Eye-See, MA4-ID9, June 2021

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EYE-SEE PRODUCT REPORT

TITEL PAGE

Titel	Eye-See: improving online therapy
Report type	Product report
Project start	01.02.2021
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Team	No. 9
Main supervisor	Christian Tollestrup
Co-supervisor	Radoslav Darula
Pages	22

Stefan Dybro

Lea Becker Frahm

ABSTRACT

The following report is a product report, describing the process of developing the product Eye-See by the group Ma4-id9.

Eye-See takes on the problem of not having eye contact in online video calls. This is done with a focus on a therapy setting, where eye contact is important, especially for the patient. The health care sector is becoming increasingly digital, and online consultations are a priority, making it relevant to improve online consultations.

The proposal is Eye-See; a webcam, that can move in front of the screen. By placing the webcam on the forehead of the patient on the screen, the therapists can look at the patients, reading all the micro-expressions, while the patient has a feeling of eye contact.

Eye-See is developed through user involvement of both therapists and patients and has contained multiple tests of prototypes. Moreover, the technical aspects and assembling, as well as the business case, are defined.

TABLE OF CONTENT

ONLINE THERAPY

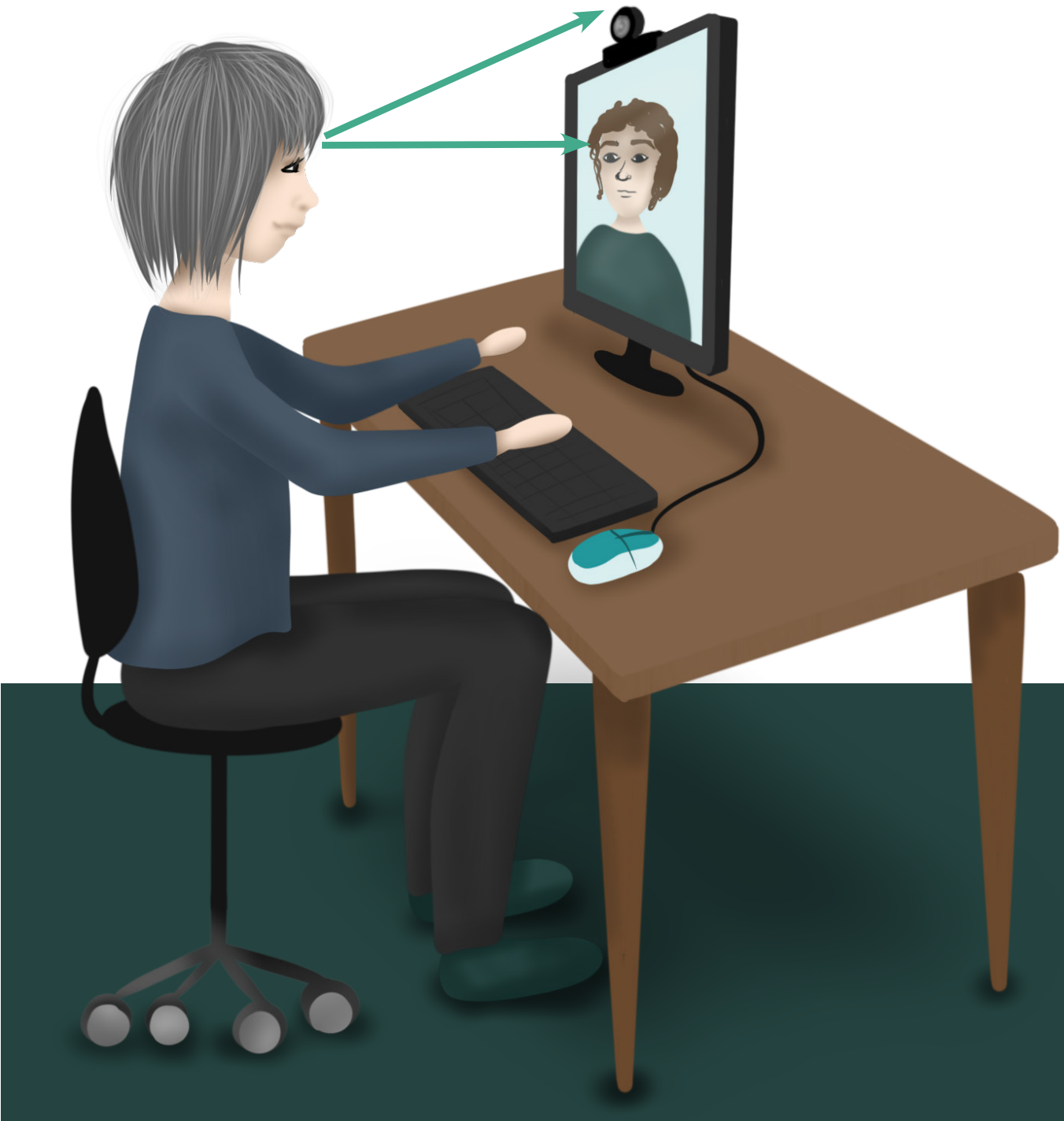
Online consultations have been a focus area at the Danish hospitals for a number of years, where psychiatrists and psychologists started providing their treatment both online and at physical meetings.

Online therapy has lots of advantages. Even though you move far away from the big cities, you maintain the possibility to pick and choose the right therapist for you. Furthermore, online therapy is a way of taking care of patients; for some, it is hard even to get out of the house due to anxiety. Then imagine also having to take a public bus to get to the hospital. For others, physically going into the hospital feels overwhelming. And on top of this comes all the logistical advantages. When people do not have to enter traffic to go to therapy, there will be fewer delays, and during a pandemic like right now, people do not have to postpone their therapy sessions for months.

On the other hand, online therapy has some limitations. Through interviews with several different types of therapists, it has become clear that the therapists spend a lot of energy looking into the webcam while providing online therapy. They do so to give the patient a feeling of having eye contact and hence 'mimic' the presence one feels at a physical therapy session. However, the therapists are also dependent on decoding the body language of the patients, hence they must look down at the screen sometimes and thereby break the eye contact.

PROBLEM:
DUAL FOCUS

The core of the problem is that therapists need to look at the patients to fully capture what the patient is expressing (verbally and non-verbally). But, by doing so, the patients lack the feeling of eye contact, which they value and use to figure out whether the therapist understands what they are saying.



(Office, n.d.)

USER SEGMENT

The main users of Eye-See are therapists providing online consultations. Hence Eye-See is relevant for anyone from psychologists and psychiatrists to coaches and psychotherapists.

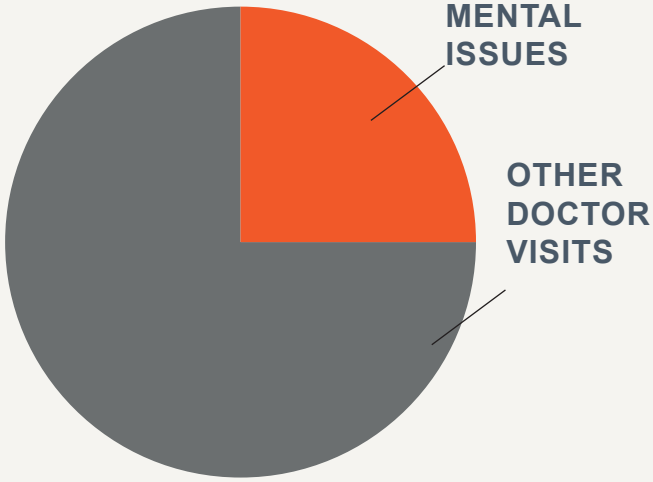
Eye-See is developed in cooperation with several psychologists, a psychiatrist, a coach, and a student priest, all chipping in with their expertise on therapy sessions. Furthermore, patients with years of experience with therapy have been providing their knowledge and experiences.

Hence, Eye-See has been tested by experts - both the ones providing the therapy and the ones receiving it.

Even though Eye-See is developed for online therapy, it can be appliable for numerous other online purposes. E.g., online consultations with a doctor, sales meetings, lectures, etc. Every online context, where a great presence and eye contact is valued.

(Doctor and psychologist, n.d.)

STATISTICS & MARKET



1 IN 3 GET A MENTAL DIAGNOSIS

(Det siger statistikkerne, 2021)

25% OF REGULAR DOCTOR VISITS IS ABOUT MENTAL ISSUES

(Det siger statistikkerne, 2021)

47%

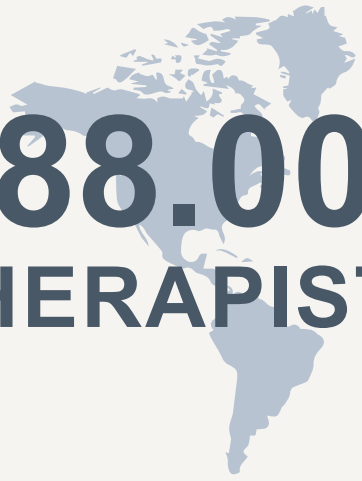
GROWTH IN PSYCIATRIST IN 6 YEARS

(WHO, 2018)

15%

GROWTH IN PSYCOLOGIST REFERALS IN 5 YEARS

(Dansk Psykolog Forening, 2021)



188.000 THERAPISTS

IN AMERICA

(WHO, 2018)

140.000 THERAPISTS

IN EUROPE

(WHO, 2018)


EYE-SEE
A WEBCAM FOR THERAPISTS
THE WORLDS FIRST WEBCAM
ENABLING EYE CONTACT

ENABLING EYE CONTACT

THERAPIST
USE EYE-SEE WEBCAM

PATIENT
RECIEVING EYE CONTACT IN ONLINE THERAPY

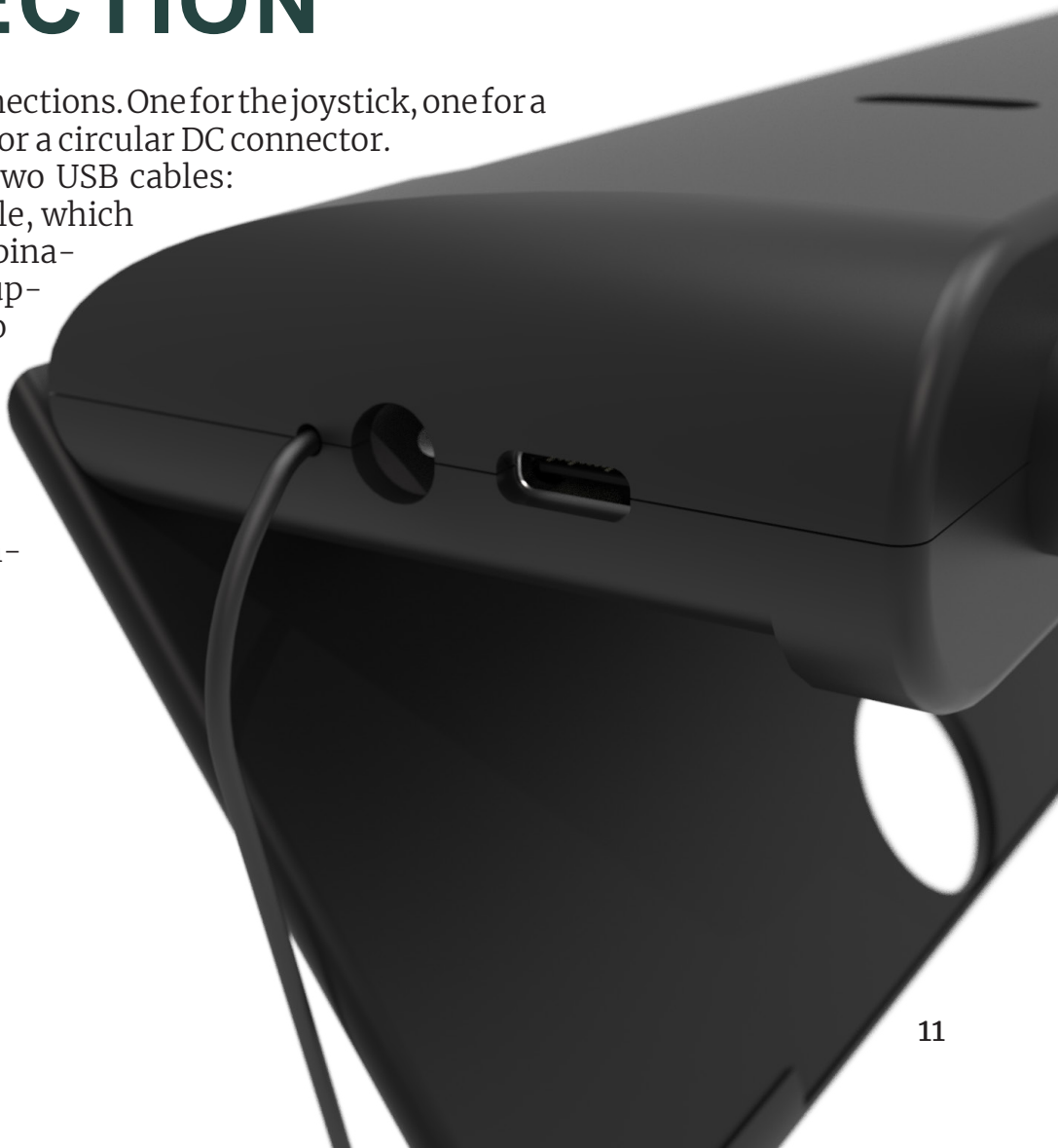
EYE-SEE

Eye-See is a webcam, like no other webcam. By being able to move the camera, the camera can be placed where you look.

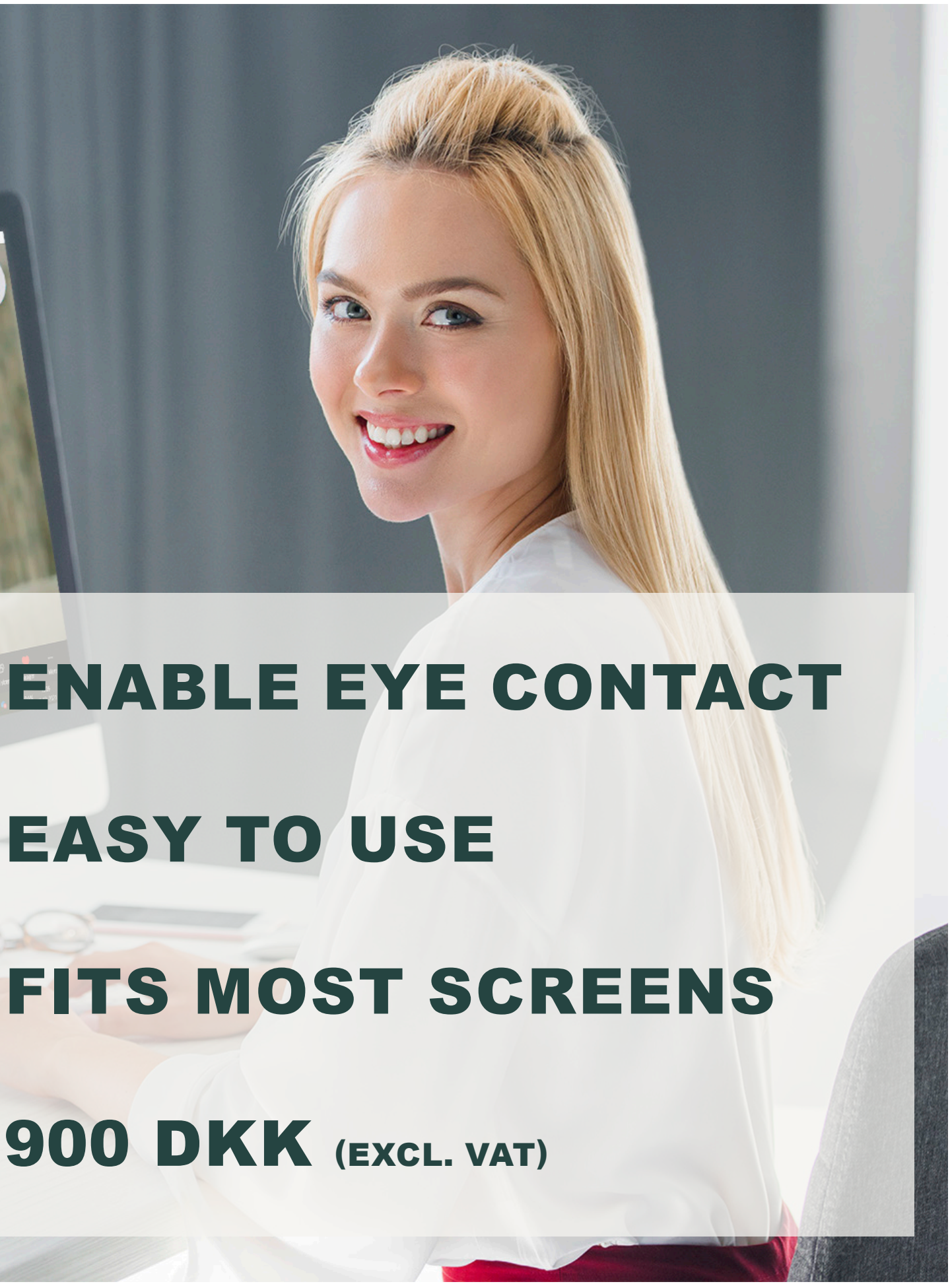
By moving the camera, the therapists will be able to place it, where they look at the screen and hence give the patient eye contact, thus a more present experience of online therapy is achieved.

CONNECTION

Eye-See has three connections. One for the joystick, one for a USB Type-C, and one for a circular DC connector.
The box comes with two USB cables: A USB-C to USB-A cable, which must be used in combination with the power supply, and a USB-C to USB-C cable, where no power supply is needed. Hence, Eye-See supports both setups with and without a USB-C connection.

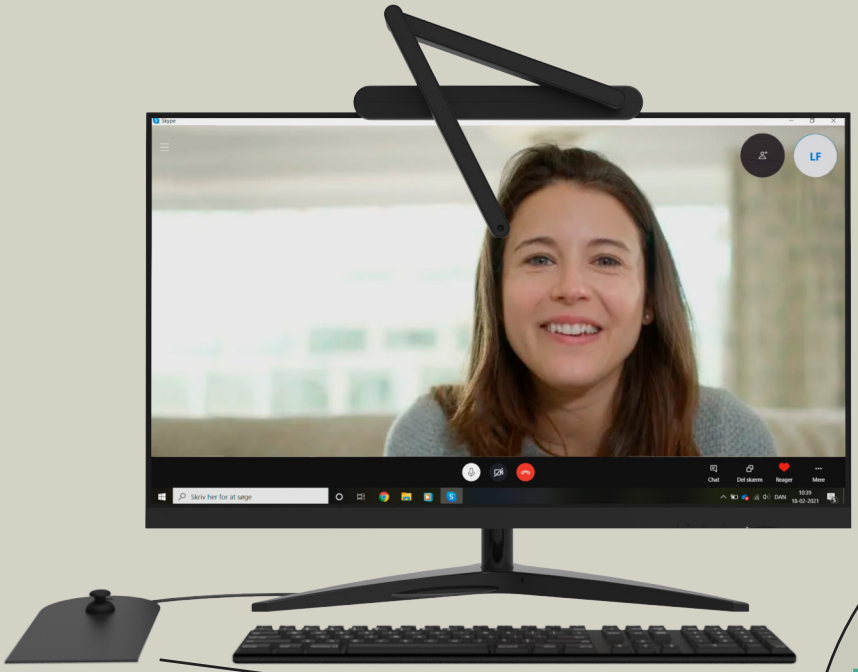


1.

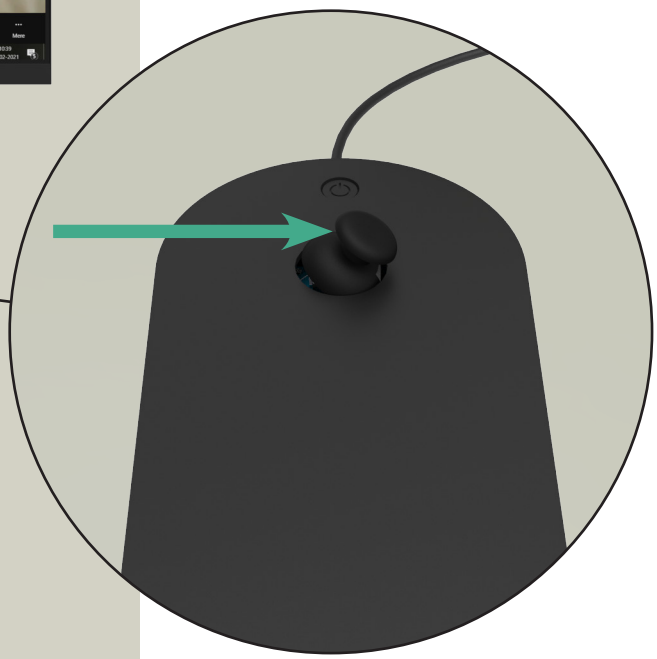


(Officeworker, n.d.)

USE

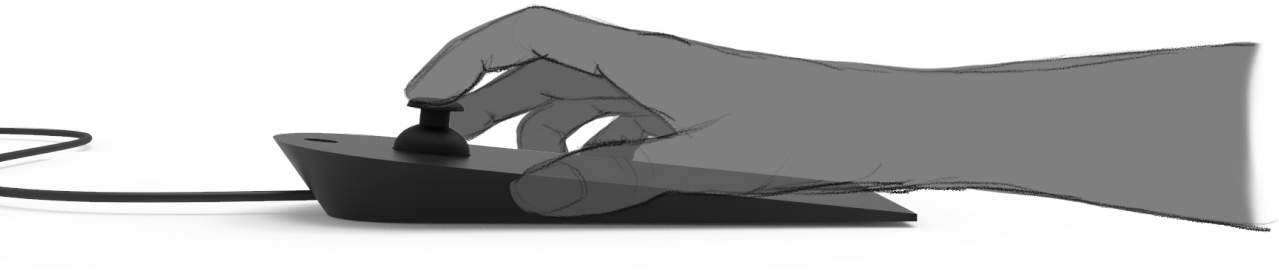


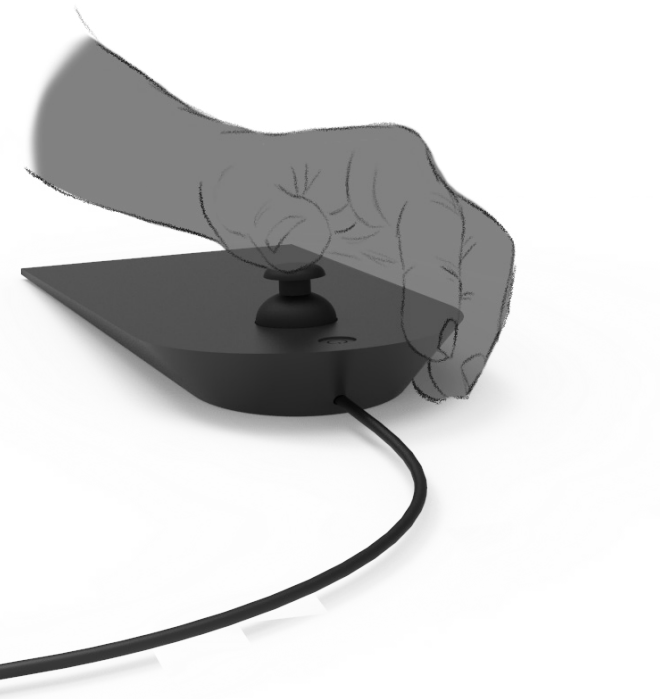
The camera should be placed in the forehead of the person.
If the patient moves away from the webcam, the joystick can be operated, simply by pressing it to the side.



The camera will then steadily move into position. Once placed in the forehead, the feeling of eye contact is reestablished.

CONTROL UNIT





AMBIDEXTROUS USE

The controller unit is easy to maneuver and can be used with both left and right hand.

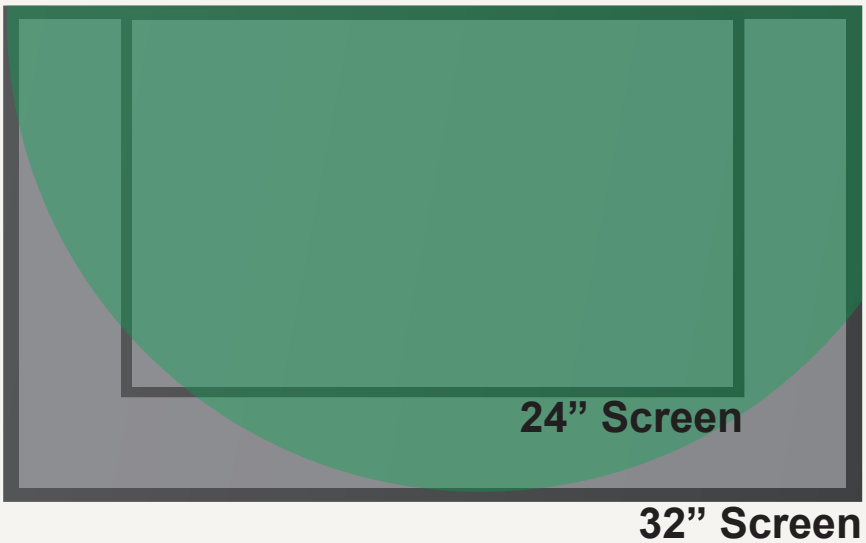
ERGONOMIC SHAPE

The shape of the controller unit is developed in collaboration with an occupational therapist and has an ergonomic shape that prevents tendonitis.

SIMPLE SETUP

The button on top of the control unit turns the product on/off. When turning on Eye-See, the webcam will go to a starting position. When turning it off, the webcam will go back to its resting postion.

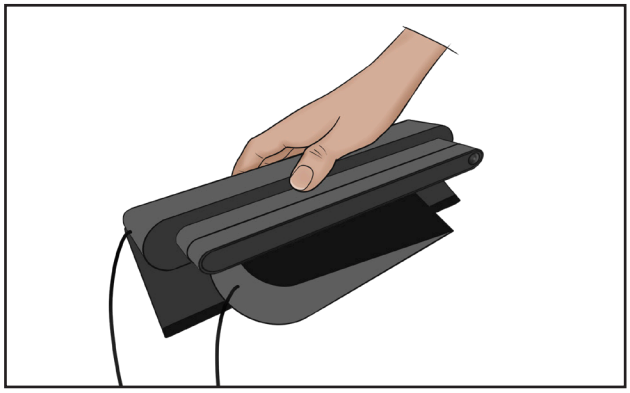
FITS MOST SCREENS



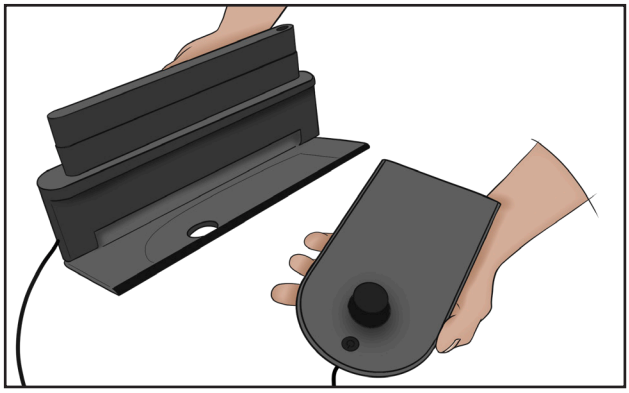
Eye-See has two arms with a total length of 40 cm. This makes it possible to cover most of the screen, no matter if it is a 24 or 32” display. This way Eye-See is compatible with the most common screens found on the market. The illustration shows the areas (green), which can be reached by the camera module.

MOUNTING ON SCREEN

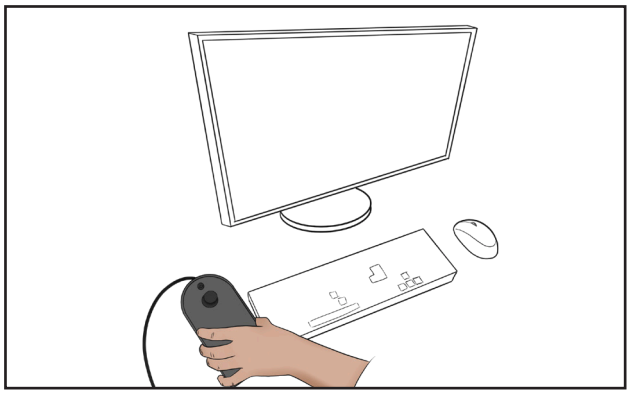
Fits screen down to 9 mm thickness, and with a bezel down to 6 mm.



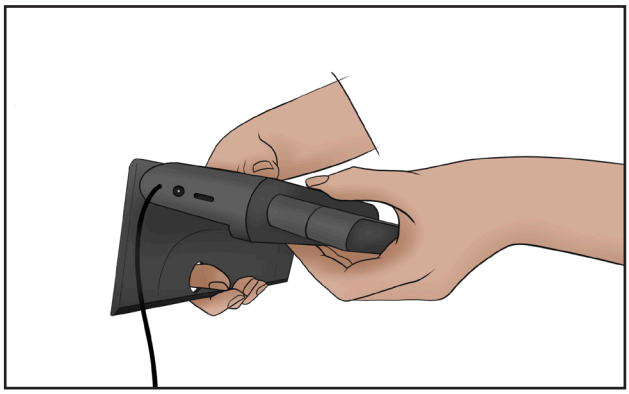
1: Unpack Eye-See



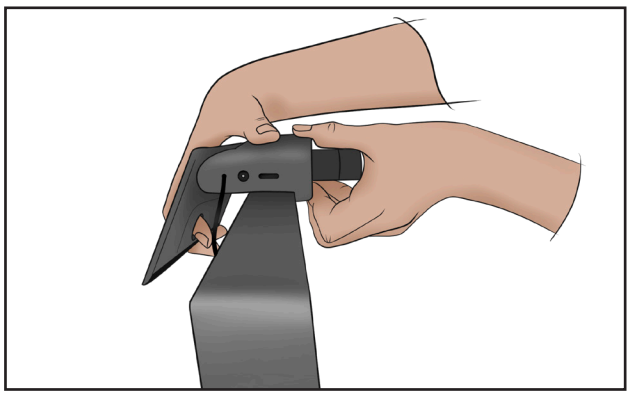
2: Remove joystick from the base



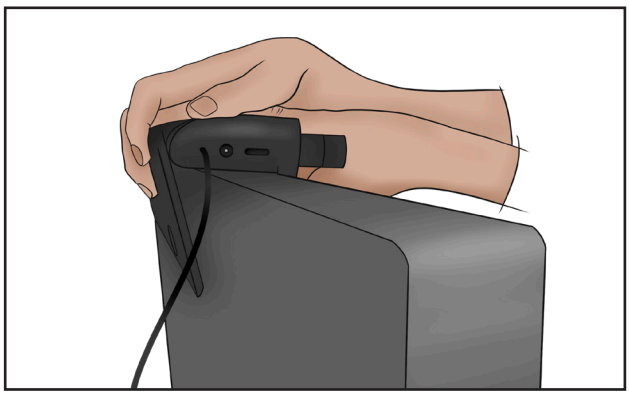
3: Set joystick aside



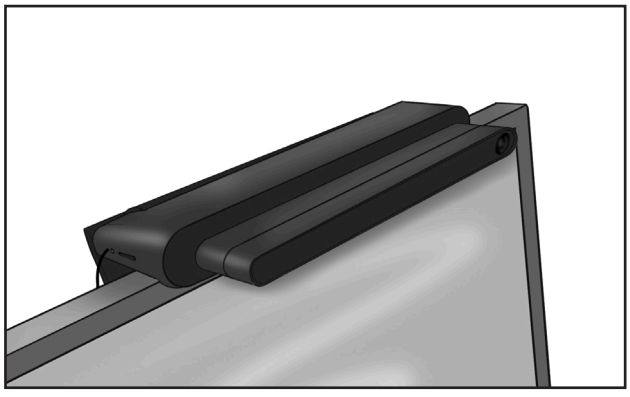
4: Pull out the flap on the back of Eye-See



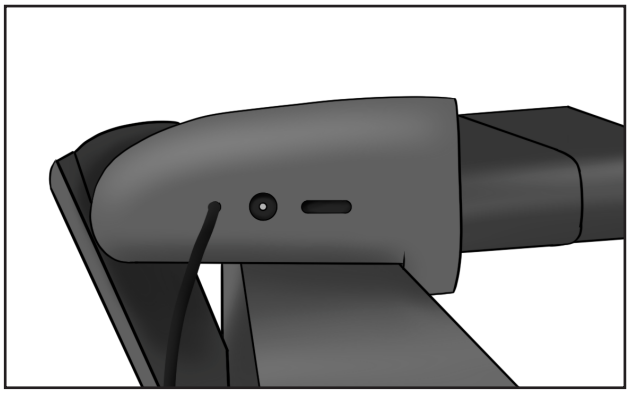
5: Align the edge of Eye-See with the top of the computer screen



6: Allow the clamping mechanism to push gently against the back of the computer screen



7: Eye-see is now mounted on the screen



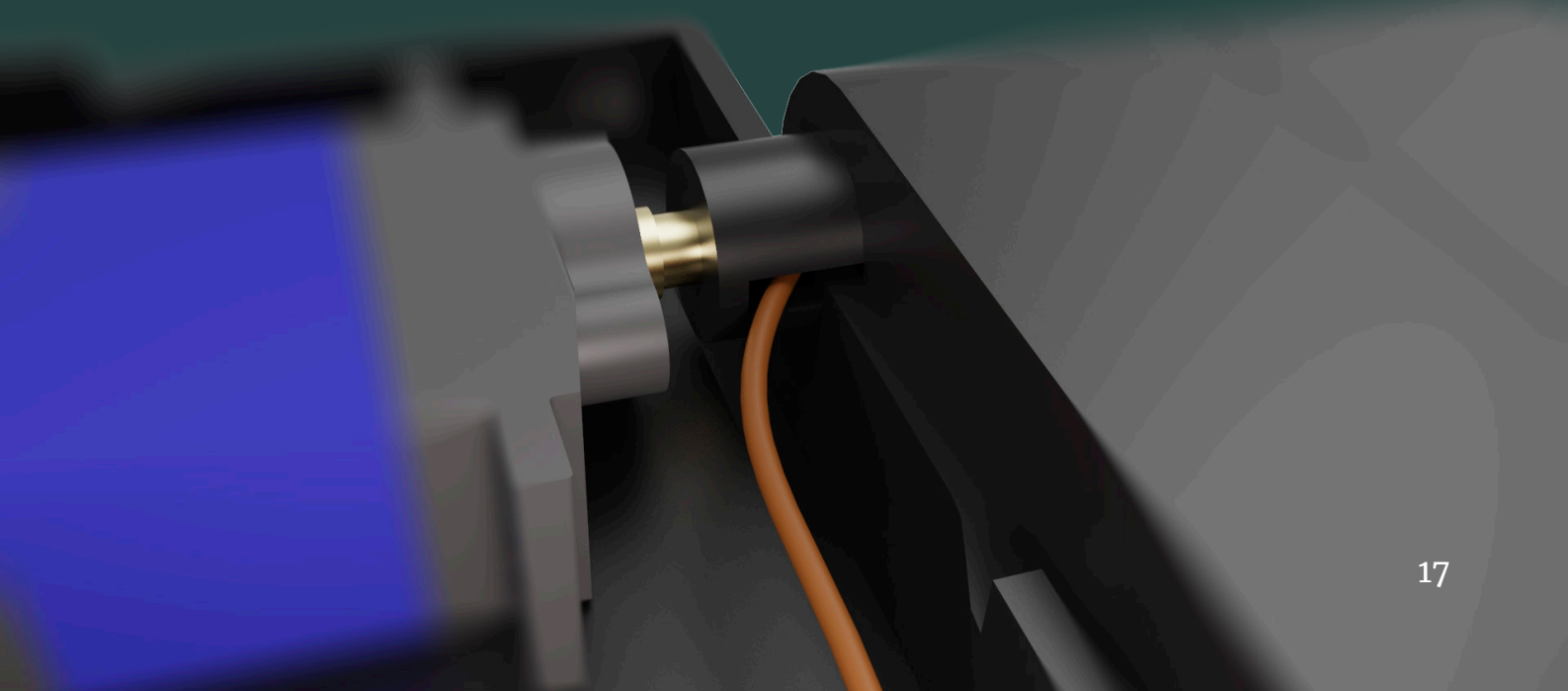
8: Plug in the power adapter and the data-cable

SOFT RUBBER

Where Eye-See rests on the screen, rubber pieces are added. These ensure a safe fit that does not slip, as well as protects the screen from scratches.

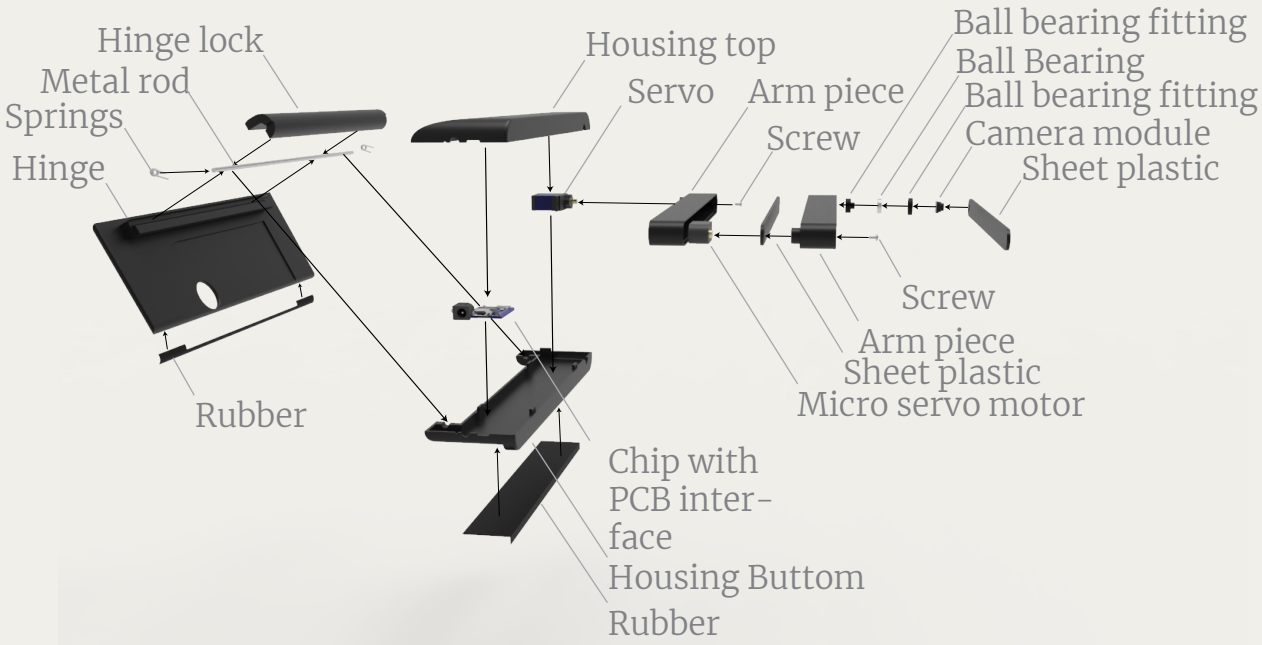
MANUFACTURING

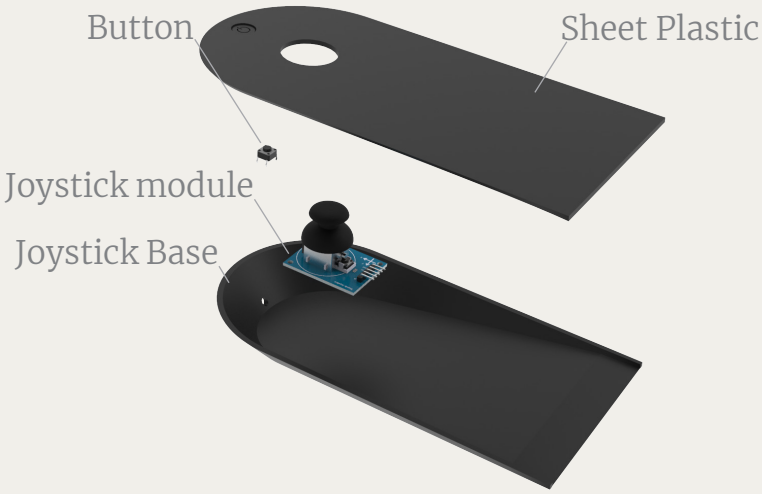
Wires run to the arms, to power the servo motor, as well as the webcam module. The arms are mounted with a small shaft, containing a hole able to run the wires through.



CONSTRUCTION

Eye-See is produced with a webcam attached to moveable arms. These arms move with servo motors. A joystick is attached to the product.
The different parts and their connections can be seen on the exploded view below.

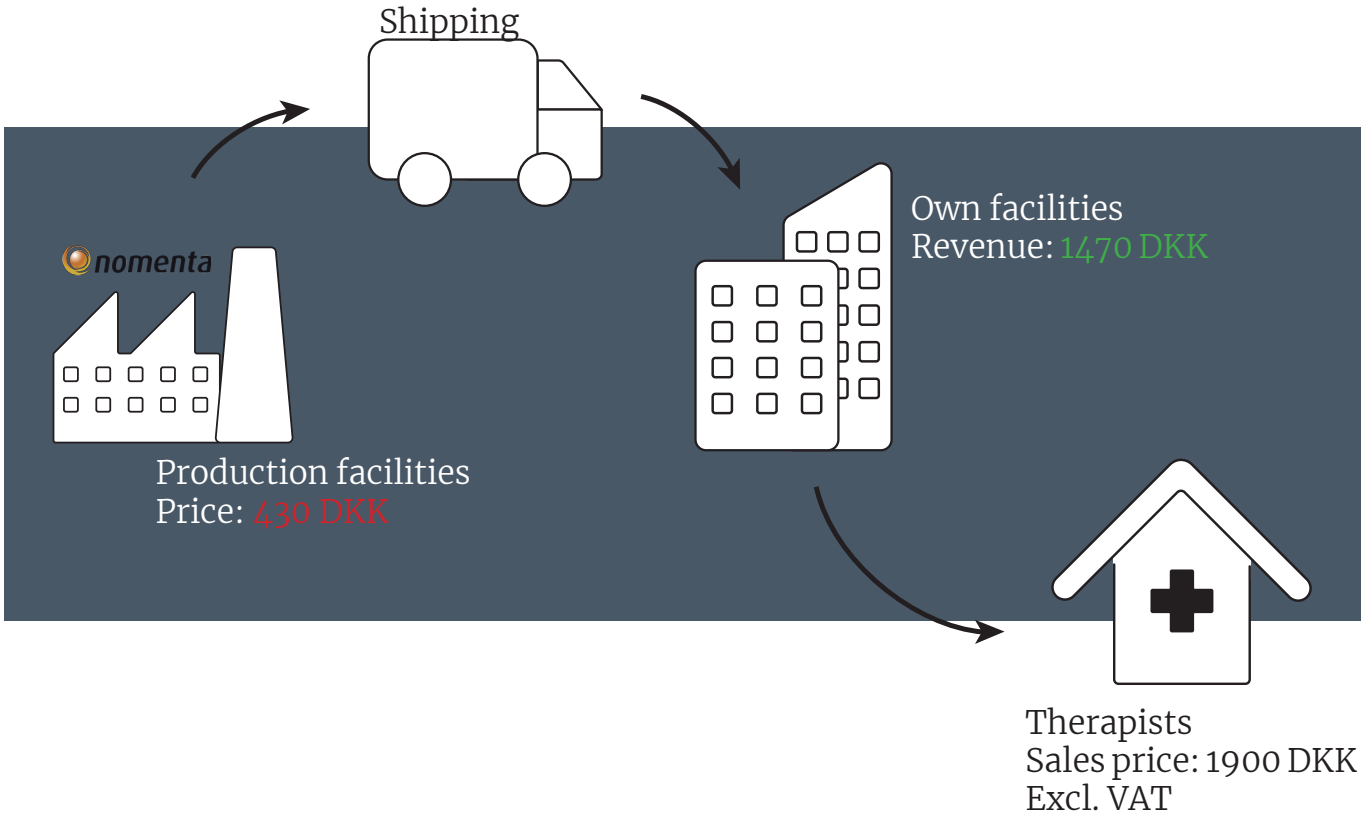




Here several components are needed. However, the majority are standard components, that can be bought relatively cheap. All internal components are based upon standard components, that can communicate. Hence only the casing has to be custom made.

BUDGET

Eye-See is sold at 1900 DKK (excl. VAT). This is sold directly to private practicing therapists, as well as hospitals. Making a big production will ensure a production price of 430 DKK, leaving a revenue of 1470 DKK, to develop the business, make advertisement and gain more customers.
This budget is made based on an Injection Molding process. To make proof of business, the first batches are made in high detailed 3D print, with a contribution margin of 450 DKK.



In the first year of business, only small batches are made, with a lower contribution margin. This is to have as small a start-up cost as possible.
It is expected, that the first couple of years will have a relatively low sales number until procurement to hospitals is established. Furthermore, the budget will allow a more international approach, once the first batches are sold in a national context.

	Year 1	Year 2	Year 3	Year 4	Year 5
Sales	100	300	1.000	2.000	4.000
Income	530.000 dkk	570.000 dkk	1.900.000 dkk	3.800.000 dkk	7.600.000 dkk
Expenses	485.000 dkk	604.000 dkk	1.280.00 dkk	2.000.000 dkk	3.000.000 dkk
Total	45.000 dkk	- 34.000 dkk	620.000 dkk	1.800.000 dkk	4.600.000 dkk
Bottom line	45.000 dkk	11.000 dkk	631.000 dkk	2.431.000 dkk	7.031.000 dkk

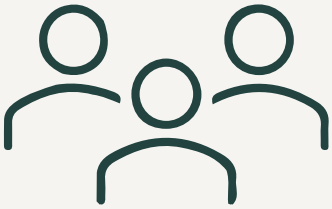
EXECUTION PLAN

A plan for developing the initial products, that will be used as market verification and proof of business are made. Furthermore, the necessary steps in upscaling the production are highlighted. The first versions are expected to be available on the market in 6 months.

	1	2	3	4	5	6	7	8
			20,000 DKK	30,000 DKK			220,000 DKK	
User servey Evaluation Concept detailing	Contact key customers Create prototypes Present for customers	Apply funds (50.000 DKK)	Identify improvent Get CE approval	Find PCB board manufactu-ring partner Sign manufactu-ring agree-ment Start 3D print production	Start sales	Apply funds (250.000 DKK)	Find injecti-on molding partner Sign manufactu-ring agree-ment	Start high number sales
4 Months	1 Month	1 Month	1 Month	3 Months		Upon 100 sales		

REACHING COSTUMERS

The therapists do not have any special purchasing channels. As the product is made for a niche market, having general electronic stores as retailers, is not relevant. Hence Eye-see is sold directly to the therapists.
Private practicing therapists already spend time promoting themself on social media platforms, which then is a suitable market where we can promote our product. Using social media advertising also enables us to focus the advertisement on therapists. Furthermore, therapists are relying on recommendations from colleagues. Hence we would like to establish pilot projects, where therapists get a product in exchange for recommendations and advertising material.



Therapist seeks inspiration and promotes themselves on social media

LEAN MODEL CANVAS

The lean model canvas provides an overview of the solution, as well as the business potential, and the market being focused on.

<table>
<tr>
<td rowspan="2">Problem
When having online video calls, one loses the intamacy of having eye contact, as one is not looking into the camera (see pp. 5)

Existing solutions
- Teleprompters (often expensive and big)
- Eye-correcting software (Still faulthy, and faking sensitive situation)</td>
<td>Solution
Eye-see
 
First webcam enabling eye contact</td>
<td rowspan="2">Unique value proposition
Eye contact in online video calls

High level concept
Intimacy improving webcam</td>
<td>Unfair advantages
First movers on market.</td>
<td rowspan="2">Customer segments
Therapists (psychiatrists, psychologists, coaches, etc.) providing online therapy

Early adapters
Private practicing therapists</td>
</tr>
<tr>
<td>Key metrics
100 sales in 1 year, and 4000/year in year 5</td>
<td>Channels
Own webshop

Ads on Facebook and Instagram

Pilot projects</td>
</tr>
<tr>
<td colspan="3">Cost structure
Fixed costs
82.000 DKK (Insurances, it ect.)

Variable costs
Injection molding: 430 DKK
SLS 3D print: 1442 DKK</td>
<td colspan="2">Revenue streams
Product price: 1900 DKK

Revenue Injection Molding: 1470 DKK
Revenue SLS 3D print: 458 DKK</td>
</tr>
</table>

From this we see a business focusing on providing eye contact in online video calls. This is done through a webcam, that will be mounted on ones screen, and is a much more affordable and efficient solution than current alternatives.
The early adaptors of the product is private practicing therapist. With a production price of 430 DKK, a revenue of 1470 DKK/unit can be achieved, at a cost price of 1900 DKK.

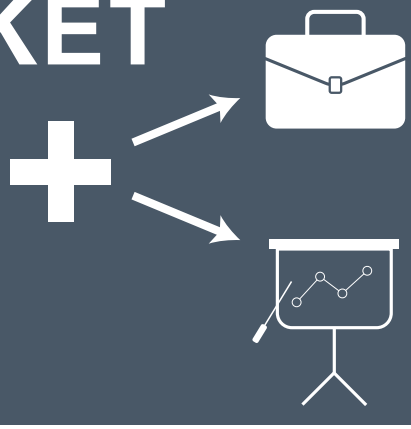
CONNECT must have ads on social media

Therapist value reviews/recommendations from others

Early adapters gets Eye-See for free in exchange for participating in video ads

EXPANDING MARKET

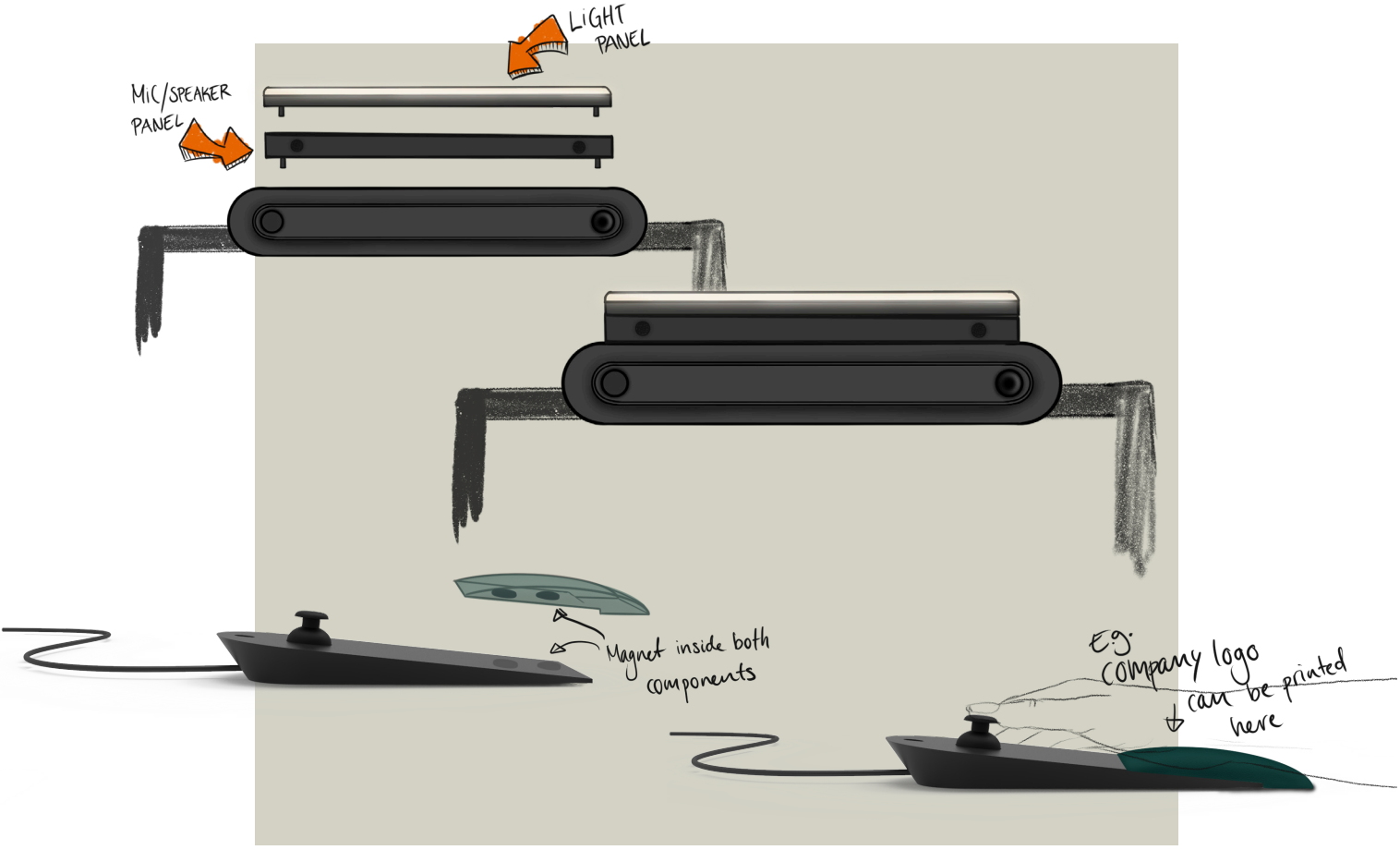
The solution is implemented in a health care context, where it is in particular high demands. However, we see potential in expanding the value of eye contact in business meetings, presentations, etc. which will lead to a bigger market, and broader use of the product.

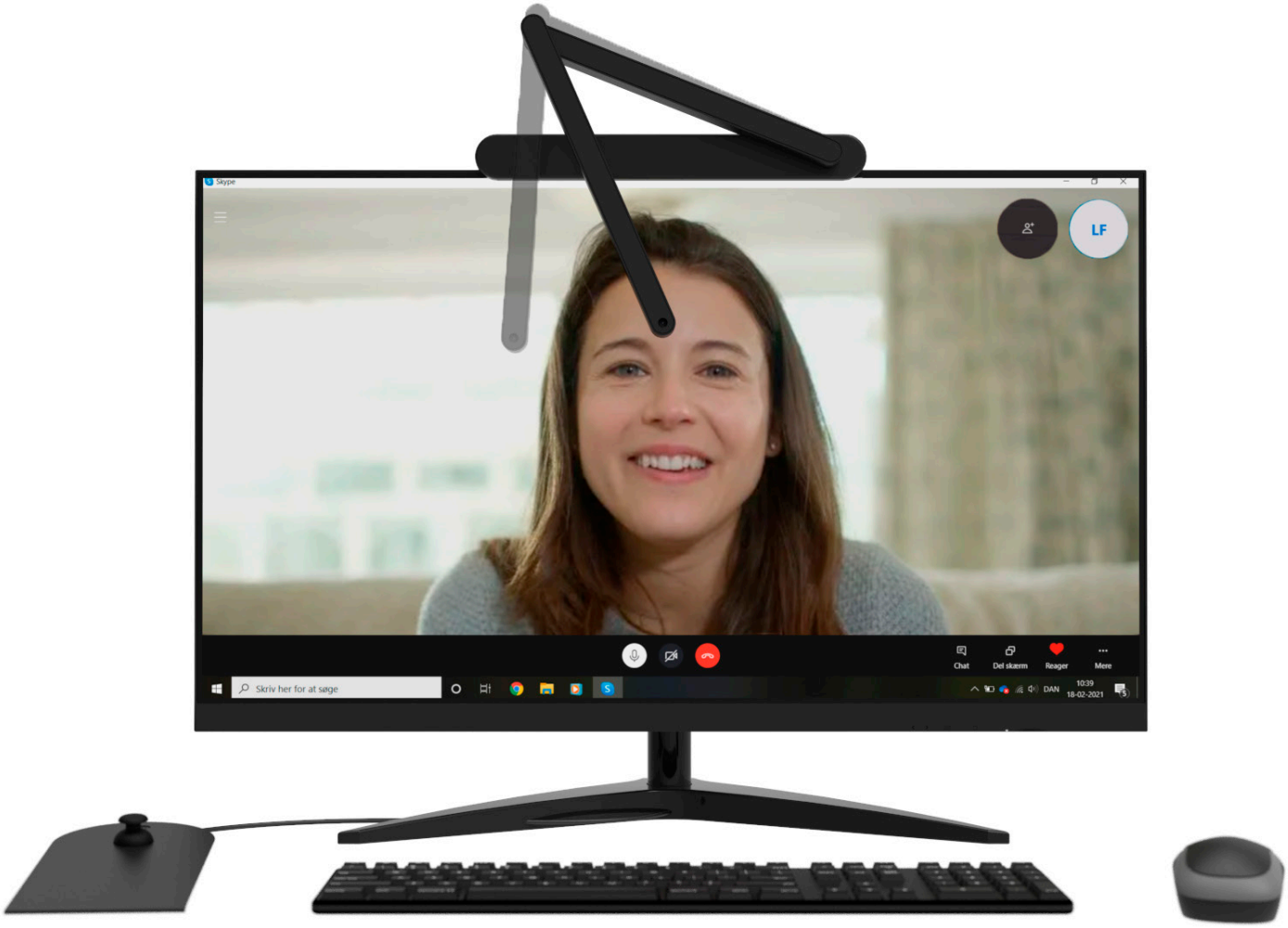


PRODUCT SERIES

Version 1.0 - Add ons

The current product proposal focuses on the camera aspect of the product. This enables eye contact in an online meeting. To further improve the experience of online conversations, elements such as audio (microphone and speaker), and light can be added to panels, which can be mounted on top of Eye-See. Moreover, extra padding with e.g. one's company logo can be added to the joystick. These features will be able to purchase as add-ons to one's product and will be available on the market once funding is sufficient.





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Dansk Psykolog Forening. 2017. Rekordmange psykologer uddannet i 2016 | Dansk Psykolog Forening. [online] Available at: <https://www.dp.dk/rekordmange-psykologer-uddannet-i-2016/#:~:text=Det%20samlede%20antal%20erhvervsaktive%20psykologer,%C3%B8get%20fra%208.181%20til%208.516.> [Accessed 26 March 2021].

WHO, 2018. Mental Health Atlas. France, pp.32-33.

ILLUSTRATIONS

Illustrations are made with the use of following:

n.d. Doctor and psychologist. [image] Available at: <https://www.colourbox.com/image/portrait-of-a-female-doctor-and-senior-male-patient-in-a-bright-office-of-a-modern-private-clinic-image-50656170> [Accessed 1 June 2021].

n.d. Office. [image] Available at: <https://www.colourbox.com/image/modern-interior-of-home-office-with-writing-table-image-2142326?fbclid=IwAR1laPDxgvWjKliRBNOwSlPBIj6ha7ZsI34m0wsM7CEhlk7fQt81RUlJLOI> [Accessed 1 June 2021].

n.d. Officeworker. [image] Available at: <https://www.colourbox.com/image/beautiful-young-businesswoman-smiling-at-camera-while-working-with-desktop-computer-in-office-image-32922206?fbclid=IwAR1laPDxgvWjKliRBNOwSlPBIj6ha7ZsI34m0wsM7CEhlk-7fQt81RUlJLOI> [Accessed 1 June 2021].

All other illustrations are selfmade

AALBORG
UNIVERSITY

STUDENT REPORT

Eye-See, MA4-ID9, June 2021

Lea Becker Frahm
Stefan Dybro

EYE-SEE

PROCESS REPORT

Titel	Eye-See: improving online therapy
Report type	Process report
Project start	01.02.2021
Submission	03.06.2021
Team	No. 9
Main supervisor	Christian Tollestrup
Co-supervisor	Radoslav Darula
Pages	96
Appendices	22

Stefan Dybro

Lea Becker Frahm

ABSTRACT

The following report is a process report, describing the process of developing the product Eye-See by the group Ma4-id9.

Eye-See takes on the problem of not having eye contact in online therapy. This is done with a focus on a therapist setting, where eye contact is important, especially for the patient. The health care sector is becoming increasingly digital, and online consultations are a priority, making it relevant to improve online consultations.

The proposal is Eye-See; a webcam, that can move in front of the screen. By placing the webcam on the forehead of the patient on the screen, the therapists can look at the patients, reading all the micro-expressions, while also giving the patient a feeling of eye contact.

The product is developed through user involvement, of both therapists and patients. Concepts and models are presented to the users, finding the right solution, and the latent needs for both. The solution improves the felt presence by the patient, who will not need a specialized setup but will directly benefit from the webcam the therapist uses. Furthermore, the report also presents the business aspect looking at the solution as a startup, making the solution affordable, and making it possible to make proof of business without a large initial investment. Moreover, technical details are defined, ideas for a product series is presented, along with a reflection upon how the project could have turned out differently.

TABLE OF CONTENT

READING GUIDE

This report is divided into thematic chapters, hence it is not a linear, chronological explanation of the process. Consequently, some chapters refer back- and forwards to other chapters.
Furthermore, the three icons below will mark the finding of a new requirement, insight, or specification.

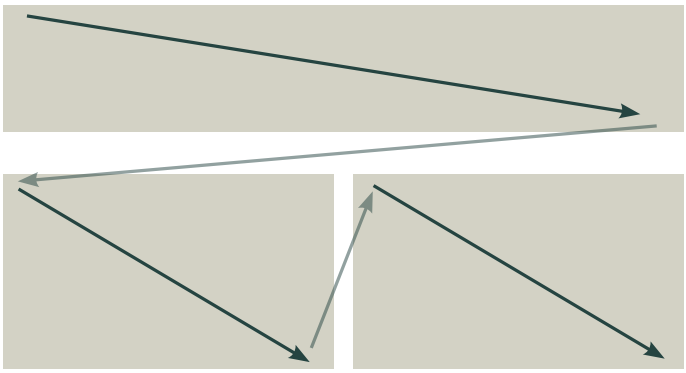
Icons:

New requirement

New insight

Specification

Reading columns at a page:



Throughout this report, hyperlinks will lead to video demonstrations of some prototypes. These videos were made as a part of the process as a prototyping tool and are **not** necessary to watch. However, they show how the concepts were presented to some of the users.
The product report is made, as material for seeking investment. Hence some information will overlap the process report, for the product report to be a standalone material.

PROJECT SCOPE

Working in this field of creating a more present online consultation, there are things which we are not able to control, nor influence. Among these is the internet connection. Hence, bad image quality, poor or lagging sound caused by connection problems are not factors, that we can improve. Moreover, the software used by therapists is out of our control, due to e.g., the GDPR-rules, which they have to follow carefully.

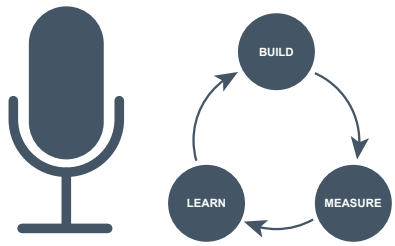
What is possible to influence is how the therapists' approach the consultations and one's ambient conditions while doing so.

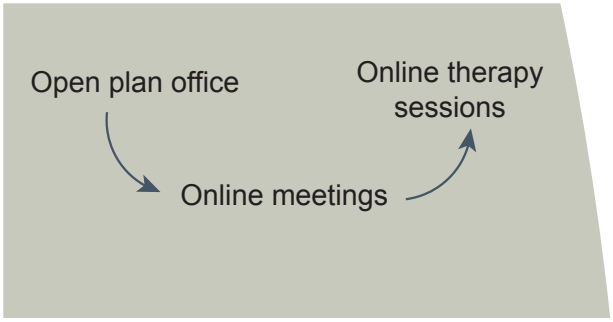
- Support a present conversation through e.g. eye contact
- Control the interaction with the product

- Bad sound, image, etc. due to bad internet connection
- Software used for online conversations

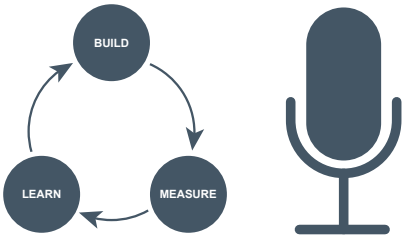
PROJECT OVERVIEW

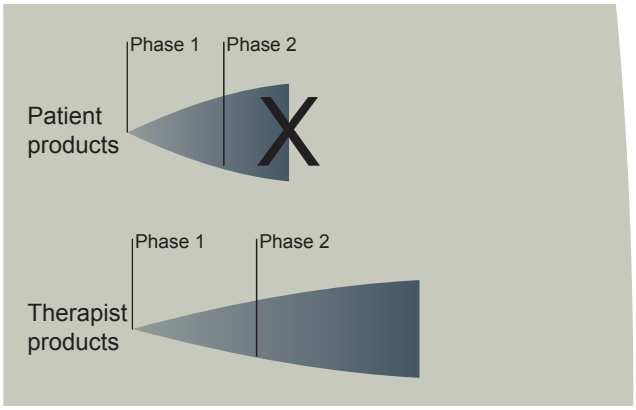
PROBLEM IDENTIFICATION



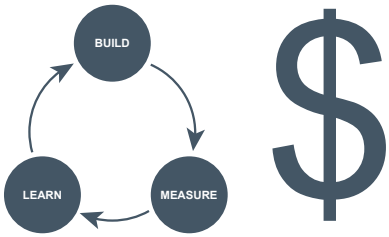


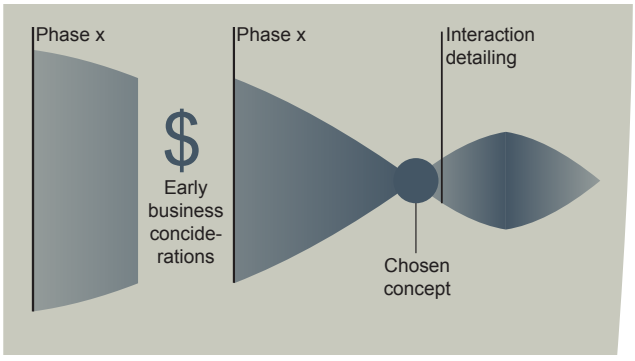
PROBLEM UNDERSTANDING



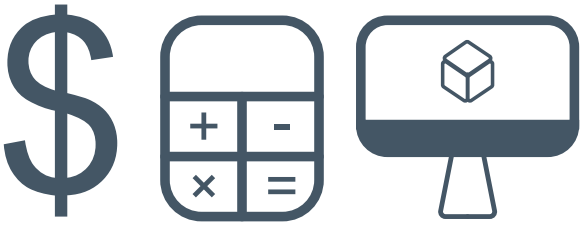


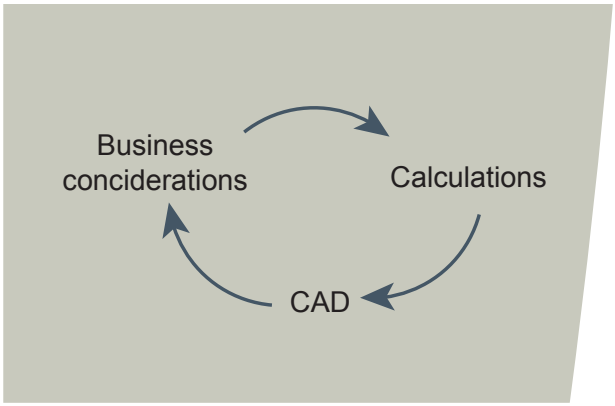
PRODUCT DEVELOPMENT





DETAILING





1 RESEARCH

This chapter gives an introduction to the problem. We explore what telehealth is, and some of the benefits from it. Furthermore, we look into how the health care sector purchase, and briefly on the market. A user panel is introduced, which will be used throughout the report for feedback and testing, and therapists current setup for telehealth communication is analyzed.

TELE-HEALTH

The health care sector, is becoming increasingly digital. This has lead to the invention of the term 'Tele-Health', which is essentially digital health care.

"Tele-Health is the use of information- and communication technologies to support preventive, treating or rehabilitating activities from a distance."
(Kommunernes landsforening, 2013)

There are several different activities involved in Tele-Health. The development has broadened during the last years, and the availability of new technologies is speeding up this process. E.g. the 5G network is expected to influence the Tele-Health sector.
Today Tele-Health includes several services, which can be grouped into three categories.

TeleHealth shall as a minimum support the same quality as the traditional service/offering in the health care sector, meanwhile the offering is delivered more efficient.
(Kommunernes landsforening, 2013)

Main Tele-Health activities

Communication
Calls with doctors/nurses. Often video calls.

Monitoring
Monitoring of patients health, e.g. blood preassure, pulse ect.

Automation
Automation processes, such as ordering of goods, and planning of resources, done from a computer data analysis.

This project focuses on the communication aspect of Tele Health. This is done in a therapist context. Therapy sessions already utilize remote consultations. However, both patients and therapists experience that a regular online video call, is not as good as the traditional offering. To achieve the goal of "support the same quality as the traditional service/offering..." this media needs improvement.

ONLINE THERAPY SESSIONS

This page is based on the initial semi structured interview with Marlene L., psychiatrist

Pros of online sessions

Therapists are working towards a more digitalized therapy session strategy. This development is both seen in the Danish healthcare sector, but also in the development of online platforms, such as "Betterhelp", an online therapy database, supporting the development of online therapy sessions. Some of the benefits from online therapy sessions are:

Waiting time

People spend a lot of time in waiting areas, as people tend to be early. This can be minimized online.

Transportation

Can be an inconvinience if living in a remote area. Also some patients with anxiety experiences public transportation as being almost impossible.

Expert Personnel

No matter the area you live in, you have acces to the most qualified personnel to treat your problem.

Cons of online sessions

However, there are some known downsides to online communication in general. Among these are:

Less personal

Less Nonverbal communication

Lack of privacy at home

Some of the reasons for the online therapy session, not being as good as the traditional offering, is due to less personal communication form. A greater distance is experienced through the screen. There is less nonverbal communication from body language and facial expressions.
For some patients, a privacy issue can apply, if one does not have a private area available to take the session.

These are some of the immediate pros and cons. To get a better understanding of therapist and patients needs, interviews need to be conducted.

MARKET SIZE & ONLINE THERAPY

1 IN 3 GET A MENTAL DIAGNOSIS
(Det siger statistikkerne, 2021)

(WHO, 2018)

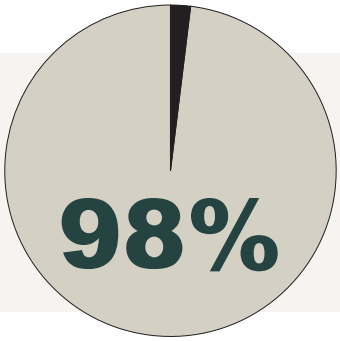
In 2016 there were **8.870 working psychologists in Denmark**. (Rekordmange psykologer uddannet i 2016 | Dansk Psykolog Forening, 2017)

Danish psychiatry had **1.201 employed psychiatrists**

and **296 child and adolescent psychiatrists** in 2017. (Sundhedsstyrrelsen, 2020)

BetterHelp (an online therapist platform) have **900.000 active users** and **8.000 licensed therapists**. (BetterHelp Review, 2021)

98% of the BetterHelp users have experienced notable progress, Making online therapy a usefull resource. (About Us - The Largest Online Counseling Provider | BetterHelp, 2021)



HEALTH CARE PURCHASING MANAGEMENT

In 2020 Danish Regions published their procurement strategy for 2020-2025, describing four main goals they seek to achieve. The following is a selection of details from the report pointing towards the Danish Regions being interested in a product improving online therapy.

The procurement strategy 2020-2025 aims to:

1 DEVELOP AND SUPPORT THE CORE TASKS OF THE REGIONS THROUGH INNOVATION AND CREATING VALUE

- Increase the use of new healthcare technologies
- Standardizing across hospitals
- Create pilot projects with the focus of increasing the value for patients by purchasing innovative

2 SHOP GREEN

- Support the sub-goal of the UN World Goals, 3.4: *"Lower the mortality, and better treatment by purchasing innovative technology, as well as procurement cooperation with the municipalities"* (translated quote from (Mål 3: Sundhed og trivsel, n.d.))

3 DEVELOP THE REGIONAL PROCUREMENT COOPERATION AND CONTINUE THE PROFESSIONALIZATION OF THE PROCUREMENT AREA

- Increased standardization, incl. categorization (*note: to our knowledge, this means that all regions will get the same equipment and services regarding some specific areas of the health care system)

4 FURTHER EFFECTUATION

- Increase the level of digitalization

(Regionernes indkøbsstrategi 2020-2025, 2020)

With the new procurement strategy, all the Danish Regions will get the same equipment, meaning that Eye-See will be supported regardless of where you live in Denmark. This supports the possibility of choosing the specific therapist you like, as requested (see the interview with the patient, appendix 1)

Digitalization of Danish hospitals is a desire, incl. healthcare technology

Pilot projects must be used to find fitting technologies that afterward will be spread to all hospitals

USER PANEL

Throughout this project, we have been in contact with several different therapists, who have giving feedback on our concepts and provided us with knowledge from their fields. This has helped explain the strengths and weaknesses of our ideas and concepts, as well as online therapy in general.

Besides that, we have also used other people of a varied age group to test some mock-ups and prototypes, when the specific knowledge of a therapist or a patient was less important than getting fast feedback from people in general.

Primary user:
Therapists are the ones physically interacting with the product.

Marlene Lauritsen
Psychiatrist
University hospital of Aalborg

Maren Moltsen
Psychologist
The Cancer Counselling, Aalborg

Christen Sinding
Priest
Student Priest Aalborg

Tanja Becker
Coach

Rikke Elster
Privately practicing psychologist
Providing online therapy

Asmund Lund
Privately practicing psychologist
Providing online therapy

Naturally, we have also been in contact with some people, who have experience with being in therapy and getting treatment, online as well as physical.

Secondary user:
In the final concept, the **patients** are not directly/physically interacting with the product. However, they are affected by the functionality of the product. Thus, they are important to take into account.

Patient #1
Female
19 years old
Three years of experience with therapy on/off

Patient #2
Male
30 years old
2,5 years of experience with permanent therapy and years on/off

Other experts:
Furthermore, an occupational therapist, a founder of a 'treatment community', a photographer and a software developer has provided with their knowledge about respectively ergonomics, procurement strategies, knowledge about cameras and lenses, and software development.

Tanja Becker
Occupational therapist

Marlene Boel
Founder of a 'treatment community'

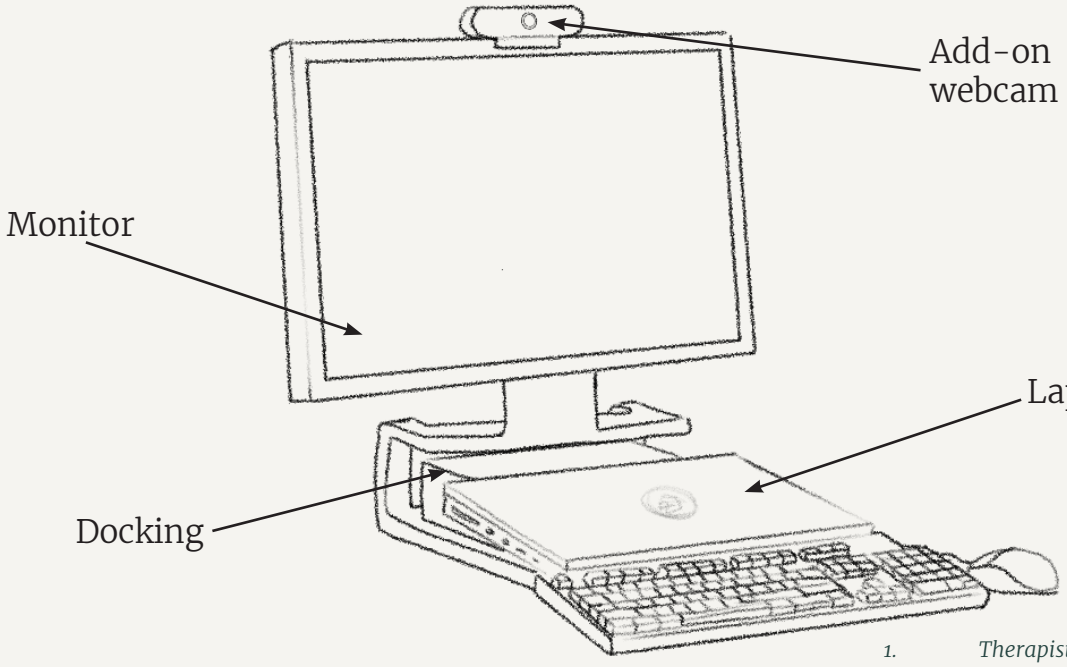
Meick Jensen
Photographer

Thomas Vagning
Software developer

CURRENT SETUP

The current setup is slightly diferent on the therapist and the patient side. Here is an overview of which products the two parts use. This is to understand which context a solution should relate to.

THERAPIST SETUP



1. *Therapist's office setup*

PATIENT SETUP

Laptop **Tablet** **Smartphone** **Earpods**

The therapists are all using laptops, in combination with a docking station and a monitor. Furthermore, some therapists use add-on equipment, such as headsets and webcams.

The patients vary more in their main platform, from laptops and tablets to smartphones. If not using built-in speakers, they tend to use in-ear headphones.

Therapists use Laptop and monitor

Patients use Laptop, tablet or smartphone

RECAP

In this chapter, a problem area and initial research is established. We see that digitalization is a priority, and we know both some pros and some cons of online video consultation. Here the cons, primarily being the presence felt in online communication, are lowered.

A potential in selling to the regional procurement cooperation has been observed. And a user group of different therapists and patient is established, giving the opportunity for making user testing and getting feedback.

INITIAL PROBLEM STATEMANT

How can experienced presence and trustworthy communication be improved at virtual meetings between a therapist and a patient?

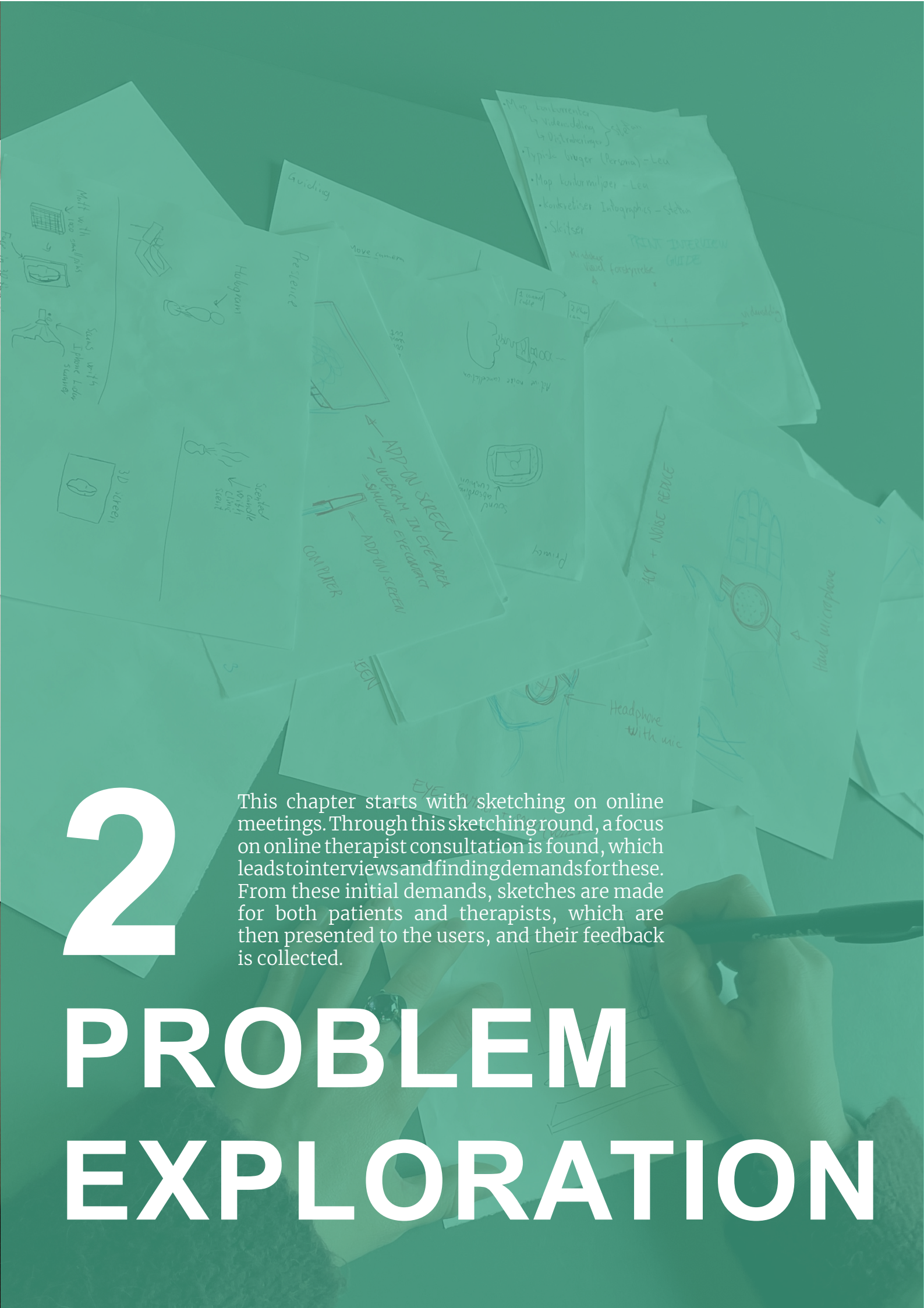
NEW INSIGHT

Digitalization of Danish hospitals is a desire, incl. healthcare technology

Pilot projects must be used to find fitting technologies that afterward will be spread to all hospitals

Therapists use Laptop and monitor

Patients use Laptop, tablet or smartphone



2

This chapter starts with sketching on online meetings. Through this sketching round, a focus on online therapist consultation is found, which leads to interviews and finding demands for these. From these initial demands, sketches are made for both patients and therapists, which are then presented to the users, and their feedback is collected.

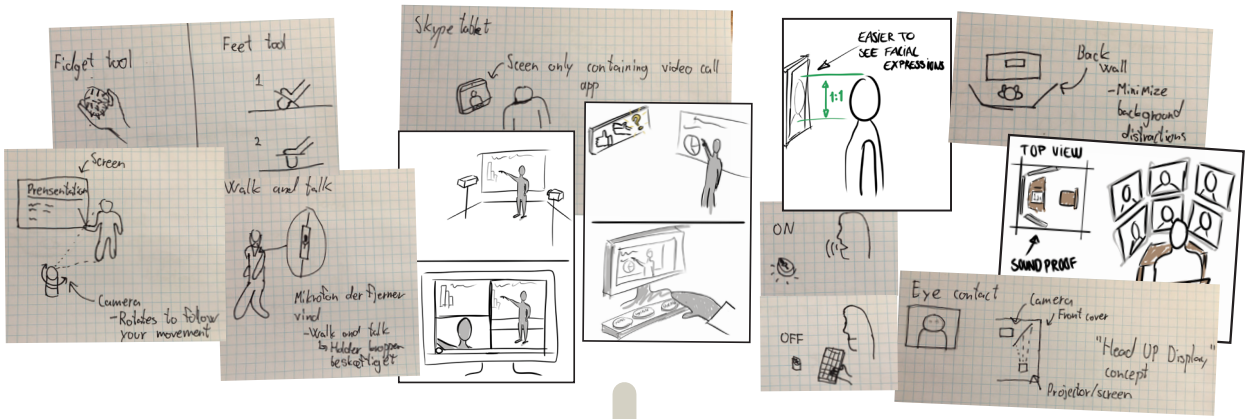
PROBLEM EXPLORATION

INITIAL IDEATION

The purpose is to make the initial idea generation on the theme "online communication", and to get nearer a specific problem/case for this project. Hence select a few sketches to show people, who use online communication in their work-life to get feedback.

The first sketching round was followed by a sketching round divided in two, where the focus was partly to generate ideas on products for online presentations and partly on products for online meetings.

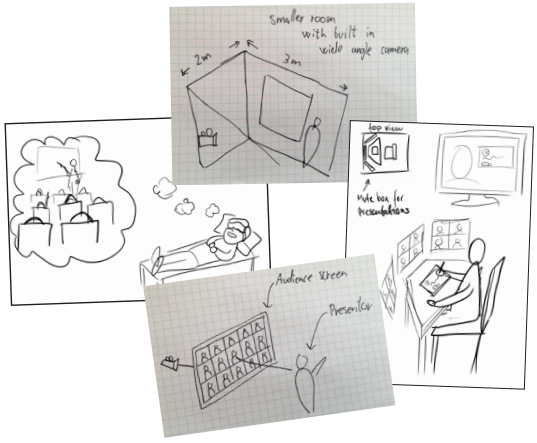
Sketcing round 1



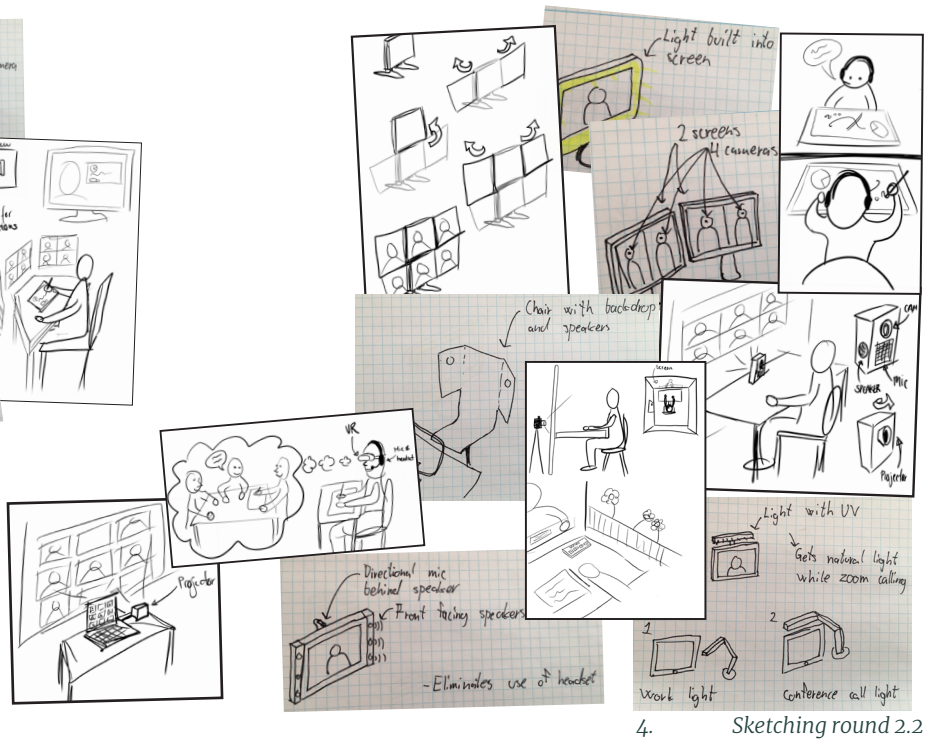
2. *Sketching round 1*

Online presentations

Online meetings



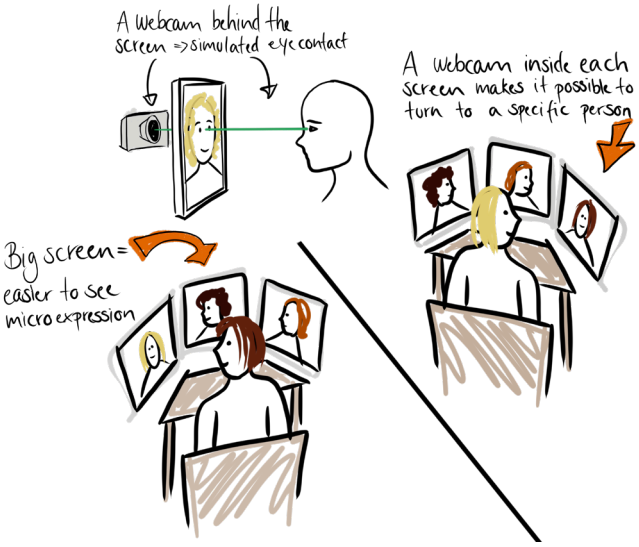
3. *Sketching round 2.1*



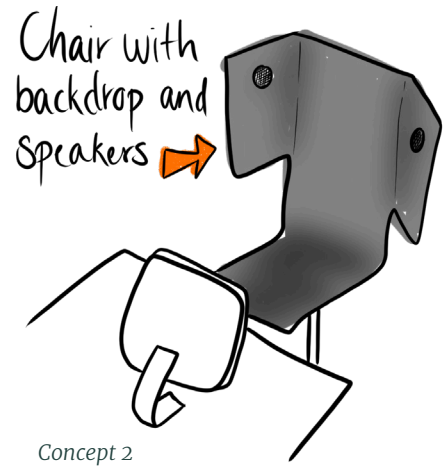
4. *Sketching round 2.2*

As it shows on the previous page, it was much easier for us to generate diverse ideas for online meetings. Thus, this led to the decision of working with online meetings. These were presented to users, to get feedback on concepts.

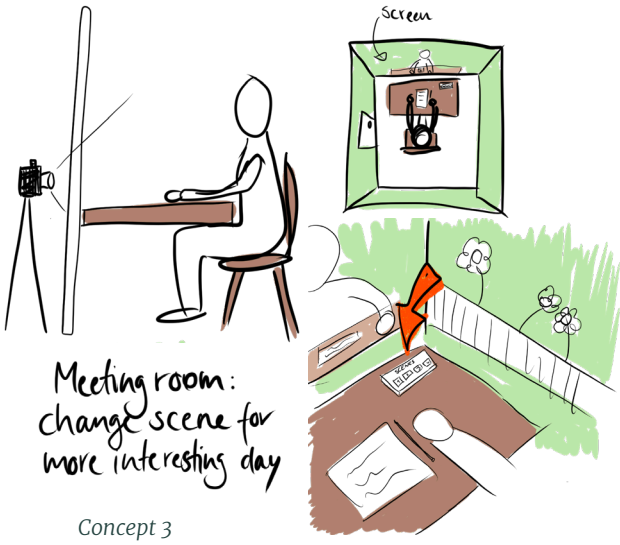
Online meetings



5. *Concept 1*



6. *Concept 2*



7. *Concept 3*

User feedback

Concept 1
The psychiatrist Marlene showed great interest in the first concept and said that it would be useful for the psychiatrists at the hospital since it is a big priority to have more online consultations with their patients. Due to the COVID-19, they must have all their consultations with patients online - either by phone or computer. Hence, they lack the feeling of eye contact, among other things, they usually use as "tools" when treating patients.

Concept 2
The original idea of the second concept (creating a silent zone in a room with more people) did not have much potential, since the psychiatrists at the hospitals have meeting rooms for talking to patients, so they do not get interrupted. Nevertheless, Marlene said, that if it improved the sound quality (both speaker and microphone), it could still be valuable. Other than it being important, that the patients can hear the psychiatrist loud and clear, it is also important for the psychiatrist to hear the patient clearly. This is due to the fact, that one can get a lot of information from the way things are said.

Concept 3
The feedback on the third concept was that it was more a funny idea rather than particularly useful. Marlene elaborated, and said, that the new 'office prank' is to change the background when talking through Teams, etc.

Evaluation
By coincidence, the first person we showed the concepts to was the psychiatrist, Marlene L.. She explained that it is a big priority at the hospitals to digitalize the consultations with patients and has been a priority long before the outbreak of COVID-19 in Denmark. This led to a conversation about how the digitalization can be valuable for hospitals, and which problems they currently experience with it.

Conclusion
Based on this conversation with the psychiatrist, Marlene L., it is decided that the project scope should be focused on the online consultations between therapists and patients.

Next step
Dig deeper into the pros and cons of online consultations. Hence, how respectively the therapists and the patients cope with the problems, and which parameters are the most important when having online consultations for each of them. Furthermore, develop concept for both patients and therapists to improve the online consultations.

Eye-contact and presence in online conversation is relevant for therapists

INITIAL PROBLEM

Some initials semi-structured interviews (Kvale and Brinkmann, 2015) about having online therapy sessions were held to dive into the problems and possibilities. (See appendix 2)

"Digitalization is also a way of taking care of the patients, that are not well in the first place"
- Marlene, psychiatrist

"They were a little more in their comfort zone, because they were at home"
- Marlene, psychiatrist

"With the current solutions, all noises are equal, which is disrupting. Not like in real life, where we are able to ignore the background noise of other people talking"
- Marlene, psychiatrist

"We need the presence to see how the patient is doing"
- Marlene, psychiatrist

"There is another physical distance to the people you talk to, which actually feels safer and makes easier for some people"
- Maren, psychologist

"Sometimes there is a bad internet connection. So the focus is two completely different places"
- Tanja, coarch

"With the current solution, we can't really look each other in the eyes"
- Christen, student priest

"Being able to see how the other person is sitting, tells me a lot"
- Christen, student priest

"One need to make sure to have somewhere with peace and quieteness. I don't think you should sit in the kitchen, e.g."
- Marlene, psychiatrist

From the interviews, it was highlighted several times, that there is less of a feeling of presence in online meetings. The different therapists had different viewpoints on digitalization; some were not in favor of online consultations, primarily due to the lack of non-verbal communication. However, some saw (and have experienced) the potential and benefits of online consultation. It was also pointed out, that online therapy is a way of taking care of patients, who live far from the hospital or have some barriers in order to go there.

In conclusion, there is a large potential to support online therapy sessions, e.g., by improving the parameters of a conversation, which are now more or less lacking; hence create a greater feeling of presence, a hierarchy of sounds and noises, improve the eye contact, make body language and micro expressions more visible, give privacy, etc.

DESIGN BRIEF

Background

The Danish health care is aiming towards having more digital consultations. This is already effectuated through E-Mail consultations with your doctor, and phone conversations with the hospital. One of the sectors with difficulties due to this format, and with a big focus on the experience of these online consultations, is psychiatrists and phycologists.

Goal

To develop a better and more present experience of an online consultation between therapists and patients.

Users

Therapists
Psychiatrist
Psychologist
Coaches, etc.

Patients

Business potential

The regional procurement cooperation is in charge of buying health care solutions in Denmark. In Denmark in 2016 there were 8.870 working psychologist (Rekordmange psykologer uddannet i 2016 | Dansk Psykolog Forening, 2017) and furthermore 1.201 psychiatrist at the hospitals (Sundhedsstyrrelsen, 2020). The international established platform "BetterHelp" provides online therapy and have several thousands of counsellors (BetterHelp Review, 2021)

Scope

The project will not deal with the internet connection. Furthermore it will only relate to relevant software, rather than defining new software. Hence the focus will be on the physical setup around the therapy session.

Needs

Privacy (Patient side)

A greater feeling of presence trough:

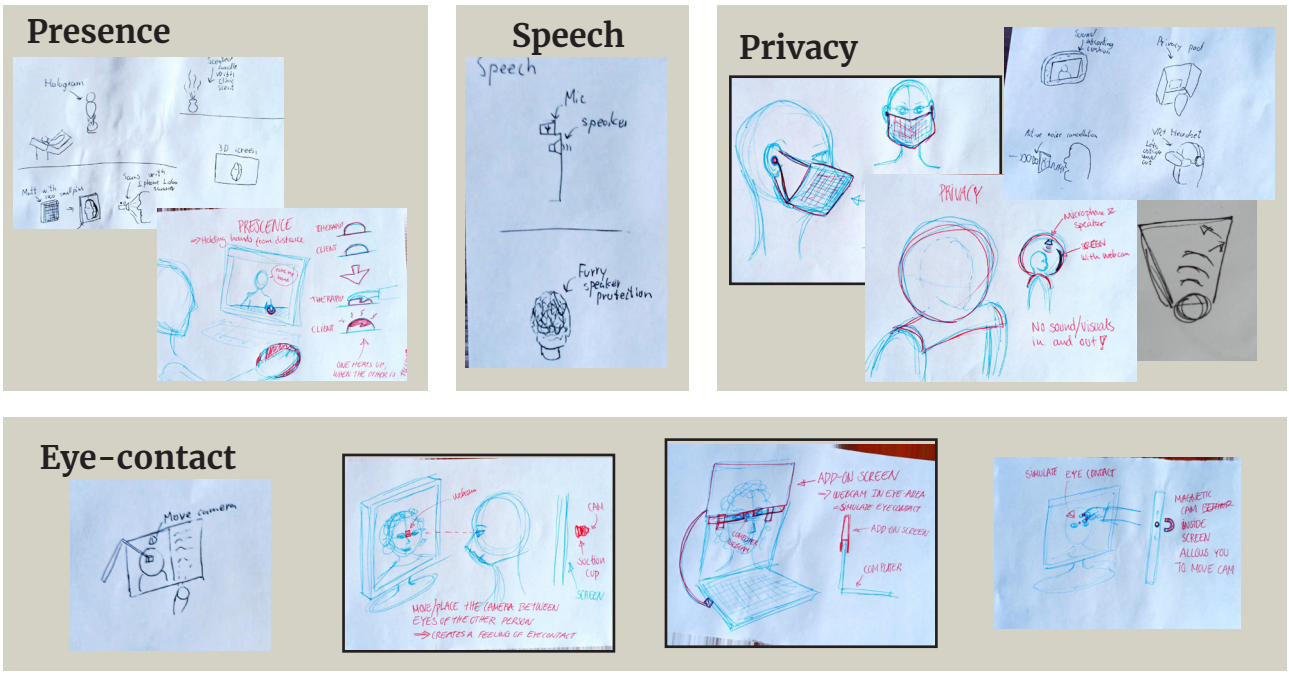
Eye-contact

Clear seech

Facial expressions

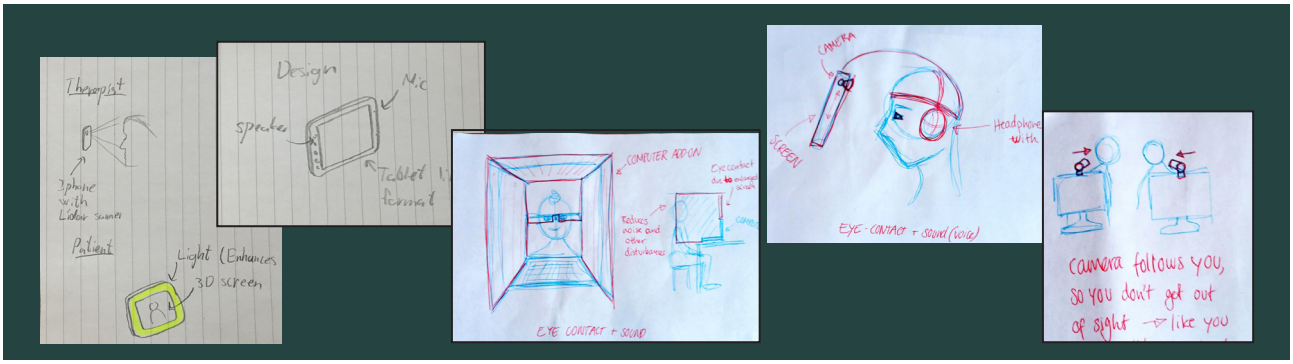
CONCEPT DEVELOPMENT

The purpose of this sketching round is to investige different directions for solution spaces. These being privacy, clear speech, eye-contact and experienced presence.



8. Sketches

These sketches were very principal. This has led to another sketching round, where different ideas were combined:



9. Sketches

Some of the sketches were more aimed at either the therapist or the patient. Hence it was decided to show the privacy mask, sound protective walls and the tablet with built in camera behind screen to the patients.

On the therapist side, the add on screen, camera on top of screen and auto following camera was showed. The feedback on these concepts will be highlighted on the following pages.

Product for the patient

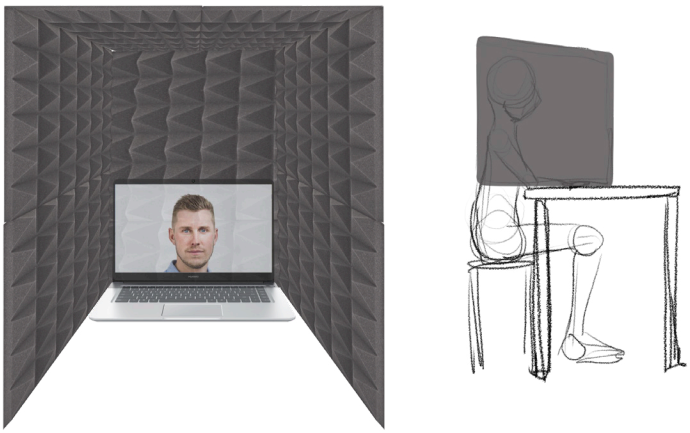
Product for the therapist

CONCEPTS FOR PATIENTS

The purpose of this task is to get feedback from the patients on a selected number of concepts and investigate whether they would be willing to either buy or rent a product, to improve virtual consultations. This is done through an open conversation about the concepts (full interview in appendix 3, that were sent to the patients beforehand. Throughout this part of the concept development, a few mock-ups were made as well. These were used to test principles of the concepts and make them more tangible, than the sketches. Photos and notes can be found in appendix 4.

Concepts

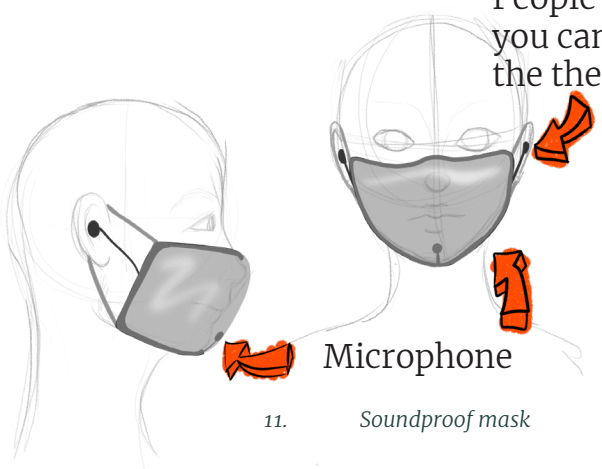
MuteBox with sound-absorbing material: Makes it harder for people around you to hear your conversation and reduces the noise from your surroundings.



10. MuteBox

Soundproof mask: People around you cannot hear what you are saying
See-through: The therapist can see your mouth

Headset: People around you cannot hear the therapist



11. Soundproof mask

Patient feedback

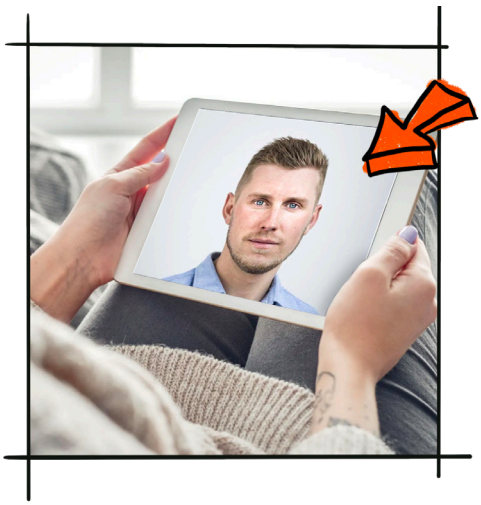
"If I really wanted to, I would be able to find somewhere peaceful, I think"
- Patient #1

"I would be annoyed if the professional were sitting somewhere noisy."
- Patient #1

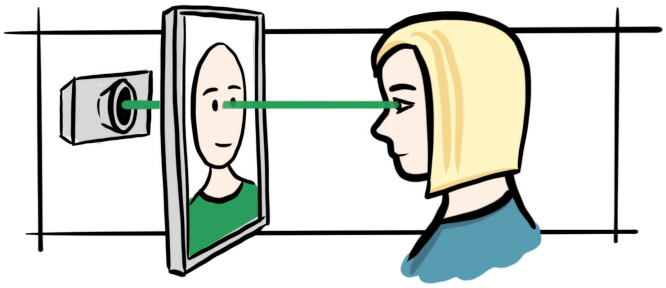
"If I am going to store something like a MuteBox, it must be functional for more than a few days a month. [...] I like the MuteBox. I can use that for other purposes. At work or in creative contexts."
- Patient #2

"The functions are quite fascinating, but I am a little burned out on the mask-concept itself."
- Patient #2

"First of all, masks are not nice to wear in the first place, secondly I think the whole idea of covering your face while talking to someone is a step back."
- Patient #2



Simulating eye-contact: Camera inside the screen, behind the eyes



12. *Eye contact through screen*

"It is simple. I know what to do with it. It can be tucked into my bookshelf, and stay there until next Wednesday."

- Patient #1

"I think you lost me. To have a tablet with only one function? [...] But then again, I would rather have a tablet than so much else...[...] I am properly not super excited about that idea either"

- Patient #2

"If it was just some software, it would make great sense to have at home."

- Patient #2

How would you feel if only the therapist had such a tablet and you were sitting with your own computer? Then it would look like the therapist kept eye-contact, but you did not look into the eyes of the therapist the same way?

"I actually think, I would be okay with that. From my point of view, it would look like we have eye-contact."

- Patient #1

Analysis

Even though the patients disagree regarding which products they like the most, their latent needs seem to be aligned. E.g., they both put great value on eye-contact and think it is an important part of having a deep and meaningful conversation. However, if the product creates value for the therapist (like eye-contact only for the therapist.), they do not want it. They also agree that they would only consider buying/renting a 'conversation product' if they were going to use it often. Once every two weeks is not enough. Either they should be in therapy more often, or the product should be useful for more occasions.

Furthermore, they both mentioned that background noise might be a problem, but they disagree on whether they need a product to solve it.

In general, both patients will rather borrow than buy something. Patient #1 have some doubts about if people will treat the product properly, and if it will be returned, whereat patient #2 thinks, that the products will be returned, if there is some kind of security deposit.

Reflection
Letting the user group have the concepts beforehand turned out to be very efficient. They have had time to think about the concepts before giving their feedback, which resulted in a more fluid conversation than experienced in previous semesters. The user group had a better overview, and they seemed more capable of comparing and judging the concepts.

Conclusion
In conclusion, both patients value eye-contact and associate the eye-contact with the connection between people.

They are more willing to rent a product, but they are not unequivocally excited about having a product home with only one function. For the patients to store a product for online consultations, it must give them direct value. Concerning the noise-problem, it remains unclear, whether it is a general problem to find somewhere quiet for online therapy sessions.

Furthermore, the patients expressed that if they should have a product at home, they would either like to have a product, that does not take up a lot of space, or they should be able to use it for other purposes than just calling the therapist.

Next step
Generate concepts for the two directions: small/compressible products and products usable for multiple purposes. Thus, decide whether the patient should have a product at home or if there should be only a product for the therapist.

A homeproduct should be small or multifunctional

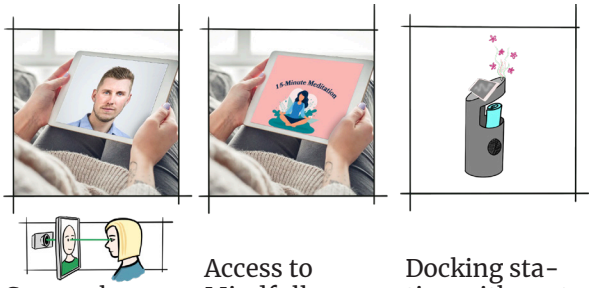
Eye contact is valued by the patients

FURTHER DEVELOPMENT

To make sure, that the decision on whether the patients should have a product for online consultations or not is based on the right foundation, concept development is made to accommodate the feedback the patients gave on the previous concepts.

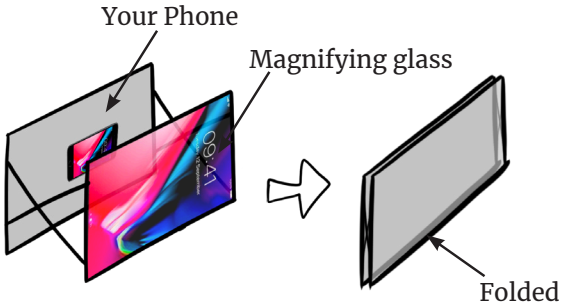
Small/compressible product

Product usable for multiple purposes



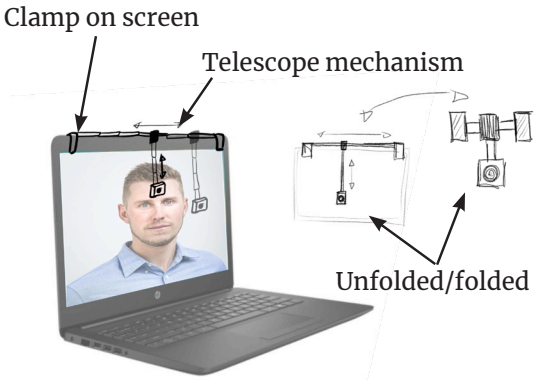
13. *Patient product: tablet*

> ***"It feels like things are added... Just to add more things?"*** - Patient #1
>
> ***"I clearly see an advantage"*** - Patient #2
>
> ***"If I had the interest, I would probably just buy the equipment myself... This is something I should be talked into buying"*** - Patient #2



14. *Patient product: Magnifying glass for phone*

> ***"I would probably just use my computer with a bigger screen"*** - Patient #1
>
> ***"I feel it's kind of a gimmick"*** - Patient #2
>
> ***"It's something I would buy on WISH instead"*** - Patient #2



15. *Patient product: Add-on webcam*

> ***"I think I would be more occupied with moving the camera than listening"*** - Patient #1
>
> ***"If we turned it 180 degrees, and the therapist looked into my eyes, it would be awesome!"*** - Patient #2

Analysis

From the interview it was found that a small iPad would be nice. However, there was still some resistance in having a product, which would primarily work towards improving the experience for the therapist like concept 2 and 3. However it is suggested to reverse these, to give the patient a feeling of eye-contact. Having a camera in front of screen, seemed disturbing to the patients.
The extra features of assisting the therapy seemed interesting to the patients. However they believed they might just buy the items individually if necessary. A concept somewhat similar to concept 1 was shown to these patients earlier, and got the feedback that they did not want a product, only to improve the presence for the therapist. Hence this still applies for this concept.

Conclusion

The concept round told us, that there was not really an interest in having a product focusing on therapist sessions, even if it had different related features. These features would be something the patient already owned, or would buy themselves. However, they felt an interest in the therapist having a product, which would increase their own experience.

PATIENT PRODUCT SUM-UP

The concepts for patiens has had three focuses; Giving privacy, Having a mutual feeling of presence, and supporting the therapy with additional features. Here it is found that the patient is not very interested in having a product at home. Our feedback has been:

Privacy

"If I really wanted to, I would be able to find somewhere peaceful, I think"

- Patient #1

This tells us, that privacy is important to them, but that they do not have a problem with gaining privacy right now.

Mutual feeling of presence (Eye-contact)

"If it was just some software, it would make great sense to have at home."

- Patient #2

"If we 'turned it 180 degrees', and the therapist looked into my eyes, it would be awesome!"

- Patient #2

There has been an interest in having eye-contact, however users has expressed that it was more important to them, that the therapist looked them into the eyes, rather than they were looking into the eyes of the therapist. Hence they are not willing to have a product at home, which they believe is a help for the therapist rather than themself.

Added features

"It feels like things are added... Just to add more things?"

- Patient #1

"If i had the interest, i would probably just buy the equipment myself... This is something i should be talket into buying"

- Patient #2

Initially there has been some interest in having added functionality. However concepts focusing on this, was either something they would rather buy themself, or it was an added software to e.g. their own tablet.

Hence it has been decided to make a product, which will focus on the therapist side. This product can still improve the experience for the patient, however it will not be a product which they need to invest in or store, to get a better experience in online therapy sessions.

The product should be located on the therapist side

The product shall give the patient a feeling of eye-contact

CONCEPTS FOR THERAPISTS

The purpose of this task is to get feedback from a therapist on different concepts, their usability and ability to improve a consultation (full interview in appendix 5).

Concepts

16. *Webcam on screen with suction cup*

17. *Add-on screen*

Therapist feedback

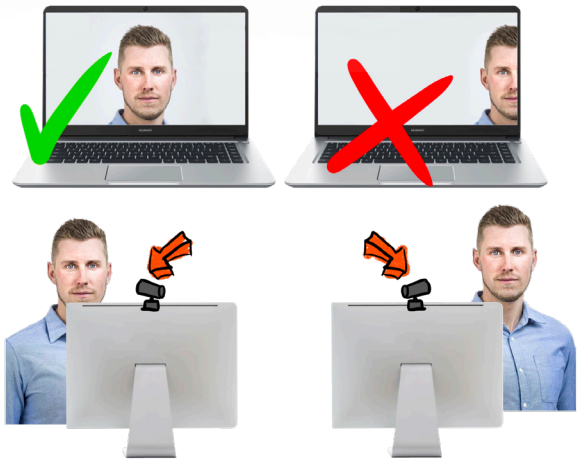
"The one I am the biggest fan of is the camera on the screen. I would like like to have that! [...] It is not much of a difference from what I do now. [...] I move around often, and then I adjust the camera."
- Christen, Student Priest

"It is an interesting idea [...] I feel like I have to force myself to look up and into the camera, as it is now. Of cause, I need to keep up with what is happening on my screen. And mimics, as we talked about before, I can see what is going on in the other person's face like normal. Hence this would solve the problem, I think. It is hard to avoid that it would be somewhat distracting at the same time."
- Christen, Student Priest

"My immediate thoughts are that there is a bigger challenge here with getting the camera placed somewhere, making it looks like you have eye-contact. [...] I think it might be a problem to maintain the face in the center of the screen."
- Christen, Student Priest

18. *Webcam inside screen*

> ***"How can you make sure that the stationary placement of the camera in the middle of the screen matches the location of the face?"***
> - Christen, Student Priest



19. *Webcam following therapist*

> ***"The one sitting and looking at me would always be able to see my face, no matter how I sit, but I would still have the problem that I must remember to look up. [...] Maybe if you could combine it with the camera on the screen? Then that is the one I would like to buy."***
> - Christen, Student Priest

Analysis

From the interview, we found that Christen was somewhat pleased about the idea of having the on-screen camera with a suction cup. In general, moving the camera down was a good idea, in his opinion. However, he felt that a stationary camera placement would not work, as he must have the ability to move the camera to the person's location on the screen, or to adjust it to his own position, when moving around. Hence, he was also somewhat pleased about the idea of the camera following his movement, because that solved the problem of him having to adjust the camera every time he changed position.

The preference of the on-screen camera placement tells us that the solution should be somehow simple and easy to understand. It is a what-you-see-is-what-you-get solution. Furthermore, creating a retrofit product also accommodate the procurement strategy for 2020-2025 of the Danish Regions (pp. 11), since that is a more sustainable solution than throwing away and buying, e.g., new computer screens for every psychiatrist at the Danish hospitals. Besides that, we want to approach this project as a start-up company (see the chapter 'Business' pp. 82) and hence work towards making a Minimal Viable Product (MVP), whereby a retro-fit solution matches very well.

Ideally, Christen would love that both parties had an eye contact mechanism. However, it seemed like he did not expect the other person to have a product/camera like this. Thus, this indicates that he valued the ability to give the impression of eye contact to the receiver very high.

Conclusion

The most popular concept was the webcam on a suction cup, followed by the webcam, which follows the movements of the therapist. They both offer situational adaption, meaning that they either can be adjusted to the position of

the therapist or the position of the patient. Thus, the possibility of adjusting the camera position seems very important.

Next step
Generate new retrofit-ideas, and explore them through prototypes.

The product must be a retro-fit to the current setup
The webcam must be movable on the screen
The setup must be simple/easy to understand

RECAP

In the previous chapter, a focus on online meetings, in general, has been narrowed down to looking at online therapy consultation. Here the demand for at present online conversation seems significant, and users are interested in getting a solution.

We found that eye contact is important for the patients, as it gives them a feeling of presence. The therapist also liked having eye contact, however, they did not feel a need for eye contact to read the patient's facial expression. As the patients have had some resistance to getting a product used in online therapy, the proposal is decided to focus on the therapist side, which also improves the patients' experience through eye contact. Here we found that it was important for the therapists to be able to control the camera placement when the patients are moving.

As it matches the Danish regions procurement strategy and our start-up approach (hence seeking to make an MVP) making a retrofit seems to be the right solution. Hence the development will continue in direction of making a camera for the therapist, that can improve the feeling of presence through eye contact for the patient.

DEMANDS FOR FURTHER DEVELOPMENT

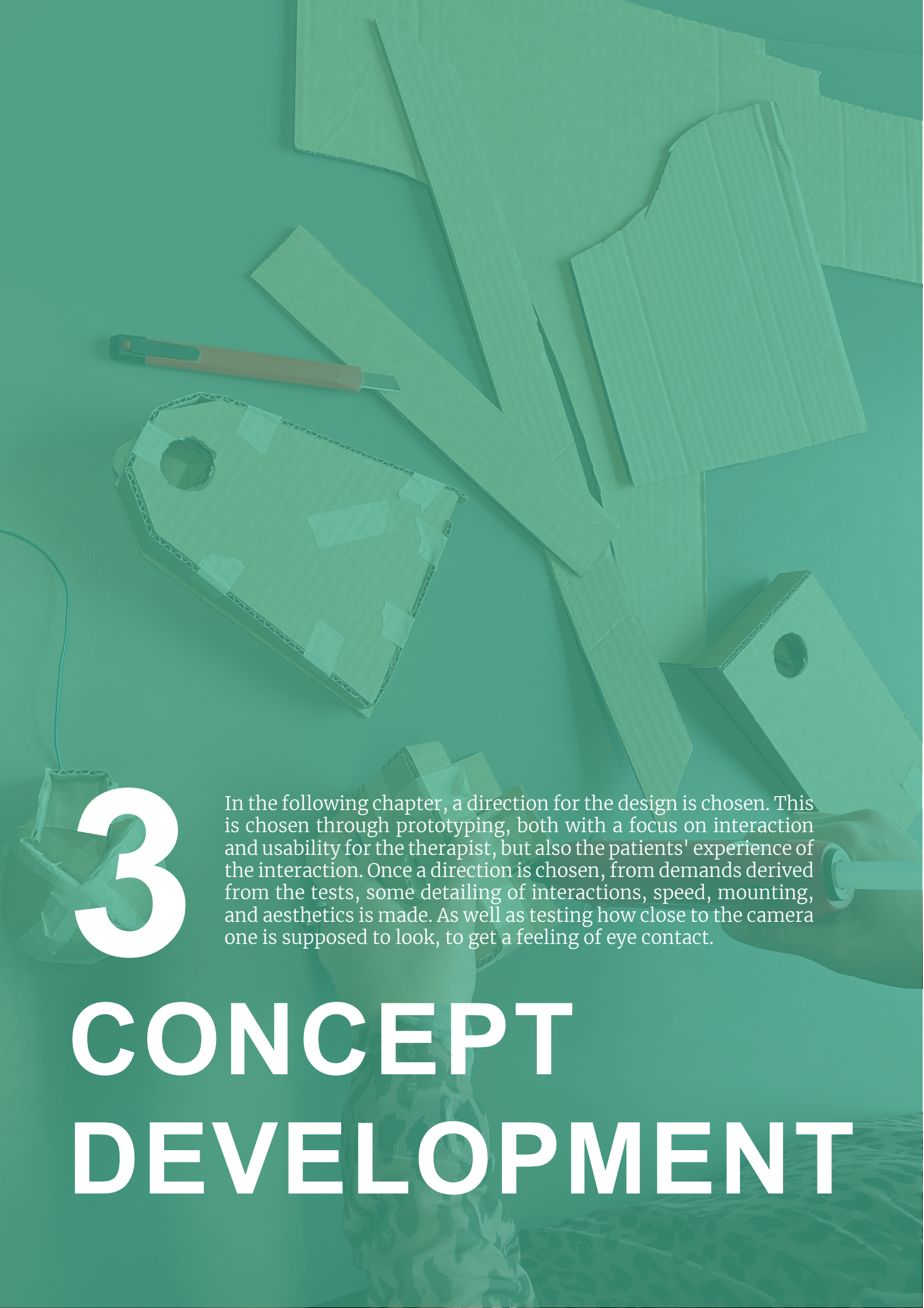
The product shall give the patient a feeling of eye-contact

The product must be a retro-fit to the current setup

The webcam must be movable on the screen

The setup must be simple/easy to understand

The product should be located at the therapist.



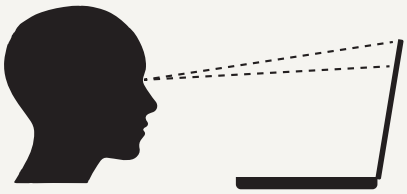
3

In the following chapter, a direction for the design is chosen. This is chosen through prototyping, both with a focus on interaction and usability for the therapist, but also the patients' experience of the interaction. Once a direction is chosen, from demands derived from the tests, some detailing of interactions, speed, mounting, and aesthetics is made. As well as testing how close to the camera one is supposed to look, to get a feeling of eye contact.

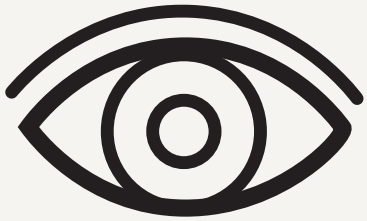
CONCEPT DEVELOPMENT

PROBLEM AND GOAL

THERAPIST TALKING



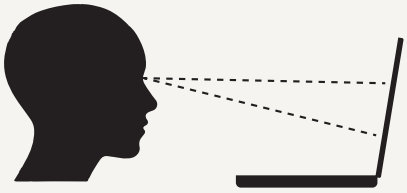
20. *Therapist while talking*



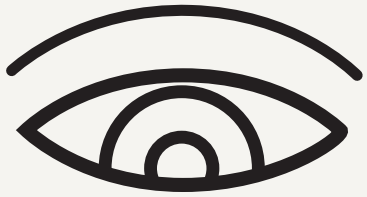
21. *Eyes of the therapist from patients point of view*

While talking, the therapists focus a lot on looking into the camera to give the patients the feeling of eye-contact. Hence, they chose not to look at the patients.

THERAPIST LISTENING



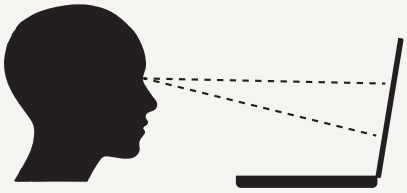
22. *Therapist while listening*



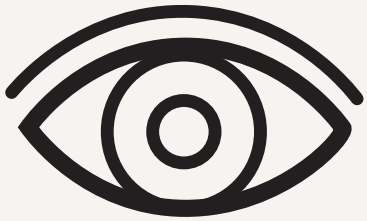
23. *Eyes of the therapist from patients point of view*

When the patient talks, the therapists prioritizes looking at the screen, and hence the patient. This is to read microexpressions and get a general impression of whether there is a correlation between what the patients say and express nonverbally.

GOAL



24. *Therapist while listenin and talking*



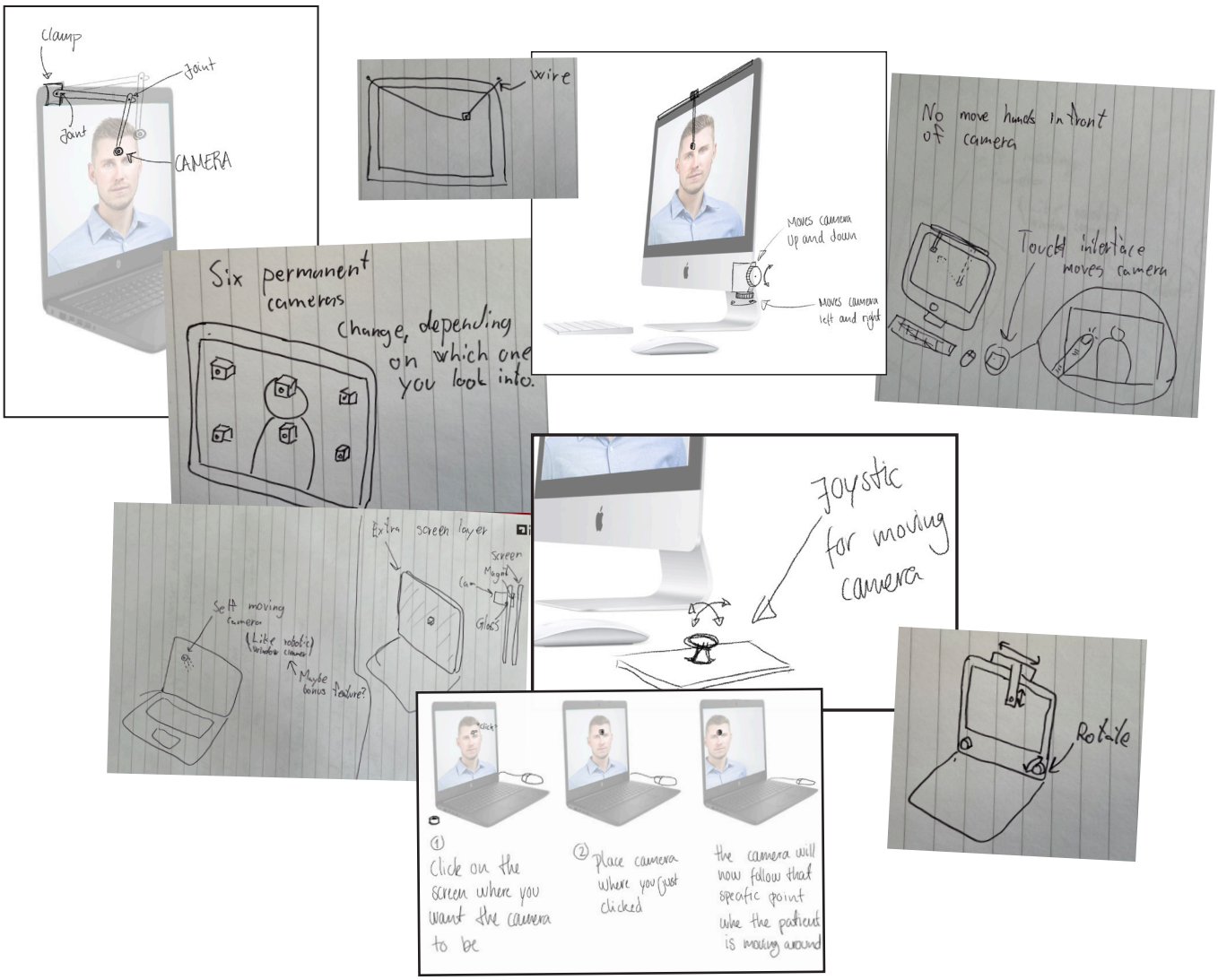
25. *Eyes of the therapist from patients point of view*

The therapist looks into the webcam and the eyes of the patient at the same time to give the patient a feeling of eye-contact and read the non-verbal expressions.

Problem statemant:
How can we improve therapy for the patients by increasing the experience of presence in online therapy?

FURTHER DEVELOPMENT

In continuation of the concept feedback (pp. 28-29), several sketches were created to accommodate the new requirements and with focus on the interaction. (All sketches are in appendix 6)



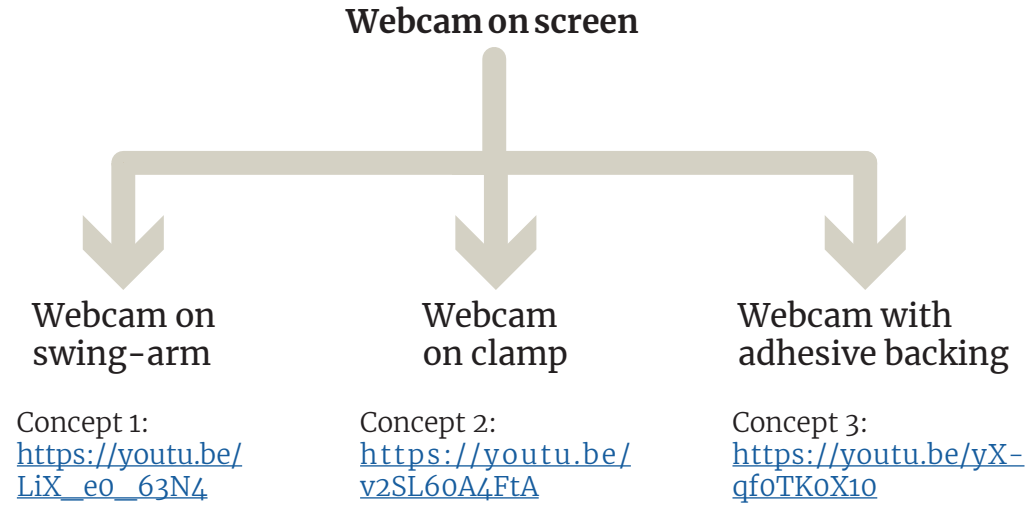
26. Selected number of sketches

From the 16 new ideas, some were selected, combined, and turned into three concepts and a plan on how to build them as low-fidelity prototypes.

PROTOTYPES

Due to the COVID-19 restrictions, getting people to test prototypes had some challenges. Thus, we made some short videos demonstrating the use of each low fidelity prototypes (Preece, Rogers and Sharp, 2002) and send them to a therapist, we were unable to visit. The three prototypes all aim to provide a greater feeling of presence through eye-contact, and hence the purpose of testing these prototypes was to find the most appropriate interaction with the product.

One test was made by Lea went visiting the therapist Marlene, who agreed on testing the prototypes by acting-out (Bagger & Sperschneider, 2003). Stefan was acting as the patient on a video call, while Marlene tested the prototypes. Furthermore, the demo-videos were sent to Christen, who responded by email. (See interview and email in appendix 7)



Webcam on swing-arm

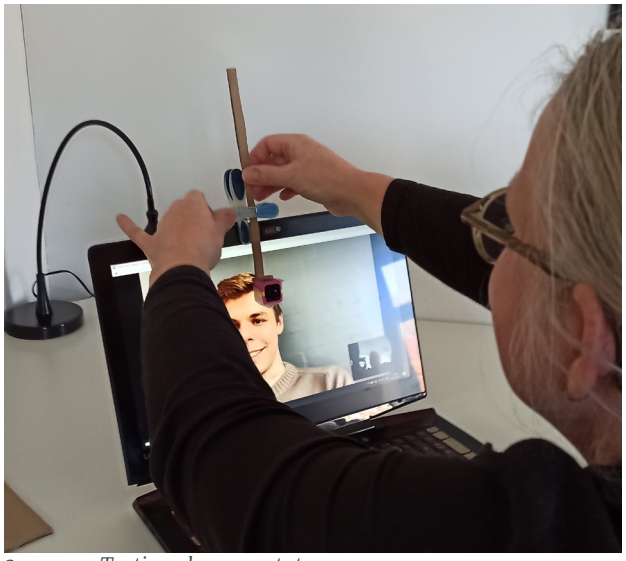
27. *Testing swing-arm prototype*

28. *Testing swing-arm prototype*

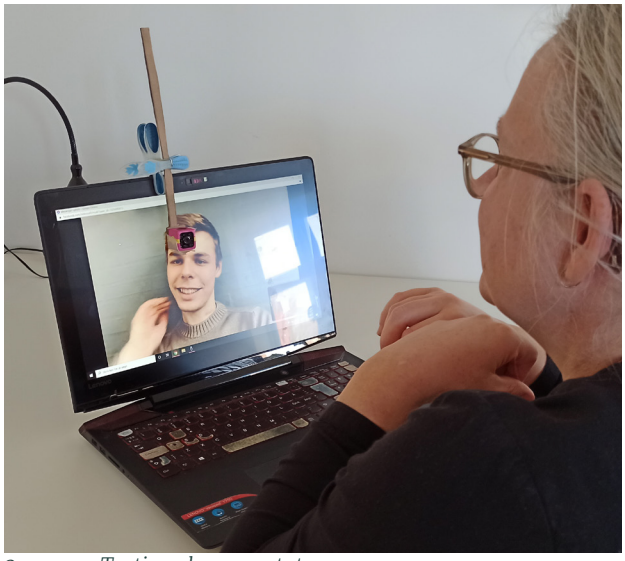
"I think it is okay, actually. [...] I also think that sometimes one would say: 'never mind he is moving a bit, I will just keep it there'. [...] It is also interrupting if I move it all the time." - Marlene, Psychiatrist

"One feel a little like: 'ahh... I cannot really see you'." - Marlene, Psychiatrist

Webcam on clamp



29. *Testing clamp prototype*



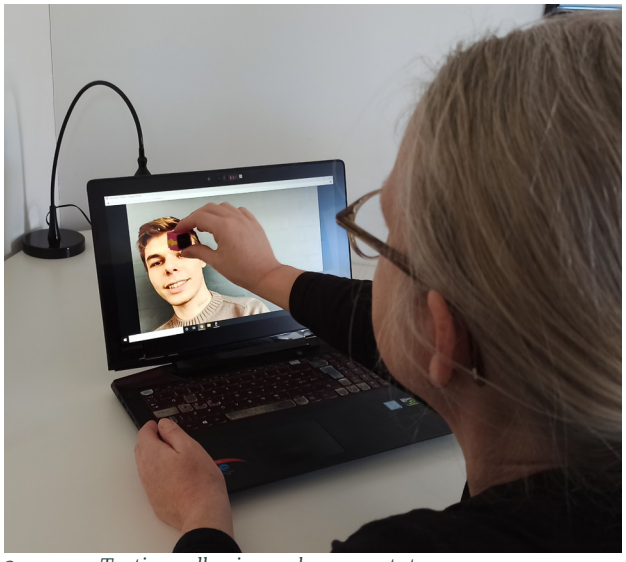
30. *Testing clamp prototype*

"The clamp-model looks the most user-friendly. It might even be optimized by making the rod very slim, so it pretty much does not disrupt the picture."
- Christen, Student Priest

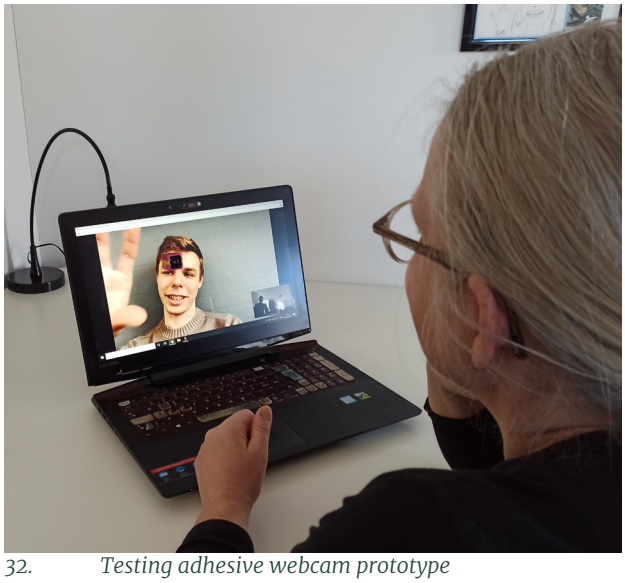
"My immediate thought was: 'This one is super good' but then I started using it, and then it goes sideways [...] First thing I want to, is to do something with the clamp on the front, and it is actually the other one, you must begin with."
- Marlene, Psychiatrist

"It does not take up a lot of space in your face."
- Marlene, Psychiatrist

Webcam with adhesive backing



31. *Testing adhesive webcam prototype*



32. *Testing adhesive webcam prototype*

Marlene: ***"Does it not get a little too intimidating for you?" (asking the 'patient' while moving the webcam)***
'Patient': ***"I almost get a hand just in the face?"***
Marlene: ***"Yes!"***

If you were going to choose one of these, which one would get?

"The clamp-solution actually, even though I thought it was a bit hard too. There was something about it, but I really liked it." - Marlene, Psychiatrist

So maybe, if it was as easy to manoeuvre as the swing-arm-solution?

"Yes! I think so. And I actually thought the swing-arm-solution was good when I saw it. It looked good, but the other one (red. clamp-solution) just did something for me." - Marlene, Psychiatrist

Reflection
In general, this experiment went well, however it turned out to be somewhat confusing for the user, that the camera on the prototype did not work. We might have lost some information, since the user sometimes asked the "patient" how different things felt, when she moved around the camera.

Analysis
To sum up the feedback on these three concepts, the webcam with adhesive backing is a no-go since you might give the patient the feeling of you 'grabbing them'. Hence, your hands must not get too close to the camera to avoid this experience for the patients. The clamp-solution was harder to manage compared to the swing-arm, but it only covered the forehead of the patient, which worked very well and made it easy to see the eyes and mimics of the patient. Hence this solution of approaching the head from above was nice. However, the interaction of the clamp-solution was a bit unnatural, since the vertical clamp moved horizontal, and the horizontal clamp moved the webcam vertical. Furthermore, it showed that to relocate the webcam in the most efficient and natural way, you must use the clamp on the backside first, which felt wrong.The swing-arm had a smooth interaction and way of relocating the camera, which was great, but it covered the patient's face differently, depending on how the patient was sitting. Furthermore, the camera entering the screen from the side felt disrupting compared to the clamp-solution.

Conclusion
The solution must enter the screen from the top and down. The clamp-solution seemed the most user-friendly, however, it needs a clearer mapping between interaction and the output. Besides, a potential in the smooth interaction of the swing-arm is seen. The interaction must not be directly on the camera.

Next step
Further concept developing with a starting point in the clamp-concept, and maybe with the inspiration from the smooth interaction of the swing-arm-concept. Moreover, buy a camera on which we can rely for prototyping, preferably also smaller.

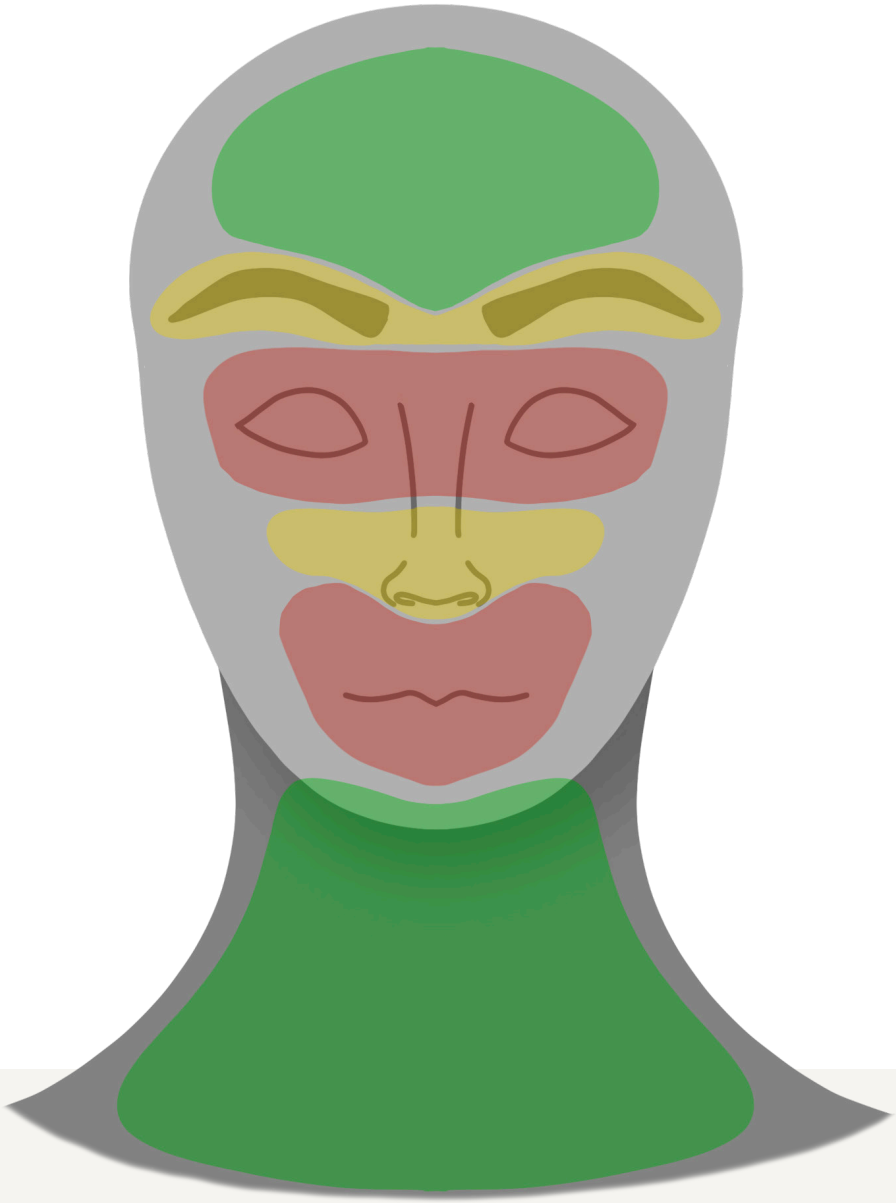
The webcam must enter the screen from the top and down (covering as little of the patients face as possible).

The interaction surface must not be directly on the webcam.

IMPORTANT AREAS OF THE FACE

The following illustration is based on discussions with especially the psychiatrist Marlene L. and shows the areas of the face, which this product can cover and must not cover.

For the therapists, it is essential to be able to read the mimic and facial micro-expressions, thus it is important not to cover the mouth and eyes.



33. Areas of the face: Red = avoid covering, yellow = limit the covering, green = can be covered

We think, that the forehead is the part of the face, which we can best do without?

"I think that is right." - Marlene, Psychiatrist

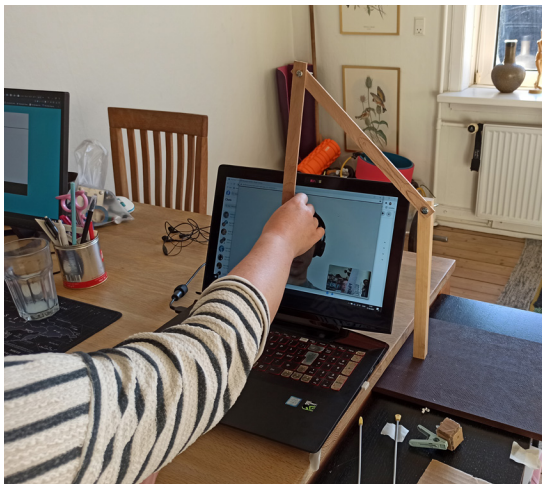
FURTHER DEVELOPMENT

To move on from the prototypes, we made a bunch of new sketches based on the new knowledge and requirements. We combined, selected, and improved these sketches and started building new low fidelity prototypes (Preece, Rogers and Sharp, 2002). Hence, the purpose of these prototypes was to investigate the interaction with a product that improves eye-contact. Once again, the set-up was that Lea brought the prototypes to Marlene, while Stefan acted as the patient on a video call.

We prioritized getting the tests done *quick and dirty*, rather than spending a week or more on making functional Arduino models, which we were going to completely discard afterward. Hence we used an acting out approach (Bagger & Sperschneider, 2003) , where two out of five prototypes were tested using the method 'Wizard of Oz' (Harwood, n.d.). The test using the 'Wizard of Oz', we assessed to be too complicated for the therapists to do by themselves, and therefore we once again decided to record small movies of our prototypes, and send them to the therapists, who we could not visit, due to the lockdown. (See interviews in appendix 8)

Concepts

Webcam on swing-arm



34. *Test of prototype, webcam on swing-arm*

35. *Prototype, webcam on swing-arm*

Therapist feedback

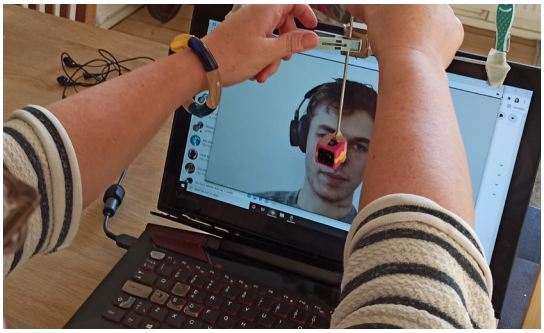
This concept received both positive and negative feedback. On the positive side, the interaction was recognizable and easy ("like an architecture lamp") and possible to adjust with only one hand. However, to adjust it, the hands get too close to the webcam. Compared to the very similar concept from previous tests, it was an improvement that the swing-arm entered the screen from above.

"It is better, that it enters from above, compared to last time"
- Marlene, psychiatrist

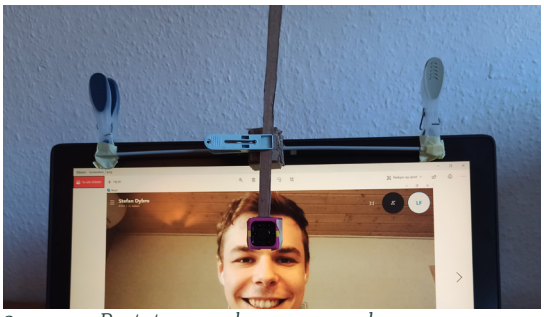
"It might be disrupting, that you can see, that I reach to move the webcam"
- Maren, psychologist

"When you can do it single-handed, it requires less effort. You do not need to focus a lot on it"
- Maren, psychologist

Webcam on a rod



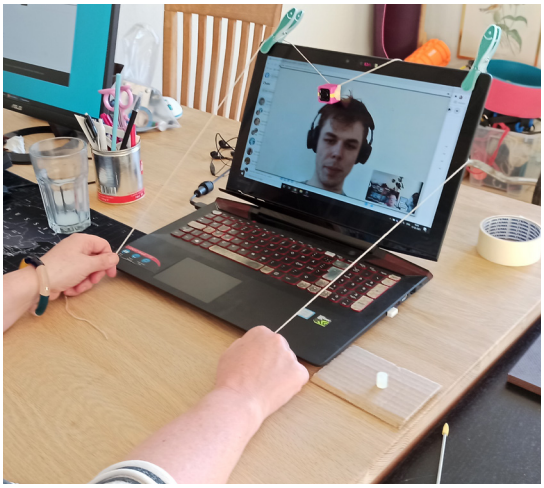
36. *Test of prototype, webcam on a rod*



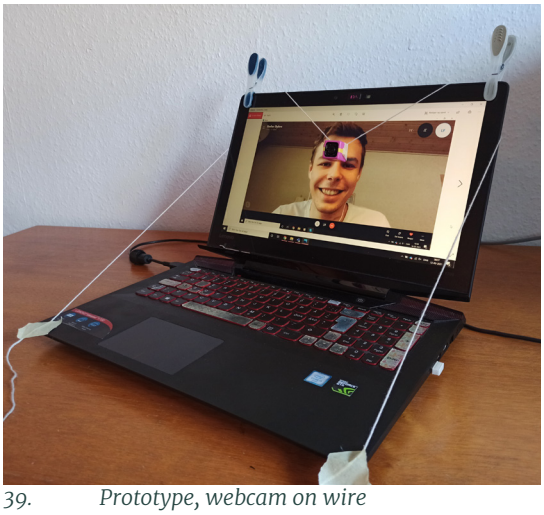
37. *Prototype, webcam on a rod*

This concept is also further developed from a previously tested concept (the 'webcam on clamp'). This concept mainly got negative feedback since the hands get too close to the webcam, resulting in a very non-discrete interaction. Moreover, the interaction contained two different processes, which seemed unnecessarily complicated to the therapists, compared to the other concepts.

Webcam on wire



38. *Test of prototype, webcam on wire*



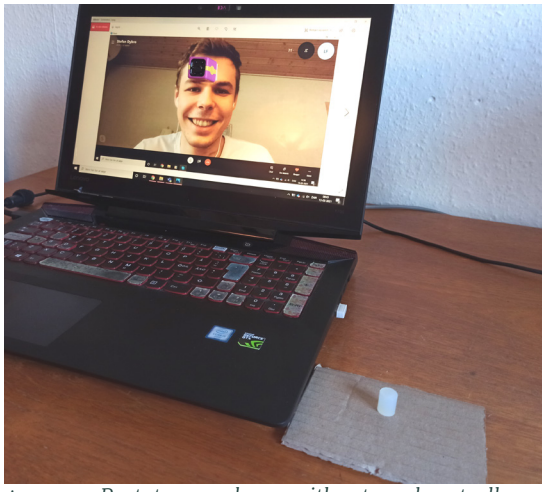
39. *Prototype, webcam on wire*

The only positive feedback this concept got was from Maren, who said it was good, that the interaction was out of sight of the patients, although it might require some practice. However, Maren only saw the concept on a video, and both Marlene (who tested the prototypes) and Christen agreed that the interaction seemed difficult.

"It gets very mechanic. It is a little unprofessional, I think"
- Marlene, psychiatrist

These two following mock-ups were tested using the 'Wizard of Oz' method (Harwood, n.d.)

Webcam with extern controller



40. Prototype, webcam with external controller

The concept containing an external controller next to the keyboard/mouse was undoubtedly the most popular one. The interaction seemed simple and matched the context. Furthermore, it got complimented for being discrete and having a single-hand operation.

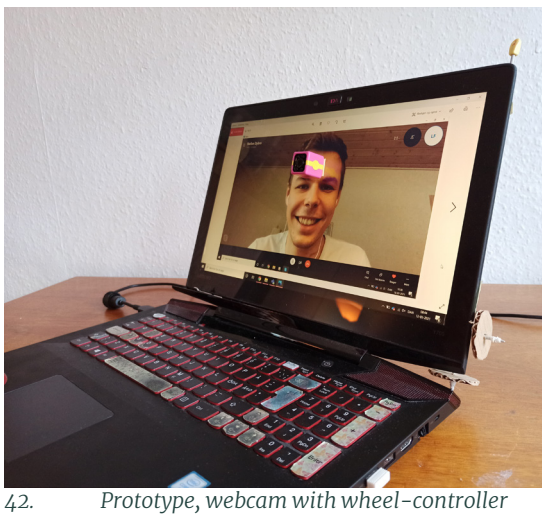
"The primary thing for me is to have a simple operation, which allows me to have as much focus on what I am doing, and as little focus on how to adjust the webcam"
- Christen, student priest

"It matches the things you sit with"
- Marlene, psychiatrist

"It is very smart because it is a very well-known movement [...] We are used to using it, and it can lay on the desk, so adjusting it is not very visible"
- Maren, psychologist

Webcam with wheel-controller

41. Prototype, webcam with wheel-controller



42. Prototype, webcam with wheel-controller

Adjusting the location of the webcam through two wheels mostly received negative feedback since it affects their other setup. All therapists pointed out that they had to reach far to adjust the webcam, which was expected to be interrupting and non-discrete. Besides, this is also an unfamiliar interaction containing two processes.

"It is just easier if there is only one part to adjust."
- Maren, psychologist

"It would require the right distance to the screen."
- Christen, student priest

Analysis
From the test, we find that the swing arm and external controller get a positive response, as they are one-hand operations. Compared to the previous test, the swing-arm was better this time, due to the top-down movement on the screen. The wheel controller is also a one-hand operation, however, there are two processes, which the therapist does not like. The external controller received more positive feedback than the swing arm, as one would operate it outside the view of the patient. Both wire and rod concepts had too complicated interactions requiring two hands. The rod has a disadvantage since it takes up a lot of space above the computer screen when not in use. Furthermore, the wires were not providing a stable movement of the webcam, compared to e.g. the solid arms.

Keeping the desire to make an MVP in mind, the complexity of the solution must be minimized. This speaks for choosing the arm-solution in combination with an external controller, and not e.g. a webcam moving freely on the screen. Moreover, if the arm was mounted on top of the screen, it has a visual difference between active and passive state, unlike e.g. the rod-solution.

Reflection
Only one of the three therapists tested the prototypes, where the two others gave feedback based on videos demonstrating each concept. However, they were surprisingly similar which indicates that making videos as an alternative way of testing prototypes has some value when we could not test in person due to the covid restrictions.

Conclusion
This investigation clearly showed that the therapists like a solution like 'webcam with extern controller' where the interaction is discrete for the patient, is familiar, does not require a lot of focus, and can be done with one hand in a single operation. This will be combined with the arm-solution entering from the top of the screen, for a stable movement of the webcam.

Next step
To further investigate this solution, we must generate ideas on how the external controller should work. Moreover, make a functional Arduino prototype.

Single-hand operation

Well-known/familiar interaction

Discrete interaction (out of sight of the patient)

Single process interaction

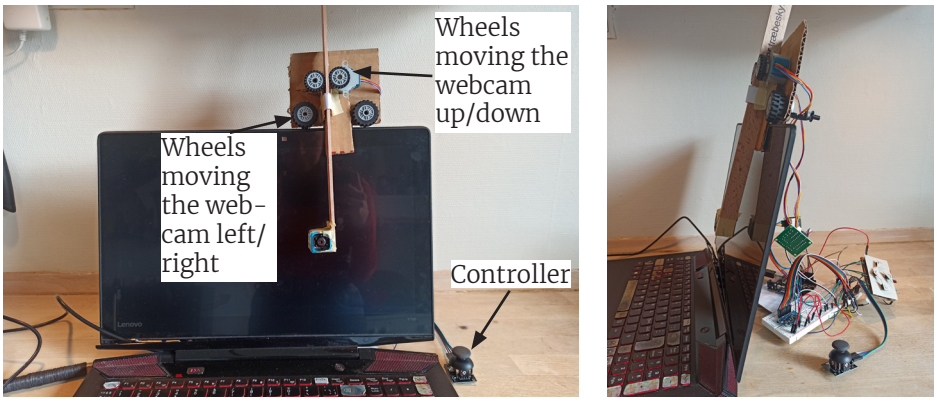
Links for demo-videos of the prototypes:
Webcam on swing-arm: https://youtu.be/yEiVFbcNQrI
Webcam on a rod: https://youtu.be/kAKKgzz7vaQ
Webcam on wire: https://youtu.be/4IeGOEUJ-8M
Webcam with extern controller: https://youtu.be/87gIzMxY5Ag
Webcam with wheel-controller: https://youtu.be/HWawQWG62yA

ARDUINO PROTOTYPE

This investigation had two main purposes;

1) to figure out how much the patients move around while having online consultations

2) to investigate whether a moving webcam on the therapist side is distracting for the patient.



43. Photos of LEGO/Arduino prototype mounted on a computer

HOW MUCH DOES THE PATIENTS MOVE?

To study how much people move around while having an online conversation, we called some with the pretext that we just wanted to talk about their easter holiday and catch up. The underlying purpose was to see how much the therapist must move around the webcam. While having the conversation, the screen was recorded and only one was sitting in front of the high fidelity prototype (Preece, Rogers and Sharp, 2002) like in an online therapy session.

Analysis

All of the recordings clearly showed that people moved very little. The general pattern was that people were sitting on the same spot, moving their heads very little - only around a 5 cm radius on the screen(tested on a 15" screen), when moving the most. The biggest movements were of two different purposes; for drinking something or for stretching their bodies. However, these two activities are both short and very often resulted in the person going back to almost the exact same spot afterward.

Reflection

Only one out of six people we talked to were one of the patients, nonetheless, the outputs were so similar, that they are expected to be true and fair. Moreover, these people did not know what kind of small experiment, they were participating in for the first 5-10 mins of the conversation. So the possibility of people acting differently because they knew that their body language was being watched, is excluded. However, these conversations were all lightly and relaxed, whereas therapy can involve very difficult topics, which leads the patient to act otherwise.

Conclusion

The patient moved on the 15" screen in a radius of approximately 5 cm. When moving further away, it was for a shorter period of time, and one often ended back in almost the same position as last time.

IS IT DISTRACTING FOR THE PATIENT, THAT THE WEBCAM MOVES?

The other part of the experiment was to investigate whether it is distracting for the patient, that the therapist's webcam moves around. This part was handled so, that while having the online conversations, the webcam was moving around almost all the time and adjusted to where the people ("patients") were on the screen.

"It just looks like you move your chair a bit because the background is not moving"
- Testperson

Have you noticed, that the webcam was moving around all the time?

"Not at all!"
- Testperson

Did you notice, that I have been looking you into the eyes?

"Yes, actually. It is very nice"
- Patient #1

Analysis
No one noticed that the webcam moved and seemed very surprised when the setup was revealed. However, a few mentioned that it looked like the other person (Stefan or Lea) moved to the side when it was actually just the webcam. None assessed this small movement to be disrupting. This indicated, that the patients might not even notice, that the adjustments of the webcam, which is very positive since this is important for the therapists. However, they all said, that they have felt eye contact throughout the conversation. For some of them, this felt a bit weird, mostly due to the fact, that it was uncommon while having virtual conversations, while others deemed it great (including Patient #1).

Besides, this shows, that the current speed of the webcam (1,2 cm per second) might be fitting as well, since it was easy to keep up with the "patients" movements, and it was not fast enough to be noticed.

Final conclusion
In conclusion of this 2-in-1 experiment, we found that people are only moving very little and not very often, when having online conversations (around an area of 5 cm of radius at maximum, however depends on screen size). Thus, it was not a problem at all to follow the person on the screen with the webcam, with a prototype moving 1,2 cm in 1 second. Furthermore, none of the test persons noticed, that the webcam was moving around, however, they had a great feeling of eye contact throughout the conversation.

Next step
Build some different interaction methods for this prototype, and let therapists test it.

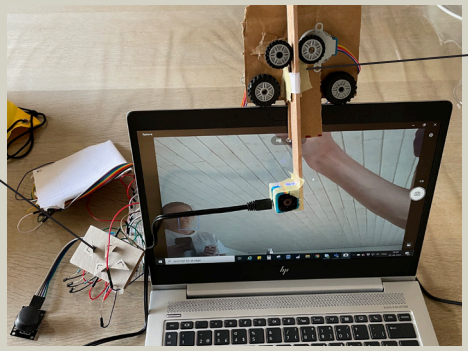
The patient does not move much, approximately only in a radius of 5 cm.

A speed of moving 1,2 cm/s is not noticeable for the patient.

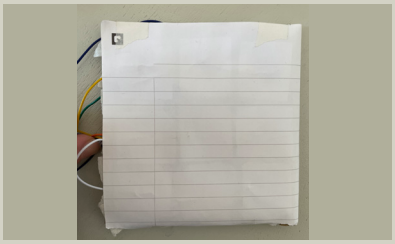
CAMERA MOVEMENT

See interaction-sketches in appendix 9

The purpose is to investigate how the product should be operated. This is done by three different solutions for an Arduino model, allowing the user to test and feel the difference between the interaction principles.



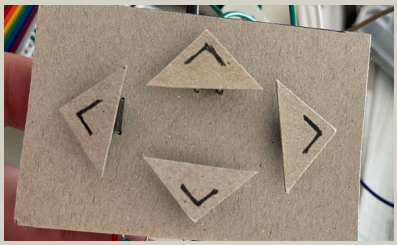
Setup



Trackpad

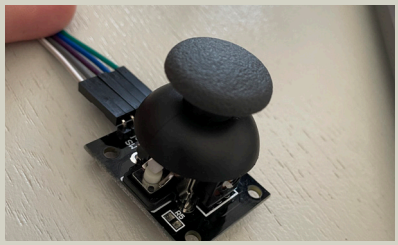
"I know how to use it"

"It seems like a good solution"



Buttons

"Here I need to change hand position a lot"
"I have to look down to find the right button"



Joystick

"The joystick is very smooth"
"It kind of reminds me of gaming equipment"

44. Photos of prototypes

Analysis

The buttons were ruled out quite quickly, as they took more energy to use than the two other models. Both the trackpad and the joystick received quite positive feedback. However, two of the test persons had a doubt about the joystick before using it, because it had associations to a gaming interaction. However, they fastly changed their minds. The joystick have some benefits, as it does not look like something you would otherwise use to control your computer, whereas the trackpad might be mistaken for a computer trackpad, moving the mouse. Furthermore, it was positive, that the models were not right-left oriented, so the user was able to e.g. use the joystick with one hand and the mouse with the other.

Reflection

The model used on the screen, had a slightly different working principle, which can have an effect on the comprehension. Moreover, the joystick was a 'naked' component, whereat the buttons were covered with cardboard. This might be an explaination for the gaming-equipment association of the joystick.

Due to the lack of wires, all interaction parts are close to the Arduino model, making the user need to reach a little.

Conclusion

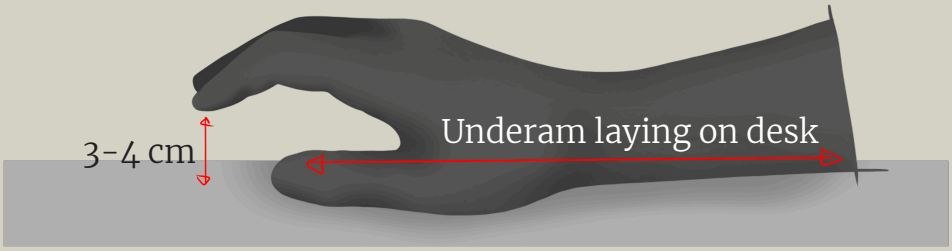
It is decided to work on the joystick interaction. This has a smooth operation, which is easy to understand. It is not mistaken for something else, like the trackpad can be. However, the shape of it needs refinement, in both size and understanding. This is both to help the controlling, but also to loose the association of gaming equipment.

The interaction should rely on the joystick principle.

JOYSTICK ERGONOMICS

During the feedback on the aesthetics (pp. 61), several therapists expressed their desire for a joystick with good ergonomics. Therefore, different joystick designs are tested, to determine the best possible ergonomics. The test is made on different students to get the test done fast.

Moreover, an occupational therapist, Tanja, was consulted to get insights on which positions of the hand and wrist are ideal for working with a controller/joystick at a desk. Following is an illustration made in collaboration with her to show the optimal position:

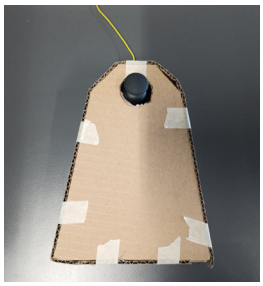


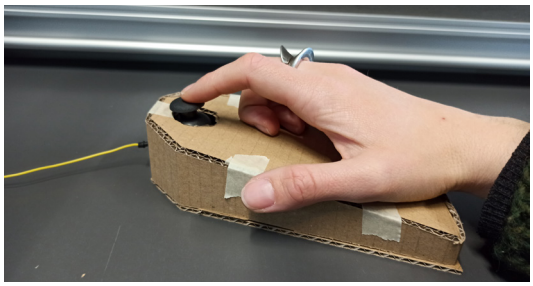
45. *Ergonomic position of hand*

"The angle of the wrist must match the position of the underarm laying on the desk, and then the joystick must be placed just underneath the fingers, without increasing the angle of the wrist. This will prevent tendonitis and carpal tunnel syndrome" - Tanja, occupational therapist

All mock-ups were held still throughout the test to simulate the weight of the real product, which should be heavy enough to not move on the table, while in use.

The first three mock-ups tested:

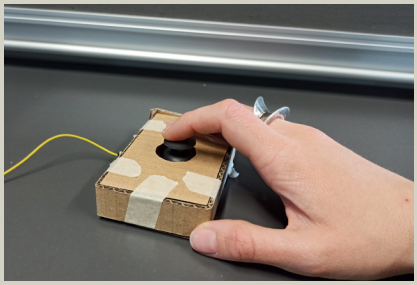


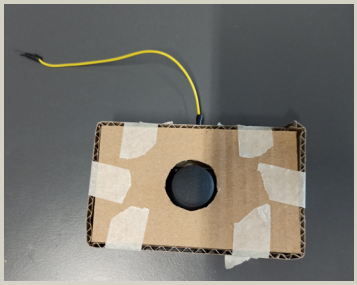


46. *Photos of mock-up no.1*

Mock up no. 1

"I like this one the most. It is pretty nice that I can rest my hand on it."

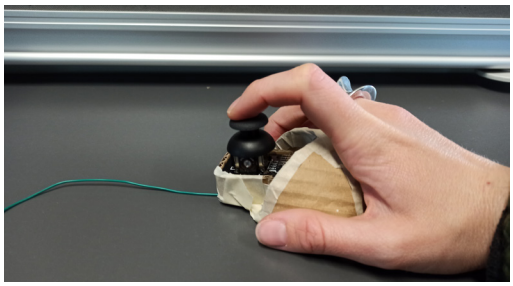




47. *Photos of mock-up no.2*

Mock up no. 2

"This one is not nice. It is way too tall."



48. Photos of mock-up no.3

Mock up no. 3

"Why isn't it for my thumb? I think if the ball was bigger, and would fit by palm, it would seem nicer."

"This one fits nice in my hand. I like it!"

Analysis

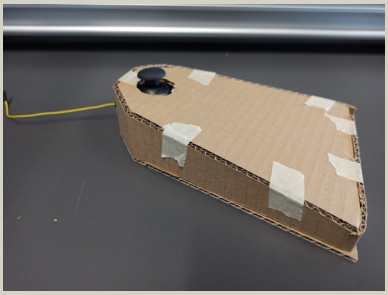
From the test, it was evident that Joystick 3 (the round one) felt nice if it fitted into the hand. However, very uncomfortable if the size does not fit.

Every test person agreed that solution 2 was uncomfortable, partly due to the angle of one's hand when operating. As it is elevated from the table, people bent their fingers more to operate the joystick. Joystick no. 1 got the most positive feedback, no matter the size of one's hand. Both the ability to rest one's hand and the angle of the rest were great. Furthermore, it has a clear direction, which minimizes the misuse of the product.

Reflection

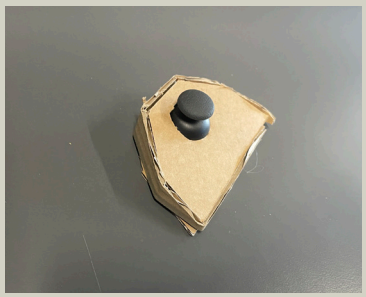
This model (mock-up no.1) is rather big and does not match the 'anonymity' of the therapists' working setup (see photos in appendix 10). It takes up a lot of space and looks somewhat cumbersome. Hence, more models were made to test out a similar system of an inclined interaction, in a smaller form factor.

Next three mock-ups tested:



Mock up no. 1
(from previous test)

Mock up no. 4



Mock up no. 5

49. Photos of mock-up no.1, 4 and 5

"I think joystick 1 is still slightly more ergonomic than number 2, but ***I would much rather have number 2, as it seems a lot less bulky."***

"I think Joystick 1 is pretty comfortable. 2 is good too, but ***3 I feel like it should be just slightly longer, so that I can put my fingers around it.*** *I like that I can grab around the other two."*

"Joystick 3 is not really good. ***Whether it is number 1 or 2 is probably not that important."***

Analysis

None of the test persons liked joystick no. 3, due to its small size and lack of support of the palm. Mock-up no. 1 and 2 are very similar, however, the test persons pointed out that no. 1 feels slightly better. Nevertheless, no. 2 was the one which they would like the most (aesthetically speaking) to have to lay on their desks since it looks the least bulky.

Moreover, it was observed, that people maneuvered the joystick differently: some using only the thumb or index finger, where others used both at the same time. Ergonomics is a parameter, which the therapists have pointed out as important to them without even being asked for other than the aesthetics of the product. This reveals that they place great value on ergonomics and that this somewhat overrules the aesthetics.
Hence, the final decision on whether the base of the joystick should be lifted from the ground, is based on feedback from the occupational therapist;

"No. 4 is the most ergonomic. The wrist will be at an improper angle if the hand must be elevated like mock-up no. 1. However, the fingers might seek the curved end of no. 1, which looks good for relieving the finger joints." - Tanja, occupational therapist

Reflection
The test was carried out by sending photos to the occupational therapist and testing on different students. These were not primary users, however, as it has been a phenomenological test of the ergonomics, the real user group should be less important than getting varied feedback. Ideally, the final testing would have been carried out on primary users, to ensure a maintained understanding of the interaction.

Conclusion
The test persons liked a big surface to place their hand on while maneuvering the joystick. Moreover, the joystick must not be placed higher than 4 cm above the top of the desk. The starting point from the aesthetic detailing must be mock-up no. 4 with a curved edge like no. 1.

Next step
Explore the aesthetics of the mock-up no. 1 based on the style boards pp. 60. Take into account, that the joystick must remain ambidextrous and be possible to maneuver using only the thumb or index finger, or both.

JOYSTICK WEIGHT

The purpose of this test was to investigate the weight of the joystick, in regards to how the unit is perceived and how it feels in use. Clay is used to adding weight to a 3D printed joystick and glue is used to simulate a non-slip underside (see appendix 11). The test is made with five randomly chosen people. They got to use the joystick without added weight (= 57 g), with a weigh of 116g (at the low-end), 142g (at the top-end) and 190g evenly distributed.

Analysis
Overall people liked when the joystick weighed 190g.

"It has a great weight. If it was a product I took down from a shelf in a store, I would think it was good quality, because it has some weight"
However, it shows to be mostly relevant to have weight in the top-end of the joystick to prevent it from tipping over if one places weight on the side of the unit. The low-end of the joystick is held down by the wrist, and hence the weight here is less relevant.

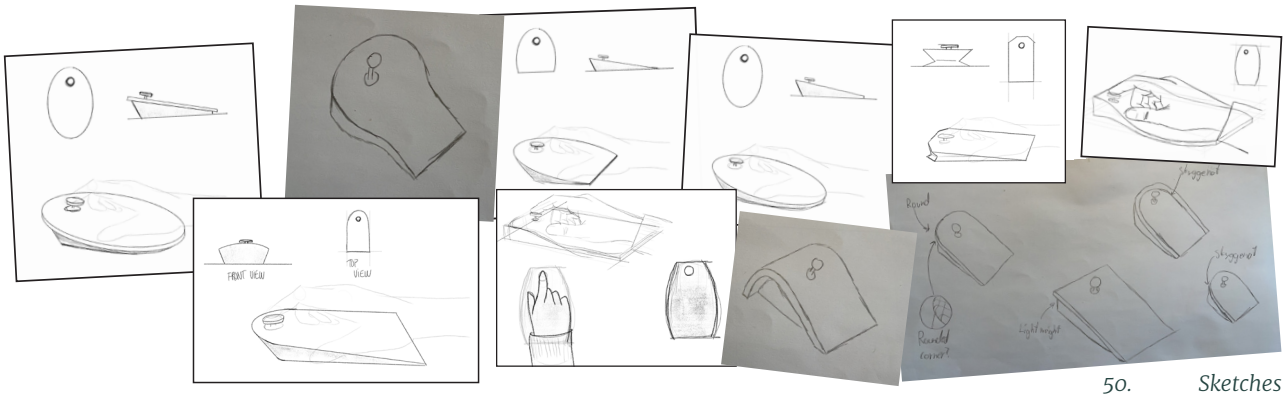
Conclusion
The joystick must weigh 190g, primarily adding the weight to the top-end.

Joystick should have a weight of 190 grams

Joystick should be inclined, and have a curved end at end top-end

JOYSTICK AESTHETICS

With mock-up no. 4 and the style boards (see pp. 60) as a starting point, several sketches were made to explore the aesthetics of the joystick.



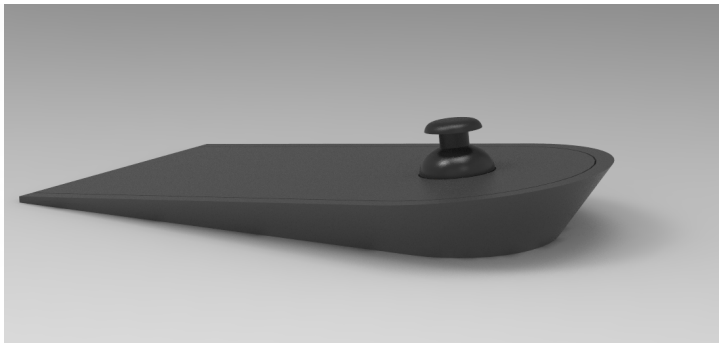
50. *Sketches*

51. *Photos of circular mock-up*

The soft, round shapes aligned very well with the feedback from the occupational therapist and the style board, hence a fast mock-up was created to investigate the size of a circular joystick-base in 1:1.

Compared to a male hand and a regular-sized laptop, the circular mock-up seems unnecessarily large. The final shape of the joystick will therefore have straight sides and a curved edge at the end.

Moreover, the inclined surface of the base supports the different hand positions observed. Besides that, it will get a shadow groove like the arms of the other part of the product, which both has an aesthetic and a practical purpose.



52. *Rederings of joystick*

"I think it will seem de-stressing, that the fingers can wrap around a nice and curved edge - don't underestimate that"

- Tanja, occupational therapist

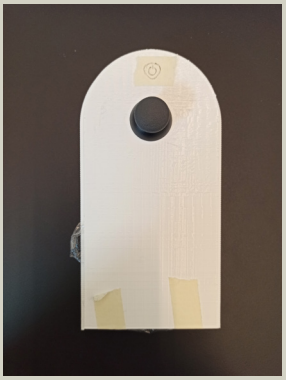
ON/OFF BUTTON

The product needs an on/off button. This could either be placed on the joystick or the mounted base on top of the screen. Since the base must stay aligned with the computer screen, and the screen itself might not be very stable if you push on the top, the button must be on the joystick.

Moreover, the joystick is the only part meant to be touched after the product is mounted on the screen. Hence, it is natural to place the on/off button on the joystick as well. To find the optimal position a test is made, using masking tape with a button drawn on it. The following three positions are investigated with different hand positions (see appendix 12). The test is made by three test persons not containing therapists, however, since it is a phenomenological test, the specific user is less important.

53. Version 1: Button at the bottom

54. Version 2: Button below joystick



55. Version 3: Button above joystick

56. Version 4: Button on curved surface

Analysis

Version no. 1 has a clear disadvantage, due to the ambidextrous design of the button. By placing the button on the left side, it feels unnatural to use the joystick with the left hand and hence place the hand on top of the button. The same goes for version no. 2, even though it is not ambidextrous. By having the button below the joystick, it feels wrong to cover the button with your palm. Furthermore, it is a concern whether this position will make people lift their palms and not rest the wrist on the base of the joystick as ergonomically intended.

On version no. 4 the button is out of sight, which in itself can cause trouble finding it. Besides, this can lead to unintended pushing of the button if holding around the curved top, which must not happen. Hence, the most optimal position of the button is above the joystick, like on version no. 3. Thereby, it is easy to see, and the symmetrical position maintains the no-left-right orientation. Here the chance of unintended pushing the button seemed very small.

Conclusion

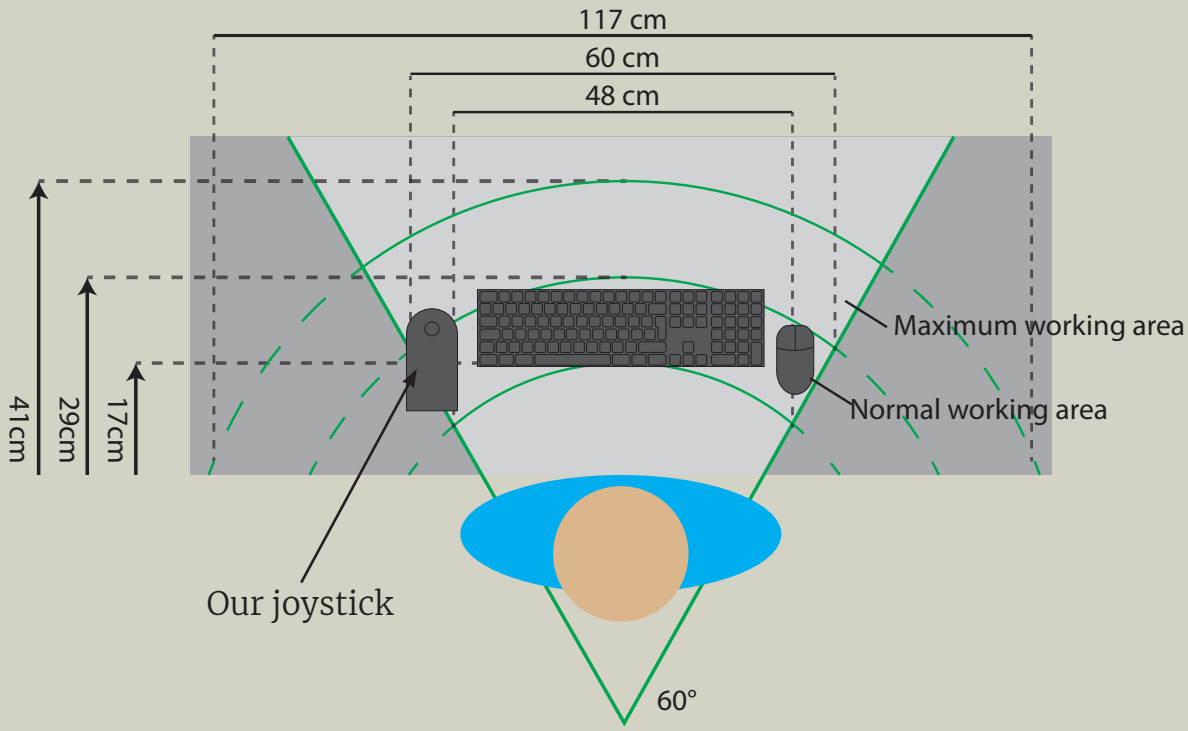
The on/off button will be placed in the centerline of the joystick base, above the joystick.

On/Off button should be placed above joystick in the center

WORK PLACE ERGONOMICS

As the product is used in a work environment, it is relevant to look at the Danish Ministry of Employments guidelines towards workspace. Hence the goal is to determine placement of joystick, and maximum size.

Their report of work environment, states the working distance for a sitting employer. Sitting down, the normal working area, is withon 29 cm of the employee (Beskæftigelsesminiteriet, 2008). A drawing of the optimal working area, including a full size keyboard with numpad mouse and our joystick is shown on the illustration below.



57. Danish Ministry of Employment guidelines for proper working area sitting down. Keyboard and mouse is added the illustration.

From the ilustration, it is seen that keyboard and mouse already take up a lot of space in the normal working area. However making a solution fitting the left side of the setup will be possible. Using left hand to maneuver will also make it possible to controll mouse or keyboard with right hand while adjusting the camera placement.

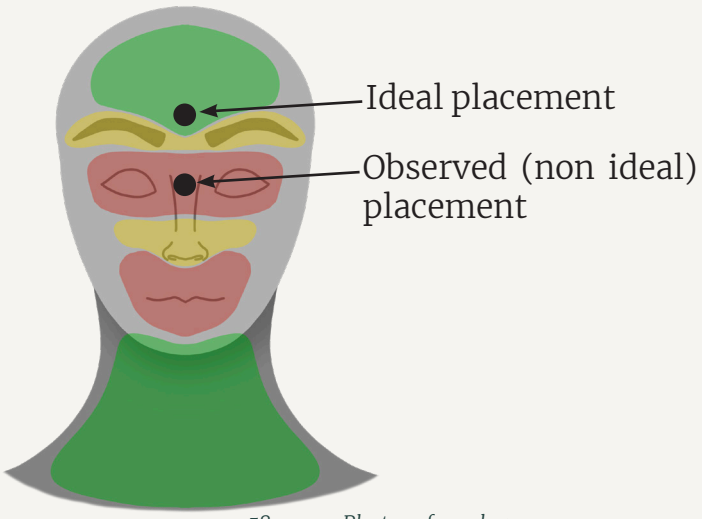
Conclusion

It is seen that the joystick can fit inside the normal working area, if the user puts it on the opposite side of the computer mouse.

It is possible to have a controller within the recommended working area.

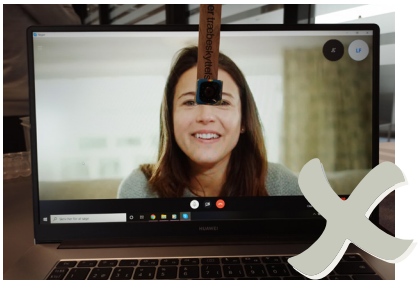
CAMERA PLACEMENT

While testing previous prototypes, it has been observed that the psychiatrist, Marlene B. tends to place the webcam lower than needed (see illustration below). Hence, the webcam becomes interrupting, and it is unnecessary to locate it this low to create eye contact (see pp. 53 & 56).



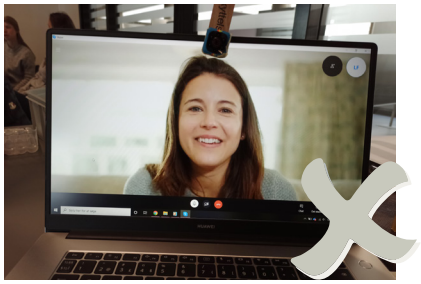
58. Photos of mock-up no.1

Consequently, we made a simple setup to test whether this was a coincidence or a general problem. The mock-up was tested individually by a group of students at CREATE who had not heard of the project.



59. 3/5 placed the webcam inappropriately between the eyes

60. 1/5 placed the webcam correct



61. 1/5 placed the webcam inappropriately, on the top of the screen, because she did not see a problem with the current placement

Analysis
One of the five people placed the webcam correctly. However, she said that she thinks the eye contact would be better, if she placed it between the eyes, but thought it was annoying that the eyes were covered. One placed the webcam on the top of the screen because she did not think the 'normal' webcam placement was a problem regarding eye contact. The rest of the group placed the webcam right between the eyes.

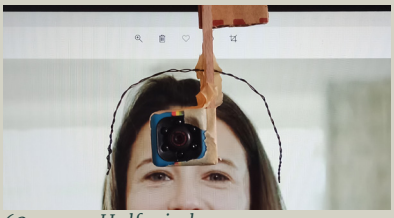
Conclusion
The test showed, that people tend to place the webcam lower than needed.

Next step
To make the therapists place the webcam on the most appropriate spot, we need to develop a feedforward feature.

Need indication of how to place the camera correctly.

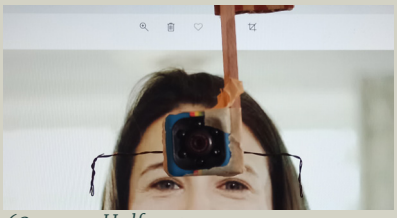
FEEDFORWARD CAMERA PLACEMENT

To investigate different methods to give a feedforward about the placement of the camera when having a video conversation, different add-ons were made and tested. (See all mock-ups and sketches in appendix 13). These were tested by the therapist Marlene.



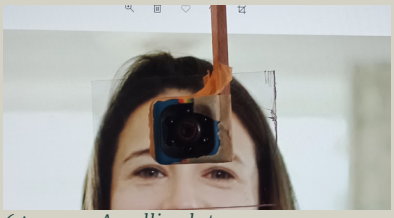
62. *Half-circle*

"Ahh okay! Then just align with the top of the head"
- Marlene, psychiatrist



63. *Half-square*

"I think it's a little too small"
- Marlene, psychiatrist



64. *Acryllic plate*

"It's easy to see, it does not disturb."
- Marlene, psychiatrist

"It think it would be easier to align if the plate was a little further down"
- Marlene, psychiatrist

Analysis

From the test, the most positive feedback was concerning the acrylic plate and the half-circle wire. The acrylic was pleasant as it was easy to look through, but still a little more visual than the wire. The half-circle of the wire gave a concrete idea of where to place it on the face. However, this does not take into account the size of the head, which can be different depending on how far away from the screen the patient sits. The current version of the acrylic had some downsides, as the test person placed the eyes in the middle of the acrylic. As the camera was in the middle of the acrylic this placed the camera in the middle of the face. Hence moving the acrylic to only be under the camera could give a better indication of how to place the camera. Moreover, when the product is folded, the acrylic plate will disturb the user (see ill 61).

When this product has earned enough money, the desire is to make a product, that moves automatically, hence the feedforward becomes obsolete (see chapter 7 Future products page 92). Thus, this becomes a question of whether the feedforward is more important than having an distraction free screen when the product is not in use. This was discussed with the therapist Marlene, who agreed, that this might be solved more wisely with e.g. a detailed manual.

65. *Rendering: Product folded with acryllic plate*

Conclusion

Creating feedforward in the shape of something hanging from the arm is not a great solution. Moreover, it is a desire to make an automatic product with time, hence the users will be informed about correct use through manuals, etc..

Next step

Find a solution to explain the correct placement

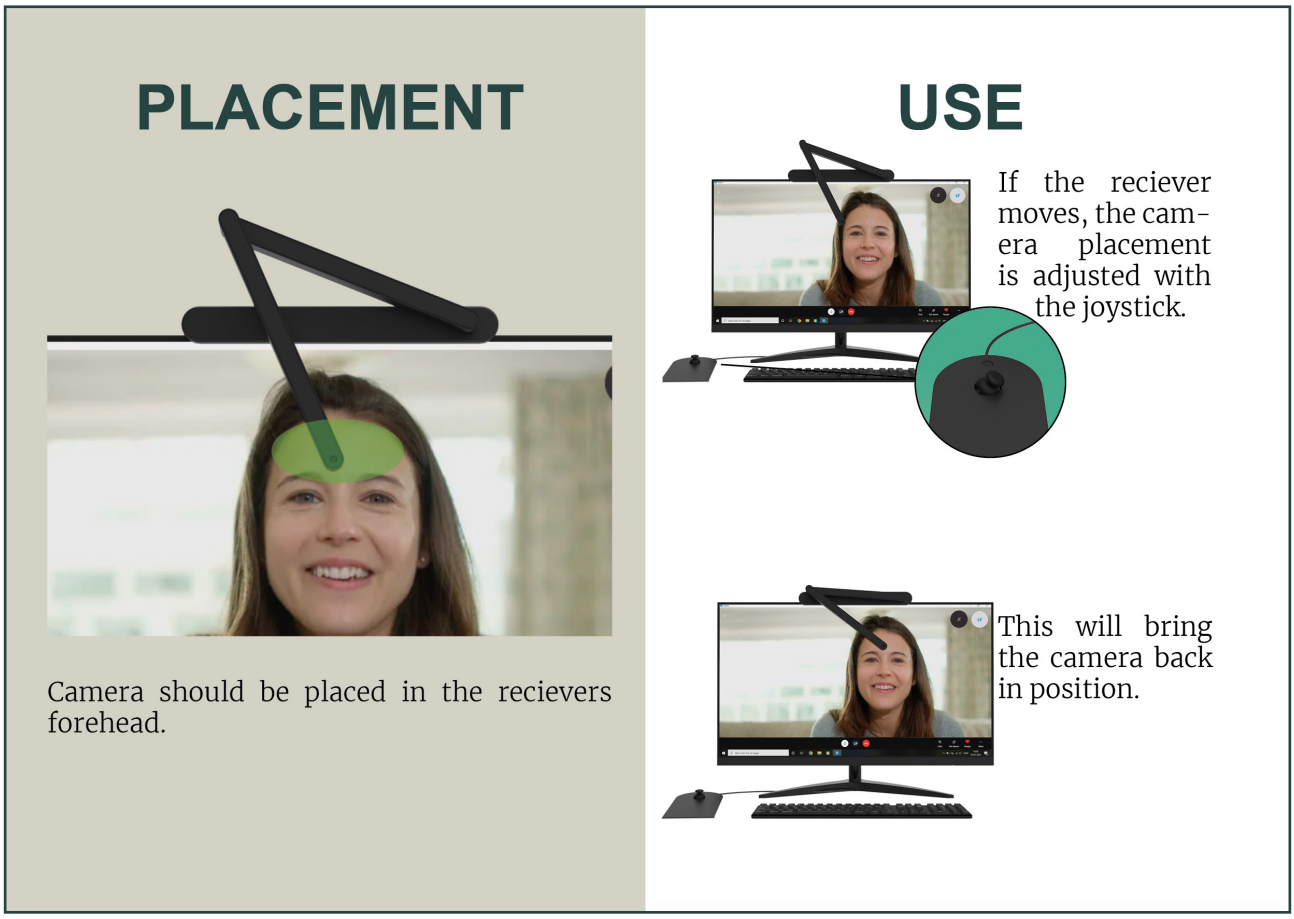
CORRECT PLACEMENT

In order to make a solution for the placement, it has been assessed that the magnitude of the problem, does not justify making an expensive solution with a self-rotating piece or similar. This is based on the wish to make an automatically moving future version (See page 94), as well as the fact that once it is learned where to place the camera, it is likely that a solution taking up space at the screen, will be more distracting than guiding. Hence it is decided to make a solution, that explains the placement, rather than a feedforward on the product.

Due to the fact that the product is desired to sell to hospitals , we contacted Marlene to hear, how they usually receive new IT-products.

"We unpack it ourselves. If we get something like a computer, we can ask the IT-people for help, but usually we do it ourselves" - Marlene, psychiatrist at Aalborg hospital

Hence the chosen solution has been to make a flyer that comes in the package, and explains both where to place the product, and how to use it.

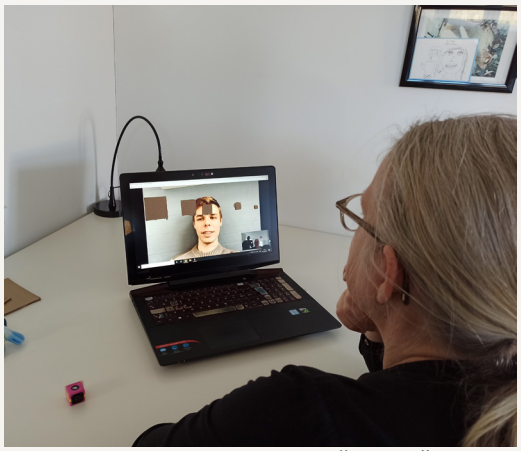


66. Flyver: placement and use

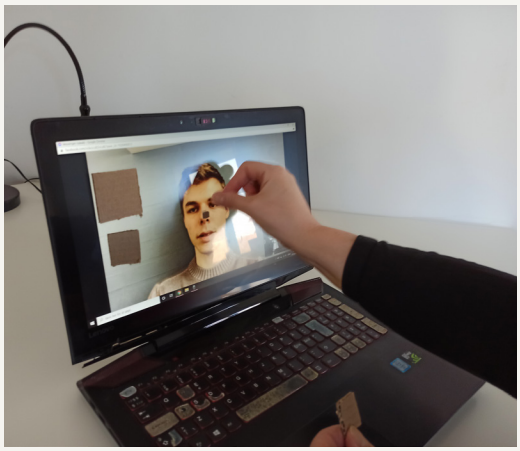
This flyer will then serve as a quick guide for using the product.
Alongside the guide to use, the flyer will also contain a guide on how to mount the product. This way the flyer will act as a complete quick guide on how to use the product. The mounting guide can be found in Product report page 14.

SIZE OF WEBCAM

The purpose of this experiment is to investigate how big the camera on the screen can be without taking too much focus from the patient. Lea visited the therapist, Marlene L., who was willing to test the models by acting out (Bagger & Sperschneider, 2003), while Stefan acted as a patient on video call. The sizes tested were: 0,8*0,8 cm, 1,5*1,5 cm, 2,5*2,5 cm, 3,5*3,5 cm and 5*5 cm. (See interview in appendix 14)



67. *2.5 x 2.5 cm webcam on "patient"*



68. *Placing 0.8 x 0.8 cm webcam on the nose of the "patient"*

While testing 2.5 x 2.5 cm camera:
"I think it would work. [...] but the other ones are too big."
- Marlene, Psychiatrist

"As small as possible. That would be great." - Marlene, Psychiatrist

Analysis

Marlene played around with the different sizes to evaluate them. By having this 'free investigation' she eventually, by herself also tried to place the smallest model on the nose of the "patient" to investigate other placements of the camera. However, this gave associations to a funny clown-nose, which is detrimental in the case of having a serious conversation with a patient.

The test person finds a size of 2,5*2,5 cm to be okay. However it was highlighted that the smaller versions was better. A bigger camera was however too disturbing.

Conclusion

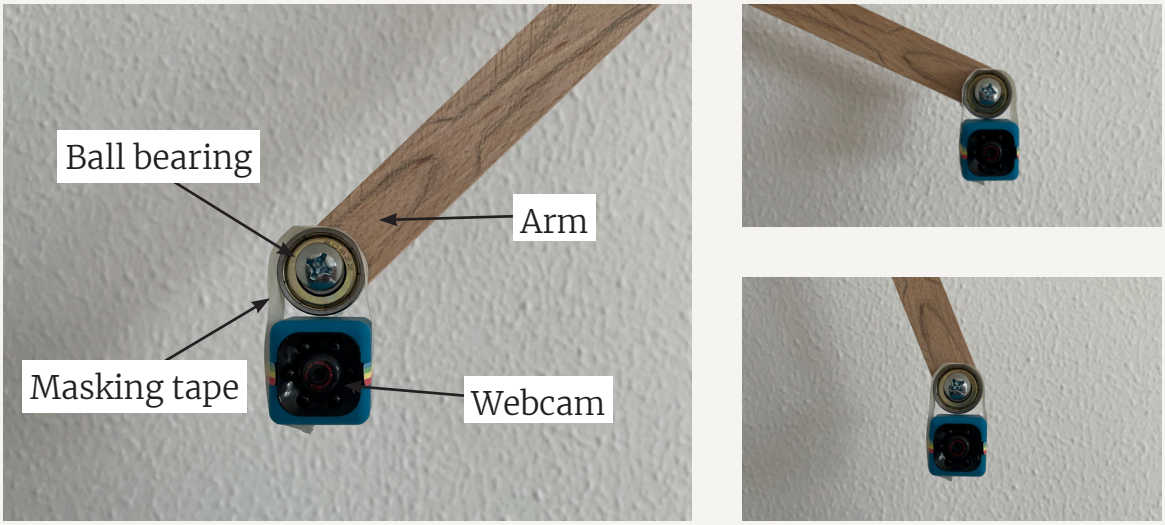
The camera must be as small as possible, and the maximum allowable size of the camera is 2.5 x 2.5cm.

The webcam must be as small as possible (preferably smaller than 2.5 x 2.5 cm).

ROTATING THE WEBCAM

Due to the movement of the arms, the webcam must somehow be kept in a horizontal position, in order to make the image look right to the patient. This can be done in many ways, e.g.; by a servo motor rotating the webcam, a ball bearing and a small weight mounted on the webcam, or a software solution rotating the image on the screen, making it look correct. However, both a small servo motor and software are solutions that will increase the cost price and maintenance of the product greatly.

Thus, a simple model was build to investigate whether a ball bearing could do the job of stabilizing the webcam, hence the image, when the arms move.



69. Test of webcam on ball bearing

As the photos above show, using a ball bearing works well for stabilizing the webcam. Furthermore, a video was recorded with the webcam to make sure, that the image was not shaking while moving the arm. The recording showed a video with a smooth moving image, **consequently, a ball bearing will be used for stabilizing the webcam.**

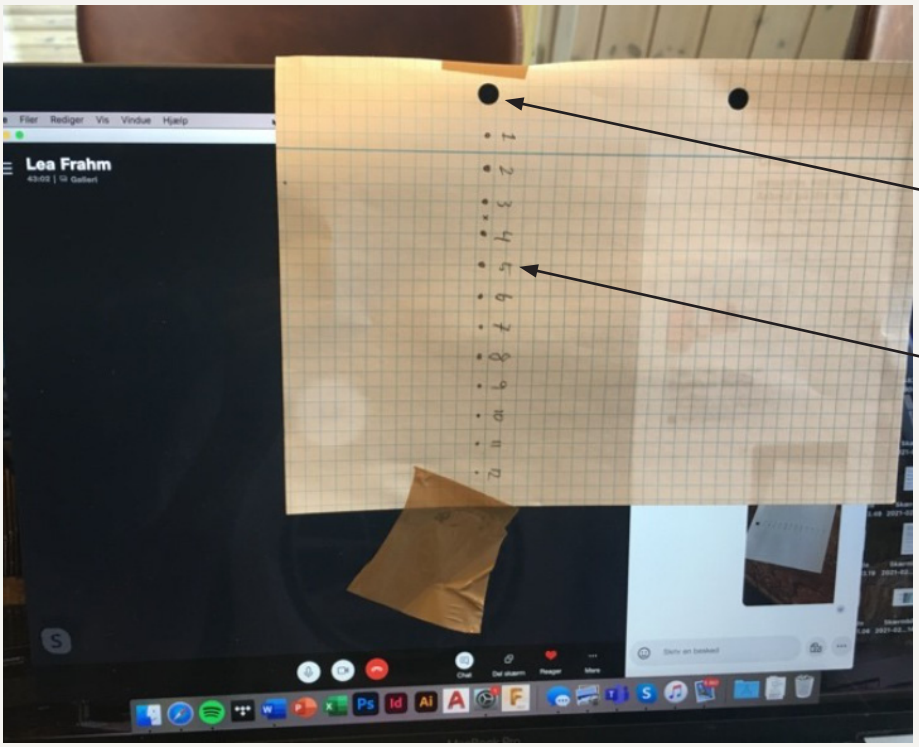
A ball bearing will be used for stabilizing the webcam

HOW DIRECTLY DO YOU HAVE TO LOOK INTO THE WEBCAM?

The purpose of this test is to get an understanding of how far from the webcam a person can look while the opposite person still has a feeling of eye-contact. A scale was made on checkered paper with a hole for the webcam, and this was taped to a computer. Then, one person was looking into the webcam and on each of the points at the scale, while the other took a screenshot for each centimeter. The test is done with the scale in a horizontal and vertical position.

To evaluate the feeling of eye-contact, a survey with the screenshots in random order was answered by 10 people. People rated the eye-contact on a scale from 1 (=bad/no eye-contact) to 5 (= good eye-contact). (See results and photos in appendix 15)

The person on the screenshots is sitting at a approximately 40 cm distance from the face to the computer and seeks to position his head directly straightforward while looking to the side/down.

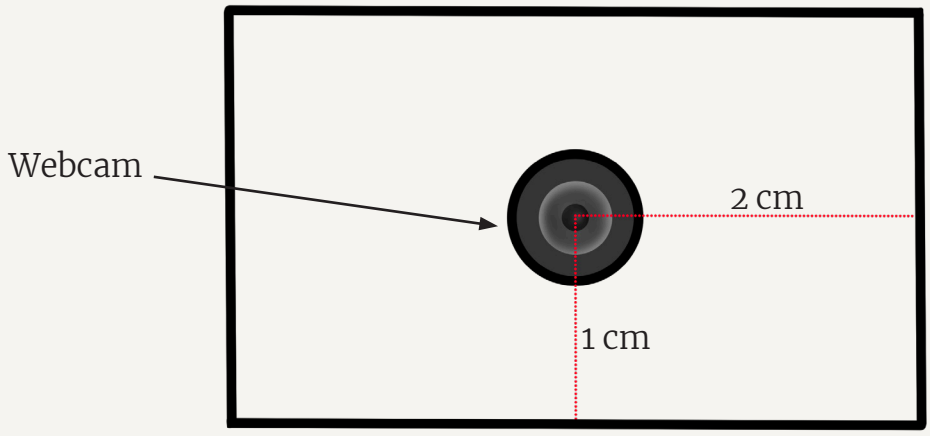


70. *Photo of the set up (vertical version)*

Analysis
Both the vertical and horizontal examples have a defined stop, where eye contact is no longer present. For the vertical examples, the big difference happens between looking 1 and 2 cm below the webcam, whereas the huge difference in the horizontal examples is between looking 2 and 3 cm to the right.

Reflection
After finishing the survey, one of the respondents mentioned that her answers might have been affected by the different moods, the guy on the screenshots expressed. E.g., she said that when he smiled, she felt a greater connection, which might have led to a stronger feeling of eye-contact. This can be the explanation of why the response on the horizontal-examples, in general, are more positive, than the vertical examples. If remade, the person on the screenshots should have kept the same facial expression through all pictures.

Conclusion
The tolerance for how close one has to look into the webcam is shown on the following illustration:



71. *Square symbolizing the area in which you have to look to give the other person a feeling of eye-contact.*

FURTHER DISCOVERY

As a by-product of the Lego/Arduino prototype test (pp. 42), we found that the accepted distance between the patient's eyes (on the screen) and webcam is larger than this test shows. Apparently, the dynamics of a live, online conversation requires less pricition to simulate eye-contact, compared to static pictures.

The prototype test showed, that a distance from eyes (on the screen) and webcam could be up to ~ 3-4 cm, while still giving the patient a feeling of having eye-contact.

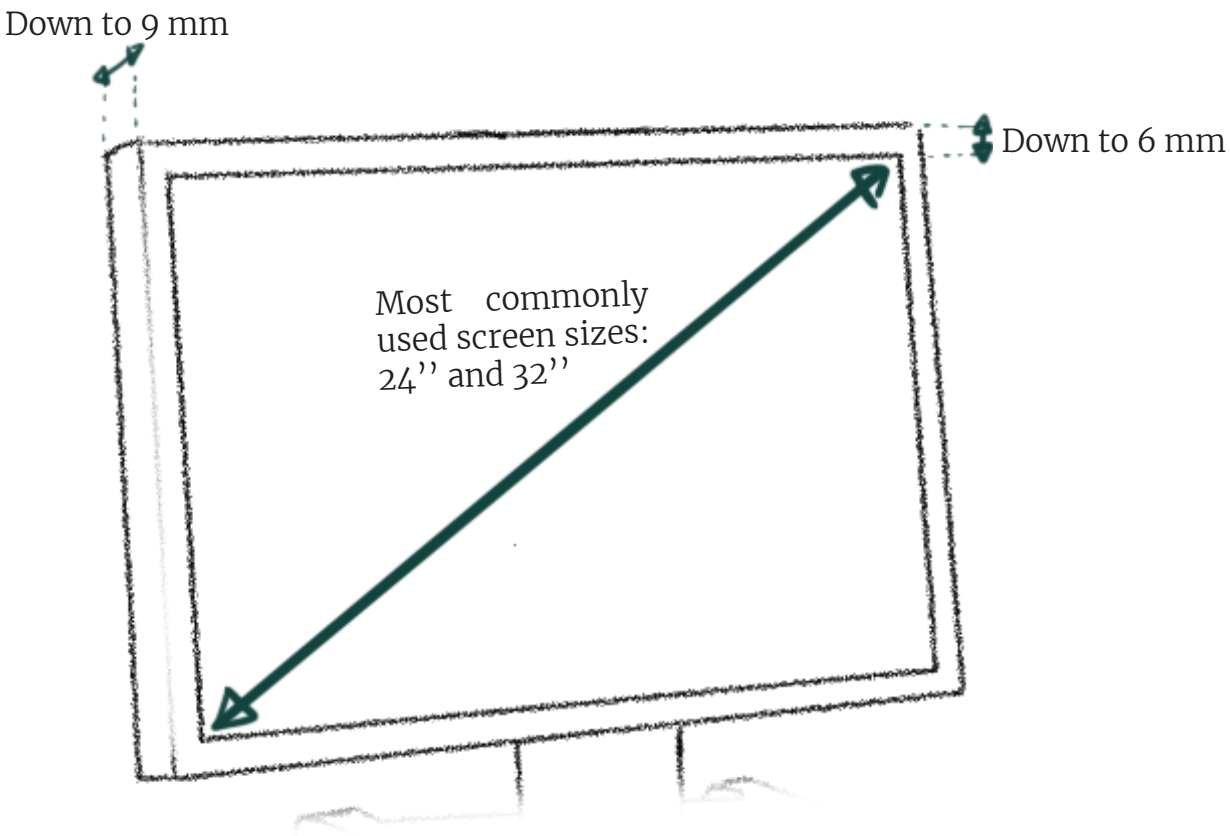
The webcam should be placed within 3-4 cm. from the patients eyes.

THE TERAPIST'S SETUP

During the current lockdown situation, all therapists work from home, using laptops with either the built-in webcam or an add-on webcam. However, at their offices, they use a monitor and laptop plugged into a docking station, combined with an add-on webcam (see setup at page 14). Since the therapists expect to get back to their offices full time again soon, this product must fit the office setup.

This means that the product must fit a computer monitor with a non-curved screen. Since the setup is stationary at the therapist offices, the product must be a semi-permanent solution, that does not interferer with the daily use of the monitor, when there are no meetings.

The sketch below illustrates the dimensions of a regular monitor, measured at Elgiganten.



72. *Screen dimensions*

Product should be able to mount on a screen down to 9 mm thick, and with a 6 mm bezel. Screen size is 24-32"

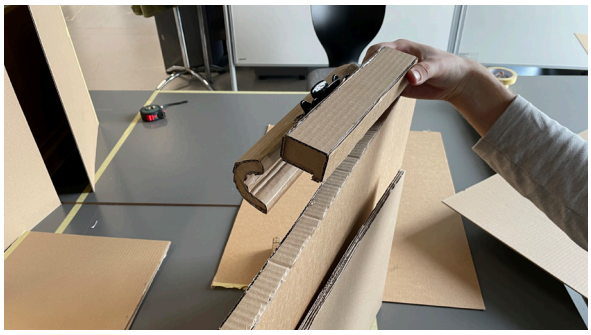
MOUNTING ON SCREEN

To test if people understood the mounting principle, a cardboard model is made, and different test persons are asked to mount it to a screen.

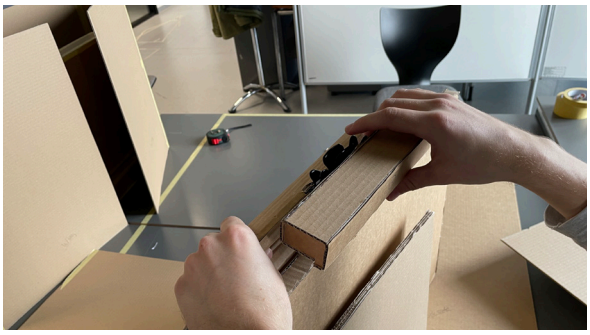
The model is a cardboard model, with a clip mounted. The users are instructed not to hold the clip, but to hold the body of the product instead. Then they are told to mount it to a cardboard screen.

73. *Cardboard model of gripping mechanism*

In general there was two different grips. A one handed grip, and a two handed grip. Most people tended to make sure to pull out the clamp far, before they mounted the camera.



74. *One hand grip*



75. *Two hand grip*

However, all six of the respondents mounted the camera the right way, with the camera module facing out towards the person in front of the screen.

From the test, it is found that the respondents was able to mount the camera right, in their first try. It seemed like there was no big difference between using one or two hands, neither in time or in alignment with the screen. Hence, using either one or two hands does not matter.

Reflection

There was only tested one version of a mount. Hence we can conclude that the feedforward of the mount is sufficient, and that the user is able to use this model. However, we cannot determine if there is another solution which is better. Ideally we would have made more models, and timed how long it took for the user to mount the camera. Furthermore, the test has a major error source, since the test is cardboard-on-cardboard and not plastic-on-screen. It seems fair to assume, that people tend to care less about mounting cardboard on a cardboard-screen, than mounting a "heavy" plastic product on their computerscreens.

Conclusion

It can be concluded, that the tested design can be used. The model is understandable, and the users all managed to align the front of the screen, and balance the module without it falling down.

The product is mounted with a torsion spring

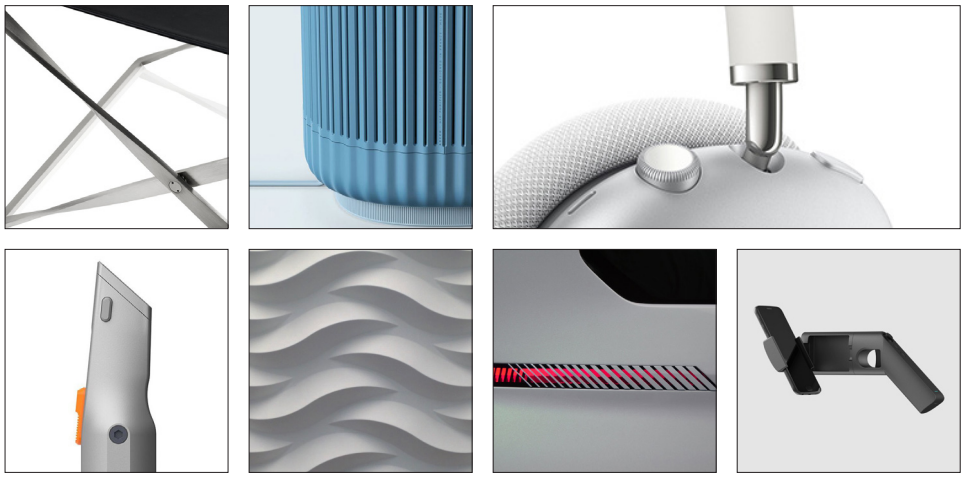
STYLEBOARD

To have a visual reference, styleboards are made. These are made with a focus on expressing: “soft”, “motion” and “lightweight”.

SOFT

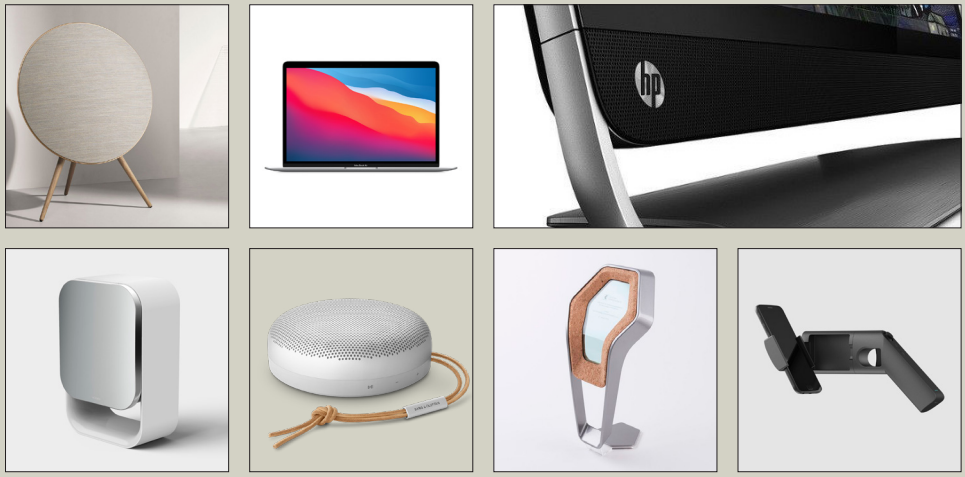
A soft touch will increase the trust in a product moving in front of the screen.
This is achieved trough **Round shapes, Matte materials, clear solid colors, shadow grooves** and **Soft refelctions**

MOTION



Motion helps the user understand it is supposed to move. This is done with **Hightlighting Direction**, and **Focus on joints.**

LIGHTWEIGHT



Lightweight improves the trust in placing it on top of the monitor. This is achieved trough **Bright colors, Slender legs, curved button** and **Carry handles.**

76. Styleboards

AESTHETICS

To get feedback on the aesthetics of the product, three different 3D models were made. The 3D models were based on several sketches on the key words: soft, light, and movement from the style boards. (See sketches in appendix 16)
Note that this was made before working with the shape of the joystick, hence different previous joysticks are presented in this.
The three different product renderings were presented with short texts and sent to several therapists – some familiar with the project and some without any knowledge of the project (See concept presentations sent in appendix 17).

VERSION 1

The idea of this concept is, that the white surface will blend into the (often) white background of the patients' room, hence the black color match the therapist's computer. Focus on the joints shows that the arms can rotate.

"I like version 1 the best design-wise, and it seems to take up the least space on the screen. However, the color choice makes me a little concerned if the light will reflect, as just a small amount of reflection will be disrupting"
- Asmund, online psychologist

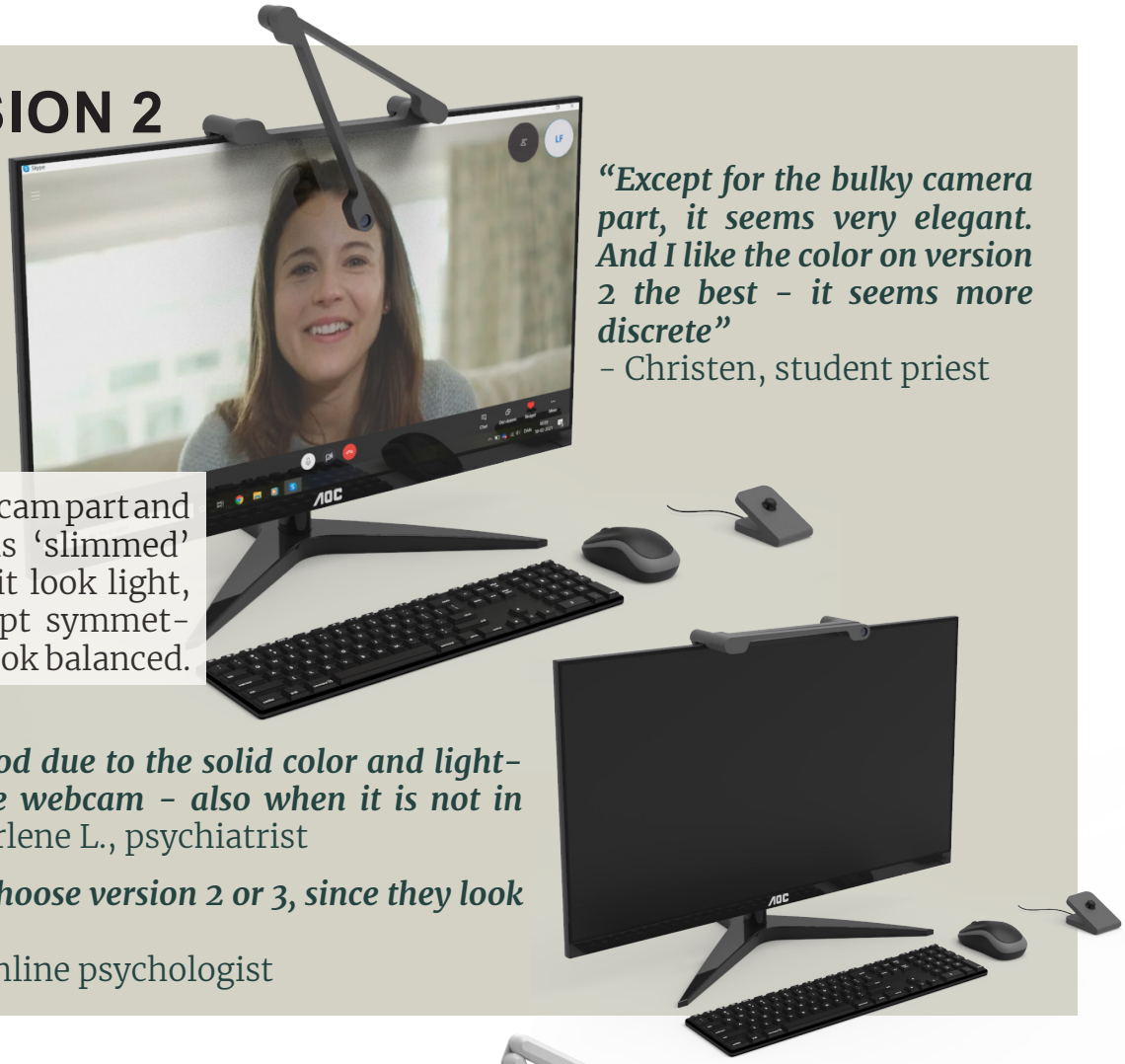
"The two colors will disturb me, I think"
- Tanja, coach

"I like that you've been thinking about the storage of the joystick"
- Marlene, psychiatrist

The joystick can be stored in the base

77. *Version 1*

VERSION 2



"Except for the bulky camera part, it seems very elegant. And I like the color on version 2 the best - it seems more discrete"
- Christen, student priest

Both webcam part and joystick is 'slimmed' to make it look light, but is kept symmetrical to look balanced.

"Looks good due to the solid color and lightness of the webcam - also when it is not in use" - Marlene L., psychiatrist

"I would choose version 2 or 3, since they look smallest"
- Rikke, online psychologist

78. *Version 2*

VERSION 3

Arms laying on top of each other to make it visible, how the arms will unfold. Big joystick-base for resting the hand.

"In general, I think that the least it covers the screen, the better - that speaks for version 1 or 3"
- Christen, student priest

"Regarding the joystick, I like version 3. I think version 1 is the one I would like the least (red. in terms of joystick)"
- Marlene L., psychiatrist

79. *Version 3*

"It is important, that the joystick is as comfortable and ergonomically correct as possible" - Christen, student priest

"I am in doubt about the joystick. My immediate thought was, that I would choose model 1 since it looks like it would best for relieving my wrist, due to the lower angle compared to the two others, but the 'button' might be harder than the others to control. I would like to try them!" - Tanja, coach

(See answers in appendix 18)

Analysis
In general, the feedback on the aesthetic has been very influenced by the functions. This tells us, that the context is very much more functional driven, than aesthetically driven.
All the therapists agreed on the color - they prefer a matte, solid color product in black/dark grey as concept version no. 2. One adds that this color fits the best, since the reflection of light on e.g. a white polished surface would be very problematic. Hence, our initial thought of highlighting the movement by contrast in the point of rotation has not been approved by the therapists. Furthermore the therapists commented on the ergonomics of the joystick, rather than the look.

A general misperception is the size of the arms; people access version 2 as thicker in the camera part, than version 1 is everywhere. It seems like the changing thickness of concept no. 2 makes it look heavier. So instead of looking lighter due to the slim parts of the arms, it is perceived as heavy due to the bulky ends. Furthermore, version 3 is twice as wide as version 1, due to the servo motor, which is positioned otherwise to have them stacked horizontally. However, almost everyone seems to have a different perception of which one is the smallest. Nevertheless, everyone agrees on wanting the smallest possible. Thus, version 3 is excluded, as it is bigger at the top. Version 1 and 2 are equally big in the 'important end' where the camera is placed, which is the end that covers the face on the screen. Hence, due to the misperception of version 2 being bulkier, and that the two models are equally small in the area covering the patient's face, version number 1 has been chosen.

Reflection
The great misperception of size tells us, that we were not good enough to visualize the actual sizes of the arms. Ideally, we should have presented physical models for the therapists, so they were able to get a greater impression of the experience. However, this would have been much more time-consuming even to make it as cardboard models, especially due to the ongoing corona-lockdown, and the difficulties of meeting users in person. In any case we still got to know some latent requirements, such as the ergonomics of the joystick.

Conclusion
The following development will be based on version no. 1 in a solid black/dark grey matte color, with an ergonomic joystick.

Next step
Dig deeper into the shape of the joystick, including the ergonomics and aesthetics (Note, this was done on pp. 45-49)

The joystick must be ergonomic

The product must be solid color in black/dark grey

RECAP

Throughout the chapter, a final direction for the product proposal is chosen. The working principle of having two arms seems the best, as it approaches the face from the top, which is the least disturbing for the therapist.

The interaction is detailed as a joystick, which can be maneuvered with ease by one hand. The speed of the movement has worked fine, both for patients and therapist when moving 1,2 cm/s. Mounting the camera is done with a clamping mechanism.

In order to get a feeling of eye-contact, the camera should be placed no more than approximately 3cm from the patients' eyes. Here a placement in the forehead will be optimal. In order to show the therapist how to place the camera, a small guide will be attached in the packaging. Further, the different necessary working principles, such as camera rotation has been tested in order of having a proof of concept.

NEW KNOWLEDGE

The webcam must enter the screen from the top and down

The interaction surface must not be directly on the webcam.

Single-hand operation

Well-known/familiar interaction

Discrete interaction (out of sight of the patient)

Single process interaction

The webcam must be as small as possible (preferably smaller than 2.5 x 2.5 cm).

The webcam should be placed within 3-4 cm. from the patients eyes.

Product should be able to mount on a screen down to 9 mm thick, and with a 6 mm bezel. Screen size is 24-32"

The joystick must be ergonomic

Camera moving 1,2 cm/s is not noticeable for the patient.

The interaction should rely on the joystick principle.

Joystick should have a weight of 190 grams

Joystick should be inclined, and have a curved end at end top-end

On/Off button should be placed above joystick in the center

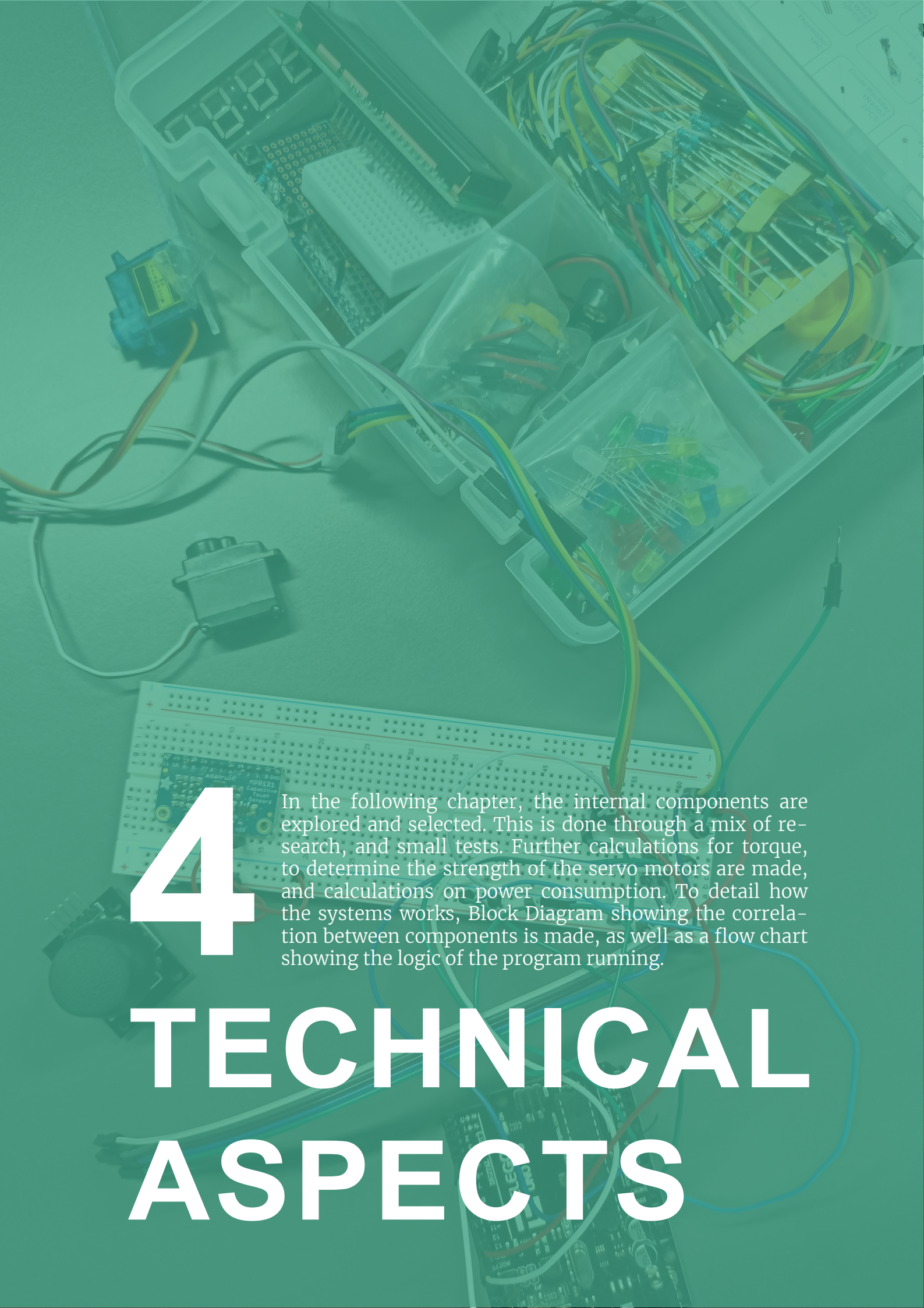
A ball bearing will be used for stabilizing the webcam

The product is mounted with a torsion spring clamp

The product must be solid color in black/dark grey

The patient does not move much, approximately only in a radius of 5 cm.

It is possible to have a controller within the recommended working area.



4

In the following chapter, the internal components are explored and selected. This is done through a mix of research, and small tests. Further calculations for torque, to determine the strength of the servo motors are made, and calculations on power consumption. To detail how the systems works, Block Diagram showing the correlation between components is made, as well as a flow chart showing the logic of the program running.

TECHNICAL ASPECTS

VIDEO RECORDING

A video works by capturing pictures, at a high speed. Usually 30 FPS are good enough for having video without disturbances. Some high-end cameras record in 120 FPS, however not many screens have a refresh rate high enough to utilize this potential yet.

QUALITY

To have a reference for quality, existing products are investigated, though online research.

2020 Macbook Pro
Resolution: 1280*720
Megapixel: 1.2 MP
(Hiner, 2021)

Iphone 11 Front camera
Resolution: 4000*3000
Megapixel: 12 MP
(Hiner, 2021)

Microsoft Surface Book 3
Resolution: 1920*1080
Megapixel: 5 MP
(Surface Book 3 – Tekniske specifikationer, 2021)

There is quite a difference in quality. However, the better quality, the more data it requires to transfer the video live, and the bigger demands for the internet connection. Often the resolution 1920*1080 deliveres a combination of a good quality, as well as a signal able to livestream. (How to create the best at-home videoconferencing setup, for every budget, 2021)

According to the megapixel, these will be a factor in determining the specific component. Here we see that the iPhone front camera has high amount of megapixels. This will be needed if one is to make a larger print of a photo. However, for a webcam, where the output will always be displayed on a screen, 2 Megapixels will often be sufficient. (What Are Megapixels and Do They Matter?, 2021)

CONNECTIVITY

To connect the camera to a computer, information should be send in a specific codex, for the computer to understand the signal. UVC (Universal Video Class), is supported by USB, and works across Windows, Mac, Linux and other softwares implementing this standard. (An explanation of the USB Video Class (UVC), 2021)

Conclusion
From the data found, we want to provide a better image quality than the Macbook camera, as this is at the low end of the specter. However, as the output is used on a computer, and no prints, etc. having the quality of the iPhone camera is not needed. Hence a resolution of Full HD (1920*1080), with 2 megapixels, should deliver a sufficient display in the context.
A refresh rate of at least 30 FPS, and UVC compatibility, will ensure a smooth video signal that can be processed by both windows, mac, and Linux.

Target resolution: 1920*1080p
Minimum Megapixels: 2
Minimum 30 FPS
UVC compatible

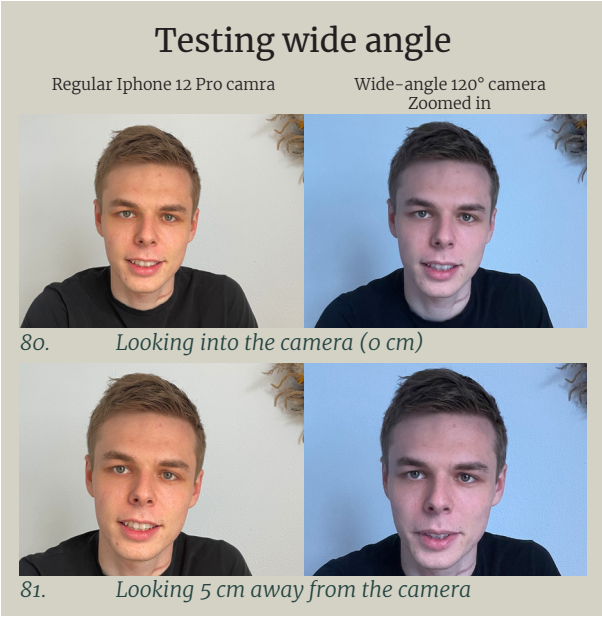
FIELD OF VIEW

EYE CONTACT

The wide-angle has an impact on how wide the picture is, but whether it made a difference concerning the eye contact was unknown. Therefore, a test of cameras with two different wide-angles was made, besides contacting a photographer to get more knowledge on the field.

"The human perception of having eye contact is much more loose than a camera's perception of eye contact. Humans have two eyes or "lenses", so to speak A camera only has one, so you have to look much more directly into the camera. A wide-angle lens does not change that. It only changes how much background you see"

- Meick, photographer



80. Looking into the camera (0 cm)

81. Looking 5 cm away from the camera

From the photos, the eyes are close to being the same when the face is cropped in similar sizes. Hence the field of view from the camera does not have a big saying in whether the patient will have a feeling of eye contact or not. What is important is rather that the therapist is in the focus of the camera, and that he can move as he pleases.

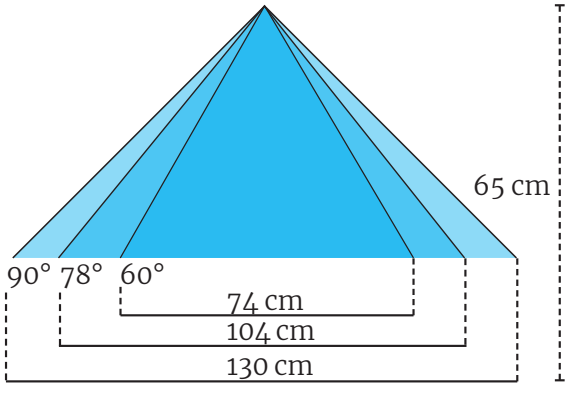
Conclusion
The field of view does not have an impact on the perception of eye contact feeling, hence wide-angle is only a parameter to concern regarding how much the therapists move.

A Wide angle of 60° is sufficient.

ZONES WITHIN THE CAMERAVIEW

The field of view will have an impact on how much the therapist can move, while still being inside the camera's view. This has multiple aspects to it. One is the area which the therapist is able to move around in. Another is how much the therapist actually move, or wish to move in front of the screen.

It is assumed that most workers sit approximately 65 cm from the screen (Charness et al., 2008).
Moving from a 60° Field of view, to a 90° gives almost the double moving distance. The average shoulder with is approximately 45 cm (Dreyfuss, n.d.), leaving only 15 cm on each side to move with a 60° angle.



82. Wide angle and width

PREFERED MOVING DISTANCE

The therapist are asked, how much the would typically move around in a consultation. This is done to get an idea of, what would be the most pleasant field of view for them.

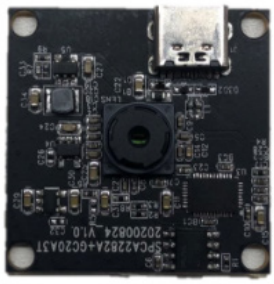
"I hardly ever move when I talk... if so, I only move further down in the chair" - Christen, student priest

"I try not to move too much... It can also be distracting for the patient" - Marlene, psychiatrist

From these answers, it is not very important for the therapist to have a wide field of view. The ability to move from side to side when in calls is not used, or might even be avoided.

WEBCAM

Regarding selecting the webcam the wide-angle does have not a big say since the therapists actively try to sit still, and it does not affect how close you have to look into the camera to create eye contact. Hence, the choice of webcam relies on demands for video recording. This specific camera component from T-view is delivered with a PCB, leaving it with a size of 32.05*32.05*7.23 mm. However, the camera module will be connected to another PCB by wires, meaning that the camera module within the arm will be much smaller. Aproximately 9 mm.



83. Webcam moduleon PCB (Webcam, n.d.)

Resolution	1920 x 1080 p
Megapixels	2 MP
Frames pr. sec.	30 FPS
FOV	76.9°
Operating Current	112mA
Voltage	2.8 V
Weight	12 g
OS	Windows 7 & 10, Mac, Linux , Android
Connection	USB 2.0
Size (incl. PCB)	32.05*32.05*7.23 mm

(Webcam, n.d.)

The camera module is a T-view 1080P module

WEIGHT

An approximate weight of the product is used to determine if the product will tip, or if the screen seems unstable with the given weight on top. The weight is:

Ref.	Part	Weigh	Quantity	Total weigh
(Webcam, n.d.)	Webcam	12 g	1	12 g
(Micro Robot Servo | Adamant Namiki Precision Jewel Co., Ltd., 2021)	Small servo motor	12 g	1	12 g
(Towerpro MG 92B, n.d.)	Big servo motor	13,8 g	1	13,8 g
*	Arm	30 g	2	60 g
*	Base	194 g	1	194 g
			SUM	**291,8 g**

*Each arm has a total volume of 2990 mm3. The products are manufactured in ABS plastic, which has a density of approximately 1 g/cm3. This will give a weight of 29,9 grams. Hence with 2 arms, we have 2*30 grams = 60 grams. The base part has a total volume of 194000 mm3
Given that this plastic has the same density, this part has a weight of 194 grams.

Here far below half the weight is in the arms, which makes it possible that the unit will not tip over. In order to determine if it will affect the stability of a screen, weight is applied to a laptop screen, which will be more vulnerable than a monitor.

84. Test setup

A test mounting a water bottle of 300 gram, on top of a laptops is made. This in order to determine if the hinges get loose, when a weight is mounted, and if this might cause problem in some applications.
This made no problems, and neither did the screen move, nor did it feel more or less loose in the hinge when rotating the screen.

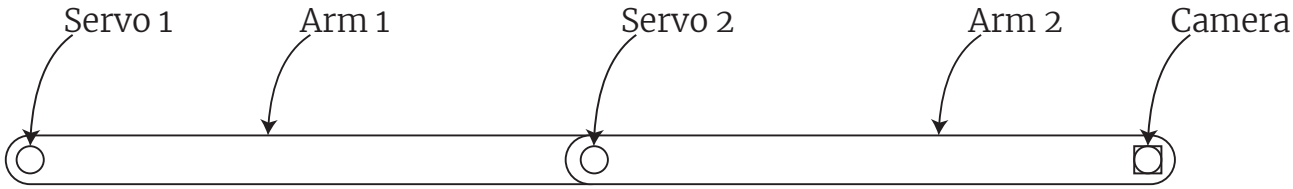
Reflection
The tested weight is placed somewhat different than the actual weigh will be distributed. However as it relies on rough estimation, this will be good enough for the current test.

Conclusion
The test showed no signs of problems due to the weigh. The screen was no more bouncy nor did it tilt, hence the weight of the product is no concern at the given stage.

The weight does not impact the screen

SERVO MOTOR

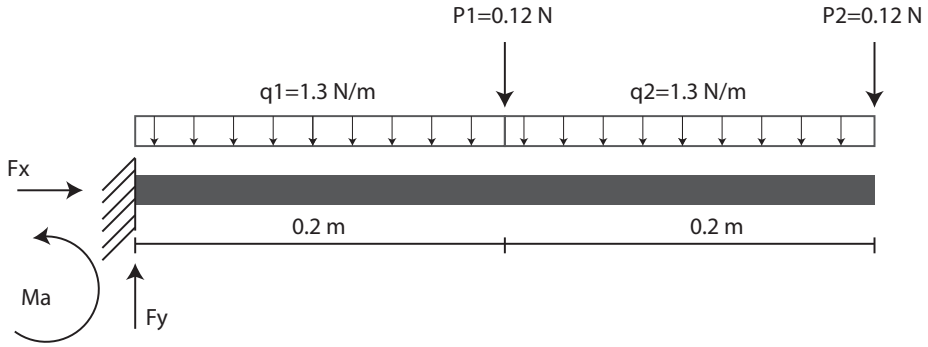
To maneuver the webcam, we need to know the position of each motor and be able to move it from one specific point to another. To do so, we must use a servo motor. An advantage of servo motors is that they will go back to a defined point when turning them on. Thus, it will not cause any trouble if the therapists turn off the product by pulling out the power supply, leaving the arms in a random position.
The system we use for making calculations:



86. Free body diagram

In order to determine which servo motor to use for the application, we first need to determine the torque a servo motor has to deliver, to move the two arms.

A free body diagram of the system, is shown below:

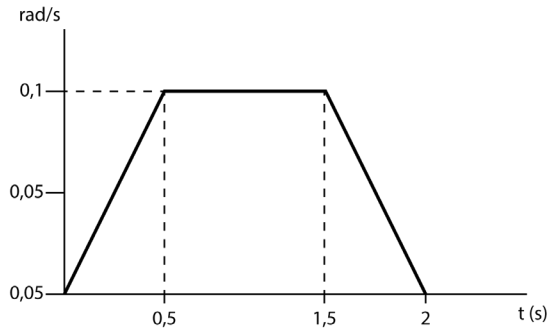


85. Free body diagram

The free body diagram, represents both arms horizontally, as this will be the situation with the biggest torque. The free-body diagram has P1, which is the weight of the servo motor for operating the outer arm. P2 is the weight of the webcam. q1 and q2 is the weight of the first and second arm.

We are interested in finding Ma, which will be the torque of the inner motor. This can be found in a static expression by saying $\sum Ma=0$. For our application, where we have a slight movement, we also want to determine torque with acceleration, by using Newton's Second law, saying $\sum T=J*\alpha$.

For a slender rod rotating around the end, we have the formula for the mass moment of inertia, $J=1/3*m*l^2$. The angular acceleration has been accessed to 0,2 rad/s^2 (see appendix 19).
As the speed can be accessed as shown on the graph to the right, we need to calculate for both a positive and negative acceleration.



87. Speed curve

This leaves us the following calculations:

For positive acceleration:

$$\sum M_a = J \cdot \alpha \qquad M_a - 1.3 \cdot 0.2 \cdot 0.1 - 0.12 \cdot 0.2 - 1.3 \cdot 0.2 \cdot 0.3 - 0.12 \cdot 0.4 = 0.2 \cdot 0.004053333333 \xrightarrow{\text{solve for M\_\_a}} [[M_a = 0.1768106667]] \text{ Nm}$$

For negative acceleration:

$$\sum M_a = J \cdot \alpha \qquad M_a - 1.3 \cdot 0.2 \cdot 0.1 - 0.12 \cdot 0.2 - 1.3 \cdot 0.2 \cdot 0.3 - 0.12 \cdot 0.4 = -0.2 \cdot 0.004053333333 \xrightarrow{\text{solve for M\_\_a}} [[M_a = 0.1751893333]] \text{ Nm}$$

For no acceleration:

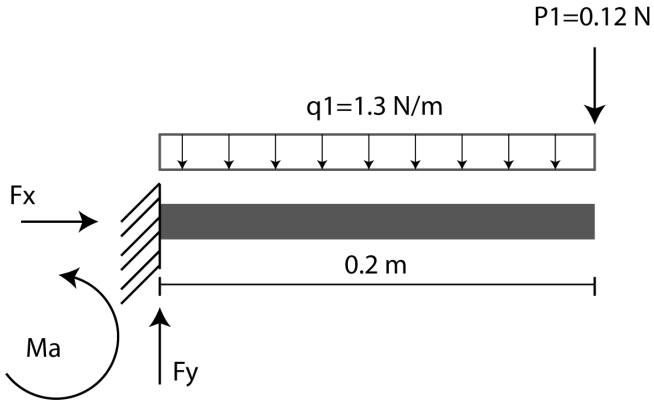
$$\sum M_a = 0 \qquad M_a - 1.3 \cdot 0.2 \cdot 0.1 - 0.12 \cdot 0.2 - 1.3 \cdot 0.2 \cdot 0.3 - 0.12 \cdot 0.4 = 0 \xrightarrow{\text{solve for M\_\_a}} [[M_a = 0.1760000000]] \text{ Nm}$$

Here it is seen, that as the angular acceleration is so low, it has nearly no impact on the torque. The impact is 0,0008 Nm, hence it is acceptable to determine the static expression for the calculation.

We see that we need a torque of 0,176 Nm in order to rotate the arm. Applying a safety factor of 1,5 the torque equals 0,264 Nm.

Making a similar calculation for arm 2, we get that this needs a torque of 0,05 Nm. This free body diagram can be seen to the right.

Adding a safety factor of 1,5 to this, we have a torque of 0,075 Nm.

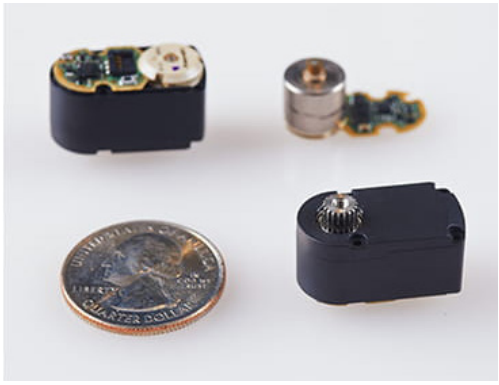


88. Free body diagram

Finding a servo motor able to fit into the arm

As the arm will potentially cross over some parts of the screen, finding a servo as small as possible, still delivering the required torque is wanted. Adamant Nakimi's "Micro robot servo" has a form factor of 12*14*24 mm, and can deliver a torque of 0,147 Nm (Micro Robot Servo, 2021).

This motor is sufficient for arm 2, however not strong enough to run arm 1 and 2. Hence we need a bigger motor.



89. Micro robot servo

Finding a servo with a torque of minimum 0,264 Nm

For servo 1, a cheaper, and a more powerful alternative is chosen. The form factor is less important for this part, since this motor is in the base of the product. Here, the Towerpro MG 92B is chosen. This has sufficient torque and metallic gears. Metallic gears are prioritized prior to the cheaper plastic gears, as plastic gears are less reliable, and will easier break. (Towerpro MG92B, n.d.)

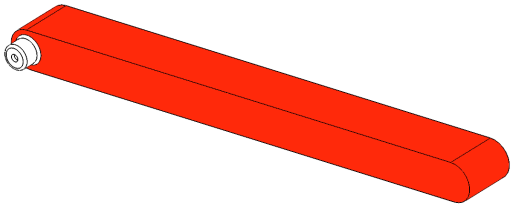
(See datasheets for servo motors in appendix 20)

90. Big servo

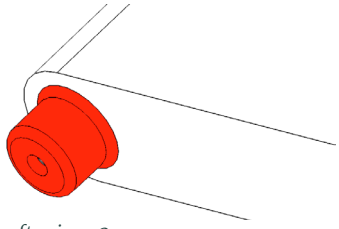
The servo motors are a Towerpro MG 92B and Adamand Nakimi Micro robot servo

STRESSES IN PLASTIC

In order to determine that the plastic arms do not break, a strength analysis of these objects are made. In order to do so, the object is devided into two parts. A beam, and a shaft. Hence the reaction forces are found in the beam. Here stresses in the beam is also calculated. Then these forces are transfered into the shaft.

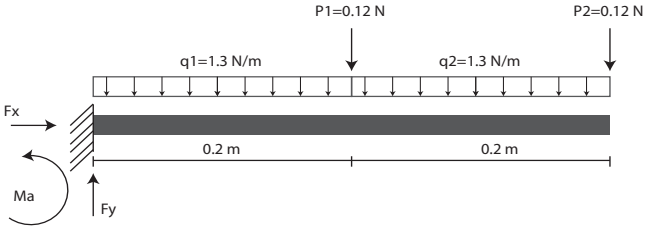


95. *Beam, piece 1*



96. *Shaft, piece 2*

The first object to look at, is the beam. Here a free body diagram is made, to determine the maximum reaction forces.
When calculating these into stresses, a Von Mises stress of 0,58 MPa is found (See appendix 21). Using the moment force (176 Nm), and applying it to the shaft, we will see the most critical part.



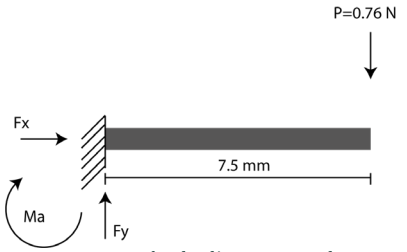
91. *Free body diagram beam*

$$\sum F_x = 0 \quad F_x = 0$$
$$\sum F_y = 0 \quad F_y - 1.3\cdot 0.2 - 0.12 - 1.3\cdot 0.2 - 0.12 = 0 \xrightarrow{\text{solve for F\_y}} [[F_y = 0.7600000000]]\,N$$
$$\sum M_a = 0 \quad M_a + 1.3\cdot 0.2\cdot 0.1 + 0.12\cdot 0.2 + 1.3\cdot 0.2\cdot 0.3 + 0.12\cdot 0.4 = 0 \xrightarrow{\text{solve for M\_a}} [[M_a = -0.1760000000]]\,Nm$$

92. *Reaction forces*

Shaft

In the transition from the beam to the shaft, we calculate a Stress concentration of 1,5. Hence the moment is 264 Nmm (See appendix 21).
This is calculated into a shear stess with the formula $\tau_{max} = T*r/I_p$, giving a shear stress of 1.35 MPa. Adding a σ_x, we calculate this stress, from looking at the shaft as a beam.



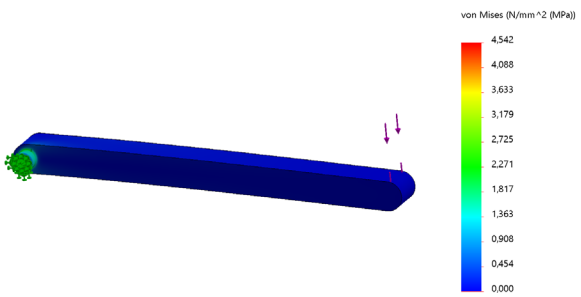
93. *Free body diagram stud*

Hence we are able to calculate our Von Mises Stresses:

$$\sigma_{VM} = \sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x\cdot\sigma_y + 3\cdot\tau_{xy}}$$
$$\sigma_{VM} = \sqrt{0.07257448434^2 + 0^2 - 0.07257448434\cdot 0 + 3\cdot 1.344537815} = 2.009696619\ MPa$$

FEM analysis

The manual calculation, relies on some simplifications of the system. Hence a FEM, with the same simplifications is made. Here a result of 2,8 MPa is found, which is 39% from the manual calculation.
Making a FEM on the actual model, we get a stress of 4,542 MPa.
The tensile Strength of ABS Plastic, is between 22 and 60 MPa (MatWeb - The Online Materials Information Resource, 2021), giving us a safety factor of at least 4,8. As the system is representative, and the product is not subject to harsh environment, this is sufficient in the application.



94. *FEM of actual model*

POWER CONSUMPTION

A power consumption analysis is made. This is done in order to figure out what is necessary to run the model.

The module is already connected to USB, in order to get a video signal.
There are two main types of USB to consider, which is USB Type A and USB type C. Both provides a 5 Volt output. The newer USB type C supports up to 3 Amps of output. However, depending on the model, some older USB Type A outputs only have 500 Milliamps (0,5 A) (USB power solutions for your Windows 10 PC, 2021). Hence a solution working on 500 mA would be optimal as it suits any output.

The components necessary to run are a webcam module, two servo motors, and a CPU module. A table of power consumption is shown below:

Module:	Voltage:	Amps:
Broadcom BCM 2837	5V	400 mA
Camera module	2,8 V	112 mA
Small servo	3,7V	1200 mA
Big servo	5V	1200 mA
Total	5V	2912 mA

All units despite the webcam and the small servo motor runs 5 V, hence a voltage regulator is needed for these two components. However, the whole systems requires more than the 500 mA that a USB A can provide. It is still able to run on a USB C, but if one is using a USB A connection, an external power supply is needed. Since the therapists under normal circumstances have a private office, a semi-permanent product is fine. Hence, having a power supply is not a problem.

This power supply should be a 5V 3A DC power supply. It is possible to connect directly to a power outlet. This will leave a small safety margin, if some components take more power than assumed.

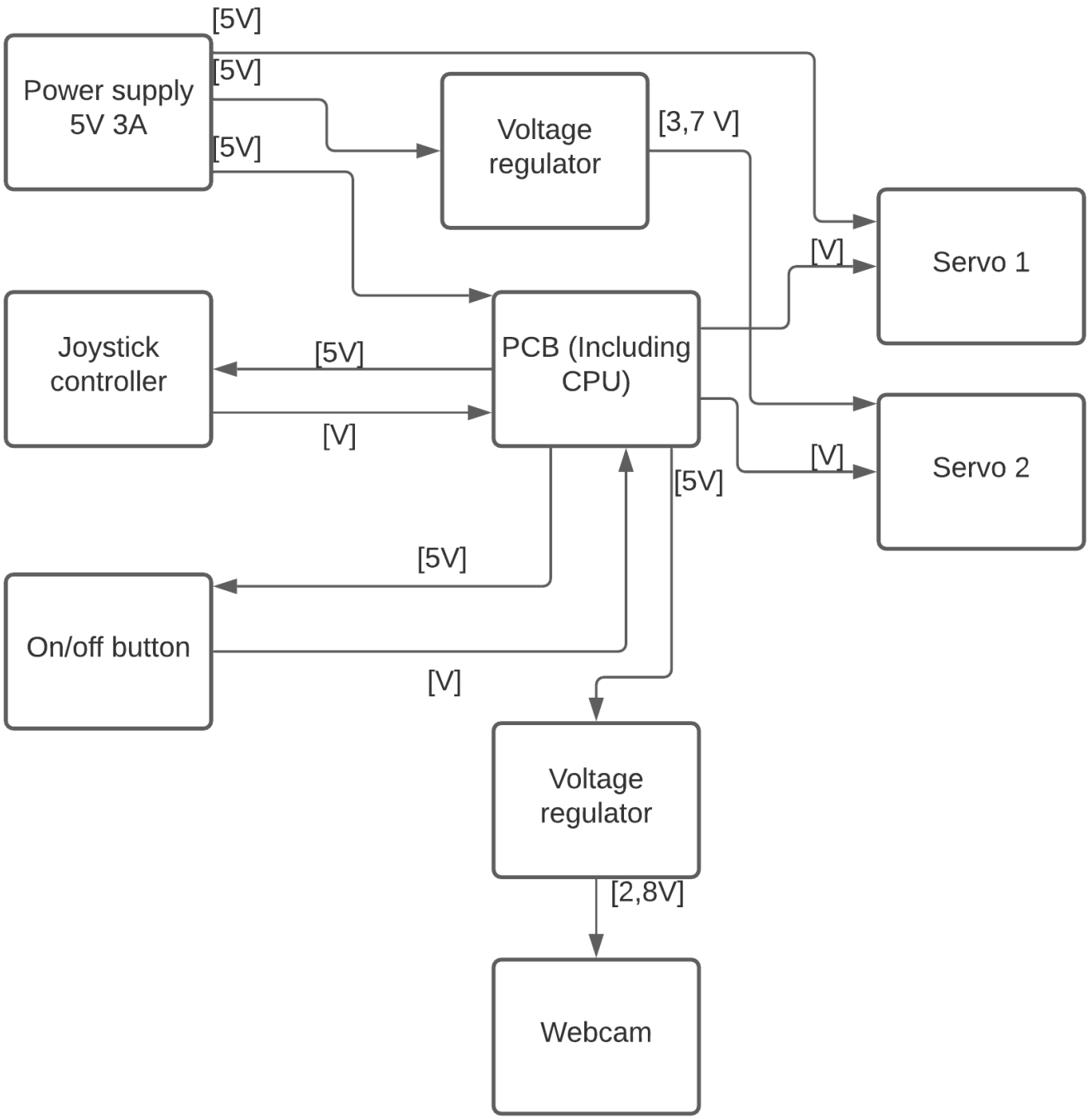
Conclusion
As USB C is not yet the common standard, the product needs an external power supply. This should be a 5V 3A DC power supply. Furthermore, the webcam and the small servo motor needs a voltage regulator.

The product needs a 5V 3A DC power supply in combination with a USB A.

A voltage regulator is needed for the webcam and the small servo motor.

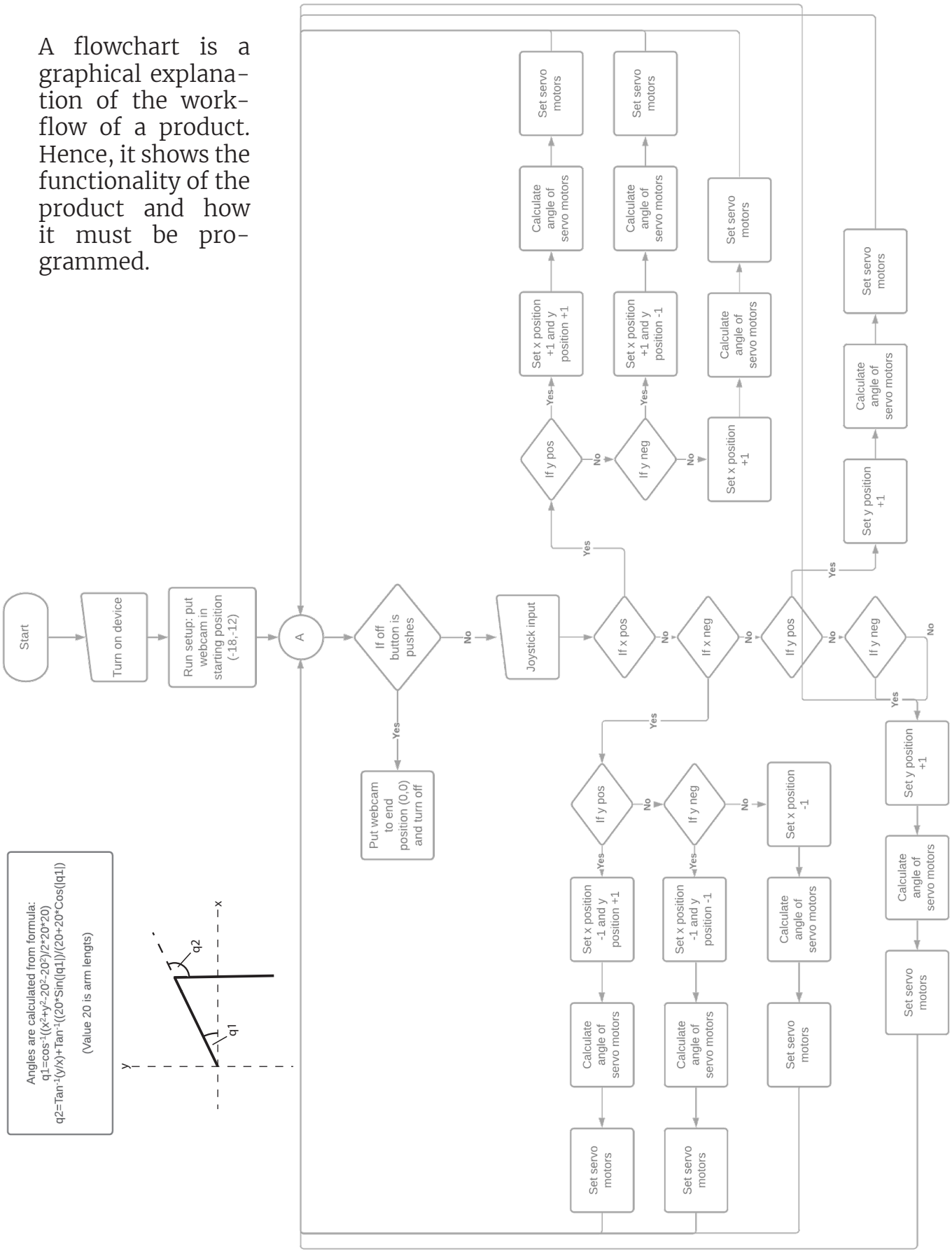
BLOCK DIAGRAM

The following block diagram shows how the physical components are connected and communicate with each other.



FLOW CHART

A flowchart is a graphical explanation of the workflow of a product. Hence, it shows the functionality of the product and how it must be programmed.



RECAP

In the previous chapter, we found a camera module, capable of delivering a 1080p resolution at 30 FPS. The camera can connect to both Windows, Mac, and Linux operating systems with a USB A. As the therapist sits still while consulting, and the fact that webcam's field of view does not affect the eye contact, this has little importance for selecting the module.
The servo motor's strength is determined from dynamics calculations, showing that the inner arm needs a torque of 0,352 Nm, and the outer arm only needs a torque of 0,1 Nm. Based upon this, two different servo motors are chosen. Due to the servo motor's high power consumption, it has been necessary to add a 5V 3Amp power supply. However as the solution is a semi-permanent fit, that can stay on the top of the screen, this will only need interaction in the setup of the product. A block diagram shows how power and signals are sent between the different components and a flowchart explains the workflow.

NEW KNOWLEDGE

Target resolution: 1920*1080p

Minimum Megapixels: 2

Minimum 30 FPS

UVC compatible

The camera module is a T-view 1080P module

The servo motors are a Towerpro MG 92B and Adamand Nakimi Micro robot servo

The product needs a 5V 3A DC power supply in combination with a USB A.

A voltage regulator is needed for the webcam and the small servo motor.

The weight does not impact the screen

5 MANUFACTURING

In the following chapter the manufacturing as well as manufacturing partner is determined. Here there is both looked into start-up cost, how the pieces are assembled, and which certifications are necessary to have, to launch a product and ensure the safety of the product.

MANUFACTURING PARTNER

As the product is electric powered, it needs a PCB including a CPU, as well as wires connected to servo motors, power supply, etc. In order to manufacture this, a manufacturing partner is needed.
A partner could be Nomenta. Nomenta is a manufacturing partner, with facilities in Hong Kong. Nomenta produces PCB's and has different manufacturing capabilities for plastic parts.
Nomenta has specialized in helping start-ups, and can deliver however much of the product one wishes. Hence, we can use Nomenta, in the beginning for producing the PCB/electronic parts, while doing the assembling ourselves and having a more unit-based production, and move towards a series production entirely done by Nomenta, as sales go up. (Nomenta, 2021)

nomenta

97. Nomenta

CERTIFICATIONS

To sell products in Denmark, it needs to fulfill the Danish Standard (DS). Concerning our product and other 'electrical and electronic products', it must have documentation proving that it does not contain Hazardous Materials. To do so, one can e.g. obtain supply declarations of RoHS (Restriction of Hazardous Substances), compliances of all the components, or test the components oneself using the standard DS/EN 50581:2012. DS/EN 50581:2012 shows how to provide the needed technical documentation of this compliance. (Elektrisk og elektronisk udstyr skal CE-mærkes, 2020)

CE

98. CE certification

Furthermore, the manufacturer needs a production control procedure, making sure the production complies with the EU regulation no. 768/2008/EF. (Elektrisk og elektronisk udstyr skal CE-mærkes, 2020)

RoHS

99. RoHS certification

- Manufacturing partner is Nomenta
- Product needs to comply with DS/EN 50581:2012
- Product must comply with EU Regulation no. 768/2008

SMALL PRODUCTION (100 UNITS)

In order to make a proof of business with the least possible startup cost, the first products will be produced in 3D print, as there is no tooling cost.

With advise from Mikkel Huse, we investigated differerent production methods, for small batched.

3D print has very little demands for the shape. However, 3D print has the drawback, that it is typically relatively easy to see lines from 3D print, and it might need much post processing in order to get a good product finish.

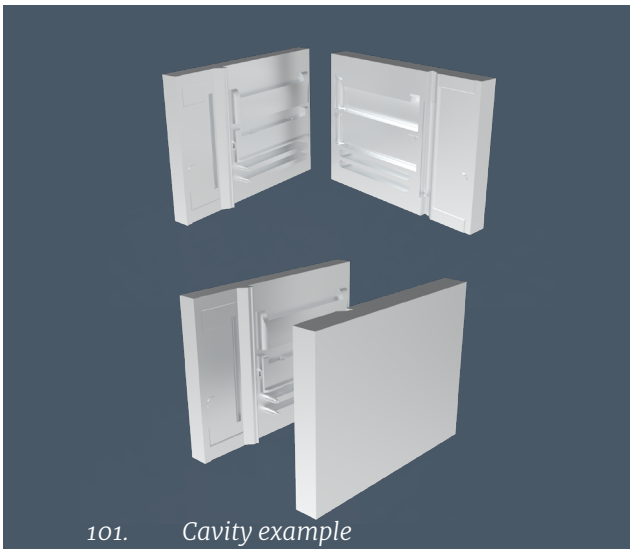
SLS 3D print was found to be the best solution. This has a matte finish as decired, and even though the surface has some roughness to it, it still has an appealing surface finish.
Hence this will be used as the production method for the first 100 products.

100. SLS 3D printed parts

LARGE PRODUCTION (100+ UNITS)

When moving to a larger production, injection molding is the desired manufacturing. This will make for very small production unit cost, however, there is a startup cost.
In order to lower the startup cost, an aluminum mold is purchased. This is cheaper to make than a steel mold, as aluminum is easier to cut. However, where a high quality steel mold can last 1.000.000+ cycles, an aluminum mold is only good for approximately 10.000 units.
In order to lower the mold cost, a mold with all six cavities in are made. Hence all six parts are produced in one press. (See mail from Fimek appendix 22)

For this production method we need draft angles in order to pull the piece out of the mold. Furthermore, an evenly distributed wall thickness is desired. If this is not possible, then a smooth transition into bigger material thickness, will help reduce shrink marks.
The material chosen is ABS. This is relatively cheap to injection mold, and it is possible to glue, injection mold, or make other assemblies. As the product is not subject to harsh environment, nor extensive forces, this is not important for the material.



101. Cavity example

- First batches are made in SLS 3D print
- Big batch production is made in Injection molded ABS plastic

ASSEMBLY

An assembly of the product is necessary.

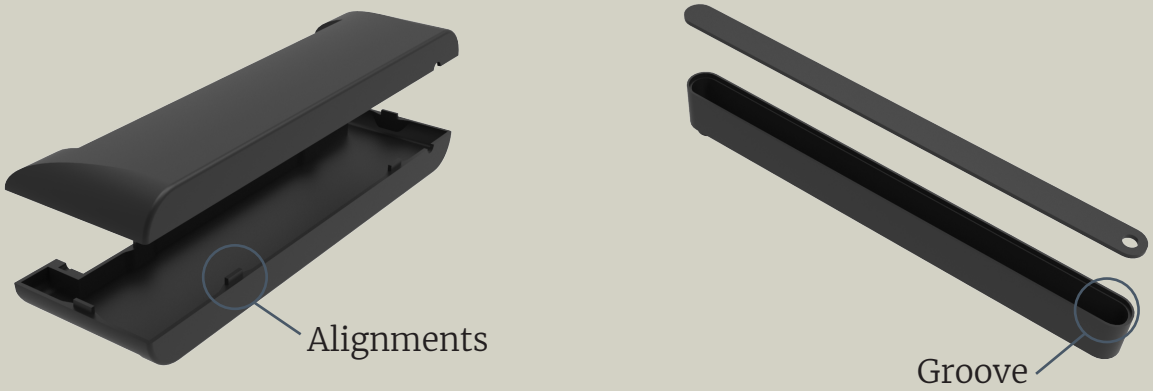
Here different methods are investigated. Initially making plastic snap fittings was seen as the best solution, as it would both be environmentally friendly if pieces could be disassembled in order to repair a faulthy object.

However, speaking to Fimek (an injection moulding partner), it is found that making snap fitting in an aestheticly pleasing way, which needs some degree of undercuts in the molds, and would heavily increase the tooling cost. Hence, due to the decision of starting as a start-up (see page 83), a more acessible manufacturing is chosen.

Plastic welding requires more manufacturing processes, hence, the choice has been gluing the parts together.
A number of different glues can be used to bond ABS plastic. As our application is not subject to extreme temperatures, not any noticeable forces, a cheap glue can be used.

In order to ease the manufacturing when gluing the parts together, some detailes are made on the plastic parts

Pieces for assembly

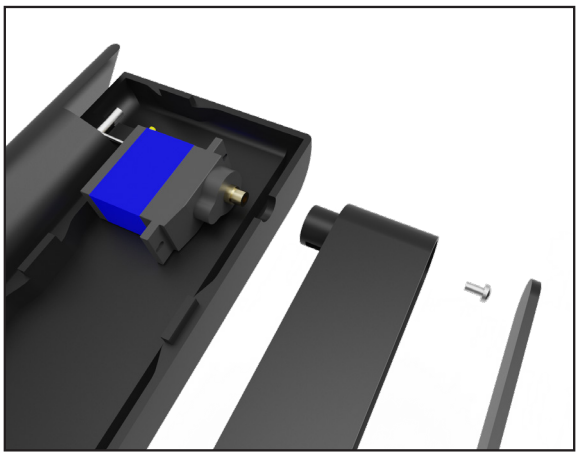


102. Product assembling

Making small alignments studs, or grooves for placing the fitting piece into the arm, makes it a lot easier to align the parts. This will ease the manufacturing, and once all internal components are fitted, the pieces can be glued together.

Assembling the arms to servo motor

The arms are mounted to the servo motor, by a small screw. The plastic piece is hence held in place by the screw, connecting to the servo motor. Once the internal components for each arm is fitted, the lid can be glued into the groove.



103. Product assembling

The pieces are glued together

RECAP

In the chapter, the manufacturing partner Nomenta was chosen, as they specialize in working with start-ups, andit is possible to scale the production here. Both in terms of units, but also in terms of how much of the product they produce.

The first 100 Units are SLS 3D printed. However, after this, once the business is proved, injection molding will be used, as it is much cheaper pr. unit. The pieces are either glued together as this is the cheapest assembly or pieces mounted to servo motors are screwed.

NEW KNOWLEDGE

Manufacturing partner is Nomenta

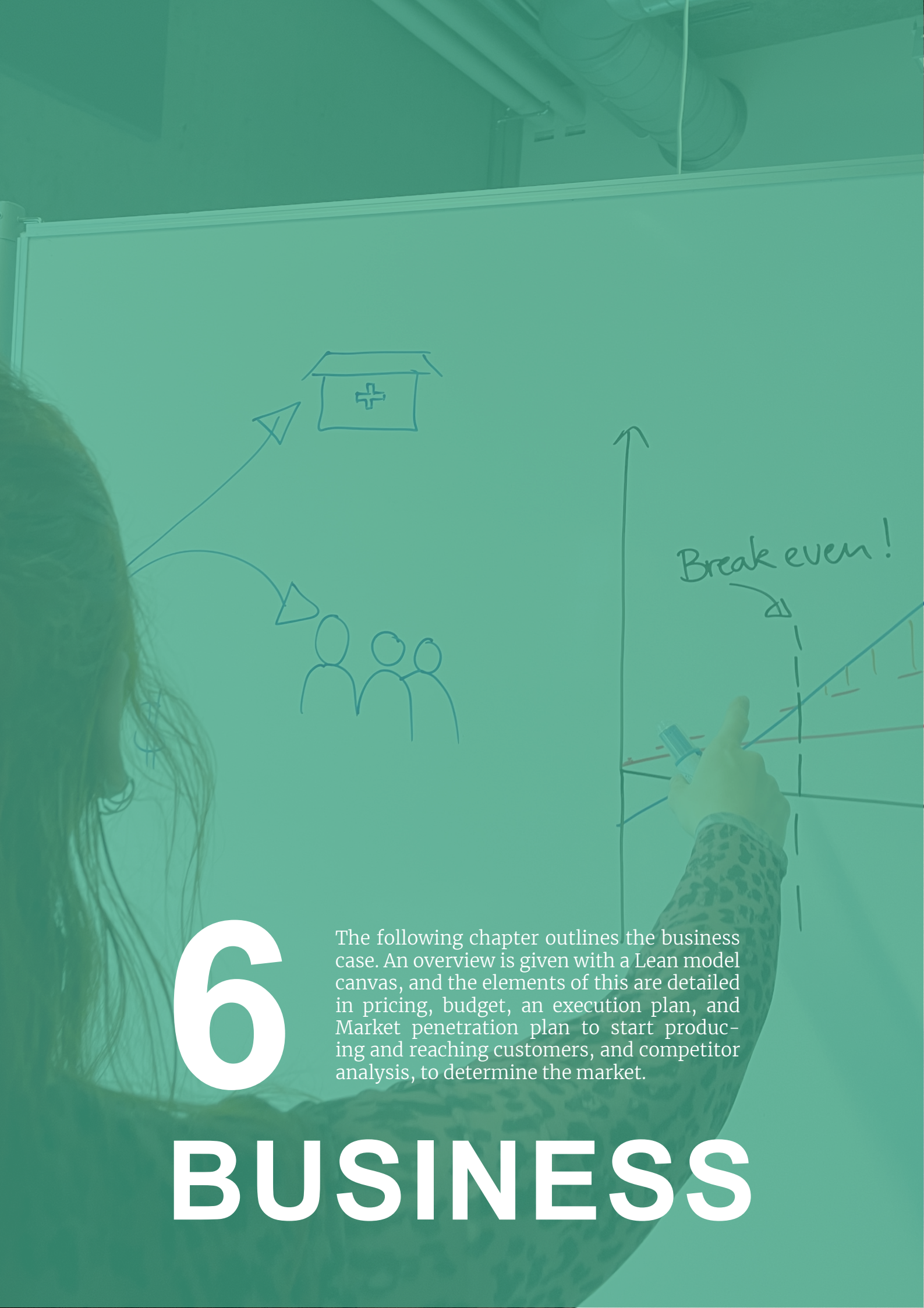
Product needs to comply with DS/EN 50581:2012

Product must comply with EU Regulation no. 768/2008

First batches are made in SLS 3D print

Big batch production is made in Injection molded ABS plastic

The pieces are glued together



6 BUSINESS

The following chapter outlines the business case. An overview is given with a Lean model canvas, and the elements of this are detailed in pricing, budget, an execution plan, and Market penetration plan to start producing and reaching customers, and competitor analysis, to determine the market.

START UP COMPANY

There are a few different manufacturers of webcams. However, most of these companies are focused on consumer end-products, being a part of their mission statement. For example, part of Logitech's mission is to make "everyday consumer products" (About Logitech - Our Story and Focus, n.d.).
As most market leaders do not have a focus on niche markets, such as therapist webcams, and due to the relatively low entrance barriers of making a webcam (lots of camera modules are available for a low cost, and custom PCB's are becoming increasingly cheaper), it is decided to access the product as a start-up.

LEAN MODEL CANVAS

A Lean model canvas is made to outline the business. This shows the problem, solution, the value of the solution, and how it will reach a certain customer group. Furthermore, cost and revenue are highlighted.

<table>
<tr>
<td rowspan="2">Problem
When having online video calls, one loses the intimacy of having eye contact, as one is not looking into the camera
(see pp. 32)

Existing solutions
- Teleprompters (often expensive and big)
- Eye-correcting software (Still faulthy, and faking sensitive situation)</td>
<td>Solution
Eye-See
  </td>
<td rowspan="2">Unique value proposition
Eye contact in online video calls

High level concept
Intimacy improving webcam</td>
<td rowspan="2">Unfair advantages
First movers on market.</td>
<td rowspan="2">Customer segments
Therapists (psychiatrists, psychologists, coaches, etc.) providing online therapy

Early adapters
Private practicing therapists</td>
</tr>
<tr>
<td>Key metrics
100 sales in 1 year, and 4000/year in year 5</td>
</tr>
<tr>
<td colspan="2">Cost structure
Fixed costs
82.000 DKK (Insurances, it ect.)

Variable costs
Injection molding: 430 DKK
SLS 3D print: 1442 DKK</td>
<td colspan="3">Revenue streams
Product price: 1900 DKK

Revenue Injection Molding: 1470 DKK
Revenue SLS 3D print: 458 DKK</td>
</tr>
</table>

104. Lean Model Canvas

PRICING

In order to set a pricepoint for the product, renderings of the product is send out to several different therapist (see appendix 18). Each of the therapists were told, that the product had a different price; from 1900 dkk to 2900 dkk (excl. VAT). The purpose of this was to find the right price point for the product, hence figure out what the value of this product is worth to the therapists.

Price 1900 DKK
"The price is fine! 1900 would fast make its own money in a business"
- Tanja, coach

Price 2400 DKK
"The price seems fine"
- Marlene, psychiatrist

Price 2700 DKK
"On one hand 2700 DKK is not much to solve this problem. However, I would have high demands to video quality, auto focus etc. I think I would investigate the prices of teleprompters before I bought it."
- Asmund, psychologist

Price 2900 DKK
"I would like some studies that approve the importance of eye contact, and verify the solution..."
- Rikke, psychologist

Price 2900 DKK
"The price seems at first suprisingly high, compared to prices of e.g. some laptops ...."
- Christen, student priest

Regarding the price, 1900 dkk appears to be fine, whereas 2900 dkk seems a little too expensive. For both the therapist getting told the price was 2700 dkk and the one getting told it was 2900 dkk, they mention that they would have great expectations to webcam-solutions this expensive (e.g. auto-focus functions, lighting adjustment, etc.). However, they are not completely dismissive, and both argue that it solves a big problem. Whereas at a price of 1900 DKK, the decicions seems to be much easier. Here they just mention that the would buy a product, and the barriers to purchase seems much smaller.

We then decide to make the price 1900. It seems like we are still able to sell the product at nearly 3000 DKK, however it will take more conviscing, and hence we believe that a bigger profit can be achieved from selling more units, rather than earning a little extra on each unit.Moreover, this investigation has an error source, since the therapists knew, they were answering a fictive question, hence signing up for a newsletter or a pre-purchasing list might have lead them to answer otherwise.

The selling price is 1900 DKK excl. VAT

COST PRICE

A price estimation is made, for producing the product. This estimation is made in both a 3D printed version, as well as an injection-molded production price. Each internal component is found on alibaba, ebay etc. Hence these items already have prices.

Variable cost

Component pricing:

The internal components are priced from online found prices. Here, the small servo motor is an expensive part. However, it is also a crucial part, of making the design as little distracting in front of the screen as possible. The price of this motor is from 2016 when it was first launched, hence it might be cheaper today when more units are produced (Kashiwao, 2016).
The webcam is also an expensive module, however again a crucial part of the product. When buying a webcam product priced at 1900 DKK, one will expect a good quality video signal.

Hence the total cost of internal components is 372,5 DKK.

Item	Price
Small servo	150 DKK
Big servo	30 DKK
PCB	20 DKK
CPU	15 DKK
Power Adaptor	21 DKK
Webcam	90 DKK
Torsion spring	21 DKK
Wire	18 DKK
Ball Bearing	6 DKK
Joystick	1,5 DKK
Total	**372,5 DKK**

105. Prices of internal components. Refs: (Kashiwao, 2016), (Towerpro MG92B, n.d.), (PCB, n.d.), (CPU Atmega 328p, n.d.), (12v 2a Power Adapter, n.d.), (Webcam, n.d.), (Pianotråd - Vridfjedre / Torsionsfjedre, n.d.), (Electric Wire, n.d.), (Miniature Ball Bearing, n.d.), (Joystick, n.d.)

3D print:
Prices from the company "Xometry", states that we can produce SLS 3D printed parts for 1070 DKK each. (See appendix 22)

Hence the total cost of a 3D printed unit is ≈ 1445 DKK

Injection molding
For injection molding at Fimek,the mold costs of 220.000 DKK. However, each unit can be produced for 57 DKK. (See appendix 22)

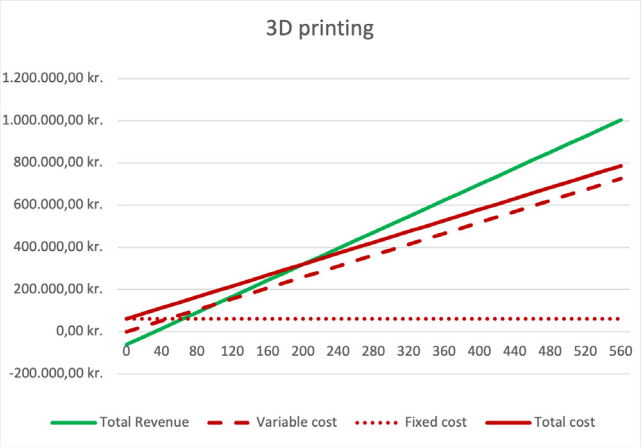
Hence the total cost of an Injection molded unit is ≈ 430 DKK.

These prices are used to calculate revenue based on sales.
Note that this has some inaccuracy. The pricing of internal components are not based on bulk orders, and hence it is likely that these prices will be a little lower when buying several units at a time. However, this will only contribute to a better economy.

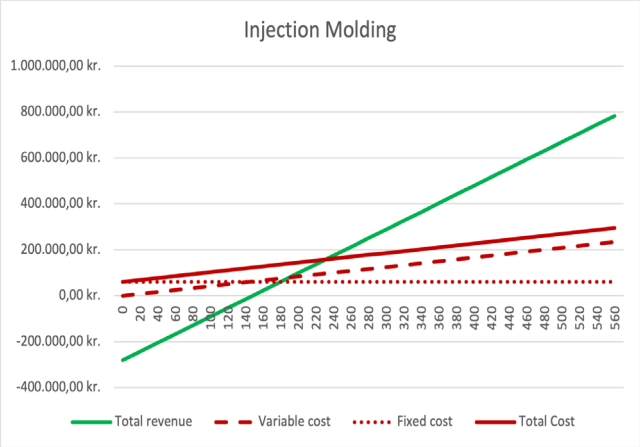
Fixed cost:
The fixed expenses for the business are relatively low. It includes; IT systems, insurances, marketing, and auditor.
IT systems, including Mail, text program, and economics software, is approximately 500 DKK a month (Vagning, 2021).
Insurances are a must-have for a business. Here both mandatory third-party insurance, as well as product insurance, is needed, to approximately 8.000 DKK a year. (Vagning, 2021)
Auditor to make a financial report by the end of the year cost approximately 6.000 DKK (Revisor1, 2021). A website domain costs 1.000 DKK (Vagning, 2021), and in the first year, prototypes of 4.000 DKK are produced.
Marketing rounds up to 40.000 DKK a year, in magazines directed target audience.
This makes a total fixed expense of 61.000 DKK

Item	Price a year
IT systems	6.000 DKK
Insurance	8.000 DKK
Auditor	6.000 DKK
Website	1.000 DKK
Marketing	40.000 DKK
Total	**61.000 DKK**

This provides us with the knowledge needed to make a CVP analysis, determining when breakeven is achieved. This is done for both the 3D printing and Injection molding, and these are then compared:



106. 3D printing Cost-Volume-Profit analysis



107. Injection moulding Cost-Volume-Profit analysis

From these graphs, it is seen that it takes a long time before the revenue from 3D printed parts, has paid the fixed cost. However, there is very little start-up cost. Compared to the injection moulding, it is needed to sell nearly the same amount of units to create a profit. However, once breakeven is achieved the injection-molded production creates a much greater revenue. This however has a bigger startup cost.

Hence, it is desired to start of with a 3D print production, due to the low startup cost. This is to make a proof of business. Once the first 100 units are sold, the investment of injection molding is made. This will make for a bigger profit in the following years, where the startup cost is already paid.

The first 100 units are 3D printet, to make a proof of business. Then an injection-molding cavity is purchased.

LIQUIDITY BUDGET

A liquidity budget is outlined, in order to determine the amount of money needed to run the business, and that there is always sufficient money to pay bills.

The first year is highlighted here:

Cash flow budget												
	September	October	November	December	January	February	March	April	May	June	Juli	August
Production of units			10	10	10	15	20	20	10		100	
Unit's sold			3	5	10	10	13	15	12	12	10	10
Balance i enheder			7	12	12	17	24	29	27	15	105	95
Income												
Grants	50.000									250.000		
Income from sales			5.700	9.500	19.000	19.000	24.700	28.500	22.800	22.800	19.000	19.000
Own Investment	40.000											
Expenses												
Prototypes	2.000	2.000										
Registration of APS	700											
CE Certification		20.000										
Marketing			4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000
Tooling investment											220.000	
Production cost			14.420	14.420	14.420	21.630	28.840	28.840	14.420	0	43.000	0
Website					1.000							
Warehouse and office	0	0	0	0	0	0	0	0	0	0	0	0
IT (mail, software, financial software)	500	500	500	500	500	500	500	500	500	500	500	500
Insurances	3.000		5.000									
Sallary												
Auditor				6.000								
Total expenses	6.200	22.500	23.920	24.920	19.920	26.130	33.340	33.340	18.920	4.500	267.500	4.500
Total available funds	83.800	61.300	43.080	27.660	26.740	19.610	10.970	6.130	10.010	278.310	29.810	44.310

108. Liquidity budget

Here, we see that we have relatively little startup cost. The biggest expense is getting a CE-certification on the product. This will, alongside operation cost, be the only major expense. Once an adequite amount is sold, and that the business case has been proven, a injection moulding tool is bought which will significantly lower the manufacturing cost. However, it is quite an investment.

Hence to start running the company, a total investment in the first year of 300.000 DKK is necessary. However, the 250.000 DKK of these, are not necessary before the business has been proven.
The first year of business, we have fixed cost of 61.000 DKK. All other costs are variable cost, or tooling cost.

5 years

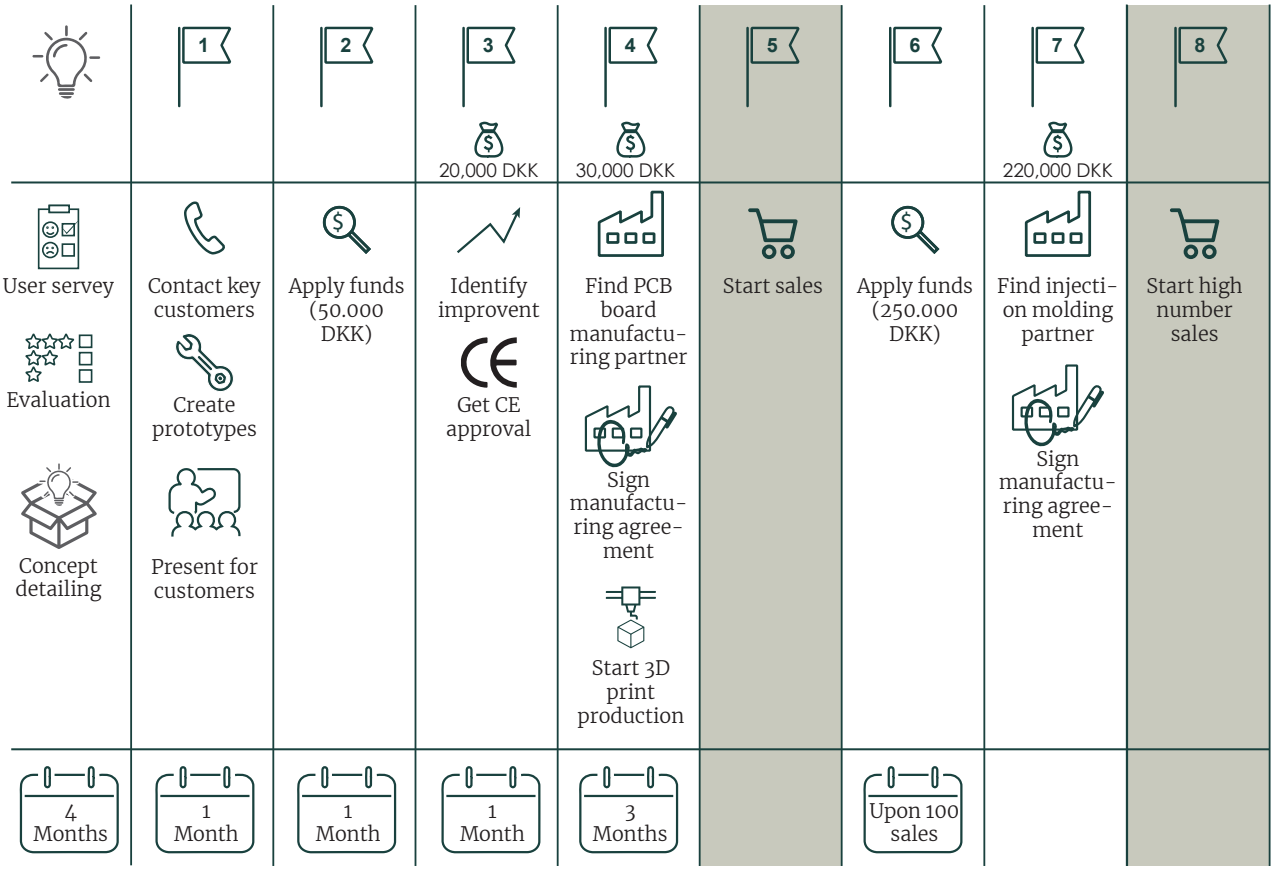
Following is breaking sales into a 5 year plan. Marketing cost etc. expands when sales raises. The sallary will raise, as the income goes up. A simple budget for the first 5 years of business will look like this:

	Year 1	Year 2	Year 3	Year 4	Year 5
Sales	100	300	1.000	2.000	4.000
Income	530.000 dkk	570.000 dkk	1.900.000 dkk	3.800.000 dkk	7.600.000 dkk
Expenses	485.000 dkk	604.000 dkk	1.280.00 dkk	2.000.000 dkk	3.000.000 dkk
Total	45.000 dkk	- 34.000 dkk	620.000 dkk	1.800.000 dkk	4.600.000 dkk
Bottom line	45.000 dkk	11.000 dkk	631.000 dkk	2.431.000 dkk	7.031.000 dkk

109. 5 year overview

EXECUTION PLAN

In order to reach the market, several steps are needed. To get an overview of these steps, an execution plan is made. This includes the steps to make the first products, that will be used to make a Proof of Business, as well as steps towards making a higher batch production. This plan only includes steps necessary to start production and we are, at the time of writing, in phase 0. A plan for reaching the customers is found on page 89.



110. Execution plan

Here the ideation phase has evolved into this product proposal. After this, some more detailed prototypes are made, which can be tested on users. This is in order to make some improvements, that might be necessary.
A funding of 50.000 DKK is necessary. This can either be through funding programs, or taking a bank loan.
After this the last approvals like CE is found, and a production is startet. Once the first 100 Units are sold, a bigger production is started and additional funds of 250.000 DKK in order to produce the mold for injection moulding.

MARKET PENETRATION

To make a market penetration strategy and get to know the procurement structures of private practitioners, we contacted Marlene B., who has started a 'therapy community'. Here 10 therapists with different backgrounds each rent a room and provide their treatments and therapies.

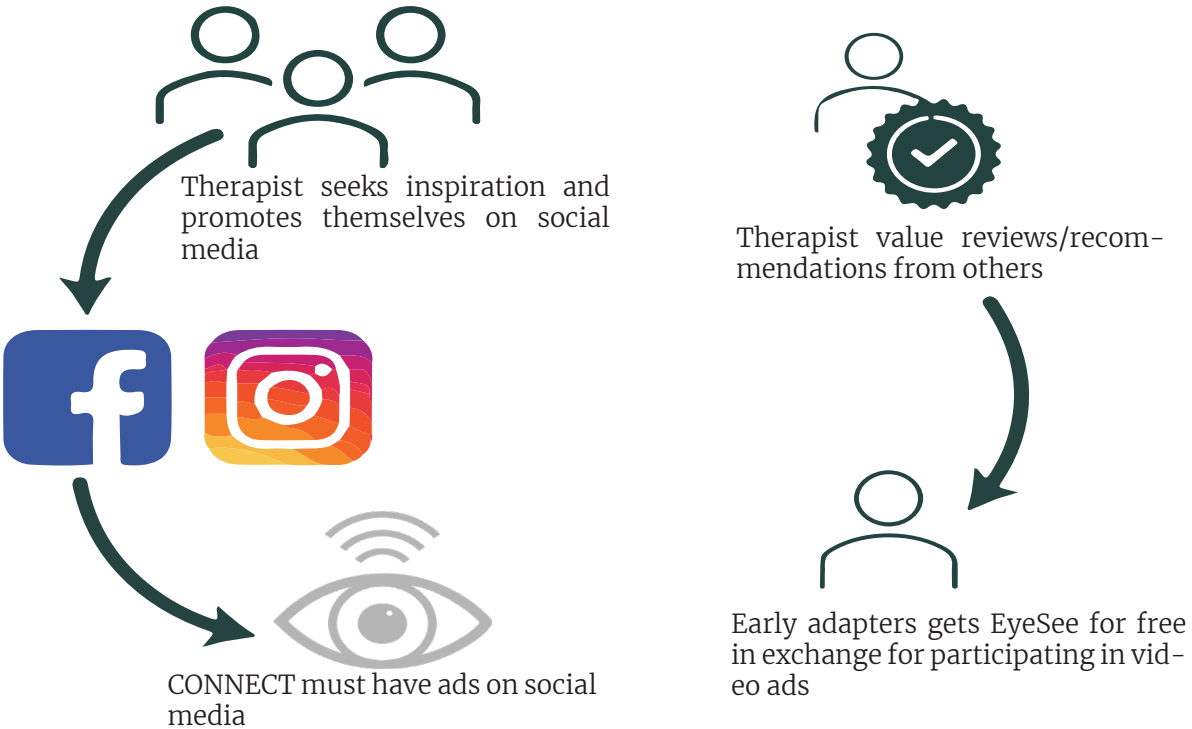
Marlene B. tells us, that they do not want printed advertisements, and if they get some, they throw it away without looking at it first. Furthermore, they do not have any special procurement agreements.

To sell the product, it is decided to sell directly to the therapist/hospital, without a retailer. As the therapist does not have any specialized sales channels this is not an opportunity. Furthermore, it would not make sense to sell the product in general electronics retailers, as the focus of this product is a niche market. By selling the product directly, a bigger contribution margin will also be achieved.

When they need new equipment for their offices, they search for it online. A part of having a clinic is also to create an atmosphere, hence they seek inspiration on platforms like Instagram. Besides seeking interior inspiration on social media, they also use Facebook and Instagram for free self-promotion and paid advertisements to get more customers in their clinic. Thus, social media is a great place to hit this target group.

Moreover, they value recommendations from other therapists and tests comparing similar products before buying something new.

Thus, it is expected to do the advertisement on social media by ourselves, since that is a relatively simple but somewhat time-consuming task. However, we will need to spend money on creating professional looking content, like videos and product photos, besides the renderings we can make ourselves.



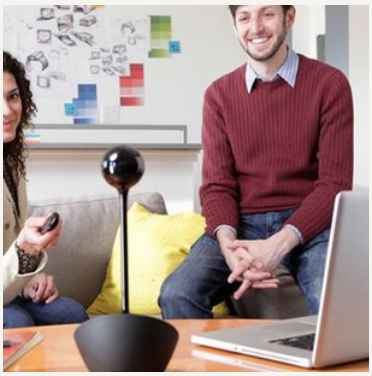
COMPETITOR ANALYSIS

Online consultations were a thing way before the coronavirus forced everyone to stay home and digitalize. Hence, there already exists products, which to some extend supports virtual meetings. Following is an overview of the products, including a comparison with our product requirements.

Add-on webcam
Price: 200 dkk - 1000 dkk
Regular webcams are the only used solution among our respondent therapists. It has the pitfall, that it does not provide eye contact and the possibility to look at the patient on the screen, at the same time. Furthermore, does not allow the therapists to adjust the webcam without the patient knowing.

111. *(Webcam, n.d.)*

Conference webcam
Price: 1.999 dkk
The conference webcam has not been observed used by therapists, however, they could potentially put it in front of their screens to simulate the eye contact functionality of our product. However, the "webcam ball" is rather large and will (together with the "pillar") cover a lot of the screen.



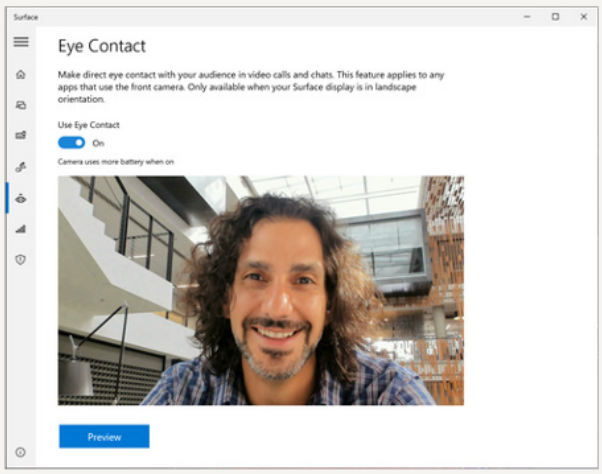
112. *(Logitech BCC950 ConferenceCam, n.d.)*

Teleprompter for tablet
Price: 4.045 dkk (+ tablet and camera)
Using a teleprompter, as a solution for the lack of eye contact, has been mentioned by the psychologist, Asmund. He stated that it was a matter of price and webcam quality, whether he would choose our product or a teleprompter. Looking into videos of this setup, it shows that depending on the lighting, the camera behind might be visible, hence the patient looks 'transparent', which might cause loss of details. Using a teleprompter also includes buying a tablet large enough to give an acceptable image size. Besides that, one will also need to buy a camera that fits the setup, which is mostly large video cameras. Moreover, one needs to be capable of connecting all these things to the conference call software and make it run smoothly.

113. *(Teleprompter for tablet, n.d.)*

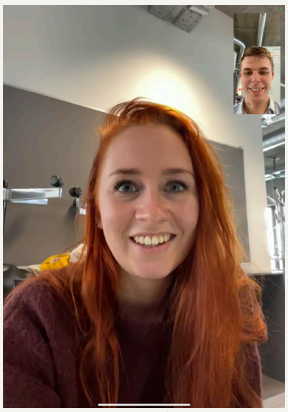
Continues on the next page

Eye correction software
Price: Built-in software
The first issue regarding using software to correct the eyes, hence simulate eye contact, is that it does not work very well according to our tests (see photos). Furthermore, there are ethical problems in faking the mimics in this specific context, since facial expression and non-verbal communication are a huge part of therapy. The software may become a good solution for correcting the therapists' eyes in the future, but at the moment it looks too unnatural.

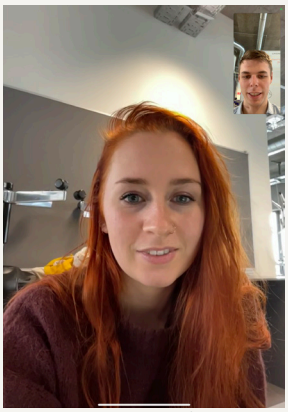


114. (Microsoft eye contact software, n.d.)

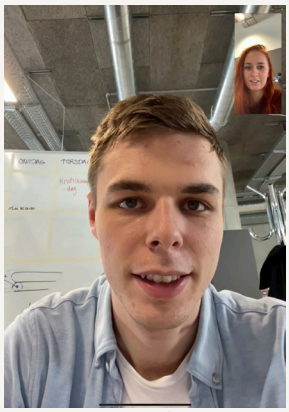
Testing the eye correction software of Apple's Facetime:



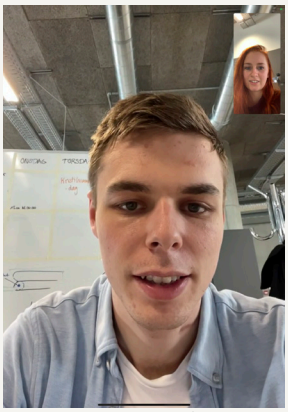
115. Looking into camera



116. Looking at the others eyes



117. Looking into camera



118. Looking at the others eyes

RECAP

The previous chapter has outlined a business plan for a startup. A sales price of 1900 DKK excl VAT is determined. A liquidity budget shows that the first year of business needs 300.000 DKK in investments. This investment is necessary once the business plan has been proven, by producing lower number batches in 3D print. The first customers will be private practicing therapists, and these will be contacted on platforms they are already utilizing themself, such as Facebook, Instagram, etc. The therapist will often get product recommendations from colleagues, and hence it is important to get into these clinics. A plan for starting production and the necessary steps are made. From this, it will be possible to have the first sales, 6 months after starting up. The chapter has also looked at competitors and found that there are a lot of different cameras, and conference call products on the market. Here it is also seen, that no solution delivers a solution for eye contact, satisfyingly without having compromises that prevent the ability to read facial expressions for the therapist.

7

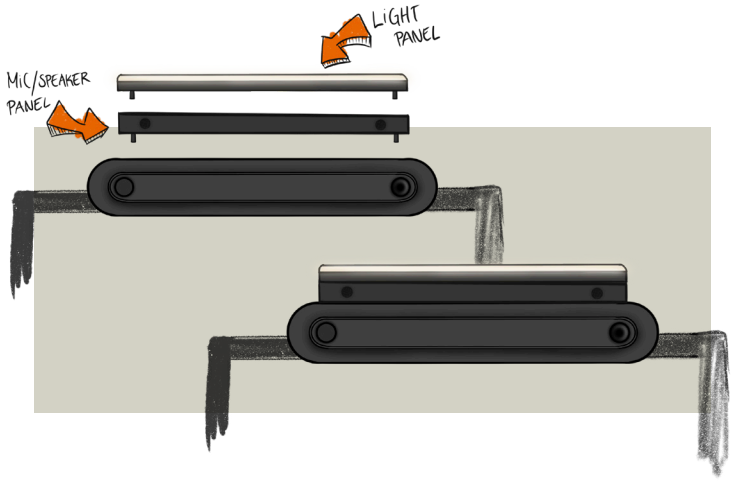
FUTURE PRODUCTS

Through this project, we have focussed on the MVP, and hence, detailing the first of a series of products for the market. Thus, the following chapter is sketches and thoughts of the first modifications and other products to come.

FUTURE ADD-ONS

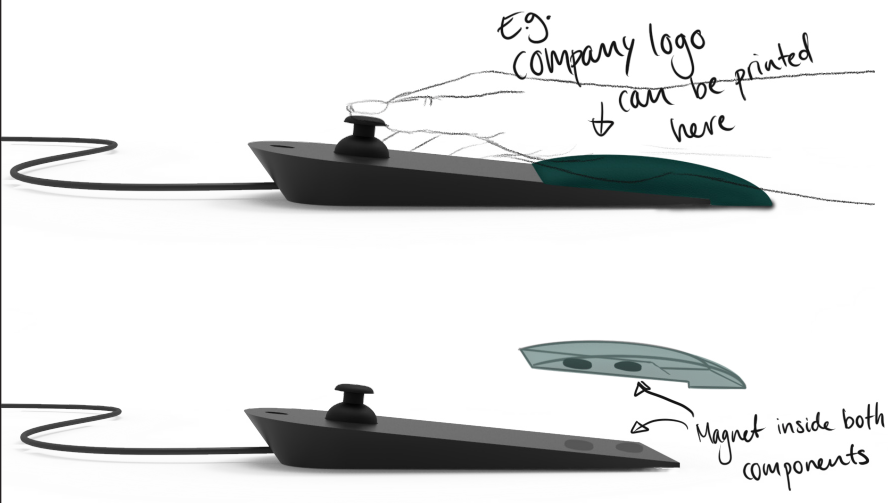
The first modifications for Eye-See are supposed to be add-on panels, providing respectively light and a microphone/speaker, and a add-on padding for the wriston the joystick. Hence, the first version of Eye-See must be prepared for these add-ons. The lighting panel will make sure, that the therapist sits in the optimal lighting for video calls, whereas the microphone/speaker panel improves the sound aspect of the product. Furthermore, the padding will increase the support of the wrist.
The add-ons will serve to provide greater value for the therapists, besides increasing the income and hence gather money to develop and produce the next products.

Extra functionality



119. Add-ons

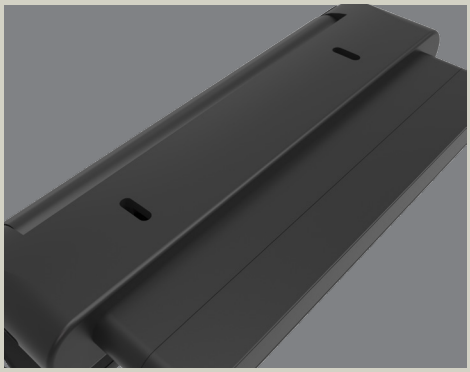
Extra comfort



120. Add-ons

Connection

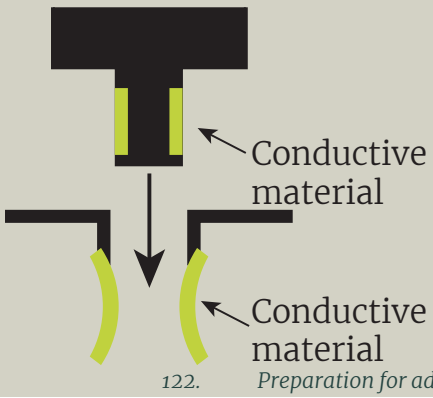
The standard module comes ready for add-ons. Two grooves in the top enables a secure fit for the add ons, as well as gives the necessary connections for power and data transfer.



121. Preparation for add-ons

Working principle

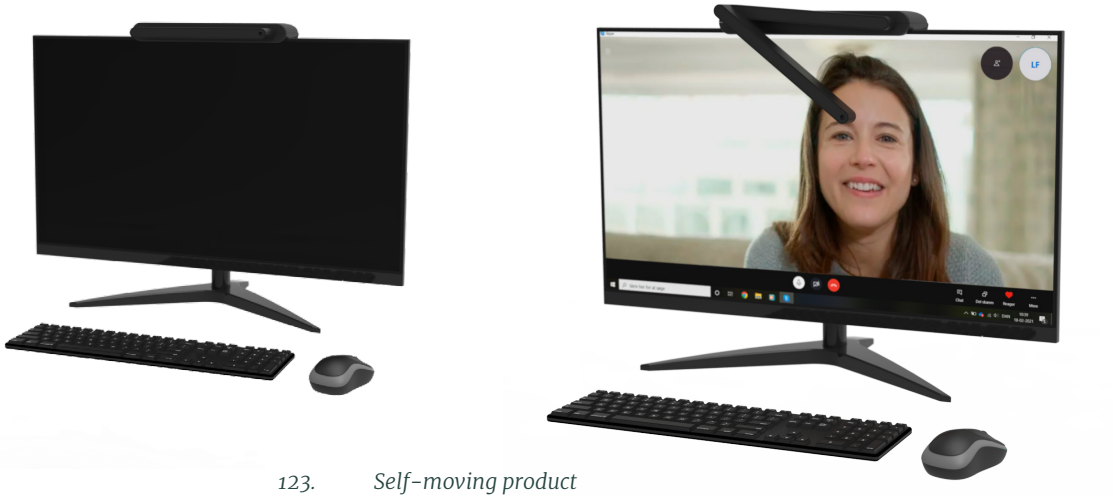
Inside the base, copper strips or another conductive material lies. By placing them inside, there's no risk of shocks. The add on has similar conductive material, that will have contact when added.



122. Preparation for add-ons

AUTOMATICLY MOVING

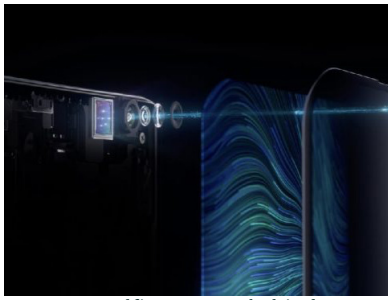
Hereafter, the goal is to make an automatic version of Eye-See, which moves by itself. It will be costly and time-consuming to make such a product since we need secondhand development of a software to maneuver it.
We have been in contact with a software developer, Thomas, whose estimate is, that it will take twice the time and money to make the product self-moving compared to controlling it with the joystick. Whether this product will be a good idea, depends on how much more extra value it gives the users versus how big of an investment is needed to produce/sell/buy it. Hence both we, and the users, will need an cost-benefit-analysis to figure this out. Another way of providing this product, could also be to upgrade the existing product, which is much cheaper.



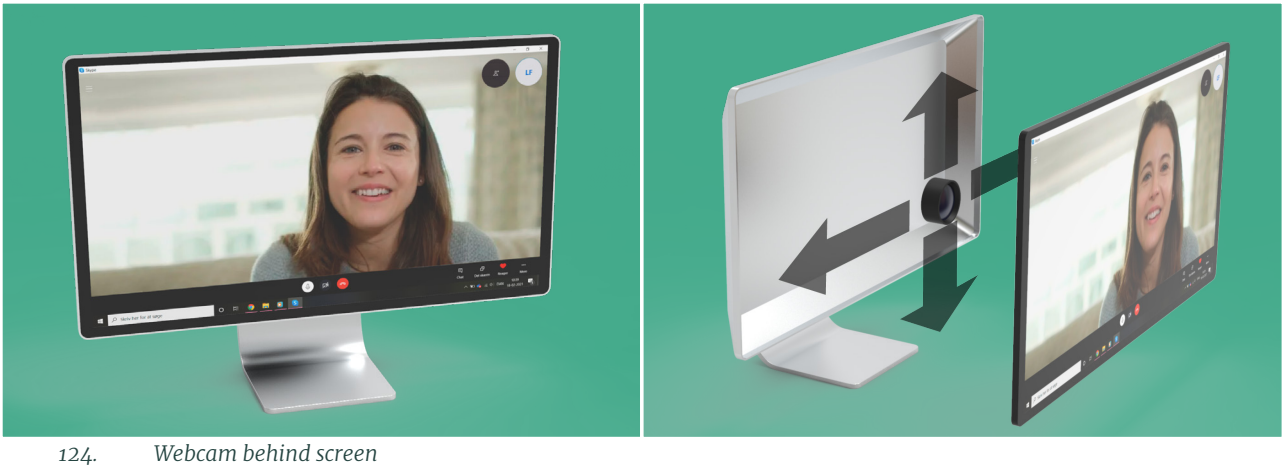
123. *Self-moving product*

WEBCAM BEHIND SCREEN

Subsequently, it is a desire to launch a computer screen with a built-in webcam. The webcam must move automatically inside the screen, not being visible from the outside to minimize disturbances. This will give a hazzle free interaction, where the therapist won't have any distractions on the screen. There is already examples of screens with camera behind, today seen in the first commercially available smartphones. This makes it likely, that such a technology will be commercially available in the future.



125. *Selfie camera behind screen on Oppo Phone*



124. *Webcam behind screen*

RECAP

Here, a few add-ons are presented, further development of the interaction is accessed, and a future version with a camera behind the screen is presented. The add-ons as well as an automatically moving product will be implemented once adequate funding is achieved. Here the first version is prepared for add-ons, by having grooves ready for connection.
The future version with a camera behind the screen utilizes technology that is not yet commercially accessible. However, some smartphones started implementing a similar technology, making it reasonable that the technology will soon be available for mass production, also in monitor settings.

PROJECT REFLECTION

Compared to other semesters, we have to a much greater extend worked on developing and exploring the problem alongside the solution. Hence, we started this project with the intention of improving the working environment of open-plan offices, moved on to improving meetings, then online meetings and finally online therapy. Hence, we have learned to explore the problems more through solutions and hence less through desktop research. Besides it being more interesting to work this way, we have got deeper into investigating the problem faster, than if we had done it through desktop research, which rarely makes one aware of the latent needs. Thus, the specific requirements often comes with entering the reality.

At the very beginning of this project, we decided to approach it as a startup company, since we wanted to use our master thesis to gather all the knowledge we could on how to run a business. This mindset has led us to consider manufacturing and general business aspects along with developing the concepts. We have had the MVP in mind at all times and hence have not developed a great, complicated product with multiple features just to tear it all apart to "find" the MVP at the end of the project, like other semesters.

We have created a product for therapists, which improves online therapy for the patients. Hence, having another approach will have lead to a completely other project and solution. E.g. one could frame the project as facilitating a more pleassant working space for the therapists providing online therapy, or focussing exclusively on making a product for the patients.

Furthermore our product is an MVP, relevant for todays market. The focus on an MVP has giving some limitations, e.g. our product will most likely be outcomped-ed by technology in 10-20 years, if we do not evolve the product. We have already observed a smartphone for the consumer market, which have a selfie-camera behind the screen. The technology has limitations at the moment (the pixels shuts off, when using the camera), but we see a potential. Hence, our product fill in a gap, which is currently in the market. We think, this gap will be smaller in the future, when the technology is ready for it, but it will take time before the perfect technology is cheap enough to get to the consumer market. Thus, we could also have framed this project for future instead of the present. That might have led us to a project, where the proof of concept to a higher extend should be based on research and predictions on the technologies of the future, and less on prototypes.

CONCLUSION

The project started with a broad focus on online meetings and quickly focused on online therapist sessions.

Problem statement:
How can we improve therapy for the patients by increasing the experience of presence in online therapy?

From here, different proposals on how to improve an online consultation have been made, probing different concepts, for both therapist and patient. This showed that the patients were not interested in a product for therapy sessions, however, they had a great interest in improving online consultations. When trying to probe different solutions to both patients and therapists, both parties continued focusing on the ability to have eye contact, which told us that this was a big priority for both parties.

The different concepts for the therapist were received positively, and the therapists saw great potential, in being able to provide eye contact to the patients, hence create a more present online experience. A lot of the therapists even told us, that they already spend a lot of energy on switching between looking at the patients, when these talk and look into the webcam, when they talk themselves. This is to give the patients a feeling of eye contact. However, they need to look at the face of the patient, to read their facial expressions.

Throughout different prototypes for the therapists, considerations about business, involvement of patients and determining whether it was possible to place a camera on top of the screen, and how to maneuver such a camera, a product proposal of a webcam, that can be moved in front of the screen has been made. The product Eye-See has webcam module on two arms, that moves by servo motors. With an arms width of only 16 mm, it takes up as little space as possible on the screen. In order to make the movement as discrete for the patient as possible, these are controlled from a joystick beside the keyboard. The webcam is mounted on top of a monitor, by a clipping mechanism. The colors are matte black, preventing any reflections in the product, which can distract the therapist.

At a price of 1900 DKK (excl. VAT), it is an affordable solution on a market with a lot of different webcam equipment. The only real alternative with the possibility to provide eye contact, is a teleprompter setup, with takes a lot more space, money, and equipment.

At the start of the production, small 3D printed batches are produced. Afterward, the product shifts into being injection molded. The electronic parts are made by a manufacturing partner, Nomenta, who will connect the necessary components, and create a custom PCB. This will create a revenue of 1470 DKK/unit when selling directly to the users.

To follow up the business plan, a number of initiatives are planned. Add-ons to provide the functionality of light and sound can be added to one's product. A future version, improving the interaction by removing the joystick controls for the therapist, will also be implemented. Once having a more established market model, a high-tech version of a screen, with a camera behind is desired.

ILLUSTRATIONS

1. - 75. Own illustration

76. Styleboards;
Soft:
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