BASHAR SHAHMORAD
JONAS JOHANSEN
MSC04 - ID13 - 2021

SAHD

A CLEAN DECISION

TITLE PAGE

TITLE	SAHD - A CLEAN DECISION
PROJECT THEME	GLOVE DISPENSER
PROJECT PERIOD	1ST FEBRUARY 2021 - 3RD JUNE 2021
STUDY PROGRAM	MSC04
PROJECT TEAM	ID13
MAIN SUPPORVISOR	MÁRIO BARROS
CO-SUPERVISOR	RADOSLAV DARULA
TOTAL PAGES	28

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ABSTRACT

This thesis deals with designing a product that increases glove hygiene in hospitals and the healthcare sector. Poor hygiene allows hospitals to become hotspots for dangerous diseases that sometimes prove fatal, as happens to 75 000 people in America yearly. The cleanliness of a persons' hands is the first line of defense and seeing how the process of putting on gloves right now raises questions to the underlying hygiene involved and the need for a radical change when it comes to the hygiene of hospitals.

SAHD is an automated glove dispenser and glove dresser that eliminates the current process of glove-dressing, removing the user from interacting with the outside of the glove keeping the hygiene & cleanliness of the users' hands while also making the whole process a lot faster than the current. SAHD has been developed during the Covid pandemic which has made visiting hospitals for observation almost impossible negatively impacting the development phase dragging it out in certain areas.

IMMUTECH

Immutech is a Meditech startup that delivers simple solutions for complex problems in the healthcare industry. Immutech is created to be a service-oriented glove supplier with special attention to hygiene.

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STORY

"After I co-founded the family butcher shop, Meat n'joy, the use of disposable gloves became part of my everyday life after university work. There I soon found out that it was not a pleasant process and especially not if the hands were damp as they often were after washing them. At the same time, they often burst and more came out of the pack than you needed. This led me to think that I couldn't possibly be the only one with these problems, and from there came the idea; an innovative product needs to be made that makes putting on gloves easy and simple."

-Bashar Sharmorad

GLOVE USE

Adobe, 2017. Hospital doctor in a meeting with colleague. [video] Available at: <https://stock.adobe.com/dk/video/hospital-doctor-in-a-meeting-with-colleague-putting-on-gloves-before-an-exam/177988841?prev_url=detail> [Accessed 26 May 2021].

It has long been known that the prevention of sickness is the most effective way to keep people healthy.

While estimates vary between 60 000 to 100 000 Americans who make up around 4% of the world population, die each year due to hospital acquired infections. scale this up to the world and a conservative estimate quickly surpasses a million deaths annually.

Deaths that medical experts agree are mostly preventable with increases to the best practice when it comes to hygiene.

UNIQUE SELLING POINTS

INCREASED HYGIENE

Our hands are only as clean as the last things we touched are. This is why contact-free glove dressing is so crucial to keep a sick population healthy.

TIME-SAVING

Dressing a pair of gloves takes more time than you think. dressing a pair of gloves can take upwards of a minute, while SAHD can lower this time to half of that.

EASY APPLICATION

We have recognized that the thumb makes dressing a glove a more difficult task than most people imagine. making the opening of the glove taller than the hand allows your hand to slide into place.

INTUITIVE DESIGN

SAHD uses recognizable geometries and colors to make you the user able to easily and smoothly operate the glove dressing interaction.

SHIELDED GLOVES

The gloves while being stored in SAHD will be better protected against infectious diseases and pathogens in the environments and circulating in the air.

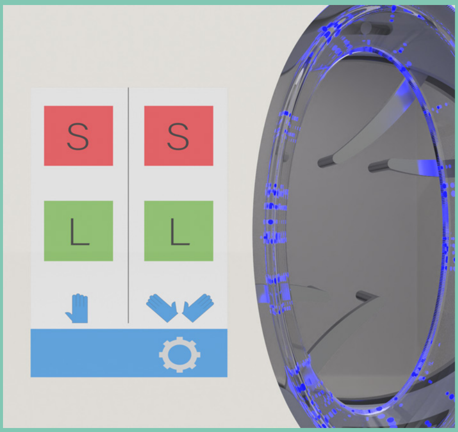
LIGHT-FIELD SAFETY

The users are protected by a light-field safety system to keep the system from closing on the user and is also used for registering when a glove has been removed.

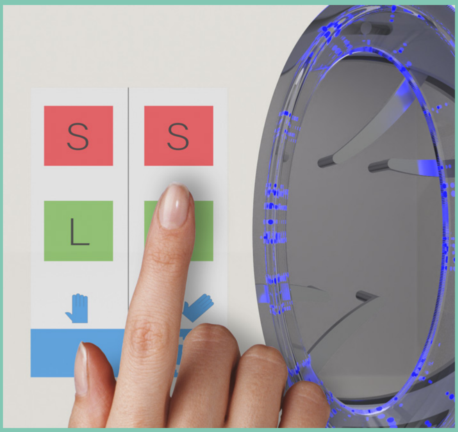
A BETTER PRACTICE

SAHD aims to be a part of best practice in the healthcare sector and the medical community. by removing dirty and semi-clean hands from dirty or unsafe glove storing practices and dressing.

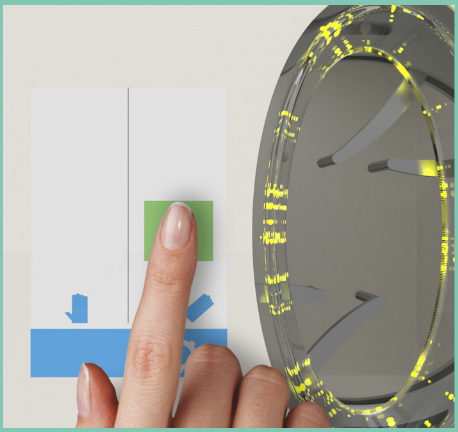
USER INTERACTION



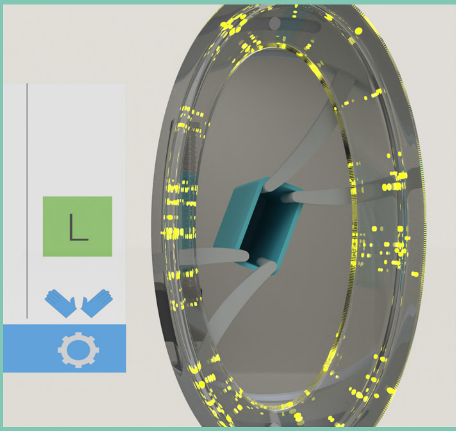
While idle SAHD lights up in a blue light indicating it is ready to operate.



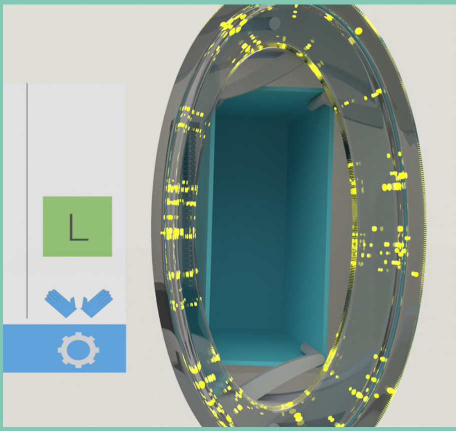
Select a size of glove and amount of gloves to be dispensed.



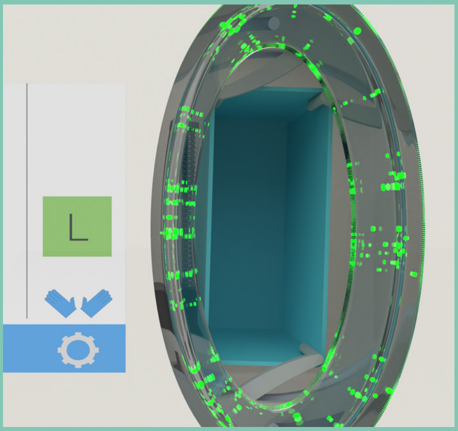
On selection of size and amount, SAHD will turn yellow indicating that it is operating.



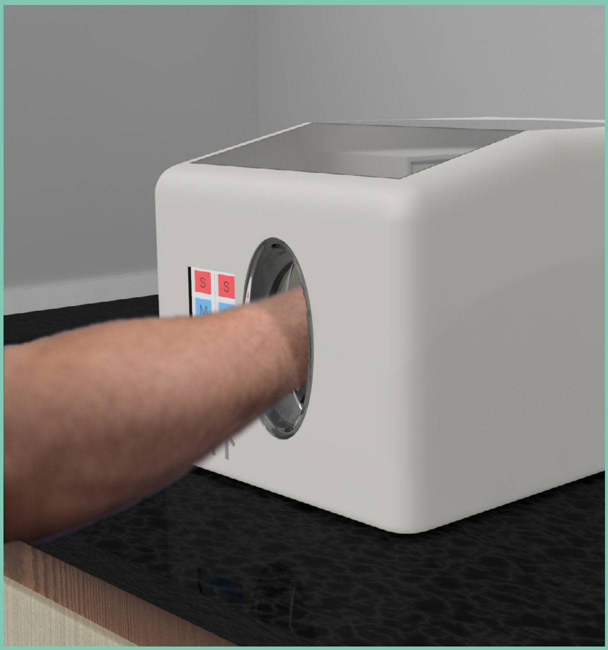
The glove will be placed at the ready, at the entrance of SAHD.



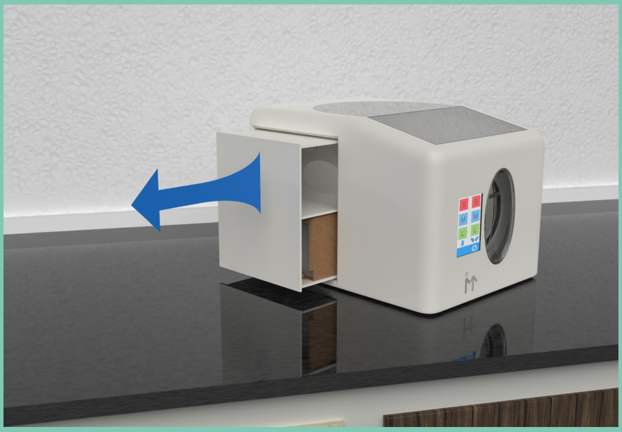
SAHD will then stretch open the glove for easy and trouble-free dressing.



When SAHD glows green the glove is ready for dressing, simply slide in your hand thumb side up, and keep inserting until the glove lets go.

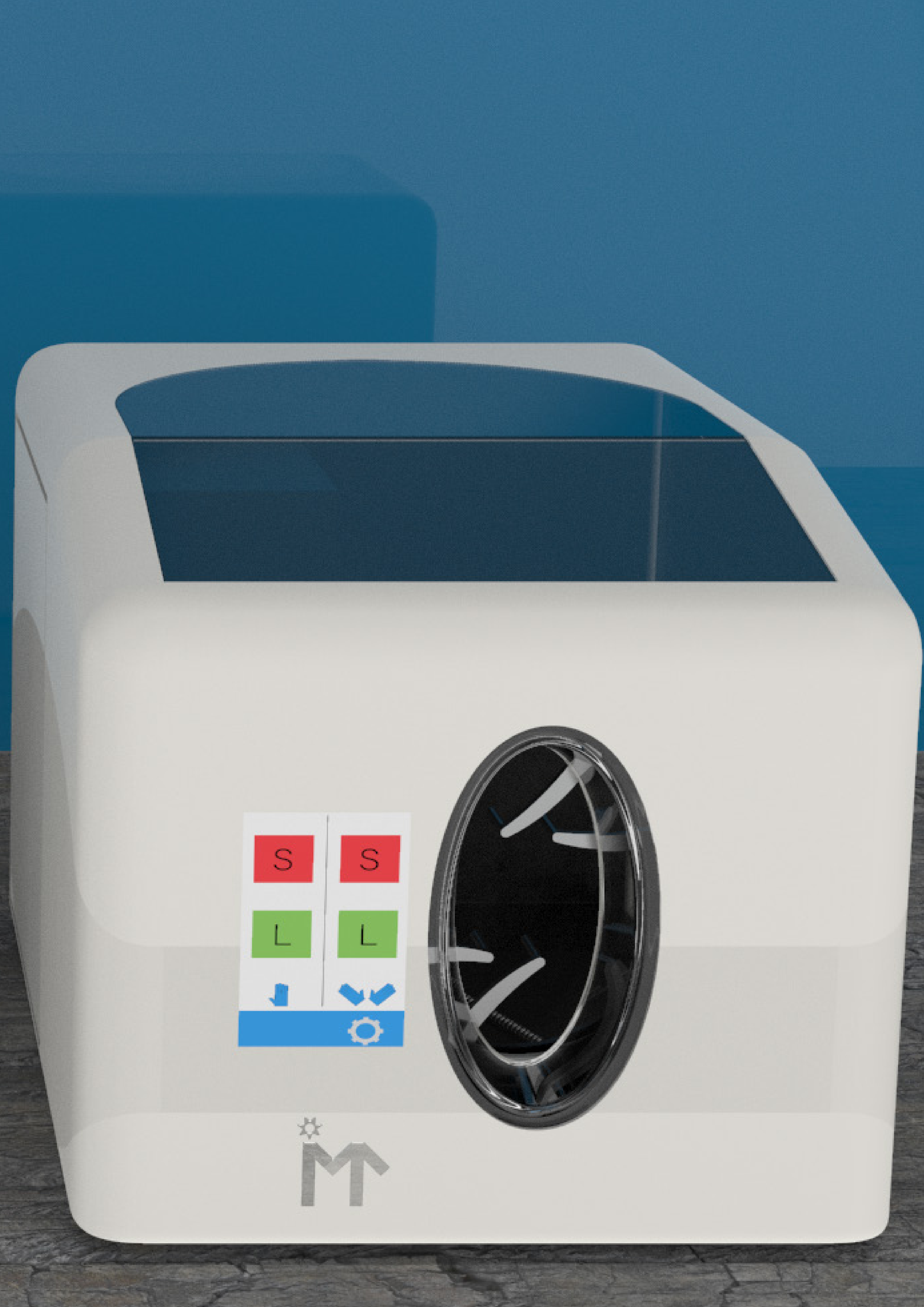


Using SAHD the user will never have contact with the outside of the usable areas of the glove.
Bringing better hygiene and increasing the margin for errors among medical staff.



To open the glove storage give the compartment a light but firm push and the compartment will present itself to you, ready for you to refill the compartment with gloves.

SAHD HAS PLENTY OF VISIBILITY TO MAKE YOU FEEL SAFE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GLOVE STORAGE

SAHD has two compartments for gloves while Immutech offers different sizes of gloves the compartments can accomodate any size of gloves Immutech offers.

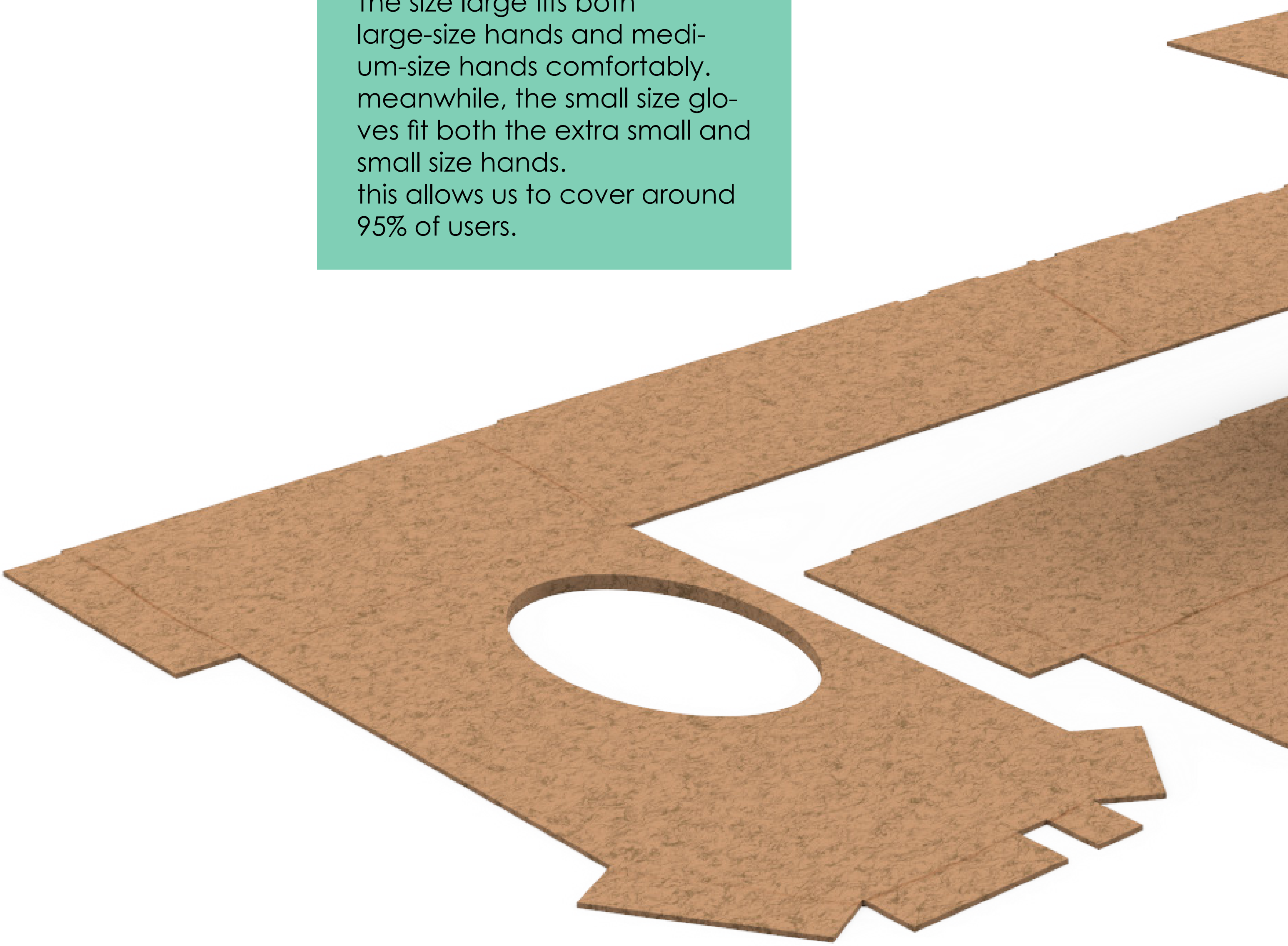
The compartment for gloves can be easily opened with a firm push on the surface of the storage compartment and can be closed just as easily. just listen for the audible click and tactile response.

GLOVE PACKAGING

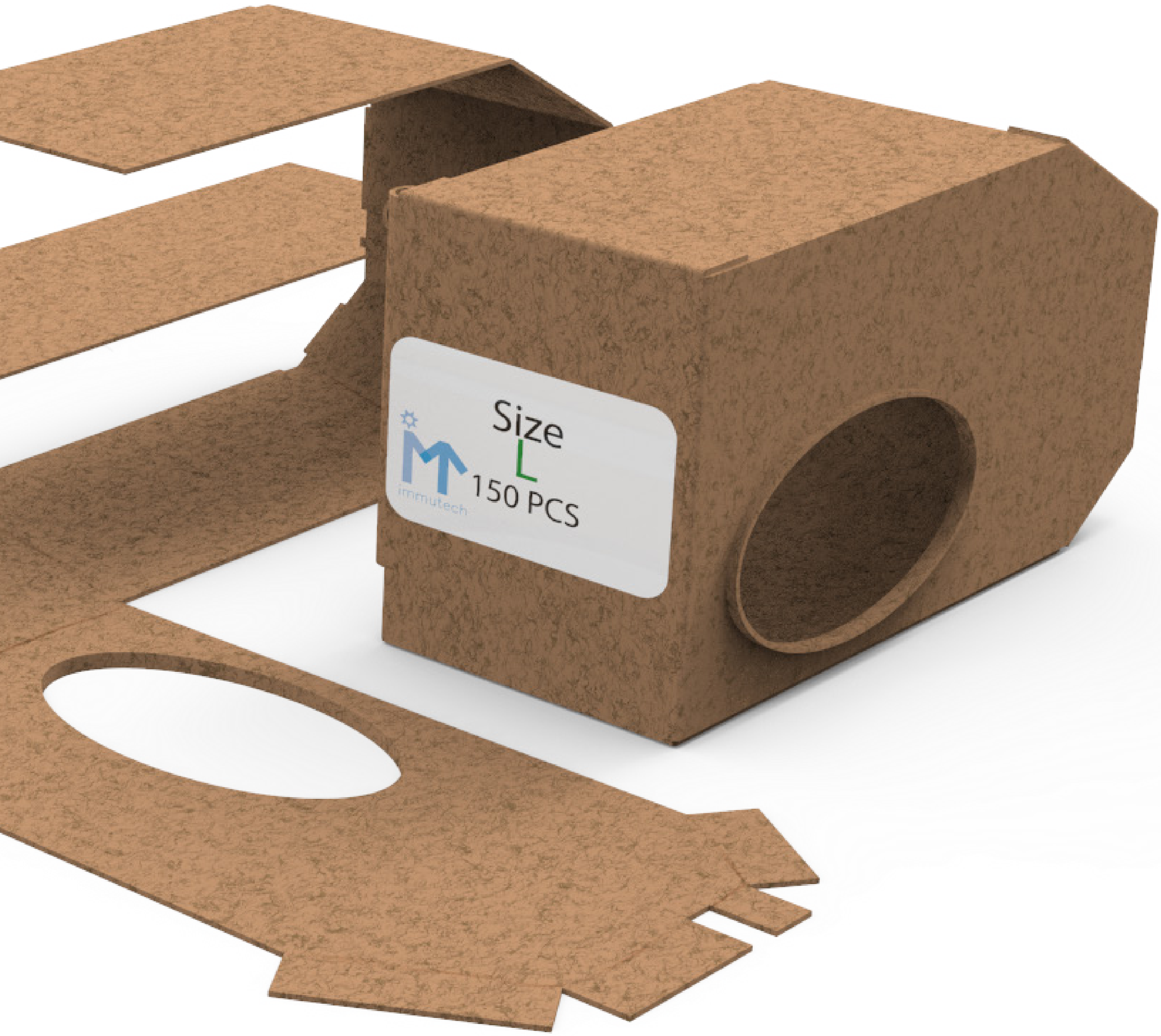
The boxes of gloves come in two sizes

- Large
- Small

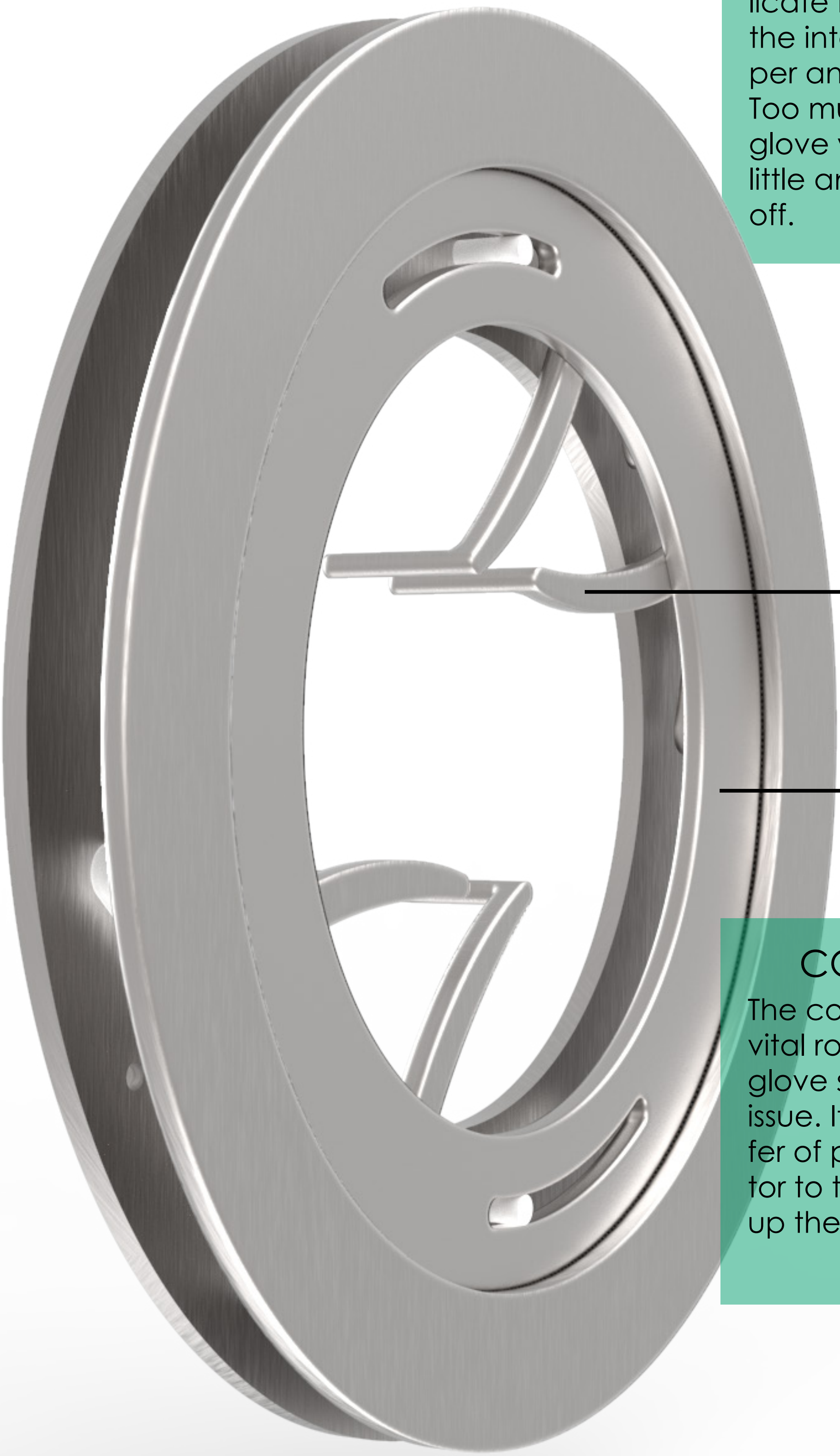
The size large fits both large-size hands and medium-size hands comfortably. meanwhile, the small size gloves fit both the extra small and small size hands.
this allows us to cover around 95% of users.



The boxes are made from beautifully cut corrugated cardboard and needs only be inserted into the storage compartment for the gloves to be available for use.



GLOVE OPENING



GRIPPER

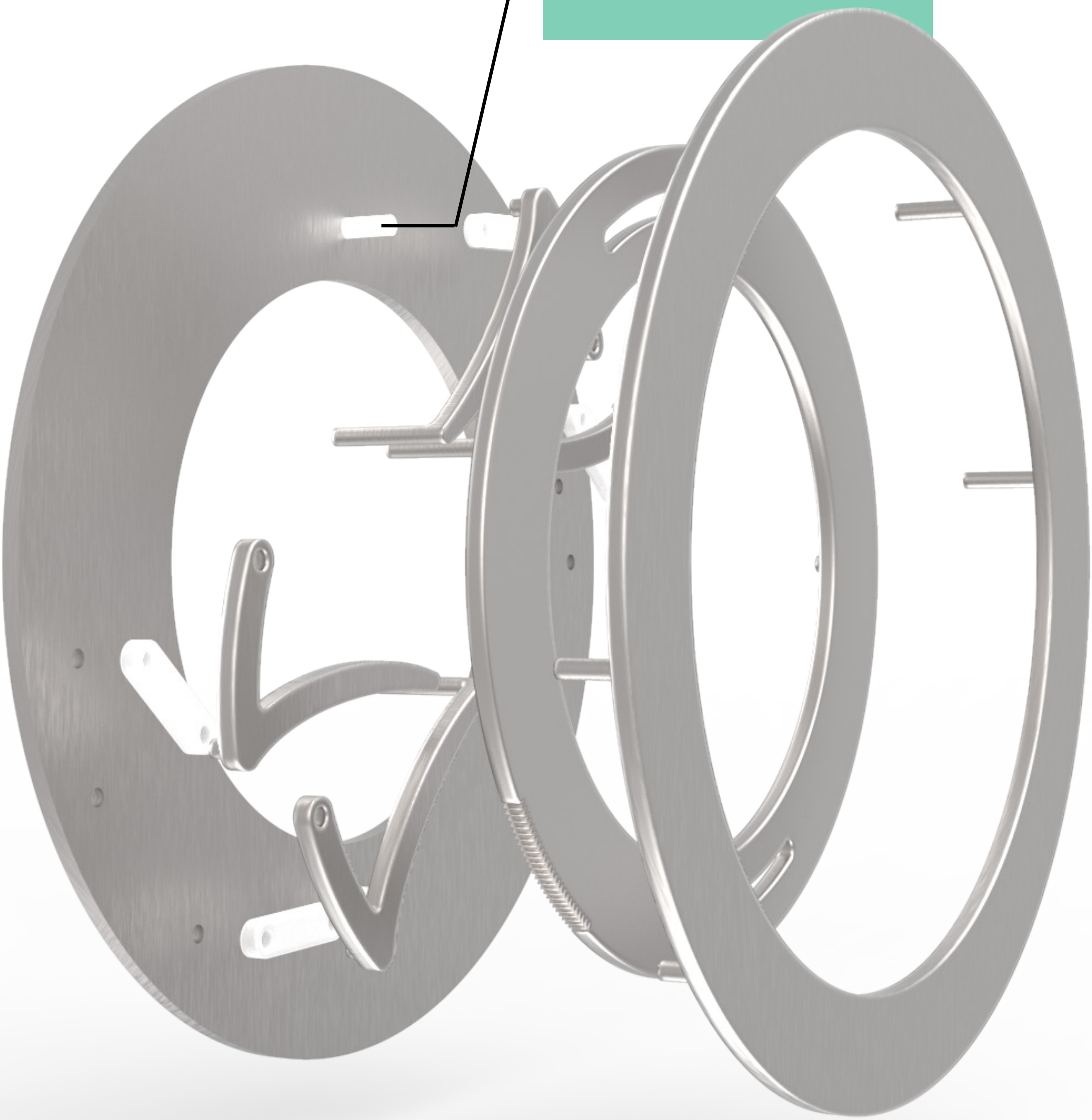
The gripper is a key component, as it holds the glove in place during stretching, there is a delicate balance between the interaction of the gripper and the glove.
Too much friction and the glove won't move. Too little and the glove will fall off.

CONTROL RING

The control ring serves a vital role in opening the glove safely and without issue. It serves as the transfer of power from the motor to the grippers to open up the gloves for easy use.

PTFE - BUSHING

Friction, wear, and tear is common with any product, and looking out for such issues can be expensive. To avoid this issue we use maintenance-free PTFE bushings.



CONSTRUCTION

GLOVE STORAGE

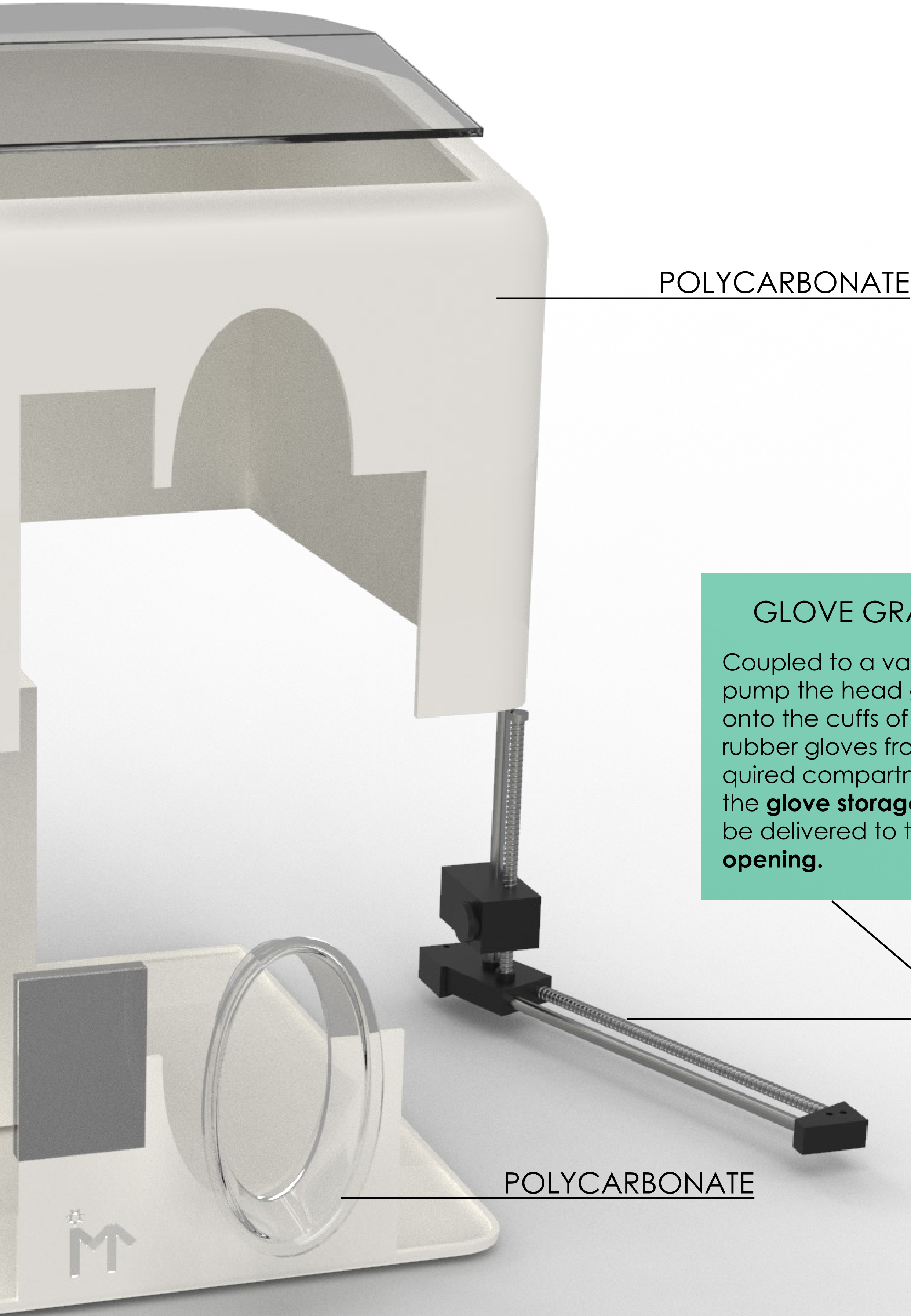
The glove storage has two compartments for boxes of gloves which can accommodate around 95 % of users with the current range of gloves.

GLOVE OPENING

The centerpiece of the product allows for smooth routine operation. the design is the culmination of intense research and testing of various methods of opening the glove for easy dressing.

STAINLESS STEEL

MAGNESIUM ALUMINIUM ALLOY



GLOVE GRABBER

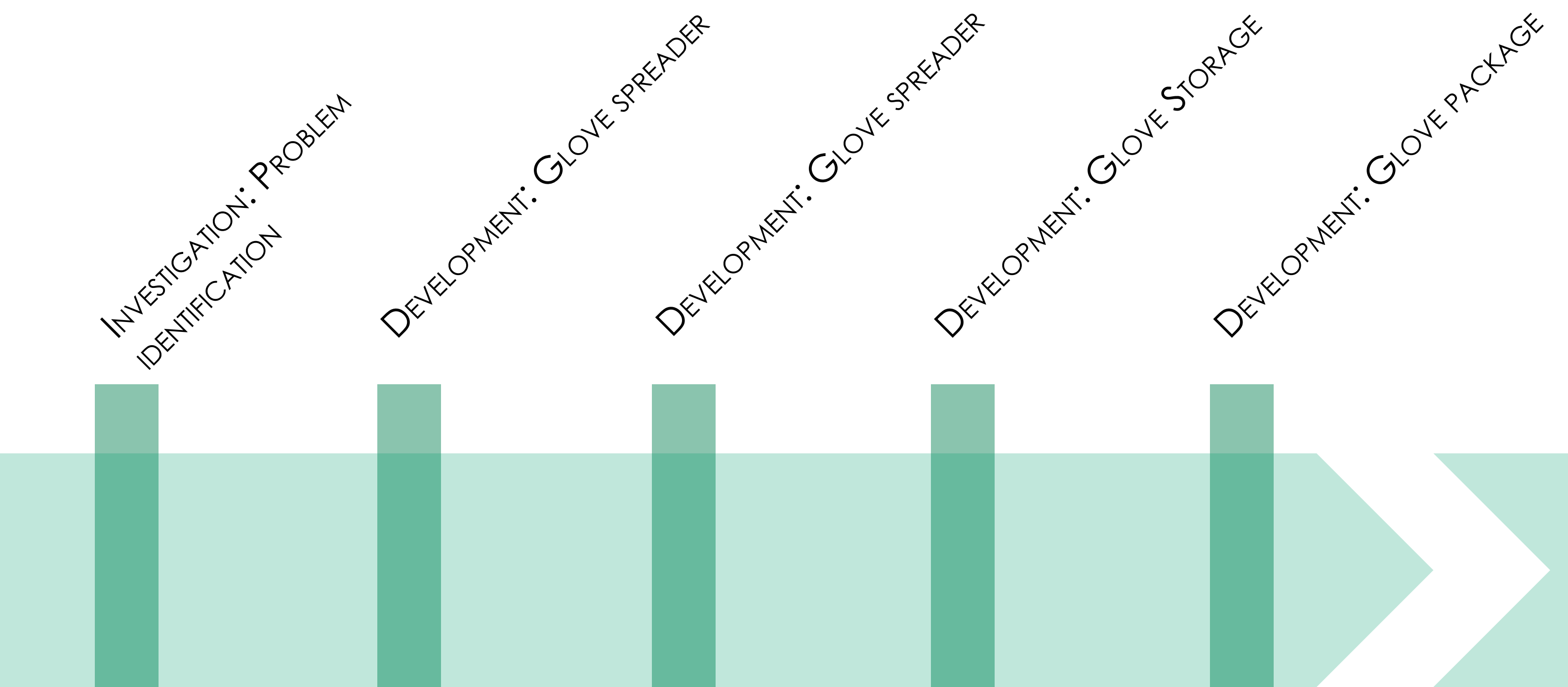
Coupled to a vacuum pump the head grabs onto the cuffs of the nitrile rubber gloves from the required compartment from the **glove storage** and be delivered to the **glove opening.**

SPECIFICATIONS

DIMENSIONS (D X W X H) WEIGHT	52,5 X 40 X 36,5 [CM] 10 [KG]
PRICE CONSTRUCTION*	4.600,00 KR. $800,00
LEASE PRICE	500,00 KR. $80,00
PRICE PER GLOVE BOX	150,00 KR. $30,00
TIME PER GLOVE** TIME TO DRESS A PAIR***	ESTIMATE 10 [S] ESTIMATE 25 [S]
POWER****	30 [W] 220 [V] 0,14 [A]

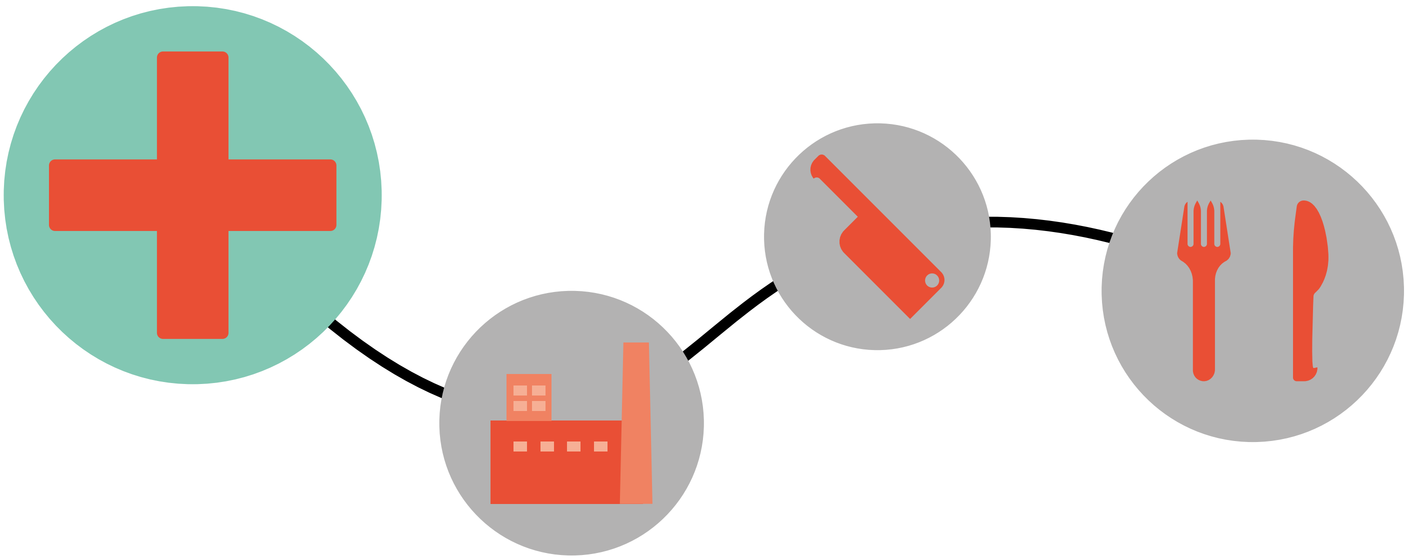
* Prices consider an exchange rate of 6 DKK to 1 USD with some rounding.
** The time it takes for the grabber arm to move is not ready yet so a time of 5 seconds is used
*** Human interaction time may vary, time from ** also apply
**** Electricity use is estimated as the vacuum pump and motors for moving the suction head has not been specified.

MILESTONES PAST



SCALABILITY

Many industries besides the healthcare sector can get used out of SAHD especially the food industry and laboratories where you have requirements for contaminants.
Mainly the product will have a rollout in a single hospital where we can get data of improvements to get a wide range of acceptance.



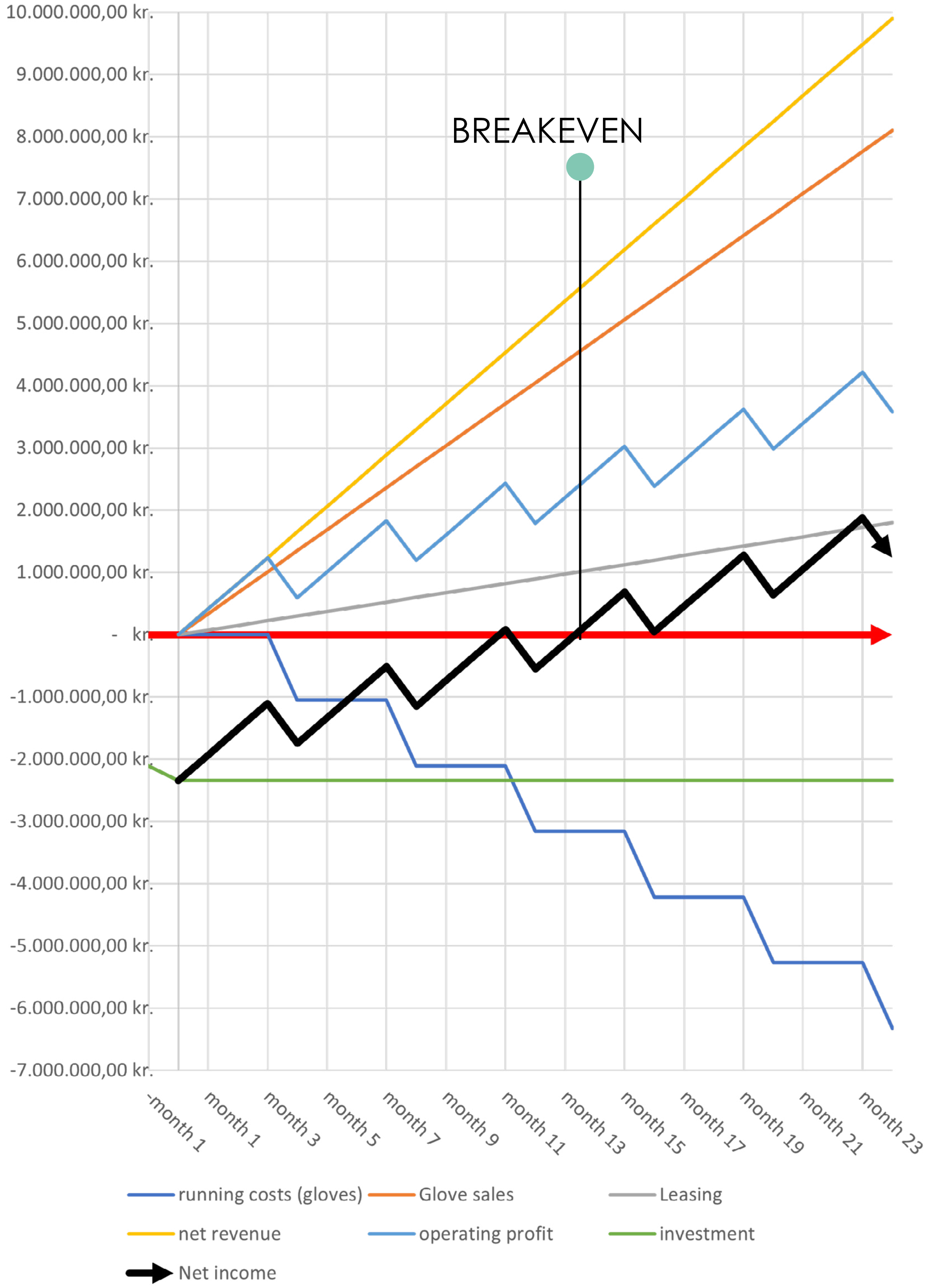
MILESTONES FUTURE

PHASE 1: PROTOTYPE
- Develop final components
- Search for investors
- Develop prototype
- Test Prototypes

PHASE 2: ALPHA MODEL
- Fix issues with Prototype
- Sell alpha model
- Develop Alpha model
- Send out alpha model

PHASE 3: BETA MODEL
- Fix issues with Alpha model
- Sell beta Model
- Develop Beta Model
- Send out beta Model

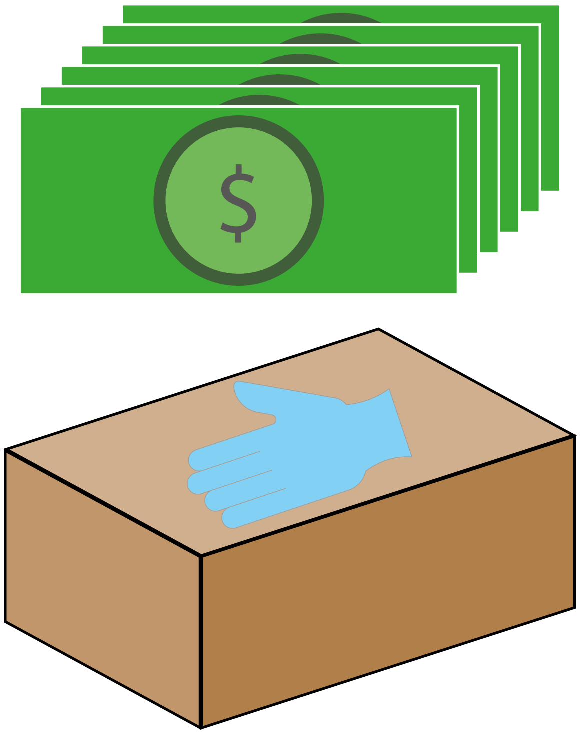
PRICING



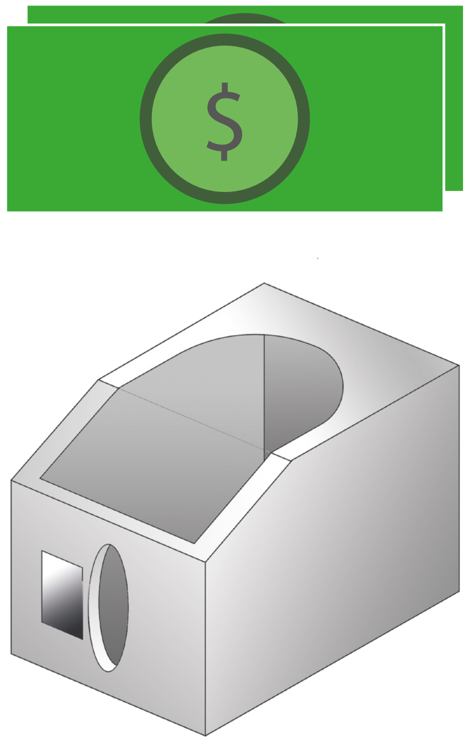
BREAKEVEN
10.000.000,00 kr.
9.000.000,00 kr.
8.000.000,00 kr.
7.000.000,00 kr.
6.000.000,00 kr.
5.000.000,00 kr.
4.000.000,00 kr.
3.000.000,00 kr.
2.000.000,00 kr.
1.000.000,00 kr.
- kr.
-1.000.000,00 kr.
-2.000.000,00 kr.
-3.000.000,00 kr.
-4.000.000,00 kr.
-5.000.000,00 kr.
-6.000.000,00 kr.
-7.000.000,00 kr.
-month 1
month 1
month 3
month 5
month 7
month 9
month 11
month 13
month 15
month 17
month 19
month 21
month 23
running costs (gloves)
Glove sales
Leasing
net revenue
operating profit
investment
Net income

We estimate being able to reach a breakeven before 14 months with 150 units being leased. Most of the income comes from the sale of gloves not from the leasing of products. while it does come close at month 16 it does not drop below the red line.

The gloves can only be bought in bulk sizes larger than the needs of a month, around 3 months to be exact but we expect a regular shipping schedule can be arranged flattening out the steps in the running costs of glove sales.



Sales



Leasing

SAHD

– A CLEAN CHOICE

AALBORG
UNIVERSITY

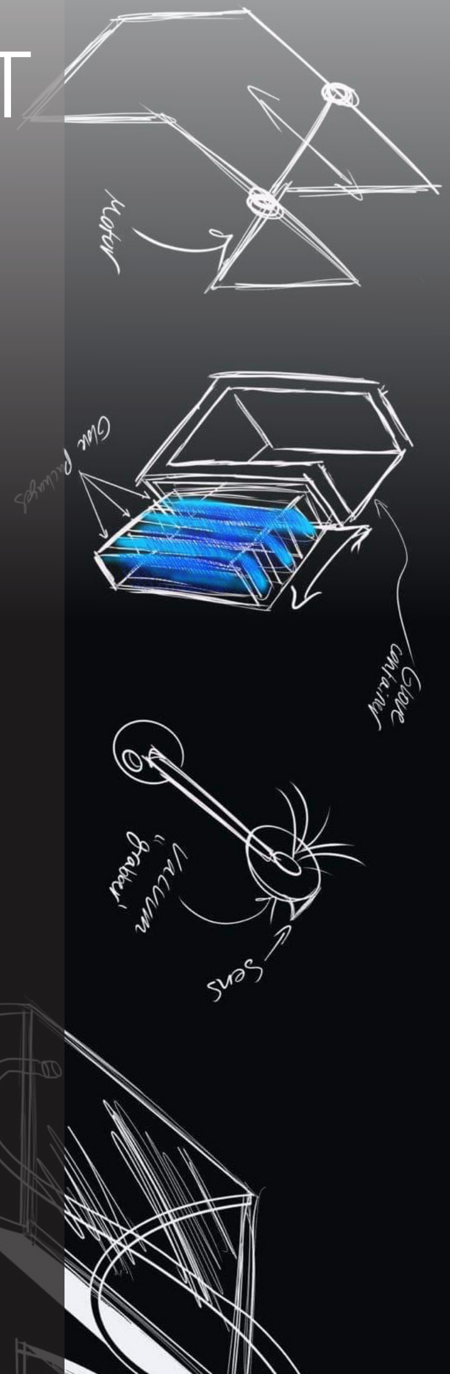
STUDENT REPORT

PROCESS REPORT

SAHD: Sophisticated Automatic Hand-glove dispensor

MSc4-ID13

May 2021



IMMUTECH

Bashar M.K. Shahmorad

Jonas V. Johansen

Titlepage

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The group

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Abstract

This thesis deals with designing a product that increases glove hygiene in hospitals and the healthcare sector.

Poor hygiene allows hospitals to become hotspots for dangerous diseases that sometimes prove fatal, as happens to 75 000 people in America yearly. The cleanliness of a persons' hands is the first line of defense and seeing how the process of putting on gloves right now raises questions to the underlying hygiene involved and the need for a radical change when it comes to the hygiene of hospitals.

SAHD is an automated glove dispenser and glove dresser that eliminates the current process of glove-dressing, removing the user from interacting with the outside of the glove keeping the hygiene & cleanliness of the users' hands while also making the whole process a lot faster than the current.

SAHD has been developed during the Covid pandemic which has made visiting hospitals for observation almost impossible negatively impacting the development phase dragging it out in certain areas.

Reading Guide

This report describes the process of designing and developing MedTech product for the health-care-sector in Denmark. This report has been made as a collection of the worksheets made throughout the whole process, thus collected into chapters. Even so, the process report is almost chronological and is built upon almost as the whole project has progressed through the past half year almost. Each chapter will end with a conclusion for the chapter and a sum-up.

Delimination

The business aspect is asumed to be business-to-business in dealing either with monicipalties or health-care clinics.

Dictonary

Glove dressing
This term is refered to the process of taking on gloves (hands).

Acknowledgement

This master's thesis marks the end of an intense semester in the midst of Covid-19 and rounds up our Master's in Industrial Design Engineering at Aalborg University. Likewise, it is the final chapter of five years of studying - a journey of acquiring and striving for knowledge, humble development as human beings and broadening of our horizon of understanding the world in many different perspectives, courtesy of Aalborg University and its many teachers, supervisors and lectures that has been held throughout the years. It has truly been a privilege - Thank you.

Firstly I, co-author Bashar, would in my thesis and key to future like to mention and acknowledge my parents. My father Malek and my mother Iman whom I without would never been able to reach where I am today and be the individual I am the present if it were not for their sacrifices, hard work and dedication for me and my three brothers. They truly deserve each and every humble piece of success that I have achieved and will ever achieve, and therefore my part of this work as well as my academic titles are humbly and respectfully dedicated to them. Thank you.

Secondly we would like to thank our supervisor Mário Barros for the guidance and throughout the process of this. Here his knowledge has offered us key elements for framing and questioning our process and project together with discussions challenging us to explorer further. It has been a pleasure working with you. We would like to thank our co-supervisor Radoslav Darula for his likewise valuable insights, constructive feedback and guidance for all of the technical aspects and challenges that has been faced there in this project - Thank you!

Lastly, a big thanks to all of the users that has helped us for devoting their time and sharing their knowledge and opinions and LSI!

Ill. 1. (Hospital hallway, n.d.)

Project management method

To have a guideline for manging the timeframe efficiently throughout the semester, the team predefined seven Milestones and their deadlines. Both Jonas and Bashar have worked as project managers in the different phases and shared responsibility upon the different matters making sure that no one had more than could be handled.

The day-to-day project management has been structured through daily targets and partly through Scrum with done-criteria and expected time needed to finish an assignment. These were sorted in the categories to-do, doing, verify and done. Everything was structured and put into Monday.com - a very efficient online tool for structuring and making it able for both parties to see and change in the schedule easily. This was a tool from earlier semesters that proofed to be good at the beginning of the Covid-19 pandemic in 2020. Meetings were held as needed and usually always one in the morning. As each member was mostly home the most of the semester, lunch was taken whenever needed, so a walk outside or like.

MILESTONES:

1 Problem Identification

2 Market

3 Design Brief

4 Initial Concept

5 Manufacturing & production

6 Business plan

7 Execution plan

Table of Content

Initial problem

After Bashar co-founded the family butcher shop, Meat n'joy, the use of disposable gloves became part of his everyday life at work after university. There he quickly found out that it was not a pleasant process and especially not if the hands were damp as they often were after washing them. At the same time, they often **teared apart**, *and there was more coming out of the package than one had to use. It led him to the idea that he couldn't possibly be the only one with these problems, and from there came the idea; an innovative product must be made that makes it* **easy and simple to put on gloves**.

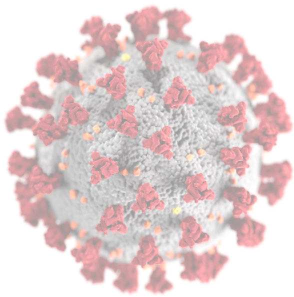
Ill. 3. (Hand, n.d.)

Hands on...

Bashar and Jonas teamed up to work on this project and explore and identify the problems within this subject to come up with a creative and useful solution. We knew, that the project would be difficult due to the fact, that it's a complex problem with a **technology and mechanical challenge**, so therefore also a very "hand on" project, but we also knew, that it would be an exciting opportunity and seek our best bid for a solution At the same time, we chose to scale the situation into a bigger context where gloves are used more regularly and chose to focus on the healthcare sector.

Covid-19

We also knew, that our project would be made doing the peak of the Covid-19 lockdown, and that there the world therefore be limitations in some of the work processes and potentially access. But, we didn't want that to hinder our **goal of this project.**



Ill. 4. (Covid-19, 2019)

Chapter 1:
Problem Identification

As the problem of the usage of gloves is identified the problem will be unfolded at the following chapter. This will be through user-tests and observations mostly, where this research should give demands for the product that can be used in the concept development. Some of the answers to be unfolded are among others:

- How long does it on average take to put on gloves?
- How big is the glove-business worldwide in the health-care sector?
- Where in the glove-dressing process do problems occur?
- How much of a difference in time is there in the glove-dressing process when the hands damp?
- Do medical-students and doctors wish for an easier glove-dressing process?
- How many types of gloves are used in the health-care sector?
- What is the storyboard as of right now?

Methodology
Everything in the following chapter, including the answers of the questions above will be done through internet research, interviews, experiments and observations. The purpose for the team has been to explore the problem and also figure out medical students opinions on the glove-dressing process.

Observations
To get in contact with medical students who use gloves regularly, the teams network has been contacted and observation scenarios were conducted to determine the time and troubles in the glove-dressing process.

Interviews
To get in contact with medical students who use gloves regularly, the teams network has been contacted and interviews have been conducted to better understand their opinions on the glove-dressing process.

User survey
By being granted access to big Facebook medical groups it has been possible to get a user-survey answered by 166 relevant people to help us understand certain questions.

Internet research
To get a scope of the size of the glove market and the problem internet research was conducted to find statistics and articles.

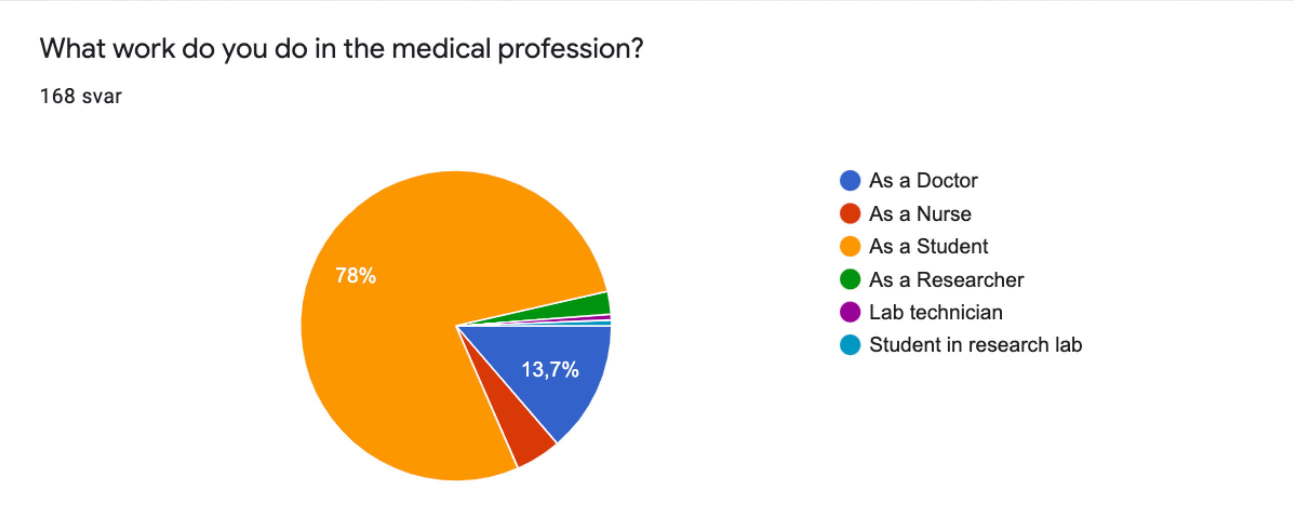
Survey

Purpose and method

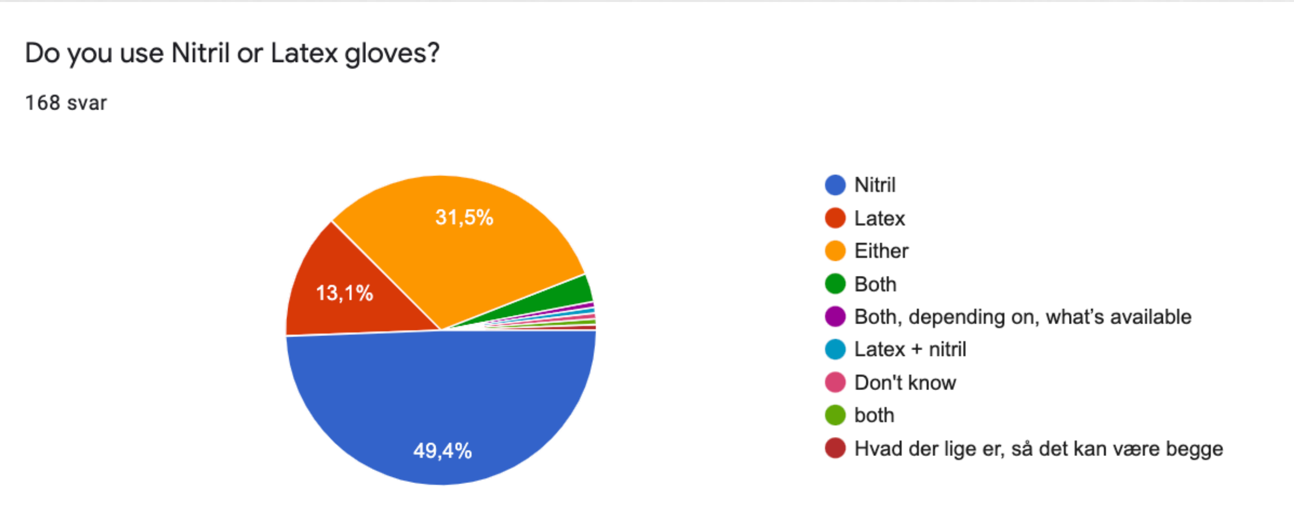
An exploratory look for a pattern in answers given from healthcare professionals with the focus on their use of gloves and their behavior with gloves. This is done to filter some of the simple questions form an interview and look for points of interest to elaborate on later. The participants were found by contacting social media groups of doctors and medical professionals and ask them to fill out the survey.

Interviews: while interviews give a deeper look into the problems available as you can make directed questions where you look for specific answers, at this point to these questions it is not necessary as most of these questions are quantitative in nature and the knowledge gained from the study would be used in interviews to find out why they act as they claim and if the answers are true.

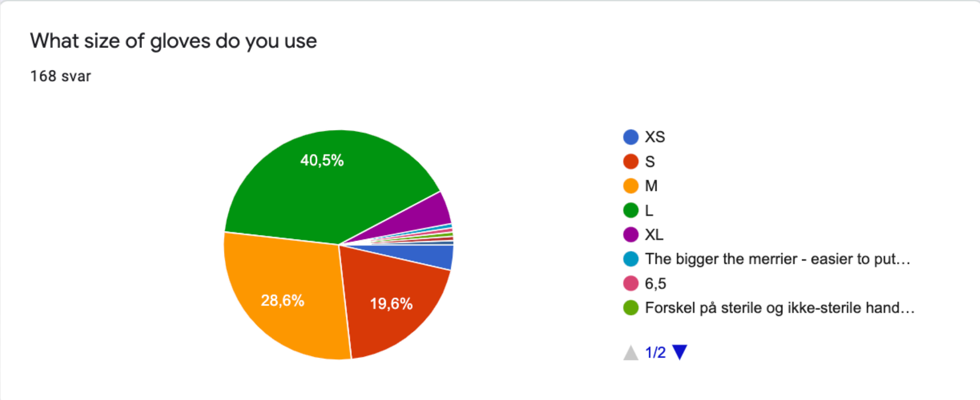
Empirical data and short descriptions



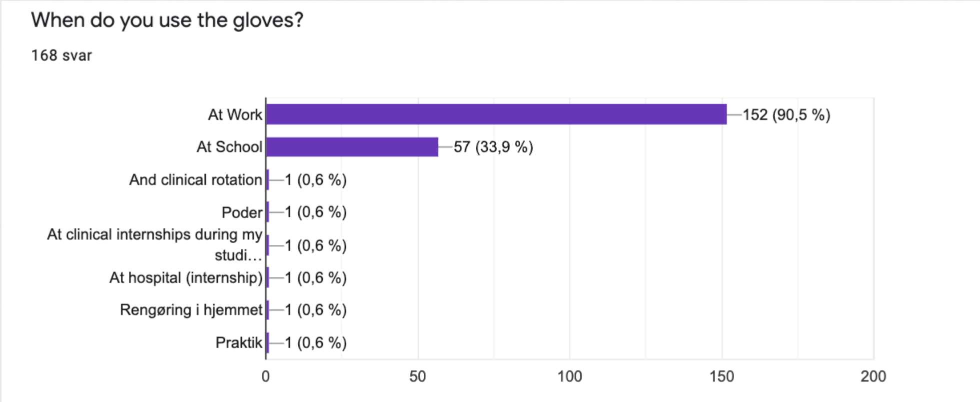
Ill. 6. Answers in % of what kind of work the people anwering the survey do - mostly medical students.



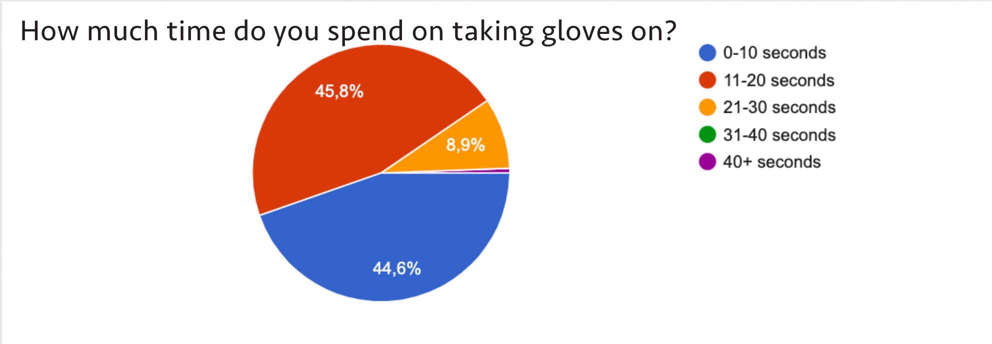
Ill. 7. Answers in % of what kind of gloves (material) that are used the most - Nitrile is the most used



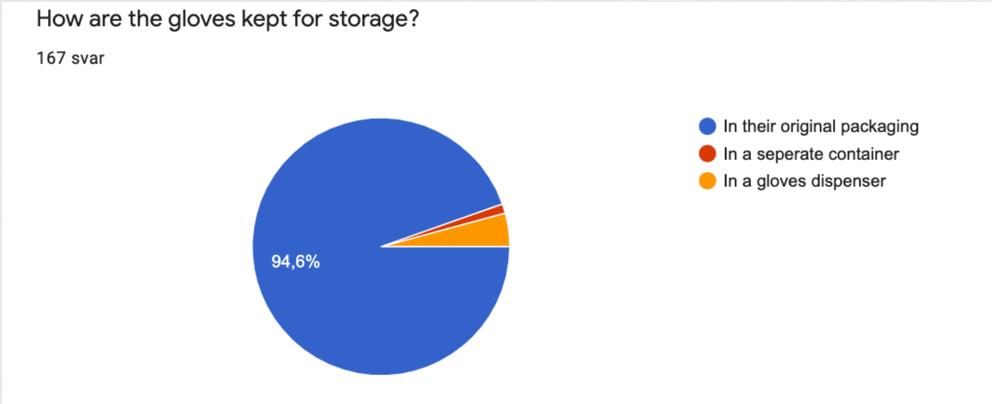
Ill. 8. Answers in % of what glove size is most used - Large is most used glove-size



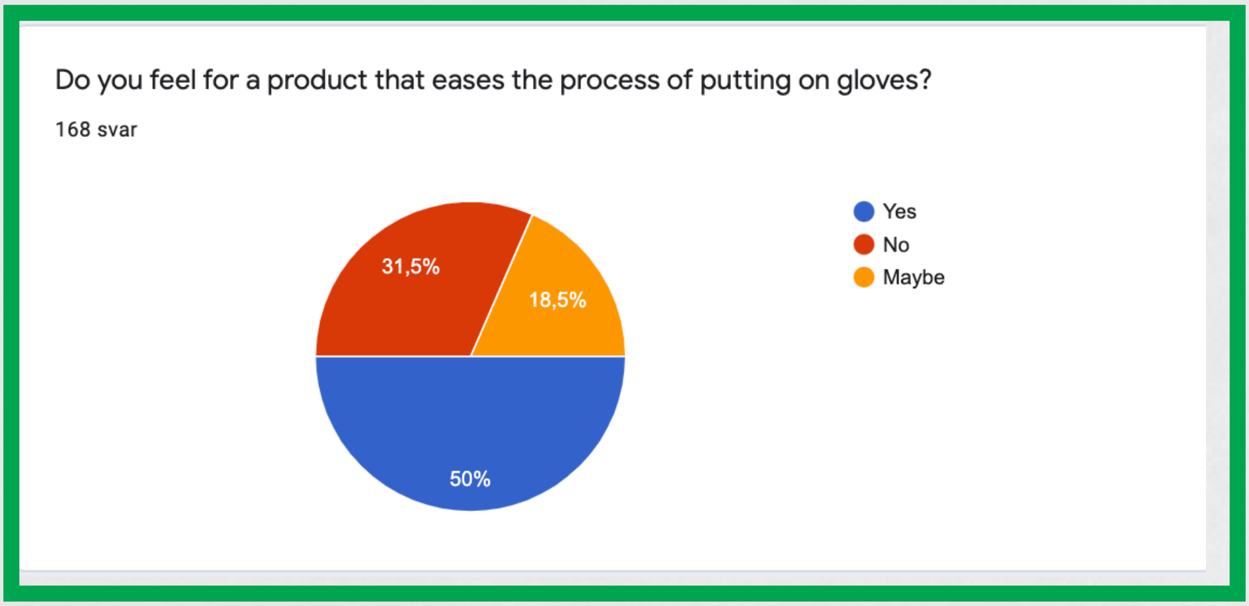
Ill. 9. Answers in % of when gloves are used mostly - it is mostly at work



Ill. 10. Answers in % of their assumption on how much time it takes them to put on a set of gloves - 11-20 seconds is most assumpted



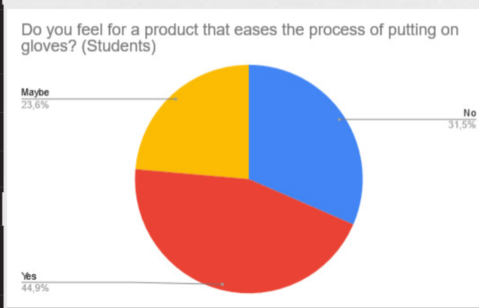
Ill. 11. Answers in % of how the gloves are kept for storage right now - in their original storage

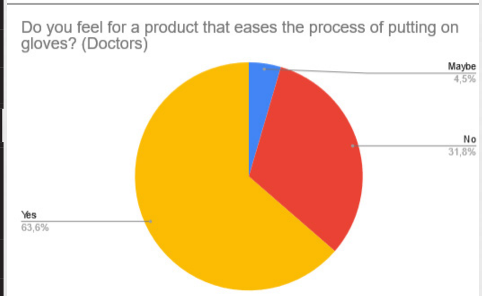


Ill. 12. Answers in % of how they feel about getting a new product - 50% says yes

amount of partici-pants	average time	total time
41	5 s	205 s
19	15 s	285 s
4	25 s	100 s
Both		9,2 s
9	5 s	45 s
8	15 s	120 s
4	25 s	100 s
1	40 s	40 s
Latex		13,9 s
26	5 s	130 s
50	15 s	750 s
7	25 s	175 s
Nitrile		12,7 s

Need for a helping device	
Answers	Those who an-swered 0-10
Yes	22%
No	58%
Maybe	20%
Answers	Those who an-swered 11-20
Yes	71%
No	10%
Maybe	18%
Answers	Those who answered 20+ seconds
Yes	75%
No	13%
Maybe	13%





Ill. 13. Summary of the Survey

Analysis/Interpretation

The average time the medical staff uses to put on as reported by what they themselves think is 11.5 seconds. The latex only people reported an average of 12 seconds, while nitrile only reported 12.7 seconds on average to put on a pair of gloves. Whereas the rest of participants reported on average 9.4 seconds to put on a pair of gloves. There appears to be something odd about the users reported time to put on gloves.
If a dispenser system is implemented with a canister system ~70% of participants would have to change how they deal with running out of gloves. Those who reported themselves as doctors were more likely to contact support staff or get a nurse to find more gloves than average. Nurses were the most likely to contact support staff to get more gloves. Students were more likely to get the gloves themselves.

Glove size reported range from XS to XXL size gloves where a majority uses Large and medium size gloves with a few edge cases using XXL and XS.
51% reported using only nitrile gloves. Whereas 12% reported using only latex gloves, 95% of participants reported having their gloves kept in the original packaging. Doctors were more inclined to find a need for a device to assist with putting on gloves than students.

Doctors were also more secure in their answer to the question than students as a significantly smaller portion answered "maybe." People who believe they spend more time putting on gloves tend to want an assisting device drastically more than people who do not think it takes up a lot of time. Find out how long is too long to put on a pair of gloves

Reflection

Self-reported data has the possibility to be either false or inaccurate which is why the glove donning time is to be elaborated on through physical testing and the method of putting on the gloves needs to be tested to see if technique changes could serve as a substitute for equipment intervention. To keep uninvolved persons away from the public survey the survey was only posted in medical groups and we could therefore eliminate some unwanted participants,

Conclusion

The survey helped find points of interest that needs to be answered further as such 3 key questions have been identified for deeper exploration and elaboration.

- Nitrile Gloves are the most used type of gloves in the medical field
- Large is most used size glove with Medium as the seconds most used
- 11-20 seconds is the time most believe it takes them to put on gloves.
- Gloves today are mostly kept in their original packaging.
- 50% of the survey-answers seek for a product that eases the current glove-dressing process.

Next step

Glove analysis/market
Questions for key-persons in the future
Is the original packaging hygienic enough to use as a storage place for gloves?
Why do 70% of the participants report getting gloves themselves? Are there no support staff to help them? Is it easier to just get it themselves, not having to worry about the right size and fit, or something else entirely?
Does it take ~11.5 second to put on gloves? Does it take longer or lower the average amount of time? Is there a difference in time between latex and nitrile gloves?

Statistics & growth

The disposable gloves market was $5.98 billion in 2019, **$11.68 billion in 2020** and predicted to reach

$11.52 billion

in 2027 as the market stabilises.

Disposable Medical Gloves Market Size, Growth | Global Report [2027], 2021)

Nitrile gloves are expec-ted to **grow** at a rate of

14.1%

annually as a substitute to latex gloves due to ri-sing **allergies**

(Global Nitrile Gloves Market Size & Share Report, 2020-2027, 2020)

290 billion

gloves were used in 2019

Disposable Medical Gloves Market Size, Growth | Global Report [2027], 2021

The healthcare sector accounts for

69.4%

of the nitrile glove market

Global Nitrile Gloves Market Size & Share Report, 2020-2027, 2020

Nr. 1 barrier for infections and spread of diseases

Stoessel and smith, 2021

Hospital Aquired infections

Ill. 14. (Bacteria, 2021)

Purpose and method

LSI stated that there is a significant risk for persons who gets a Hospital acquired infection and to look into how significant that risk is and how widespread the problem is, as saving lives are much more important than saving some time. This is going to be done by looking through articles that deal with the issue.

Empirical data and short descriptions

648 000 people in America gets a hospital acquired infection every year of those 75 000 people die (Hospital Acquired Infections Are a Serious Risk - Consumer Reports, 2015) which is a mortality rate of 11.5 %. Each year 130 million people visit the hospital in the united states (FastStats, 2021) meaning that 1 in 200 hospital visit carries an 11.5 % chance of death.

"Hospitals can be hot spots for infections and can sometimes amplify spread," say Tom Frieden, M.D., director of the CDC. "Patients with serious infections are near sick and vulnerable patients—all cared for by the same health care workers sometimes using shared equipment." (Hospital Acquired Infections Are a Serious Risk - Consumer Reports, 2015)

"C. Diff and MRSA can live on surfaces for days and can be passed from person to person on hospital equipment or the hands of health care workers." (Hospital Acquired Infections Are a Serious Risk - Consumer Reports, 2015)

"Infection control is all about the basics, starting with hand hygiene.," (Hospital Acquired Infections Are a Serious Risk - Consumer Reports, 2015)

Reflection

The information was readily available but the extend of the problem was made very clear and showed that the focus of time and convenience was slightly misplaced.

Conclusion

Hospitals acquired infections kill 1 in 9 people who contract them and 1 in 200 hospital visits ends up a person getting infected. Where experts suggest increasing hand hygiene to combat the spread of disease. It has shown that this product is not a nice-to-have product but a need-to-have product.

Next step

Identify cross contamination points

Medical-students test of gloves:
Observation: Time and difficulties

Hussein Al-Alawi, medical-student 9th Semester

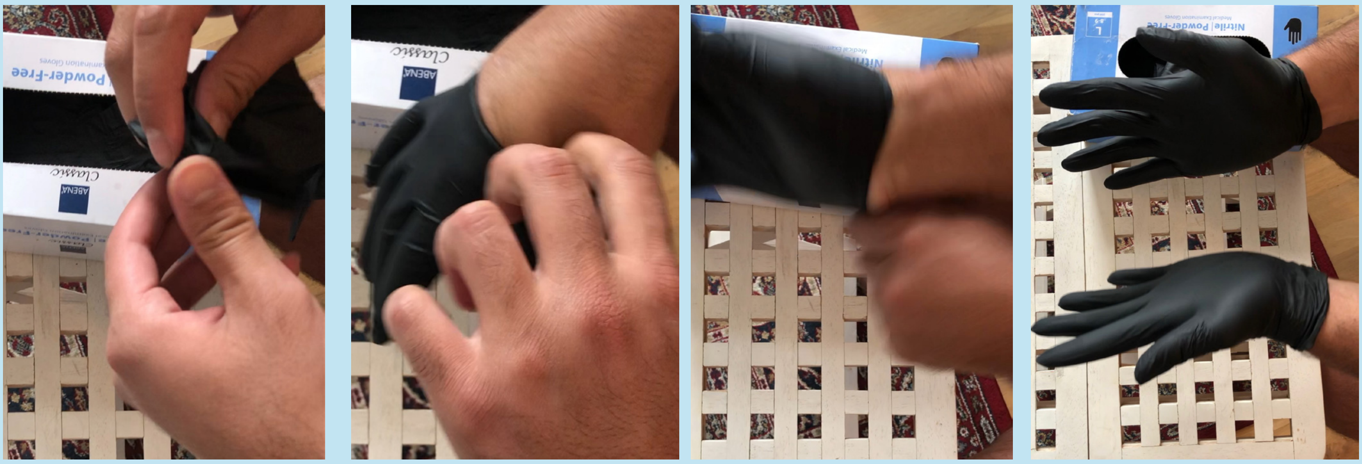
ROUND 1 WITHOUT DISINFECTION:

Observations:
-29 Seconds from starting of taking gloves on to finish having them on
- Troubles with the gloves being wrinkled together, have to fold/open them up
- The start-point of the glove being wrinkled inside of the glove when taking them on

Ill. 15. Pictures from observation of Hussein - Round 1

ROUND 2 WITHOUT DISINFECTION:

Observations:
- 27 Seconds from starting of taking gloves on to finish having them on
- Troubles with the gloves being wrinkled together, have to fold/open them up
- The start-point of the glove being wrinkled inside of the glove when taking them on
- Taking another glove out of the package with the previous glove



Ill. 16. Pictures from observation of Hussein - Round 2

Hussein Al-Alawi, medical-student 9th Semester

ROUND 3 WITH DISINFECTION (damp):

Observations:
- 35 Seconds taking on gloves
- Troubles with the gloves being wrinkled together, have to fold/open them up
- The start-point of the glove being wrinkled inside of the glove when taking them on
- Clearly to see more force used to pull the gloves on, creating larger vacuum

Ill. 17. Pictures from observation of Hussein - Round 3

ROUND 4 WITH DISINFECTION:

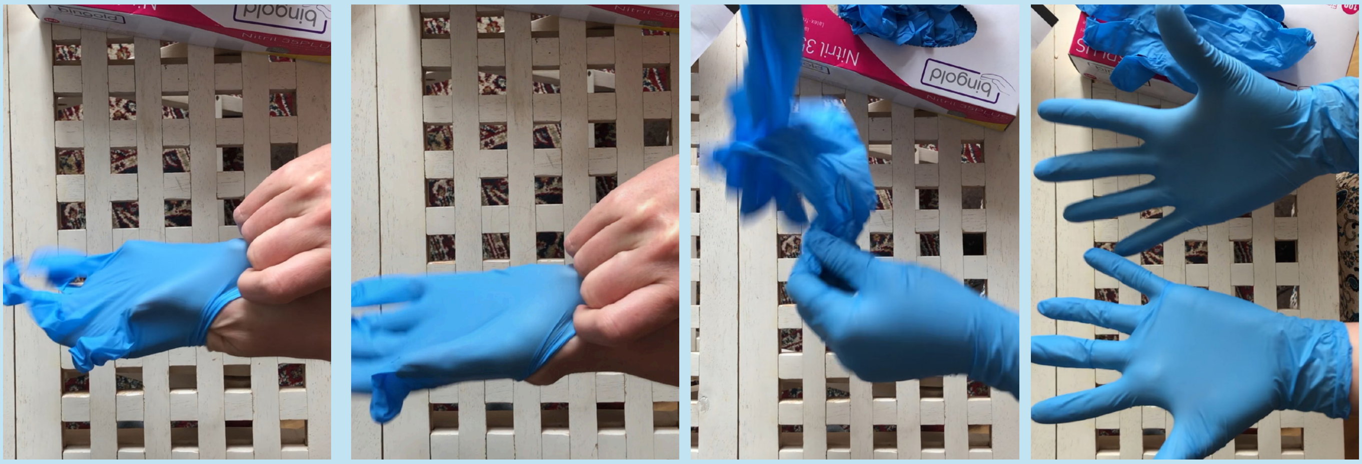
Observations:
- 37 Seconds taking on gloves
- Troubles with the gloves being wrinkled together, have to fold/open them up
- The start-point of the glove being wrinkled inside of the glove when taking them on
- Taking another glove out of the package with the previous glove
- The vacuum happens, and he has to pull the top of the glove to create air-room again.

Ill. 18. Pictures from observation of Hussein - Round 4

Mette Hurup, medical-student 9th Semester

ROUND 1 WITHOUT DISINFECTION:

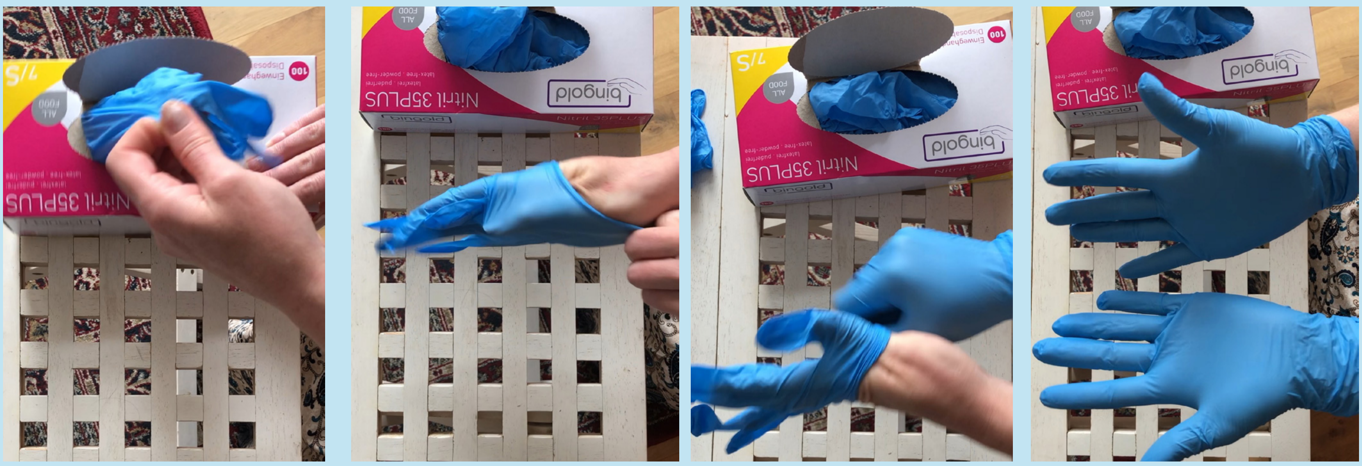
Observations:
- 39 Seconds taking on gloves
- The start-point of the glove being wrinkled inside of the glove when taking them on
- 2 gloves wrinkled together.



Ill. 19. Pictures from observation of Mette - Round 1

ROUND 2 WITHOUT DISINFECTION:

Observations:
- 34 Seconds putting on gloves
- The start-point of the glove being wrinkled inside of the glove when taking them on
- Taking another glove out of the package with the previous glove
- Vacuum being created

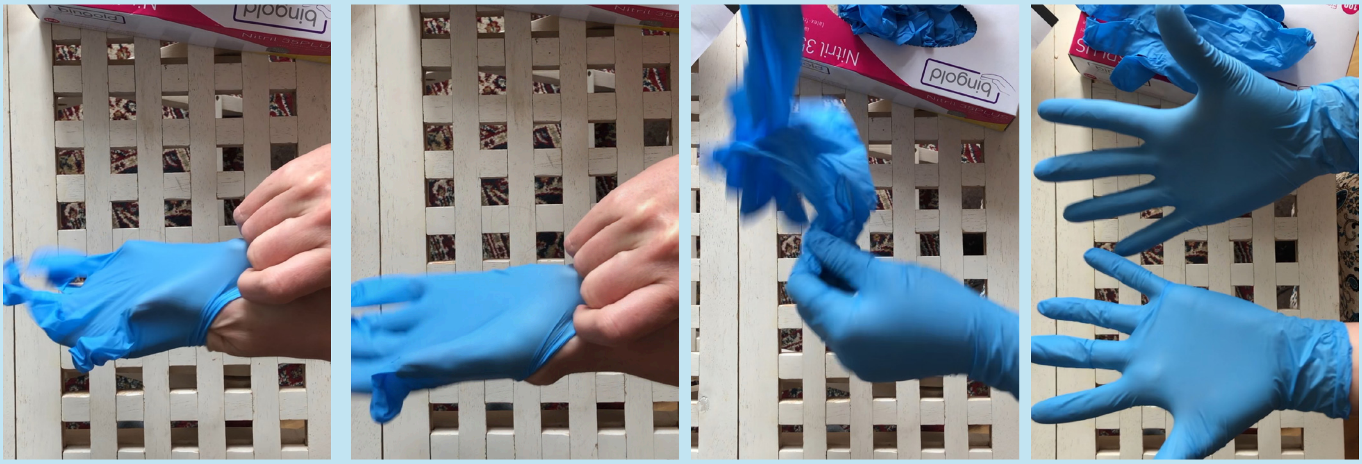


Ill. 20. Pictures from observation of Mette - Round 2

Mette Hurup, medical-student 9th Semester

ROUND 3 WITH DISINFECTION (damp) :

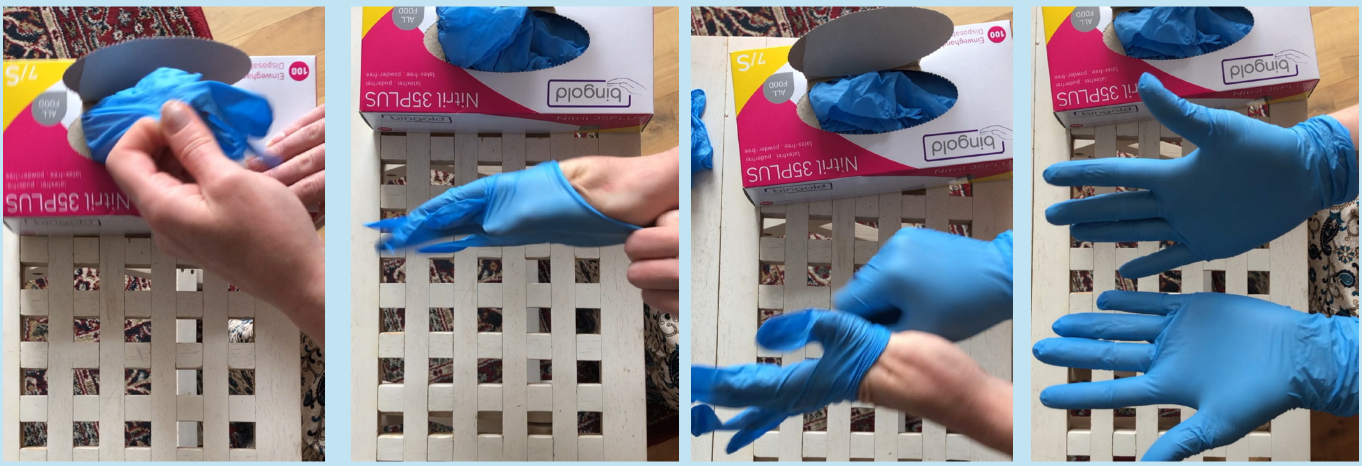
Observations:
- 32 Seconds putting gloves on
- Vacuum being created
- More strength being used to pull down the gloves



Ill. 21. Pictures from observation of Mette - Round 3

ROUND 4 WITH DISINFECTION (damp):

Observations:
- 29 Seconds taking gloves on
- The start-point of the glove being wrinkled inside of the glove when taking them on
- Vacuum



Ill. 22. Pictures from observation of Mette - Round 4

Emil Still Vium, medical-student 8th Semester

ROUND 1 WITHOUT DISINFECTION:

Observations:
- 19 Seconds putting gloves on
- Vacuum at top fingers
- Stuck together

Ill. 23. Pictures from observation of Emil - Round 1

ROUND 2 WITHOUT DISINFECTION:

Observations:
- 27 Seconds putting on gloves
- The start-point of the glove beeing wrinkled inside of the glove when taking them on
- Taking another glove out of the package with the previous glove
- Vacuum

Ill. 24. Pictures from observation of Emil - Round 2

Emil Still Vium, medical-student 8th Semester

ROUND 3 WITH DISINFECTION:
33 Seconds from starting of taking gloves on to finish having them on

Observations:
- The start-point of the glove being wrinkled inside of the glove when taking them on
- Vacuum

Ill. 25. Pictures from observation of Emil - Round 3

ROUND 4 WITH DISINFECTION:
36 Seconds from starting of taking gloves on to finished having them on

Observations:
- The start-point of the glove beeing wrinkled inside of the glove when taking them on
- Taking another glove out of the package with the previous glove
- Vacuum

Ill. 26. Pictures from observation of Emil - Round 4

Patrick Schmidt, medical-student 8th Semester

ROUND 1 WITHOUT DISINFECTION:
23 Seconds from starting of taking gloves on to finish having them on

Observations:
- The start-point of the glove being wrinkled inside of the glove when taking them on
- 2 gloves wrinkled together.
- Vacuum

Ill. 27. Pictures from observation of Patrick - Round 1

ROUND 3 with DISINFECTION:
28 Seconds from starting of taking gloves on to finished having them on

Observations:
- The start-point of the glove beeing wrinkled inside of the glove when taking them on
- Taking another glove out of the package with the previous glove
- Vacuum

Ill. 28. Pictures from observation of Patrick - Round 3

Analysis/Interpretation

It is recommended that the cuff of the glove is opened before dressing the hand to alleviate the issues found with the thumb of the glove.

Reflection

The smaller size glove exaggerated every aspect of the dressing process, but also showed some false positives, that was caused by the restrictions of the glove size which was then properly identified with the right size of the glove.

Conclusion

Focus should be placed on opening the cuff of the glove to ease the dressing process for a start and results from testing those should be used as reasoning on how to continue

Next step

TEST GLOVE CUFF OPENING

Gloves - where is the problem?

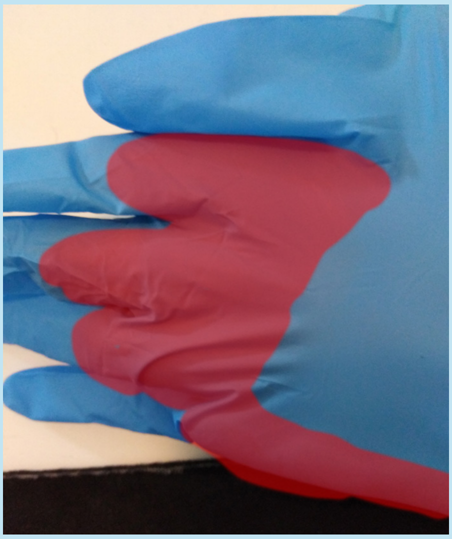
And do the users see a problem?

Purpose and method

Having found out that there is a significant problem with gloves and the use of gloves, the next step is to find out where the problems arise when putting on gloves and to ask if medical users see a problem with the current glove-dressing process.
This is done with size S and L gloves on a size L hand, the smaller glove size is there to exaggerate the issues to make it easier to see where the glove bind to or snags the hand. The large glove is there to present the regular case scenario for the use. The goal is to look for points of restriction and points where the glove sticks to the skin. The tests are done with dry hands.

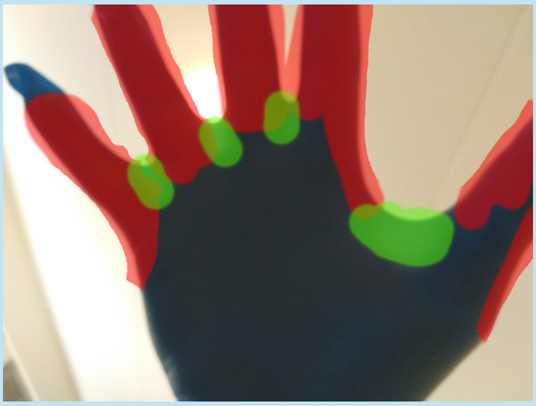
Empirical data and short descriptions

Ill. 29. Small Glove has fitting problems, where the glove is stretched thin while putting on the glove. Marked in red



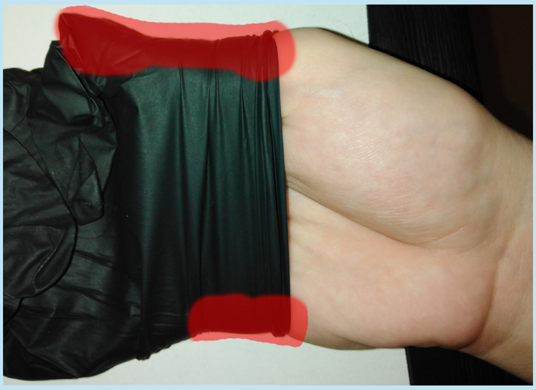
Ill. 30. Small Glove has fitting problems, where the glove is stretched thin on the fingers while putting on the glove

Ill. 31. Small Glove have fitting problems viewed from the back of the hand. Marked in red



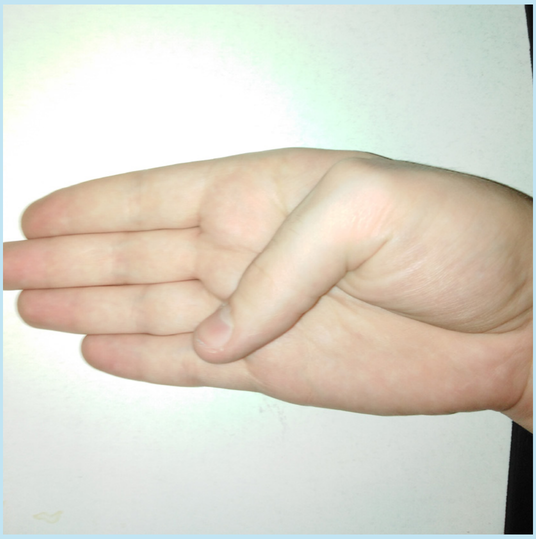
Ill. 32. Small Glove have fitting problems on the fingers marked in red, and having restrictions being properly dressed marked in green.

Ill. 33. Large glove showing restrictions when putting on the glove (the thumb join slightly bend)

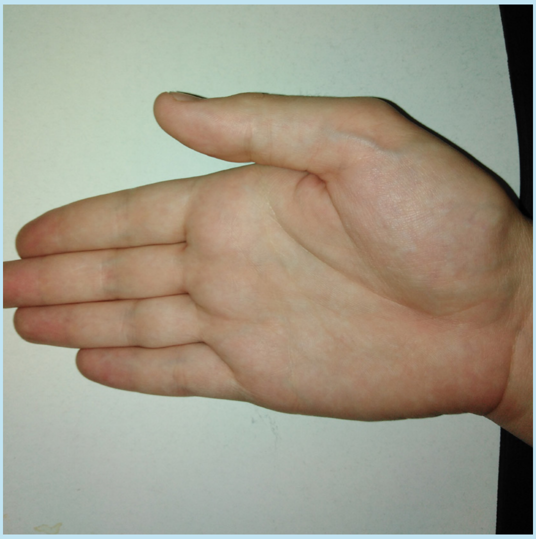


Ill. 35. Large glove showing further restrictions with flat palm, (thumb joint straight)

The glove is restricted around on the heel of the palm and the lower knuckle of the thumb. The problem is getting the glove cuff spread out and over the thumb joint as this is the area where the issues arise.



Ill. 34. Thumb ticked down to allow for the glove passing over the knuckle



Ill. 36. Thumb in neutral position that is assumed when the cuff has passend the knuckle of the thumb

In order to put on a pair of gloves, the thumb has to be tucked down Ill. 34 where the thumb cannot be placed into the glove properly without extending it creating an area or pressure and restriction Ill. 36.

Notes:
The glove is easily restricted even with small amounts of moisture, even stopping the process of putting on gloves for a moment can make the glove sticky enough to stop the process of properly dressing the glove.

The restriction with the fingers are not an issue with a glove that is the right size.

Hussein Al-Alawi:

"It takes alot of time putting on gloves and taking them off - especially with damp hands"

Mette Hurup:

"One also has to consider that when the same procedure is done so many times; it often starts to lack in quality (hygiene)"

Patrick Schmidt;

"I would really love to have a product that makes it faster and safer to apply the gloves at the hospital"

Diite Liljenberg:

"I usually take oversized gloves on so that it goes faster, or else i have to spend too much time taking on the right-sized gloves"

Emil Vium:

"There should 100% been a product on the market that makes it fast for us to wear gloves - as it is right now it is time-consuming"

Analysis/Interpretation

it is recommended that the cuff of the glove is opened before dressing the hand to aleviate the issues found with the thumb of the glove

Reflection

The smaller size glove exaggerated every aspect of the dressing process, but also showed some false positives, that was caused by the restrictions of the glove size which was then properly identified with the right size of the glove.

Conclusion

Focus should be placed on opening the cuff of the glove to ease the dressing process for a start and results from testing those should be used as reasoning on how to continue

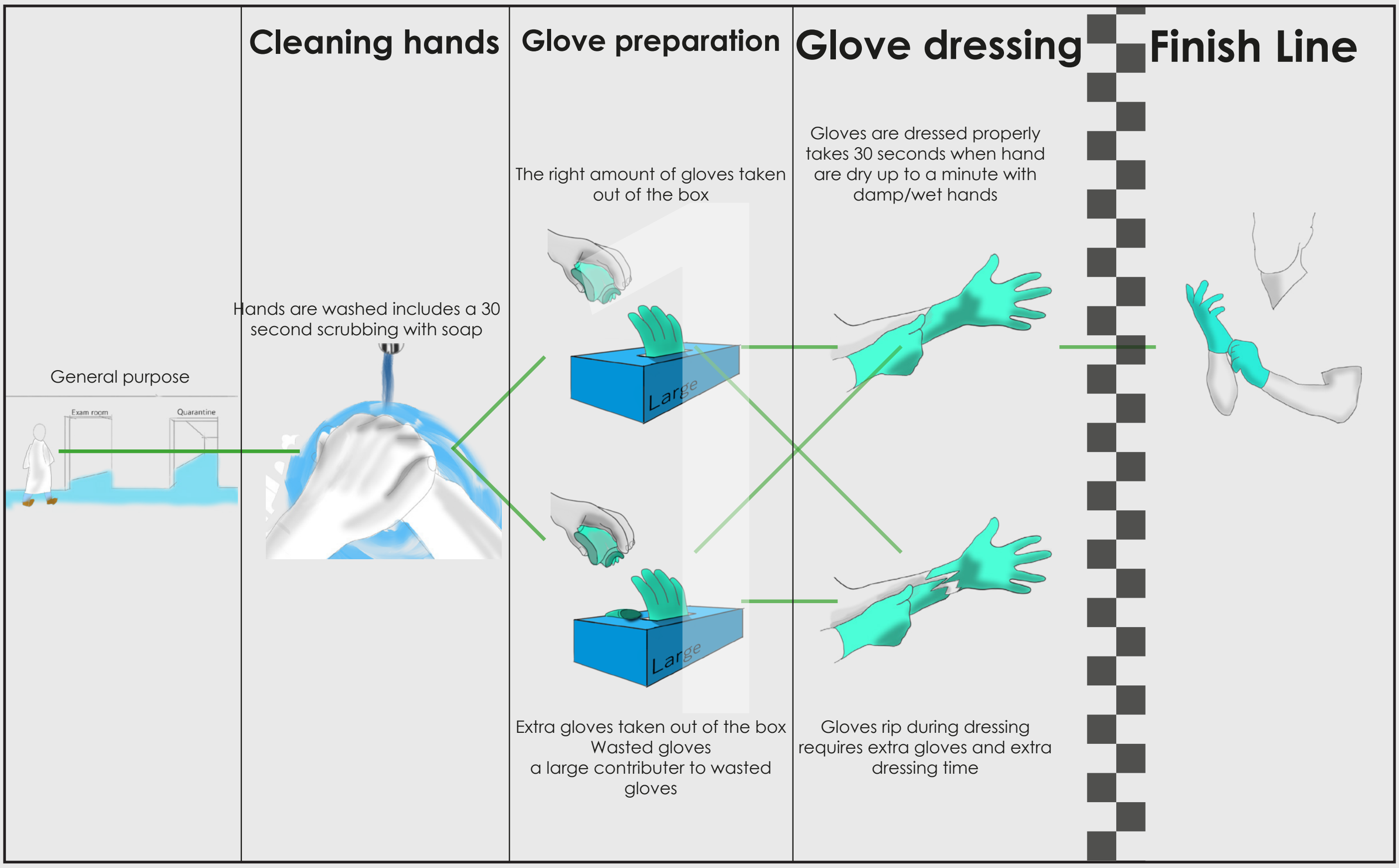
Next step

TEST GLOVE CUFF OPENING

STORYBOARD (present)

The purpose is to setup the different scenarios regarding dressing gloves in hospitals for the quarantine/ sterile areas and examination/general areas using a storyboard to understand the differences between these areas. To better clarify which areas is being moved into and identify how the gloves differ.

In all cases the use of gloves is not a substitute for clean hands but a supplement to good hygiene and prevention of disease spread. While the method of getting clean hands varies depending on the specific requirements of the environment. Sterile areas require a thorough washing to remove dirt from the skin and clean the hands.



Ill. 37. Examination/general use of gloves storyboard (currently process)

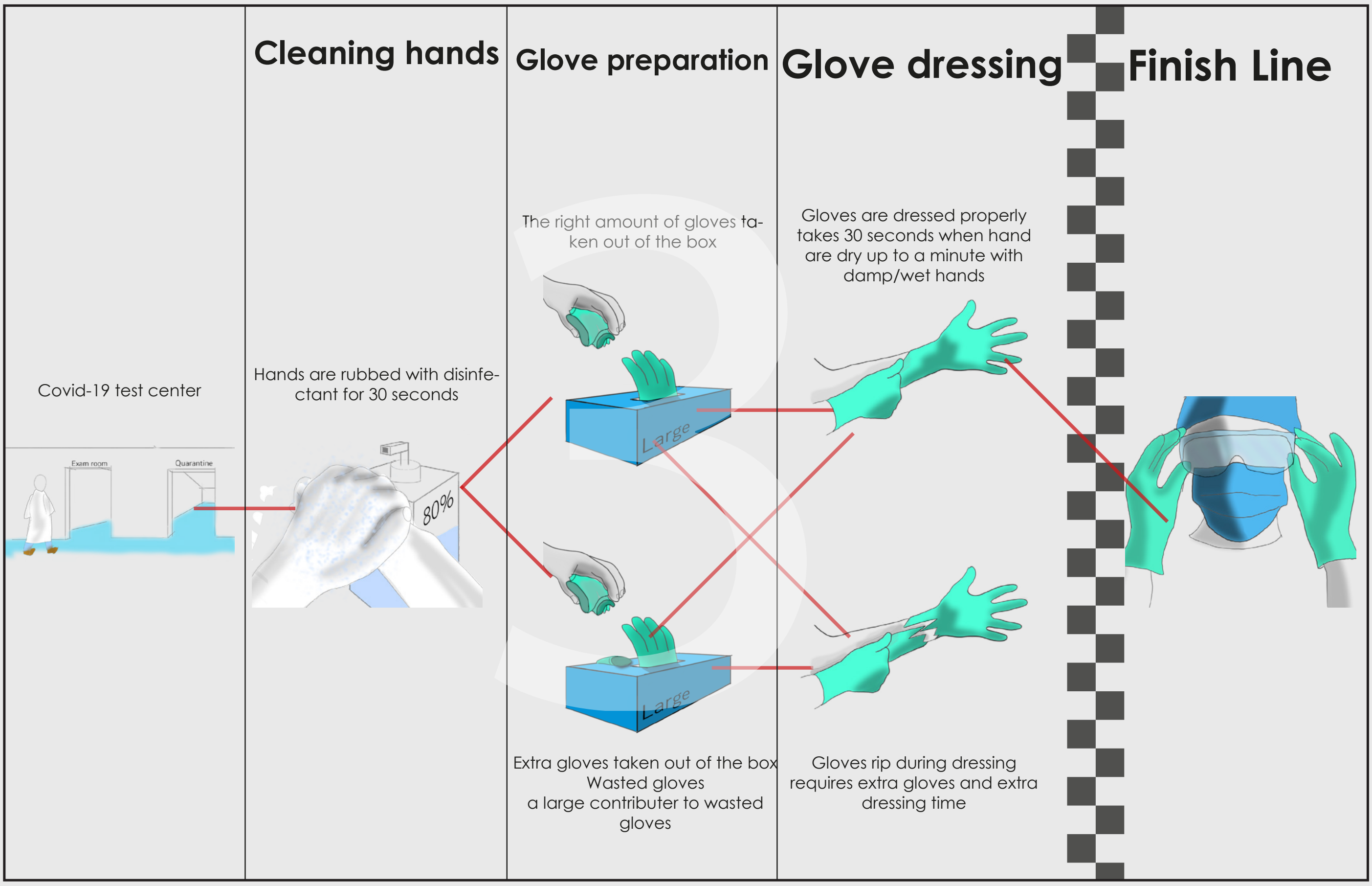
The examination/general use gloves are marked in green on Ill. 37 here shows the way to put to following much the same manner as with the quarantine application only differing with the cleaning of hands method, which follows a gentler hand cleaning method than hand sanitizer which can be quite rough.

Ill. 38. Sterile/operation storyboard of gloves (currently process)

Sterile gloves come in sealed packets containing a pair of sterile gloves these gloves must be handled correctly to not be contaminated by the hands of the wearer. If they are, the user has to start over with a new packet of gloves. The same if a glove breaks.

In the Quarantined areas the gloves are not sterile and there isn't time or a great need for sterile gloves as throughput and not keeping people potentially afflicted with covid-19 stay in contained areas with people who are potentially not afflicted. When working with non-sterile gloves, they should be replaced if broken and with every new patient.

Though it should be noted that it is possible to take more than the needed number of gloves from the glove storage in which case that/those gloves are discarded.



Ill. 39. Covid-19/pandemic storyboard of gloves (currently process)

Where as Covid-19 quarantined areas requires hand sanitizer applied on the hands and relies more on the gloves to be a barrier to stop contagion.
In the Quarantined areas the gloves are not sterile and there isn't time or a great need for sterile gloves as throughput and not keeping people potentially afflicted with covid-19 stay in contained areas with people who are potentially not afflicted. When working with non-sterile gloves, they should be replaced if broken and with every new patient. Though it should be noted that it is possible to take more than the needed number of gloves from the glove storage in which case that/those gloves are discarded.

Reflection

While the perspective is from a rough look it did give help differentiate the markets and allign them to be easier to select the needed area.

Conclusion

While taking this macro view of the three different areas of application, the only real difference between the three comes from the special method to apply sterile gloves and the risk of contaminating them when putting them on, which is a clear red flag that something can be done in this area and there is potential for great individual change. The non-sterile area has potential for great general change which is also an important area.

Next step

MOVE ON TO MAKE A CHOICE BETWEEN STERILE AND NON-STERILE GLOVES.
MARKET ANALYSIS

MARKET ANALYIS

LSI External Consultant

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Ill. 41. (Trine Søby Christensen, n.d.)

Trine Søby Christensen

Chefkonsulent
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Ill. 42. (LSI Logo, n.d.)

At the beginning of the process, we quickly found out, that we needed help opening doors for a future business. From a friend this company, Life Science Innovation (LSI), was recommended.

LSI was given a briefing of our Thesis topic and the direction we saw it going in. Where in the process we are, when it comes to designing a Medi-Tech product, we also inquired about the extent LSI could be interested in assisting in the thesis project with that an attachment of our synopsis.

Getting the help of LSI would help in increasing the credibility of our product and assist in the development phases.
Here we hoped for:

- Access to hospitals/health clinics for context understanding, interviews & user testing through key people, including doctors, nurses

- Direct sparring & feedback from stakeholders and potential purchasers

LSI arranged a meeting with us with CEO Bo Christensen and Chief Consultant Trine Christensen and it was agreed that they would help us as much as possible, and that they saw potential in our project.

DESIGNBRIEF

Design brief:

The task is to develop a hygiene station with focus on an automated glove-dressing technology to apply non-powdered gloves easily to the hand.

This product is for the contract market in the healthcare sector, and as such should have a professional and modern design, with material choices which have hygiene and cleanliness as a top priority, with a robust and lasting design simultaneously.

The product will focus on being applied in Covid-19 test-centers in Denmark as a worst-case scenario, as these are using large volumes of gloves every day with a great focus on hygiene and time management. The product should prioritize multiple architectures to fit a wider range of specializations and scenarios.

The project should aim at a deep analyzation of the use of gloves in the healthcare sector through interviews, tests and observations, with focus on the hygiene and bacteria levels as the current applying method is done, and in terms of the struggles within the applying process.

Result:

Result: What shall the idea, the solution do for the company?	The idea will be a solution for a more effective glove-dressing process in terms of hygiene and ease of use.
Target group:	Contract market B2B – major potential B2B customers include hospitals and medical supply companies, minor customers include health clinic, dentists, and health specialists. End user groups for this product: medical staff, medical specialists, medical technicians, medical professionals End users typically apply gloves to wet or moist hands as a result of disinfection fluid, which causes difficulty in applying them.
Focus:	Focus on sustainability through applying un 17 sustainability goals: 3: Good health and well-being - Increase of hygiene, maintenance of health, and reduce spread of diseases. 12: Responsible consumption and production - Considering product life circle: durability, sustainable materials, design for disassembly, maintenance, repair of used products etc. all with the perspective of a good business case for the health-care sector and a long-term good investment.
Materials:	Plastic & metal
Price, segment, customers:	- B2B products- which means this product will be bought through municipalities or private health-care clinics/suppliers. -

Problem identification conlusion + sum up

By mainly doing observations and researching there is proof of a clear problem identification in the glove-dressing process amongst medical students as it is the present time. Mainly, it is the difficulty that appears in the dressing process that seems to hinder the time-process of it. It is exciting to do further observations on how hygienic the present process is, and if this can be streamlined.

- On average it takes 34 seconds to put on a set of nitrile gloves for medical students with damp hands.

- There is a difference of 12 seconds on average in dressing gloves with and without damp hands.

- The glove-business is a big and growing business worldwide with the health-care sector appointing for 69.4% of the market.

- Right now there is 3 kinds of glove-dressing processes in the hospitals

- The problems occour in the beginning of the glove dressing and at the end

- Medical students wish for an easier glove-dressing process

Chapter 2.1:
Concept Development

The idea generation starts with different ideas and concepts. To have a clear vision and take on the sketching, it was separated in two categories; the overall ideation, and then a feature ideation. To narrow down between the ideas models was made which would be the lead on how the concept would be, and from there more features would be sketched and evaluated on. Some of the questions that was wanted to get addressed was:

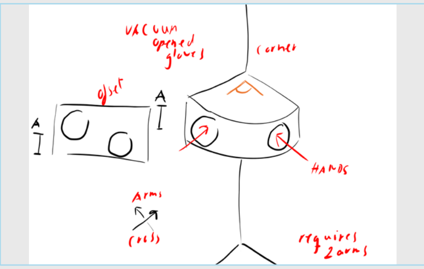
- How should the storage of gloves be?
- How should one insert his/hers hand?
- Should it be made to one or two hands?
- Should it have disinfection in it as a feature?
- How should the mechanisms work?
- How does the glove expand?

Methodology
Firstly sketches were made - from there each one was discussed. We wouldn't waste time by doing lots of "quick-models" to validate the ideas. Instead, they were put up with pros and cons orally. From there it made sense that the overall shape of the concept wouldn't need to have constant models be made of, as the concept and future design of the overall shape would be very dependent on the functions of the product. Therefore, at the beginning, it only seemed important to make models of the promising feature-sketches as these needed validation through quick prototypes.

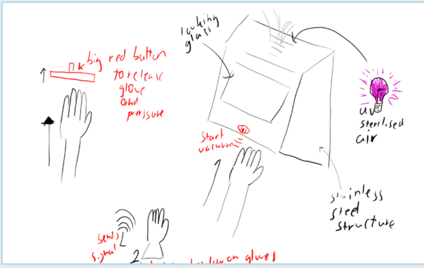
This was done with lo-fi prototypes/mock-ups, that are quickly made and could quickly give an answer. The results from these tests were gathered and put into new sketches and ideas. Concepts were presented for users, to get feedback about what they liked, and what their preferences were.

Sketching round: Ideation and features

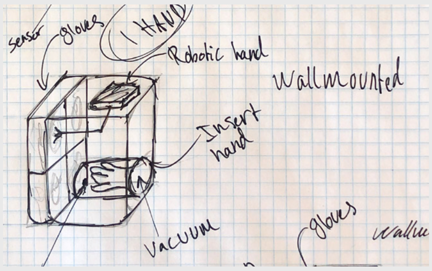
The purpose was to get started with sketching and initiating the process of ideas, mainly "warming up" the hands and getting thoughts down to paper. While allowing old thoughts to be released and allow for new ideas to take place.



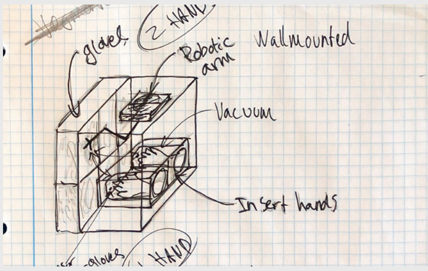
Ill. 43. Insert hands/corner shape



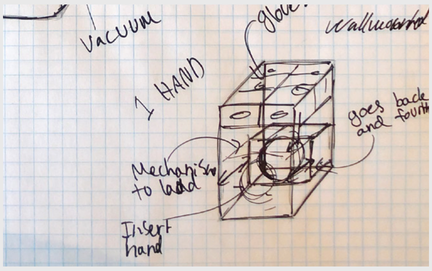
Ill. 44. Focus on angle/how to insert hands



Ill. 45. Insert hands and a mechanisme takes glove to hand-position

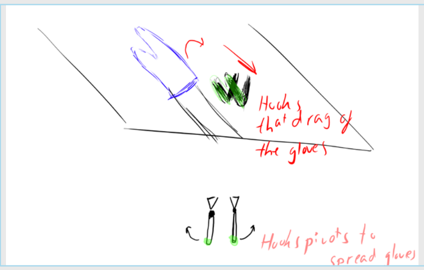


Ill. 46. Place to insert both hands and through a robotic arm the glove will be taken and expanded through vacuum

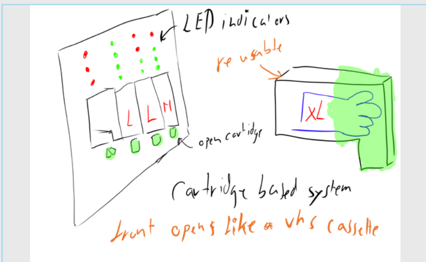


Ill. 47. Different type of setting

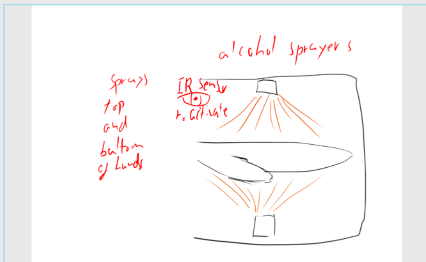
Sketching round: Features



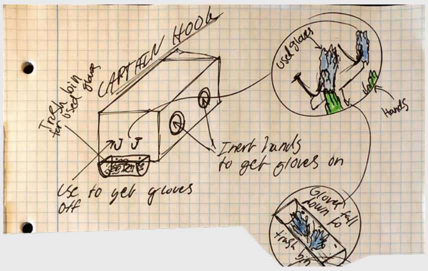
Ill. 48. Glove removing hooks that grab the inside of the glove and spread the glove opening for ease of removal without needing contact with the glove



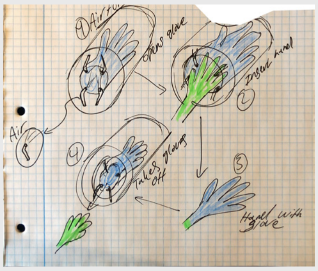
Ill. 49. A glove cartridge system with indicators for remaining gloves and ease of refill, that uses a VHS style opening system allowing for safe storage of gloves.



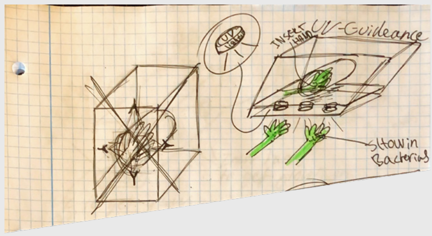
Ill. 50. Alcohol disinfectant mist sprayers on both the top and bottom for easy disinfection of hands



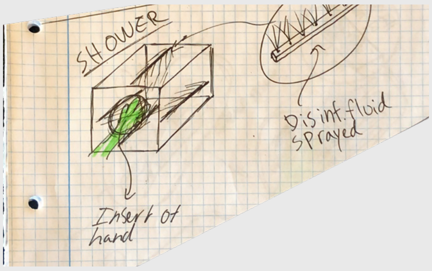
Ill. 51. A pair of hooks are placed on the side of the product to allow for easy removal of gloves without making contact with the gloves for removal.



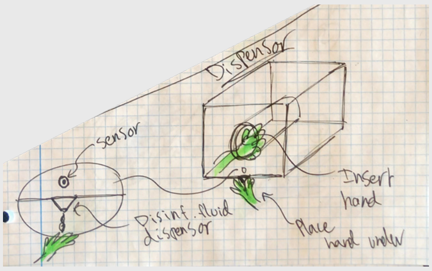
Ill. 52. idea is to inflate the glove with a jet of air to make it easier to dress the glove and use the same jet of air to remove the glove



Ill. 53. UV-light that shows how unclean your hands are and if you need to disinfecti before glove dressing



Ill. 54. A shower of disinfectant to make sure that no bacteria lives on the surface of your hands or lower forearm



Ill. 55. Disinfectant dispenser build into the product to disinfect

Ill. 56.

Analysis/Interpretation

The test was successful in the sense that the glove was expanded as hoped and expected.
It took 10 seconds. The test was successful in the sense that the glove was expanded as hoped and expected. It took 10 seconds. The test was successful in the sense that the glove was expanded as hoped and expected. It took 10 seconds.

Reflection

We needed to get old thoughts down on paper to allow for new thought to form

Conclusion

Vacuum works to expand the glove

Next step

Finding out which size the "room" should be for a fitting and comfortable hand
Find out the mechanisme that should be able to load gloves into a position

Glove Expanding Function Test

Purpose and method

The purpose has been to find out if the vacuum will expand the glove and how the setup generally will be set to achieve the expansion of the glove. This will be done through a prototype that includes cardboard, wires, batteries, tube, glue, half a bottle and a vacuum-motor.

Empirical data and short descriptions

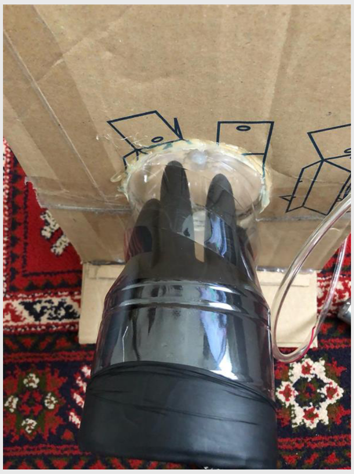
The purpose of this test was to see if the glove could expand when exposed to vacuum. The model was made out of cardboard, half of a coca-cola bottle (1L), a small vacuum motor, glue, tube and wires. By drilling a hole in the bottom of the bottle, one could glue the bottom to the tube, and by filling the front with a glove, a successful vacuum happened.

Ill. 57. All the different components for the mock-up

Ill. 58. Vacuum motor, batteries, cables and a tube glued to the back of a bottle

Ill. 59. Placing the glove around the front of the cut-up bottle

Ill. 60. Placing the electricity together so the vacuum beings = will the glove expand?



Ill. 61. Glove has expanded

Ill. 62. There was nearly not enough room in the bottle for my hand to be there, so that diffenetly has to be bigger.

The purpose of this test was to see if the glove could expand when exposed to vacuum. The model was made out of cardboard, half of a coca-cola bottle (1L), a small vacuum motor, glue, tube and wires. By drilling a hole in the buttom of the bottle, one could glue the buttom to the tube, and by filling the front with a glove, a succesfull vacuum happened.

Ill. 63. I slipped the glove of the bottle to see if it would fit.

Ill. 64. Glove is on

Analysis/Interpretation

The test was successful in the sense that the glove was expanded as hoped and expected.
It took 10 seconds. The test was successful in the sense that the glove was expanded as hoped and expected. It took 10 seconds. The test was successful in the sense that the glove was expanded as hoped and expected. It took 10 seconds.

Reflection

There was nearly not enough room in the bottle for my hand to be there, so that differently has to be bigger. A bigger room also means more space and thereby needs a stronger vacuum. The glove was inserted manually, we need to find out what kind of mechanism will be smart to load the glove automatically.

Conclusion

Vacuum works to expand the glove

Next step

Finding out which size the ”room” should be for a fitting and comfortable hand
Find out the mechanisme that should be able to load gloves into a position

Opening size and type

Purpose and method

The purpose of this mock-up user test has been to decide on wether the user feels a difference being able to see the hand or not, and at the same time, how big of a hole that feels the best.

Empirical data and short descriptions

By making 5 different holes in the cardboard; (See apendix x), and having one side clodes while the other vissible, is was able to make a test on this subject.

Ill. 65. Holes from open view and cloed view

Ill. 66. Mette chose the biggest one and visible

Ill. 67. The same did Hussein

Analysis/Interpretation

The test was quick and had to confirm the assumption that we had regarding being able to see the hand. The users confirmed that it was important for them to see their hands as this felt way "safer" than sticking their hands into an unknown subject with no visibility. At the same time, the biggest hole felt nicer as they didn't have to worry about touching anything as with the other holes.

Reflection

It could have been nicer to test on more users, but it was an extremely busy week and it was felt that it was a matter that didn't need to go through many more medical users prioritizing other more important matters.

Conclusion

Hole with diminsions xxx were chosen as minimum diameter and hand-vissibility was needed.

Next step

Finding out how the loading mechanisme of the product should be
Finding out how hyginic the current method of applying gloves is

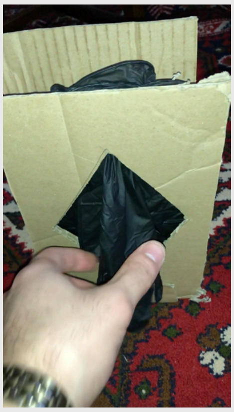
Loading test 1

Purpose and method

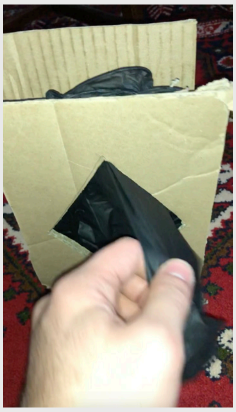
To try and create a mock-up that helps us get phyisical experience and proof of a loading-mechanisme that could potentially be applied to the final product.

Empirical data and short descriptions

By cutting cardboard pieces into different forms, and by cutting it into a linear rate spring, we were able to create a loading mechanism. Here the gloves were placed within the two big cardboard plates, and because of the constant spring being attached in the back, the plates were pushed against each other. Because of this, it was able to take a glove out one at a time with the whole mock-up while standing.



Ill. 68. Grabbing a glove out of a preasured pack of 20 pieces



Ill. 69. T a - king glove out

Ill. 70. Glove taken out while remaining still standing and none other gone out.

Analysis/Interpretation

The test was successful in the form of having a loading mechanism working out of cardboard and glue while standing.

Reflection

The whole system was fragile because it was made out of cardboard. Although it functioned pretty well and also on all sides (horizontal and vertical). This made it a pretty flexible solution in regard to the final product, as it could be implemented in all kinds of angles and ways.

Conclusion

This mock-up of a loading mechanisme can be used as a starting-point.

Next step

Finding out how the gloves should be ”travelling” inside of the final product, so that it can be seen how the loading mechanisme should be implemented

Uv Test 1

Purpose and method

The purpose of this test was to see how hygienic the current process of applying gloves on is. This was done by applying UV-Paint on the users hands, to be able to track the paint left on the gloves OUTSIDE after the process. This would give a clear indication of where and how much there is being touched.

Empirical data and short descriptions

First off they would have UV lighted on their hands and the packaging before and after the process to see the clear differences. They were also asked to go to wash their hands thoroughly after the test to see if there would be any paint left, that could be the bacterias in reality.

Ill. 71. Clearly nothing in the beginning

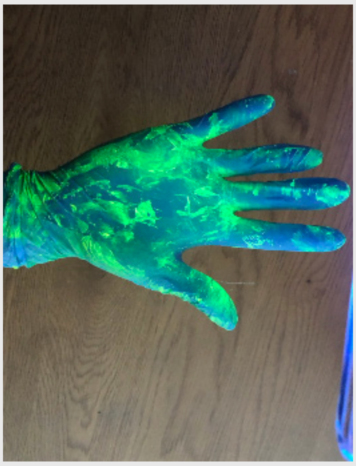
Ill. 72. Nothing in the packa-ging eaither

Ill. 73. Hands are now full in UV-paint, user is asked to put on gloves

Ill. 74. Already clear that there has been cross contamination from the hands to the rest of packaging

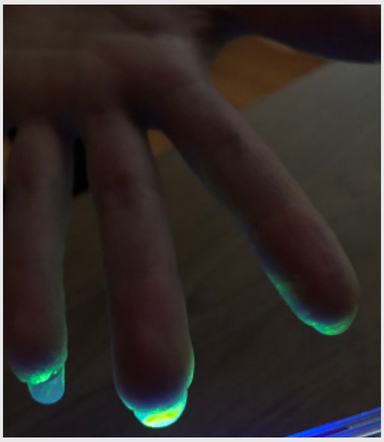
Ill. 75. Gloves were completly full of paint after being dressed on

Ill. 76. Very much especially by the thumbs and in between the fingers as it is here it is pushed down on the handsespecially by the thumbs and in between the fingers as it is here it is pushed down on the hands g dressed on



Ill. 77. Paint is litteraly everywere

Ill. 78. This was the hands after being told to hospitalwash them - the paint wasn't visible normally



Ill. 79. Especially behind the nails

Analysis/Interpretation

The test clearly showed that there was a huge cross-contamination first of all, from the hands to the gloves that isn't even used. Secondly, there is clear proof that whatever is on the hands will be spread all of the gloves being dressed on. This illustrates the proof of why people die in Hospitals as regard to cross-contamination of bacterias. Lastly, it also shows that even through professional cleaning of hands one that isn't able to see "bacterias" can have a hard time knowing when the hands are in fact "clean."

Reflection

There was nearly not enough room in the bottle for my hand to be there, so that differently has to be bigger. A bigger room also means more space and thereby needs a stronger vacuum. The glove was inserted manually, we need to find out what kind of mechanism will be smart to load the glove automatically.

Conclusion

Vacuum works to expand the glove

Next step

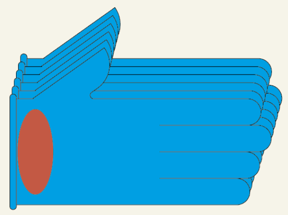
Developing an opening mechanism that assures that the hands don't touch the outside of the gloves

Glove Travel

Purpose and method

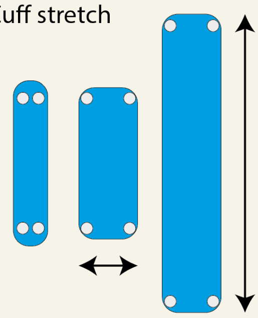
Describe the motion the glove has to take to get stretched on the opening through visual illustrations and descriptors of the prerequisits to achieve said state. this will start from the end state and work itself towards the start state. the start state being known and the end state also being known

Empirical data and short descriptions



Step 1:
Grab the glove

Ill. 80. Start state of the proces, with the gloves being stacked next to eachother in the same orientation with the cuff area marked in red



Step 4:
Cuff stretch

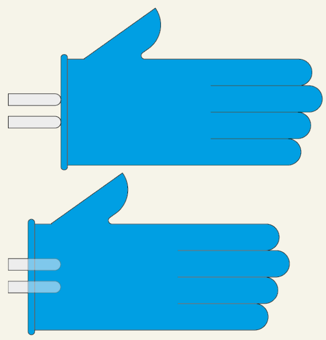
Ill. 81. End state with the glove being stretched, here demonstrating that the glove will be stretched in both the vertical and horisontal direction, with the thumb pointing upwards

End state
The end state Ill. 81 requires the gloves to have the thumb pointing upwards as this orientation is neutral for both the left and the right hand. It also requires the glove to be mounted on all the points of the stretching mechanism.

Mounting
The mounting on the mounting points Ill. 82 requires the gloves cuff to be open so as to have the mounting points inserted inside.

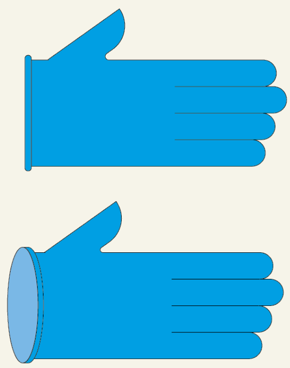
Opening the cuff
the opening of the gloves cuff Ill. 83 since the gloves has a tendency of sticking to it self requires a force to separate the sides of the gloves cuff.

Grabbing the glove
The glove should be grabbed around the cuff of the glove since it gives good control over the glove and makes the mounting easier. The gloves could also be oriented with the thumbs pointing upwards to alleviate the need for orienting later.



Step 3:
Mount the glove

Ill. 82. The mounting step where the gloves are mounted on the points.

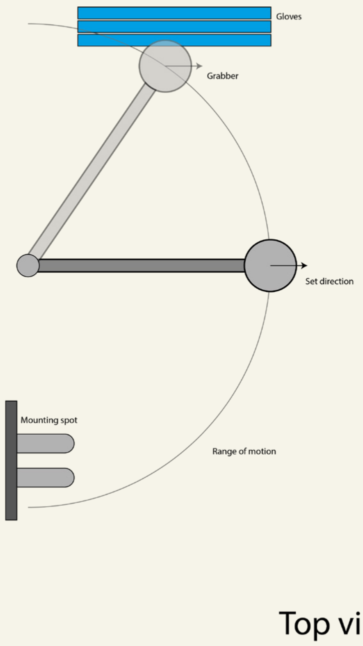


Step 2:
open the cuff

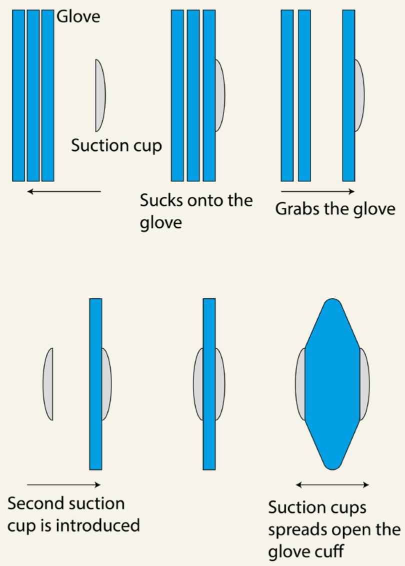
Ill. 83. The glove opening step, here the cuff of the glove is opened to allow it to be mounted on the mounting points

A proposed way of doing the motion would be Ill. 84 although it requires som detailing in how it can keep a constant set direction and how the glove is grabbed as well as how the glove cuff is opened.

Looking at Ill. 85 there is a described path to follow for the gloves to be opened using suction cups using force on both sides of the glove.



Ill. 84. A proposal of the motion of the grabber arm from a top view.



Ill. 85. A proposal of the motion of the grabber arm from a top view.

Reflection

describing the path and requirements for the motion helped in figuring out what steps are required to be performed for the wanted motion and the steps that needs to be taken.

Conclusion

there was discovered 4 steps that needs to be taken for the glove to be located stretched open while placed on the wanted location

Next step

HAVE A MEETING WITH THE CO-SUPERVISOR

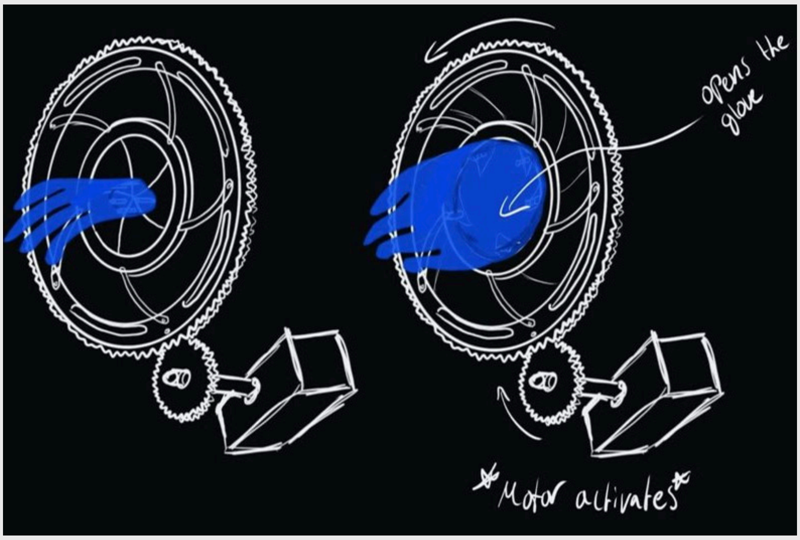
Glove Opener 1

Purpose and method

To create an opening mechanism model that can open a glove making sure that the user doesn't touch the outside of the glove in the dressing-process.

Empirical data and short descriptions

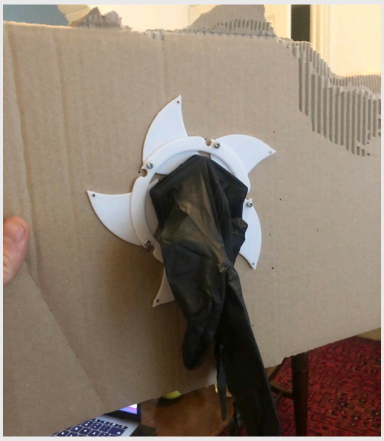
Through researching different kinds of mechanism it was pretty clear for us in the beginning that a shutter aperture mechanism could be a good potential for the future product. Therefore, it was first sketched to see it more clearly working in 2D. From there, it was created in Solidworks and 3D-printed so that it was possible to test it out in real life.



Ill. 86. Shutter amature mechanisme opening a glove

Ill. 87. Mounted into cardboard

Ill. 88. Glove being placed on it



Ill. 89. After opening it up, the glove stayed on

Analysis/Interpretation

The test was succesfull in the sense that the glove was expanded as hoped and expected.
It took 10 seconds.

Reflection

It should have been considered to create the prototype in the size that was chosen from earlier tests, so that it would resemble a real-life product more. Then it would have been possible to make a hole in the middle of the print and thereby have a hand inserted aswell.

There was a lot of work in opening the mechanism - of course in reality it would be easer with a motor, but it still made us think of if there was a more simple solution to this problem.

Conclusion

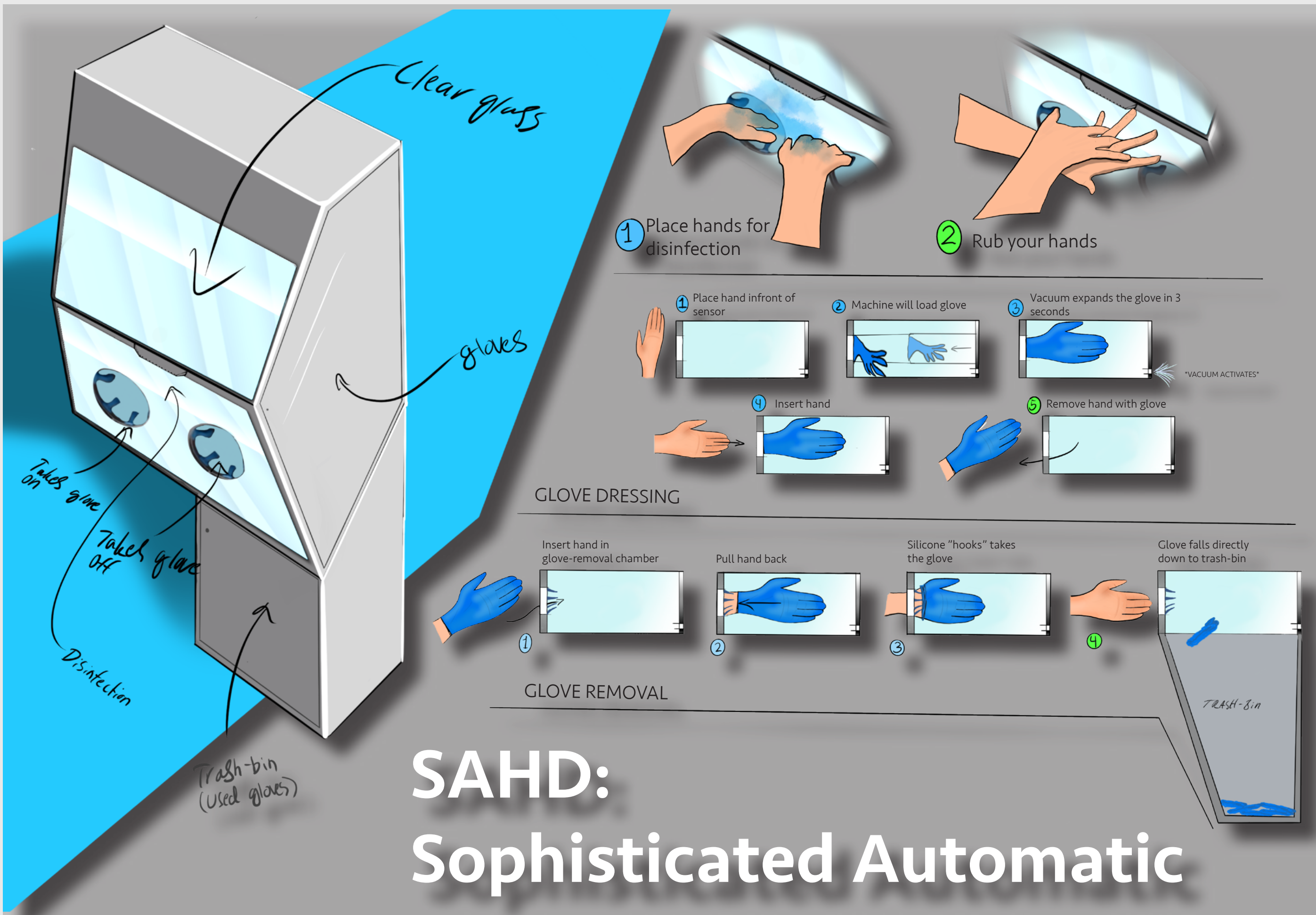
Shutter aparture mechanisme works in pracsise

Next step

Make a concept based on the present knowledge and show it for LSI and the rest of school-groups

See for other potential opening mechanismes

FIRST CONCEPT AND FEEDBACK



SAHD:
Sophisticated Automatic hand-glove dispensor

MASTERS THESIS MISSION:

To design a glove dressing machine that safely and hygienically stores single use disposable medical gloves and helps the user to put them on, even when the hands are wet without tearing the gloves apart while making the process significantly easier and faster for medical personal & nurses in hospitals and health-care clinics.

Purpose and method

The purpose was to have a concept ready for milestone 1, and also to have a board with the product and story ready to send to LSI for them to discuss the idea with nurses and potential future buyers.

Analysis/Interpretation

The first full concept had alot of functions. Besides having the function of dressing a glove unto the hand, there was also a disinfection-spray were one was supposed to disinfect hands before taking the glove on. Besides that, there was also a room to remove the glove being weared that then fell into a trash-can only for the gloves. This was to reduce contamination.

The feedback from the other groups at the milestone was mainly aimed at the size of the product. It was pointed that it was way to large for a hospital, and that it also seemed to be too expensive in the future because of all the functions and the size of it. Therefore, Hospitals would mostly not buy it, because of size and price.

There were also confusions about the fact that the idea was taking from a butcher-setting and why it moved to a hospital-setting.
In regard to LSI, they couldn't come up with a straight feedback. This is due to the fact, that their nurses that were shown the board couldn't understand what it was about.
From there, we responded to the new feedback we had been given by the different groups and told them to hold by until next concept.

Reflection

The comments about the size made sense. For us, initially, we didn't think that it was "too big", as we knew it was a new technology which is often not the size it is after 10 years being on the market. Also, it was important for us to prioritize the different functions, as this would be the key tactic to reducing the size of the product. It had to be cut down to the extreme so that it was only the necessaria that the product consisted of. It also had to be more clear why we moved from the butchers to hospitals.

Conclusion

. Too big of a product
- Need to prioritze functions

Next step

Which functions are necessary?
Find mechanics necessary for development of product

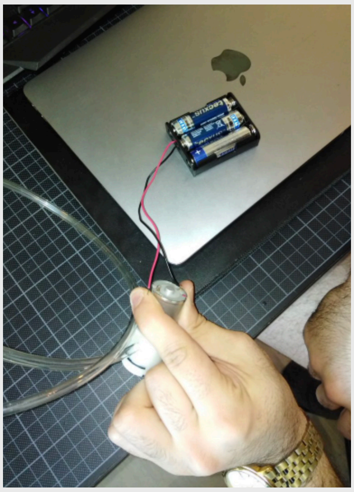
VACUUM MECHANISME TEST 1

PURPOSE AND METHOD

To find out how to ”grab” the glove from the loading mechanism and thereby take it and place it to the ”opening mechanisme.” This will be done by using a vacuum cleaner and modifying the head of it.

EMPIRICAL DATA AND SHORT DESCRIPTIONS

Ill. 90. By using rubber we placed it around the vacuum head to make sure it didn't swallow the glove. Unfortantly, the glove wouldn't stick to it.



Ill. 91. Then it was discussed wether the small vacuum motor from earlier could do the job or not - it couldn't, so we moved back to the vacuum cleaner.

Ill. 92. To modify the head of the vacuum cleaner to make sure that it wouldn't suck the whole glove, tinfoil was added with holes in it, and it worked!

ANALYSIS/INTERPRETATION

The tests showed it was possible to grab the glove by vacuum but that it definitely had to have the ”right” head to do it, and that the vacuum force alone wasn't going to do it. At the same time, the small vacuum motor didn't do the work, but here we weren't sure that it is because of the lack of force, or because of the small tube, or both.

REFLECTION

It would make sense to try and calculate the force of the vacuum that is needed to lift a glove and hold it. In that way, it would be easier to get a manufacturer to provide with the needed for the future product. At the same time, it is needed with a ”head” that allows air to go through while also being ”closed” to such a degree, that the glove can't be swallowed through the vacuum.

CONCLUSION

Vacuum is a solid function to grab a glove

Vacuum mechanisme test 2

Purpose and method

To create a head based on "Vacuum mechanism test 1", that fits a vacuum and allows air to go through while also not allowing the glove to be swallowed by the vacuum.

Empirical data and short descriptions

Ill. 93. A head was designed in Solidworks with the dimensions of the vacuum-tube. The design was spiral with air being allowed to go through.

Ill. 94. Grabbing the glove

Ill. 95. Glove grabbed and hanging perfectly

Analysis/Interpretation

By making a 3D print of the head it was much easier to try and grab the glove and document it, as the head was holding it self because of it's measures fitting to the vacuum-tube. It did bend a bit in the middle when the glove was being sucked, but it was fixed with a bit of super-glue making it more fixed.

Reflection

The 3D-print was good but it had it's weak spots, especially in the middle.

Conclusion

3D-printed head works to grab the glove together with the vacuum

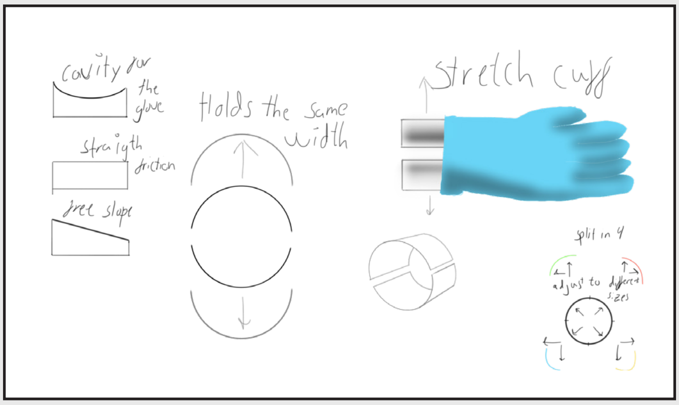
Glove opener 2

Purpose and method

The purpose is to generate designs that are viable for stretching out a gloves opening to allow for ease of access and not have struggles with the thumb during dressing. Thereby make a proof of concept to test if the idea holds up to reality, this is done with 3d printing and then testing with general guidelines from measures of man and women.

Empirical data and short descriptions

Idea 1
The main principle of this idea is 2 semi-circles that move apart stretching the cuff and opening of the glove in a single direction while maintaining a set height of the glove, with added considerations for adaptability and potential directions for increased and decreased grip.

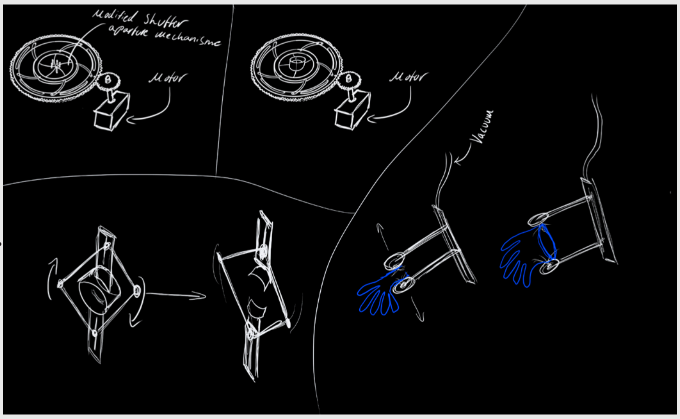


Ill. 96. Semi circle

Idea 2:
Uses the principle from the aparture design from ”Worksheet: Glove opener prototype” changed to work with a more circular form than the studs used previously.

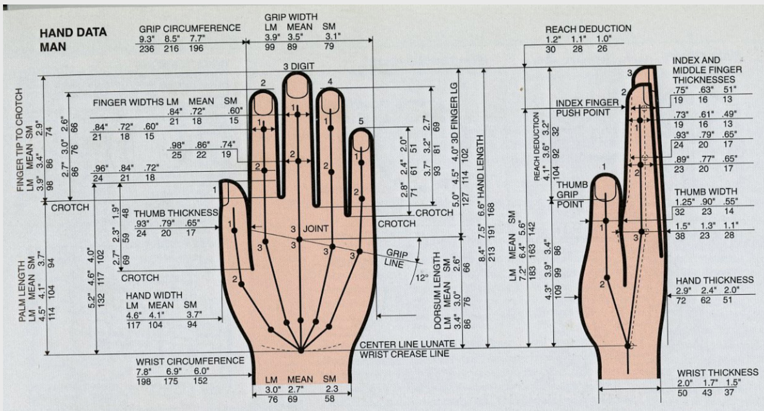
Idea 3:
Follows very closely with Idea 1 in principal and use.

Idea 4:
Uses a suction force to hold on to the outside of the glove and stretches cuff a either end stretching open the glove.



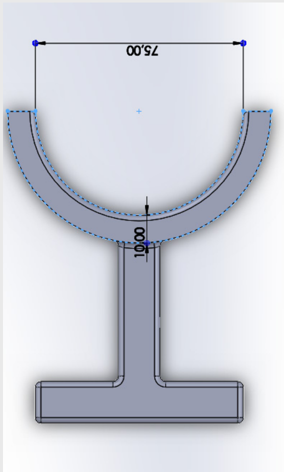
Ill. 97. Different mechanismes

All the ideas show the stretching to be done in both directions while it would be much easier and cheaper to stretch from a single direction with a stationary platform, preferably since the thumb is the problematic part as discovered in ”Worksheet: Where is the problem with gloves?

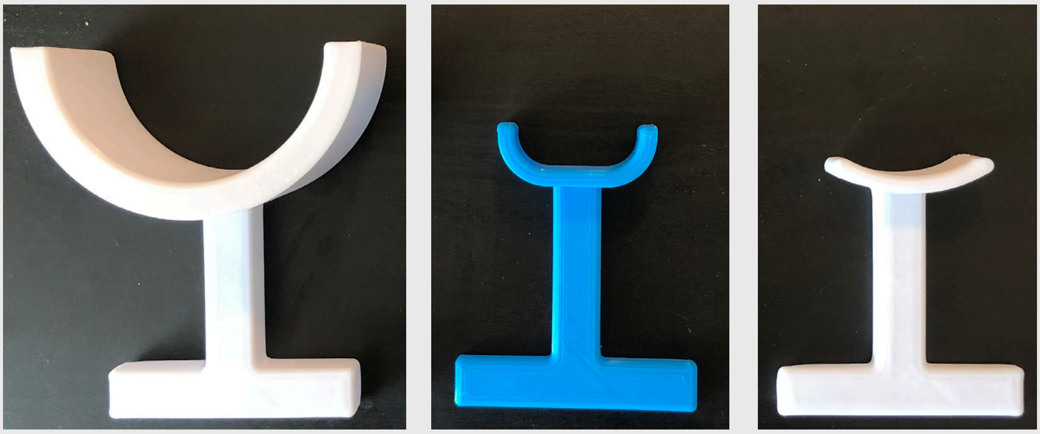


The model was made quickly with help for dimensions from Ill. 98 and the measurements there with a small increase in size to account for ease of dressing.

Ill. 98. (Tilley, 1993) describing the hand of a man the measures important is hand width for the 99 percentile.



Ill. 99. CAD-model



Ill. 100. 3D-prints of different shaped "openers"

Reflection

The ideation this time around was very narrow and focused, but it did give a potential solution that in theory could be a solution for the problem of dressing the glove properly. It was a biased beginning from the start, as the solution had been slightly discussed beforehand and the ideation in turn turned out to be no more than a thinking session for the possible development of the glove holder/spreader

Conclusion

The ideas are mainly the same, with a circular/oval shape that split apart and spreads the width of the glove while maintaining a set height. This idea needs to be tested and see if it is a viable solution.

Next step

Create a proof of concept to test out the idea.

Find out how to grab a glove and mount it.

Glove opener test + UV

Purpose and method

The purpose of this test was to see how hygienic the current process of applying gloves on is. This was done by applying UV-Paint on the users hands, to be able to track the paint left on the outside of the gloves after the process. This time it would be by an opening mechanism and compare to the earlier UV-test.

Empirical data and short descriptions

By following the process as last, they would this time apply UV-paint on their hands but without putting on gloves themselves. Instead, we would open the selected 3D-printed glove-opener and ask them to insert their hands. In this way, it would be possible for us to observe how much less/more paint there would be on the gloves afterwards.

Ill. 101. We opened the glove to have their hands inserted.

Ill. 102. Users hand being covered in UV-paint.

Ill. 103. After glove being dressed on user, there were no signs of paint on the palm-side of the hand.

Ill. 104. There no sign of paint in the back of the hand but at the wrist there were paint.

Ill. 105. Of course no cross contamination to the package of the gloves

Ill. 106. We opened the glove to have their hands inserted.

Ill. 107. Users hand being covered in UV-paint.

Ill. 108. There no sign of paint in the back or front of the hand, only a tiny bit at the wrist.

Analysis/Interpretation

The test clearly showed that there was no cross-contamination first of all, from the hands to the gloves in the package. There is almost no paint on the users gloves after being dressed by the glove-opener. A clear difference in contamination can be seen here compared to earlier test. The only place that is being left with a tiny amount of paint is at the wrist of the users. This is due to the fact, that they have a tendency to pull up the gloves when they wear them.

Reflection

The paint that is left on the wrist of the users doesn't in reality seem to have the big effect. As it is the front part of the hands that is mostly in touch with the patients and other gear at the hospital, it is that area that has the great importance of being clean. And by having these tests it is clear that these parts are untouched by the paint, and therefore, a big success in reducing cross-contamination. At the same time, it seems to be because of a habit amongst the users, that they pull the gloves from the wrist. In reality, this is a habit that could be changed through a good fitting first time through the future product, and thereby avoiding bacteria contamination everywhere, also the wrist potentially.

Conclusion

There is a clear proof that having an opening mechanism will reduce bacteria contamination severely.

Next step

Finding out how to implement the opening mechanism into the concept and different types of mechanics that can work with a motor

Find out which type of opening mechanism to be implemented.

Carriage driver

Purpose and method

We need to find a way to move a carriage linearly to open up the glove entrance, as such different mechanisms will be looked at, the mechanisms will have to be driven by an electric motor.

Empirical data and short descriptions

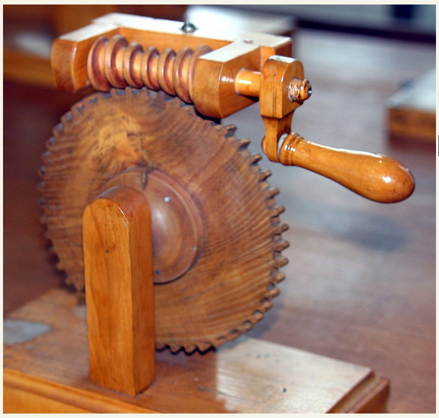
Rack and pinion

It is a basic rotational to the linear converter rotating the pinion gear creates linear movement on the rack. When the gear is supplied with rotational energy, it will start to move and when the rotational energy is stopped it will follows the will of any forces that are applied to it, meaning that it does not lock into place. Meaning that any carriage using this mechanism would fall down when the supply of energy stops. (Rack and pinion, n.d.)

Ill. 109. (Rack and pinion, 2015) showing a rack and pinion system with the pinion riding on the rack

Worm drive

Is a basic rotational to rotational gearing that changes the direction of the rotational energy to another rotational axis, the largest advantage, a worm drive has been the self-locking properties, where the gear cannot rotate if it is not driven by the screw? This mechanism has high friction between the screw and the gear. If you lock the gear then it turns into a rotational motion to linear motion mechanism. (Worm drive, n.d.)



Ill. 110. (Worm drive, 2006) a worm drive with a worm attached to a handle, and a worm gear being driven by the rotation of the worm

Lead screw

Lead screws are used to turn rotational motion into linear motion, this mechanism also has the advantage of self-locking properties so a carriage carried by what would in this case be the female connecting member. Though the biggest disadvantage to this system is the large amount of friction between the male and female connecters. (Leadscrew, n.d.)

Ill. 111. (Lead screw, 2015) a lead screw showing the male and female connectors.

Analysis/Interpretation

The self locking aspects of the lead screw and the worm drive are very important for ensuring that the carriage doesn't slip and cause injury to the user or cause damage to the machine, as the stability given by the locking mechanism ensures saef usage.

since the rack and pinion mechanism does not have a self locking properties it is therefore not a viable solution for the product.

then the choice is between the lead screw and the worm drive, where the largest difference is that the lead screws female connecter is stable in three dimensions where there is a single direction of travel but it does require the female connector to not rotate along with the male connector.

Ill. 112. Lead gear demonstrated in cad where the lead gear controls the glove stretcher in both closed and open position

Reflection

this WS works as a compilation of inforamtion and reasoning behind choice of mekanism

Conclusion

The mechanism operating the carriage linearly should have a locking mechanism the lead screw is a good mechanism to do this with while it may have high friction so does the worm drive.

Next step

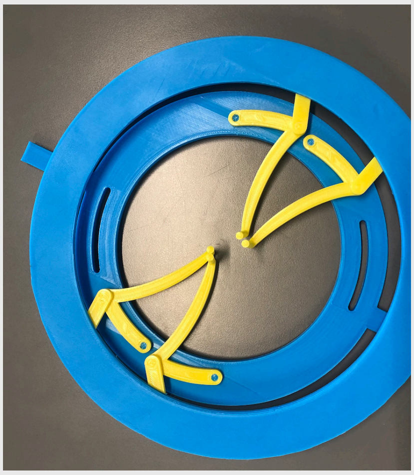
Deciding the type of opening mechanisme the lead screw should be implemented on

Glove opener 3

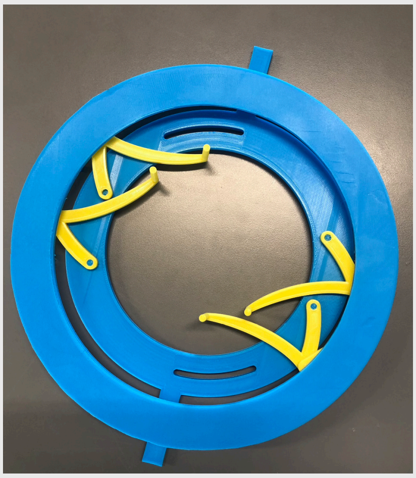
Purpose and method

To create an opening mechanism allowing more flexibility in the opening of different sized gloves. This is due to the fact, that the ”glove opener 2” was fixed in dimensions and thereby in opening gloves.

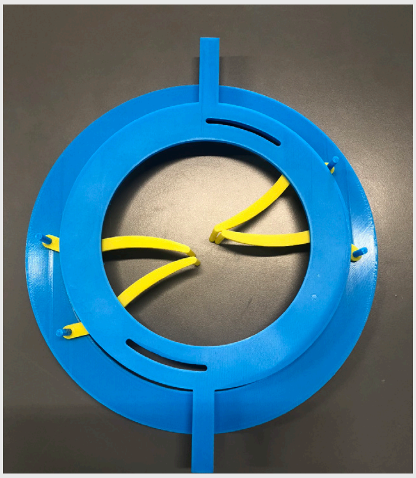
Empirical data and short descriptions



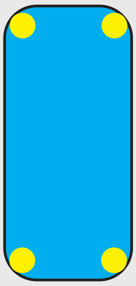
Ill. 113. 3D-model closed.
Made of the same function and the shutter aparture, but with 4 arms instead.

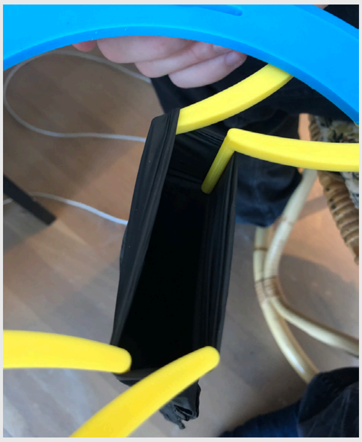


Ill. 114. 3D-model opened.
The glove will be spread in a rectangular form making it easy for insertion of hand.

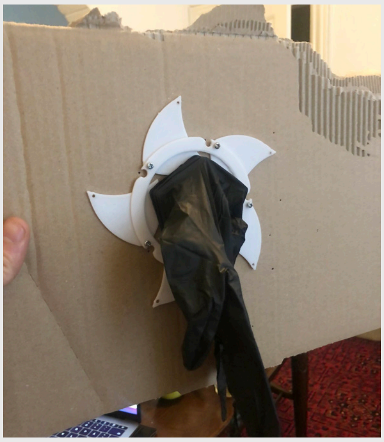


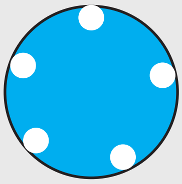
Ill. 115. 3D-model closed from behind.





Ill. 116. Glove being spread by the arms of the new 3D-model of the glove-opener. Shape of the opening to the right compared to the original opening to the right.





Ill. 117. Original inspiration of the new glove opener with the shutter aparture mechanisme. Compared to the new mode, this one opened the glove in a circular form as seen to the right.

Analysis/Interpretation

By modifying the first model ”Glove opener 1” with the shutter aperture mechanism, a new version has been made to create a more flexible opening of gloves. The main difference in this one is the fact that it isn’t opened in a circular way, but in a rectangular way as it is seen in ”Glove opener 2”, as this is the way the hand is shaped in the entrance of the glove-dressing process.

Also, it would be easy to attach a motor to the new model in the future, as it would only need a small-scale motor to make the glove opener rotate.

Reflection

There are concerns wether the arms will be able to withstand the force of opening a glove after some cycles. Also, it has to be considered in what material that would fit the best to the arms. In general, it cam seem as a bit of a ”weak” model in some points. An FEM analysis of the arms would be a good future choice to investigate if the arms can take the preassure.

Conclusion

Vacuum works to expand the glove

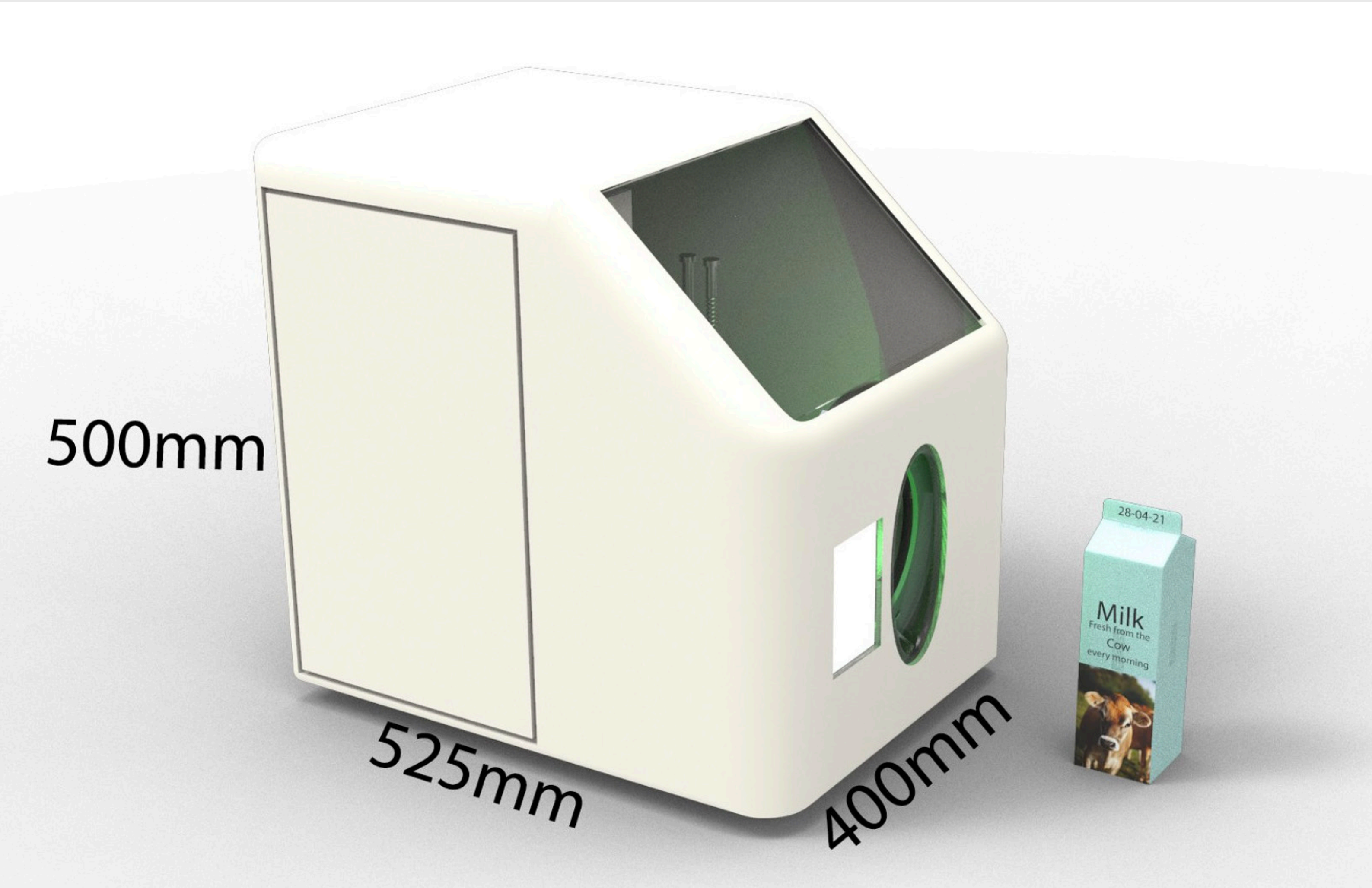
Next step

Finding out which size the ”room” should be for a fitting and comfortable hand
Find out the mechanisme that should be able to load gloves into a position

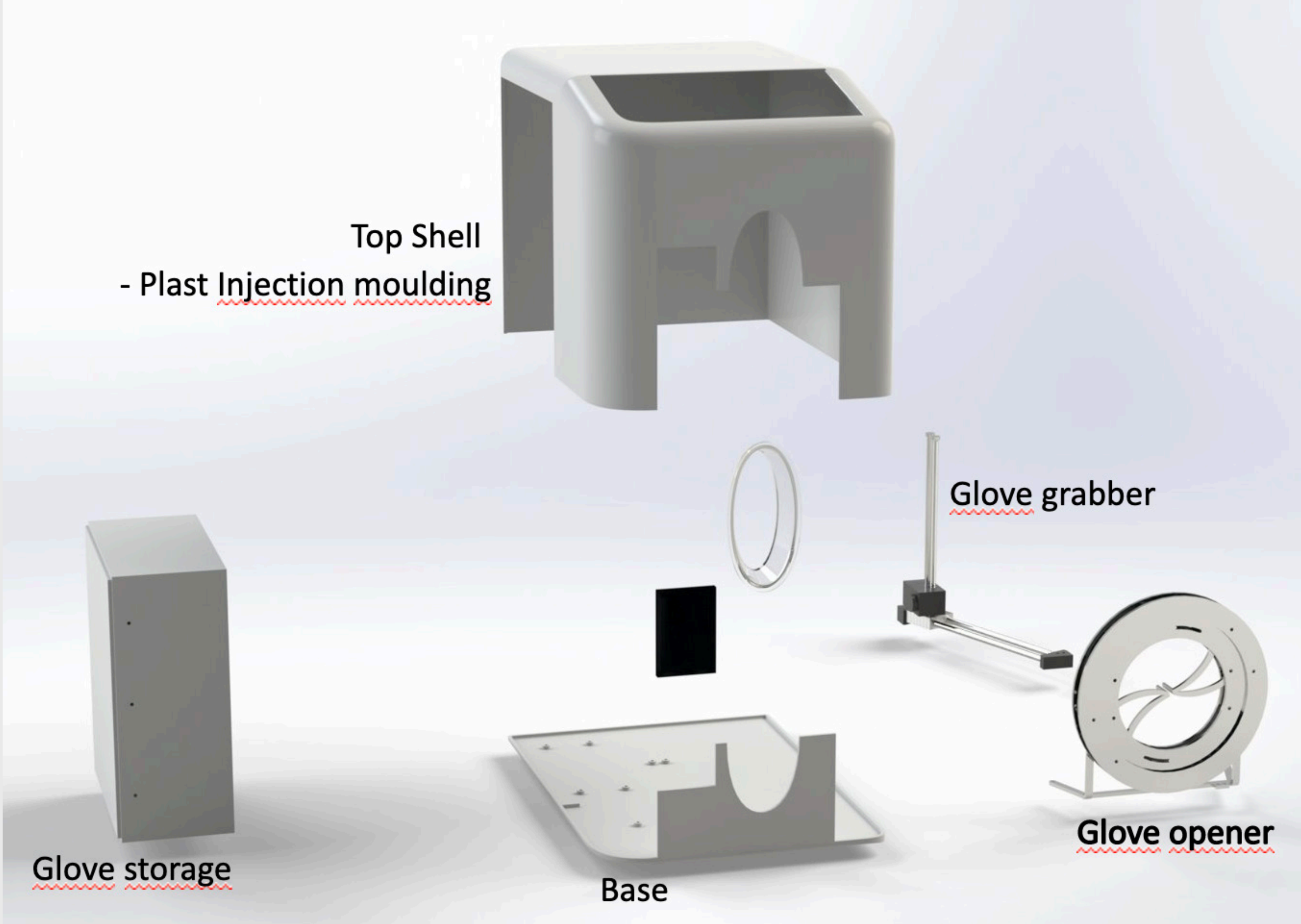
New Concept and feedback

Purpose and method

To incorporate all the new knowlege and prototypes of the functions to a new concept.



Ill. 118. New concept



Ill. 119. Exploded view of new concept

Analysis/Interpretation

The new concept was considerable smaller than the previous model. This was possible to do due to the fact, a bigger insight and modelling of the different functions was made. As these were beginning to be cleared out one step at a time, it was also possible to put it together and see the bigger picture. As previous said this project wouldn't be idea-generating as previous projects, but start out more in the concept development part as it is hands-on.

The product would at this present time consist of a glove storage that could take 3 different sizes and a glove opener made out of steel.

Reflection

It has moved from being a product that hangs on the wall to being placed on the tables that are already in the hospital rooms. This is due to the fact, that it will take way to much space than necessary. Even though it has been smaller than the first concept, it is still hard to imagine how big/small it will be in context. Therefore it would make sense to make a 1:1 cardboard model to see in real life.

Conclusion

New concept has to be reviewed for feedback

Next step

Making a 1:1 cardboard model
Feedback

1:1 Model and size

Purpose and method

To see the latest concept in a 1:1 model

Empirical data and short descriptions

A 1:1 cardboard model of the latest concept

Ill. 120. Front view of model

Ill. 121. Side view of model

Ill. 122. Above view of model

Analysis/Interpretation

It was clear to see that the mode was bigger than what was anticipated by the team. It was smaller than the original concept, but still bigger than what it seemed to be in CAD-program. It was specifically the hight that caught the eyes.

Reflection

It was a great example of why it is important to make quick mock-ups now and then of what is designed, as it sometimes gives a completely different perspective on a concept. It was clear here that it was too tall, and therefor this needs to be evaluated for a potential change and how to.

As it will be placed in a hospital it would be placed on a table which would most likely have a top-cabinet. Therefor the hight has an importance for the final product.

Conclusion

Cardboard mock-up showed a too tall product

Next step

Find out if it is important with 3 packages of gloves

See if the hight can be cut less

AMOUNT OF GLOVE SIZES/OPTION

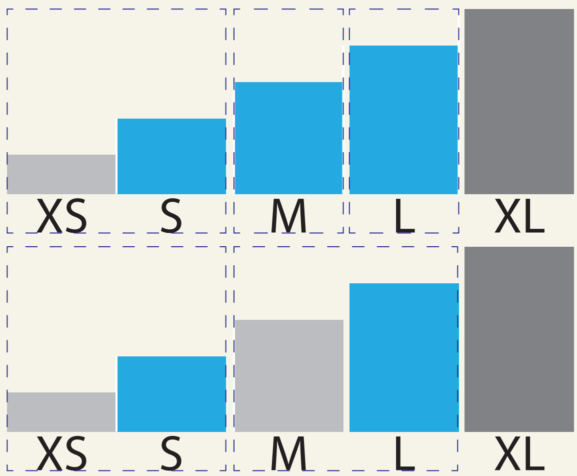
PURPOSE AND METHOD

To figure out whether or not we should have 2 or 3 different sizes of gloves available. With the sized being Small and Large or Small, medium and large. as the impact of having the medium size gloves is up in the air, especially considering the possible size constrains of the product. If it has to fit on a counter and have a cupboard above it, it becomes a question of how we can argue for getting rid of the medium size glove.

EMPIRICAL DATA AND SHORT DESCRIPTIONS

The reason for getting rid of the medium size glove instead of any other size is that wearing a glove that is too small is more uncomfortable than wearing a glove a size too large. Using this thought process a person who usually wears a size medium can comfortably wear a size large without much loss of function. Whereas the small size glove can cover for the X-small size glove as well as the small size glove.

The height of the machine with three chambers of gloves is 520mm tall.
The height of the machine with two chambers of gloves is 365mm tall.



Ill. 123. Range of gloves from using 3 sizes and using 2 sizes with the used gloves marked in blue and the covered gloves being marked with a dotted line box. dark grey shows sizes of gloves not covered

REFLECTION

Although the new approach does not cover all users, neither did the previous set up of gloves. There is still a small subsection of glove users who are not covered by the machine.

CONCLUSION

Removing a glove size and letting the large size glove act in place of the medium size glove while not being a big change allows for simplifying the product at a relatively small cost to the usability of the glove dressing machine while removing 155mm of height.

Final Concept

Ill. 124. Final concept next to earlier model (to see hight difference - compared to a milk carton

Analysis

The heights between the two different compartment options compared shows a significant change. The new design isn't being much taller than a carton of milk (1L) the lowered angle of the window can indicate lessened view of the users hands during use.

Reflection

The interaction of the user and product is at this point lacking due in turn to lack of testing in context and in person.

Conclusion

The removal of height has changed the expression of the product and the concern in how much space it takes up.

Next step

Look at manufacturing

Concept development conlusion + sum-up

A recuring feedback has been made it smaller. This forced the group to dig into what is necessary, allowing it to remove functions that wasn't a need to have but a nice to have. From there, a concept was created that was significantly smaller in size than the original, and with its main functions: dressing a glove fast and hygienic.

- There is a clear difference in cross contamination between putting gloves on as it is with SAHD compared to without.

- The product needs to fit to a hospital excamination room without being too large

- Large and small size of gloves are enough to cover most of the markets use of gloves.

Chapter 2.2:
Manufacturer

To create and establish a business and create a product, manufacturing was a necessary step and finding out how to create all the parts of the product. Therefore, manufactu-ring for the components was developed. Some of the key-questions that needed answers were:

- How much is it going to cost to produce all of it?
- Can one manufacturer produce all of the components?
- Where to manufacture?

Methodology

Internet research
To get a scope of the size of the glove market and the problem internet research was conducted to find statistics and articles.

Calculations
To Find out how much space gloves take up when placed in cardboard packages we have made calculations estimating the sizes

Stress strain testing
Finding out how much force is required for the gloves to be opened up a specific amount has required stress strain testing.

Manufacturing and Production

Purpose and method

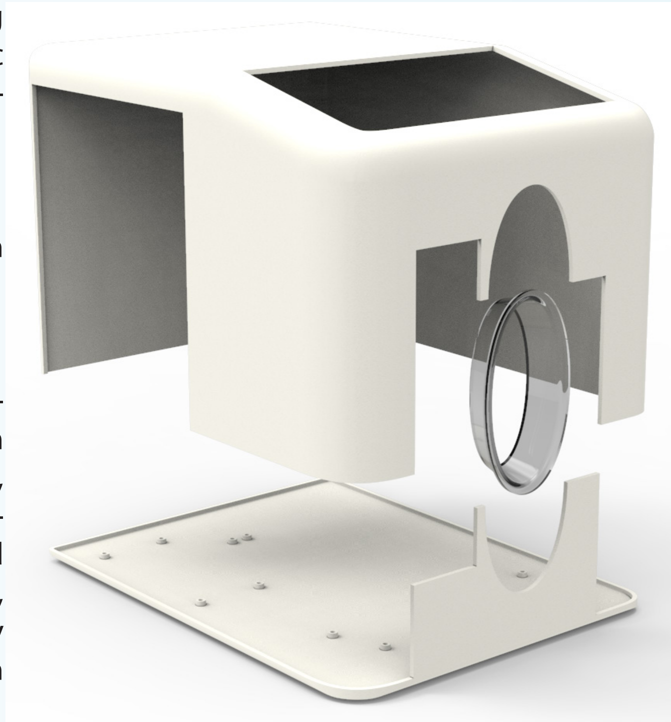
The purpose is to remove uncertainty of production of certain parts, not all parts of the product specifically; the outer shells of the product; the glove opening mechanism; and the box for gloves

Outer Shells

The outer shells of the product are to be made using plastic injection molding with polycarbonate plastic being used for all three outer shell parts in two different variations.

Injection molding
Injection molding is the forceful injection of molten resin into a mold before cooling the resin.

Design concern
Products or part made using injection molding requires draft angles so the part can be removed from the mold (Xometry design guide: injection molding, n.d.) the tall sides and large sides are a cause for concern and will likely require ribbing for strength and riggidity (Xometry design guide: injection molding, n.d.). The same is true for the screw mounts. They will also likely require gussets and ribs for strength and smoother molding.

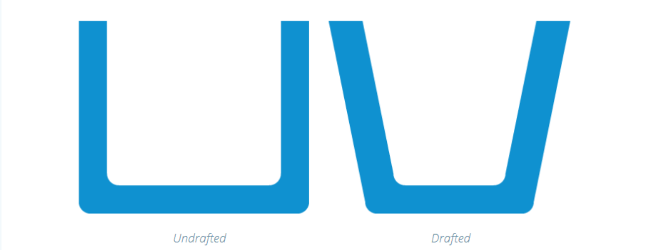


Ill. 125. Rendering of the shells three parts exploded shown in representative materials

Transparent polycarbonate
there are some big differences when it comes to plastic injection molding in opaque and transparent resins, mainly the attention to detail required.
Areas of concern transparent
since we have gone to the effort of making the parts transparent and clear any scraping and tool marks from the injection and the extraction process are going to be very visible this also applies to any imperfections in the mold. The imperfection cannot be hidden in the same way as with opaque were texturing the mold can hide some manufacturing flaws. Since we cannot have visible injection points and extraction points specifically from the extractor pins.

Ill. 126. (xometry design guide: injection molding, n.d.) screenshot from the design guide about their recommended

SURFACE DESCRIPTION	MINIMUM DRAFT
For "near-vertical" requirements	0.5°
Most common situations	2°
All shutoff surfaces	3°
Faces with light textures	3°
Faces with medium textures	5°+



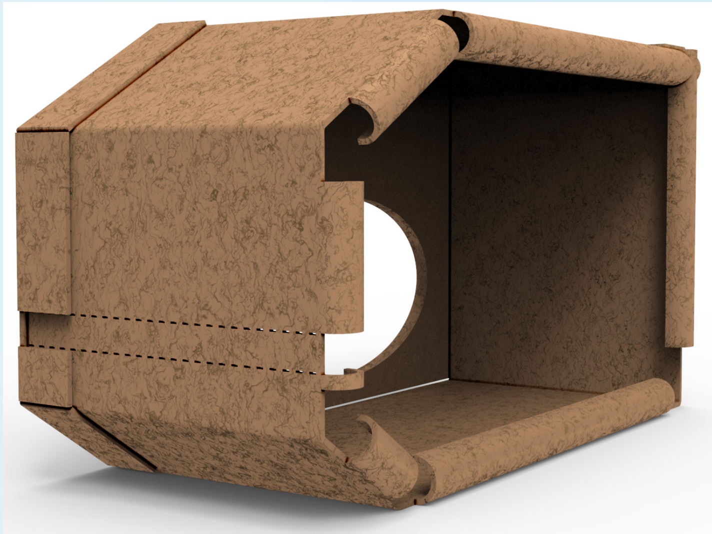
Currugated cardboard type E flute

CNC cutting and creasing

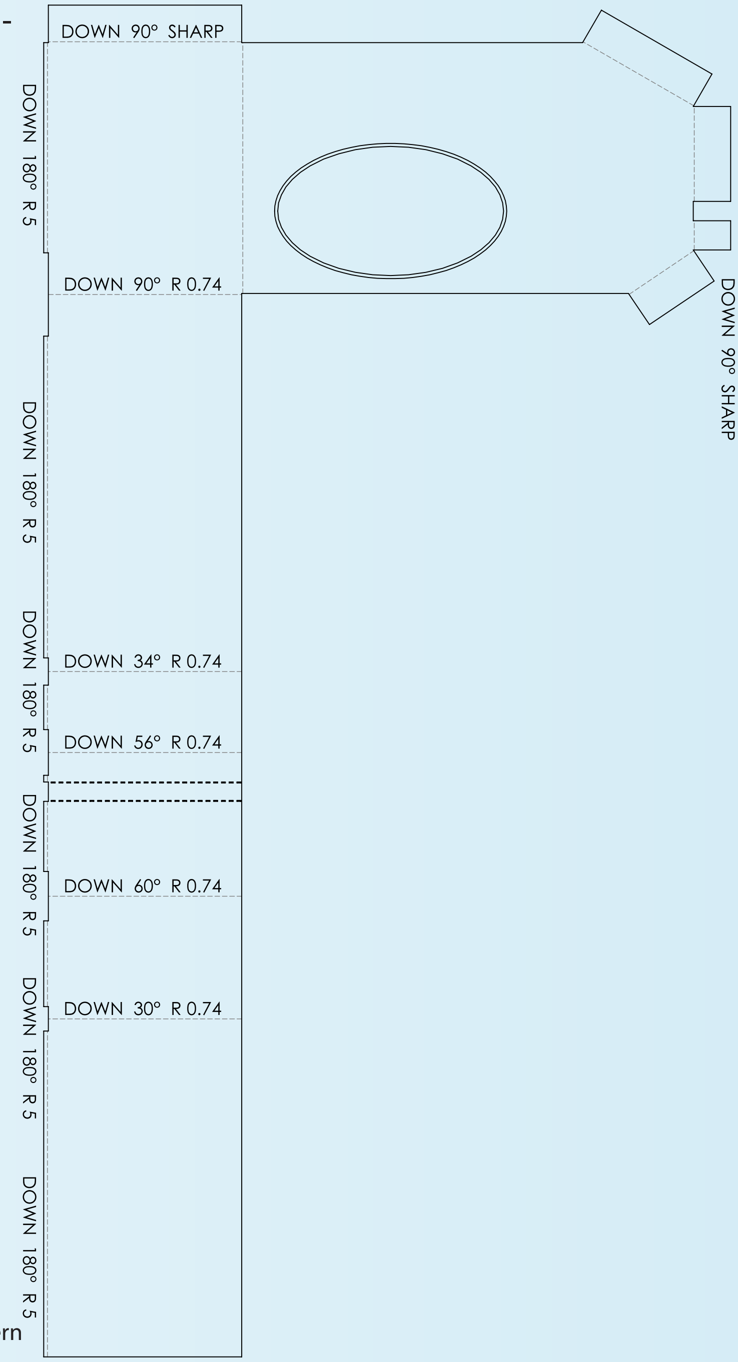
CNC cutting with an oscilating knife and creasing attachment (Corrugated/Honeycomb Cardboard Cutting with CNC Oscillating Knife Cutting Machine, n.d.)

Areas os concern

the only areas of concern with the manufacturing is the end stage curling of the ends to seal the box, as the only place the curling (see Ill. 129) is actively used is with cardboard tube ends and tube shaped boxes.
in case of the curling not being an applicable production method a tab with a tear away option is considered



Ill. 127. Cardboard box for gloves folded

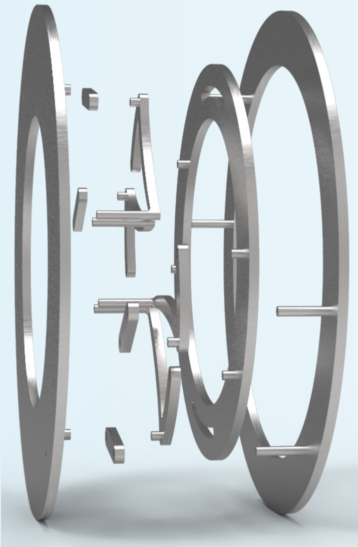


Ill. 128. Cardboard box for gloves folding pattern

Ill. 129. (edge crimped and curled, n.d.) edges of tube containers with their edges curled up.

Glove opening Mechanisme

The glove opening mechanism is set to be made in metals and plastics with critical parts made in metal and supporting parts made from plastics.



Ill. 130. glove opening mechanism exploded

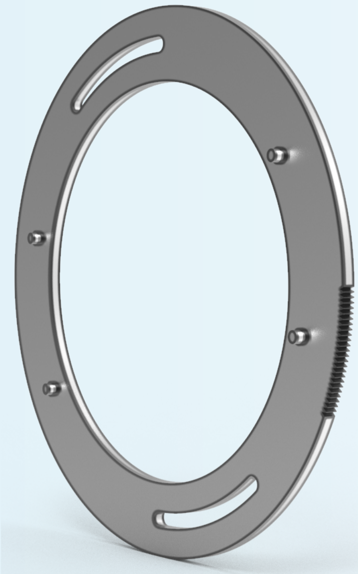
Gripper arm
The gripper arm is made from a stainless steel alloy the specifics are at this stage not known. The gripper is made from sheet steel and CNC cut using either a plasma cutter or water cutter. With the cylindrical grabber being joined through welding.

Control ring
The control ring is made from a stainless steel alloy that has been cut using CNC plasma cutter or water cutter.

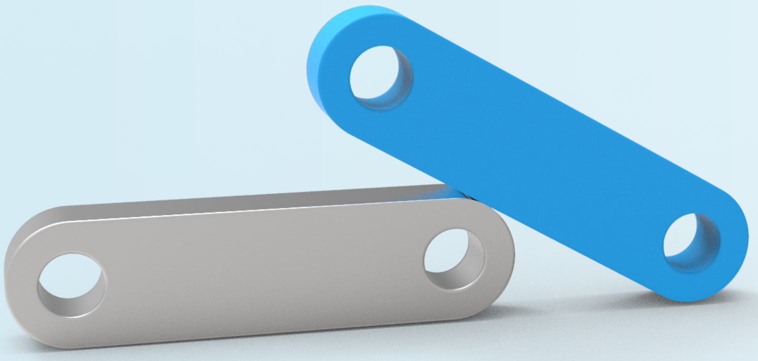
Connecting rod
The connecting rod is being considered in both plastic and steel depending on the load on the connecting rod, there is also the possibility of shaving some excess material. In steel it will be treated like the control ring with the possibility of using die cutting press to stamp out the connecting rods in large number depending on strength requirements. In plastic it will likely be made using either injection molding or extrusion and cutting to the right thickness.

Water cutting
This process is well made for dealing with steels of any kind and have no effective limitations on the thickness of the cut material both criteria coming at the cost of processing time (water jet cutting a technology on the rise, 2010).

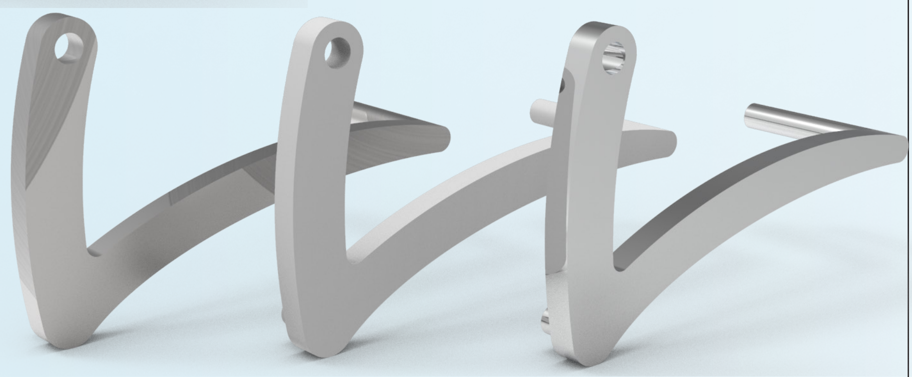
Could not find a design guide for plasma cutting



Ill. 131. glove opening mechanism control ring with marked up contours for cutting edges



Ill. 132. Connecting rods made from Steel (metallic) and plastic (blue)



Ill. 133. Glove gripper arm in three different materials, from the left; steel; plastic; and

Reflection

Most manufacturers have resources available such as design guides to help designers make better use of their services. While they are not readily available for cardboard.

Conclusion

The most certain production method among the ones brought up would be the plastic injection molding. The cardboard cutting and creasing is also quite certain with some potential for design changes as information increases. When it comes to the opening mechanism, there are some parts of different production methods with some uncertainties that can be dealt with as more information is gathered.

Next step

Assembly

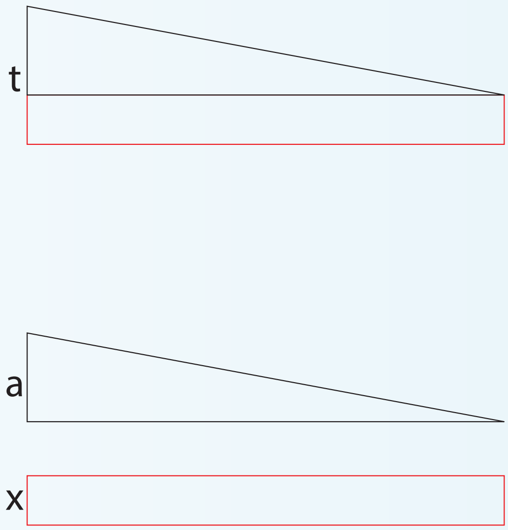
Glove thickness

Purpose and method

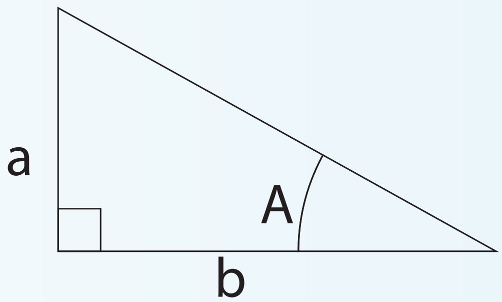
To find out how much space a 100, 150 and 200 stack of gloves takes up when packaged while looking at different ways of packaging instead of laying them in a single layer. These calculations are simplifications of the real situation.

Equations and approach

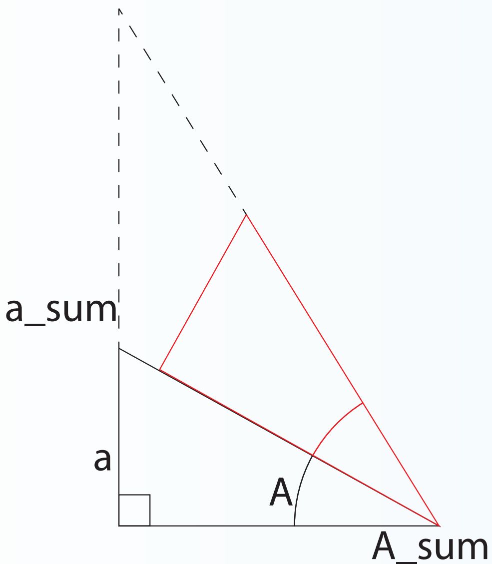
A disposable glove typically has a rolled cuff that allows for easy grabbing and detecting where the glove opening is. But this rolled cuff makes the glove thicker than the thickest part of the fingers creating a wedge shape where the angular deflection would produce problems when enough gloves are stacked on top of each other. As a simplification the thickness of the thickest point of finger tips is separated from the calculations and added on top (see Ill. 134). And the angular deflections are added together separately see Ill. 135 for simplicity the length is used as seen in Ill. 135 to calculate the total thickness of the stack of gloves



Ill. 134. Displayed here is the separation between the glove thickness and the angle created by the cuff and the

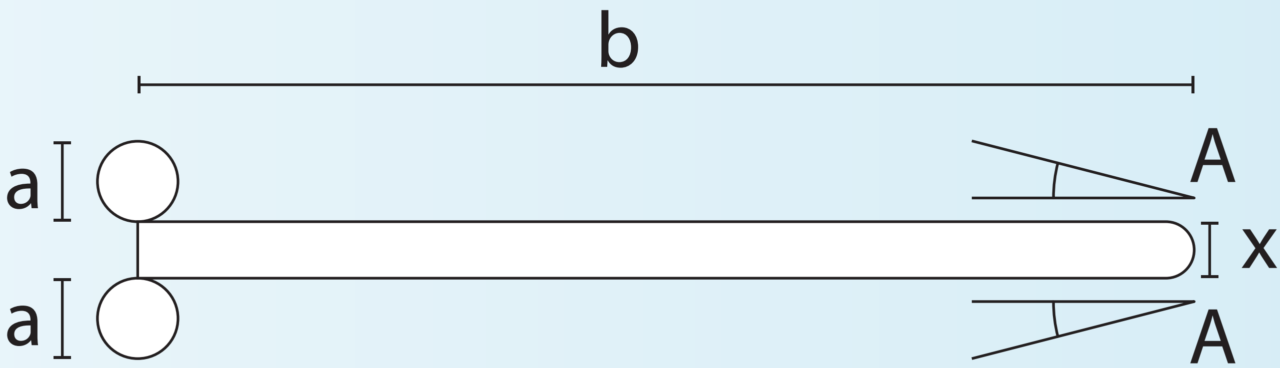


Ill. 136. illustration displaying the components of the equation: $A = \tan^{-1}(a/b)$



Ill. 135. displayed here is that as the angle doubles the length of a_{su}m increases non-linearly

the images and illustrations shown here are not to scale



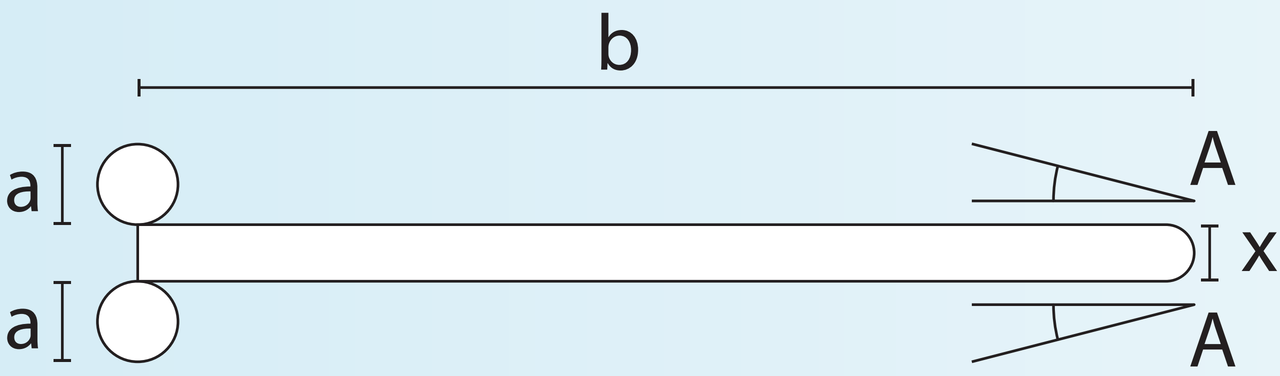
Ill. 137. Seen here is the largest consideration for the stack of gloves.

a	=	0,5	mm
b	=	230	mm
x	=	0,25	mm
n_1	=	100	
n_2	=	150	
n_3	=	200	

$$t_{thickness}=2a_{sum}+x$$
$$a_{sum}=b*\tan(A_{sum})$$
$$A_{sum}=A*n_y$$
$$A=\tan^{-1}(a/b)$$

In order to find the angle deflection at n_1 and n_2 amount of gloves, to see how large the angle becomes at the respective number of gloves. We use trigonometry to find the angle A.

$A = 0.125$ degrees
$A_{sum\_n1}=12.5$ degrees
$A_{sum\_n2}=18.68$ degrees
$A_{sum\_n3}=25$ degrees
$t_{n1} = 76.2$ mm
$t_{n2} = 114.7$ mm
$t_{n3} = 153.6$ mm



Ill. 138. Seen here is the largest consideration for the stack of gloves.

a	=	0,5	mm
b	=	230	mm
x	=	0,25	mm
n_1	=	100	
n_2	=	150	
n_3	=	200	

$$t_{thickness} = 2a_{sum} + x$$
$$a_{sum} = b * \tan(A_{sum})$$
$$A_{sum} = A * n_y$$
$$A = \tan^{-1}(a/b)$$

In order to find the angle deflection at n_1 and n_2 amount of gloves, to see how large the angle becomes at the respective number of gloves. We use trigonometry to find the angle A.

A = 0.125 degrees
A_{sum_n1}=12.5 degrees
A_{sum_n2}=18.68 degrees
A_{sum_n3}=25 degrees
t_{n1} = 76.2 mm
t_{n2} = 114.7 mm
t_{n3} = 153.6 mm

Conclusion

We require that the gloves can be placed into our packaging from the manufacturer and laid cuff to cuff and tip to tip.

Next step

Stress strain Nitrile rubber

Stress strain of nitrile rubber glove

Purpose and method

To find out how much force is required to stretch a nitrile rubber glove to a given length by taking stress and strain measurements by applying a force of tension on the glove and noting down the strain on the glove.

Setup

The glove is being measured while being stretched out while suspended in tension as the glove size L does not transmit stresses while in compression.

the glove is meassured before being stressed. with a light weight of 31g

the gloves are being stressed using 4 known weights

stress strain	Test 1	Test 2	Test 3	Test 4
Start length	9	9	9,1	8,9
404,8 g	10,2	10,4	9,9	9,7
595,7 g	10,5	10,7	10,5	10,1
737,6 g	11	11	11,1	10,4
1107,5 g	12,8	13,2	12,7	11,1

Ill. 140. Table of test results for stresses and strains

While doing the tests it was discovered that the glove would respond to continuos stress by increasing the strain and further increasing the elongation from the test.

elongation static load	405 g	596 g	738 g	1108 g
unloaded length	9	9	9	8,9
start	10,1	10,2	10,5	11,2
10 minutes	10,7	11,5	11,6	14,4
additional elongation	106%	113%	110%	129%

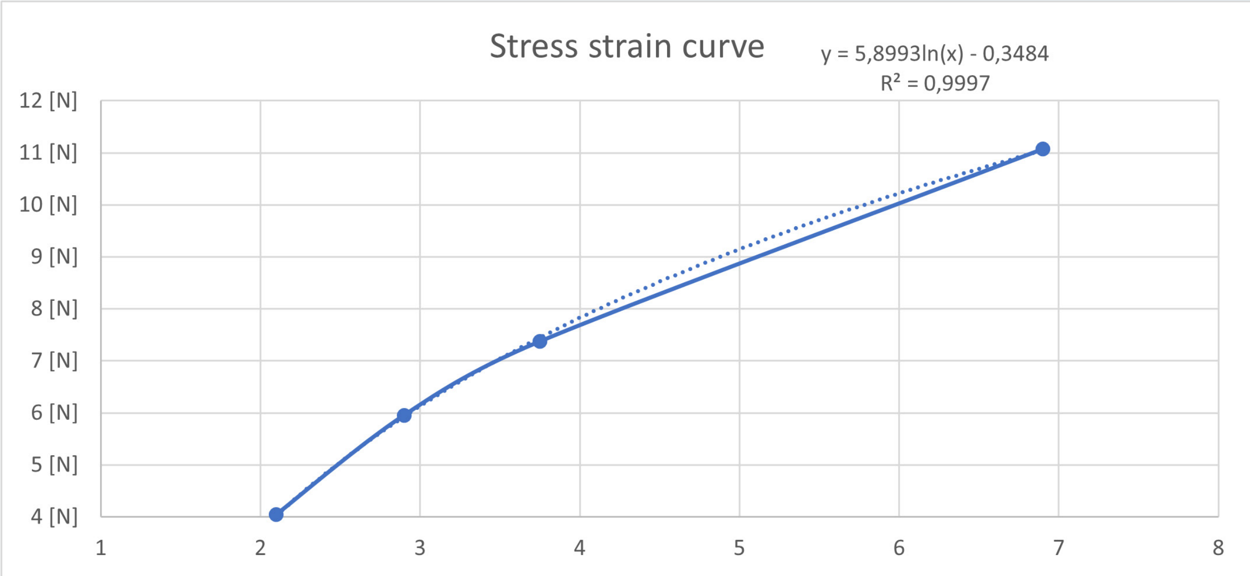
Ill. 141. Table of test results for loaded accrued deformation as a result of time

as can be seen in the table the additional strain rises with increased stresses in a non-linear fashion or since the amount of tests were not extensive the additional elongation rate could be described as eratic. possibly as a result of being in plastic deformation instead of being in elastic deformation.

Ill. 142. glove being strained by a known weight to get the strained length

Ill. 139. glove being placed in an "un-loaded" state to measure the start length before strain.

Analysis/Interpretation



Ill. 143. Stress strain curve using the data from table 1 using the average value for each weight. with a logarithmic regression line as there are some doubts about the validity of the curvature that is pressent in the data.

as seen in Ill. 143 the logarithmic regression fits well with the test points from Ill. 141 as there are some uncertainties as noted in Ill. 142 therefore a safety factor of 1,5 should be added onto the calculations

Reflection

While there are discrepancies in the data acquired as he gloves elongates over time and the measurements were not taken at the exact moment of strain but some seconds after that the results could be screwed, as such a margin of safety is required when it comes to dimensioning the force required to open the gloves.

Conclusion

For calculating the strain-stresses for the motor the logarithmic regression will be used as with the margins for errors in the testing this gives the while not most accurate picture of the gloves but the safest picture to use given the circumstances. With the force required for a given strain being given with $y = 5{,}8993\ln(x) - 0{,}3484$ at a safety factor of 1,5

Next step

DIMENSION THE FORCE REQUIRED TO OPEN THE GLOVES

Glove requirements

Purpose and method

The purpose is to make clear the requirements for the glove manufacturer

Requirements for the gloves

The gloves are required to not stick to themselves or eachother, as with the gloves sticking to themselves will require the gloves to be unstuck before they can be mounted on the glove opener.

REQUIREMENTS FOR PACKAGING

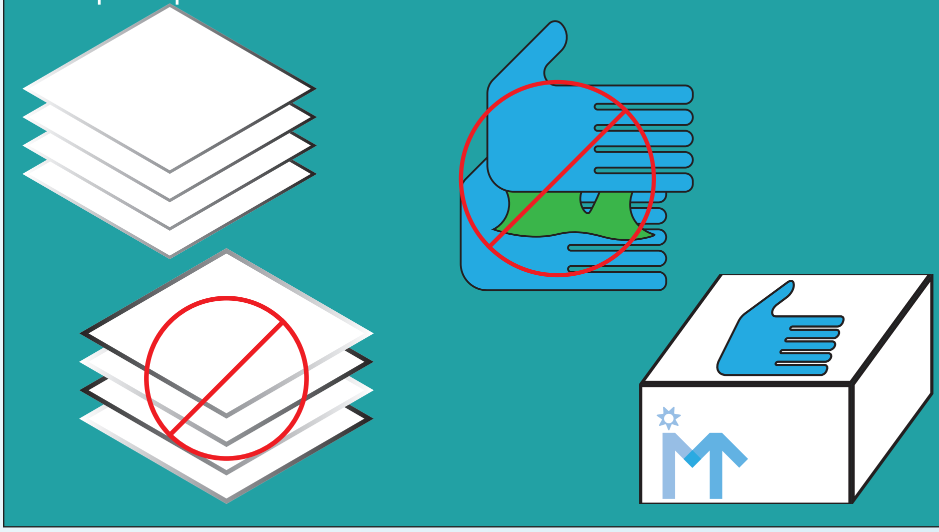
The gloves are required to be packaged with the thumbs pointing the same way and laid flat. they should be laid cuff to cuff and fingers to fingers while being packaged in the Immotechs glove packaging.

Reflection

we have known for a long time what the requirements for the glove manufacturers are but it has taken some time for this WS to be made

Conclusion

we require that the gloves can be placed into our packaging from manufacturer and laid cuff to cuff and tip to tip



Next step

Detailing

Manufacturer conlusion + sum-up

Having gotten a greater understanding of the manufacturing process and what is required to manufacture the individual components and the limitations the materials presents, and the overall interaction that is between the parts and its manufacture.

The box for gloves is made from Type E flute corrugated cardboard cut and pressed.

The Glove opening mechanism is made from metal cut with a water jet cutter.

The number of gloves in a pack of gloves amounts to 150 pieces.

We know how much force is required to stretch the glove cuff

Chapter 2.3:
Detailing

The task ahead is getting some details in order which will be the theme of this chapter. This will be done through calculations, stress-strain testing materials doing Finite Element Method (FEM) analysis, and verification using stress testing. This research should lock in some key details.

- How much force do the grabbers need to comfortably hold?
- How much power does the motor moving the grabbers need to output?
- Verify that the grabbers can hold the stresses from the gloves.

Methodology
The following chapter will use Calculations, FEM analysis, and stress testing on models to answer some questions regarding the strength of material and shape and model.

Calculations
Using the Stress-strain curves from the previous chapter we can find the required output required for moving the motor which in turn requires knowing how much force the glove grabbers need to exert on the gloves to get a required deformation.

FEM analysis
Using the CAD model made earlier representing the glove grabber we used the SolidWorks Study tools to set up an FEM analysis for the stresses applying knowledge from the calculations. And using said FEM analysis to find structural weaknesses in the design and apply fixes to them.

Stress testing
The physical glove grabber models made from the resin were stress-tested using the forces calculated and see if they can withstand the forces required.

Opening mechanisme: Motor

Purpose and method

Use the material information from "Worksheet: Stress strain of nitrile rubber glove" to size the motor for opening the gloves to the wanted size.

Sizing the motor for opening the glove

In order to find the required amount of power [Watt], [Nm/s] that is required of the motor to open the glove sized large to the required size.

$l_{circumference\_start}$	=	231	[mm]
l_{end}	=	120	[mm]
w_{end}	=	40	[mm]
r_{corner}	=	2,5	[mm]

The first thing that needs to be established is the elongation of the glove and how much force is required to perform this deformation. As such we need to know the original circumference of the glove and the wanted circumference. The wanted circumference is found using these calculations.

$$l_{circumference\_end} = \left((l_{end} - 2 \cdot r_{corner}) + (w_{end} - 2 \cdot r_{corner}) + (r_{corner} \cdot \pi)\right) \cdot 2$$

$$l_{deformation} = l_{circumference\_end} - l_{circumference\_start}$$

Ill. 144. Circumference calculations with the red rektangel showing the frame of the calculations, blue showing the pins and black showing the length and width after removing the radius of the pins from the red rektanle

Now that we know the wanted circumference and the difference between the original circumference and the wanted circumference.
We can use the stress-strain regression from "Worksheet: Stress strain of nitrile rubber glove"

$$F_{deformation} = l_{deformation} \cdot a + b$$

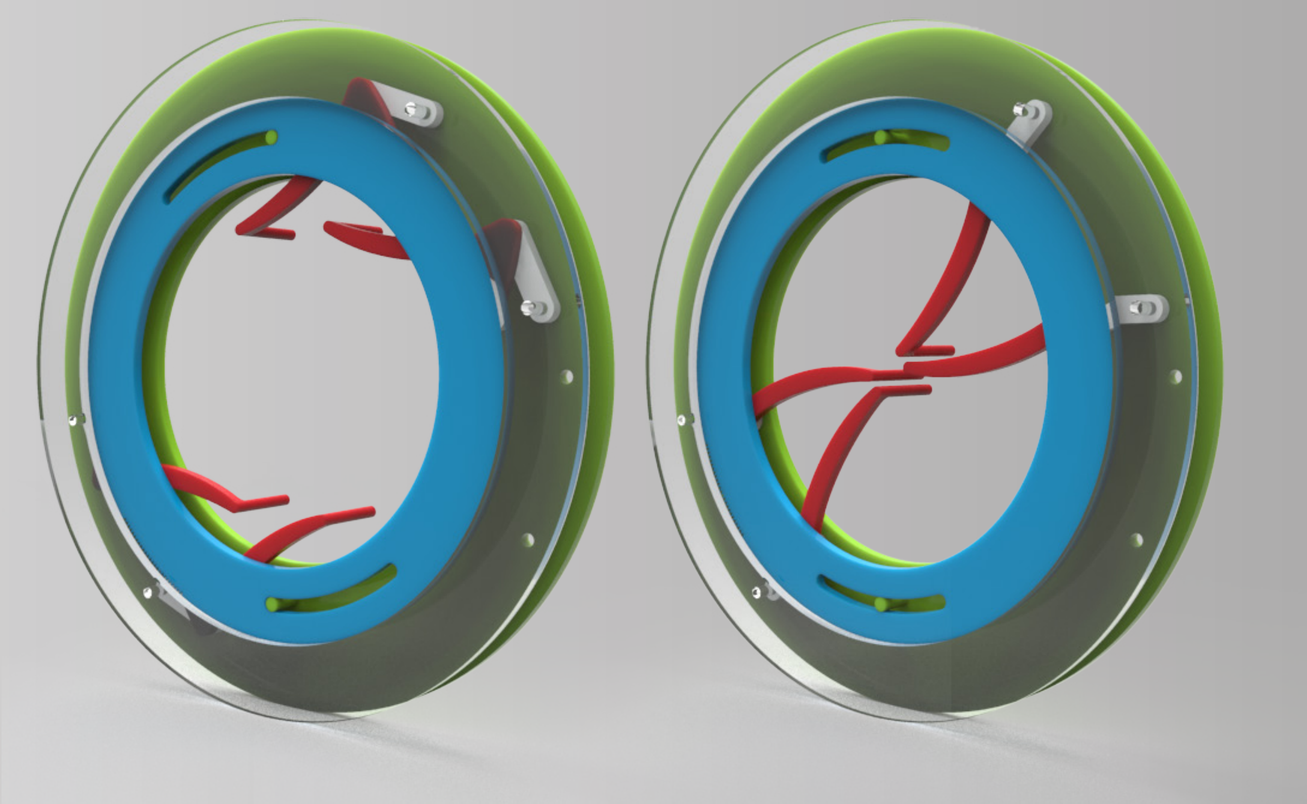
With the force required to make the deformation on the glove now known, we need to know the force required to overcome the friction of steel on steel lubricated. The force of mass is multiplied with the coefficient of friction of 0,23 (Friction and Friction Coefficients, n.d.)

Angle θ	=	35 degrees	
t	=	2 [s]	
Regression parameters			
a	=	5,8993	
b	=	-0,3484	
S_{safety}	=	1,5	
S_{loss}	=	1,5	
mass	=	0,93	[kg]
μ	=	0,04	
r_{circle}	=	110	[mm]

$$F_{friction} = m \cdot g \cdot \mu$$

The total force required is equal to.

$$F_{total} = F_{deformation} + F_{friction}$$



Ill. 145. the opening mechanism being shown marked in colors with the point of motor contact marked in blue with a radius called r_{circle} being 110 [mm] and is responsible for transfering the power from the motor to the glove

Now that we know the force required we can find the torque required to get the wanted deformation on the glove

$$\tau = F_{total} \cdot r_{circle}$$

in order to find out how much work the motor has to do we need to know the revolutions required in a given time. In these case revolutions per second.

$$rps = \frac{\theta}{360 \cdot t}$$

With the revolutions per second, we can now find the angular velocity which we can use to find the output watt of the motor using the angular velocity (ω) and the torque. (τ)

$$\omega = 2\pi \cdot rps$$

$$W_{output} = \omega \cdot \tau \cdot s_{safety}$$

W_{output} =6,123 [W], [Nm/s]

Now that we know the required output of the motor, we can use the motors efficiency to calculate the Winput of the motor which can be found as a function of the motor efficiency and further be defined as

$$W_{input} = E_{motor} \cdot W_{output}$$

$$W_{input} = V \cdot I$$

Reflection

With the safety factor of 1,5 for unaccounted forces, stresses, frictions and such. So while the motor may be over sized. This along with the data regression data from ”Worksheet: Stress strain of nitrile rubber glove” being taken as the worst case scenario points towards the 6,123 [W] likely being over dimensioned for the task.

Conclusion

We have found out that the amount of work that has to come out from the motor with a safety factor of 1,5 is 6,123 [W] with the V [V] and I [amp] depending on the selected motors efficiency.

Next step

(Which new things do we need to do now? What should we look further into?)

References
Engineeringtoolbox.com. n.d. Friction and Friction Coefficients. [online] Available at: <https://www.engineeringtoolbox.com/friction-coefficients-d_778.html> [Accessed 30 April 2021].

Stress test of resin "grabbers"

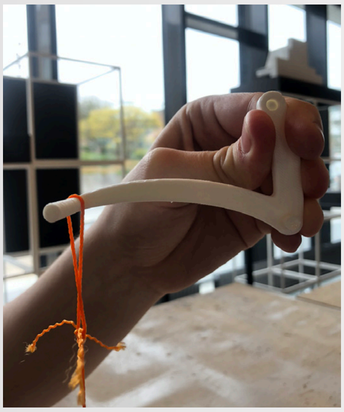
Purpose and method

The purpose have been to find out if vacuum will expand the glove and how the setup generally will be set to achieve the expantion of the glove. This will be done through a prototype that includes card-board, wires, batteries, tube, glue, half a bottle and a vacuum-motor.

Empirical data and short descriptions

The purpose of this test was to see if the glove could expand when exposed to vacuum. The model was made out of cardboard, half of a coca-cola bottle (1L), a small vacuum motor, glue, tube and wires. By drilling a hole in the bottom of the bottle, one could glue the bottom to the tube, and by filling the front with a glove, a successful vacuum happened.

Ill. 146. Testing strength by lifting 400ml



Ill. 147. Testing close-up

Ill. 148. Silicone form and resin model with kobber inside for increased strength

Analysis/Interpretation

The test was successful in the sense that the glove was expanded as hoped and expected.
It took 10 seconds.

Reflection

There was nearly not enough room in the bottle for my hand to be there, so that differently has to be bigger. A bigger room also means more space and thereby needs a stronger vacuum. The glove was inserted manually, we need to find out what kind of mechanism will be smart to load the glove automatically.

Conclusion

Vacuum works to expand the glove

Next step

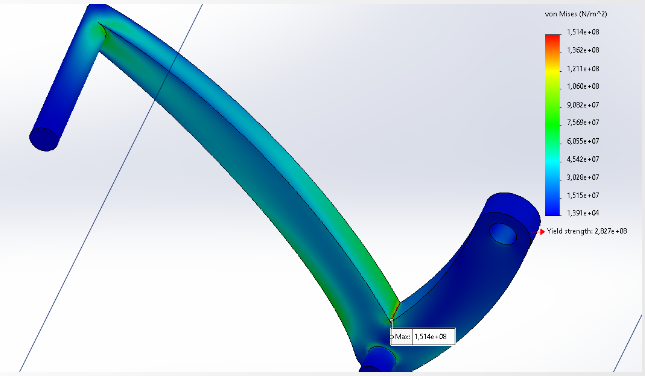
Finding out which size the "room" should be for a fitting and comfortable hand
Find out the mechanisme that should be able to load gloves into a position

Stress strain analysis

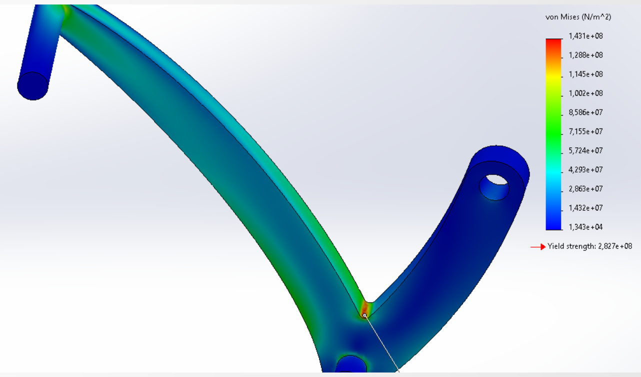
Purpose and method

To find out how durable the glove spreader arm is and how much force can be applied to it before breaking a finite element analysis needs to be carried out. While a calculation could be carried out as well, the complexity of the shape would give a large error and would be somewhat incomparable

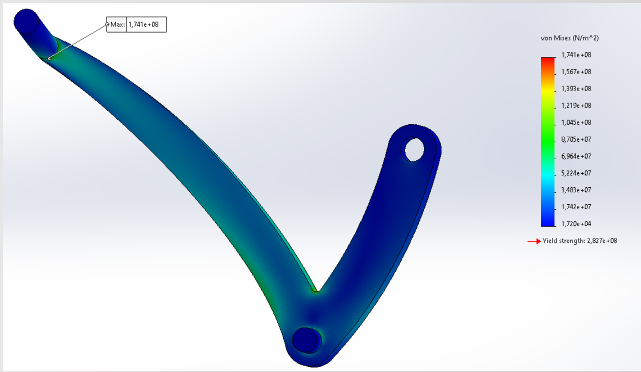
Empirical data and short descriptions



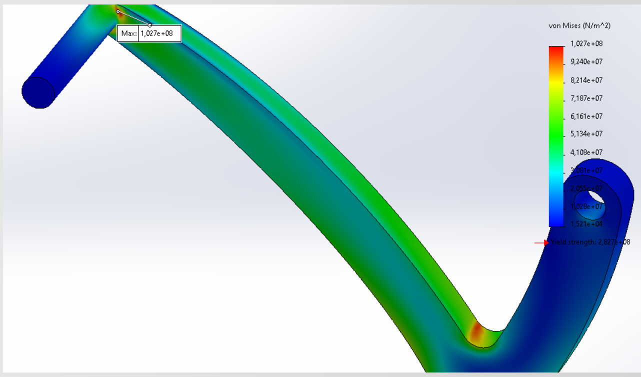
Ill. 149. finite element simulation of the spreader arm in the start configurations showing large stress conccentrations in the seam. while still being within strength requirements is concerning to see. the material tested being steel



Ill. 150. With a fillet given to the stress concentrations found the location of a former ”fix” to the concentration issue has shown up again as a problem.



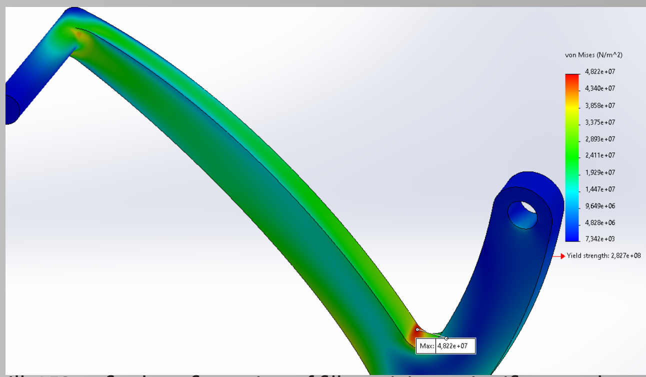
Ill. 151. location of stress concentration has been given a fillet to spread out the load an decrease the stress concentration, in turn showing the location of another stress concentration



Ill. 152. the fillets used to fix the stress concentrations has been increased to spread out the load further

Analysis/Interpretation

With a yield strength of 2,827e8 (282 700 000) N/m2 and the stresses being between 1,5e8 (150 000 000) N/m2 to 1,8e8 (180 000 000) N/m2 depending on which configuration the spreader arm is in. seeing a reduction to Ill. 153 shows 4,822e7 (48 220 000) N/m2 giving a safety factor of 5,8 should prove strong enough to not break from any sudden failures while still being able to withstand some degree of fatigue, but fatigue could become an issue in future.



Ill. 153. final configuration of fillets giving a significant reduction from the start calculations, with the potential to reduce the stress concentrations further if needed

Reflection

Hand calculations could have been used to supplement any mesh errors in the simulation that would have given false indication of problems, and different mesh sizes and types could have been used to better deal with strange behavior. But the continuous stress concentrations in the same spots shows that the significant areas of concern are not unfounded

Conclusion

Using finite element the loads in the simulations were able to be better distributed in the material and lowering the stress concentrations significantly.

Next step

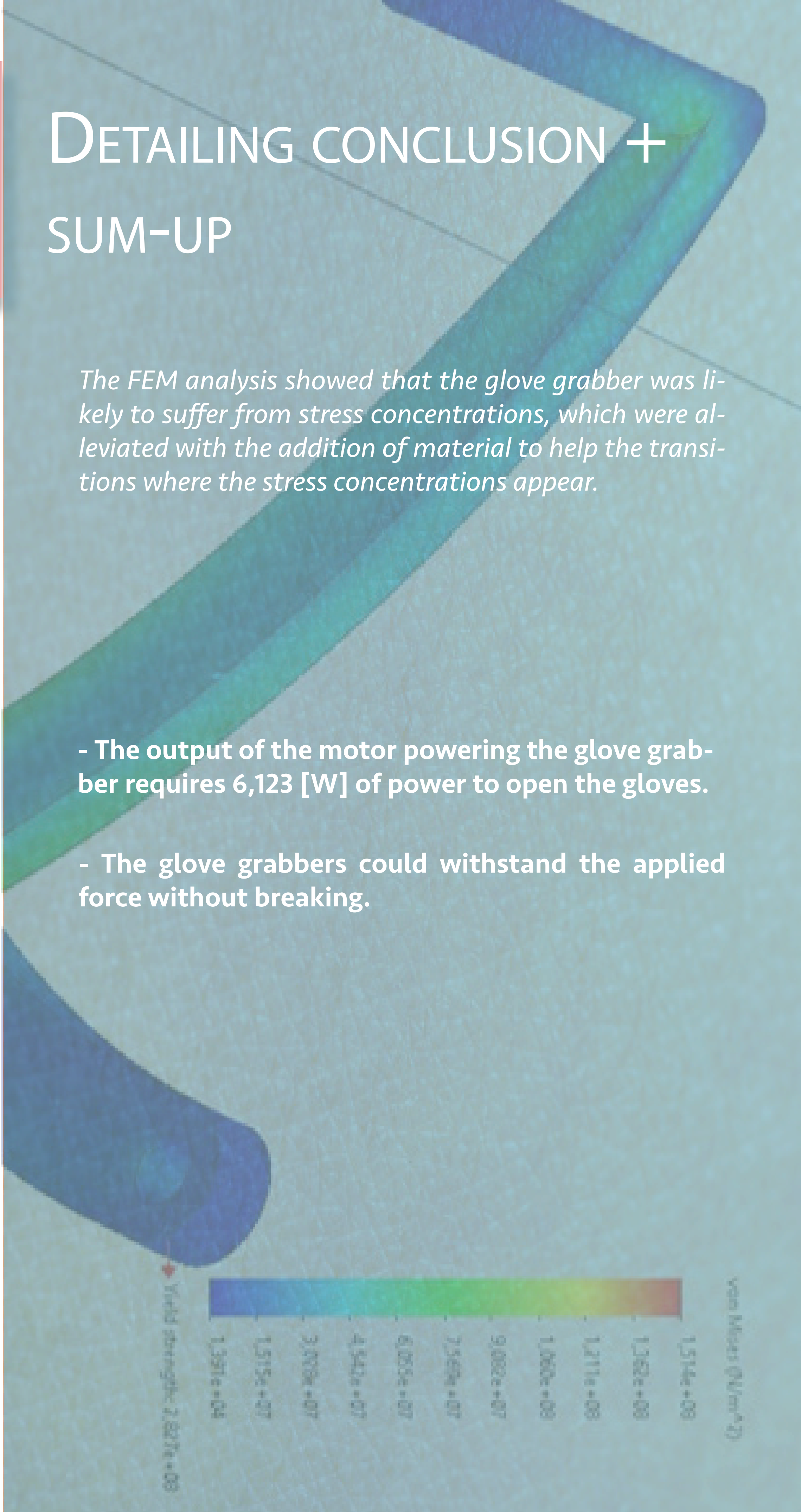
(Which new things do we need to do now? What should we look further into?)

DETAILING CONCLUSION + SUM-UP

The FEM analysis showed that the glove grabber was likely to suffer from stress concentrations, which were alleviated with the addition of material to help the transitions where the stress concentrations appear.

- The output of the motor powering the glove grabber requires 6,123 [W] of power to open the gloves.

- The glove grabbers could withstand the applied force without breaking.



Chapter 3: Business

The following chapter deals with doing business how we compare with the competition, what our beachhead market is. What the action of execution is and business canvas of the company.

What is the market?
How do we enter the market?
What is the business model?
How are we aligned with the competition?

Methodology.
The following chapter makes use of Competitor mapping, beachhead market, and business canvas to establish a business model and a setup of an execution plan to carry out the business model.

Competitor mapping
The competitor mapping looks at the IGIN glove dispenser and looks at how to align SAHD, so they have a different value proposition and use scenarios to avoid undue competition.

Beachhead Market
In the beachhead market, seven questions are asked adhering to the market and the health and plans for moving to different markets.

Business canvas
Is a tool for showing the business model and used to document the business model.

Execution plan
This section contains the plans to be carried out in the future regarding the development of the product and steps to be taken before product launch.

Competitor mapping

Purpose and method

Compile the information we have about the competition and our own product and find areas of differentiation that would allow less direct competition on the market during the startup phase of the product. And end up with the unique selling point of the product.

Empirical data and short descriptions

IGIN
Values

Time optimization	supplyline optimization
Environmental waste reduction / glove use optimization	
Hygiene	mobility

Ill. 154. Table comes from "Worksheet: IGIN values"

The IGIN is lacking when it comes to user considerations and the user in general and doesn't come across as intuitive at all and lacks semiotic symbolism or instructions in general. Ease of use does not appear to be a general consideration for the IGIN with the exception being around the glove dressing function making the product look more like an advanced proof of concept or prototype than a finished product. "Worksheet: IGIN values"

Strengths
- High capacity of gloves
- Mobile
- Hygenic
- Quick glove dressing

Weaknesses
- Lack of user interaction points
- Lack of semiotics for product understanding
- Large footprint and bulky
- no obvious product direction
- runs on battery

SAHD
values

Hygiene Longlasting
Dependable Inclusive

As these values are the wanted values for SAHD

Analysis/Interpretation

SAHD

The SAHD has no wish at this time to be a mobile platform for glove dressing. Instead, the function is to be a stationary hygiene station where the user(s) can reliably expect the product to be placed. We do not expect a great need for several hundreds of gloves to be a necessary component of the product which will allow the product to be that much smaller. While the product being easily attachable to a power outlet does not require a battery to operate like the IGIN does as such there isn't any extra considerations for making a more longlasting product by replacing the battery every so often or the inconvenience of what to do when the charge runs out indicating the dependability of the product.
A great point for differentiation would be to improve on the semiotics to fight the weak spots of the competition. There is also the idea of glove removal and assisting the user in removing the gloves safely and contain them to a secure area.

- Clear indication of how to use the product (inclusive)
- Smaller size to better fit on a wall (inclusive)
- Stationary placement. (dependable)
- Glove removal (hygiene)
- No running the product primarily of a battery (dependable, longlasting)

Reflection

The approach towards the marked is a reactive approach, looking at what is wrong on the marked and seeing what weaknesses the competition has and trying to one up them, while adding on a few features that will help the product stand out. Meaning we have found the products unique selling points in the marked coincidentally these USP also coincides with the products values.

Conclusion

We succeded in finding ways that the values of our product and the flaws of our competitors to open up areas of differentiation where ALL of out values are represented, which is a really great boon.

- Clear indication of how to use the product (semiotics)
- Smaller size to better fit on a wall
- Stationary placement.
- Glove removal
- No running the product primarily of a battery

Next step

Compile all criterias for the requirements

Beachhead market

Purpose and method

to find out if the selected beachhead marked of danish hospitals are an appropriate beachhead marked and analyse the market by asking these 7 questions.

1. Is it well funded?
2. Do we have ready access?
3. Do we have a compelling value proposition?
4. Can we deliver the whole product?
5. How is the competition?
6. Can we use the beachhead to leverage access to other markets?
7. How does the market fit with our personal allignment?

Is it well funded?

According to the conversation with LSI (appendix xx) the funding is mostly based on the value proposition when it comes to the danish healthcare sector. If the product can become a part of best practice then the funding available becomes well secured. While there are economic incentives for innovations in the healthcare sector.

Do we have ready access to the customer?

While access has been restricted and hard to get during the Covid-19 pandemic we are hopeful that in future when the situation has gotten under control and the vast majority of Danes have been vaccinated and the state of the world goes back to ”normal” we expect the access to improve.

Do we have a compelling value proposition?

The value of reducing diseases and the spread of diseases especially when it comes to infections that are most commonly acquired during hospital stays and visits like MRSA and C. Diff. Are the main perpetrators but our product can also help as a pandemic measure to reduce the spread in hospitals.

Can we deliver the whole product?

It has always been the plan to deliver the product along with a service of gloves, so we can be sure that the gloves and the machine fit together and the requirements of the gloves meet the desired requirements for the machine to function properly.

How is the competition?

While saying that there is not competition is strictly not true, there is no product that directly competes with the functions of our product. When it comes to incumbent competitors like the glove suppliers, we will run into some pushback. But we expect that with the government incentivising innovation in the health sector will help alleviate these incumbant competitors.

Can we leverage the beachhead market?

We expect that with some hospitals using the product and hopefully seeing the improvement it brings that we can move to other countries in with the product.

That being said we also see that we can move into food suppliers by stating that these are up to the task of hospital abuse and spread.

Does the market fit with our personal allignment?

Jonas: I find the current state of the healthcare system to have areas of absurdity and places of insincerity the problem with how gloves are handled is something I find strange. The acknowledged best line of defense is being treated haphazardly by the healthcare professionals. Especially in how they are treated during the dressing phase and keeping sure that the gloves are kept safe.

Bashar: Since childhood i have personally always wanted to be a doctor and more specifillay a brain surgeon. Since then i also had a dream of becoming a dentist, so a facination in the health-care sector has always been something. As a son of a Mechanic, industrial products and mechanics have been a big part of my life. Together with my love and facination of Industrial design today, this product sums up as one big combination of both worlds that i love, the medical and industrial.

Reflection

The beachhead market shows promise but there is concerns about the normal size of the markets growth as we would struggle to keep up with a possible demand. This makes us reflect upon the fact that we would need a strong foundation of investors to be able to keep up with the market demands and expectations in regard of providing service for the product and selling of gloves.

Conclusion

The danish healthcare sector is an almost ideal place to make a beachhead market the main downside being the Covid-19 pandemic putting restrictions on the access. otherwise with government incentives and the lack of powerful encumbent competitors. coupled with the potential of the leverage granted by the marked makes it very hard to see the downsides of the market as a beachhead

Next step

Business canvas
Initial execution plan

Preliminary Business Model

Purpose and method

To create and have an understanding of a potential business case where the different aspects of a companies actions and responsibilities.

Empirical data and short descriptions

<table>
<tr>
<td rowspan="2">Key partners

Glove supplier
Investors
Manufactures</td>
<td rowspan="2">Key activities

Innovation
R&D</td>
<td rowspan="2">Value propositions

Creating a hygie-nic environment
Time saving
Sustainability</td>
<td>Customer relationships

Costumer as-sistance
B2B</td>
<td rowspan="2">Customer Segments

Healthcare sector
Food sector
Cleaning sector
Laboratories and chemical facilities</td>
</tr>
<tr>
<td>Channels

Events/ Conferences
LSI</td>
</tr>
<tr>
<td colspan="3">Cost structure

Product design
Manufacturing
Software development
Costumer service
Employees
R&D
Advertisement
Product Certifications</td>
<td colspan="2">Revenue streams

Sale of product/service
Glove supply</td>
</tr>
</table>

Reflection

This business canvas was created at the beginning of the whole process to get into the company state of mind. It hasn't been developed on since then, but would definitly be evaluated in the future of the company.

Execution plan

Phase 1: Prototypes

Development	Prototyping	Fundraising	Manufacture
Glove grabber carriage	Test: Functions	Find angel investor	Create prototypes for functions
Glove grabber head	Test: Interaction between components	Apply for grants	Create prototypes for assembly
Interaction between components			

Phase 2: Alpha Model

Development	Prototyping	Fundraising	Manufacture
Fix issues found in tests	Test: pump	Find angel investor	Create prototypes pump test
User interaction	Test: User interaction	Apply for grants	Create prototypes User interaction
Size up the required motors and pump		Start selling Alpha models	Create Alpha model
			Setup small scale production

Phase 3: Beta Model

Development	Prototyping	Fundraising	Manufacture
Fix issues found in alpha deployment	Test: Beta Model	Find angel investor	Create Beta Model
Setup study for difference made using alpha model	Test: User interaction	Apply for grants	Create large scale production
Beta Model		Start selling Beta Models	

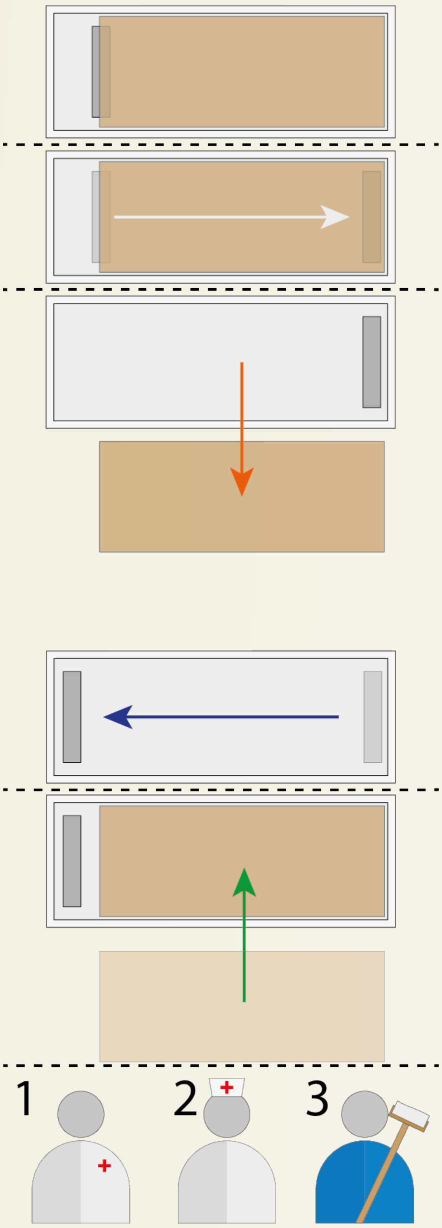
Value chain

Purpose and method

the task is to explore the different ways of storing gloves with illustrations detailing the interaction between the user and the glove refilling. Ending out with a solution that does not have a high amount of complications for its use case and looking through the different solution cases and assesing their implementation cost against eachother. and create a framework for the changes to the supply chain that follows as a result of implementation of the product.

Big box glove container

Step 1
Here the box of gloves has a considerable amount of gloves remaining



Step 2
As the gloves are being removed the compressive glove pusher is pushing the gloves close to the intended use point until there are no gloves left.

Step 3
With no more gloves left the box containing the gloves can be removed pulled out without problem.

Step 4
Having removed the container the box comes in it is now possible to reset the compressive glove pusher.

Step 5
Now that hte compressive glove pusher is reset a new container of gloves can be inserted, refilling the the amount of gloves available

This solution is intended for all types of users, where the estimated primary refiller being the doctor or nurse who needs to use the gloves.

Step 1
Multiple containers of gloves are stacked and kept in place by the pressure from the compressive glove pusher

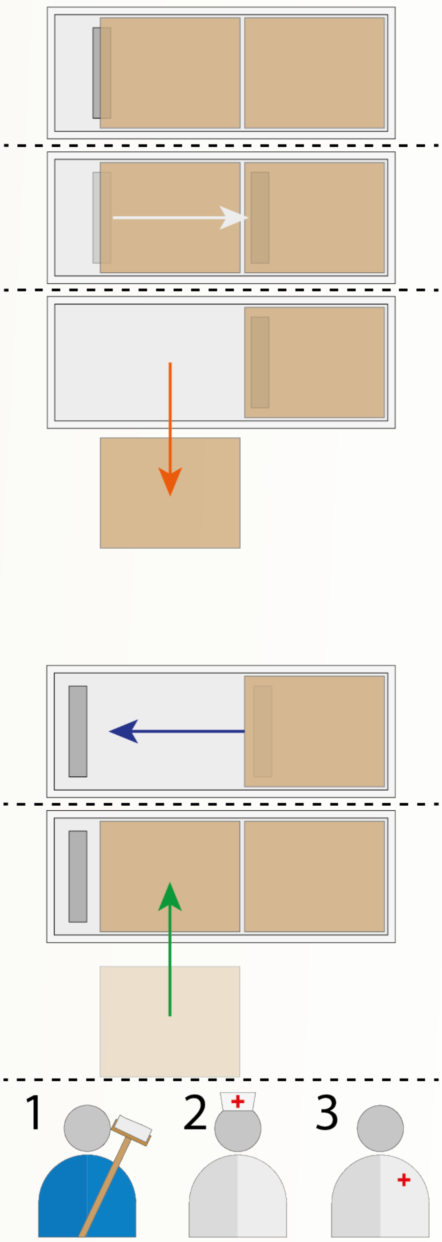
Step 2
As the gloves are being used up the compressive glove pusher moves further along its path

Step 3
when the compressive glove pusher has moved past a glove container completely it can be removed from the stack.

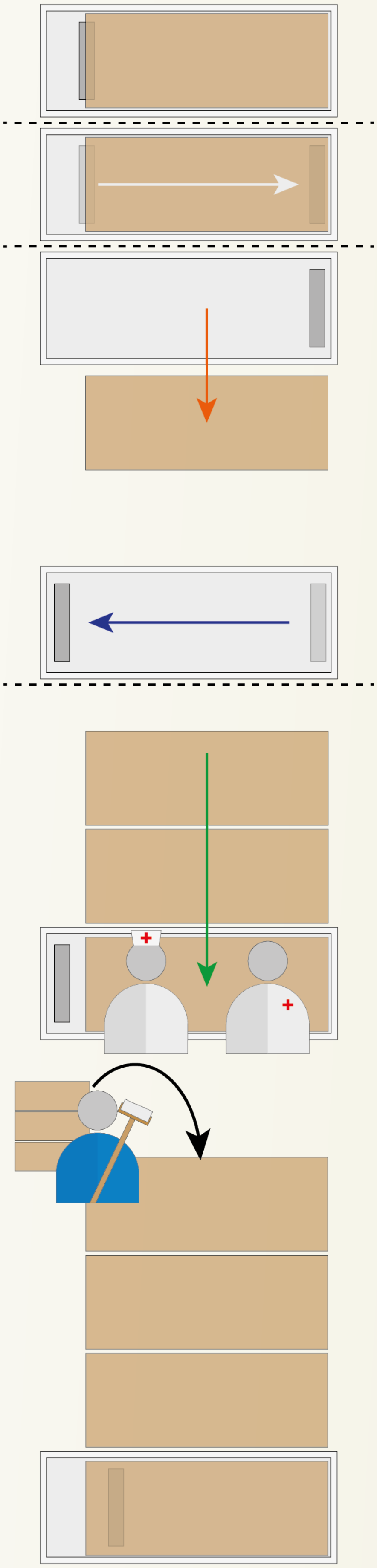
Step 4
with the container removed the compressive glove pusher can be reset.

Step 5
with the compressive glove pusher reset a new container of gloves can be inserted and be refilled.

This method is primary dependent on maintenance staff to restock the machine before it runs out of gloves and in worst case a nurse or a doctor can refill it in case they run out.



Quick glove container replacement



Step 1
Here the box of gloves has a considerable amount of gloves remaining

Step 2
As the gloves are being removed the compressive glove pusher is pushing the gloves close to the intended use point until there are no gloves left.

Step 3
With no more gloves left the box containing the gloves can be removed pulled out without problem.

Step 4
Having removed the container the box comes in it is now possible to reset the compressive glove pusher.

Step 5
with the compressive glove pusher reset the next box in line can slide down to take the place of the removed box, from the stack of glove boxes

Step 6
Maintenance staff refills the stack of glove boxes when there are no longer a large stack of boxes of gloves stacked on top of eachother

Analysis/Interpretation

Big box glove container
It fulfill everything that is required of a glove storage solution, it comes with the downside of only having the cartridge replaceable when it runs out of gloves

Multiple glove box compartment
While the fact that not running out of gloves is a good thing, keeping track of when the compartments are in need of restocking and making sure that the compartments are restockable while also being able to feed from one box of gloves to another may be a bigger challenge than just letting the machine run out of gloves.

Quick glove container replacement
while it is possible to do this, it is not possible to implement in the current configuration of the product, and requires extensive redesign and reconfiguration just to add a storage for glove boxes which doesn't add much to the product aside from making the product larger than it needs to be. While much the same could be achieved by having a few extra boxes of gloves placed next to the machine.

Reflection

the resulting solutions are variations of the same solution principle and does not introduce additional or different principles as such the scope of the task is not as exploratory as it could have been but more of an ivestigative comparison between a few variations of solutions.

Conclusion

in conclussion Big box glove container is the solution going forward as it has the least amount of complications with the design going forward requiring the following.

- A way to keep the gloves hygeinic while refilling
- a way to have the compressive glove pusher compress the gloves while making the glove box extractable.
- A sanitary solution to compressing the gloves.

Next step

HOW IS THE BOX SHAPED AND HOW IS THE REQURIEMENTS BUILD INTO THE SOLUTION

Conclusion

The master thesis project has worked with two problems the first one was the annoyance created by putting on nitrile rubber gloves and the other was the hygiene problems that was discovered during a conversation with LSI. Learning about the hygiene problem and the damage to society the problem has made for a change in priorities, the time it takes to put on a pair of gloves was no longer as big of an issue, this is not to say it is not important. If it takes too long time to put on a pair of gloves the product would likely not be used, so this aspect should not dissuade people from using the product, but no further than that. Shifting to hygiene also impacted the value proposition greatly, the value proposition was immediately changed from a nice to have product to a need to have product as 75 000 Americans die because of hospital acquired infections each year, many of which could have been avoided, we have purposefully avoided asking the question of how much this cost society as it would quickly become a very advanced calculation and could be the theme of an entire research paper to figure out but we suspect with the extra hospital beds used and lost work hours quickly becomes a number in the billions of $ in lost value.

SAHD focuses primarily on getting your hand gloved without creating contact with the outside of the glove when putting on the gloves. SAHD removes any interaction that requires a user to place their hands on the glove leaving them with only touching the inside of the glove as their hands slide on inside. Removing not the need for frequent cleaning of hands but the tolerances required when washing hands. Lowering the risk of unintended infections and spread of disease in an environment where people are already in a weakened state. SAHD would be an effective product for hospitals and healthcare clinics to keep communicative diseases and infections under control where they are most needed to be under control. This combined with an industry that knows it needs better ways of putting on gloves especially with powdered gloves being removed from the market leaving gloves harder to put on properly.

Reflection & to do next

Challenges: Covid-19

During the project, the corona pandemic has had its impact on the development process of SAHD, while the shutdown of society has been disruptive in the workflow regarding communication in the project group and with supervisors. It has also had a more direct impact on the restrictions placed on hospitals and the healthcare areas. Reducing our ability to conduct in-person testing and questioning of medical professionals. To tackle this situation, we grabbed hold of personal contacts with medical students to do early tests [test of early gloves] and quantitative questionnaires. The biggest issue that covid has brought was the restrictions in doing context analysis and verification as can be seen in [going from 3 to 2 glove sizes] where we went from small, medium, and large size gloves to small and large sizes, using assumptions photographs found on the internet, being the only point of reference and making assumptions on the relationship between the distance between a kitchen counter and kitchen above counter cabinets being equal at home and the hospital. In general, the lack of knowledge and personal reference to the context

Topology

Not working with an idea of what the design rules are, as you would know when designing furniture where you have an established ruleset to follow. Topology-free design space is always a strange place to design and develop from, so some inspiration has been drawn from IGIN to reduce the topology challenge. This, coupled with the lack of context for design, has left its marks on the product development phases, especially when working with a Lean product development. Where the lack of context left too many unknowns for too long especially in the early design phases, leaving us to do feature reduction based on a mixture of gut feelings and logical conclusion, leaving, for instance, the hand disinfection for too

Challenges: Technical aspects

Initially, we underestimated the restrictiveness of covid on getting contacts and context and we became clearer on the difficulties that would be brought along with getting the concept verification done by doctors and nurses. This, coupled with the extensive technical aspects of the product, made it a lot easier to get the technical aspects in order and choosing a challenge where we could have an active development phase when trying to do more research into the context where the access and results would be uncertain.

Future work: Glove grabber

The underdeveloped areas include the glove grabbing head and accompanying carriage for moving it around. And finding out how the accompanying system should function. Needs further development and clarification as it is now, it has been left in a black-box state with the assumption of everything working out fine. To which we use 3d printers as a guarantee of function and industrial robots for the

Disinfection

How we keep the product safely disinfected when placed and continuously operated in a “hostile” environment is a great challenge, while considerations have been made early on where the solution considered was ultraviolet and we not seeing any big reasons not, the challenge comes down to dealing with the few downsides of the technology and working with the upsides as well.

References

2010. Water jet cutting a technology on the rise. [ebook] kmt waterjet. Available at: <https://www.kmt-waterjet.com/PDF/KMT_technology%20description_ENG_101019.pdf> [Accessed 6 May 2021].

2016. *The Weldbuilt Glove Donning Machine*. [image] Available at: <https://www.youtube.com/watch?v=pzCnovFClAs> [Accessed 2 June 2021].

2017. medical examination room. [image] Available at: <https://www.nreionline.com/sites/nreionline.com/files/styles/article_featured_standard/public/medical-office-examining-room.jpg?itok=1E2W8q_1> [Accessed 16 February 2021].

2019. *Covid-19*. [image] Available at: <http://www.pngall.com/coronavirus-png> [Accessed 1 June 2021].

2019. *IGIN*. [image] Available at: <https://www.youtube.com/watch?v=I8tkCHEZmKY> [Accessed 2 November 2021].

2020. Testcenter Risskov. [image] Available at: <https://www.rm.dk/globalassets/foralle/faelles_blokke/corona/billeder-testcenter-aarhus/testcenter_risskov_fullres-6.jpg> [Accessed 16 February 2021].

2021. *Bacteria*. [image] Available at: <https://www.news-medical.net/news/20210222/Disinfectants-could-be-helping-bacteria-to-become-resistant.aspx> [Accessed 1 June 2021].

Ada.org. 2016. FDA bans most powdered gloves. [online] Available at: <https://www.ada.org/en/publications/ada-news/2016-archive/december/fda-bans-most-powdered-gloves> [Accessed 3 February 2021].

advanced medical certification, n.d. glove removal. [image] Available at: <https://advancedmedicalcertification.com/wp-content/uploads/2016/11/glove-removal-a-300x300.jpg> [Accessed 23 February 2021].

amflex, 2018. Nitrile gloves. [image] Available at: <https://www.amflexind.com/wp-content/uploads/2018/01/Nitrile-gloves-1.jpg> [Accessed 9 February 2021].

Amor Digital Cutter. n.d. Corrugated/Honeycomb Cardboard Cutting with CNC Oscillating Knife Cutting Machine. [online] Available at: <https://www.amorcnclaser.com/corrugated-honeycomb-cardboard-cutting-with-cnc-oscillating-knife-cutting-machine/> [Accessed 5 May 2021].

audioengine, n.d. speakers. [image] Available at: <https://audioengineusa.com/wp-content/uploads/2018/02/black1-1.png> [Accessed 23 February 2021].

blanco, 2019. Sink. [image] Available at: <https://www.advancedcabinetry.com.au/wp-content/uploads/2019/04/Blanco-LEMISXL6SLIFK5-Flushmount-Kitchen-Sink.jpg> [Accessed 23 February 2021].

Blink.ucsd.edu. 2020. Gloves Overview. [online] Available at: <https://blink.ucsd.edu/safety/occupational/PPE/gloves/index.html#Glove-selection> [Accessed 2 February 2021].

Blink.ucsd.edu. 2020. Gloves Overview. [online] Available at: <https://blink.ucsd.edu/safety/occupational/PPE/gloves/index.html#Glove-selection> [Accessed 9 February 2021].

Borchert, M., 2020. Nitrile vs. Latex Gloves: What's the Difference?. [online] MSN. Available at: <https://www.msn.com/en-us/health/medical/nitrile-vs-latex-gloves-whats-the-difference/ar-BB135JmQ> [Accessed 2 February 2021].

Cdc.gov. 2020. When and How to Wash Your Hands | Handwashing | CDC. [online] Available at: <https://www.cdc.gov/handwashing/when-how-handwashing.html> [Accessed 10 February 2021].

Cdc.gov. 2021. FastStats. [online] Available at: <https://www.cdc.gov/nchs/fastats/emergency-department.htm> [Accessed 28 February 2021].

Danish medicines agency, 2020. Danish medicines agency medical equipment classification. [image] Available at: <https://laegemiddelstyrelsen.dk/da/~/media/02E18C9AA98F4796A10CE287CC216172.ashx> [Accessed 10 February 2021].

DOES THE GLOVE FIT? CRITICAL CONSIDERATIONS FOR THE SELECTION OF MEDICAL GLOVES. [ebook] Halyard, p.4. Available at: <https://www.halyardhealth.com/media/213510/c14219-clinical-issue-four-does-the-glove-fit.pdf> [Accessed 3 February 2021].

Dyson, n.d. Vacuum cleaner. [image] Available at: <https://www.directvacuums.co.uk/media/catalog/product/cache/1/image_lst_ea99c9f9d536d615fd6b4fb3e4dc485a/1200x1200/9df78eab33525d08d6e5fb8d27136e95/d/y/dyson-up22-lmf.f.jpg> [Accessed 22 February 2021].

En.wikipedia.org. n.d. CE marking. [online] Available at: <https://en.wikipedia.org/wiki/CE_marking> [Accessed 10 February 2021].

En.wikipedia.org. n.d. Snap-fit - Wikipedia. [online] Available at: <https://en.wikipedia.org/wiki/Snap-fit> [Accessed 10 May 2021].

Engineeringtoolbox.com. n.d. Friction and Friction Coefficients. [online] Available at: <https://www.engineeringtoolbox.com/friction-coefficients-d_778.html> [Accessed 30 April 2021].

Fleron, B., 2020. Covid-19 swab test center. [image] Available at: <https://journalistforbundet.dk/sites/default/files/2020-05/05052029-betinafleron-4079-corona_og_danskerne.jpg> [Accessed 16 February 2021].

Fortunebusinessinsights.com. 2021. Disposable Medical Gloves Market Size, Growth | Global Report [2027]. [online] Available at: <https://www.fortunebusinessinsights.com/industry-reports/disposable-medical-gloves-market-101484> [Accessed 3 February 2021].

Fortunebusinessinsights.com. 2021. Disposable Medical Gloves Market Size, Growth | Global Report [2027]. [online] Available at: <https://www.fortunebusinessinsights.com/industry-reports/disposable-medical-gloves-market-101484> [Accessed 3 February 2021].

FTCB, n.d. Lock ring. [image] Available at: <https://www.flowtrend.com/product/image/medium/117599_1.jpg> [Accessed 7 May 2021].

Giro, n.d. Giro glove size chart for mens gloves. [image] Available at: <https://dreamruns.com/media/wysiwyg/men_glove_fitguide.jpg> [Accessed 5 April 2021].

gloves online, n.d. kevlar gloves. [image] Available at: <https://www.gloves-online.com/prodimages/GO/09-K1310-2016.jpg> [Accessed 9 February 2021].

Golisano childrens hospital, n.d. Pediatric exam room. [image] Available at: <https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/childrens-hospital/tours/allergy-visit/images/AI-tour-exam-room-617.jpg> [Accessed 16 February 2021].

Grandviewresearch.com. 2020. Global Nitrile Gloves Market Size & Share Report, 2020-2027. [online] Available at: <https://www.grandviewresearch.com/industry-analysis/nitrile-gloves-market> [Accessed 3 February 2021].

home stratosphere, n.d. trashcan. [image] Available at: <https://www.homestratosphere.com/wp-content/uploads/2019/01/traditional-steel-trash-can-jan082019-min.jpg> [Accessed 22 February 2021].

HRF. n.d. 19 Uncommon Latex Allergy Statistics - HRF. [online] Available at: <https://healthresearchfunding.org/19-uncommon-latex-allergy-statistics/> [Accessed 3 February 2021].

Igintech, n.d. Back of igin. [image] Available at: <https://static.wixstatic.com/media/83a196_b4b0c7437e6243079134164341a522a6~mv2.png/v1/crop/x_0,y_448,w_1625,h_1900/fill/w_506,h_589,al_c,q_85,usm_0.66_1.00_0.01/eight2.webp> [Accessed 17 February 2021].

Igintech, n.d. Front of Igin machine. [image] Available at: <https://static.wixstatic.com/media/a53d14_b30d520d81d544e48568f3879eab1063~mv2.jpg/v1/crop/x_0,y_5,w_1272,h_1492/fill/w_503,h_588,al_c,q_80,usm_0.66_1.00_0.01/left-side-machine.webp> [Accessed 17 February 2021].

Igintech, n.d. screencapture of igin tech homepage. [image] Available at: <https://www.igintech.com/> [Accessed 17 February 2021].

K&N, 2008. Airfilter. [image] Available at: <https://www.knfilters.com/images/l/RC-5177.jpg> [Accessed 23 February 2021].

konstsmide, n.d. RGB lights. [image] Available at: <https://www.lights.ie/mini-rgb-led-rope-light-1-000-cm-139858-ie-en.html> [Accessed 23 February 2021].

Lægemiddelstyrelsen. 2018. Udvikling af medicinsk udstyr. [online] Available at: <https://laegemiddelstyrelsen.dk/da/udstyr/udvikling-af-medicinsk-udstyr/> [Accessed 10 February 2021].
Mad elevator Inc, n.d. Sherman Elevator button. [image] Available at: <https://www.vantageelevation.com/wp-content/uploads/2020/10/BS-Touchless-Pushbutton.png> [Accessed 16 April 2021].
Mad elevator inc., n.d. Phantom touch PB. [image] Available at: <https://www.madelevator.com/explore/images/Phantom-Touch-PB.png> [Accessed 14 April 2021].
Mad elevator inc., n.d. Touch to go touchscreen. [image] Available at: <https://www.madelevator.com/images/products/TouchToGoTouchscreen.jpg> [Accessed 14 April 2021].
Madelevator.com. n.d. Germ Free Elevator Solutions | COVID Solutions | MAD Elevator Inc.. [online] Available at: <https://www.madelevator.com/germ-free-elevator-solutions/page.html> [Accessed 16 April 2021].
magid, n.d. PVA gloves. [image] Available at: <https://www.magidglove.com/ansell-pva-15554-smooth-finish-poly-vinyl-alcohol-gloves-15554pp> [Accessed 9 February 2021].
Monmouth Rubber & Plastics. n.d. Is Nitrile Butadiene Rubber a Sustainable Product? - Monmouth Rubber & Plastics. [online] Available at: <https://monmouthrubber.com/is-nitrile-butadiene-rubber-a-sustainable-product/> [Accessed 2 February 2021].
n.d. Acute healtchcare hospital - exam room. [image] Available at: <https://i.pinimg.com/originals/d5/96/88/d5968842f3dad3f213d2f9e1745f0e79.jpg> [Accessed 16 February 2021].
n.d. *Autoglove*. [image] Available at: <https://www.youtube.com/watch?v=qXFq42Sj3ck> [Accessed 2 June 2021].
n.d. *Bo Christensen*. [image] Available at: <https://www.lifescienceinnovation.dk/kontakt/> [Accessed 1 June 2021].
n.d. *Bo Christensen*. [image] Available at: <https://www.lifescienceinnovation.dk/kontakt/> [Accessed 1 June 2021].
n.d. edge crimped and curled. [image] Available at: <https://i.ytimg.com/vi/L2xGNWhzAt8/maxresdefault.jpg> [Accessed 5 May 2021].
n.d. *Glove box holder*. [image] Available at: <https://www.henryschein.com/us-en/Global.aspx> [Accessed 2 June 2021].
n.d. *Glove compartment*. [image] Available at: <https://www.alibaba.com/product-detail/Plastic-Clear-Acrylic-Disposable-Glove-Box_60745223335.html> [Accessed 2 June 2021].
n.d. *Hand*. [image] Available at: <https://www.pinterest.dk/pin/504403227017664969/> [Accessed 1 June 2021].
n.d. *Hospital hallway*. [image] Available at: <https://wallpaperaccess.com/hd-hospital> [Accessed 1 June 2021].
n.d. *LSI Logo*. [image] Available at: <https://www.lifescienceinnovation.dk/> [Accessed 1 June 2021].
n.d. snap-fit. [image] Available at: <https://i.pinimg.com/originals/12/90/9a/12909a3fd2ef68e65597c7137f87853b.png> [Accessed 10 May 2021].
n.d. xometry design guide: injection molding. 2nd ed. [ebook] xometry. Available at: <https://cdn2.hubspot.net/hubfs/340051/Design_Guides/Xometry_DesignGuide_InjectionMolding.pdf> [Accessed 5 May 2021].
n.d. xometry design guide: injection molding. 2nd ed. [ebook] xometry. Available at: <https://cdn2.hubspot.net/hubfs/340051/Design_Guides/Xometry_DesignGuide_InjectionMolding.pdf> [Accessed 10 May 2021].
Noble, n.d. Latex glove. [image] Available at: <https://cdnimg.webstaurantstore.com/images/products/large/76797/441953.jpg> [Accessed 9 February 2021].

pestrolpro, 2021. PVC gloves. [image] Available at: <https://www.pestrolpro.com.au/buy-online/pvc-protective-gloves/> [Accessed 9 February 2021].
Prnewswire.com. 2021. IGIN introduces a smart device for putting on sterile gloves automatically and easily. [online] Available at: <https://www.prnewswire.com/il/news-releases/igin-introduces-a-smart-device-for-putting-on-sterile-gloves-automatically-and-easily-301206059.html> [Accessed 5 February 2021].
purell, n.d. hand sanitizer. [image] Available at: <https://images-na.ssl-images-amazon.com/images/I/61qwHSPElWL._SL1500_.jpg> [Accessed 22 February 2021].
rtGrandviewresearch.com. 2020. Global Nitrile Gloves Market Size & Share Report, 2020-2027. [online] Available at: <https://www.grandviewresearch.com/industry-analysis/nitrile-gloves-market> [Accessed 3 February 2021].
safety gloves, n.d. viton glove. [image] Available at: <https://www.safetygloves.co.uk/uvex-profaviton-butyl-rubber-and-viton-chemical-gloves-bv-06.html> [Accessed 9 February 2021].
Shiffer, S., 2017. History of Medical Gloves That Saved Millions. [online] Gloves Mag - Best Gloves Amazon Review Guide. Available at: <https://www.glovesmag.com/medical-gloves-history/> [Accessed 3 February 2021].
Showagroup.com. n.d. SHOWA - Official Glove Manufacturer | 6110PF. [online] Available at: <https://www.showagroup.com/ca/en/product/en/single-use-disposable-6110pf> [Accessed 2 February 2021].
SKF, n.d. PFTE bushings. [image] Available at: <https://www.skf.com/binaries/pub12/Images/0901d19680479877-SKF-PTFE-polyamide-bushings_tcm_12-266196.png> [Accessed 7 May 2021].
Skf.com. n.d. SKF. [online] Available at: <https://www.skf.com/group/products/plain-bearings/bushings-thrust-washers-strips> [Accessed 7 May 2021].
stoessel, k. and smith, s., 2021.
stoessel, k. and smith, s., 2021. DOES THE GLOVE FIT? CRITICAL CONSIDERATIONS FOR THE SELECTION OF MEDICAL GLOVES. [ebook] Halyard, p.4. Available at: <https://www.halyardhealth.com/media/213510/c14219-clinical-issue-four-does-the-glove-fit.pdf> [Accessed 3 February 2021].
Stormr, n.d. Neoprene gloves. [image] Available at: <https://www.tackledirect.com/stormr-rxg30n-typhoon-neoprene-gloves.html> [Accessed 9 February 2021].
Styrelsen for patientsikkerhed, n.d. Covid swab test area. [image] Available at: <https://via.ritzau.dk/data/images/00666/69cbcabf-d9a3-486d-a33b-ebe08546da2b-w_960.JPG> [Accessed 16 February 2021].
sure wave, n.d. touchless opener. [image] Available at: <http://www.accessgard.com/shop/images/D/Sure-Wave.jpg> [Accessed 22 February 2021].
sylprotec, n.d. norfoil gloves. [image] Available at: <https://www.sylprotec.com/en/disposable-latex-nitrile-vinyl-gloves/5432-27-mils-thick-silver-shield-ambidextrous-powder-free-gloves-for-chemical-protection-sold-by-pair.html> [Accessed 9 February 2021].
the safetysupply company, n.d. Butyl rubber gloves. [image] Available at: <https://static1.shop033.com/resources/7A/890/picture/5C/85677660.jpg> [Accessed 9 February 2021]. Hospital room. [image] Available at: <https://i.pinimg.com/originals/51/9b/b1/519bb1ba3c9143d8a9fb3803786f393e.jpg> [Accessed 16 February 2021].
U.S. Food and Drug Administration. 2020. Medical Gloves. [online] Available at: <https://www.fda.gov/medical-devices/personal-protective-equipment-infection-control/medical-gloves#2> [Accessed 2 February 2021].
vancouver coastal health insitute, 2017. sterilization. [image] Available at: <https://www.vchri.ca/sites/default/files/styles/article-full-masked/public/field/image/news_20170822_sterilization.jpg?itok=A3OFfFQj> [Accessed 22 February 2021].
williams sonoma, n.d. soap dispenser. [image] Available at: <https://www.williams-sonoma.ca/site/WS/Product%20Images/white-marble-soap-dispenser-hero-new-z.jpg?resizeid=102&resizeh=960&resizew=960> [Accessed 22 February 2021]. Consumerreports.org.

2015. Hospital Acquired Infections Are a Serious Risk - Consumer Reports. [online] Available at: <https://www.consumerreports.org/cro/health/hospital-acquired-infections/index.htm> [Accessed 28 February 2021].

SAHD

BASHAR SHAHMORAD
JONAS JOHANSEN
MSC04 - ID13 - 2021

S ophisticated
A utomatic
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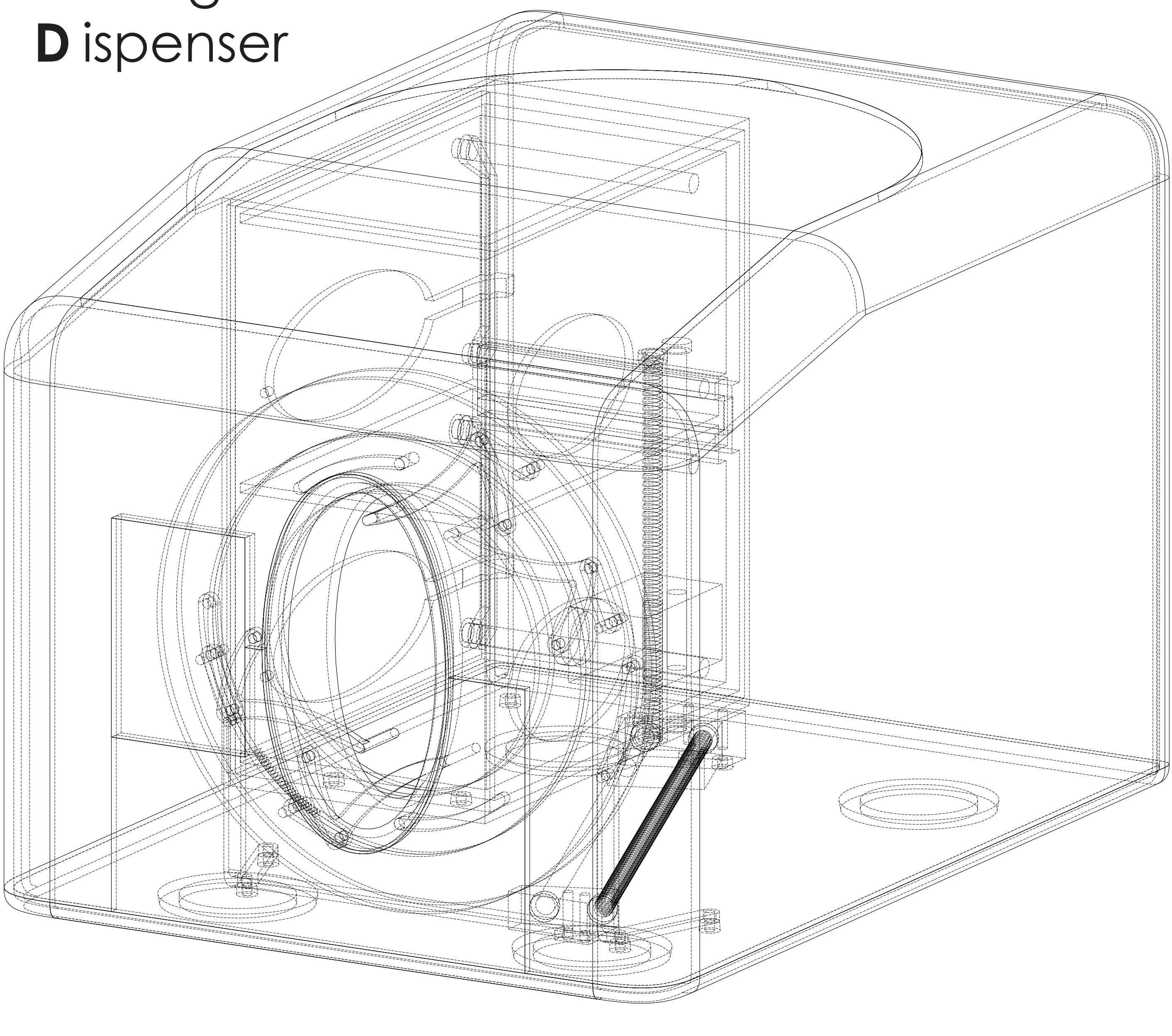
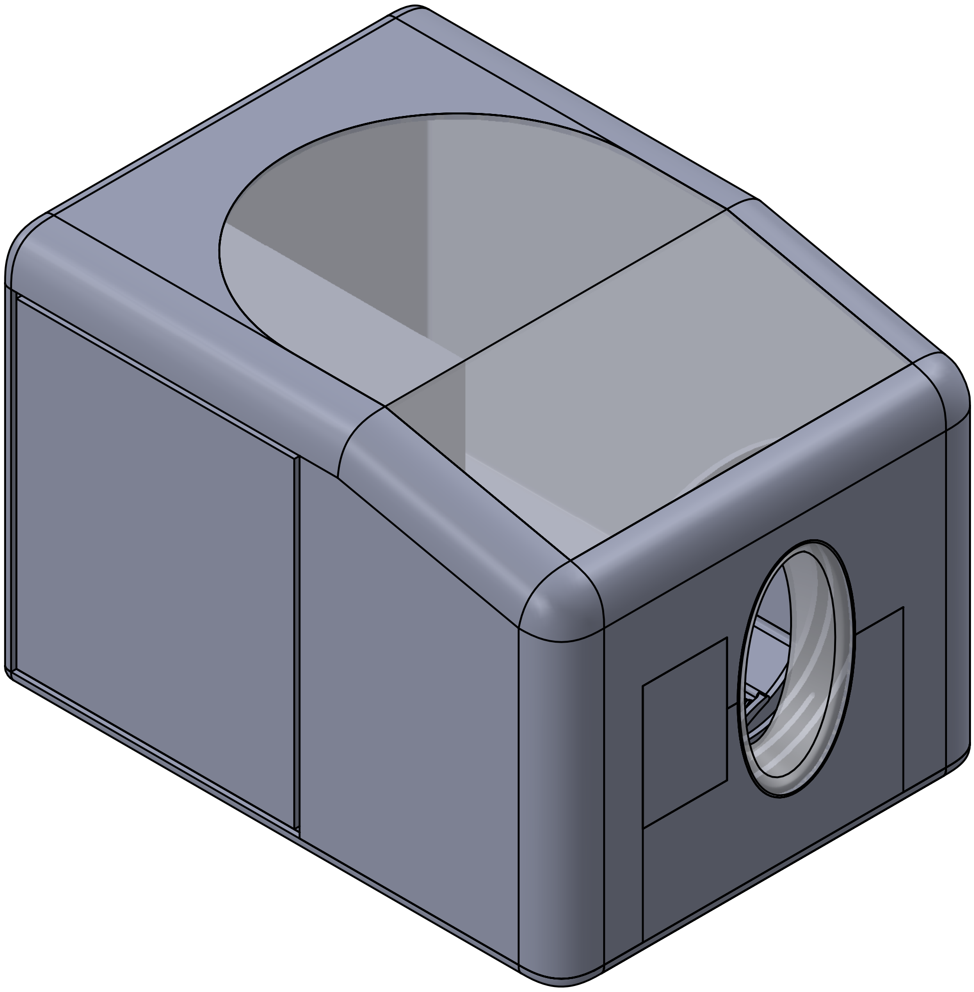
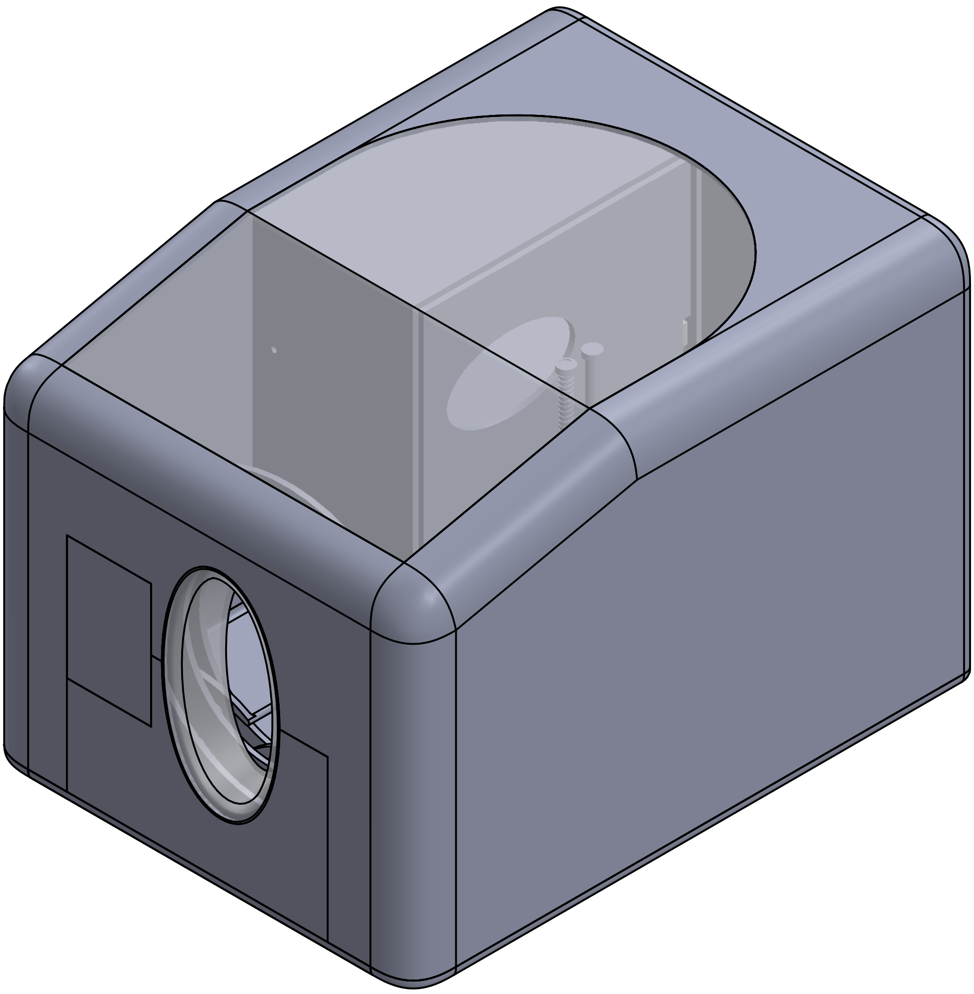


TECHNICAL DRAWINGS





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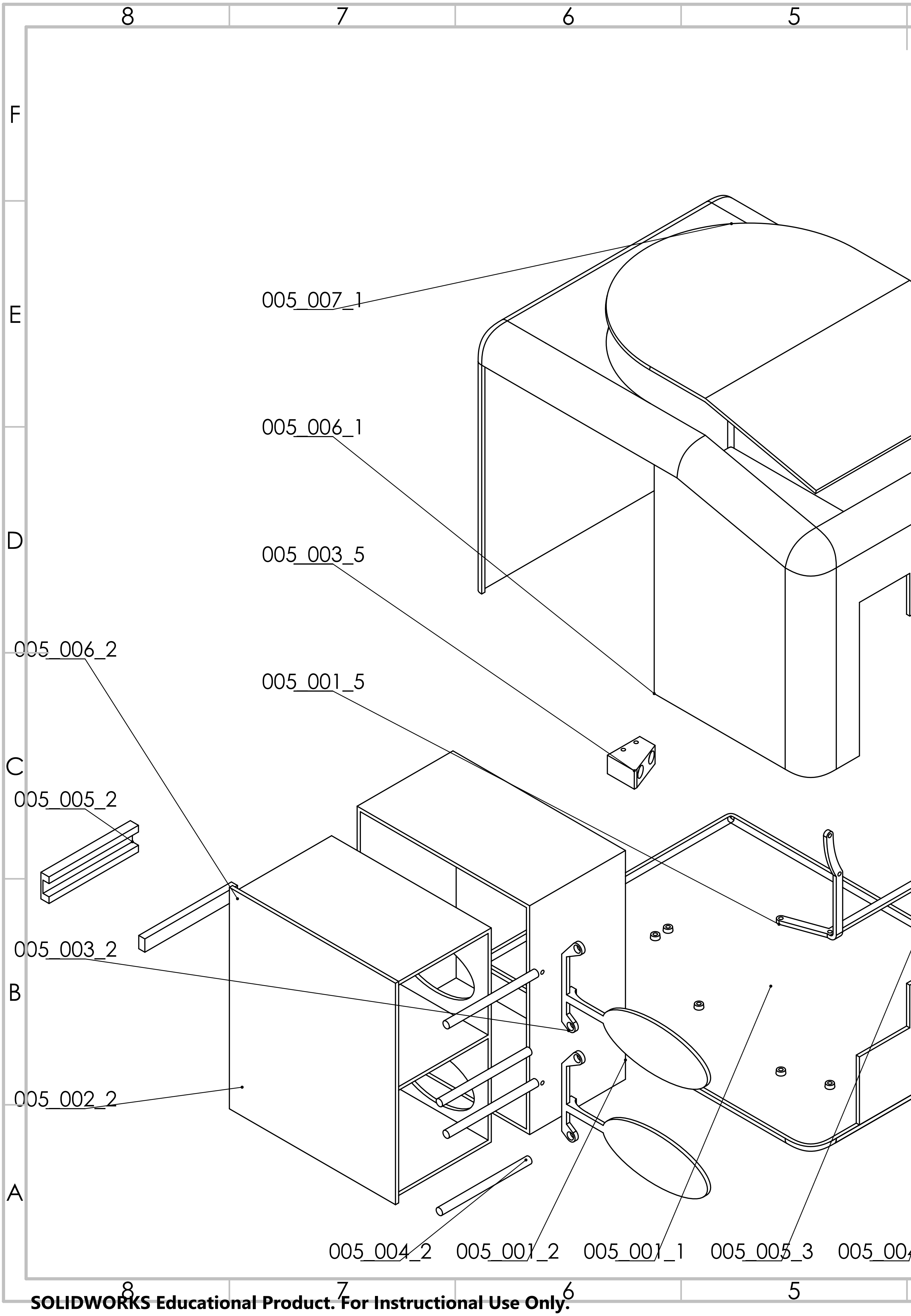
WEIGHT:			SCALE:1:5	Page 3 of 40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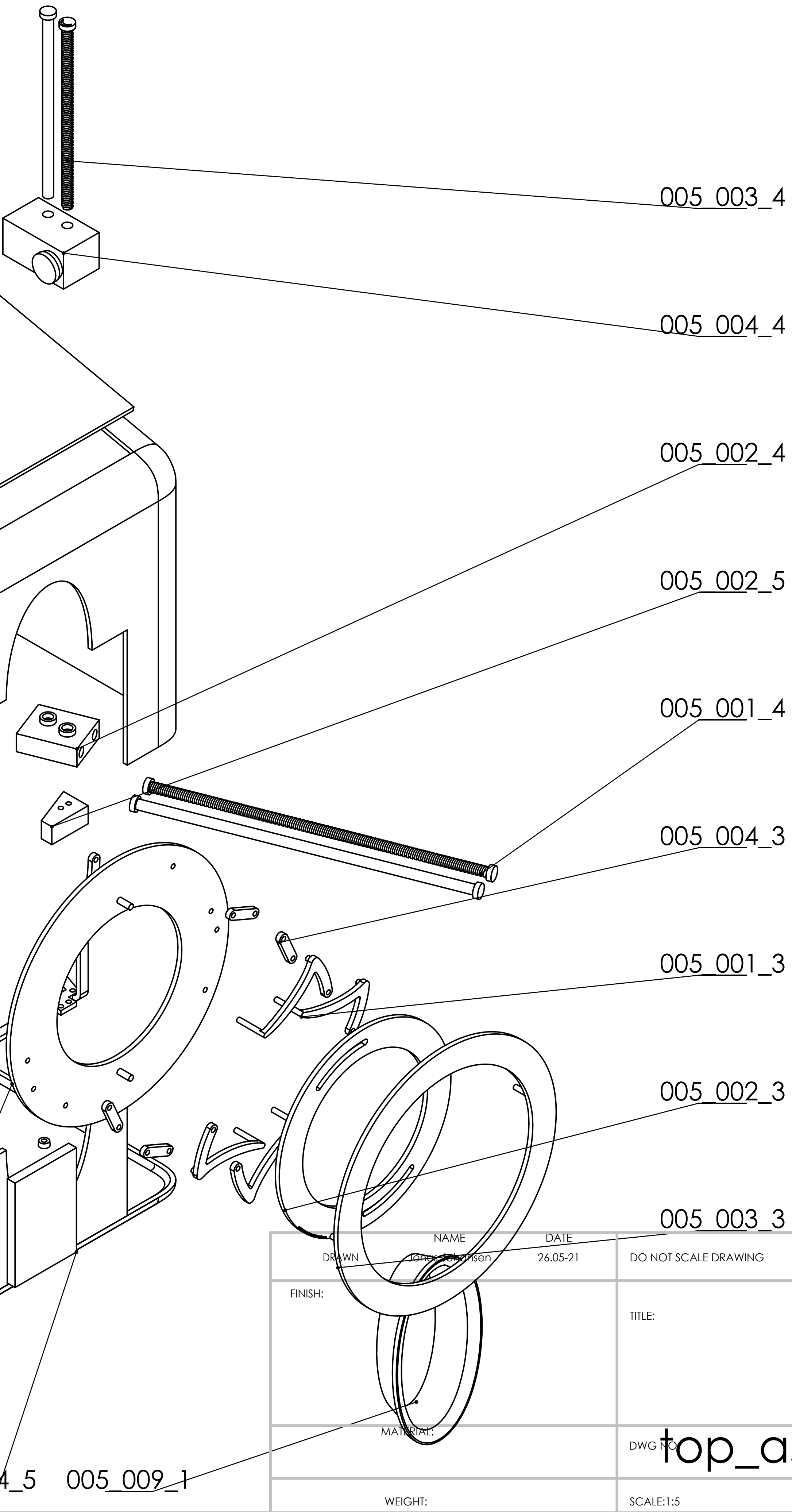

	NAME	DATE
DRAWN	Jonas Johansen	26.05-21

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Unless otherwise specified all dimensions are in mm

FINISH:

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MATERIAL:

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ITEM NO.	PART NUMBER	QTY.	Cost - Total Cost	Cost - Manufacturing Cost	Cost - Material Cost	Cost - Material Name	Cost - Stock Size	Cost - Stock Type
1	005_007_1	1	7.12	3.46	1.16	PC	NA	Plastic
2	005_006_1	1	13.38	3.46	4.92	PC	NA	Plastic
3	005_001_1	1	10.54	3.36	2.19	N/A	N/A	N/A
4	005_009_1	1	11.17	5.99	0.18	PC	NA	Plastic
5	sub_asm_03	1	49.28	37.43	2.84	N/A	N/A	N/A
5.1	005_001_3	4	3.64	3.35	0.04	Magnesium Alloy	NA	Casting
5.2	005_002_3	1	0.00	0.00	0.00	Plain Carbon Steel	8.65 x 8.66 x 0.63	Block
5.3	005_003_3	1	5.21	3.44	0.77	Magnesium Alloy	NA	Casting
5.4	005_004_3	4	3.61	3.36	0.00	PFTE	NA	Plastic
5.5	005_005_3	1	5.78	3.44	1.34	Magnesium Alloy	NA	Casting
6	sub_asm_04	1	0.00	0.00	0.00	N/A	N/A	N/A
6.1	005_001_4	1	0.00	0.00	0.00	N/A	N/A	N/A
6.2	005_002_4	1	0.00	0.00	0.00	N/A	N/A	N/A
6.3	005_004_4	1	0.00	0.00	0.00	N/A	N/A	N/A
6.4	005_003_4	1	0.00	0.00	0.00	N/A	N/A	N/A
7	005_001_5	1	8.71	3.52	0.19	7079 Alloy	NA	Casting
8	005_003_5	1	10.18	5.11	0.07	PC	NA	Plastic
9	005_002_5	1	10.14	5.11	0.03	PC	NA	Plastic
10	005_004_5	1	0.00	0.00	0.00	N/A	N/A	N/A
11	sub_asm_02	1	0.00	0.00	0.00	N/A	N/A	N/A
11.1	005_001_2	1	9.04	3.46	1.58	PC	NA	Plastic
11.2	005_002_2	1	10.99	3.46	2.53	PC	NA	Plastic
11.3	005_003_2	2	13.89	3.54	0.35	Magnesium Alloy	NA	Casting
11.4	005_004_2	1	3.35	3.01	0.34	N/A	N/A	N/A
11.5	005_006_2	1	0.00	0.00	0.00	N/A	N/A	N/A
11.6	005_005_2	1	0.00	0.00	0.00	N/A	N/A	N/A

materials marked as N/A are products to be bought
but in the case of subassemblies it is because the information is available in the components

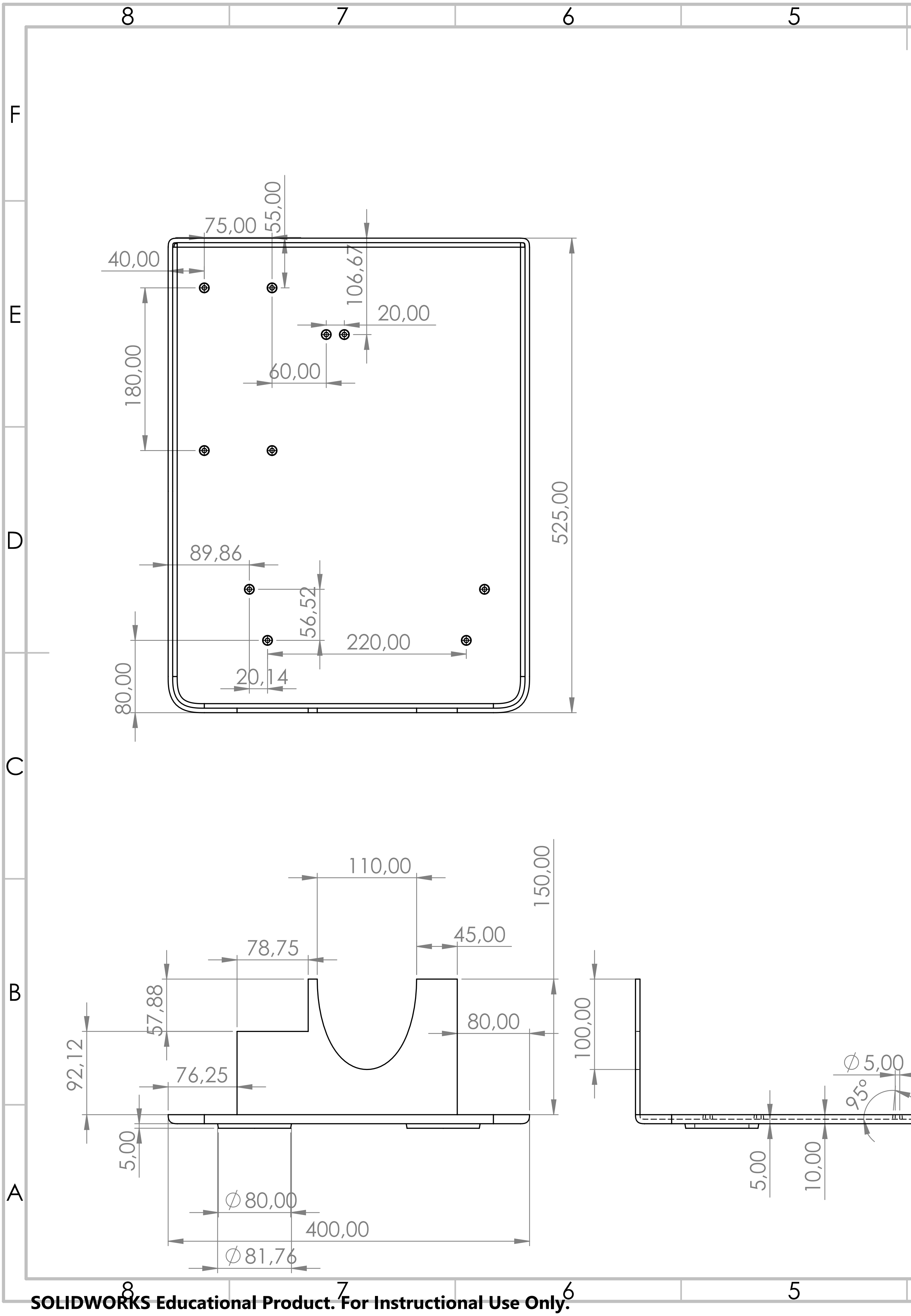
How to read

005_004_2

- 005 — Identification number
- 004 — Parts number
- 2 — Assembly number

	NAME	DATE	DO NOT SCALE DRAWING	Unless otherwise specified all prices are in USD
DRAWN	Jonas Johansen	26.05-21		
FINISH:			TITLE: Bill of Materials	
MATERIAL:			DWG NO top_asm_05	A3
WEIGHT:			SCALE:1:5	Page 7 of 40

SAHD



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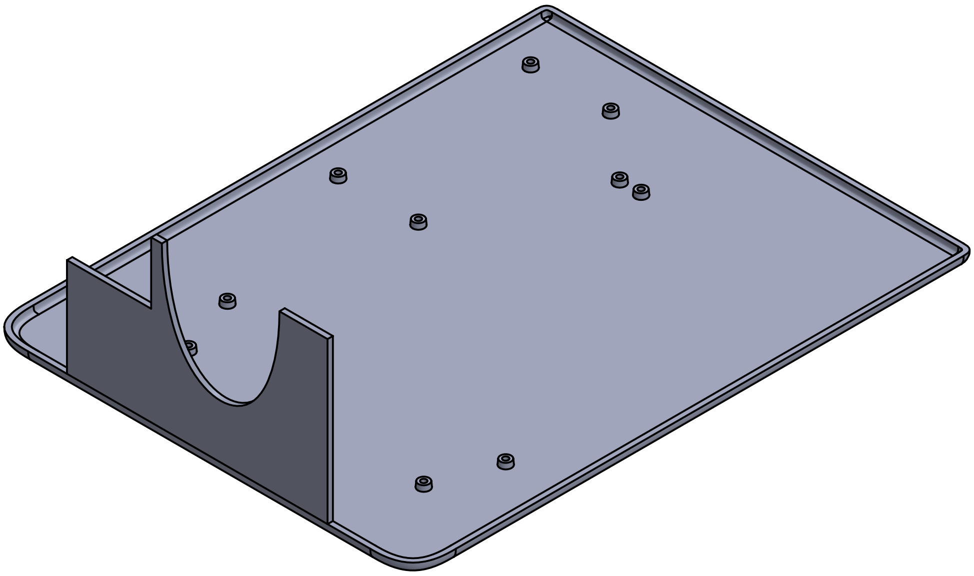
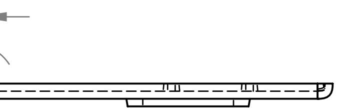
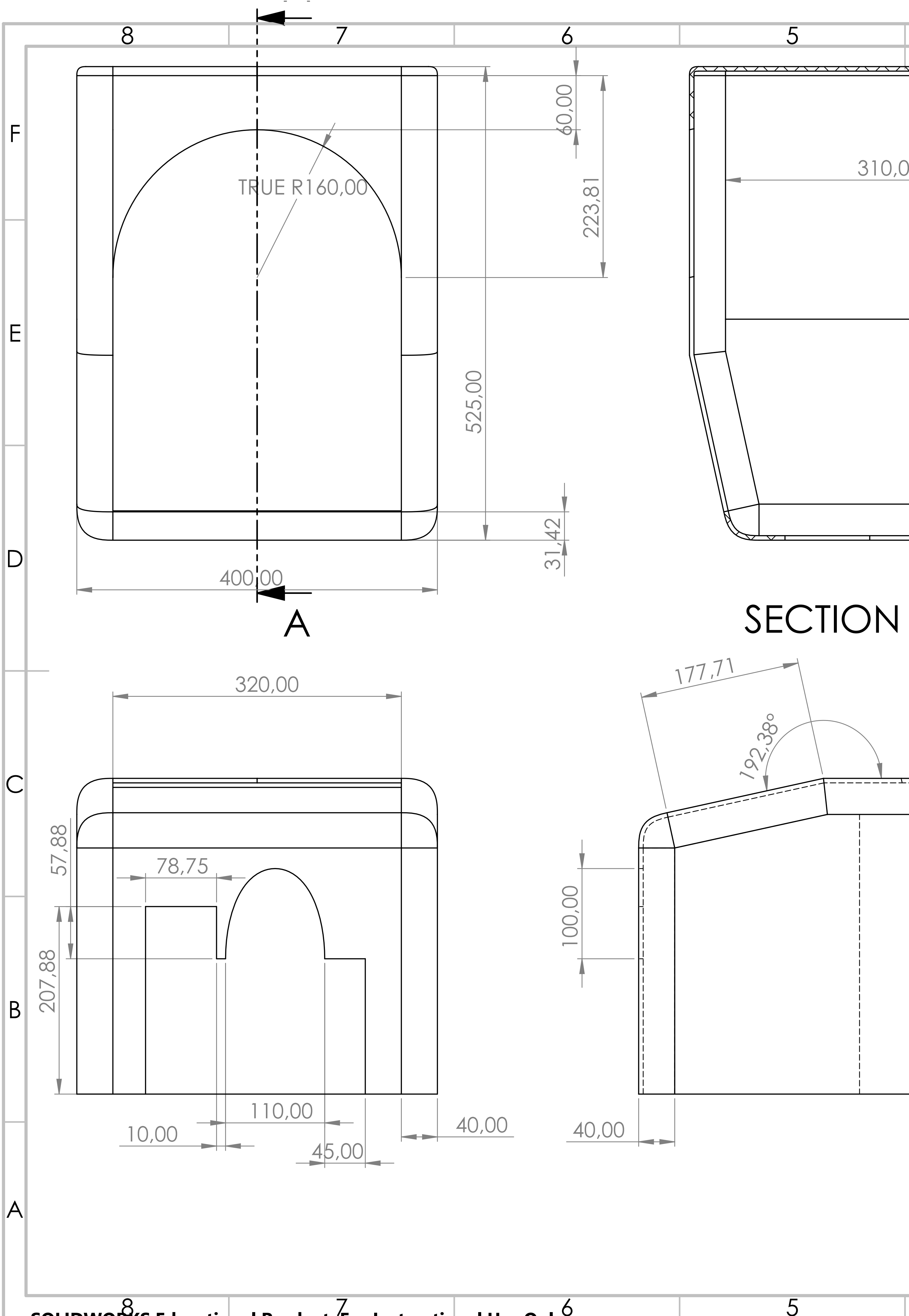
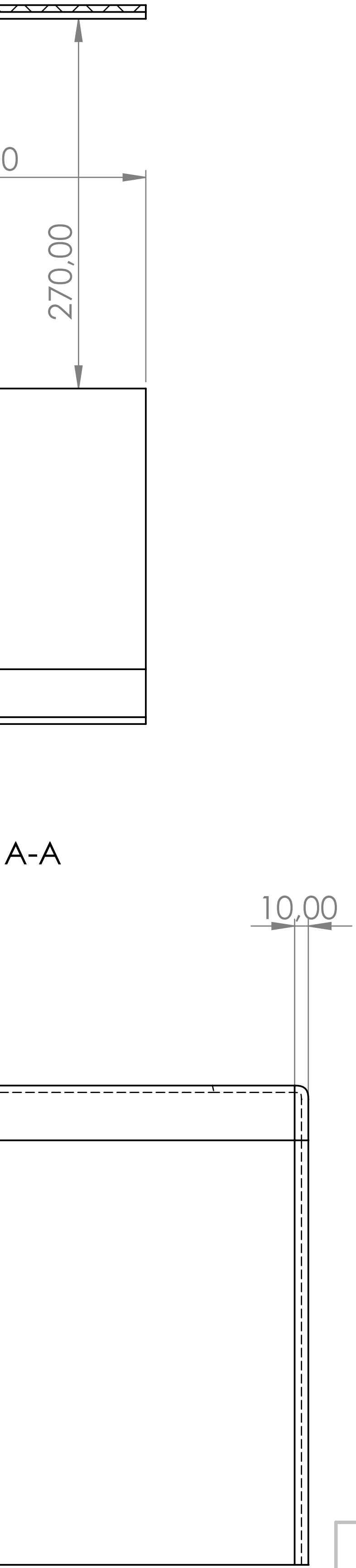
400,00
⌀81,76



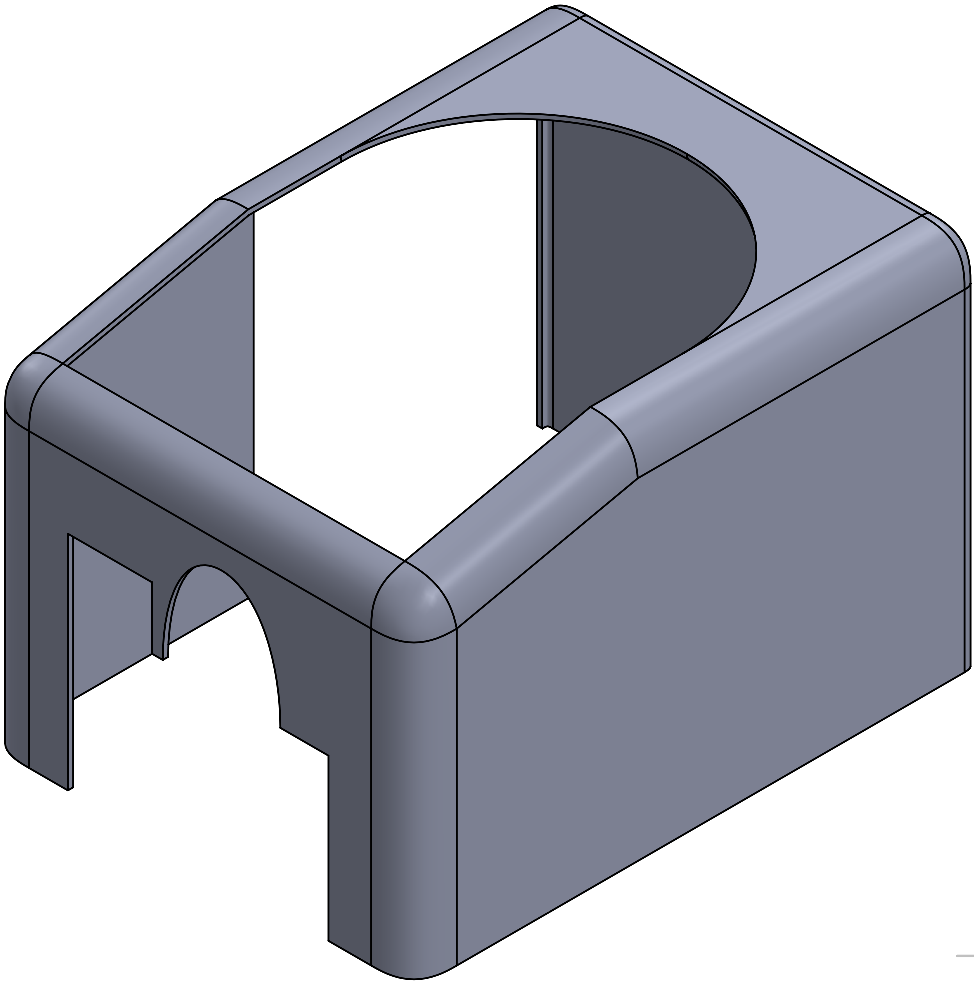


	NAME	DATE		
DRAWN	Jonas Johansen	26.05-21	DO NOT SCALE DRAWING	Unless otherwise specified all dimensions are in mm
FINISH: Mold Tech - 11010 spray dot			TITLE: 005_001_1	SAHD
MATERIAL: Poly-Carbonate (opaque)			DWG NO top_asm_05	A3
WEIGHT:			SCALE:1:5	Page 9 of 40

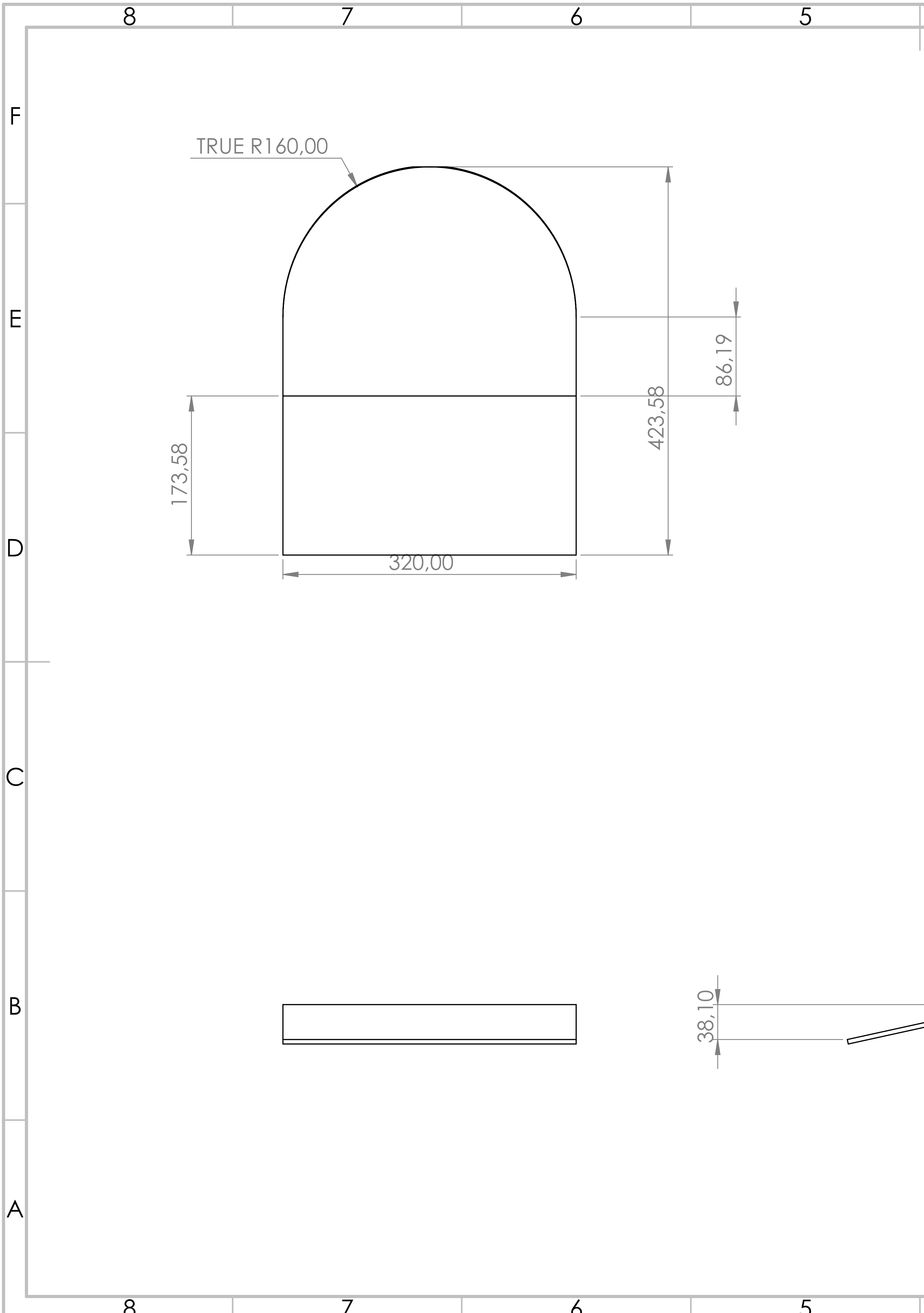

8
7
6
5
F
E
D
C
B
A
60,00
TRUE R160,00
223,81
525,00
31,42
400,00
A
310,0
SECTION
320,00
177,71
192,38°
57,88
78,75
207,88
100,00
110,00
10,00
45,00
40,00
40,00

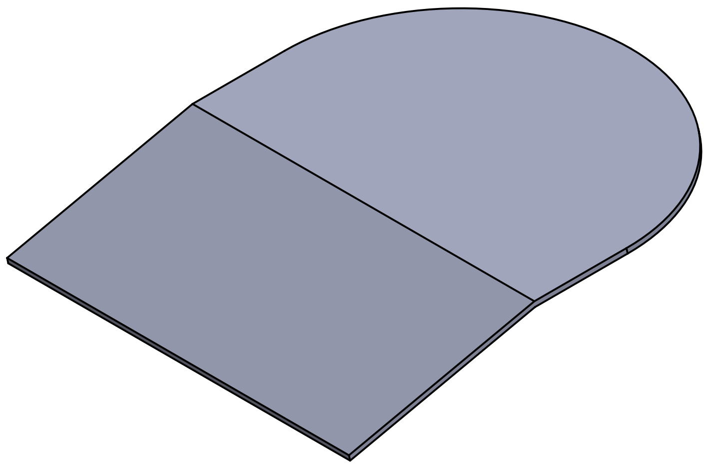


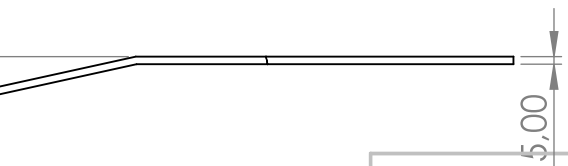
SECTION A-A



DRAWN	NAME Jonas Johansen	DATE 26.05-21	DO NOT SCALE DRAWING	Unless otherwise specified all dimensions are in mm
FINISH: Mold Tech - 11010 spray dot			TITLE: 005_006_1	SAHD
MATERIAL: Poly-Carbonate (opaque)			DWG NO top_asm_05	A3
WEIGHT:			SCALE:1:5	Page 11 of 40

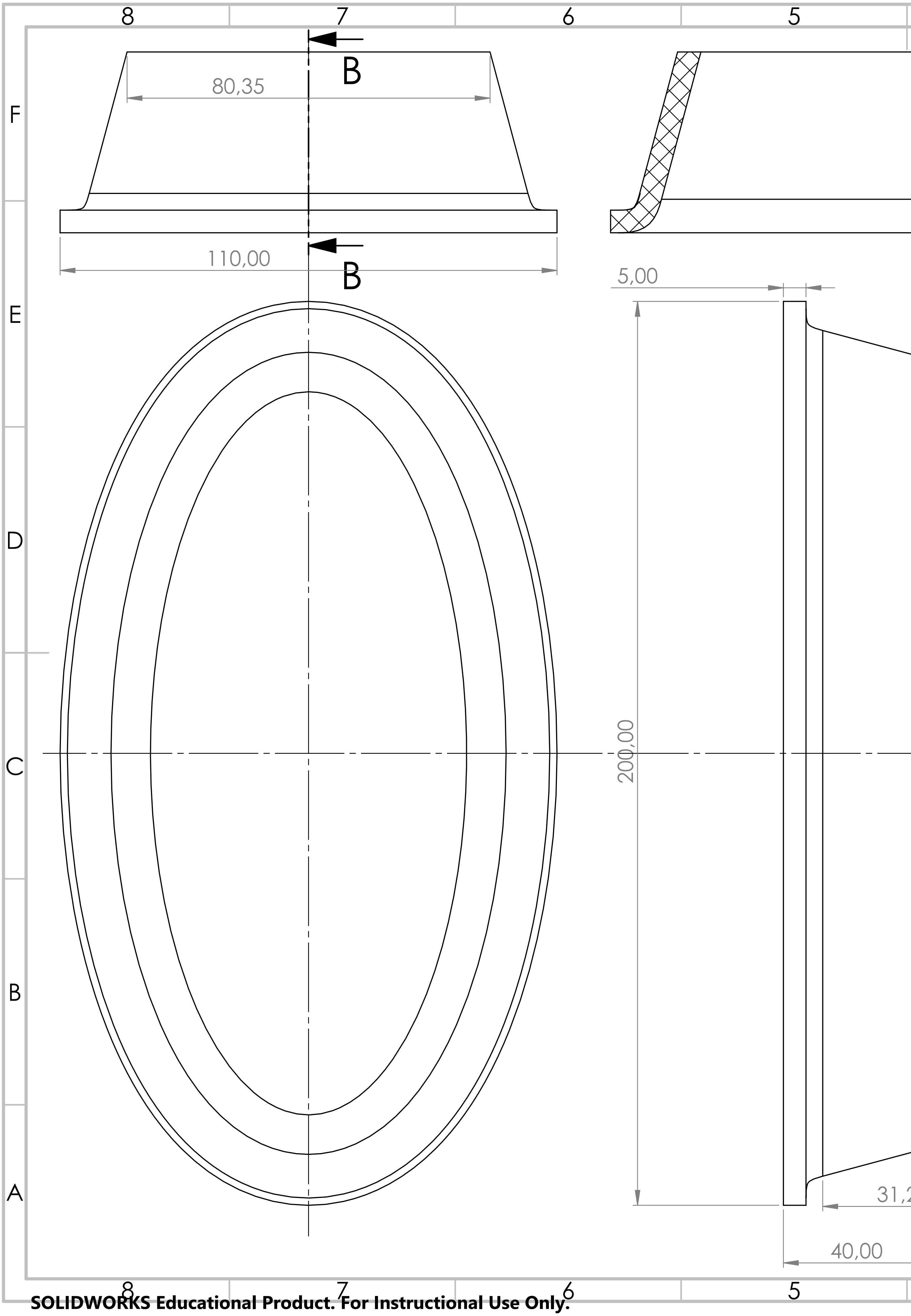

TRUE R160,00
423,58
86,19
173,58
320,00
38,10



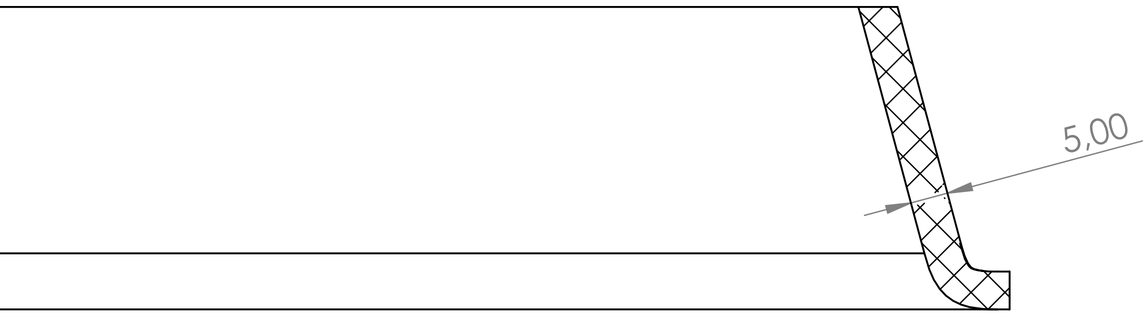


	NAME	DATE		Unless otherwise specified all dimensions are in mm
DRAWN	Jonas Johansen	26.05-21	DO NOT SCALE DRAWING	
FINISH:			TITLE: 005_007_1	
MATERIAL: Poly-Carbonate (transparent)			DWG NO. top_asm_05	A3
WEIGHT:			SCALE:1:5	Page 13 of 40

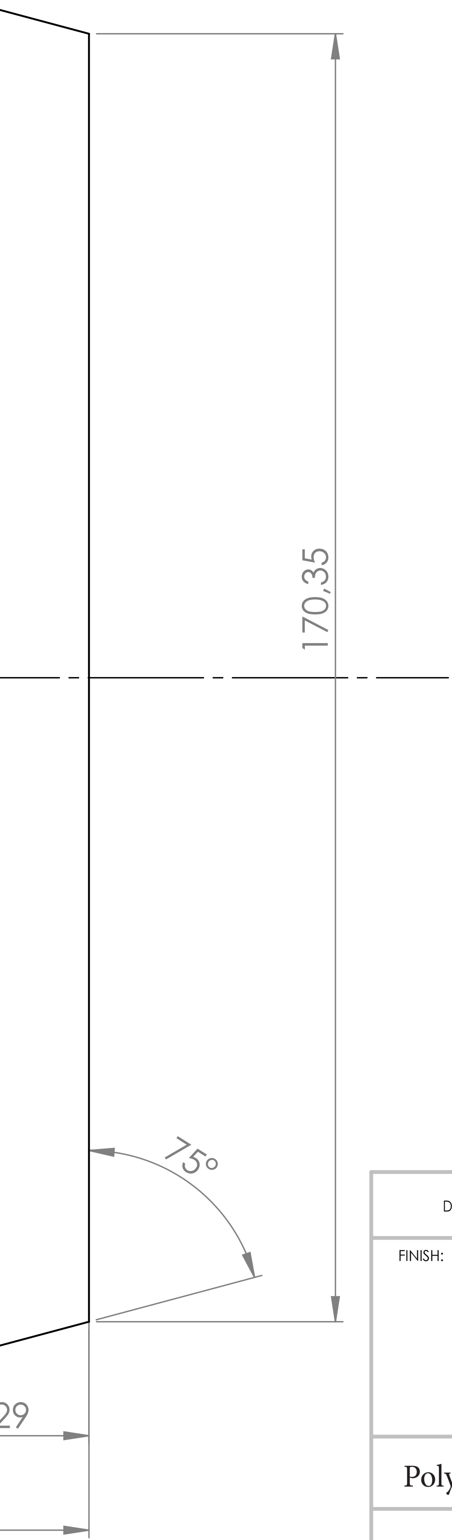
SAHD



8
7
6
5
F
E
D
C
B
A
B
80,35
110,00
B
5,00
200,00
31,2
40,00
8
7
6
5

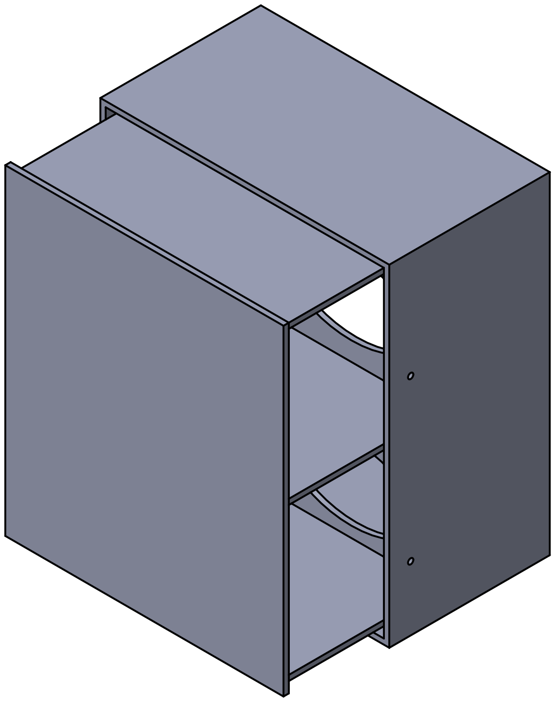


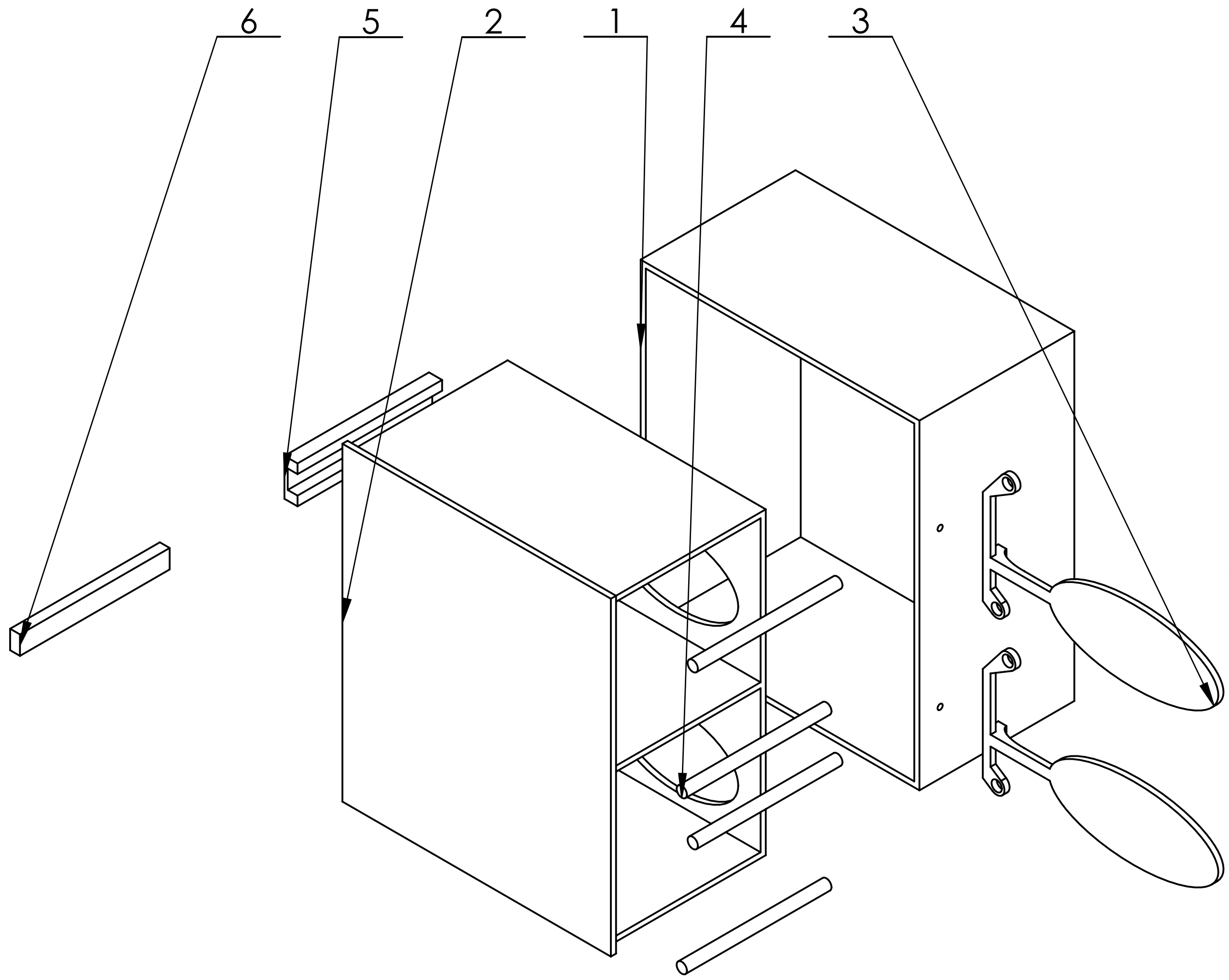
SECTION B-B



	NAME	DATE	DO NOT SCALE DRAWING	Unless otherwise specified all dimensions are in mm
DRAWN	Jonas Johansen	26.05-21		
FINISH:			TITLE: 005_009_1	SAHD
MATERIAL: Poly-Carbonate (transparent)			DWG NO. top_asm_05	A3
WEIGHT:			SCALE:1:1	Page 15 of 40

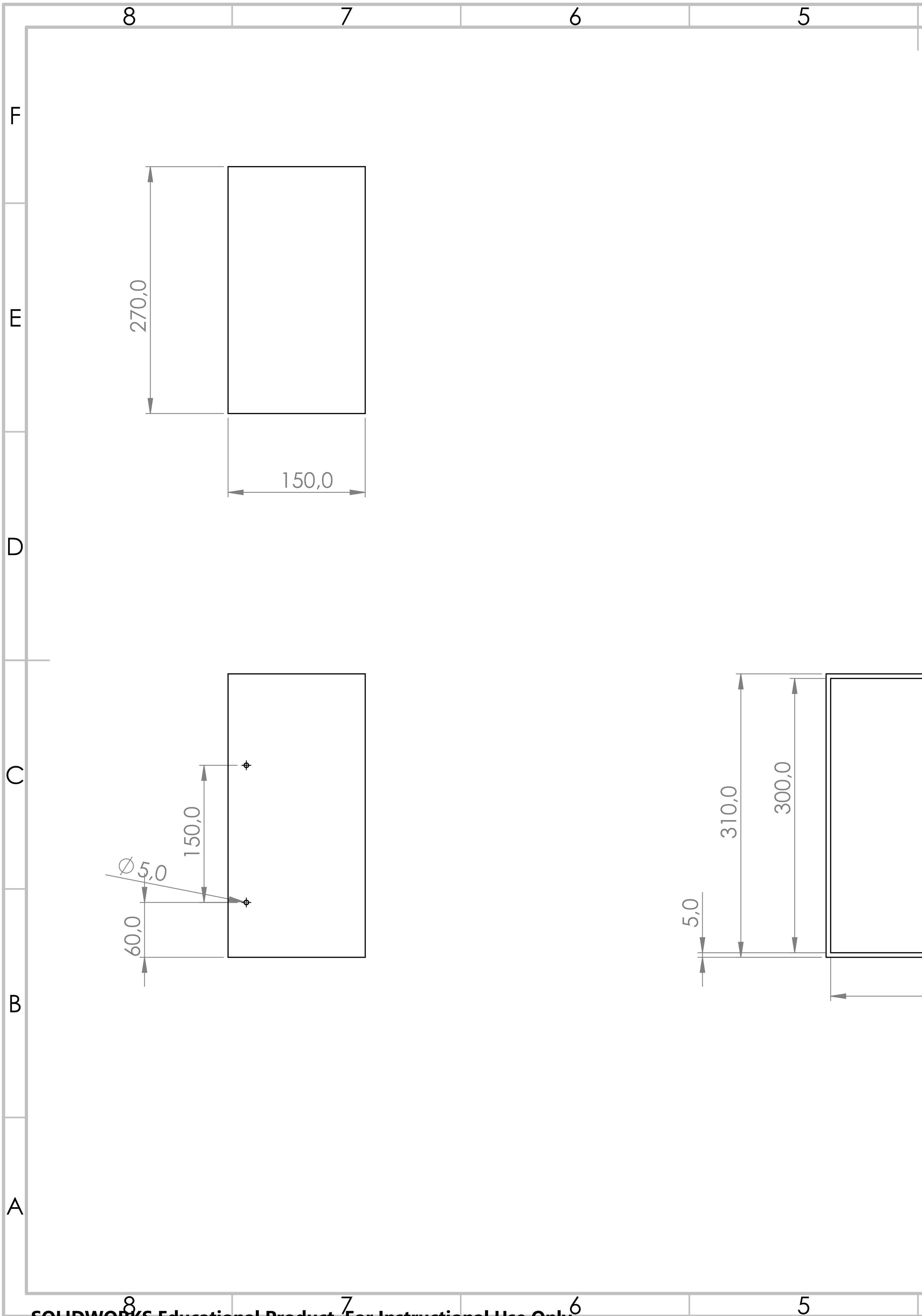
ITEM NO.	PART NUMBER	QTY.
1	005_001_2	1
2	005_002_2	1
3	005_003_2	2
4	005_004_2	4
5	005_005_2	1
6	005_006_2	1



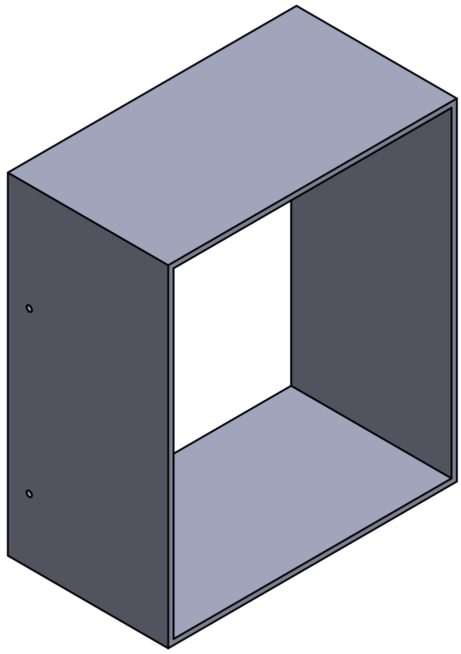


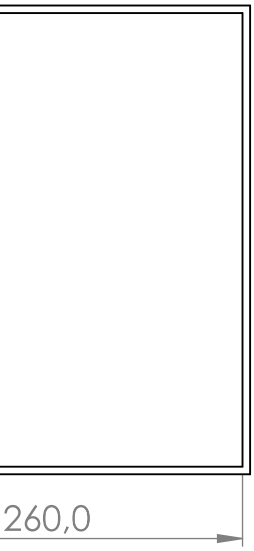
	NAME	DATE	DO NOT SCALE DRAWING	Unless otherwise specified all dimensions are in mm
DRAWN	Jonas Johansen	26.05-21		
FINISH:			TITLE:	
MATERIAL:			DWG NO. sub_asm_02	A3
WEIGHT:			SCALE:1:5	Page 17 of 40

SAHD



8
7
6
5
F
E
D
C
B
A
270,0
150,0
150,0
⌀5,0
60,0
310,0
300,0
5,0





	NAME	DATE	
DRAWN	Jonas Johansen	26.05-21	DO NOT SCALE DRAWING

Unless otherwise specified
all dimensions are in mm

FINISH:

TITLE:
005_001_2

SAHD

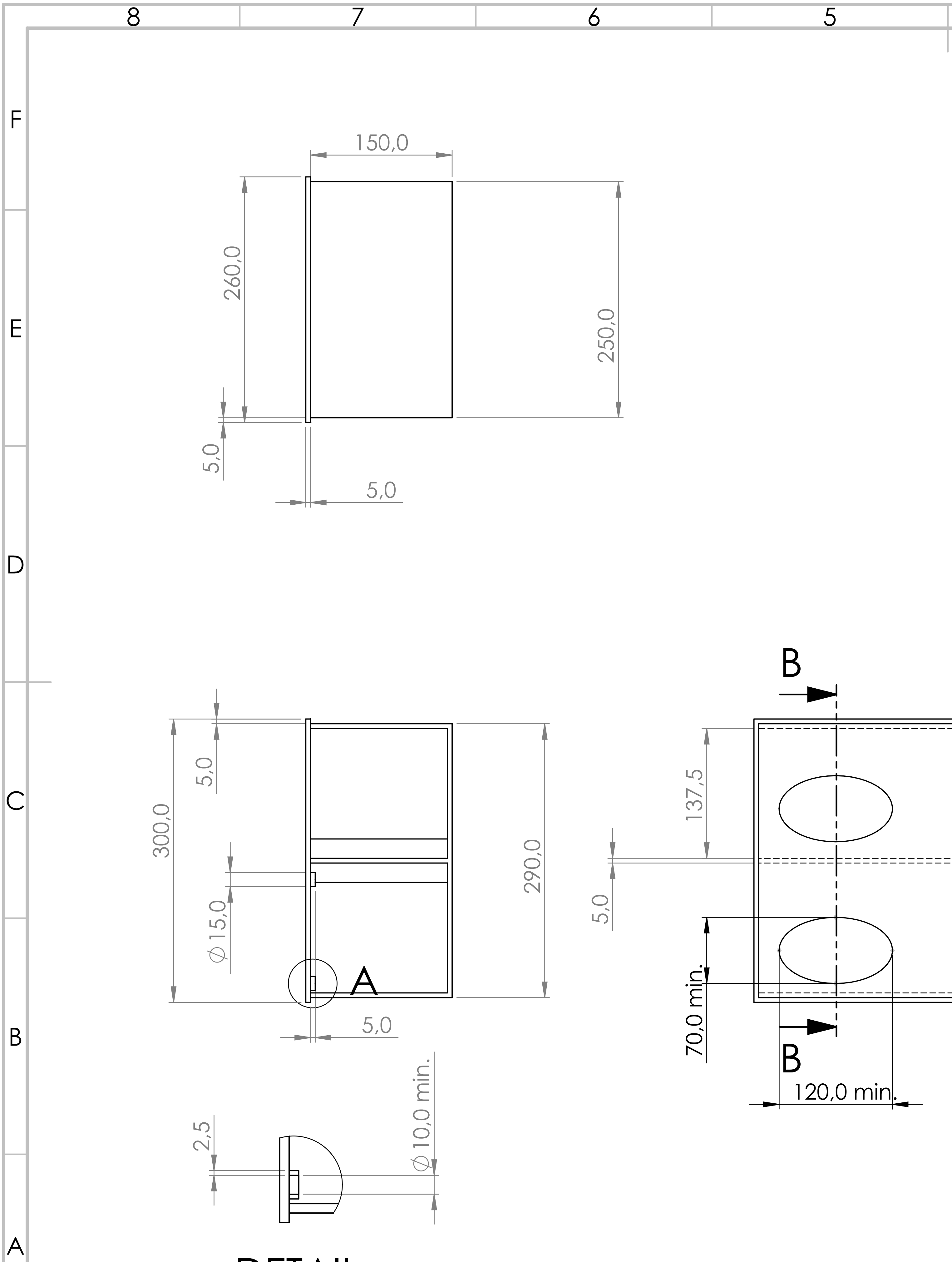
MATERIAL:
Poly-Carbonate (opaque)

DWG NO.
sub_asm_02

A3

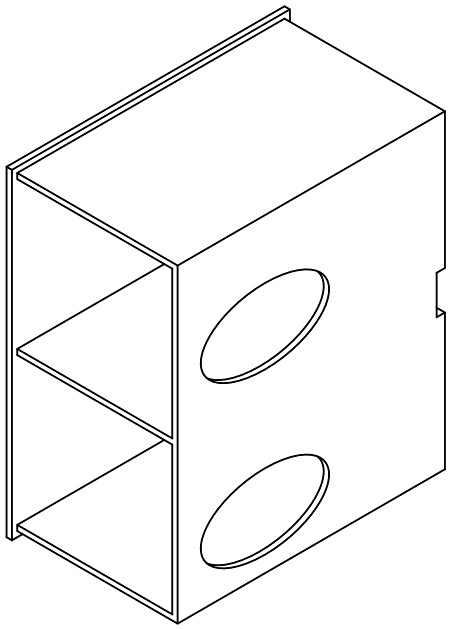
WEIGHT:

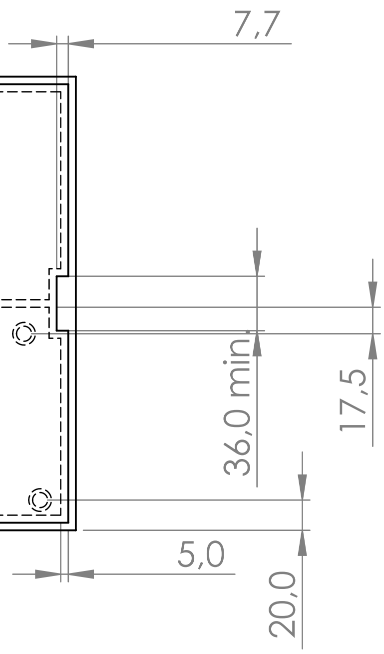
SCALE:1:5

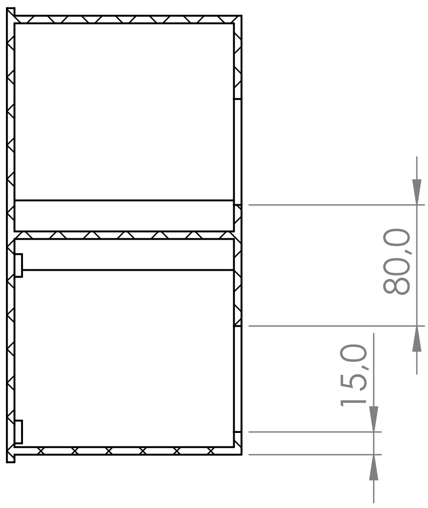


DETAIL A

SCALE 2 : 5







SECTION B-B

	NAME	DATE
DRAWN	Jonas Johansen	26.05-21

DO NOT SCALE DRAWING

Unless otherwise specified all dimensions are in mm

FINISH:

Mold Tech - 11010 spray dot

TITLE:

005_002_2

SAHD

MATERIAL:

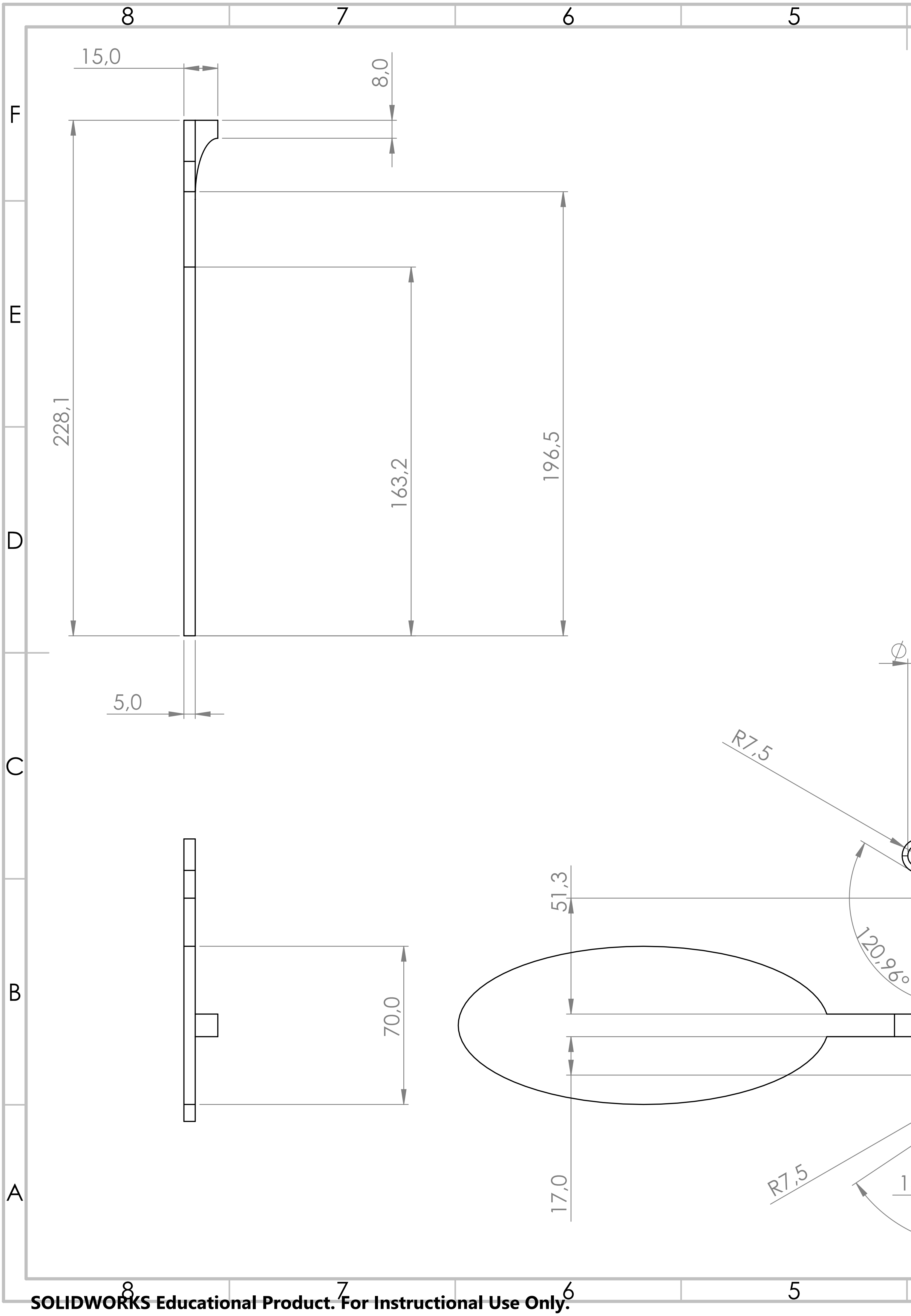
Poly-Carbonate (opaque)

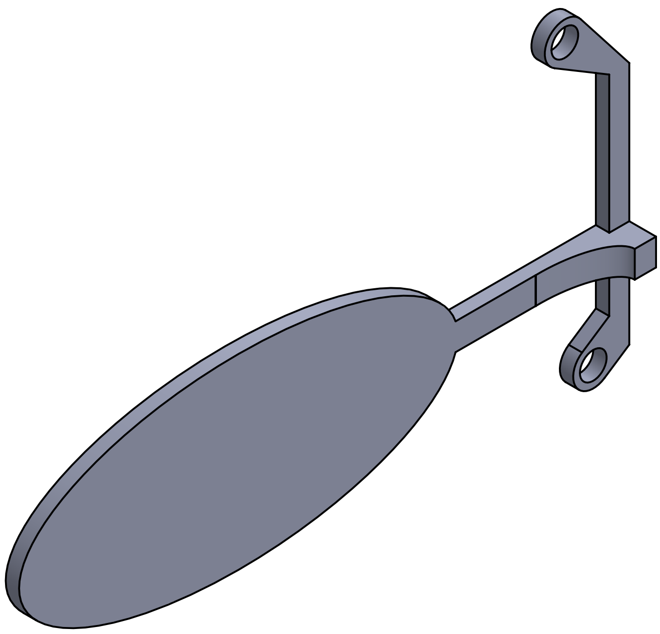
DWG NO. sub_asm_02

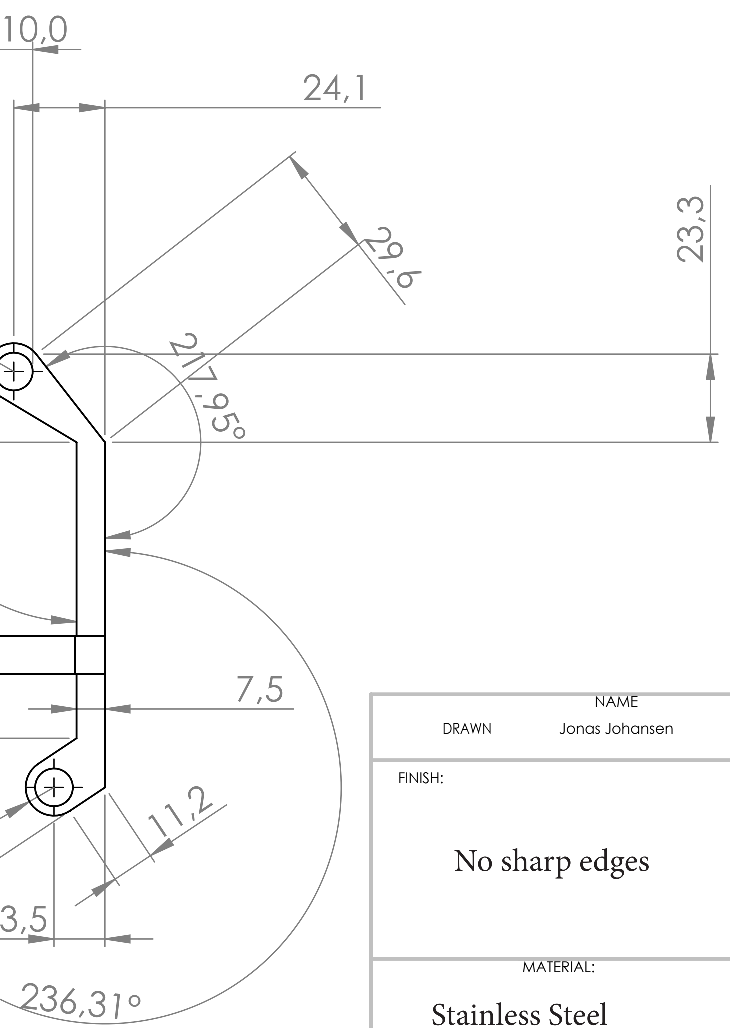
A3

WEIGHT:

SCALE:1:5


8
7
6
5
F
E
D
C
B
A
15,0
8,0
228,1
163,2
196,5
5,0
R7,5
51,3
120,96°
70,0
17,0
R7,5





DRAWN	NAME: Jonas Johansen	DATE: 26.05-21

DO NOT SCALE DRAWING

Unless otherwise specified all dimensions are in mm

FINISH:

No sharp edges

TITLE:

005_003_2

SAHD

MATERIAL:

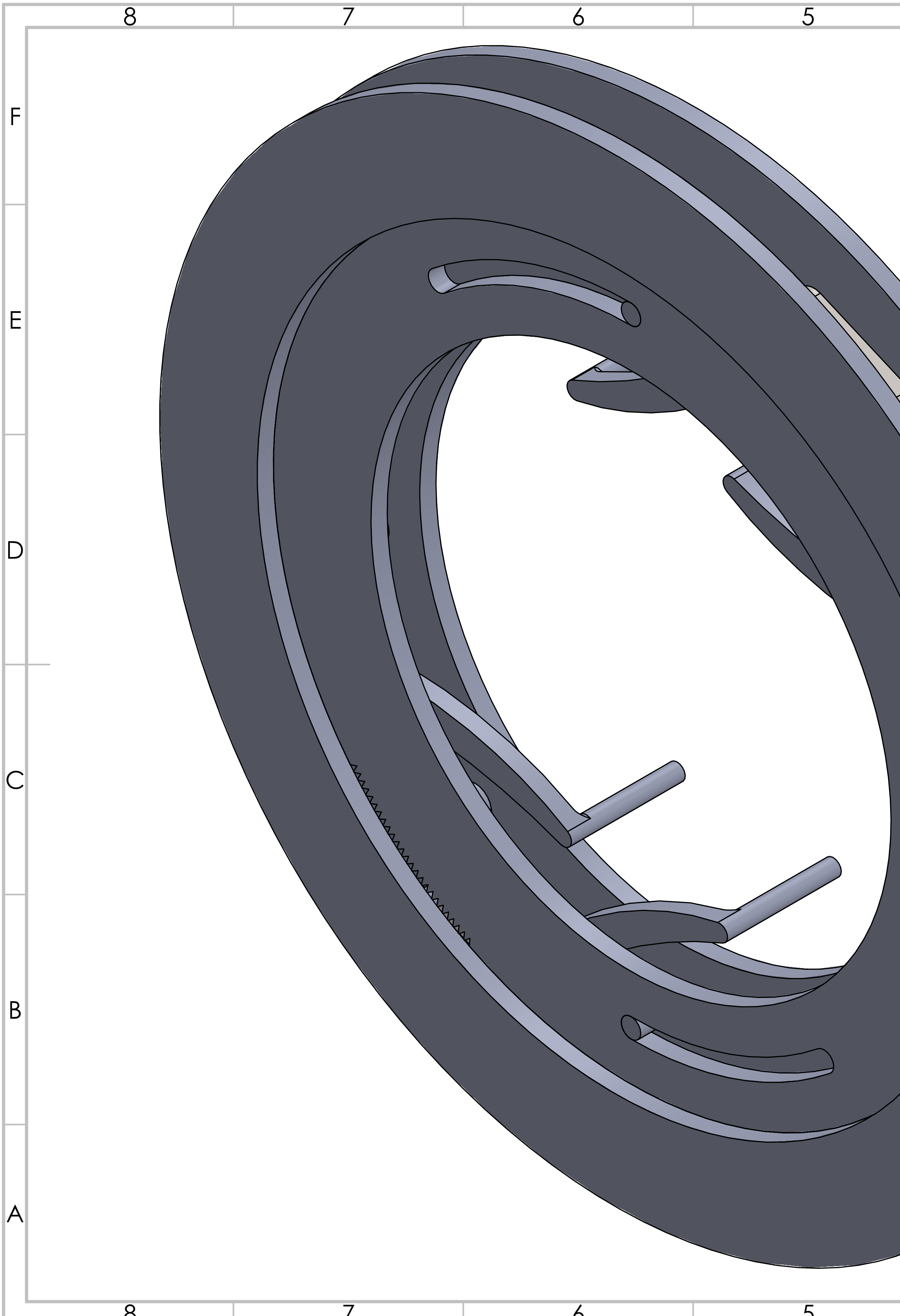
Stainless Steel

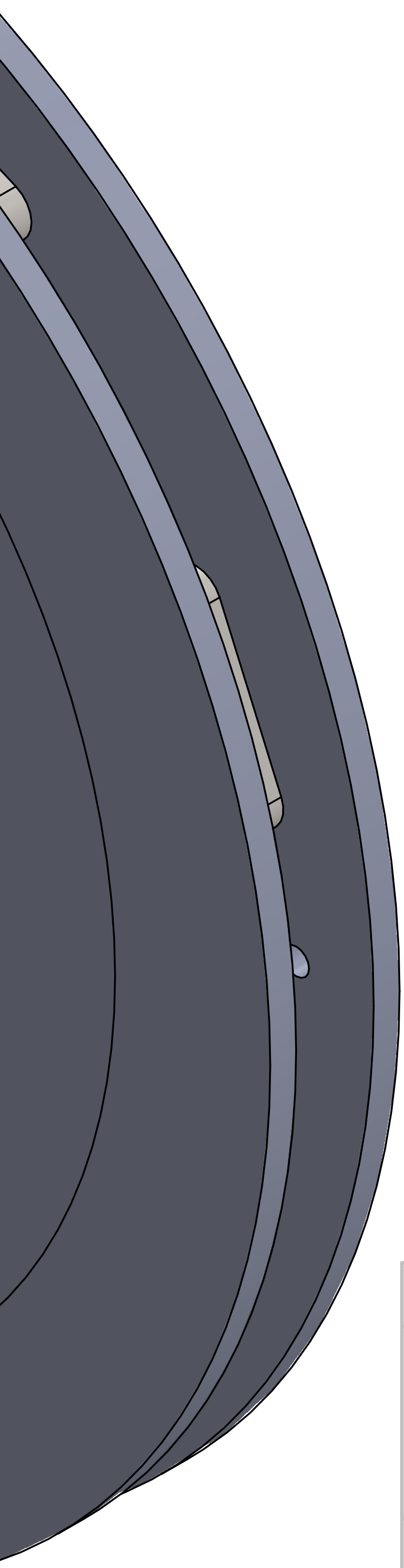
DWG NO. sub_asm_02

A3

WEIGHT:

SCALE:1:2


8
7
6
5
F
E
D
C
B
A



	NAME	DATE	DO NOT SCALE DRAWING	Unless otherwise specified all dimensions are in mm
DRAWN	Jonas Johansen	26.05-21		

FINISH:

TITLE:

SAHD

MATERIAL:

DWG NO. sub_asm_03

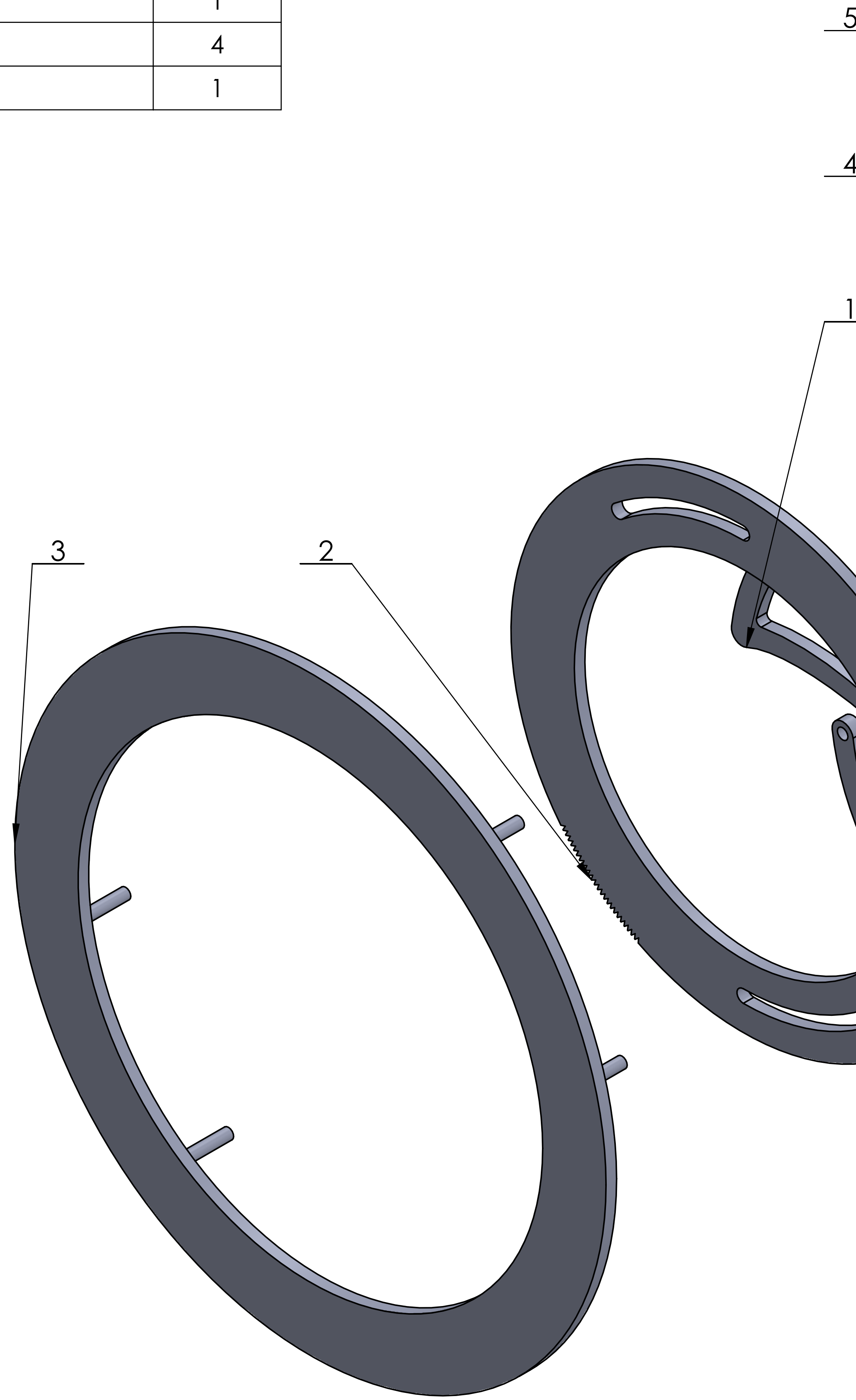
A3

WEIGHT:

SCALE:1:1

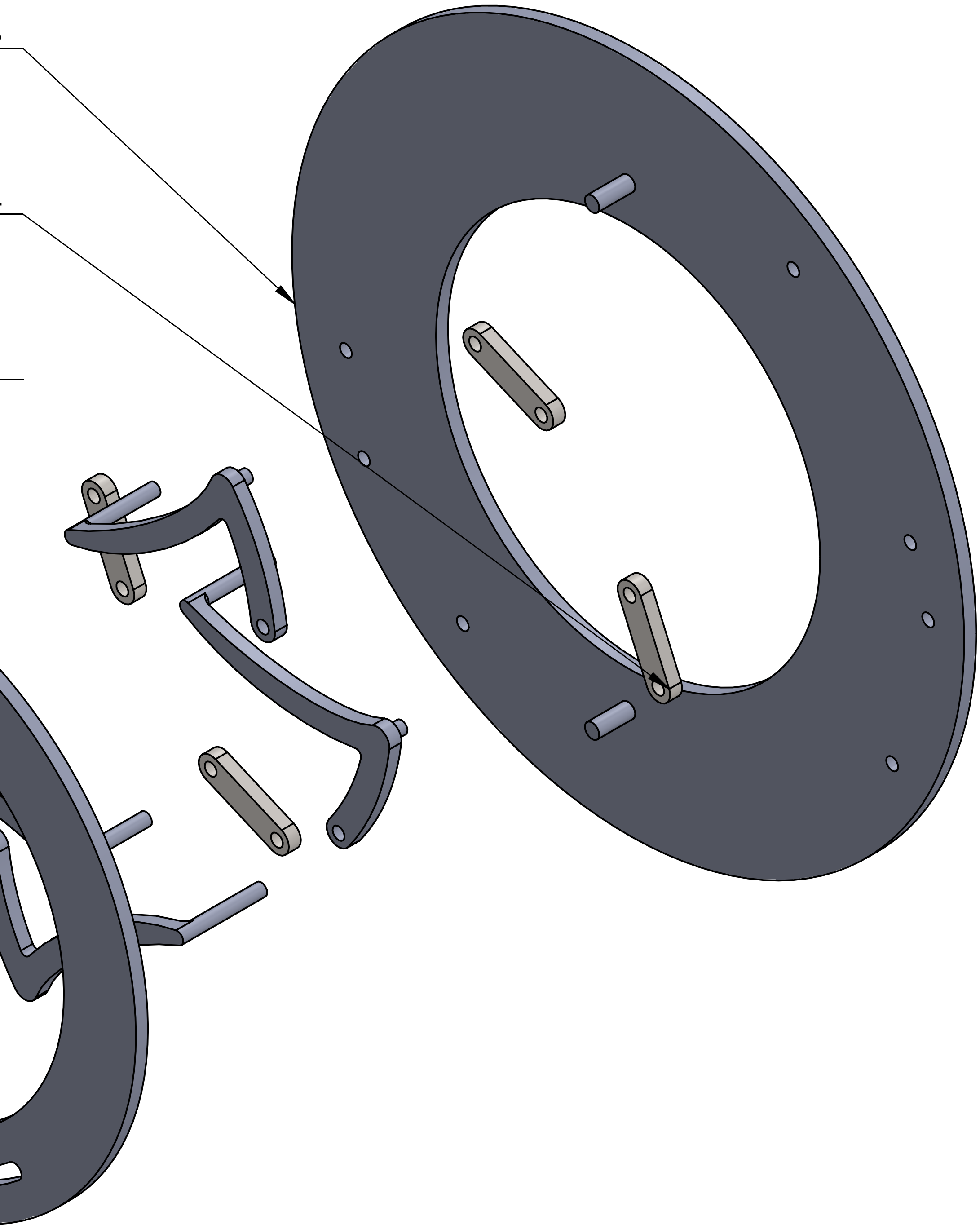
8 7 6 5

ITEM NO.	PART NUMBER	QTY.
1	005_001_3	4
2	005_002_3	1
3	005_003_3	1
4	005_004_3	4
5	005_005_3	1



F E D C B A

8 7 6 5



	NAME	DATE	
DRAWN	Jonas Johansen	26.05-21	DO NOT SCALE DRAWING

Unless otherwise specified all dimensions are in mm

FINISH:

TITLE:

SAHD

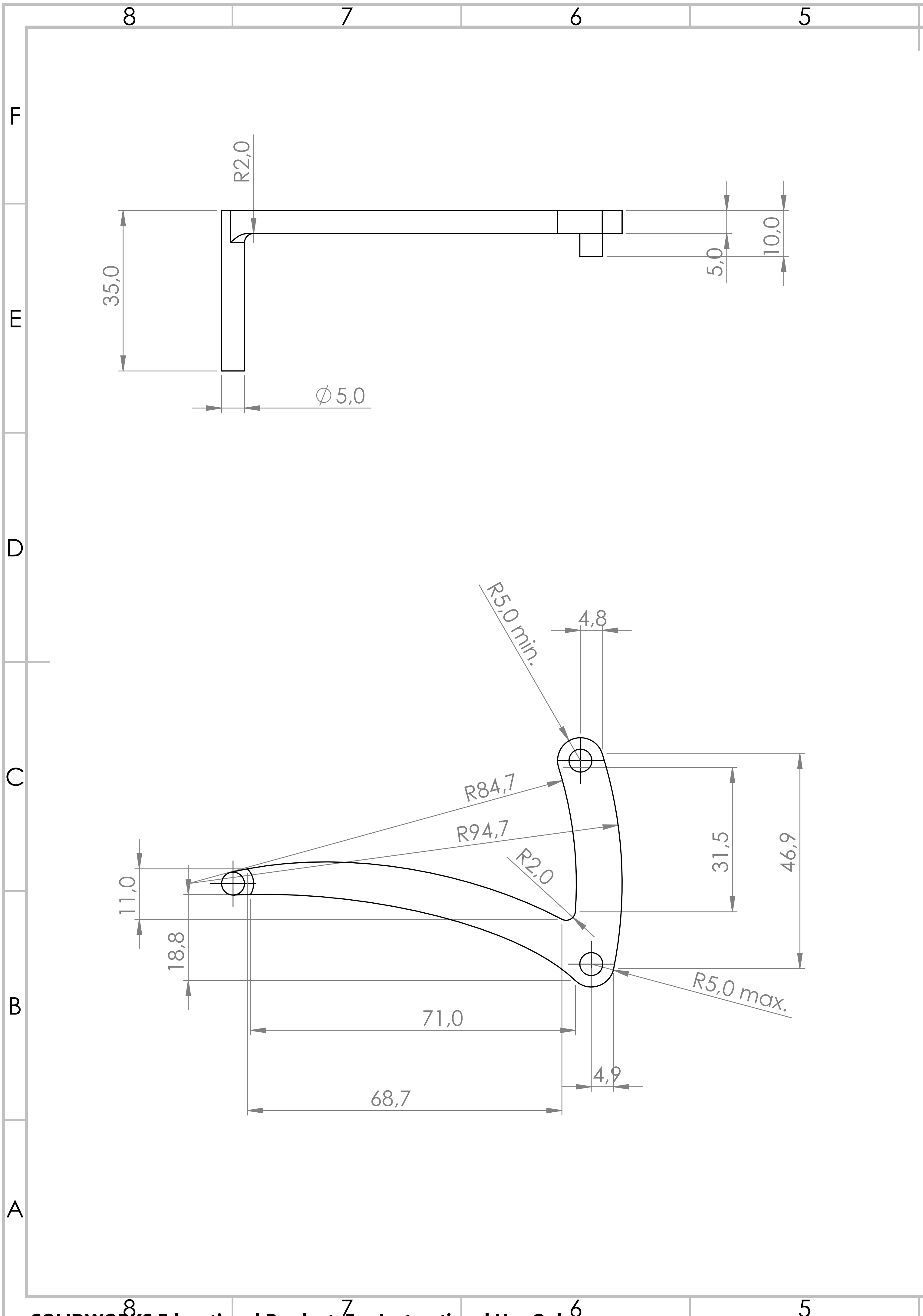
MATERIAL:

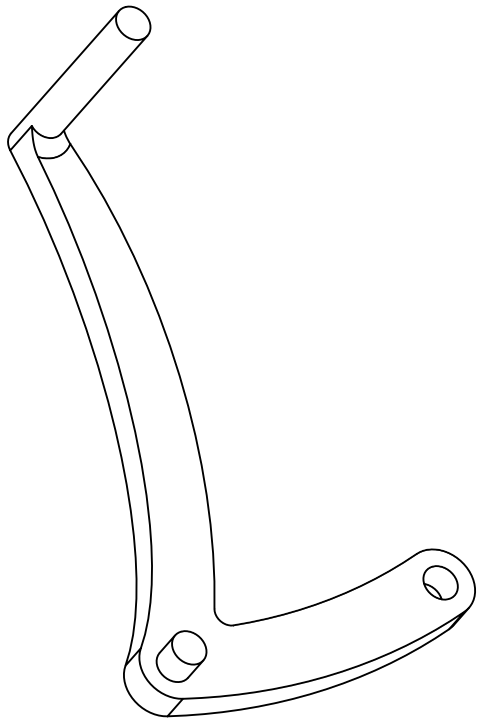
DWG NO. sub_asm_03

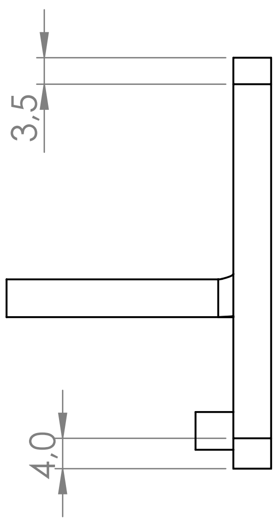
A3

WEIGHT:

SCALE:1:2


8
7
6
5
F
E
D
C
B
A
R2,0
35,0
∅5,0
5,0
10,0
R5,0 min.
4,8
R84,7
R94,7
R2,0
31,5
46,9
11,0
18,8
R5,0 max.
71,0
4,9
68,7





DRAWN	NAME	DATE	DO NOT SCALE DRAWING	Unless otherwise specified all dimensions are in mm
	Jonas Johansen	26.05-21		

FINISH:

No sharp edges

TITLE:

005_001_3

SAHD

MATERIAL:

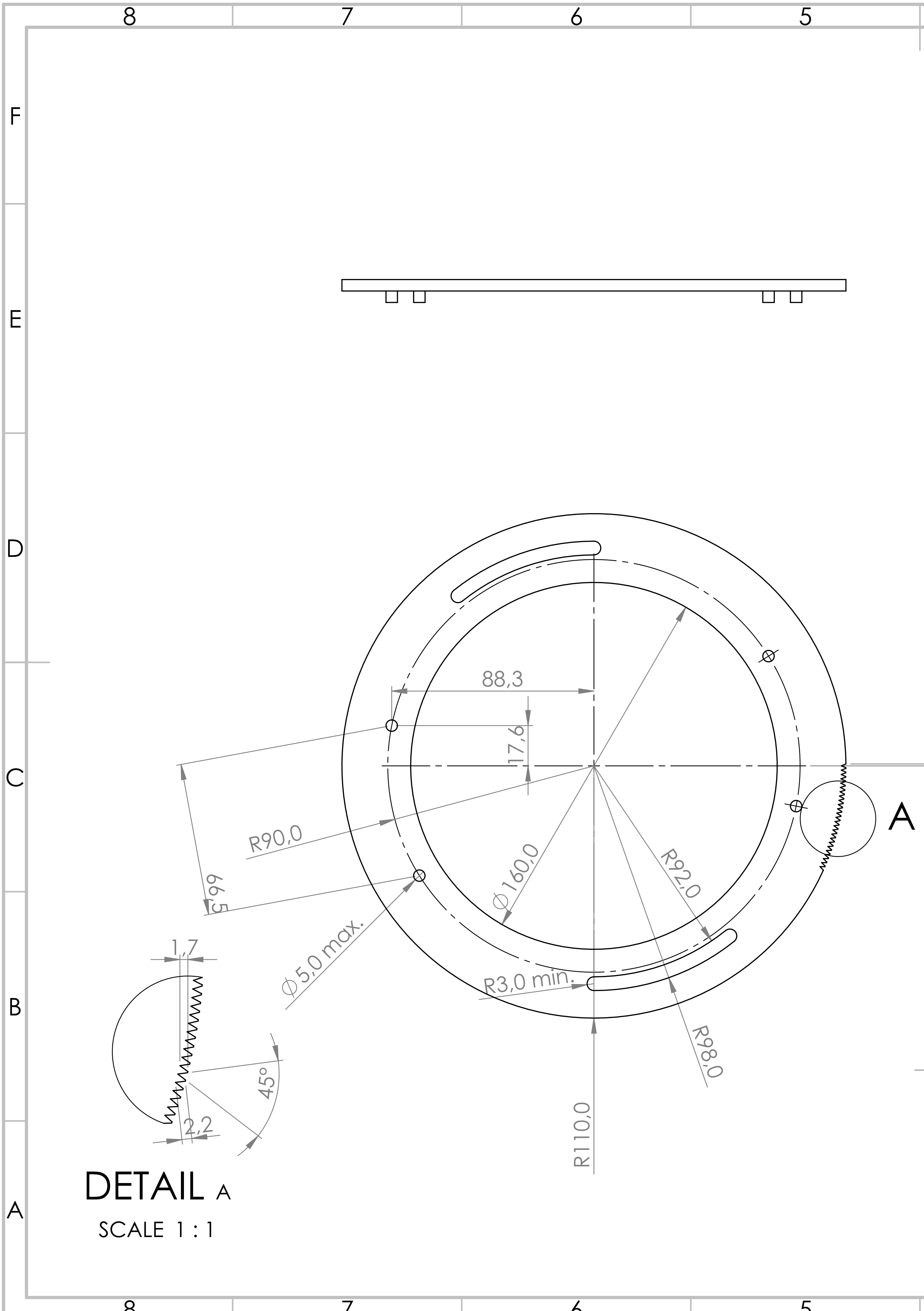
Stainless steel

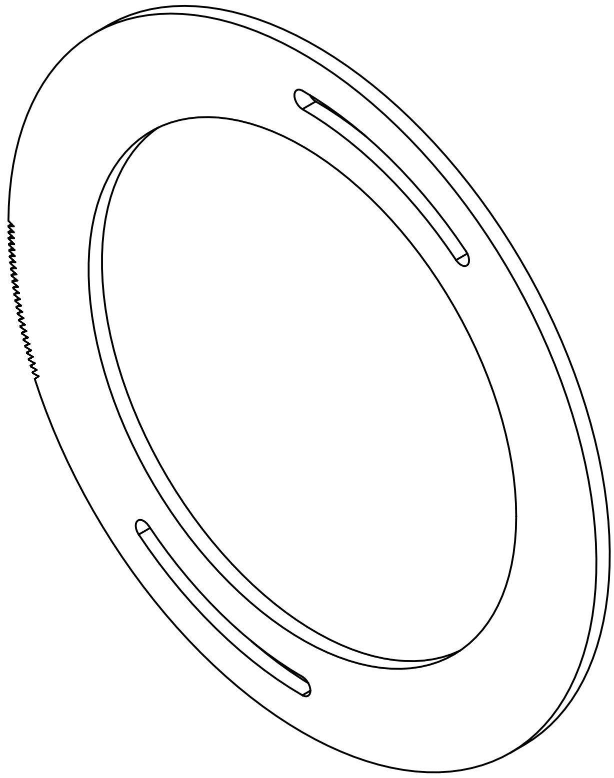
DWG NO. sub_asm_03

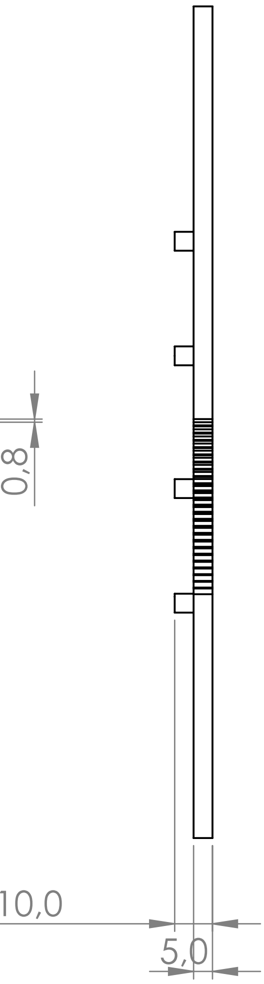
A3

WEIGHT:

SCALE:1:1

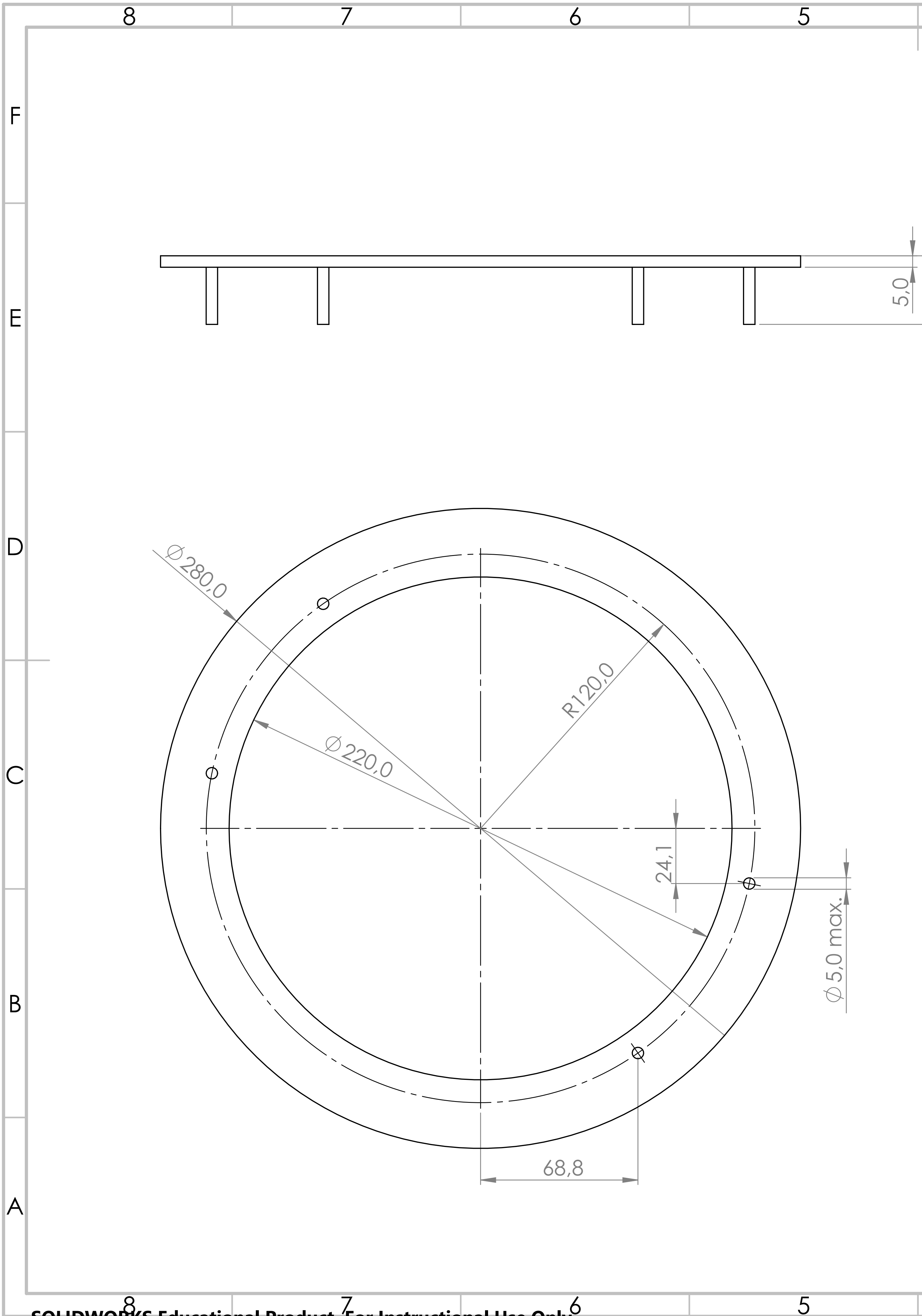

88,3
17,6
66,5
R90,0
Ø160,0
R92,0
Ø5,0 max.
R3,0 min.
R98,0
R110,0
A
1,7
2,2
45°
DETAIL A
SCALE 1 : 1

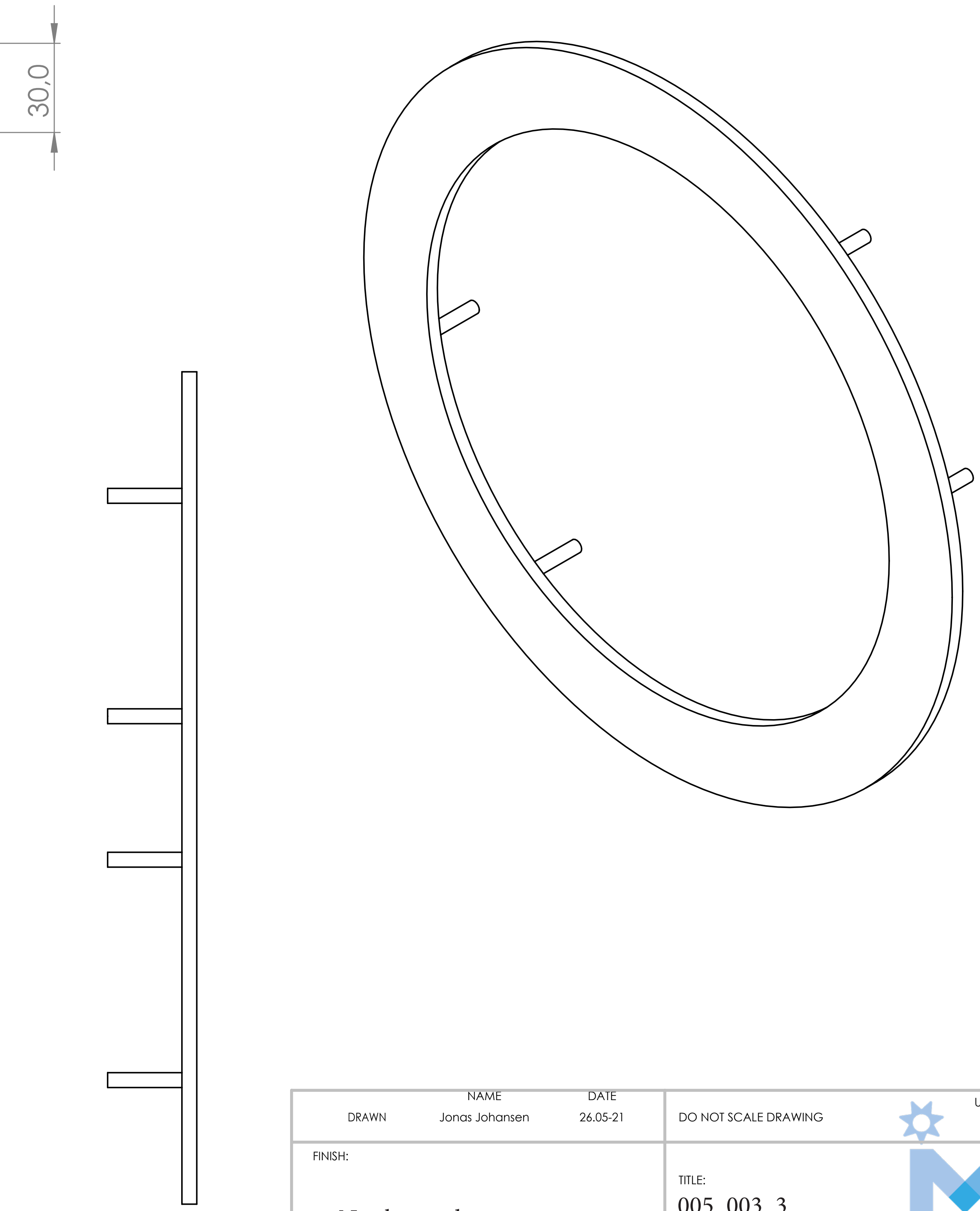




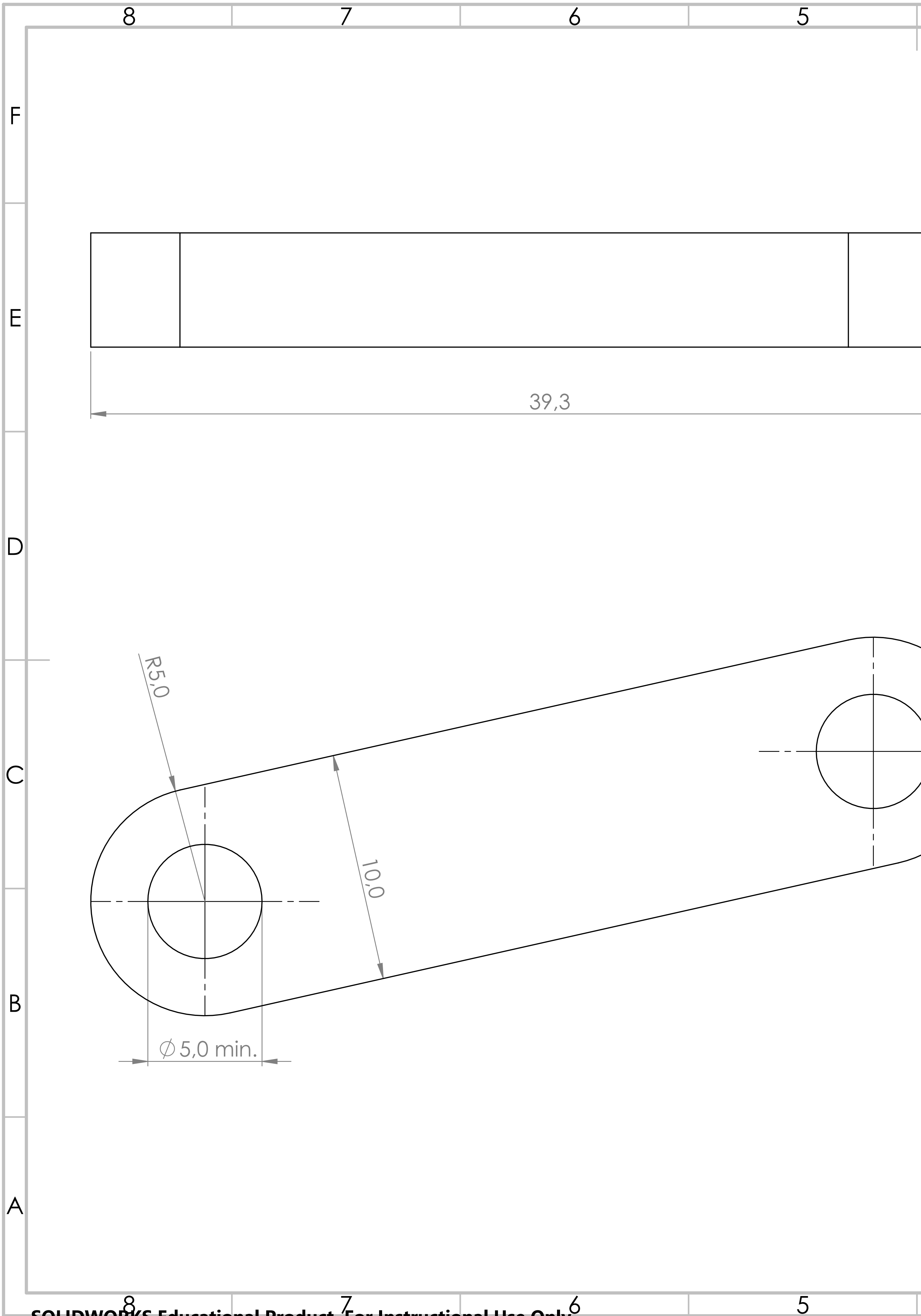
	NAME	DATE	DO NOT SCALE DRAWING	Unless otherwise specified all dimensions are in mm
DRAWN	Jonas Johansen	26.05-21		
FINISH: no sharp edges			TITLE: 005_002_3	
MATERIAL: Stainless Steel			DWG NO. sub_asm_03	A3
WEIGHT:			SCALE:1:2	Page 31 of 40

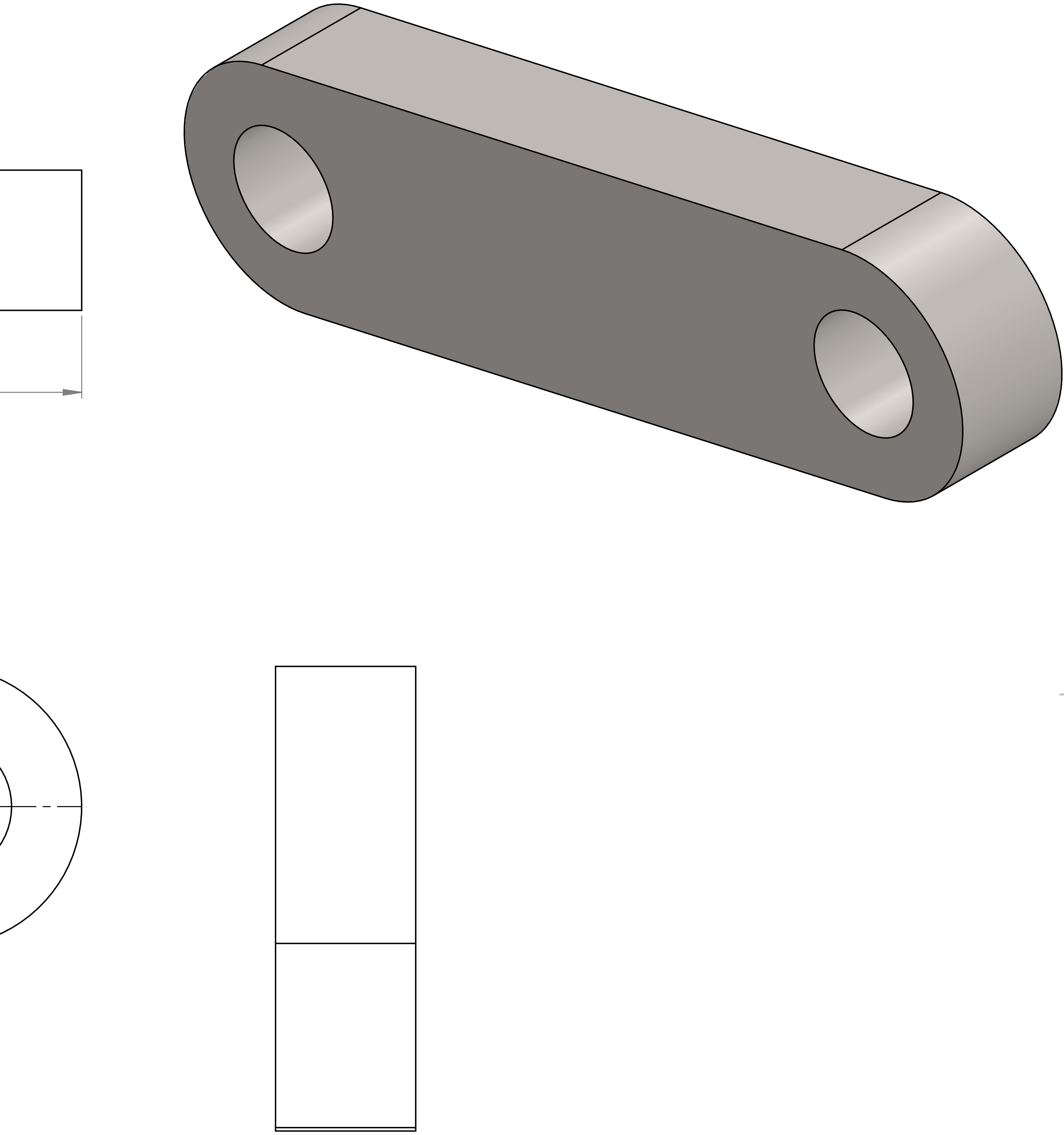
SAHD


5,0
⌀280,0
R120,0
⌀220,0
24,1
⌀5,0 max.
68,8



	NAME	DATE		
DRAWN	Jonas Johansen	26.05-21	DO NOT SCALE DRAWING	Unless otherwise specified all dimensions are in mm
FINISH: No sharp edges			TITLE: 005_003_3	SAHD
MATERIAL: Stainless steel			DWG NO. sub_asm_03	A3
WEIGHT:			SCALE:1:2	Page 33 of 40


8
7
6
5
F
E
D
C
B
A
39,3
R5,0
10,0
∅5,0 min.



	NAME	DATE	
DRAWN	Jonas Johansen	26.05-21	DO NOT SCALE DRAWING

Unless otherwise specified all dimensions are in mm

FINISH:

TITLE:
005_004_3

SAHD

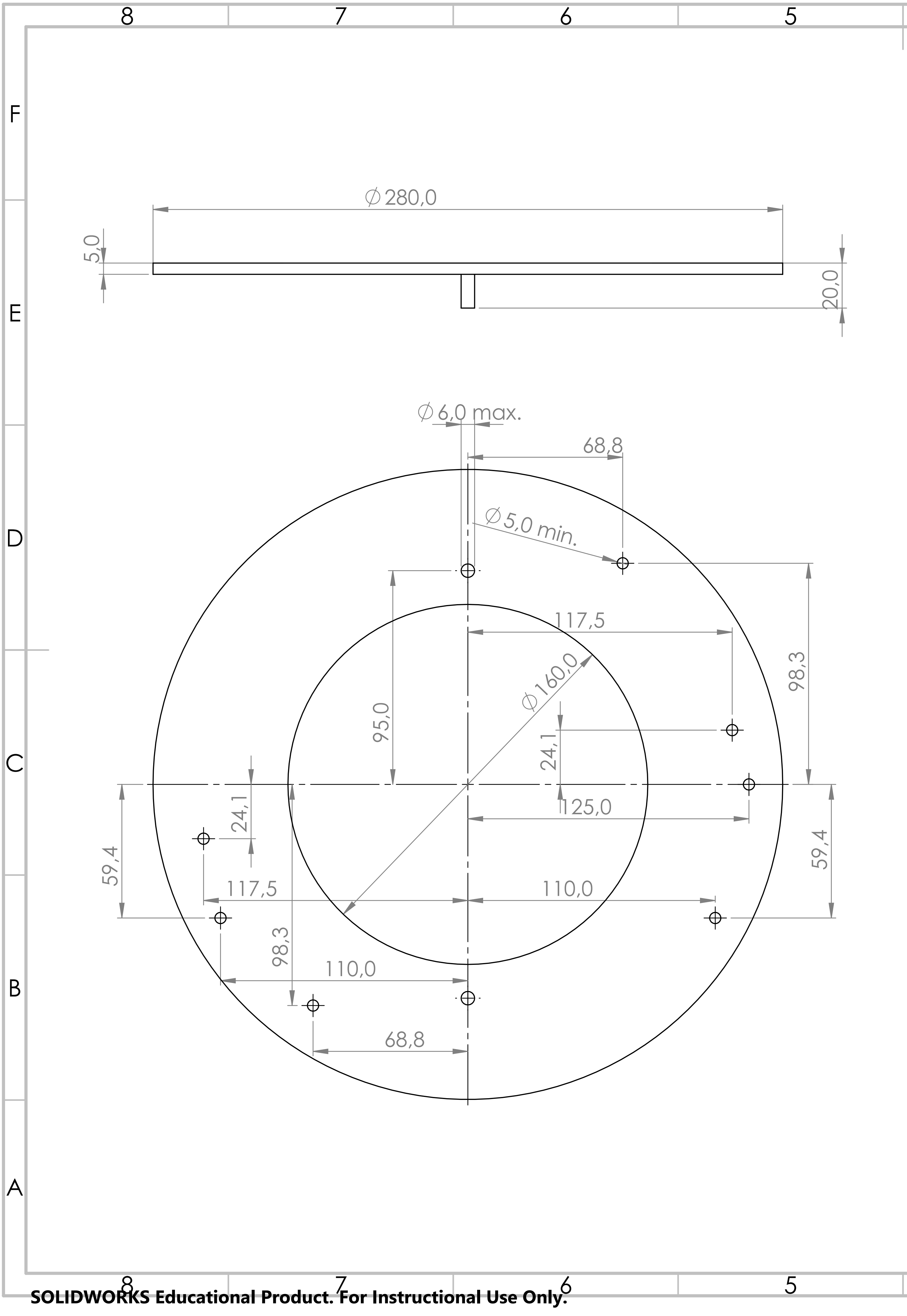
MATERIAL: PTFE

DWG NO. sub_asm_03

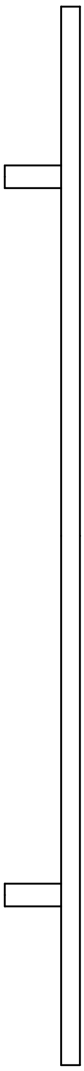
A3

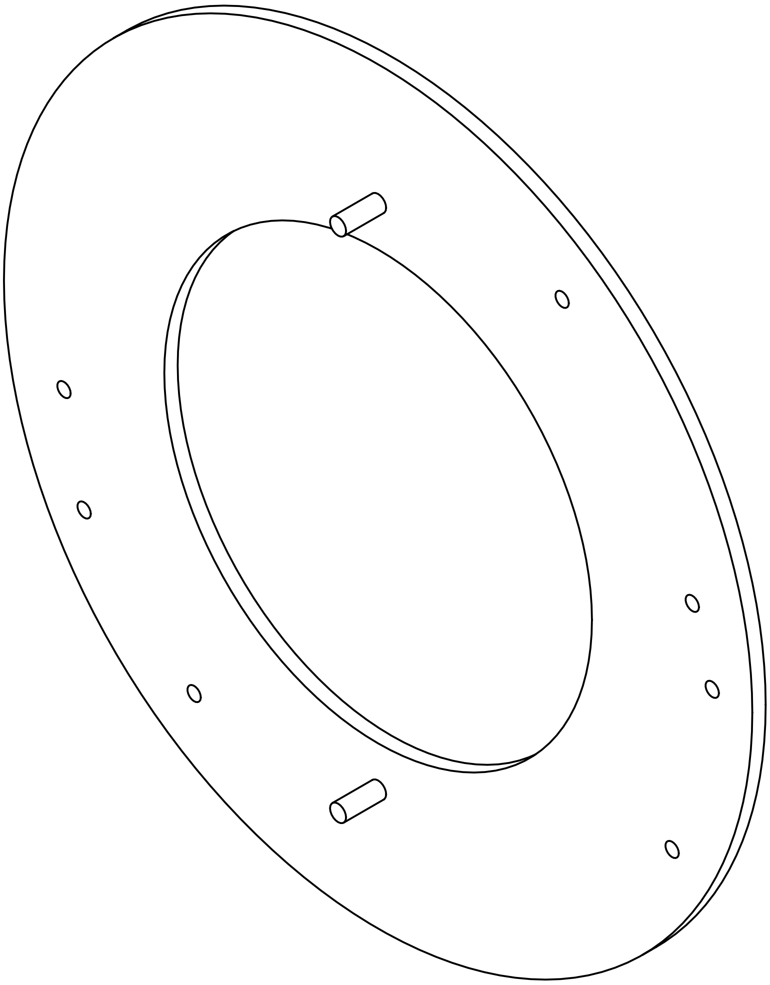
WEIGHT:

SCALE:5:1



8
7
6
5
F
E
D
C
B
A
∅280,0
5,0
20,0
∅6,0 max.
68,8
∅5,0 min.
117,5
98,3
95,0
∅160,0
24,1
125,0
59,4
117,5
110,0
98,3
110,0
68,8





DRAWN	NAME: Jonas Johansen	DATE: 26.05-21	DO NOT SCALE DRAWING	Unless otherwise specified all dimensions are in mm
FINISH: No sharp edges			TITLE: 005_005_3	SAHD
MATERIAL: Stainless steel			DWG NO. sub_asm_03	A3
WEIGHT:			SCALE:1:2	Page 37 of 40

AALBORG
UNIVERSITY

STUDENT REPORT