could play games easier. The power to grab and hold objects is more pronounced then finger movements or other fine motor skills. For this reason, new shapes were created to incorporate a joystick functionalty and enhance the hand comfort while gaming.



ill 55. Joystick sketches

04 PEDALS

This sketch was intended to represent a device operated with the foot, where there are cases for people with both hands affected in some extent. The pedals can be used alone or even as an extra piece of gaming equipment that can be connected to an existing one-hand gaming device.



ill 56. Pedals sketch

CONCLUSION

From the categories above were extracted pros and cons, as follows:

01 TOUCHPAD - The idea was good for the pressure feature, but bad for keeping the hand in the same position for hours. However it was considered further the mirror feature, that will work for both left and right handed users.
02 MICE - From the mice it is worth to take further the movement (sensor), but change the shape into a simple one as it is not necessary direct interaction with the hand.
03 JOYSTICK - The joystick control is also taken further, as an advantage replacing the buttons from keyboard into hand movements. However, the shape can be changed into an ergonomic support for the hand where all the features are reached easy by the target user without stressing the fingers and having an end for the hand to grab and hold.
04 PEDALS - This idea can be considered later in the project as an extra peripheral to a hand device, only in case that one hand is not sufficient to play alone CSGO.

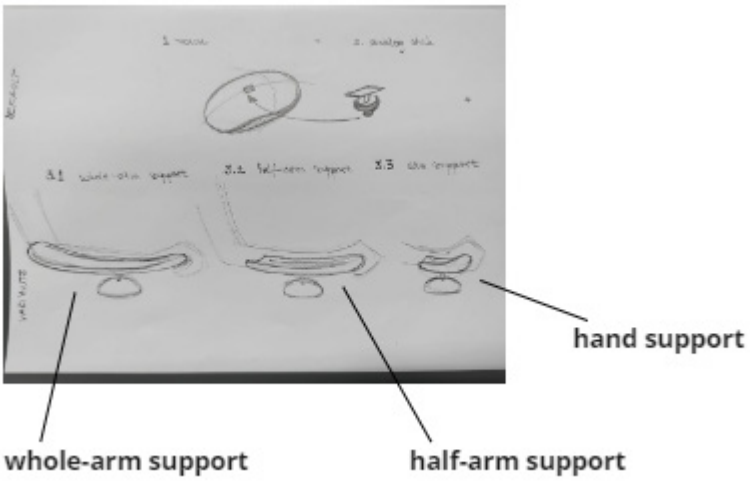
Therefore, is relevant to take further a joystick feature combined with the mouse movement.

2.2.2 SECOND ROUND

The first ideation round was taken further with the most relevant solution for the target group and techologies that match their strenghts best. Hereby, a second round was developed with the joystick technology, that was detailed and shaped in a way that supports the hand. It is consisting from a base that moves like a mouse, and an arm support on top of it that is accessed like a joystick. The goal was here to make an ergonomic device for any hand that needs support, but also for people that have spasms in both hands, considering also the level 4 of cerebral palsy.

2-IN-1 ARM SUPPORT

fig x.



ill 57. Size variants of the hand support

THREE VARIANTS

The joystick technology was taken further into the creation called an "2-in-1 joystick arm support". It combines both the mouse concept with an analog stick from the joystick concept, the last one being the icon of this idea. Playing games with only one hand in multiple directions is a challenge, but it can also be a comfortable solution for hands with problems. Here we ideate the solution in more shapes and sizes, with details such as side margins, bending degree for at the wrist level, or size of the support for arm. The goal is to have guiding sketches for the next tests with mock-ups and later prototypes.

CONCLUSION

The ideation stage is considered finalized with a detailed concept that will start on being tested. Next, a scenario for using the new 2-in-1 arm support, a combination between mouse and joystick, will be illustrated in the following section, along with the movements description.

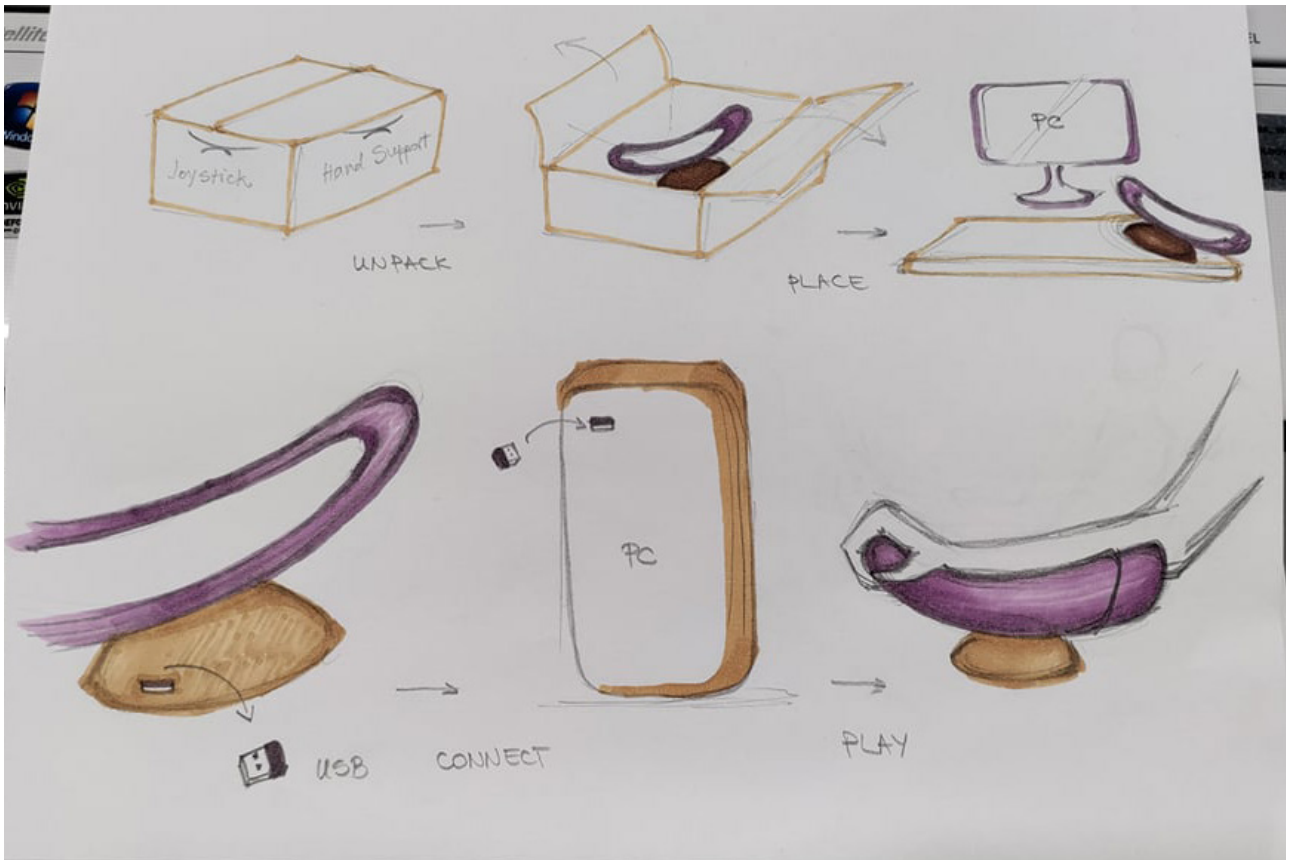
SCENARIO

Setting up and using the 2-in-1 gaming device should be simple. From the store to the home desk, it is taken fully assembled and therefore is only needed to be placed on the table side of the performant hand (left or right).

The device has then to be connected to the user's computer, with the USB stick found in the mouse base. It has to be taken out and inserted into computer, just like a normal USB for wireless mice.

After the product is connected and functional, the hand is placed on the device support with the arm resting between the support sides, and the hand grabbing the front part, where fingers will be able to reach the buttons in the back part of the support.

The user is now ready to play while combining two types of movements with one hand.



ill 58. Scenario of the 2-in-1 arm support

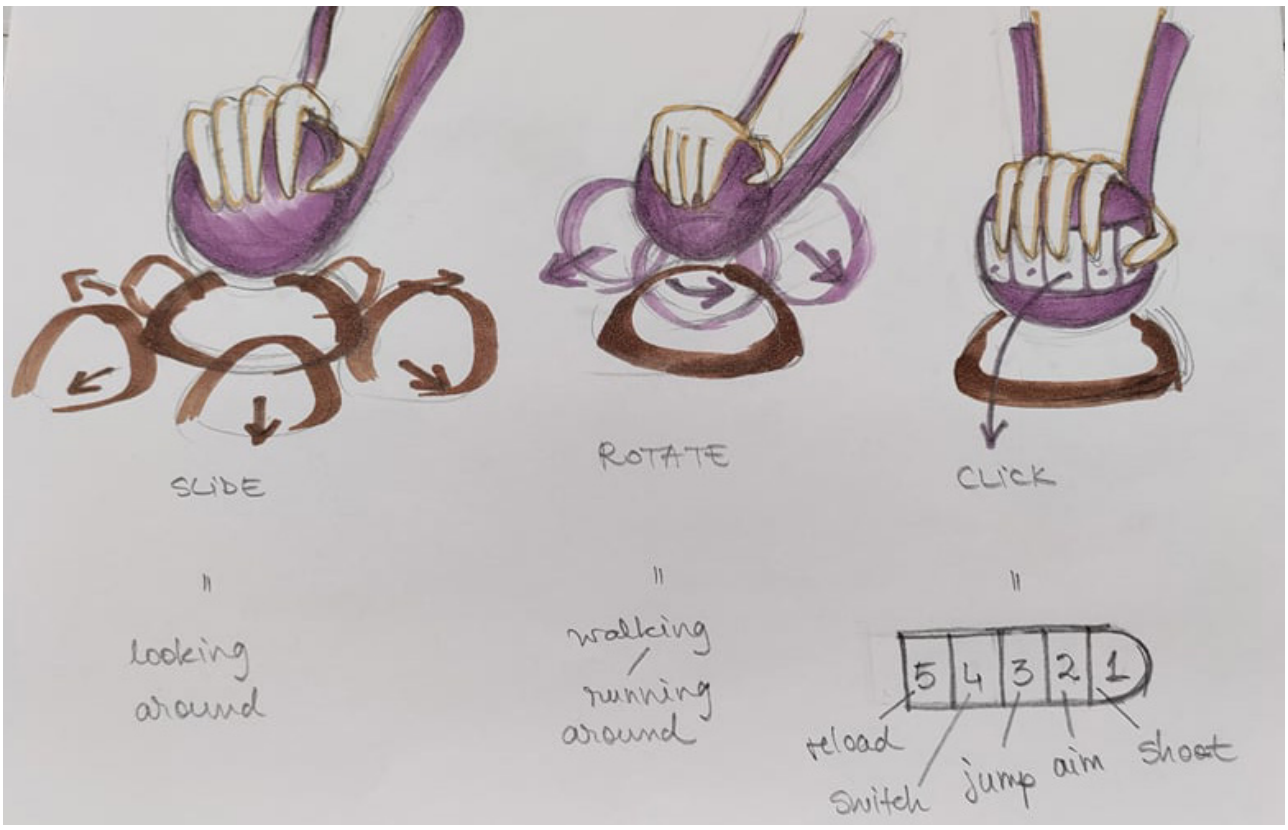
FUNCTIONALITY

As described before, the device performs both mouse and joystick movements. Therefore, the main challenge will be to combine sliding mouse movements with up, down and sides turns from the joystick movements with the same hand.

These, in CSGO will activate "look around" and "running" which are the main functions in the game. Further on, the concept will be detailed with buttons that will represent each function of the game, starting with the remaining one in tier 1 (shoot).

Each button will be assigned on the back part of the hand support. where the fingers reach them without unneccessary stress. Moreoer, they will be assigned according to their importance in the game relative to the most independent finger, or the one that has the best motor skill.

However, the buttons will be flexible for the moment, and their position on the concept will be decided after testing mock-ups/prototypes.



ill 59. Functionality of the 2-in-1 arm support

2.3 EXPERIMENTATION

The next step followed with cardboard mock-ups to represent the concept chosen through the ideation stage. Therefore, three cardboard models were made and tested further in order to compare three different sizes of the arm support (App 15). The goal was to see which size matches best the hand position and movement while gaming. the three models were tested by the team members and other healthy users. Since the focus is on designing a device with full control in one good hand, it meant the concept can also be used by healthy people. However, the first target users for this concept are people who can **only** use one hand.

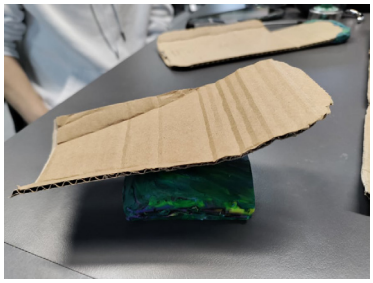
2.3.1 MOCK-UPS

ill 60. Three cardboard variants

THE SHORT VERSION

First variant is a short hand support that only covers palm until the wrist. It has side margins to support the hand when tilting left-right. The movement is simulated by a clay model instead of a mouse, which serves as base for the cardboard support. They are connected with a pillar that simulates an analog stick's movement.

After trying this model on different user hands, it was observed that the support works well in terms of flexibility and control. Being small makes it easy to tilt and rotate the 'joystick' while having the side margins help direction and control the arm.



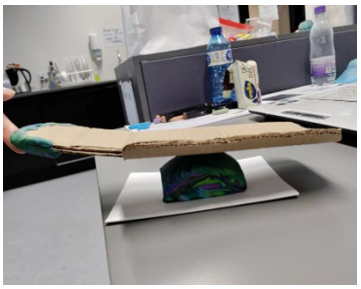
ill 61. Small variant

THE MEDIUM VERSION

It was built in the same way as the small model, but this one is covering up until half of the arm.

This way the user has better support and is able to control their hand when gaming by having side margins that hold the hand when tilting.

The arm has a higher level of support, and therefore some degree of flexibility is lost. In the iterations with the prototype below, the questions to this challenge will be answered.



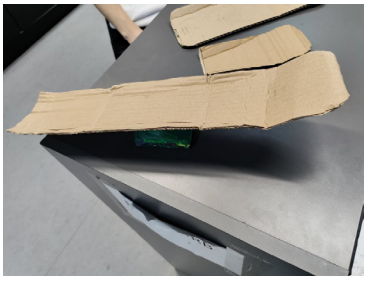
ill 62. Medium variant

THE LONG VERSION

This variant is the longest of them all. It overs both hand and arm until elbow and deliver the best support, almost like a chair hand rest.

However, being this long restricts most of the flexibility of the hand, so the control is also lost by arm restrictions.

For this reason t was decided to not go further with this variant, since gaming means rapid movements which can only be made by a flexible, free device.



ill 63. Long variant

CONCLUSION

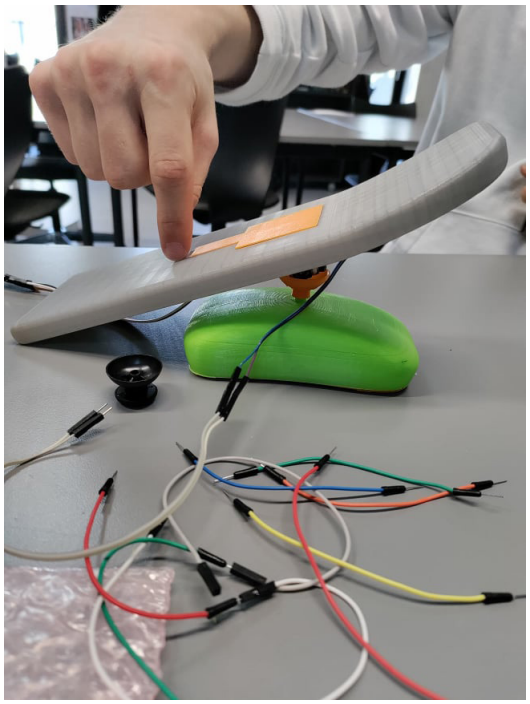
The challenge here is to find the perfect ratio between size and control. The best control gives the user the best gaming experience. This depends both on the hand support and flexibility parameters, and therefore a balance between these three must be achieved. The next goal is to experiment with a detailed physical model and evaluate the user movements with it, thinking in parameters such as comfort when gaming. To concept models helped also with finding a proper position for buttons that will represent functions in the game, regarding hand ergonomy and good control.

2.3.2 PROTOTYPING

PROTOTYPE 1

The first prototype built took the medium variant arm-support further into experimentation. Starting with this variant, a functional model was started to be created. The purpose of a functional model was to get feedback on the gaming activity while using an arm support. (App 16)

The prototype was built with a mouse sensor, from a mouse which was dissasembled. It was put in a 3D printed shell, that slides on the surface on the table to control the aim in the game. The 3D printed handle on top of the prototype was linked with the bottom part of the prototype with an analog joystick to control the movement in game, by rotating the hand in the direction the charracter should run. The shooting button is taped on where the pointy finger is, to easily be able to change its position. The analog joystick and the button is wired and programmed with an Arduino Leonardo, which is able together with a software called JoyToKey to convert the data recieved from the components into the buttons "WASD" and the left mouse click.



ill 64. First prototype - the arm support

CONCLUSION

Even though the experiment took a long time, it came out with a positive result, which is the fundament for the project start to test the concept idea, and gain a "proof of concept". The first prototype buildind helped gaining a better understanding of how to build future prototypes and how to program or wire extended versions of the product in the future, as this experiment was the ground work of the coding.

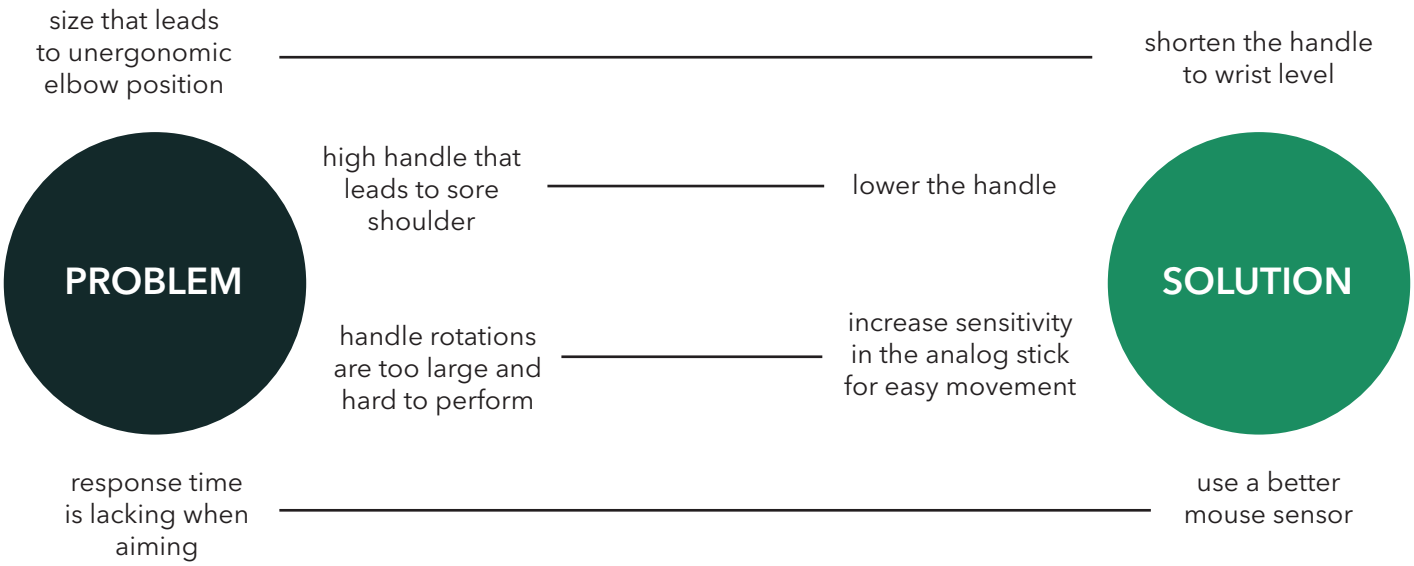
ITERATION

Testing prototype 1 was done with healthy users, which ge the project closer to a "proof of concept". The first test was a "self-test" to see if we could spot some obvious things that needs changing right away. (App 17)

Immediately we noticed how the armrest got in the when playing with it. When the handle was pushed downwards to run straight, it pushes the elbow up and creates a very unergonomic position. Another very noticable thing, was the height of the handle, which was the reason for a sore shoulder, after using the device just for some minutes

Tests were conducted further with three users with no physical or mental handicap and minor experience in shooting games, to see what problems they initially had with the prototype. The test was around 10 minutes each. They all initially had the same issue with the prototype as we observed ourselves, but some other concern aswell, which will be listed below together with potential solutions to the problem. However the problems, all of the test subjects said it was easier to control than they expected after just a few minutes of playing and they all enjoyed the experience and smiled mostly throughout the test.

ill 65. First prototype testing

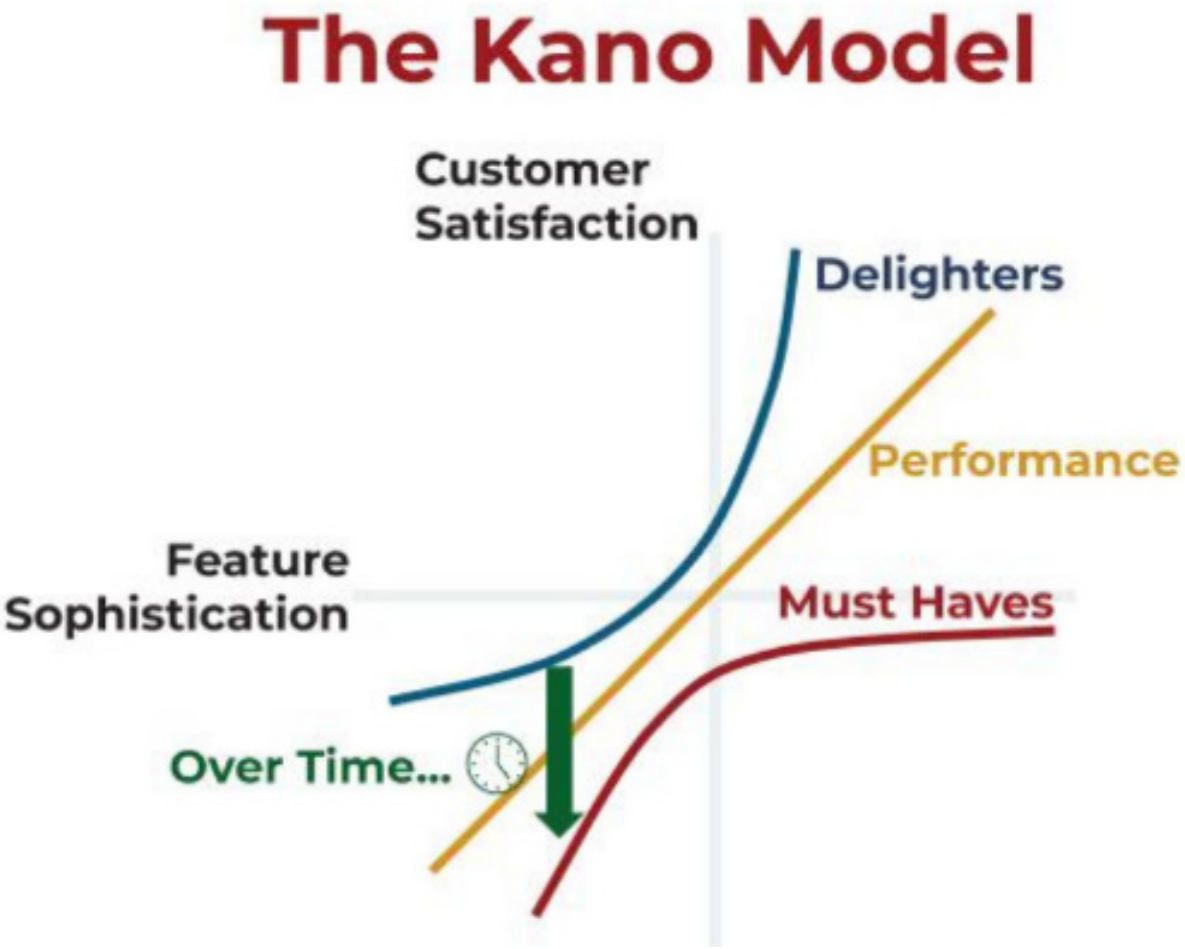


CONCLUSION

Even though the feedback was good, the structure of the test was confusing and it is unknown whether the test subjects have been a little too in tune with the project. The pictures and film is limited because the test was very impulsive, with little prework to find out exactly what to ask the users. Therefore, in the future test, the test subjects are categorized to understand what the data we get from it means. Moreover, anew goal is to test the concept on people with no experience in shooter games and compare their playgame with a regular setup with the new prototype. This way a learning curve will be analyzed from normal set-up to new set-up (the prototype), from a neutral point of view.

EXTRACTING REQUIREMENTS

From the first iteration that have been done, here are extracted clear requirements for the next prototype. These, were classified using the Kano model, which divides product requirements by their priority in three categories: must-have, performance and delighters. (App 13)



ill 66. Kano model

REQUIREMENT LIST 1.0

MUST HAVE

DESIGN
- Easy to use - move/press buttons
- Intuitive - should be straight forward and easy to figure out how to use

GAME FEATURES
- Run feature should be very accessible and should be usable simultaneously with shooting
- Crouching feature should be available at the same time as running and jumping
- (Shift)Walking feature should be accessible while running
- Jumping feature should be available simultaneously with the running and crouching feature

PERFORMANCE

DESIGN
- Lightweight parts - for easy and handy to setup
- Ergonomic (comfortable interaction and use)

GAME FEATURES
- Scoping feature should be available simultaneously with the running feature

DELIGHTERS

DESIGN
- Modular - fitting more users and CP levels
- Aesthetic pleasing - even though being a special version, it should not look weird, but just as cool as the normal versions
- Ability to expand the use to similar games such as FPS games.

GAME FEATURES
- Reloading weapons should not be easily available when shooting
- Dropping weapons should not be easily available when shooting
- Switching weapons should not be easily available when shooting

CONCLUSION

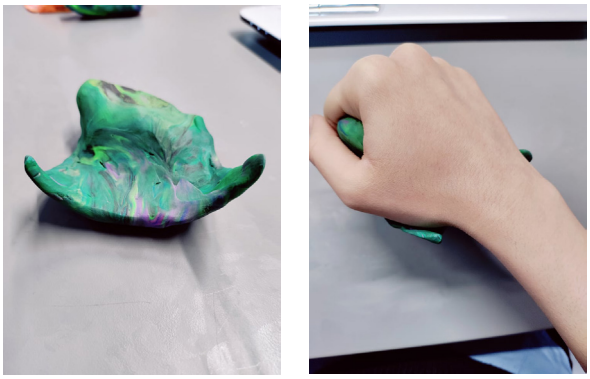
Setting clear requirements helps in guidance for making precise concepts, while organizing them by priority helps building a product in iterative steps, starting with the most important requirements and leaving the 'nice to have' features if the other ones succeed. These are requirements constantly updated based on the direction or focus shifts and experience with users from the iterations. Having a clear list of requirements was also a good method to choose a concept from the sketching rounds that fits best the list.

ERGONOMICS

This section aims to address a different topic of the product, which is the hand ergonomics. While making a functional prototype that can test the game functions, it is also a need that the prototype to have a good interaction between its shape and the user's hand. Therefore, three variants was made that tested different aspects for the hand comfort. Using a modelling clay, the hand was imprinted into the model to give the negative shape of the hand. The variants resulted were tryed on by other healthy users and one shape was chosen further for the next prototype session. However, this was combined with the set of requirements collected previously from the iteration with the first prototype, into creating a second prototype that has them all. (App 25)

VARIANT 1

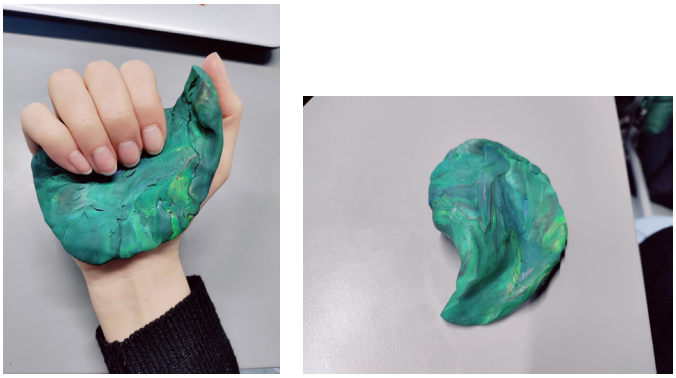
This clay support was focused on the wrist support. It is made a short size that will not interfere with the wrist. Specifically for grabbing in the hand, it has a bump at the fingers level. in the wrist sides it has supportive margins, so the hand feels protected in both wrist sides.



ill 67. The wrist support

VARIANT 2

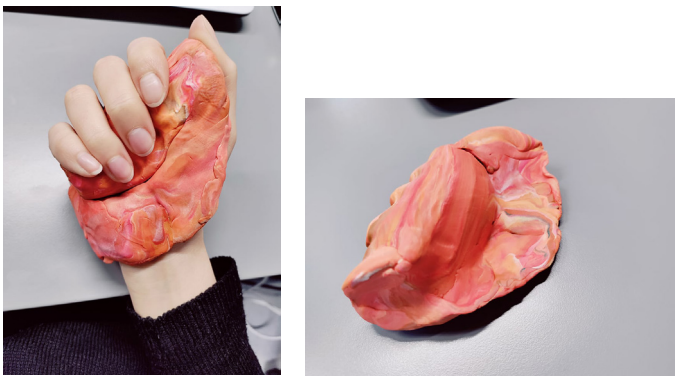
This variant has specially made a support for the thumb while gaming. It feels comfortable for the thumb, but in the same time it is missing support in the other sides of the hand.



ill 68. The thumb support

VARIANT 3

The last clay variant was modeled in such way that it combines both previous ones. It has support all around the palm, a good grip for fingers and a thumb support. This ergonomic will be tried into the next prototype together with the requirements extracted from iteration 1.



ill 69. Wrist and thumb support

PROTOTYPE 2

ill 70. Prototype 2 - the hand support

The second prototype is a hand support built on a mouse. The two has the same functions as before, joystick and mouse functions 2-in-1. The hand support was modelled in an ergonomic way, but keeping some freedom degree as well for the hand to move. After 3D modeling in the software, the hand support was 3D printed and assembled with the electronics inside.

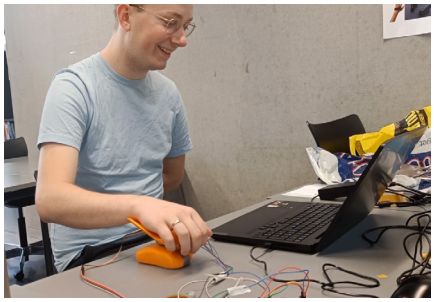
The target of the second prototype is testing with users that can operate with one hand, and get feedback on the new features implemented (in ergonomy, functionality, speed, learning curve).

The device works for looking around in the game a normal mouse, moving in game by rotating the hand in the direction wanted. For the iteration, three buttons were glued on the front part of the hand support in order, for shooting, jumping and reloading respective for the index, middle and ring fingers.

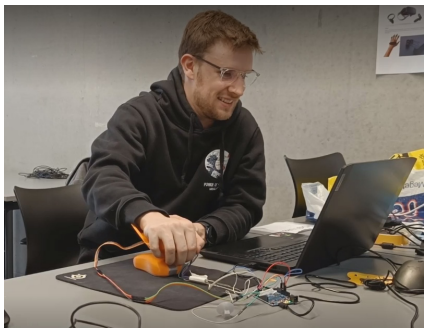
ITERATION

The product was explained to each user and the test went as follows: The game play was 2 x 10 minutes in the CSGO game mode "Deathmatch" where it is possible to walk/run around the map, and to try to shoot everyone in the way. One time (10 minutes) it was played with normal controls, the other time (other 10 minutes) was played with the new device. The order, however, was chosen by the user. The gaming tests were screen recorded and the users filmed during the iterations.

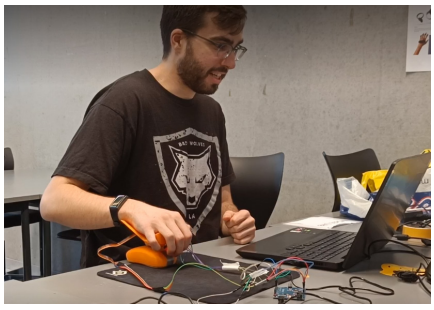
User 1: Morten , healthy user



User 2: Daniel , healthy user



User 3: Javier , healthy user



User 4: Helena,
madelung deformity user

ill 71. Prototype 2 - users iterations

ANALYSIS

The second prototype was considered rather a succes then a concept to improve. Having more pros then cons was an understanding that the process is on the right track. However, some aspects must be further improved, in the next prototype. Hereby, the iteration was analyzed in the focus categories, below.

Learning curve: After 5-10 minutes of playing with the new set-up, all users enjoyed playing at a full extent of CSGO, like with the normal set-up.

Design: Height was a problem for the whole arm that was depending on the design, but also on the table/chair set-up. Users felt their arm sore after a 10 minute match that could have been avoided with more arm support.

Ergonomy: The hand was supported in most cases and the gaming went well. There was not enough support however for the thumb, as the whole front part serves as support for the 4 front fingers.

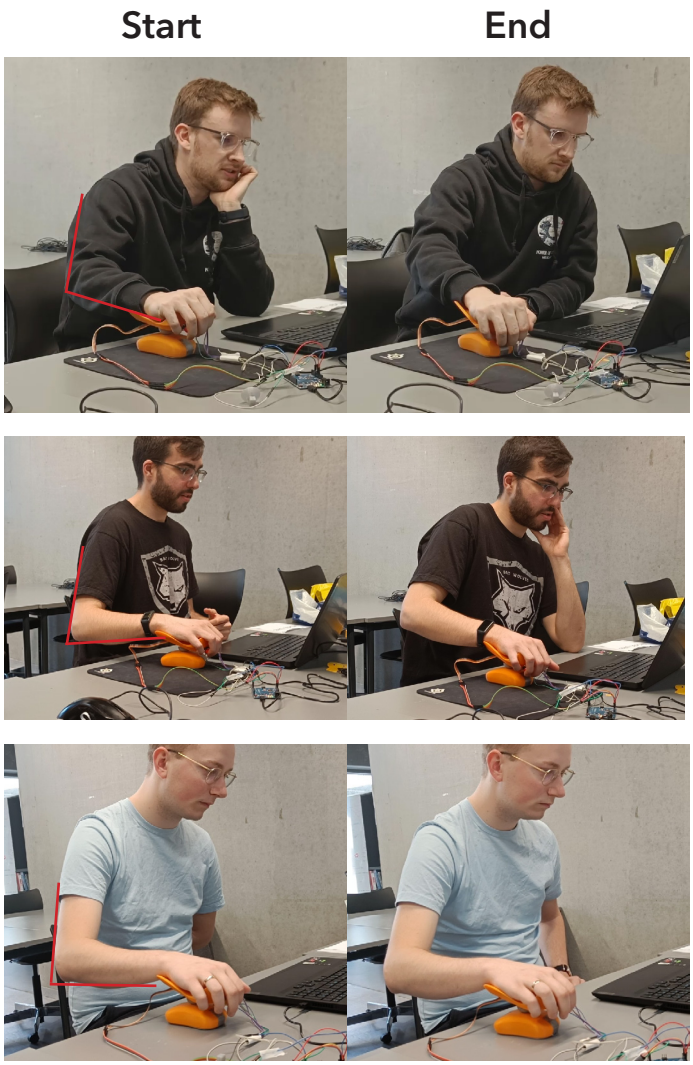
Buttons placement: The buttons attached were too few for all the game functions available. The thumb was missing one or even more functions to control, and it was not assigned to any.

Speed: The speed was measured with the new mouse sensor attached, that can be good or bad depending on how old it is. In our case was something in between, and therefore the users noticed a small diference with the better speed of performing in the game.

In addition to these, testing with another type of user (Helena, Madelung's deformity) enabled thiking of expanding the market focus for the gaming device solution. The Madelung deformity acts like arthritis which, the user tested explained, means affected joints in the arm by bones disalignments. This condition affects users by not being able to use a normal mouse set-up, as prolonged use of this gives them pain. While the common devices have bad effects om these users, the ergonomic hand device created in this project was a better experience for such user, in supporting wrist and using only one hand to play, which was easier in their coordination problems.

The next step is to improve the current prototype requirements and to test again for new feedback. The new iterations will have the same settings and will be recorded within the same structure.

One of the main takeaways from the first test was the users arm position through out the whole test.



ill 72. Prototype 2 - users hand posture

As shown in the pictures all of the pictures, the test persons keep a raised elbow throughout the whole test. (App 24)

FEEDBACK - SOLUTION LIST (APP 27)

- **The device height** – needs to be as flat as possible, or one more support that extends from the mouse base part to support a sore arm
- **The joystick control** – can be solved by making the mouse base heavier, so the movement is done easier
- **The hand support ergonomy** – should be resolved in a scanning software, where the hand shape is scanned exactly like it is and the negative can be easily 3D modelled
- **Assigning more buttons** and game functions - will be done in the detailing phase
- **The aesthetics** - Form follows function; but it also follows aesthetics, visions, stories, so it needs to represent a certain design language: gaming.
- **The friction** of the mouse base on the table can be solved by sticking glossy paper on the bottom, or other material with matching surface

CONCLUSION

Making users to play with only one hand was an interesting challenge for them and the project as well, because it was inteeresting to discover how easy the new design can replace a normal mouse and keyboard set-up. Testing on healthy users showed that the new concept can successfully replace an usual mouse, as in just 10 minutes of gaming the users were totally handling it. The project has now gained the validation needed, and the next purpose is to achieve comfort, a part which is a necessary for competing for a long time in any game. The main issue was that the arm gets tired after only 10 minutes of gaming. The prototype works, however there is a need to reduce unwanted side effects (sore hand, no positin to rest). Therefore, the shape, height, and placement of parts will be redisigned in a new prototype.

PROTOTYPE 3.1

ill 73. Prototype 3 version 1 - splitted mouse

The new prototype has only a functionality purpose, and does not reflect the aesthetics of the end product. Therefore, this prototype is just a representation of the working functions, to get feedback on the features when testing through iterations.

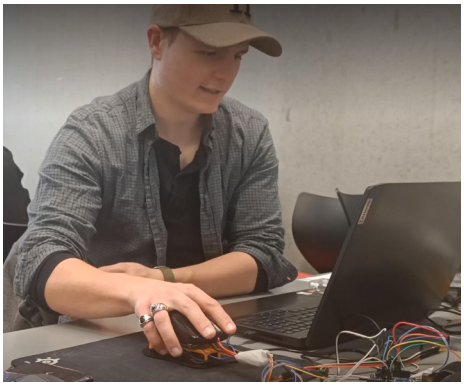
The new prototype is built from an existing gaming mouse (Zowie FK1+), giving it the analog moving feature, and re-assigned the two main buttons. The handle has been placed lower (closer to the sensor).

Regarding the buttons, "jump" feature has been changed to the push button on the analog controller (push on top of the mouse). The mouse sensor has been upgraded, as it's from an actual gaming mouse (Pixart PMW3310 optical sensor). Finally, everything inside the mouse has been tightened well together, to get a robust feeling when using the mouse. (App 29)

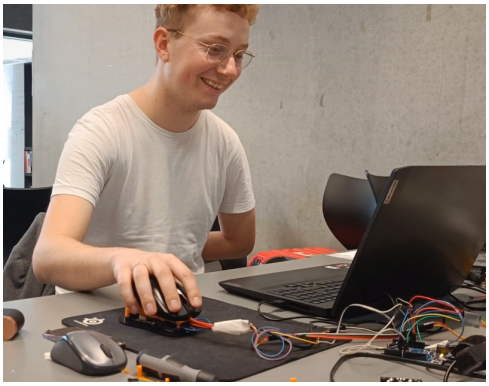
ITERATION

The next iterations will be made with the same test users, in the same context. This will allow a direct comparison between the two prototypes. The test focuses mainly on how well the mouse solves game feature/functions.

User 1: Frederik, healthy user

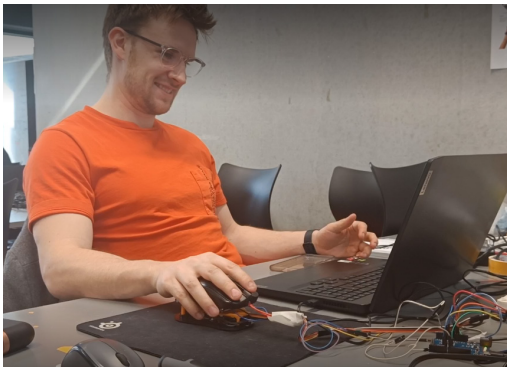


User 2: Morten, healthy user

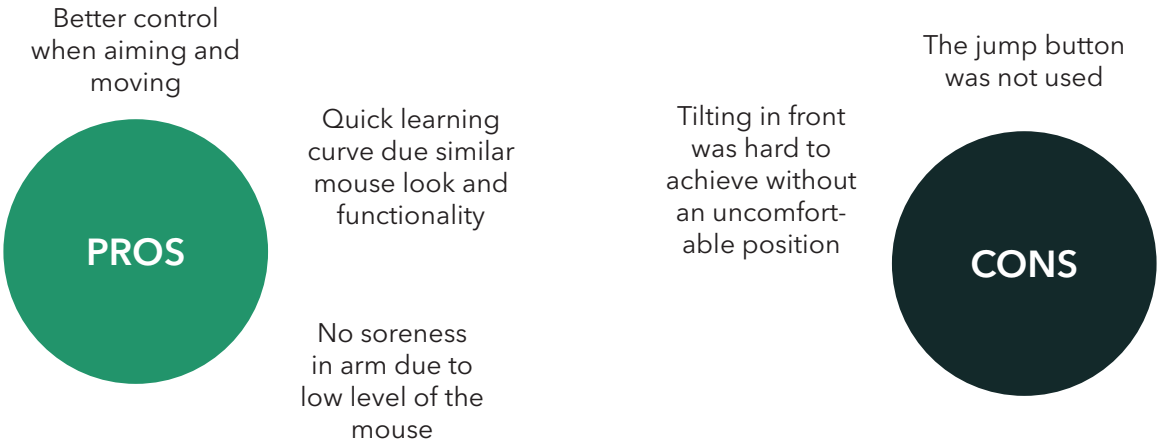


User 3: Javier, healthy user

User 4: Daniel, healthy user



ill 74. Prototype 3 - user iterations

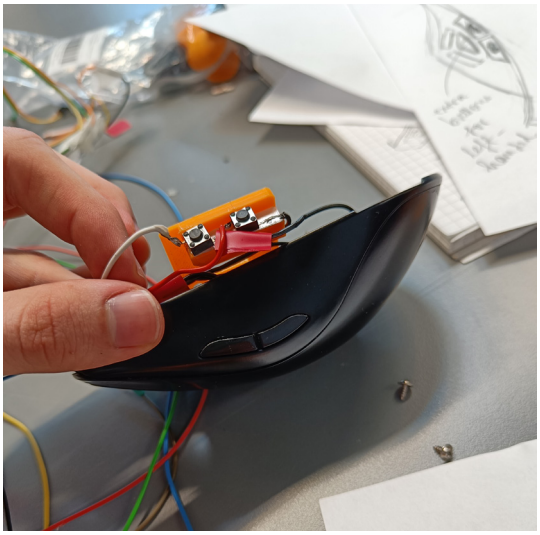


CONCLUSION

The pros and cons listed above will help in finding the solutions for the next prototype version. Hence, the pros will be kept in the prototype structure, whilst for each cons will be found a solution. First, the product angle will be changed, in a way that the prototipe will be tilted more on the back. This way the movement will be done without pain in the wrist when moving forward. Secondly, the press button will be assigned to a less used function in the game and the jump feature will be moved to a button. Moreover, buttons like crouching will be assigned to the future concept.

Another aspect to consider is regarding the environment set-up. In order to be completely comfortable with any gaming device, the chair and table settings must be made from the start in connection with the user height or hand size. Since any chair is adjustable nowadays, that is a requirement for the user itself, however this requirement will be placed in the scenario following in the next chapter.

PROTOTYPE 3.2



ill 75. Prototype 3 version 2 - splitted mouse with side buttons

The next prototype was changed only in details, such as buttons to the sides and tilted angle to the back. The shape and the rest of features that were considered pros, were kept. Therefore, 2 new buttons assigned for game functions were built in each side of the mouse, for the thumb and pinky finger. With this experiment it was important to find out if the user can use and coordinate his all fingers in the same time and how hard will that be. Moreover, the analog stick was tilted back for an easier wrist movement.

ITERATION

The iteration with the new variant of prototype was done this time with a context user, and it had a bigger goal: to see how a person with cerebral palsy use the new device, or if it is even possible.

The most important question was to know if our context users behave the same with their healthy part of the body as healthy users and to learn if there are differences between a healthy person's hand and a healthy hand of a CP user. Questions like "Can cerebral palsy people have a perfect functional hand?", or "Will the other hand affect the healthy one?" and "How good should the healthy hand work?" were just the beginning of this challenge.

Therefore, the user interviewed was a 10 years old child with some gaming experience but that couldn't play CSGO even with the 'special' gaming devices on the market. He was interviewed before in this product's process and now he was eager to test the new concept. (App 14)

Hereby, the interview started explaining the prototype and its functionality to the user. Then it followed a 10-minutes gaming round of Counter Strike in which he only played with the new device. After the game play, he filled up a questionnaire about his gaming experience in which he gave feedback. The survey was divided in three main criteria to analyze in-depth different aspects of the prototype. (App 32)

User: Jonathan
Age: ~ 10 y.o.
Cerebral Palsy level: 1-2
Gaming experience: minor games (Minecraft, Rocket League etc.)
Devices tested: Microsoft / Xbox, not suitable for CSGO

ill 76. Prototype 3 version 2 - user iteration

ANALYSIS

Starting with the design aspect, it was observed that the user could access all buttons we assigned on the new mouse, being easy as said by him. However, the pinky finger was not used for the buttons in that side.

There was a fast learning curve, as he was just starting to enjoy playing more CSGO with the new mouse. The user found it easy to perform all the gaming tasks with his only functional hand and would prefer this set-up to the traditional mouse + keyboard.

Finally, the current prototype was successful in terms of support, as the mouse size was good, and the overall feeling was relaxed, as the user also said with no soreness or pain after gaming.

Comparison with a normal user: There was no evidence that a cerebral palsy user feels different with a healthy arm compared to a normal user's healthy hand. The difference is only to the affected hand or part of body, which becomes stiff when the healthy part is focused on a task.

CONCLUSION

The experiment went well but not with so many verbal insights, as it was expected from a child. However, recording the experiment helped understanding different aspects from his hand movements or face expression.

The main take-away for this experiment is that the user was more receptive to a mouse design then to a new ergonomic shape for the hand, which was showed to him. Due to this aspect, he found it more intuitive to learn and use the new device by its traditional look.

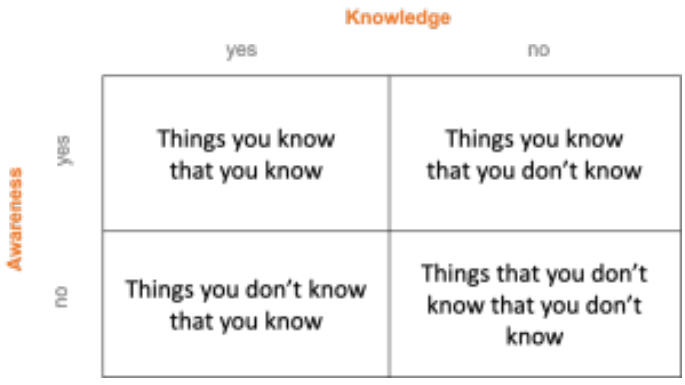
Along with his choice, with the most of the last users' tested choice that said they would prefer a basic mouse look, but also based on the equality struggles between healthy and disabled people trying to not be discriminated or treated specially, it has been made an aesthetic related decision for the final product to look like a normal mouse.

The next step therefore is to go further with more buttons on the mouse and test an even more complex prototype.

The next tests should take place with all kind of users that have a healthy hand and experiment more types of disabilities to understand what are their challenges and how many our product can solve.

THE KNOWLEDGE MATRIX

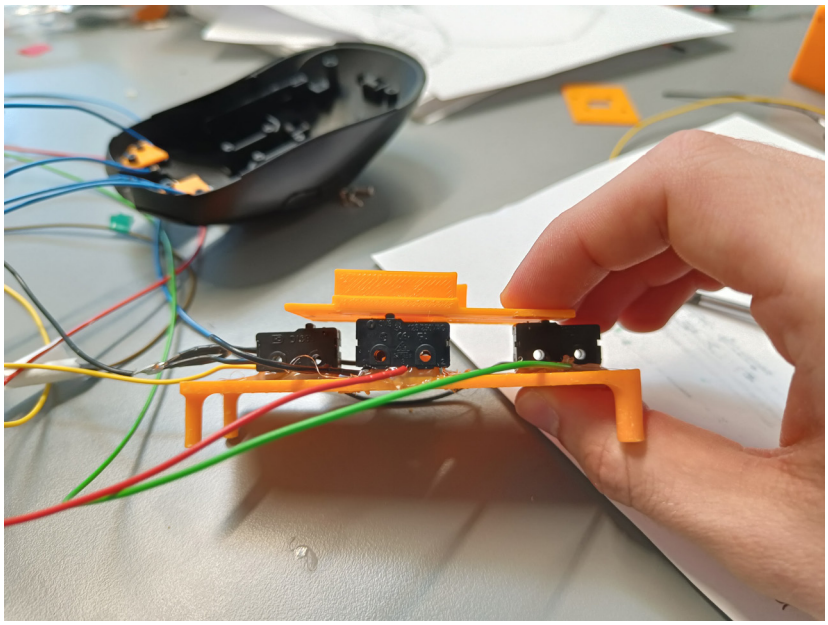
In order to know what to look for in the interview, a knowledge matrix was created and filled with the current project inputs. This model helped in creating awareness of what is known, but also in what are the unknowns that are needed in regards to the prototype-user interaction.



ill 77. The Knowledge Matrix Model

	Known	Unknown
Known	our mouse features that we focused on changing are important to test	a cerebral palsy person's perspective to our mouse
Unknown	more types of people could find benefits in using our mouse	the intuitive design aspect is also important to test

PROTOTYPE 3.3



ill 78. Prototype 3 version 3 - splitted mouse with buttons instead of analog stick

The prototype 3.3 had a structure changed with buttons instead of analog stick. Searching through technologies, it was discovered that this is a better solution when it comes to mouse similarity. The buttons that are replacing the analog stick can be pressed each direction the analog stick was assign for (front, back, left and right) with feedback in return. Therefore, when pressing all these buttons by tilting the mouse top back and forth, the "click" sound and feeling will be enough to know that you have done that movement in the game.

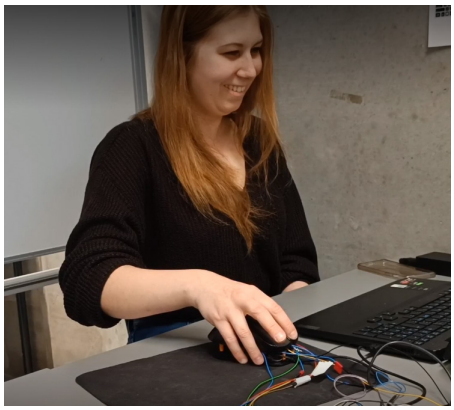
The previous prototypes were hard to guess when they were using analog stick functions, as sometimes some movements were done by mistake and it was hard to know when a function is used (for example standing still to shoot). Therefore, this idea of mouse is only improved with sound and tactile feedback and will be tested to see if it's better with buttons technology or if it's the case to go back to the analog stick. (App 33) In the interviews below it is assessed criteria such as the learning curve, speed, buttons placement on mouse, aesthetics, ergonomy and buttons feedback.

One of the interviews was with a user that can only use one hand's fingers, due to missing fingers to the other hand. For her, the experiment was fun with a positive result, as she had the chance to play something that she couldn't play before in the situation given and other products on the market.

Interview with Niki

Hand condition:
Fingers on left hand are missing

Gaming experience:
Not too much, but some like Fall Guys, Dead by Daylight, FPS (controller games/joystick)



Interview with Robin

Condition:
Healthy

Gaming experience:
Very experienced
Fps (cod, cs), dead by daylight, wow, lol

ill 79. Prototype 3 version 3 - user iterations

ANALYSIS

Overall, the new technology with buttons had good points regarding the criteria assesed: it takes just few minutes until the players get used to the design, so there is a good learning curve. Due to a new sensor, there is also a good speed achieved for the actions needed in the game. The buttons were easy to reach, the users didn't get sore after using it. the tactile feedback was in equality with the expectations and the control was better at running and standing still. The design was also appreciated and the users would consider buying such a product.

However, there were some differences between the user's hands regarding their hand saizes. The first user had a small hand size that couldn't rest on the table during a game play, whereas the second user had a bigger hand that had no problems in resting on the table while gaming. Along with this difference, some users still prefer a controller (analog stick) to the mouse with buttons. Sometimes, multiple keys on the mouse were pressed by mistake due to the rested hand on the back of the mouse.

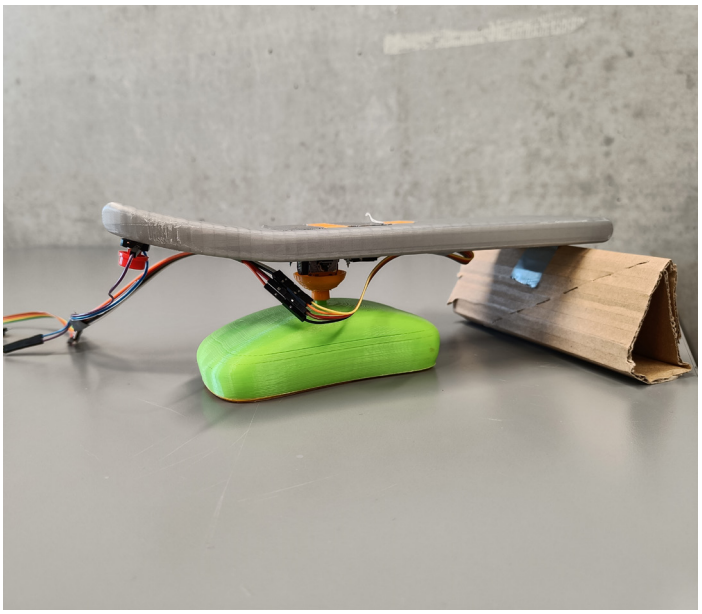
CONCLUSION

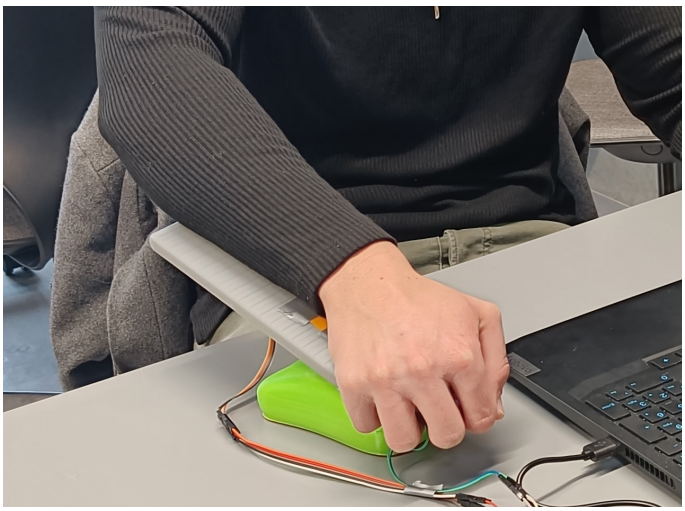
Therefore, the next improvement will be to remove half of the buttons and change the software technology in using a button to change the other buttons functions in the other half of functions remained. This way there will be a smaller amount of buttons that needs to be pressed, or can be pressed by mistake. Also, for easier hand movement with the mouse there will be removed all the wires, and thus make it more professional. Later on, the size will also be lowered in height and length dimension will be adjusted to a smaller version to meet a bigger range of users, who are especially teenagers or children which play e-sports the most.

2.4 CONCEPTS SUM-UP

In this chapter all the prototypes that have been tested so far are mapped out. The purpose of this chapter is to reflect on the decisions made and to compare results. Along with these, there will be discussed the pros and cons from each experiment to learn what changed and how. (App 34)

FIRST PROTOTYPE – THE ARM SUPPORT ON A MOUSE

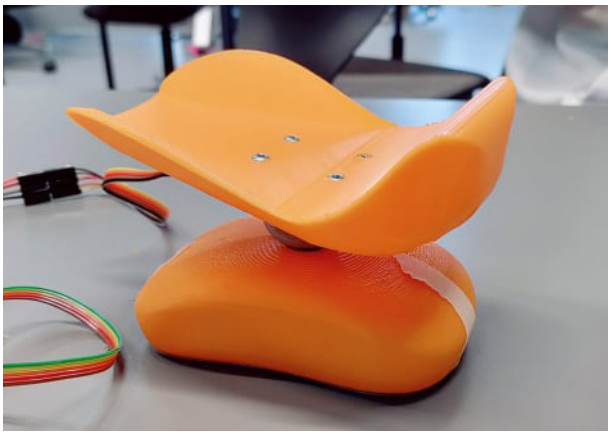




ill 80. Prototype 1 sum-up

CRITERIA	PROS	CONS	TO IMPROVE
• Control • Flexibility • Support • Comfort • Learning curve	• Arm is supported while gaming by keeping the hand position still • Good learning curve and gaming set-up	• Armrest gets in the way of elbow instead of supporting and moving with it (all directions) • High handle, that leads to sore shoulder in time • Large movements with the handle due to the analog stick low sensitivity • Response time lacking due to old mouse sensor	• Shorten the handle, so it's only extended to the wrist • Make input & output from the analog stick more sensitive so it won't require large movements • Lower the handle by putting the analog stick inside the shell instead of on top of it • Use a better mouse sensor

SECOND PROTOTYPE – THE ERGO HAND SUPPORT ON A MOUSE



ill 81. Prototype 2 sum-up

CRITERIA	PROS	CONS	TO IMPROVE
• Learning curve • Design specs • Ergonomics • Buttons placement • Speed	• After 5-10 minutes of playing with the new set-up, all users enjoyed playing to a full extent of CSGO, like with the normal set-up • The hand was supported in most cases and the gaming went well	• Height was still problematic for the whole arm, but also on the table/chair set-up. Users felt their arm sore after a 10-minute match that could've been avoided • There was missing a support for the thumb, as the whole front part serves only support for the 4 front fingers • The buttons attached were too few for all game functions available. Also, the thumb was missing one or even more functions to control, and it was not assigned to any • Speed was measured with the mouse sensor, that can be good or bad depending on how old it is. In our case there was something in between, and therefore the users noticed a small difference with the speed of performance in the game • It was hard to stand still in the game due to no feedback when moving the handle • Also, it was hard to aim due to the same concern	• Lower the handle even more, by making a new design with integrated parts • The mouse sensor will be changed to a new one made specially for gaming

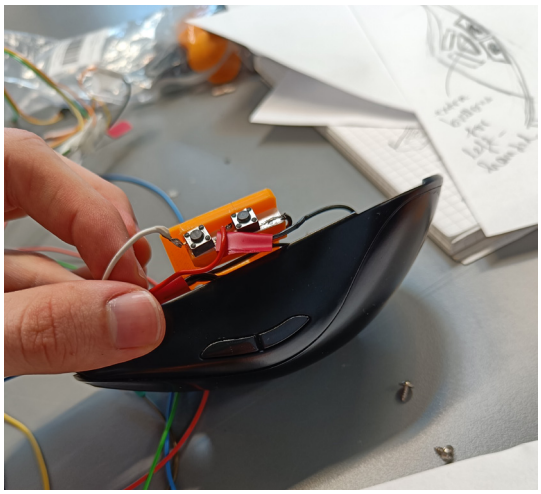
THIRD PROTOTYPE – THE MOUSE SHAPE SPLIT

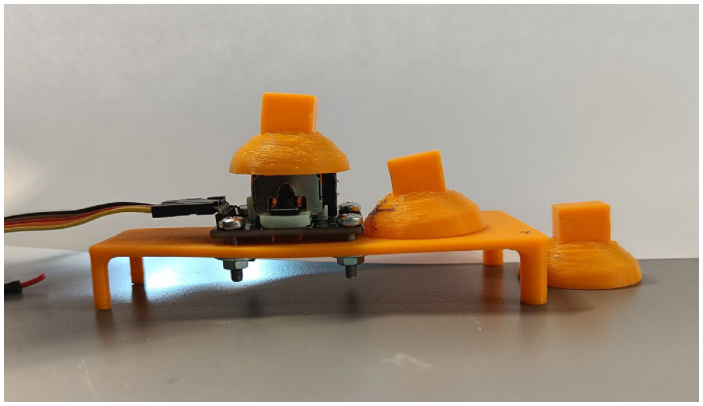
VARIANT 1 – SPLIT MOUSE WITH ANALOG STICK AND PLATFORM

ill 82. Prototype 3.1 sum-up

CRITERIA	PROS	CONS	TO IMPROVE
• Learning curve • Design • Ergonomics • Buttons placement	• Better feeling when aiming and moving • Less soreness in the arm • Better angle and position for the hand • More intuitive since it looked like a normal mouse • Better learning curve	• Didn't use the press button that was assigned to jump in the game • Still have to move the hand too much, to move forward especially	• Assign buttons differently • Make the mouse even more sensitive in order to move easier in the game • Include feedback (sound, tactile) to the buttons • Tilt back the top of the mouse • Look into the external set-up e.g., table, chair position and height

VARIANT 2 – SPLIT MOUSE WITH ANALOG STICK AND TILTED ANGLE TOP SHELL

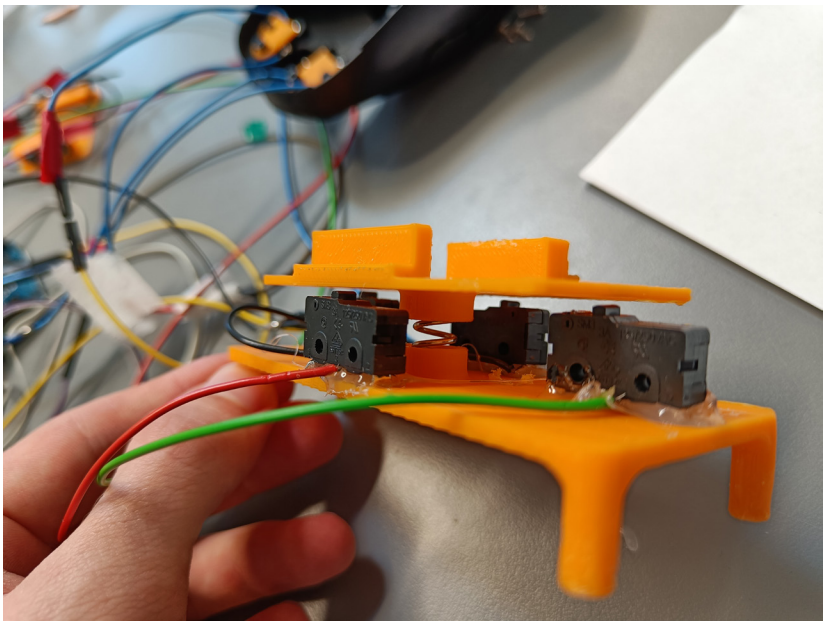




ill 83. Prototype 3.2 sum-up

CRITERIA	PROS	CONS	TO IMPROVE
• Design/ Buttons placement • Learning curve/ Abilities • Comfort/ Ergonomics	• Everything worked well this time: general feeling was fine; the buttons were intuitive placed, and the user reached a good performance in the game; the user was satisfied with the experience; at the end he was convinced to buy the product.	• The buttons for pinky finger were not used	• Add feedback to the mouse and change the technology behind, replacing the analog stick with buttons for all directions • Keep the buttons assigned for pinky finger as a mirror for the thumb buttons so the user can change itself the functions even if it is a left- or right-handed case

VARIANT 3 – SPLIT MOUSE WITH SPRING AND BUTTONS FOR FEEDBACK



ill 84. Prototype 3.3 sum-up

CRITERIA	PROS	CONS	TO IMPROVE
• Learning curve/ Abilities • Speed • Design/ Buttons placement • Comfort/ Ergonomics	• Good learning curve • Good speed for all the actions needed • The buttons were easy to reach • Good feeling after using it • Looking good • The users would consider buying it • Much better feedback • Better control at running and standing still	• Some users still prefer a controller (analog stick) to the mouse with buttons • Doesn't fit all user hands, and hence it makes it difficult for some to rest while playing • The back part resulted in accidental key presses (running backwards)	• Remove half of the buttons and change software technology by using a button to change the other buttons functions in the other half of functions remained • Remove all the wires, make it more professional

CONCLUSION

All the tests and experiments helped in improving the concept within an iterative process. It was clear that the user has a key role in the design loop of creating and testing ideas, to get feedback and improve again with new ideas and the user is the reason why a certain design was chosen.

Here will be summarized the main aspects that changed throw all prototype iterations and conclude how the feedback and changes made helped the process to go further.

It all started from implementing a 'keyboard' into the mouse, starting with an innovative research and approach on ideation and yet finished the process into the same mouse shape with 'keyboard' implemented. Hence, from A -> to B -> to A again creating a loop and arriving where we started. As much as the goal was to get out of the box with a new concept, the experiments and user interaction gave a clear output: the mouse shape is still the most ergonomic solution preferred by all and the decision are always taken regarding the majority.

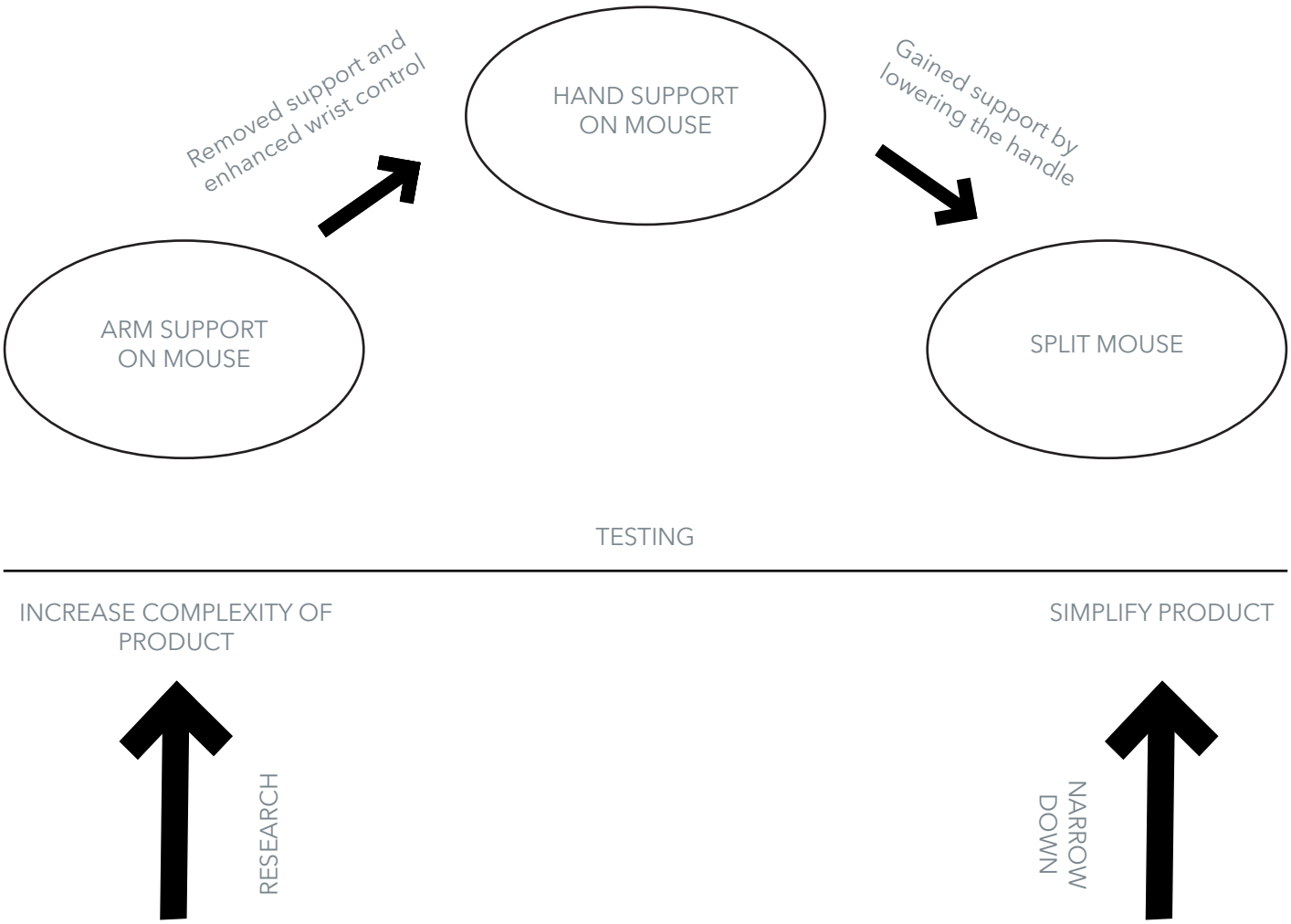
However, it was worth trying a different approach by experiencing more shapes and including different aspects into a device for one hand, as a proof for the question that many would ask: Why other shapes does not exist already for gaming devices? There must have been a reason why somebody haven't done this before, and the answer for this project case it is because of the universal ergonomic shape that the right mouse size can have.

In order to build a custom hand shaped design that each user should be comfortable with, the manufacturing of each device should be made separately. If every user would have a customized device, that would give them the best hand comfort and playing performance. However, the technological process would be too complicated to mass produce custom-made products and the price will go too high to give a break even. To show how the production method was chosen, there will be a respresentation about the prices and business case in the last chapter.

Another reason for taking a universal design and not a custom one, was that the hand needs a break once in a while from standing in the same position on the device, as gaming modes take hours in CSGO. While on a simple shape that can be grabbed in many ways, the hand would have many different positions, which gives flexibility and freedom.

Finally, the learning curve was also a key factor in the decision-making process of choosing the mouse design by the users. The conclusion after all iterations was that even if they considered the ergonomic shapes intresting and fun, they would still choose to purchase something that they are used to, that looks familiar and is intuitive to use – and therefore they would not have to learn a new way of gaming again.

In the figure below it is shown how prototypes changed from phase to phase (main features):



2.5 SCENARIO

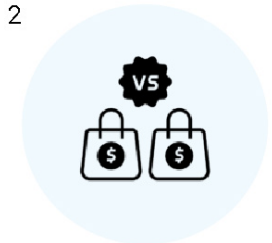
1. MARKET SEARCH

The CP user who needs a special gaming device is searching for products on the market. He looks on the internet where he can buy a broad range of products from web shops or from producers abroad, but he also searches in the local stores.

ill 85. Market search

2. COMPARISON

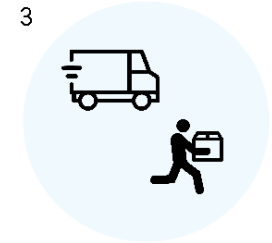
He finally finds the 2-in-1 mouse and comparing it to other related products on the market, he finds the product unique and most suitable for its qualities. He also looks at the price, being a medium range to high price and decides that it must validate its functions.



ill 86. Market comparison

3. PICK-UP

He purchases the 2-in-1 mouse and he either picks it up himself from the shop to take it home, or it is delivered to his place. The package is easy to carry, lightweight and small, and it also opens fast (or intuitively).



ill 87. Product delivery

4. MOUSE SET-UP

From the box he can see the product and immediately knows how to handle it. The mouse is taken out of nthe package and put on the user's table. He also takes out the user manual from the box where he can see step by step how to make the mouse set-up. In the package he can also find a modular hand support that can be attached to the mouse.

4

ill 88. Product set-up

5. ENVIRONMENT SET-UP

Now it is time to adjust the user table and chair (if possible), for the best hand position he can get using the mouse.

5

ill 89. Environment set-up

6. COMPUTER CONNECTION

Then, the mouse must be connected to the computer (with the USB). Setting in the game might be necessary as well, to make sure each function is assigned to the mouse buttons correctly.

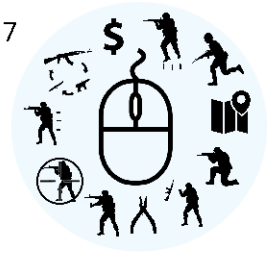
6

ill 90. Connection

7. THE GAME PLAY

Finally, the user can play CSGO with the 2-in-1 mouse. In the box a download link is included, with a notepad file and a tutorial on how to place it into the game files, after the tutorial has been completed, the buttons will be assigned automatically, and the user will be able to adjust as they desire.

7



ill 91. Game set-up and gaming

8. STORAGE

After playing with the 2-in-1 mouse, the user can keep it on his desk, or store it back in its box.

8

ill 92. Storage

9. MAINTENANCE

After use, the mouse can be cleaned with a wet paper towel to keep it disinfected, and its coating nice looking (shine/mate). In case of damage, parts can be replaced, or the whole mouse can be renewed in any electronic shop (at own user expenses). The projected lifetime of the mouse is around 2-3 years.

9

ill 93. Maintenance

3 DETAILING

In this chapter will be discussed three main topics, which are components detailing, production and cost considerations for each component and the device itself, and a detailing sum-up which will conclude with all the decisions taken in connection to the details.

First, the detailing phase starts with prototype finishing, which means adding the last components to the functional model. This stage is then followed by validating the details and their correct purpose on the mouse, by attending an event for users with various types of disabilities. Then, taking the results further, a new feedback is required from an experienced user of CSGO, this way holding focus on the mechanics of the final prototype, without any error from unknowns about the game.

The feedback regarding people with disabilities needs and prototype needs led into making the required changes into the 3D version of the model to finally have it finished and validated. While also expanding the market, idea based on the findings from the event attended.

The production considerations are listed in the second chapter, with the choice of the manufacturing technique.

Finally, in the last chapter, a sum-up of the detailing phase is made with a description of each component used for the mouse. Also, it is reflected upon all decision that has been made in this stage, regarding price, manufacturing methods, mouse dimensions and more.

3.1 COMPONENTS DETAILING

This sub-chapter will illustrate how the detailing phase was made in an iterative proces, by adding components on the functional prototype and testing it. The first step is to assign all components considering the manufacturing methods and ways in which it would be easy to assemble. Also, the details are based on giving more comfort and control to the users, by adding support where the hand needs it.

3.1.1 FIRST ROUND

The first step in detailing is to assign the last parts to the functional prototype and to make sure it works well with the last details. Therefore, the first difference in the prototype is moving the center of the bending back so it won't cause the weight of the hand to press by mistake on the back button. At the same time, it helps make it easier to press the button in the front.

The spring has been replaced with a plastic pin, to contribute to an easier assembly than it would with a spring. This principle is often used for buttons in mice, where the elastic properties of the plastic used is supposed to deform to activate a switch. It works well as long as the parts never reach plastic deformation.

Lastly, to ease the press of the front button, there were added similar thumb and pinky rests to the sides. (App 35)

ill 94. The detail components

CONCLUSION

The structure of the mouse was stabilized so the user would not run backwards by accident, as the center of the pin is directly above the point of the hand where the weight is placed. The action of running forward differed in a high degree from when the wires were attached or not. Moreover, the thumb and pinky finger rests response also differed in whether the wires were there or not. However, the changes seemed to help with the movement to the sides.

Adding these details to the functional prototype was a good way to learn that the wires change the result and may lead to errors. Therefore, the next details will include installing the mouse on a breadboard, to remove the source of error, and get a single wire as a normal mouse has.

3.1.2 SECOND ROUND

To achieve the purpose of getting a finished product feeling and utilizing all the buttons possible, the switches were wired with an Arduino Micro Pro on a breadboard. Therefore, all the excessive wires were hidden inside the mouse and the bunch of wires was replaced with a single wire connection. At the same time, the new installation made it easier to reactivate the rest of the buttons. (App 38)

The prototype details were built in to make a finished product feeling without excesive wires and activate all the possible buttons. Hereby, the goal was achieved to unlock the full potential of the prototype. The finlized prototype was tested at an event for people with disabilities, called "E-sport for everyone", that will be presented in the next chapter.

ill 95. Removing the excesive wires

CONCLUSION

The iteration ended up working well, however the resistance for the mechanism to work is too much, could lead to some sources of error. The time to construct the prototype, may have exceeded what we gained from it, even though it gave good insight, it required a lot of time that could've been spent on more important tasks.

3.1.3 VALIDATING THE DETAILS

This step was important to take in order to prove the full potential of the mouse on the market, and validate as many features of a product before it is launched. Hereby, the final version of the mouse prototype was validated at an E-sports event, hold for all people with disabilities. Participating into an e-sport event organized for people with disabilities, brought a wider understanding of the alternative users for our product (App 39). There were conducted 8 situated interviews, a method used while the users are testing the prototypes. The purpose of theis method is to obtain fresh information that comes directly as the gaming activity happens.

ill 96. Cover of the E-sport event for people with disabilities

ITERATIONS FEEDBACK FROM MORE TYPES OF USERS

01 SIZE

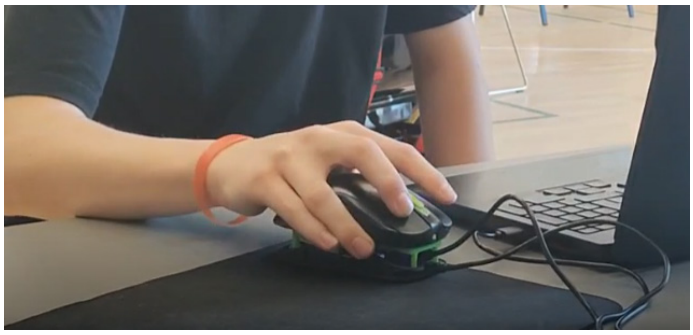
The following pictures are taken from prototype iterations conducted with the participants from the event. Overall, there were some sources of error that were noticable in most of the tests. First, the size of the prototype was too large for the majority of the participants, since it was mostly tested on children or teenagers, and for participants with larger hands it was still a slight problem.

User with small hand

ill 97. Iteration with small hand size

As it can be seen the size of the prototype causes the wrist to go into an unhealthy bend posture, to be able to put pressure on the front of the product to move forward.

User with large hand



ill 98. Iteration with large hand size

Where it can be seen on a participant with a larger hand, this isn't as big of an issue. However, his wrist still is lifted above the table, which could potentially lead to an irritated wrist over time.

03 DISABILITY

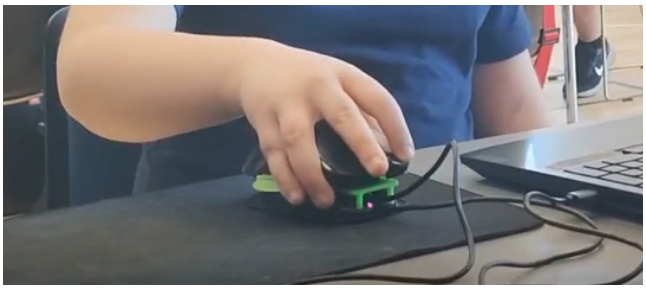
There was no guarantee that users from this project's target group with cerebral palsy of any level will be there, as it was a free-entry event. However, a test was made with an user with muscular distrophy, where it was recieved an interesting input.

After he tried the device, the user said this mouse was one of the best equipment tried for his disability. The reasoning for this is that users with muscular distrophy are able to use better weight for movement, and not rapid finger movements that other products on the market for gaming require.

ill 99. Iteration with muscular dystropy hand

02 MECHANISM

Another challenge found was tilting the mechanism to move forward, which caused some of the users to lean onto the prototype in an incorrect way, around the pinky rest.



ill 100. Incorrect hand position due to the mouse mechanism

CONCLUSION

Overall, the trip was succesful, as it was managed to get 8 participants to test the prototype. It was mostly possible to gain data on people with no dissabilities for their hands or arms. However, they led to an understanding about the device size, which was too large for the average users and the mechanism responsible for the front part too hard to push. On the other hand, it was found out that the product may have a market within people with muscular distrophy as well.

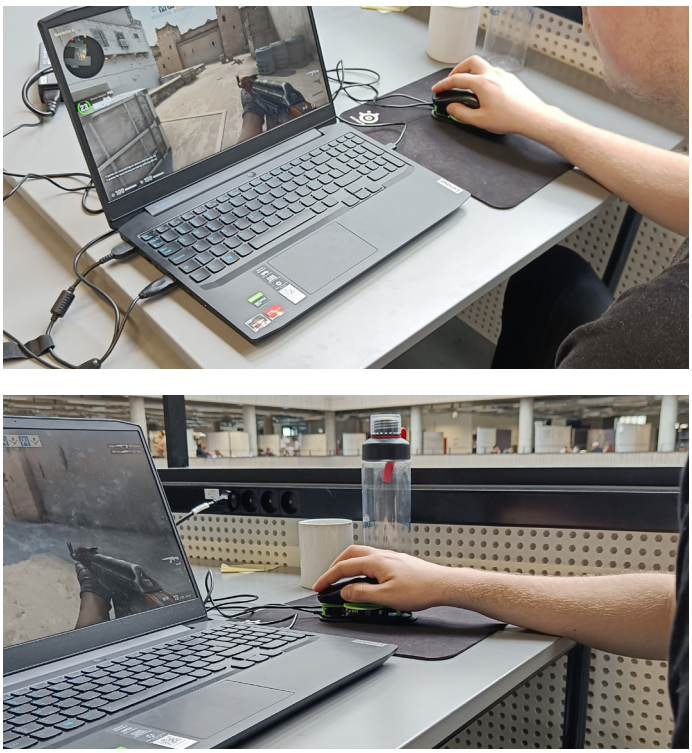
Only a few of the people who tried the prototype had experience in CSGO beforehand. Therefore, an additional iteration with experienced users in CSGO will be beneficial to tell if the final prototype meets the technical requirements of the game. As for potential future tests, it is beneficial to test if a smaller mouse size will regulate the position of the wrist and if a mechanism with less resistance could lead to a more relaxed use of the product.

ITERATION WITH EXPERIENCED USER

To get a valid understanding of the prototype techology without confusing it with the knowledge of a the gameplay that users might not have, here we test the final prototype with an experienced Counter-Strike player. (App 40)

The test was conducted on a player with around 1000 hours in the game. He told that the prototype worked well to complete the most essential game requirements. He however had one concern, which was that he wasn't able to use the buttons for the thumb (crouch and slow walk) while using the movement mechanics.

Since this is also a basic requirement present in the game requirement list (App 13), the distance to the thumb buttons will be changed for the following 3d model.



ill 101. Iteration with experienced CSGO user

CONCLUSION

The test with the experienced user on the final prototype made visible an important ability of moving in the game while crouching or slow walking. Thus, to achieve this ability, the distance from the thumb rest to the lowest buttons for the thumb should be lowered so the user will be able to press the two lowest buttons while also putting weight on the thumb rest. This feature however, will be adressed when making our the design for the product.

3.2 PRODUCTION AND MANUFACTURING CONSIDERATIONS

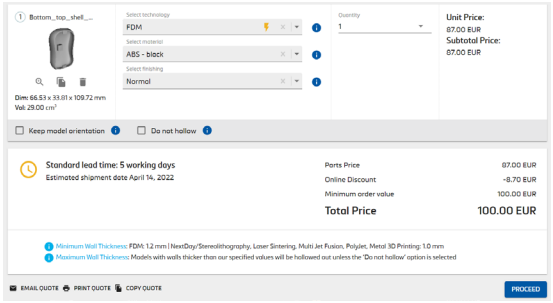
In the manufacturing chapter will be discussed two production methods used for plastis in general and for mice. As the product has same shell as a normal mouse, the materials will not be discussed further. Mice shell and components are made of ABS plastic, and so will the new mouse described here. Hereby, two plastic manufacturing methods will be compared regarding the price/quality ratio and process complexity. First, the 3D printing production method will be adressed to find out if it can be a solution for this project case. Then, the injection molding technology will be discussed following the same structure. Finally, a sum-up with the decision will be illustrated at the end of the two topics.

3.2.1 3D PRINTING

To get a quote of the unit price for different types of 3D printing, a web company was contacted via online (App 29).

FDM

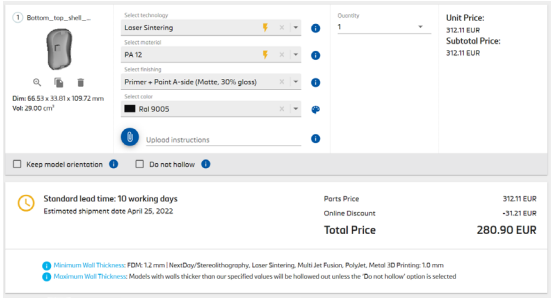
Firstly, the method FDM (Fused Deposistion modeling) was researched regarding the price. It was quickly realised the prices are very high, as a proof for the quote showing a price for the outer shell only 87 euro, without any surface finish, so lowest quality (“Materialise | 3D Printing Innovators,” n.d.).



ill 101. FDM method prices

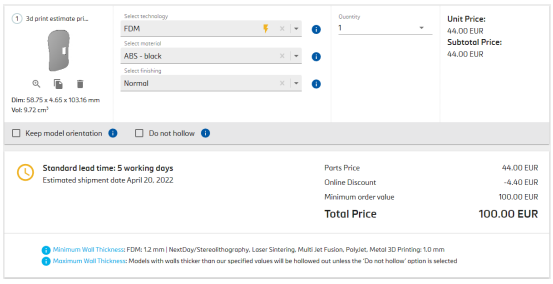
SLS

Then the SLS (Laser sintering) method was analyzed. This time, the price was taken with paint and gloss finish, and the price increased significant, up to 280 euros for the outer shell. For the product to be profitable, it would be needed at least this quality of finish.



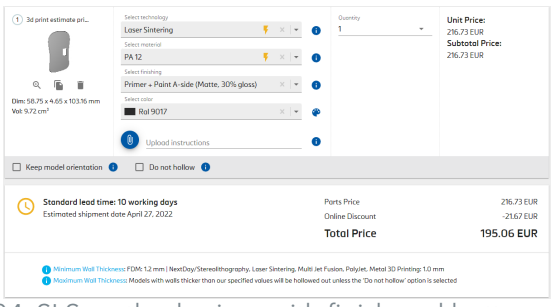
ill 102. SLS method prices with finish

The same process without finish is shown in the illustration 103, with the bottom part of the product with a cost of 44 EUR each unit.



ill 103. SLS method prices including bottom shell

In this picture (ill 104) the same process with finish, shows that the bottom will cost 216 EUR each unit, for a product with an applied finish



ill 104. SLS method prices with finish and bottom shell

3.2.2 INJECTION MOLDING

The same process was applied for the injection molding method, which meant contacting an online manufacturer specialized in plastics / mice injection molding. Therefore, the price/quality ratio given by a company was analyzed for the final decision. (App 31)

Firstly, a quote was received from a british company called Protolabs. However, after technical details about the mouse were revealed, they informed the product couldn't be done with their technology. The reason of incompatibility between company requirements and product geometry was the undercut technique that Protolabs states they don't offer.


Part Information
Product Size : 12.00 cm * 7.00 cm * 4.00 cm
Cavity : 1 | Life : <5000
Plastic : ABS
Mold Price Calculation
Mold Frame : 150.71 USD | Mold Core : 113.03 USD,p20 China Made
Copper Electrode : 113.03 USD | Total material : 376.77 USD
Production Cost : 3058.59 USD | Hot Runner : 1130.3 USD
Management Cost : 20% | Tax : 519.96 USD
Total Mold Price : 4798.8 USD
Product Price Calculation
Material Unit Price : 2.17 USD/kg | Product Material Cost : 0.06 USD
Production Speed : 60 seconds | Chosen Injection Machine : 900 Ton
Production Cost : 0.91 USD | Profit : 10%
Tax : 10% | Product weight : 0.03 kg
Product Unit Price : 1.18 USD (Note)

ill 105. Quote from Protolabs

Next, a company that offers injection molding with undercuts was found in China, which is called Emold. net. These manufacturers offered a price for both shell parts that need molds, 4.798,8 USD for the upper shell and 3.270 USD for the bottom part (around 3.2967 and 22.464 DKK). Furthermore, a unit price for the two parts costs only 1,18 and 1,13 USD, meaning approximately 8,11 and 7,76 DKK.

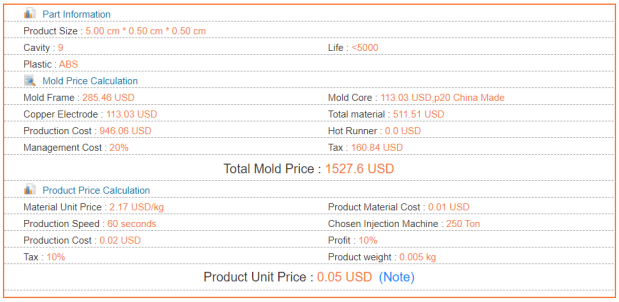

Part Information
Product Size : 12.00 cm * 7.00 cm * 1.00 cm
Cavity : 1 | Life : <5000
Plastic : ABS
Mold Price Calculation
Mold Frame : 150.71 USD | Mold Core : 113.03 USD,p20 China Made
Copper Electrode : 113.03 USD | Total material : 376.77 USD
Production Cost : 1663.05 USD | Hot Runner : 1130.3 USD
Management Cost : 20% | Tax : 282.72 USD
Total Mold Price : 3270.0 USD
Product Price Calculation
Material Unit Price : 2.17 USD/kg | Product Material Cost : 0.02 USD
Production Speed : 60 seconds | Chosen Injection Machine : 900 Ton
Production Cost : 0.91 USD | Profit : 10%
Tax : 10% | Product weight : 0.01 kg
Product Unit Price : 1.13 USD (Note)

ill 106. Price for both shell parts

With further research into the injection modling technology it was discovered that elements for injection molding of similar size and shape can be made in the same mold, called a "family mold".

In this mouse case, the buttons were likely to be very similar, therefore it would be benifitial to make them in the same family mold.

In the side picture is a quote of a family mold of 9 elements gave by the same company, where the price of the mold would be 1.527,6 USD, so around 10.488 DKK and the unit price as little as 0,05 USD, so around 0,34 DKK. ("Family mold," n.d.)


Part Information
Product Size : 5.00 cm * 0.50 cm * 0.50 cm
Cavity : 9 | Life : <5000
Plastic : ABS
Mold Price Calculation
Mold Frame : 285.46 USD | Mold Core : 113.03 USD,p20 China Made
Copper Electrode : 113.03 USD | Total material : 511.51 USD
Production Cost : 946.06 USD | Hot Runner : 0.0 USD
Management Cost : 20% | Tax : 160.84 USD
Total Mold Price : 1527.6 USD
Product Price Calculation
Material Unit Price : 2.17 USD/kg | Product Material Cost : 0.01 USD
Production Speed : 60 seconds | Chosen Injection Machine : 250 Ton
Production Cost : 0.02 USD | Profit : 10%
Tax : 10% | Product weight : 0.005 kg
Product Unit Price : 0.05 USD (Note)

ill 107. Price for a "family mold" of 9 elements

CONCLUSION

3D PRINTING **VS.** **INJECTION MOLDING**

The 3D printinig isn't a viable solution for mass production considering the price. The cheapest price per unit is about 130 EUR, which is already a very high amount, with a quality directly from the 3D printer not user friendly. For the product to be finished with paint and a smooth surface, good aesthetics and hand feeling, the unit price would rise high as 475 EUR which is around 3.500 DKK.

In the situation given, the the product should be sold to a very high price in order to reach the break even point and get in the future a slight profit on the product. Therefore it was decided that 3D printing as production method is not a viable solution for this case and is only relevant for prototyping. (App 29)

The injection molding method is taken into consideration, for having a justified price-quality connection. Hereby, the full price of the mold consisting of the two main parts and 9 extra pieces (buttons, etc.) would be 65.919 DKK. This means the unit price for 1000 units will be around only 84,85 DKK.

It is found a good deal, the fact that the molds will be paid off if the final product is sold at a pricepoint as low as 1.000 DKK (disregarding prices for components, PCB, assembly, etc.) at a total of 68 units sold (for calculations see App 31).

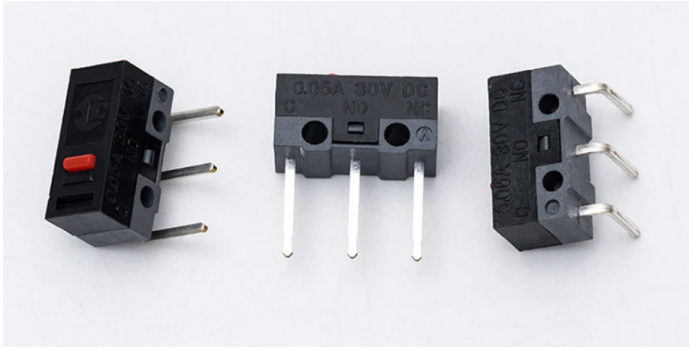
There is not known yet whether other production methods for mice and plasics in general are possible. Thus, the research still continue even after this stage in production methods and other companies offering a better service or price.

3.3 DETAILING SUM-UP

Hereby, the product was detailed with additional components (finger support, buttons) and tested not only on diverse hand sizes but also on different hand types. The iteration results showed a new size requirement for the mouse, but also the correct button placement. The connection between user and game is the device, and therefore its requirements are depending on both user and game simultaneously. As a sum-up of the detailing phase, all the components will be listed further, together with their choice documentation and their role in the product architecture. (App 43, 45)

SWITCHES

The Huano switches has been chosen for the three buttons in the top and for the four buttons for the pressure plate mechanism. This switch was chosen because it's reliant, robust with a long lifetime of up to 20 million clicks (Aibaba.com," n.d.), which is important since it's mostly used for the features with the most frequent presses (App 14).



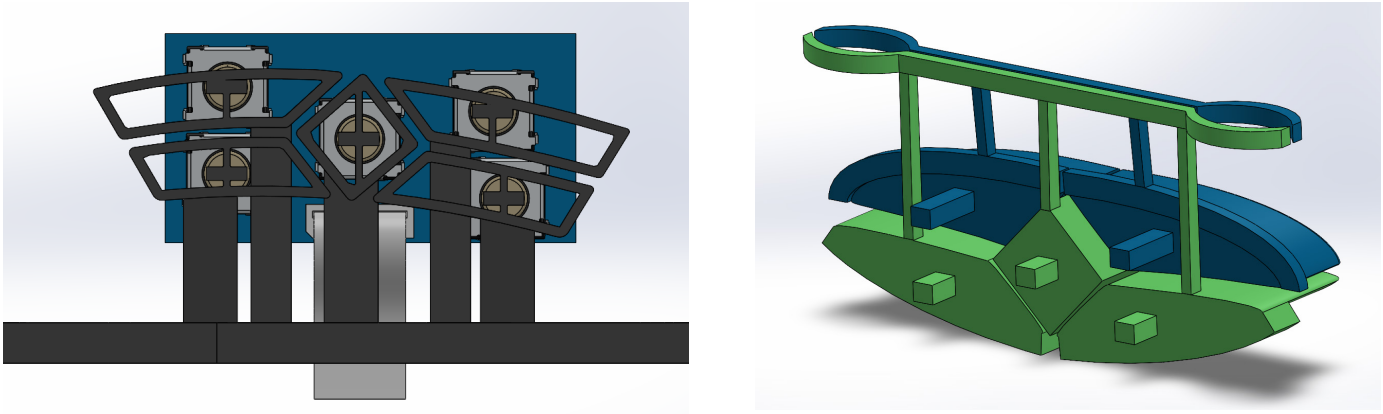
ill 108. Button switches

FLAT SWITCHES

Flat Panasonic switches are used for the less used features, as this component only have a minimum life cycle of 1 million presses (Panasonic," n.d.). This component was chosen for its compact size, which makes easy the installation of larger combination of switches.

On illustration 110 it is shown how the switches are structured inside the mouse, to allow the buttons a centered press in the switches.

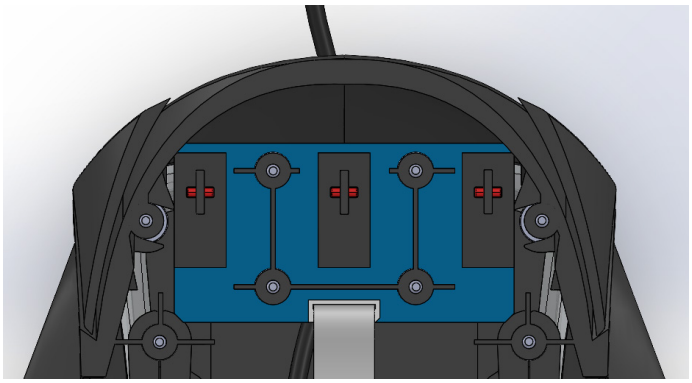
ill 109. Flat switch



ill 110. Structure of switches for side buttons

PCB

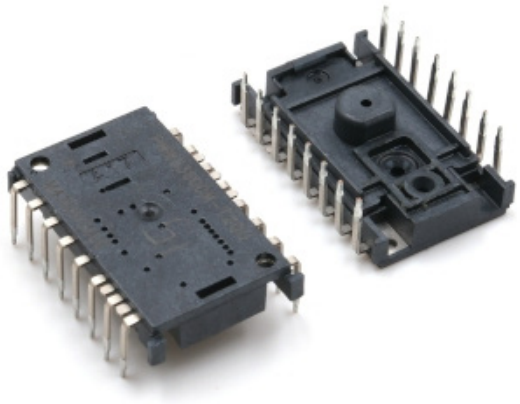
The switches are applied to a PCB (Printed Circuit Board). This way they can be assembled to the top shell and alligned, also to be pressed within the natural elasticity of the ABS plastic of the shell. The same process applies for the pressure plate system.



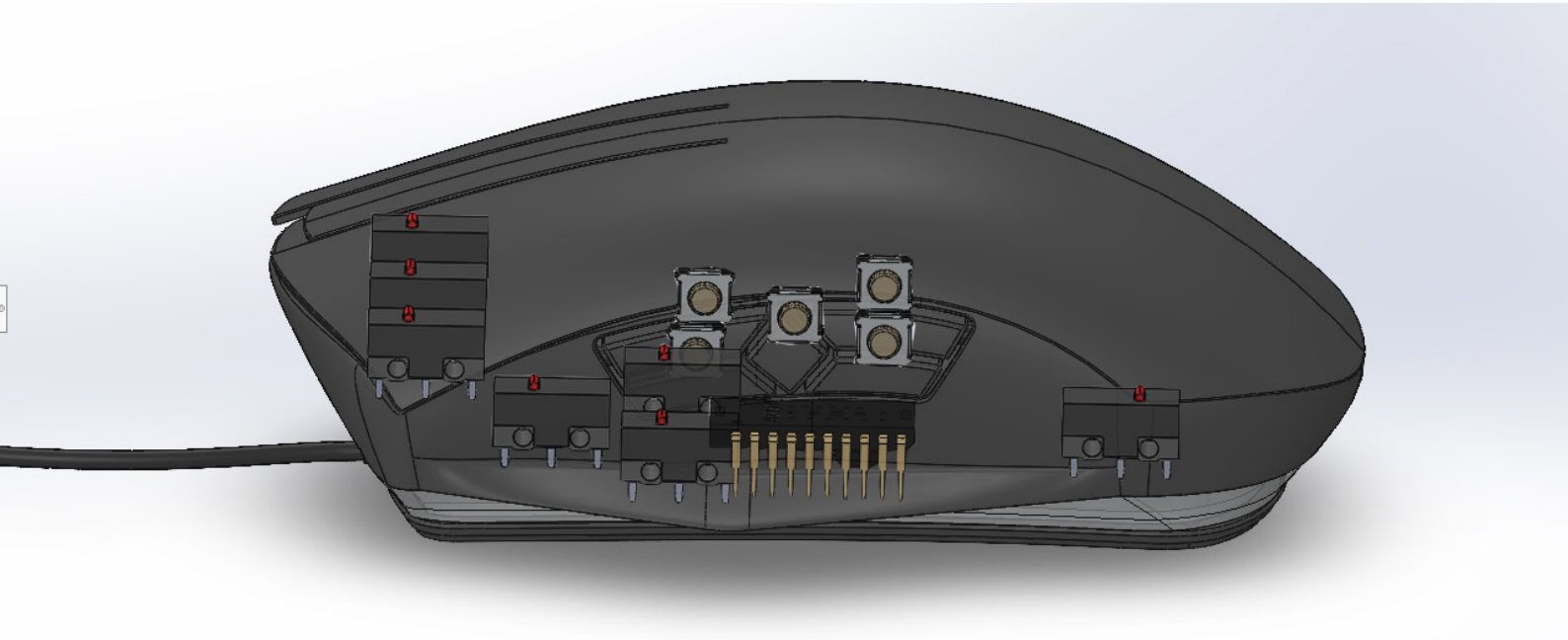
ill 111. The PCB board

SENSOR

The Pixart sensor was chosen for the mouse movement, because they deliver high precision. These are used by the best gaming companies on the marked, such as Logitech, HyperX etc. (“Flawless Mouse Sensor List - Best Sensors Only,” 2021). The PMW3360 model was selected as they promise high speed, high accuracy and high resolution gaming experience. With the same model it’s possible to expand the product category with a wireless version (“PixArt Imaging Inc. - PRODUCTS - PMW3360DM-T2QU,” n.d.).



ill 112. Mouse sensor



ill 113. The product inside view to components

CONCLUSION

The components choices have been decided, however for the switches it could be considered to use a more accesible brand instead of “Huano”, as they are only accesible through resellers. The Panasonic switches are not designed for gaming devices, so it could be beneficial to search for a similar sized switch that is designed for intense clicking purposes. Overall, all components together with the electronic part were chosen according to quality and price that fit in the new mouse design best.

REFLECTION (APP 37)

At the final stage of the product detailing a step back was taken to rethink the design process and understand what have changed during the process. (App 37) Thus, here are categorized key topics that required a decision in the mouse structure and idea. The process had unexpected benefits that haven't been thought of and considered yet, as expanding the gaming context or the market context. These adjacent aspects will be discussed further.

PRICE POINT

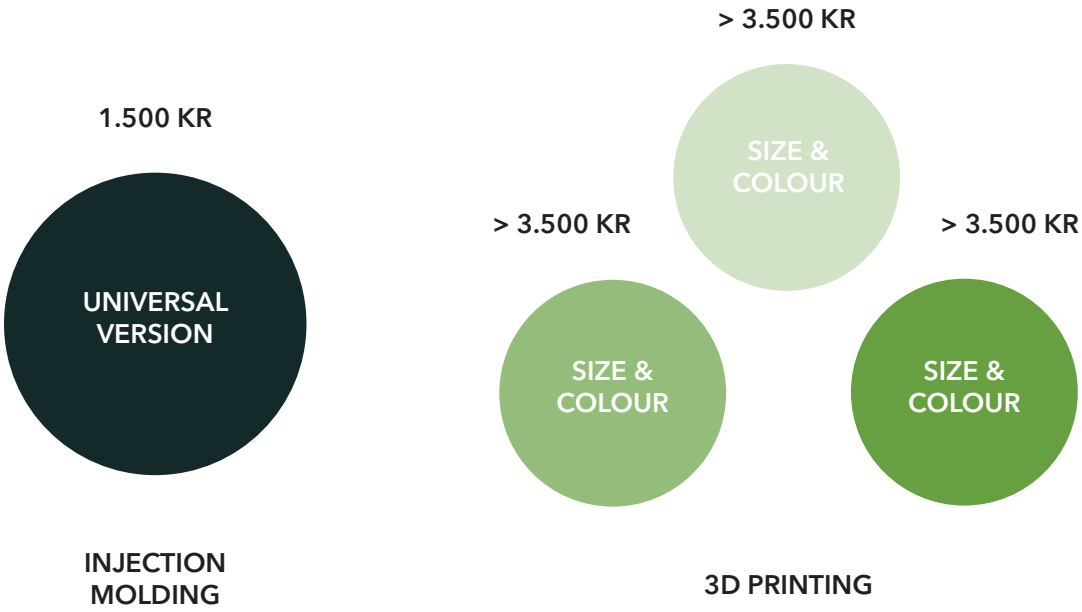
The target price was concluded to be around 1500 kr. The reasons behind were:

- Comparison with ordinary mice/gaming mice on the market;
- The desire to make no differences/ discriminations between healthy people and people with disabilities, which is the target group of cerebral palsy with level 1-2 and make them feel included in the same market (they don't recognize themselves disabled, in fact they associate with healthy people that have a difficulty in controlling one affected hand or fingers);
- Our wish to develop an accessible mouse (lowest price)
- The value this mouse gives to a person with disabiities is way higher than a normal mouse gives to a healthy person in general.

Options: 2 different production methods which allow for two variants:

- A basic mouse which has a universal size, made through injection molding, cost is low at good quality. However, there is only one size due to the mold in which same pieces are made;
- A premium mouse coming into more sizes, made using 3D printing machine and finishing the surface, which can make a different variant each time it prints another mouse at a very high price per unit.

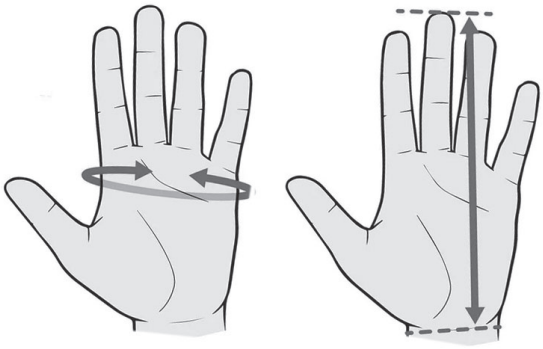
Decision: Make a basic mouse variant and consider premium versions in the future if there is market demand. These will have more sizes for people willing to pay extra and have a custom product. The mouse should change color as the user wants (e.g., boys can set a green light, girls can set purple etc.).



Challenge

The challenge in this case is clearly adapting a mouse to all the people, which is the basic challenge of any product design conditioned by direct user interaction. In this case, the interaction is limited to the hand. Therefore, different sizes of hands are the main factor influencing the design of the mouse. From the gloves measurements below it can be seen there are usually 6 sizes of hands, from length 160 mm to 215 mm. The gloves must be more precise than a mouse, as they take the hand shape, but it is a relevant example to follow in sizes.

The difference in hand sizes was spotted during the prototype iterations, which were made with one of the biggest mouse shell size on the market. Even if the prototype was tested once with a hand size that fits the prototype (size 9), two sizes below could already feel a difference in the prototype (size 7). At a small hand, the same mouse is not working as it should because of size incompatibility. Therefore, every millimeter matters in using such a complex mouse and which is making a difference between a functional fit and a useless mouse.



SIZE	HAND CIRCUMFERENCE	HAND LENGTH
6	152 mm	160 mm
7	178 mm	171 mm
8	203 mm	182 mm
9	229 mm	192 mm
10	254 mm	204 mm
11	279 mm	215 mm

ill 114. Hand measurement table

Vision and framing

The vision was before helping people with disabilities, but it is rather an empowering opportunity that we are giving them. It is not a survival / necessary product but in fact it gives more power to the one using it. So, any person with disabilities can do more and fill their lives with more. A game can take up to 5 hours every day, so it is an important amount of time a person with disability can get to do something they like. To compete, increase skills through gaming and feel included in a community.

Benefits and potential

The mouse is mainly designed for CSGO and similar games. However, it can be used for usual scrolling on browser, or using other software by assigning buttons to software functions. Instead of using keyboard for a lot of functions while you use a software, it can be more convenient to use find all functions from the mouse (e.g., 3D modeling softwares).

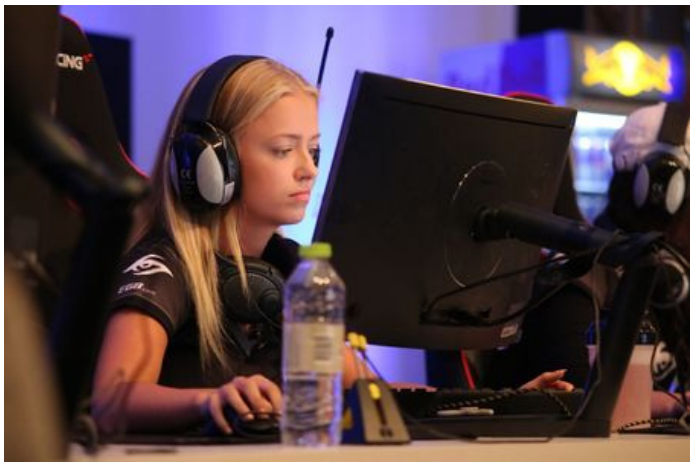
Main users are cerebral palsy level 1-2 but there are also other types of users that would benefit from using the mouse. The second group with benefits would be arthritis users, by enhancing their abilities as they cannot coordinate hands. The third group are muscular dystrophy users who would rather use pressure on the mouse, than finger movements on the keyboard.

Benjamin Bremer

ill 115. Large hand size gamer

Benjamin is a very large guy, his gaming mouse by choice is the Logitech G Pro X Superlight (“CS,” n.d.). Awarded 2nd best CSGO player in Denmark in 2020 and 2021 and worlds 6th in 2020 and 13th best player in in 2021. (“Benjamin ‘blameF’ Bremer,” n.d.)

Michaela Lintrup



ill 116. Small hand size gamer

Looked as the best female player in the world. Has won every female tournament there is for CSGO (“mimimimichaela,” n.d.). Michaela is a woman of a small size, her gaming mouse by choice is the Logitech G Pro X Superlight. (“Twitch,” n.d.)

ill 117. The universal mouse - color variants

CONCLUSION

People of very different sizes use the same sized equipment by choice and is shown to become very succesful despite of that.

CHAPTER CONCLUSION

All categories that needed a decision were listed above, with evidence and explanation why we decided one way or another. The next step is to proceed with the decisions listed above. Regarding the price, it was clear what it takes for a product to be purchased, by the value it gives compared to the price.If the value and quality are good, plus it is long lasting, then the user is willing to pay as much as needed in general.

Also, considering the gaming devices and tech/electronics on the market, the prices are going way higher (e.g., comparison with an iPhone of 8,000 kr that most people have). This, combined with a person with a disability that wish to be seen and entitled at as many activities as ordinary people have, will play a very important role in these people lives and thus they will consider it a big achievement if the device to make them more normal will exist. As much convinced are people and willing to buy, as many variants we can allow to make, customizing the product in different sizes in the future.

We concluded also with a new vision that it says the gaming ability will be like a superpower for a disabled person, giving him/her the opportunity to get along with normal users and do anything.

The full potential can be further explored and expanded from other games to even browsing and using other softwares like 3d modelling ones. Moreover, it can be expanded from other people with disabilities to healthy users who prefer the comfort of a 2-in-1 device. The possibilities are endless, and they are willing to be taken if only they start to exist.

4 IMPLEMENTATION

The implementation chapter starts with the identity topic in which will be shown where the mouse design is placed regarding trend aesthetics and design language. This topic involves testing the aesthetic features that are given by the shape, making sure that the interaction between product and user is also comfortable. Visually, the aesthetic elements are assigned without testing, as there is no direct interaction with the hand. However, in terms of eye-contact, the interaction is assessed regarding the light intensity coming from the mouse sensor. The light is diffuze to not distract the user in the game, but engaging instead in a gaming mood.

The vision of the product, together with its name and logo, will all encapsulate the product's DNA and it's unque value on the market in the value proposition chapter.

Finally, these aspects are summarized into a framing of the product, where key points are described into the business strategy chapter and it is concluded how the product with its identity will be implemented on the market.

4.1 BRAND IDENTITY

To get an understanding of what identities and styles are present in gaming mice today, a style board with mice has been made. Hereby, in this chapter it is shown where the product will be placed in the mice spectrum. (App 36)

NEUTRAL

A simple mouse design that is optimized for daily tasks at the computer, slow paced. It is characterized by smooth curves, ergonomical shape and long dimensions.

PERFORMANCE

A neutral mouse style updated with a compact shape that facilitates rapid movement and control, while having buttons attached in ergonomical way.

TRENDY GAMING

Performance style updated with combinateion of sharp and smooth edges, stricking colors and appealing aesthetics that does not necessary hold a function.

HI-TECH

Mice with sharp edges and holes between parts, delimitating each button. the language suggest a complex design with multiple functions.

CUSTOMIZABLE

This design shows how a hi-tech mouse can be splitted apart, changing components or place parts differently as the user needs require.

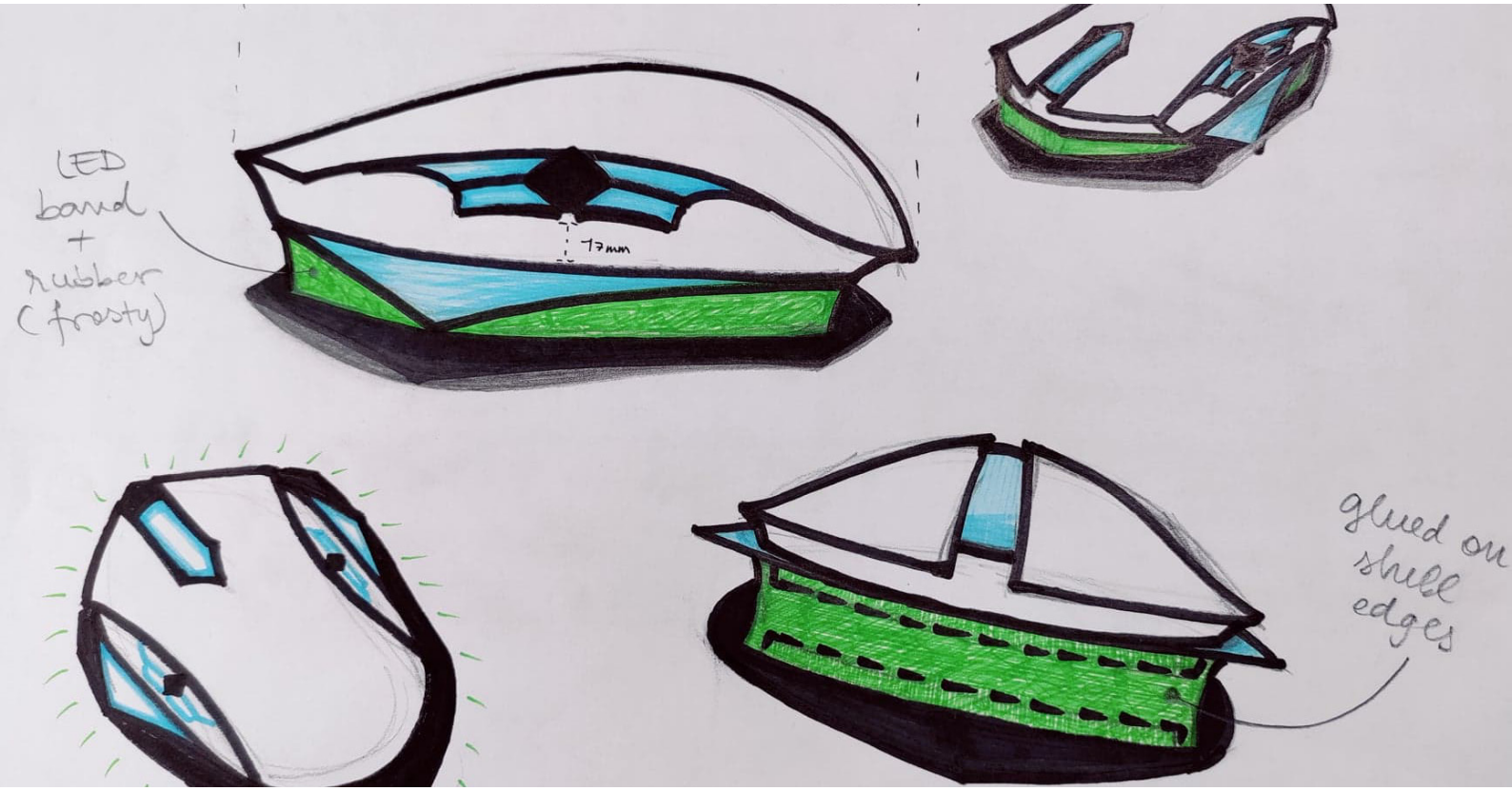
ill 118. Mice style board

CONCLUSION

The identity choice is in between performance and trendy gaming. The reasons for stepping away from the other styles or identities is that the customizable or hi-tech style would take away too much attention from the main selling point. Moreover, the mechanics would be center of attention and over time it would most likely make the whole functionality worse. On the other hand, the neutral style would be too forgettable and it would not gain the recongition of all that it has to offer, as people need to see it is more than an usual mouse.Therefore, a fusion between performance and trendy gaming based design could make the product stand out as a new type of gaming mouse, yet not having extreme looks. This resonates with the target audience desire to mix in the crowd, as they've been trying their whole life to join ordinary people and community.

4.1.1 FIRST ITERATION

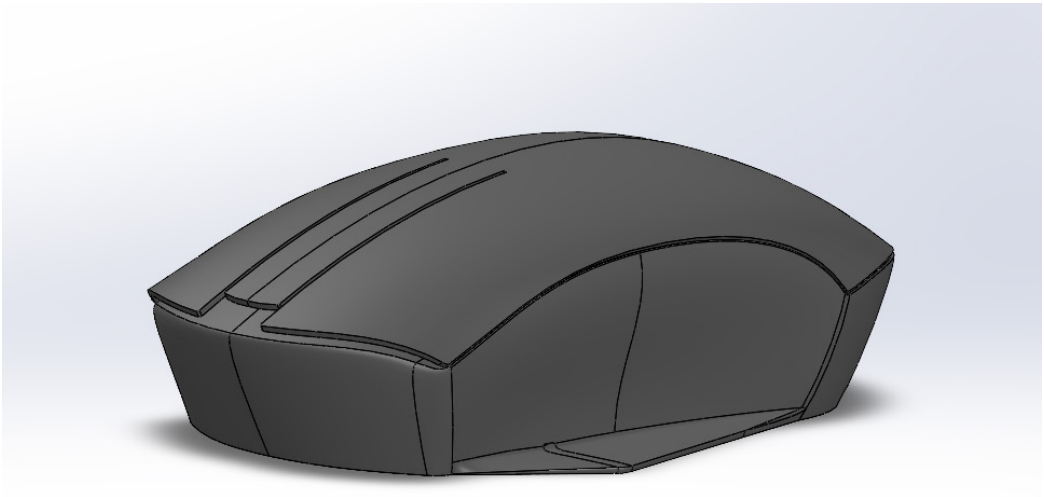
First identity iteration has been made to find the own product identity (App 41). It began with sketching of the mouse visuals, that will represent each components' aesthetic.



ill 119. Identity sketch

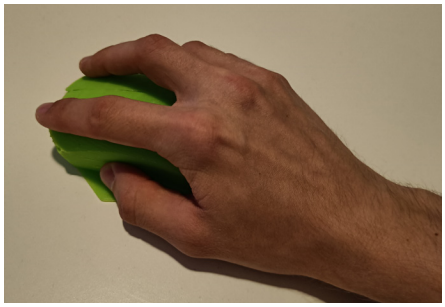
The sketches were created with inspiration from the style board presented in the beginning of this chapter, where it was adressed the type of identity has to be achieved for the mouse design.

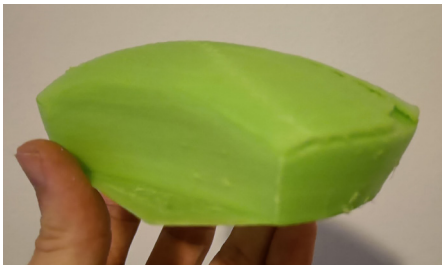
A 3D model was created following the sketches above, considering the key dimensions observed from universal gaming mice. The model focuses purely on the top part of the product, aswell as only on the visual and comfort aspects.



ill 120. Identity 3D model

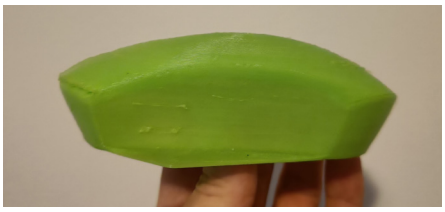
Therefore, the 3D model was 3D printed and tested only by the team members to validate if the shape given was comfortable to hold, regarding ergonomy and dimensions. (App 41)





CONCLUSION

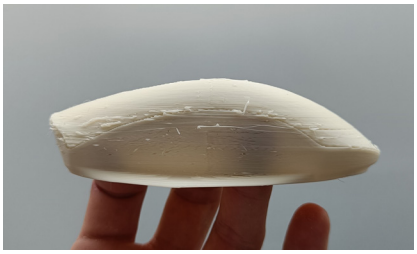
From the experiment above, it was concluded that the product needs slight adjusting regarding comfort of the hand interaction. The back part is too wide and tall, fact that causes the palm to have too much contact. Moreover, the thumb and pinky rest needs to be adjusted as well, to fit the fingers natural position.



ill 121. First identity model

4.1.2 SECOND ITERATION

To correct the details from the first itertion, a second one was made to finalize the identity of the product. (App 42)



ill 122. Second identity model

The 3D model was reworked by the back part of the shell has been lowered, to move the wrist in a better position closer to the table. The back part of the shell, has been narrowed a slight aswell, so it's easier to get a good grasp onto the device. Lastly, the space on the sides for the fingers has been made a little smaller aswell, to lower the whole device as much as possible and make sure when the buttons gets installed, you'd be able to press two of them while your thumb touches the thumb rest.

CONCLUSION

The new iteration adresses the previous flaws quite well, it has become much more comfortable to hold, beacuse of the lowered back. It looks now more dynamic and closer to the identity we was aiming for.

The new iteration fits our requirements, both for game and comfort requirements. Following there will be worked on details such as installing buttons, making it able for production, defining the bottom of the device, etc.

4.2 VALUE PROPOSITION

4.2.1 PRODUCT NAME

OMNIS is the first mouse designed for a First-Person Shooter game like Counter Strike, that can be used by people with cerebral palsy levels 1 to 3, that have only one functional side of their body. The First-Person Shooter game (FPS) is centerd on a first-person perspective, in which the player has a real life experience seeing the action through the eyes of their character. This game type popularity made Counter Strike a top choice in E-sports nowadays, however it requires two devices to play,: both the keyboard and the mouse. People with cerebral palsy have a hard time using two separate devices, and many other disabled users do.

Therefore, Omnis aims to bring together two devices in one, adding the possibility of playing Counter Strike and other FPS games by using only one hand, by cerebral palsy users from level 1 to 3 and other audience with incapacity of using one hand. The product name "Omnis" means in latin "all" and implies the products' value for giving the possibility of **gaming for all**.

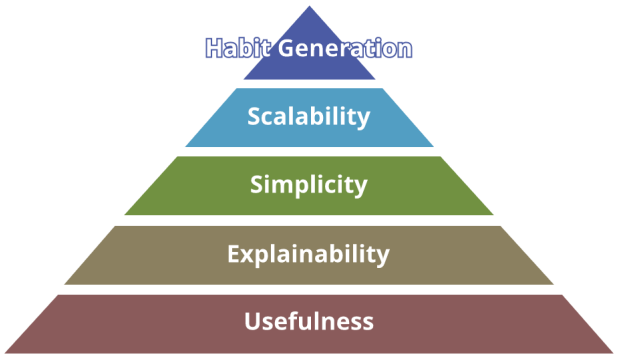
4.2.2 LOGO

Omnis is not only a product, but an experience in itself. Due to the addition of the latest features in the gaming industry, such as RGB lightning and a sharp appearance, the product offers the customer not only a basic tool for gaming but also the opportunity to enjoy gaming at a full extent like any other individual, by including them in the social gaming group.

Therefore, the striking colours of the logo represent the gaming trend that use a bright colour palette and is seen at popular gaming companies in their devices (mice, keyboards, headsets, laptops etc.), while the logo shape from the flash implies the performance that can be achieved using this device, respectively by everyone.

4.3 BUSINESS STRATEGY

An interesting point of view was discovered after some time of investigation in the target user categories. A product success is suggested within a model in which key requirements for a product are classified in levels of a pyramid ("What Qualities Make a Product Great?," 2020). The model proposed by Jorge Rodriguez-Ramos helped grasping the bigger picture of user requirements and general design features which can be implemented for a market pull. Therefore this model was applied to the project to validate the products' market potential and business strategy.



ill 123. The Five Levels of the Product Pyramid

1. USEFULNESS

The first, basic priority is to sell a product that solves a problem. This will happen in the case of people with cerebral palsy, when their problem of controlling two devices will be solved with a one hand device.

Here we refer to cerebral palsy users and others able to use only one hand. The difference comes from two understandings: 'only one hand,' or 'one hand.' And even if the two are not perceived as having the same weight, the one with 'only' counts more in the scenario of solving a problem, whilst the other variant applies also to users who can use both hands, without a real problem to solve.

2. EXPLAINABILITY

The model suggests that every solution should be easy to understand for the users and not only for the designers. It is easy to explain our solution as unifying two devices for users that can only use one hand (or one at a time).

3. SIMPLICITY

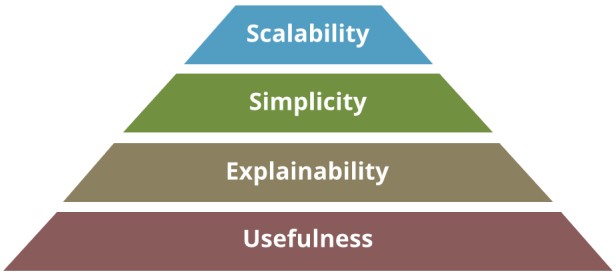
Our product is easy to use for anybody who has seen a mouse before. Its intuitive appearance needs no explanation in how to game with it. Furthermore, the buttons functions from the keyboard are placed in frequency order: from the most used to the rarest used button, assigned from the most independent and flexible finger to the least one.

The product itself is simple enough to understand and use

4. SCALABILITY

The new mouse will be scalable if it sells to at least hundreds of any users. Thus, the mold which is paid once to deliver hundreds of products, can continue to deliver thousands of the same products for 0 costs.

Each additional user adds less maintenance costs that then previous one

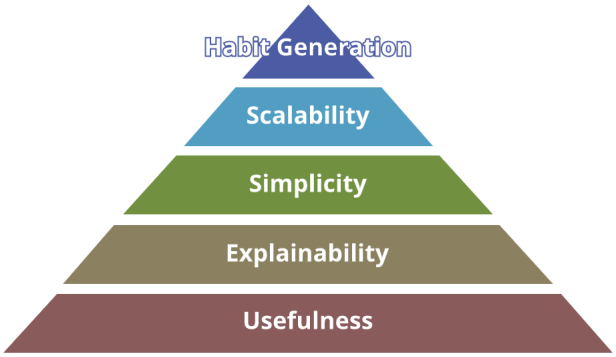


5. HABIT GENERATION

Using a mouse nowadays is a habit. But this does not mean that people cannot use another product better just because it's different. Here we make a reference to the learning curve, which amplifies very fast in any of the users' cases that has been tested throughout the process. When the learning curve reaches a constant point from where the user doesn't learn anymore and totally controls the product, here a new habit can be created.

From now on, the new product will be validated if it is better than the old one, and if so – the users will never go back to the one before. In the case of users who can only use a hand (/at a time), this will be definitely the case, replacing old set-ups made at home.

Each use adds value to the user and reduces their likelihood of looking for another product



5 EPILOGUE

OMNIS is the result product created for this master thesis project, that shares the two team members interests: one to pursue the gaming industry, combined with the other one of helping people. The project was separated in two parts - the product and the process, about which will be discussed further on.

5.1 CONCLUSION

This projects' purpose was to explore and create a gaming possibility for people with cerebral palsy that struggle every day to be a little more included in the society.
By combining two existing solutions for gaming, it was possible to adjust the traditional way of playing a First-Person Shooter game by making it available for a larger range of users.

Gaming is a rising trend in Denmark and all over the world, where people play for various reasons: from pure enterntainment, to transforming into a competitive sport and where one can gain performance, a place in a team or even on a podium winning prizes in money. However, the ultimate goal that people with disabilities have, in general, is to be part of a community where they can have the same experiences as an ordinary person.

Cerebral palsy users who can still use one hand, tend to hide in the crowd and appear like healthy people. Where in reality, they are unable to do many daily tasks with their hands and fingers that healthy people can easily do, such as tying shoes or driving. Hence, when a person with CP is required to use both hands, the activity fails and they feel frustrated and left out.

Several companies like Microsoft or Logitech developed products which have a great potential for users with disabilities. Other products on the market aim the same audience by delivering products that can be used with different parts of a users' body which are still functional, such as mouth, elbow or feet. However, all these solutions are gaming options for different types of games that don't require the same tools as a First-Person Shooter game (FPS), and for a person with a completely damaged arm.

OMNIS thrives to include as many categories of disabilities into a multinational game community, and here it differentiates through a unique technology special made for Counter Strike and FPS games.

The benefits of this product are endless, from the practicality of giving the possibility to people with mild cerebral palsy and users with one affected arm to perform a certain task with only one hand, to the even greater goal of changing theiry condition that they were born with, into having the power to become a normal person for several hours in the game, each day of their lives.

5.2 REFLECTION

The product development had two main parts to reflect upon, which are the product itself and the process.

PRODUCT

The product is the physical solution created by following a set of requirements in order to fulfill a goal.

In the new mouse, several alternative uses could have been implemented if there was more time. The mouse buttons are accessing a single function in the game, which does not depend on the pressure put on the button. Thus, for a complex gaming experience, a sensor that registers the force put on a button could have been used. This way, the product would become compatible with real user movements that are fluent, such as acceleration in racing games, that can gradually increase the speed depending on the force on the mouse components.

On the other hand, a mouse wheel could have been useful as well. Along with the possibilities for a disabled person to play games, the context activities could be extended to daily mouse activities which need a mouse wheel function. However, for the focus that was put on Counter Strike-Global Offensive and First Person Shooter games, a mouse wheel was not necessary to implement.

The smallest changes in the interior of the product can give big changes in the experience of the product. Hence, there would be multiple iterations left before the exact right combination for the mouse would be found, matching both the hand and the inside of the device at the same time.

The production methods and materials used could have been researched more in-depth. Plastic injections such as the silicone and ABS part, should be manufactured with overmolding. However, it was not discovered whether it's even possible to make those parts as they were designed. Thus, this part especially should be reconsidered.

Another question risen about the pressure plate, that is unsure if it is possible to injection mold either. However, a solution could be manufacturing it from serval parts that would be assembled afterwards.

PROCESS

The process of the master thesis development consists of different areas, that mixed together, influenced the realization of a complete process in product design: the team work and methodology or plan followed.

METHODOLOGY

Represents a structure in which the process took direction, ending within a predicted result.

Considering the time span allocated for certain activities, the structure chosen lacked in design process and had rather a functional approach. A large amount of time was used on iterative prototyping, which made the functional and ergonomical aspects better, but on the other hand took from the time meant to spend on the validation for the design language, aesthetics and variations of the product.

There was indecision throughout the process in choosing the right target audience that would fit with both the product choice and the context game. Following the methodology would meant to narrow down and be as specific as possible, whereas this was hard to accomplish when the purpose set by the team was helping as many types of users with disabilities as possible.

Another aspect to reflect upon was the hard time finding users specifically with mild cerebral palsy for interviews and prototype iterations, as this group of cerebral palsy users tend to hide among the healthy people. There are various associations or groups in which cerebral palsy users join together, however 90% of the users who join are having already advanced levels that are not part of the target group.

Therefore, the majority of prototype iterations were performed with healthy people. It would have been interesting to see from each level of CP at least one participant in the iterations and understand the differences between them. Nevertheless, the results between the tested CP users' functional hand and the healthy persons' hand came with the same feedback.

TEAMWORK

The team work was a closed collaboration between the members alone, with no external collaboration. Daily tasks were assigned every day between each of the team members, following a plan structured in the beginning of the process on a monthly calendar, for each day. The working environment was a balanced one, working 8 hours per day. It was hybrid activity, working at the University when testing ideas or prototyping, and from home when making worksheets or research.

The team has one international student and one danish student, with very different backgrounds and skills. This difference created some gaps in understanding each other points, however it facilitate the complexity of the project. Each member has contributed in a equal amount at the project, within different areas. Here was combined the practicality of one member with the ideation of the other one. Hence, a good team work had the same effort from both sides and trusted each others' abilities and will for taking initiative and be active throughout the making and completing of the master thesis.

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ILLUSTRATIONS

*Own pictures were not placed into this list

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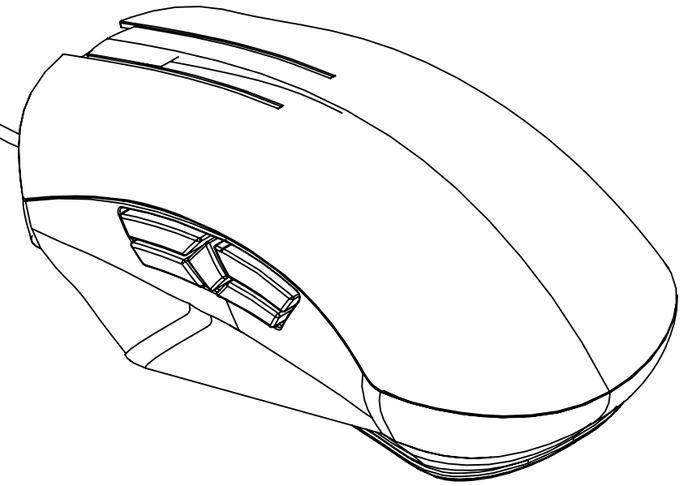
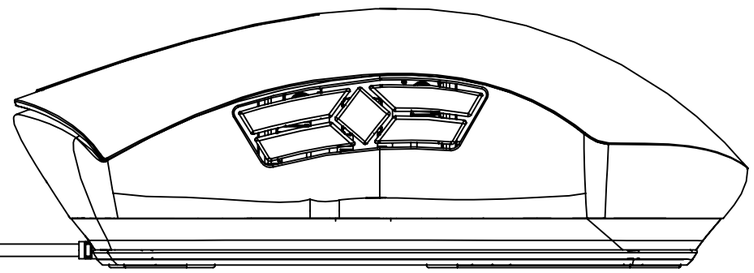
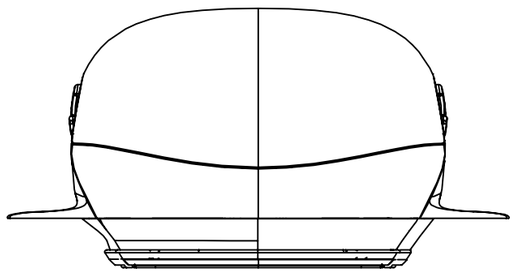
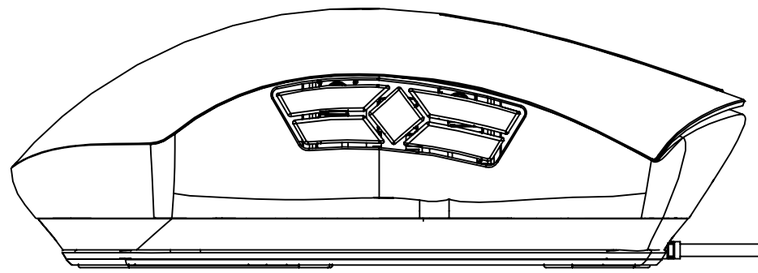
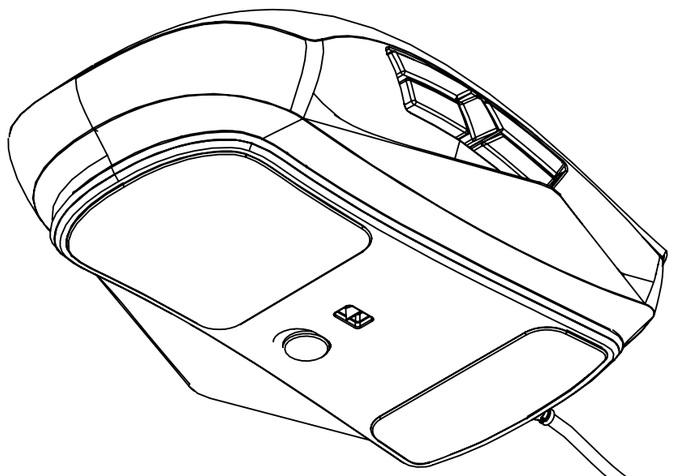
OMNIS
TECHNICAL DRAWINGS











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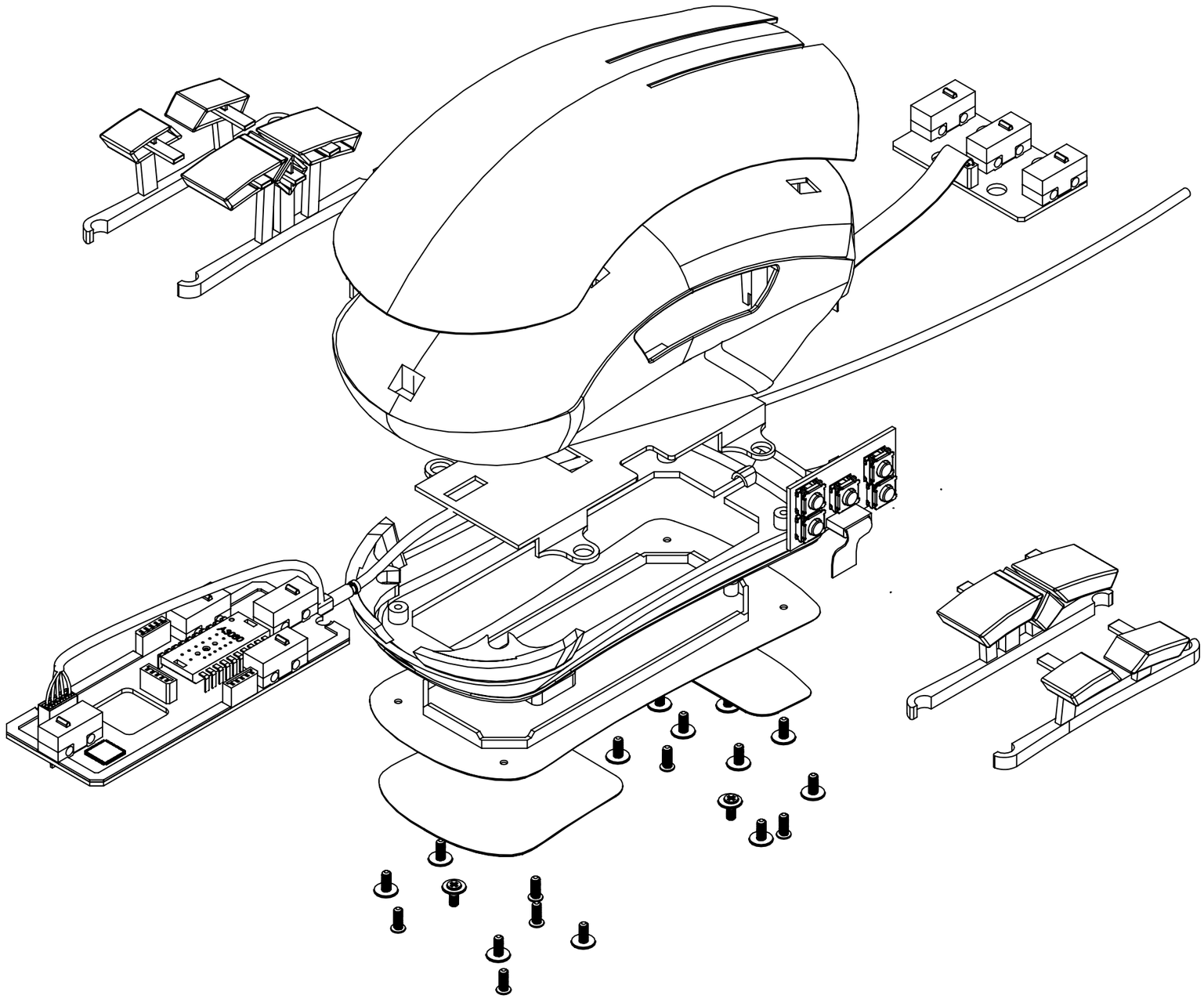

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DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH: Glossy
TOLERANCES:
LINEAR:
ANGULAR:

DEBURR AND BREAK SHARP EDGES

TITLE:
Omnis_exploded_view

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DWG NO.
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A3

WEIGHT:

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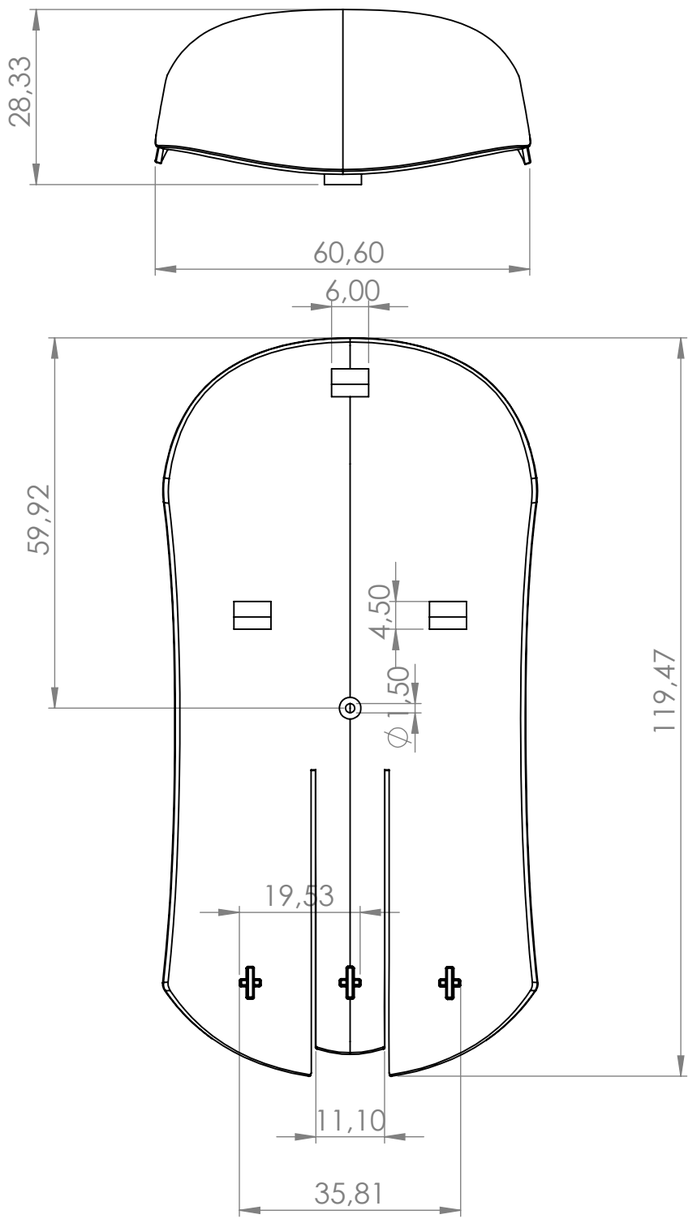
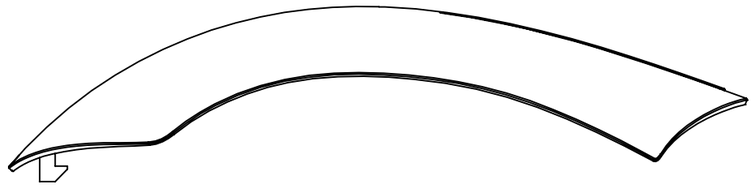
SHEET 2 OF 13





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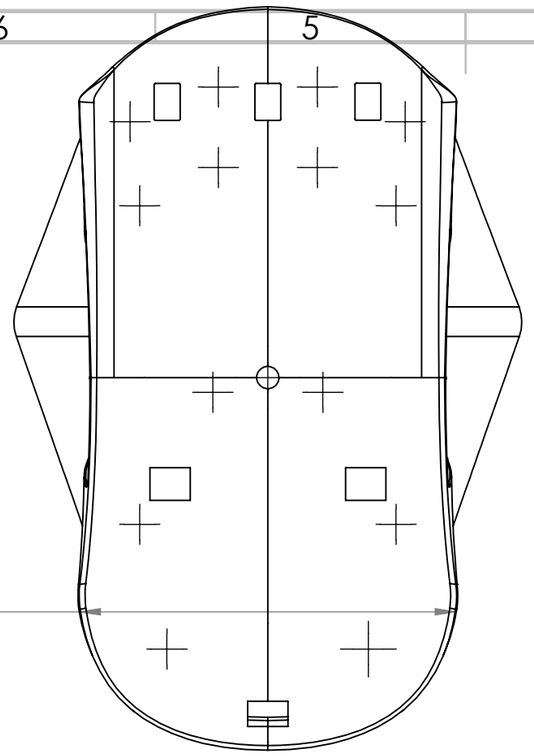
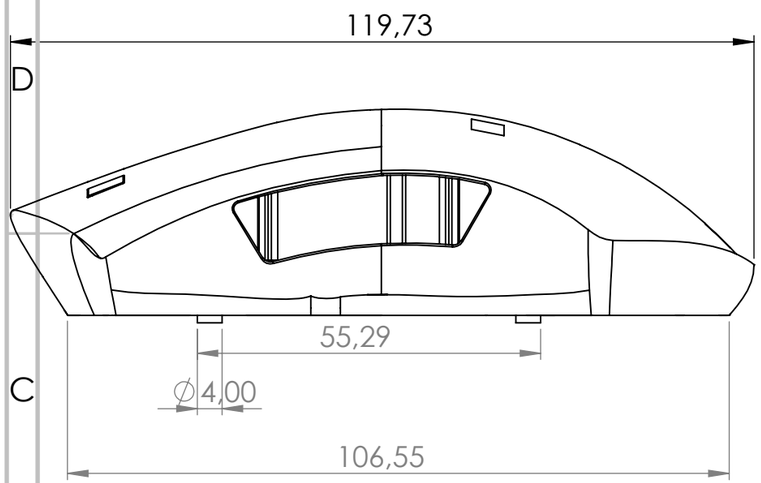
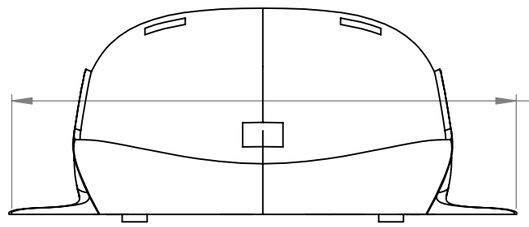
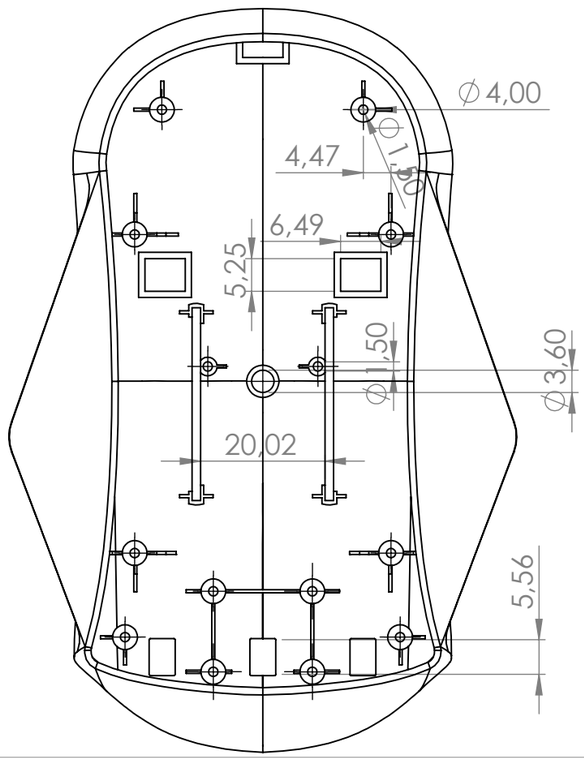
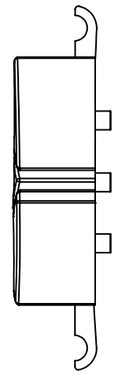


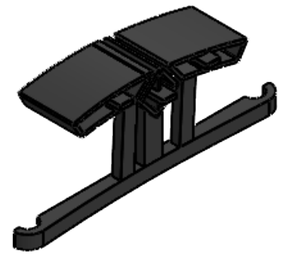


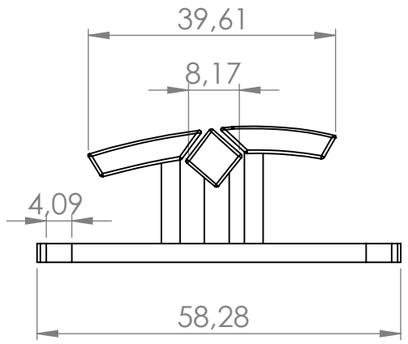


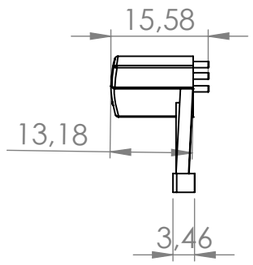


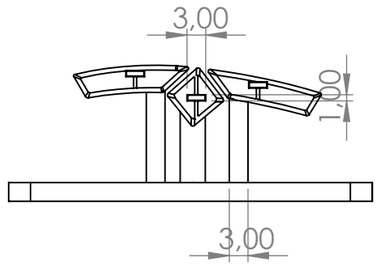
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: Mat TOLERANCES: +/- 0.25mm LINEAR: ANGULAR:	DEBURR AND BREAK SHARP EDGES	TITLE: Main_shell
MATERIAL: ABS		DWG NO. 2 — A3
WEIGHT: 18.84 grams	SCALE 1:1	SHEET 4 OF 13

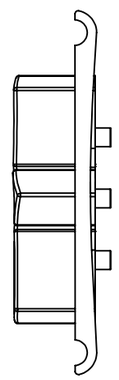




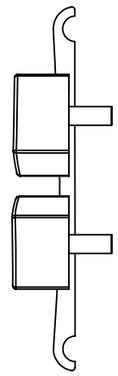


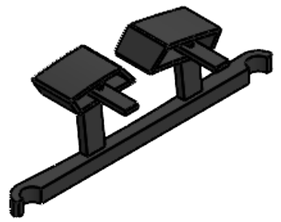


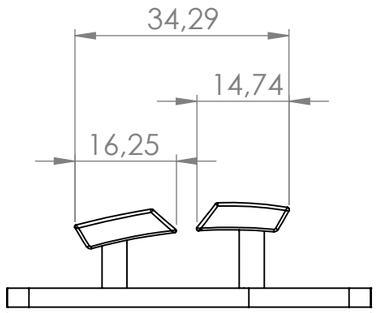


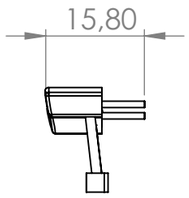


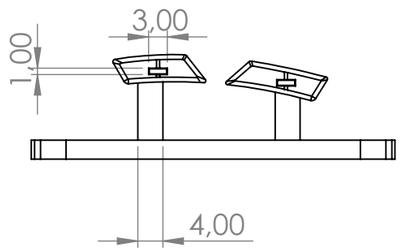
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: Mat TOLERANCES: +/- 0.25mm LINEAR: ANGULAR:	DEBURR AND BREAK SHARP EDGES	TITLE: 3_button_piece_ righthand
MATERIAL: ABS		DWG NO. 3 — A3
WEIGHT: 1.99 grams	SCALE 1:1	SHEET 5 OF 13

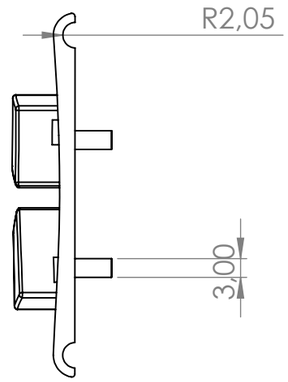




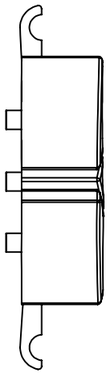


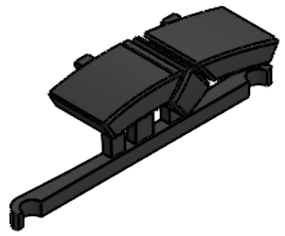


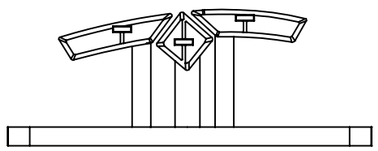


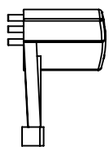


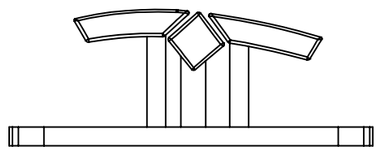
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: Mat TOLERANCES: +/- 0.25mm LINEAR: ANGULAR:	DEBURR AND BREAK SHARP EDGES	TITLE: 2_button_piece_ righthand
MATERIAL: ABS		DWG NO. 4 — A3
WEIGHT: 1.15 grams	SCALE 1:1	SHEET 6 OF 13

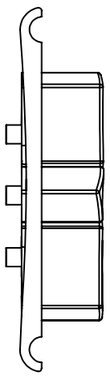




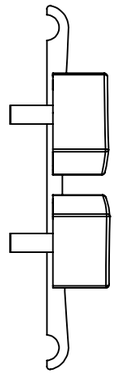


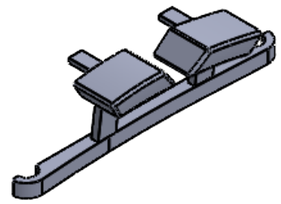


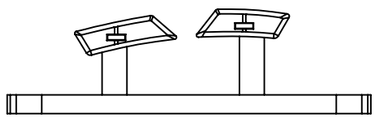


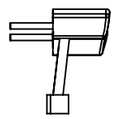


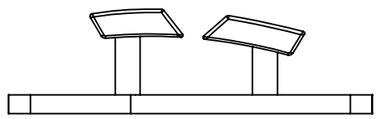
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: Mat TOLERANCES: +/- 0.25mm LINEAR: ANGULAR:	DEBURR AND BREAK SHARP EDGES	TITLE: 3_button_piece_lefthand
MATERIAL: ABS		DWG NO. 5 — A3
WEIGHT: 1.99 grams	SCALE 1:1	SHEET 7 OF 13

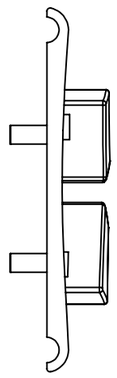




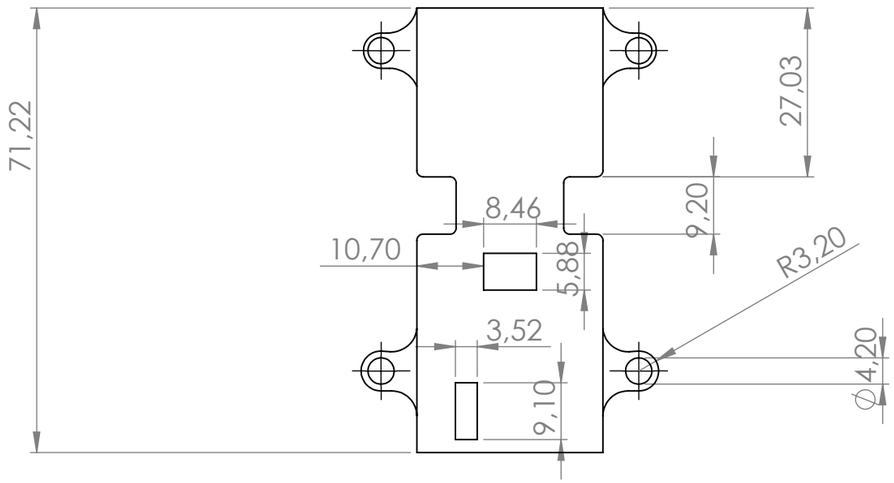


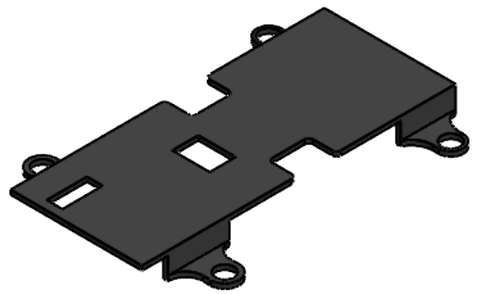


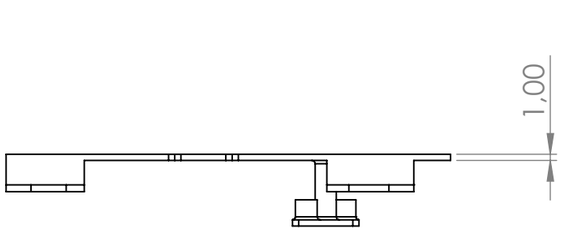


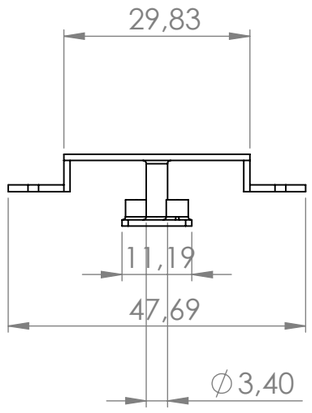


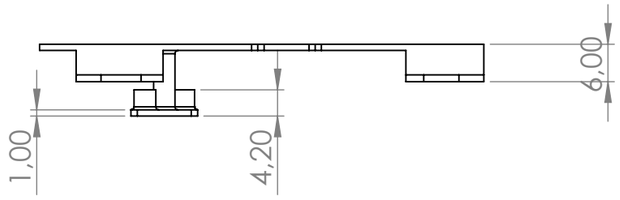
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: Mat TOLERANCES: +/- 0.25mm LINEAR: ANGULAR:	DEBURR AND BREAK SHARP EDGES	TITLE: 2_button_piece_ lefthand
MATERIAL: ABS		DWG NO. 6 — A3
WEIGHT: 1.15 grams		SCALE 1:1 — SHEET 8 OF 13

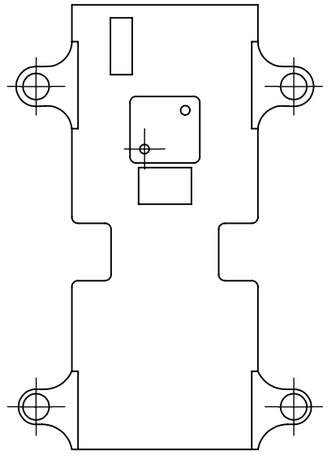




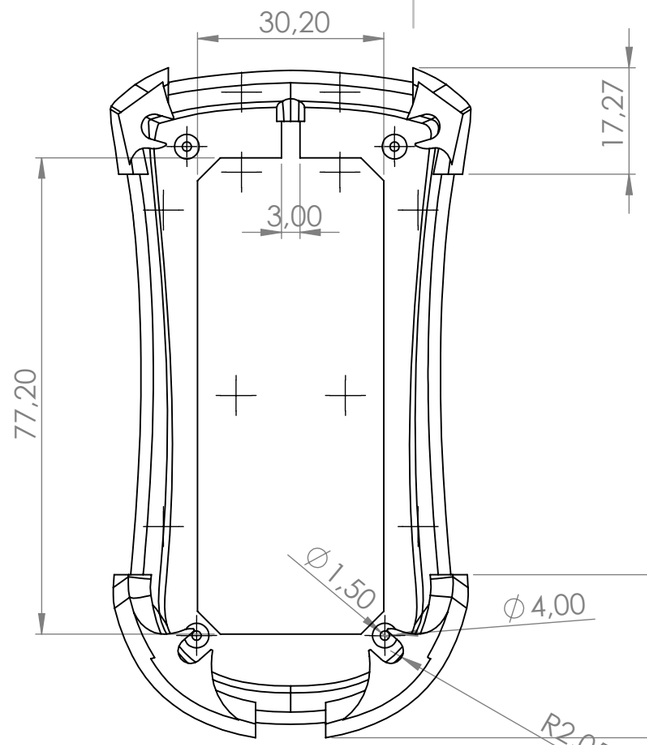


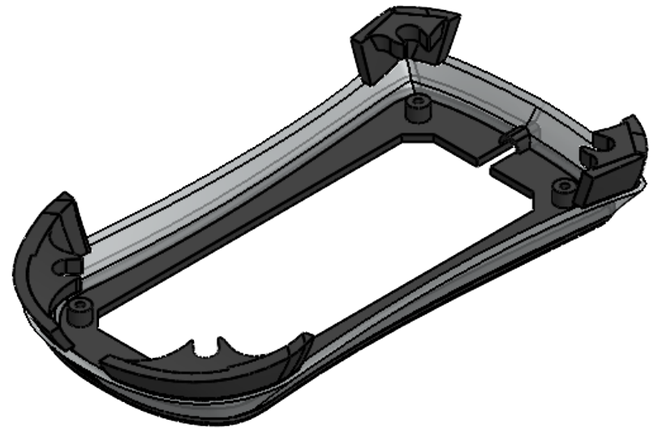


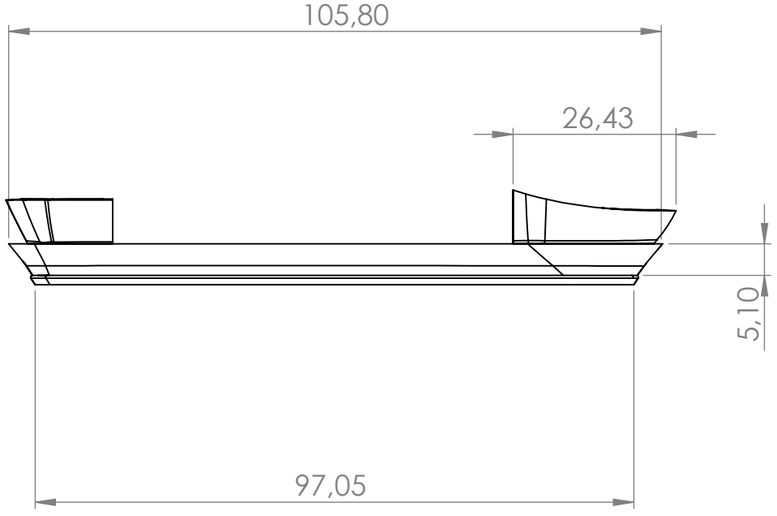


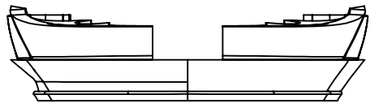


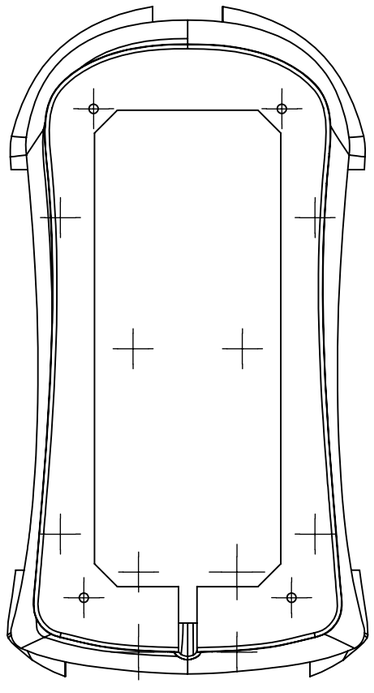
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: Mat TOLERANCES: +/- 0.25mm LINEAR: ANGULAR:	DEBURR AND BREAK SHARP EDGES	TITLE: Pressure_plate
MATERIAL: ABS		DWG NO. 7 — A3
WEIGHT: 2.63 grams	SCALE 1:1	SHEET 9 OF 13



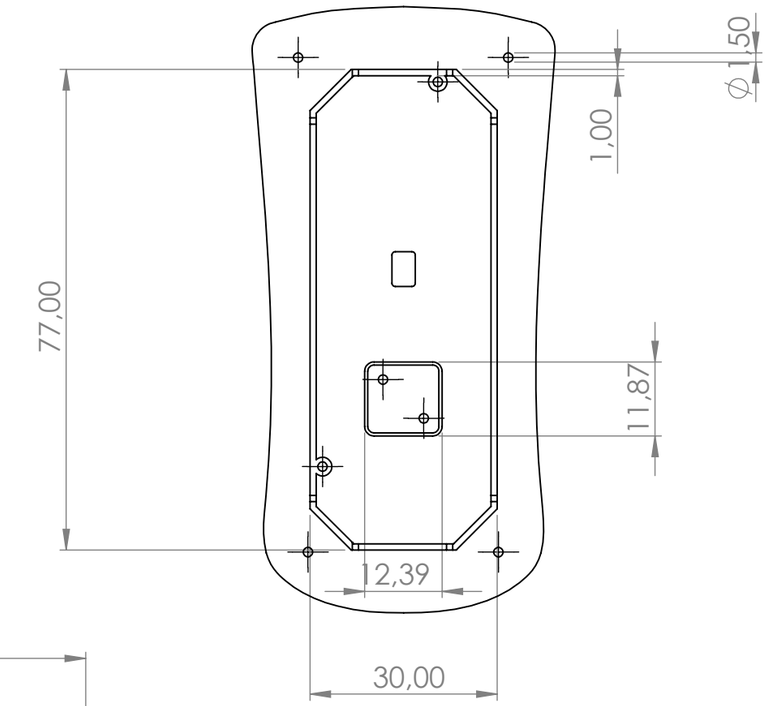


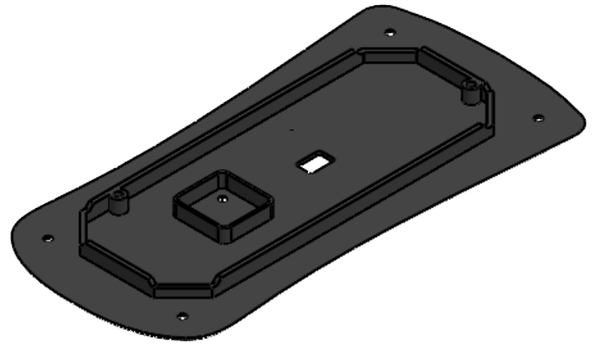


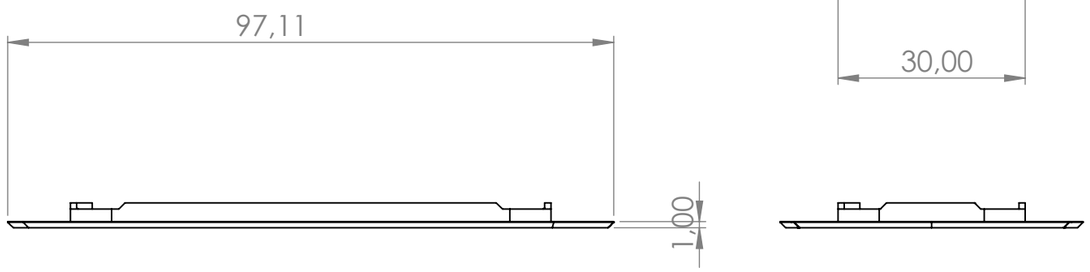


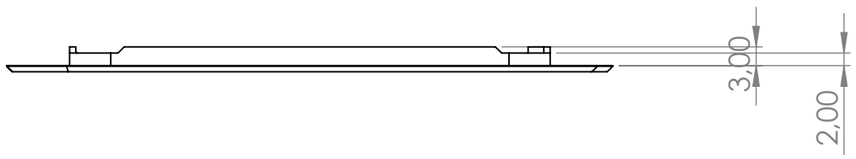


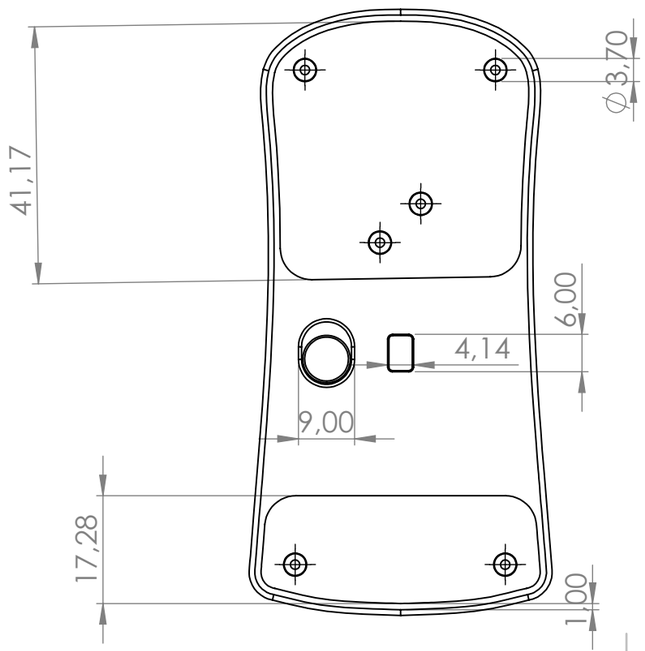
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: Mat TOLERANCES: +/- 0.25mm LINEAR: ANGULAR:	DEBURR AND BREAK SHARP EDGES	TITLE: Silicone_cover
MATERIAL: ABS, Silicone		DWG NO. 8 — A3
WEIGHT: 35 grams	SCALE 1:1	SHEET 10 OF 13



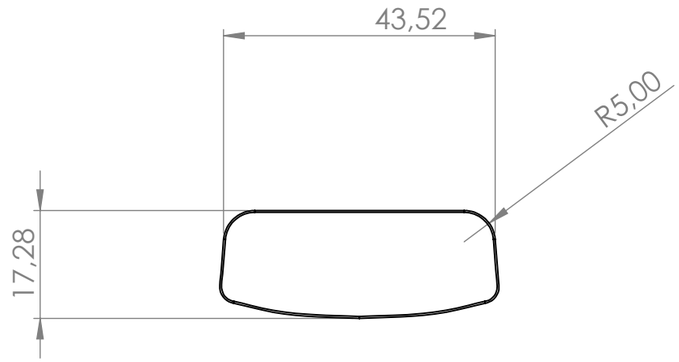




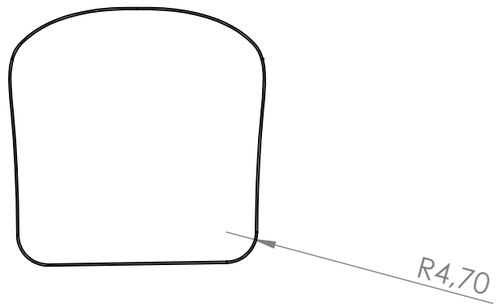




UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: Mat TOLERANCES: +/- 0.25mm LINEAR: ANGULAR:	DEBURR AND BREAK SHARP EDGES
TITLE:	Bottom_shell
MATERIAL:	ABS
DWG NO.	9
A3	
WEIGHT: 4.18 grams	SCALE 1:1
SHEET 11 OF 13	



UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: Glossy TOLERANCES: +/- 0.25mm LINEAR: ANGULAR:	DEBURR AND BREAK SHARP EDGES	TITLE: Mouse_Skates_front
MATERIAL: PTFE		DWG NO. 10 — A3
WEIGHT: 0.9 grams	SCALE 1:1	SHEET 12 OF 13



UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH: Glossy
TOLERANCES: +/- 0.25mm
LINEAR:
ANGULAR:

DEBURR AND BREAK SHARP EDGES

TITLE: Mouse_Skates_back

MATERIAL: PTFE

DWG NO. 11

A3

WEIGHT: 2 grams

SCALE 1:1

SHEET 13 OF 13