

# Inclusive Kitchen Solutions: Ergonomic Utensil Design for Hand Disabilities.

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## CRITERIA A

### **Design problem & opportunity**

Kitchen utensils and appliances are equipment that we use in our everyday lives, but some of these utensils are designed badly, are impractical or even dangerous. This is because most of these appliances are designed to cater for mostly people in the 50th percentile (this means they are made for people who have full use of their hands, legs and just full physical body use). Designs do not take into account people who may be living with disabilities, for example people with arthritis (that is people who have inflammation in their joints), people with numb fingers or who may have tendonitis of the hand and wrist and people with broken hands who may have cast who may have difficulties in using particular kitchen appliances. The following images shows people using various utensils and also shows possible hand disabilities that some people may be living with which hinder good use of the utensils.



## Design Brief

- The aim of this project is to create a product that makes it easy for people with different hand disabilities to use kitchen utensils. This is the target audience and is the main focus for this range of designs. The product that is to be designed is not a new invention a development of products that may already exist on the market for utensils such as knives, spoons, chopping board etc.
- The design requirements for this product are for the product to effectively and easily assist people who have hand problems to use certain utensils and appliances. They are required to be made from simple materials and slightly restrained in style. They are also required to be very comfortable to help reduce pain when being used by people with disabilities. The product should be made from a smooth material and should **reduce stress and strain** when being used. Lastly, the product should also allow for **easy grip**.

## Design specifications

- **Target Audience:** For this particular design product, the target audience should be distinguished because the product is addressing a particular problem that people face in their home everyday.
  - The Target audience in this case is people suffering from a variety of hand problems. This can include people with arthritis of the hand joints, tendonitis of the hand and wrist, people who may have broken their hands in an accident and wear hand casts to help them and lastly people with numb hands or people with shrivelled hands.
- Function:** The product must be able to achieve its purpose of assisting with the use of utensils and make it easy for anyone (regardless of whether they have disabilities or not) to have easy grip of the product.
- The product should be simplistic in style, not too elegant and easy to use. **Psychological function** in this case is not the main priority because people may not have emotional attachments to the products designed, but still this may be subjective. **Practical function** is most important; the idea of combining two designs such as a jar opener with a knife and fitting them into a holder.

## Design Specifications continued

**Material selection:** Materials used must be simple and comfortable for the target audience. When modelling the product, I will use ABS for my mockup so as to give an idea of what the potential prototype may be made from and to test out how the finished product may look like. The hand cap or handle can be made from simple materials such as recyclable plastics so as not to pollute the environment.

- Therefore it is important to note that the materials that this product will be made of should be easily disposable, recyclable and should also be durable when in use, e.g ergonomic wood, plasticine in some cases.

**Aesthetics:** Are not the primary concern for the product but must also be taken into account considering that if we are to place them on the market, then appearance must count to a certain extent. This can be using fair colours or semiotics which are used to decorate the product, as this will influence the buyer. For example, a dark green or blue does a good job of being aesthetically pleasing while still emphasising on function.

- Also we can style some of the designs, if possible, retro-styling can be implemented to attract the clients into purchasing the products.

## Market Research

Note: It should be noted that there are already some design products on the market that cater to people with hand disabilities but considering that some of these need improvements, hence my design product will focus on product development. Below are a few examples of the already existing designs that address this issue.

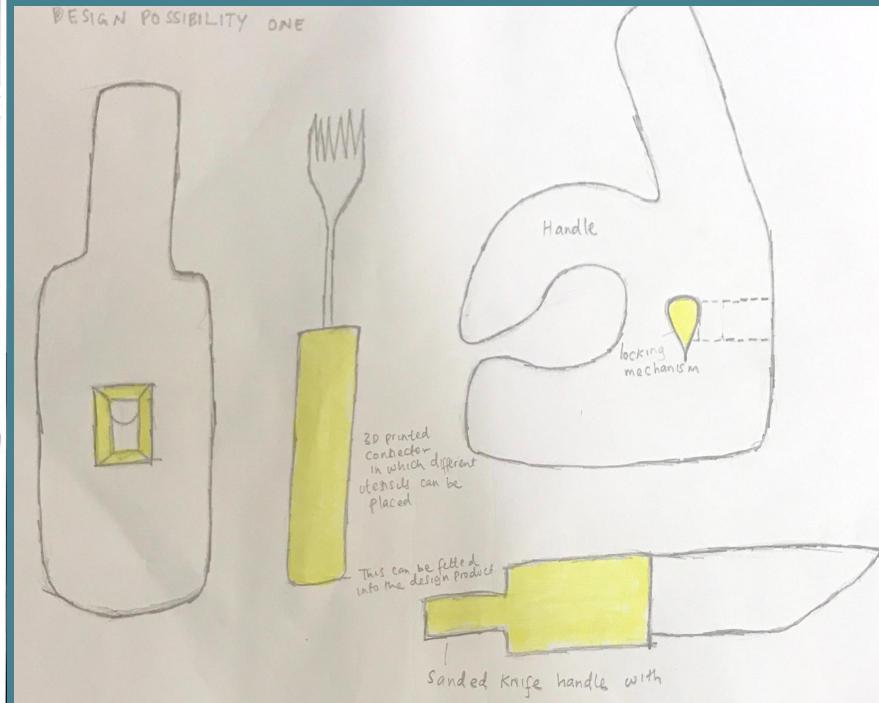
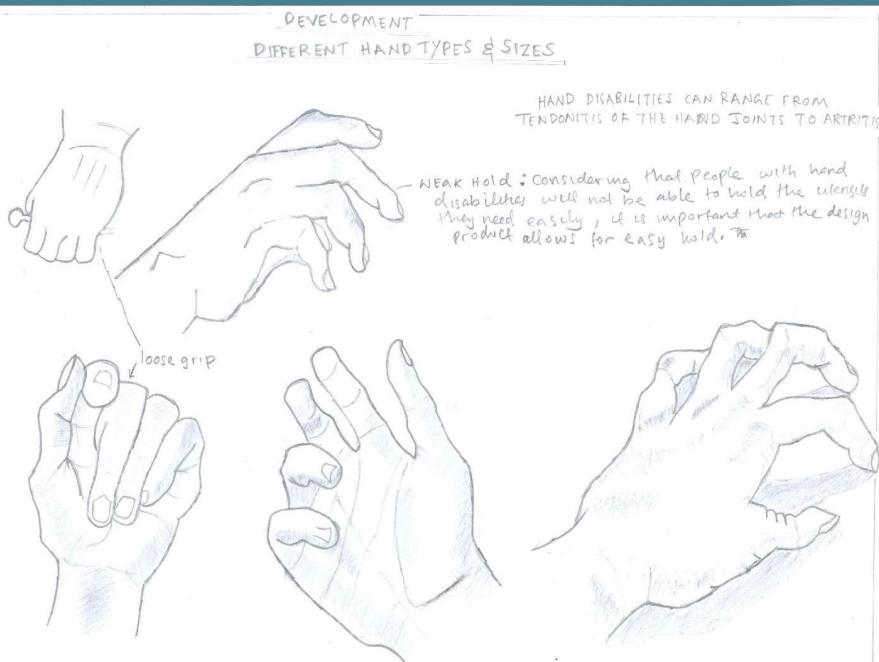


Materials pricing and product analysis

ABS	£10
MDf 2.44m sheet	£22.48
Homopolymer 1000kg	£0.56-£1.9

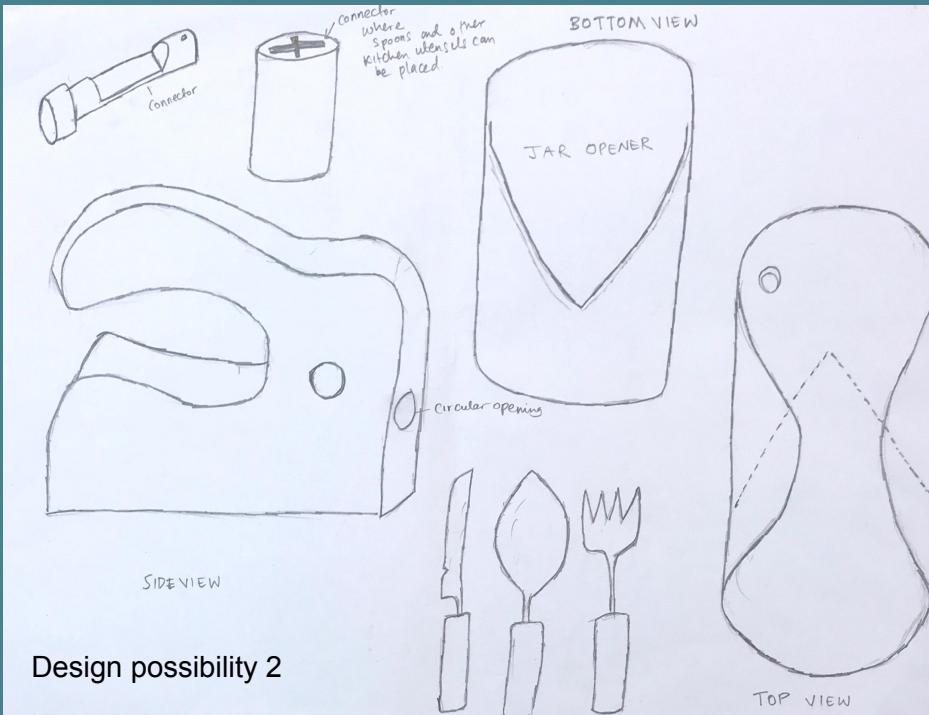
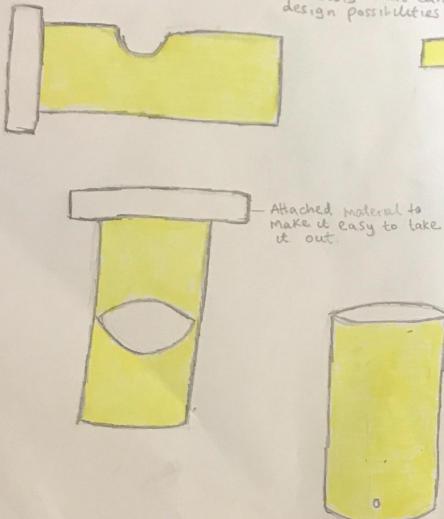
## CRITERIA B

Include initial ideas with a few drawings and specifications.

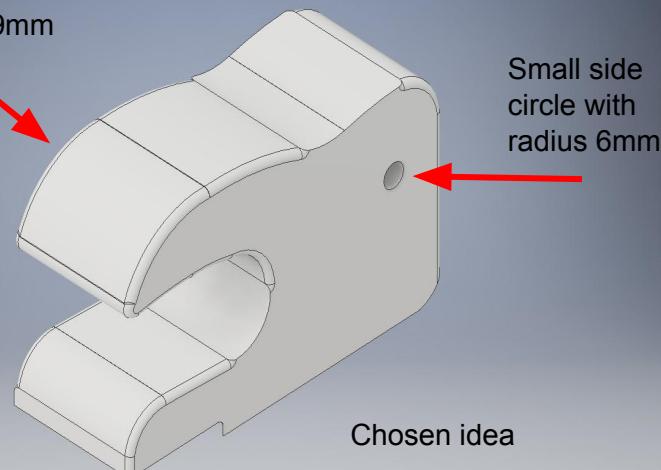


## DESIGN POSSIBILITY 2

Connectors that can be used for one of the design possibilities



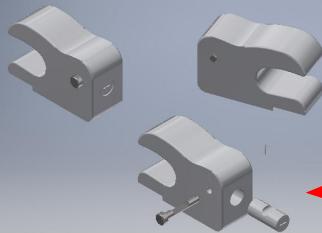
Curved handle with width 70mm and  
Curved radius 47.99mm



Screw was cut so  
as to fit connector  
1 and hold it into  
lock



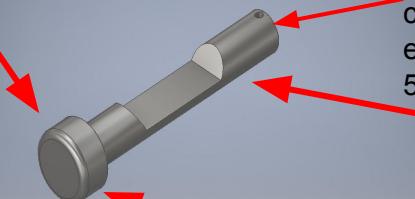
Side view



Front view

Exploded view  
detailing all  
sides and  
components

Make-like handle  
used to help in  
pulling and  
screwing

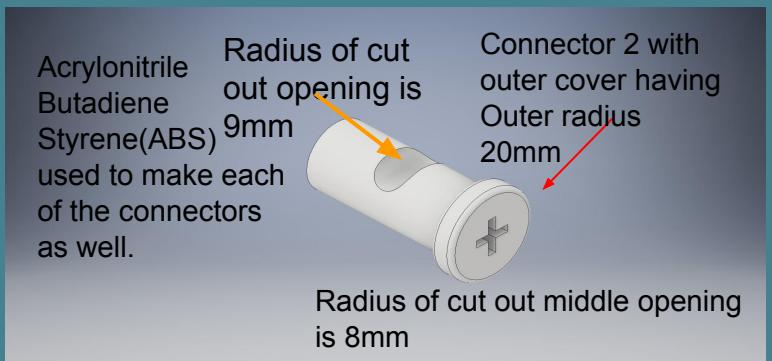
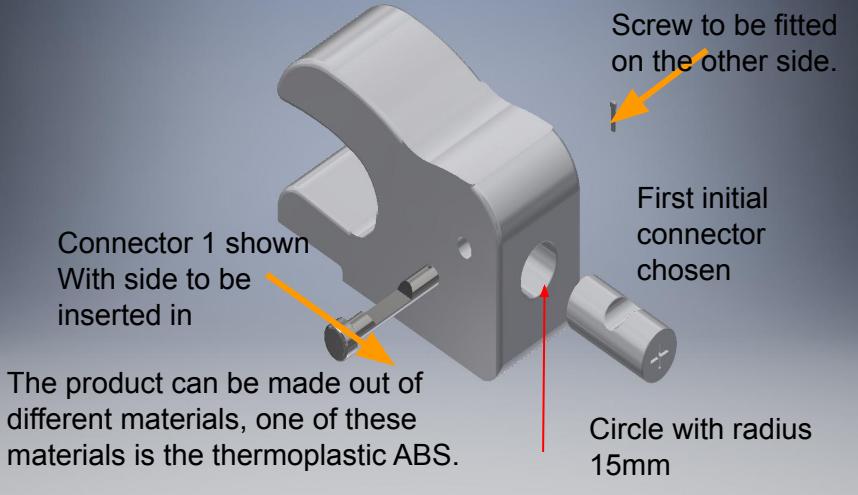


Radius of  
small  
circular  
end is  
5.8mm  
Length of  
locking connect  
or is  
73mm

Radius  
10mm

# PRESENTATION DRAWING

## FULL SIZE EXPLODED VIEW



The main function is to assist people with hand disabilities to easily use kitchen utensils. This does not eliminate the fact that there will be a percentage of error for the product. However, considering this particular design is more focused on **product development** rather than new invention, it should accommodate and reduce errors that may have been experienced in a previous similar design.

Justifying the chosen design Idea and whether specification has been met or not

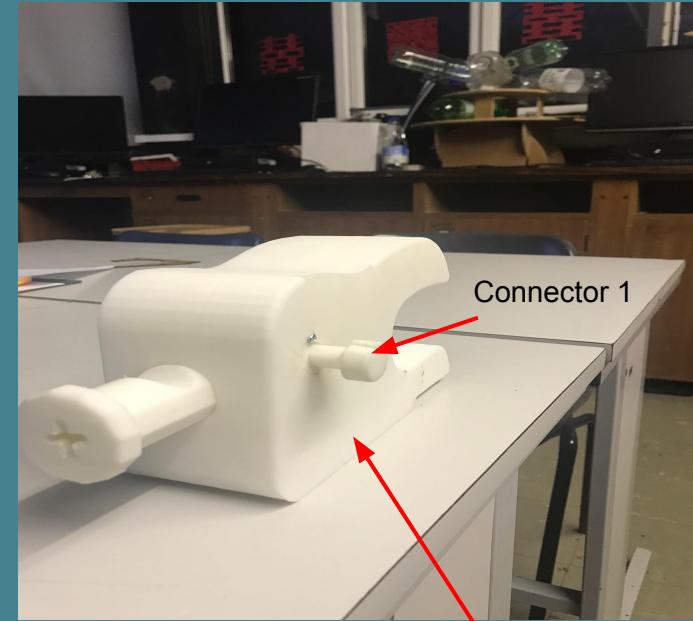
No.	Evaluation
1	Connector 1: is of right size and can be easily turned so that it can lock connector 2 in place.
2	Connector 2: rightly shaped and fits into hole. Had to be sanded a bit for smooth transition.
3	Main body: very light to hold, bigger than expected but has is easy to hold.
4	Screw: cut nicely to lock connector 1 on side.

## IDENTIFICATION

Criteria C

The table below characterises what type of materials are used to make each of the components. Each of the components are made separately and then assembled together. The only external component is the small steel screw that that was inserted next to the smaller and longer component.

Parts list	mockup material
Main body	ABS/PLA
Connector 1	ABS/PLA
Connector 2	ABS/PLA
Screw	Steel



Bottom view showing jar opener

Side view showing assembled view of mock-up

## Important material properties for mock-up

**Thermal conductivity:** For my product, the thermal conductivity should be low because it will help when the clients are using it. This is because the heat that will be experienced by users are using the product will only add to the problem of either arthritis or hand joint pains considering the target audience.

**Strength:** As the user will need to apply force to a certain degree, strength for this product is one important property. The high strength value that ABS makes it an appropriate material selection.

**Thermal expansion:** ABS however does have a high expansion, and seeing as it is the only material available in the workshop then it should be assumed it is kept low. This is because if any of the components (connectors 1,2 and screw) then it will be difficult for them to fit into the main body.

**Fracture toughness:** ABS has medium toughness and this is important for the product mock-up because it has to be highly durable and not easily broken.

## Reason for using steel as the screw<sup>2</sup>

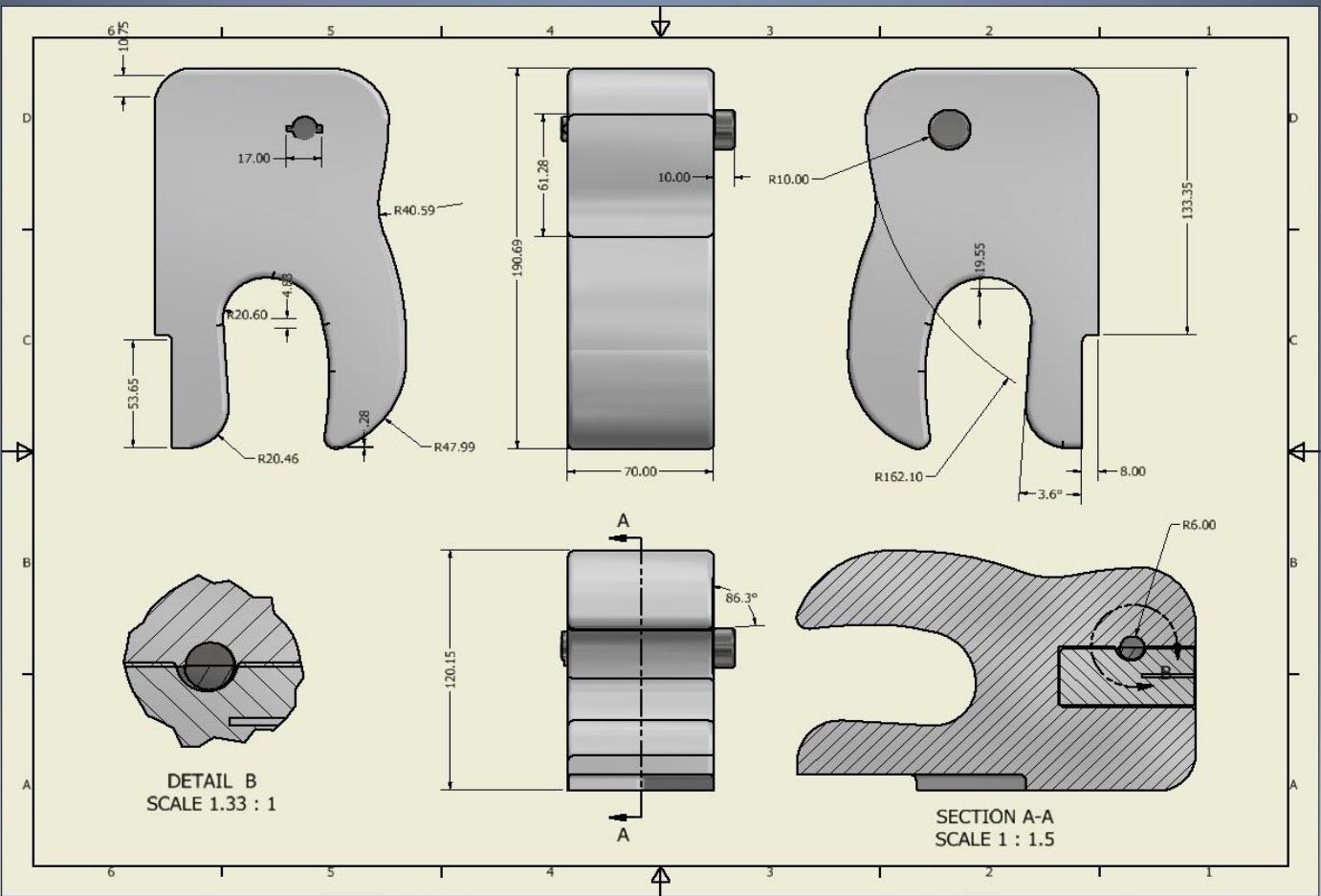
1. High tensile strength
2. Low cost
3. Lower yield strength

2: "Steel Material Properties." [www.steelconstruction.info](http://www.steelconstruction.info),

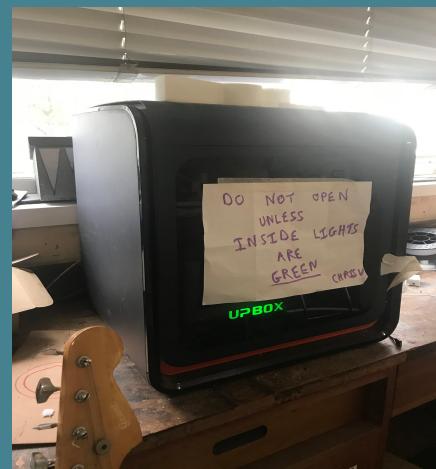
## 3D PRINTING

This is by far the best method which is efficient and effective for my mock-up. This is because one can easily manipulate the measurements and ensure accuracy when using Autodesk or Fusion 360. It must be made sure that all the measurements are accurate and so this makes using Autodesk the best option.





3D PRINTED ON  
UP-BOX



## Production plan

Processes	Equipment	Scheduling	Quality control	Risk assessment
Create CAD drawings of each of the connectors and the main body using Autodesk or Fusion 360.	Computer	Approx. 13 hours	Check if the components can be assembled virtually	Make sure not to stress your fingers when working at the computer. Also take some breaks.
Export each of the components as an STL file	Computer	Approx. 4minutes	Check for correct dimensions	
Open one of the STL files in the 3D printing software up box? Or Stratasys	Computer	Approx. 4minutes		
Make sure all dimensions are changed to mm and that the components are auto oriented	Computer	Approx. 6minutes		

## Continuation of Production Plan

Processes	Equipment	Scheduling	Quality control	Risk assessment
Load ABS filament into the 3D printer	3D printer	Approx. 20minutes	Check filament for fractures and to ensure continuous feed	
Press print	Computer		Make sure to monitor the printer	
Remove components using hands after the print is done	Gloves or hand if cooled	Approx. 4minutes	Carefully remove the components and check to see that they are printed correctly.	Mostly advised to use gloves so as to avoid injury
Sand off components to make sure they fit smoothly	Sanding paper or different sizes of files	Approx. 2 hours	For effective use make sure to add force to the edges of sandpaper or filer.	Careful when holding filer or sandpaper so as not hurt oneself
Dust off/clean the particles that fall off from the components	Use simple cloth or wipes	Approx. 6minutes	Dust off the clothes after each clean or alternate with wipes	Make sure to protect your eyes from the particles wanting to penetrate

## Presentation Drawing



The drawing represents the design product as it will be developed further in the criteria.

Parts list	Prototype material
Main body	Thermoplastic (Homopolymer)
Small connector (optional)	Thermoplastic
Turnable handle	Thermopolymer

## TESTING STRATEGY

Due to my target audience, I had to test out the product at gateways which is a service that I participate in where we visit people with various disabilities such as autism, people suffering with rheumatoid of the hands and arthritis. This was a good environment because I could get enough feedback on how to develop the design further.

## INTERVIEW WITH THE CLIENT

In order to determine suitable aesthetics, I had to interview clients and find about the aesthetics (whether product should be brightly coloured or if that will take away from main function).

## PERFORMANCE TESTING

Performance testing of the final mock-up design to determine whether clients are able to easily grip and hold the handle. If there is any strain or stress from trying to use it.

## PRODUCT TESTING/ERGONOMICS

Product testing with normal utensils such as forks, spoons, butter knives to test if they all fit nicely- also whether if all utensils can be used or if it is particular for a range of utensils.

## COMPARISON OF THE MARKET

Considering the fact that this is more based on product development, the design should be compared with already existing products and where it stands with solutions available.

## ANALYSIS OF MATERIALS

Analysis of the chosen materials, the cost, how suitable it is for manufacture and also its impact on the environment with regards to strength and biodegradability.



## Evaluation against the design specification

User need: can be used by almost every user, whether they have hand disabilities or not. There is urgent need for a lot of people to use the design product.

Branding: it is not the main concern for the product to have a branded logo, but its unique shape and figure can be taken as inspiration for any logo designs in the future.

Aesthetics: the product has a very unique shape, incorporating geometrics with elements of modernism. Some **not very bright colours** can be added such as dark emerald, dark green or navy blue. More emphasis should be added to making the design more streamlined for every particular audience.

Size: the connectors are of able size and can fit easily into their prescribed holes without much friction. The main body however is a bit larger than anticipated and hence more research should be conducted to determine perfect size.

Target audience: product can be given to people with hand disabilities in the age range of **17 to as high as 50**. The big handle width however, limits it from being used by everyone and hence should be an area of improvement.

Cost: **ABS is an expensive material** and so other cheaper and environmental materials which are in line with the specifications should be used instead.

Safety: the product has a few corners along the jar opener that if not taken with a bit of care can potentially lead to some scratches. Hence, the product should be improved to not have any such corners.

Materials: considering that ABS is not biodegradable and is not a good conductor of heat, other alternatives such as **MDF can be used** together with car body filler for the prototype.

Market analysis: the product achieves some of the specifications although producing it with ABS will be of huge cost to industries and hence a way of commercially producing it with less material (**to be glued or assembled together**) should be explored.

Competition: there are quite a few competitors on the market, however its different style makes it stand out.

In order to further develop my design into a viable prototype, I had to seek feedback from some of the clients at gateways with whom I tested the product. By doing so, I was able see which areas needed improvement and develop a design more suited to the specifications.

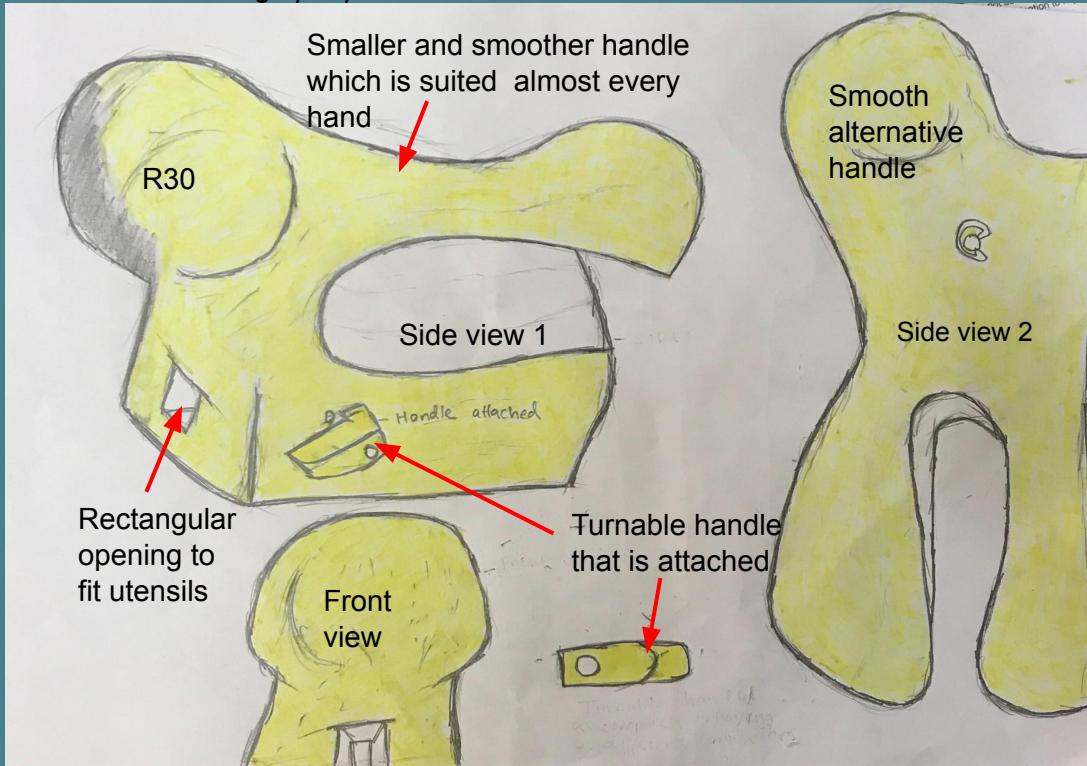
*"I really like the idea and product but I feel like you should reduce the size so that it can easily fit with other kitchen utensils"*

*"I like that it is not heavy and is easy to lift, but can you do something about the corners and making it more smoother"*

## CONTINUATION OF EVALUATION AND USER FEEDBACK

"I like that you added the jar opener at the bottom, but it is quite hard to use it. you should consider modifying it or removing all together"

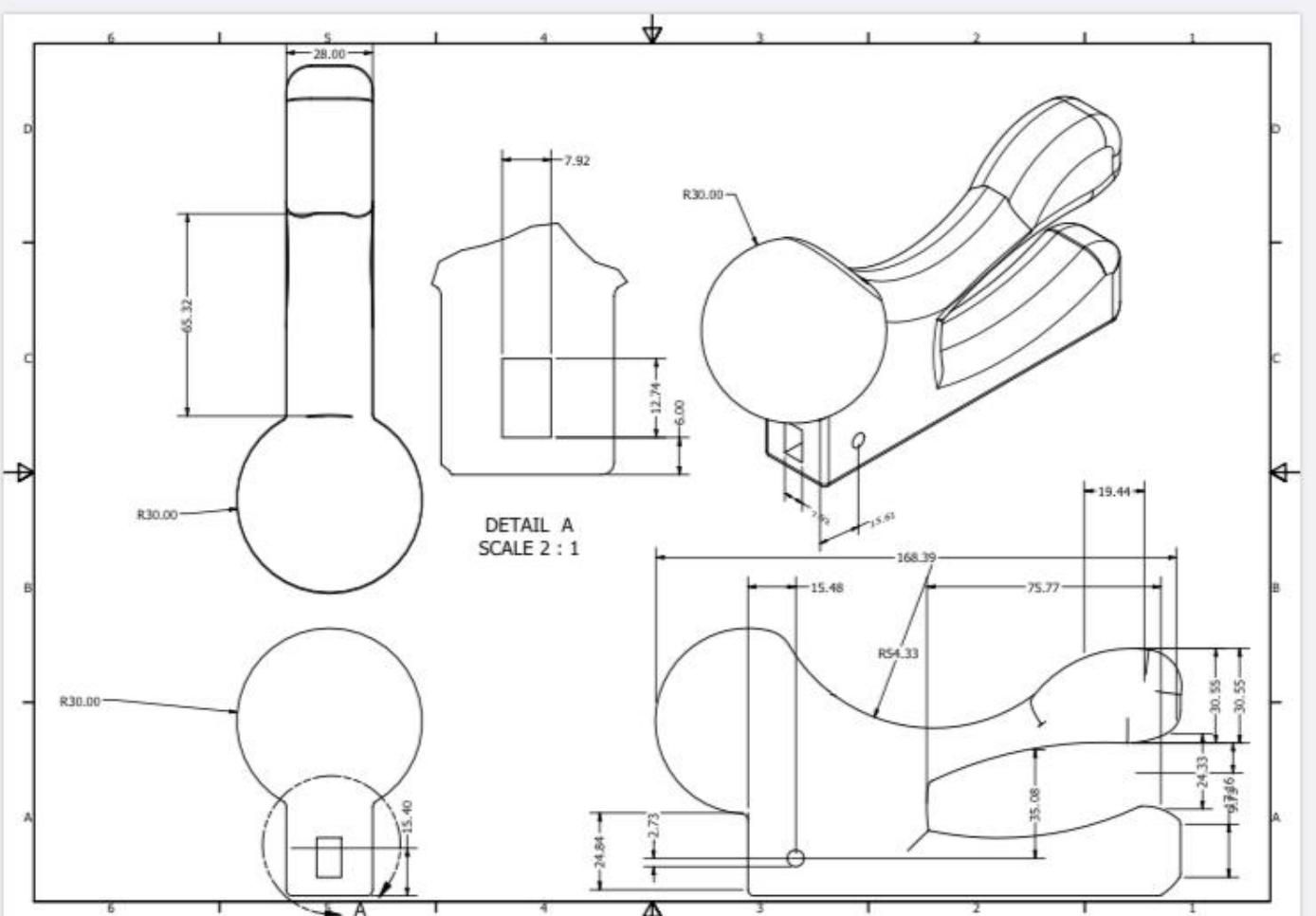
"I really like it and think that is very useful. However, you create some sort of manual to motivate and encourage people to use it"



## Clarifications of modifications

- Reduce size (handle width, height)
- Add more fillets or remove all sharp corners
- Make product out of car body filler
- Remove the jar opener design from below
- Make more ergonomic





1. Adjusted height (reduced)
2. Emphasis placed more on **ergonomics**
3. Huge block of spheric material developed as multiple hands are used to test whether hand fits for a **large percentile range**.
4. Focus of all measurements is more **user centered** with particular attention paid towards type of used (**MDF**) is substituted for ABS)
5. The opening is changed from rectangular to circular because this makes more compatible with most of the utensils used.

Based on client feedback:

- Colours are a darker shade of green which is showing the design to be a smooth clay like structure which is moulded.
- Smaller handle width of Approx. 28mm and a length of 65mm.
- Handle can be turned 360 degrees





Different views of the prototype



Side view 1

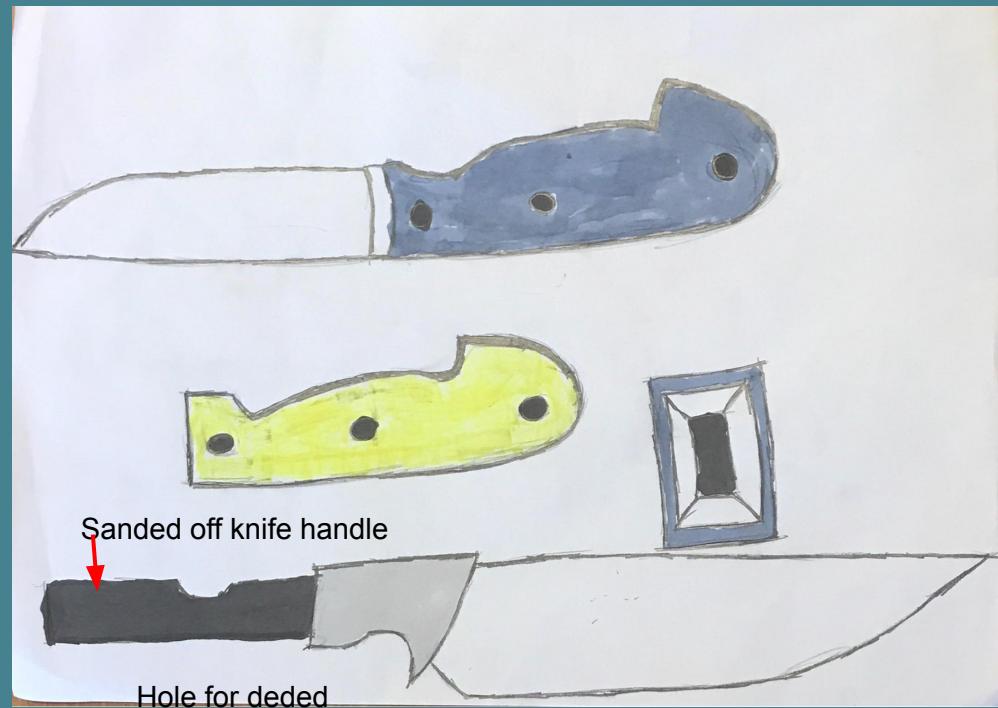


Side view 2



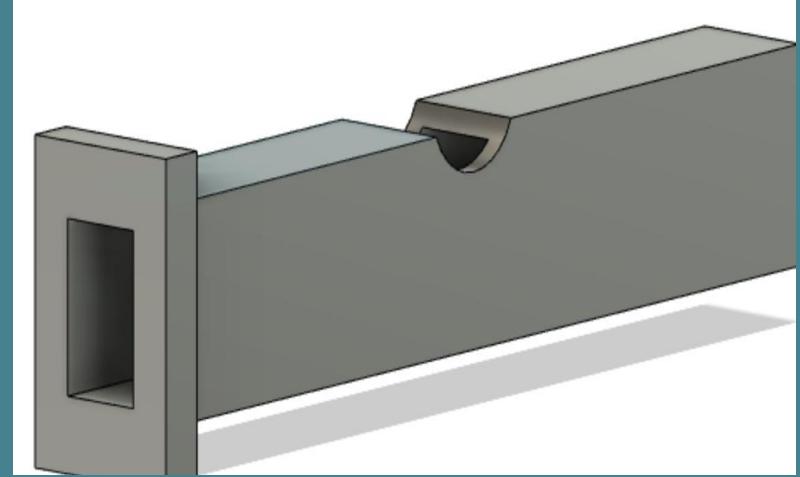
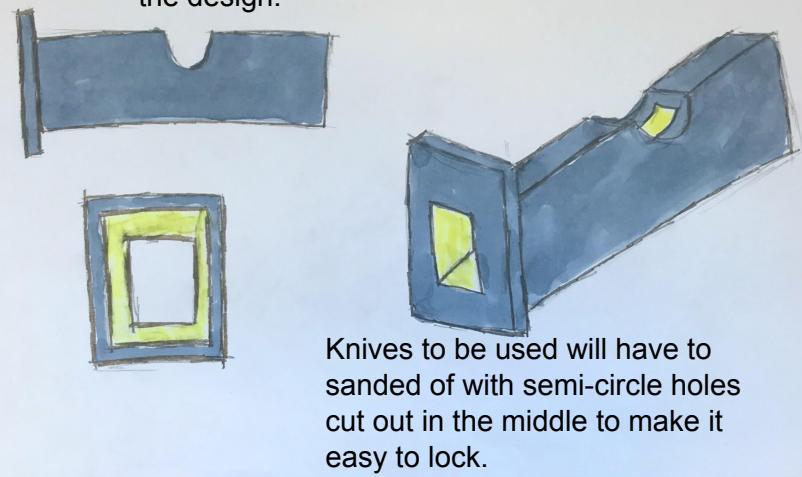
Top view

## INITIAL IDEAS OF MODIFYING AND DESIGNING FOR COMMERCIAL PRODUCTION

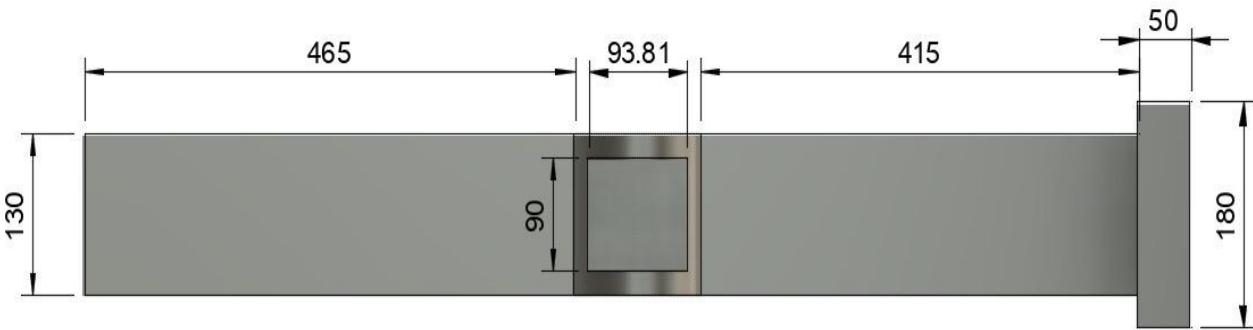
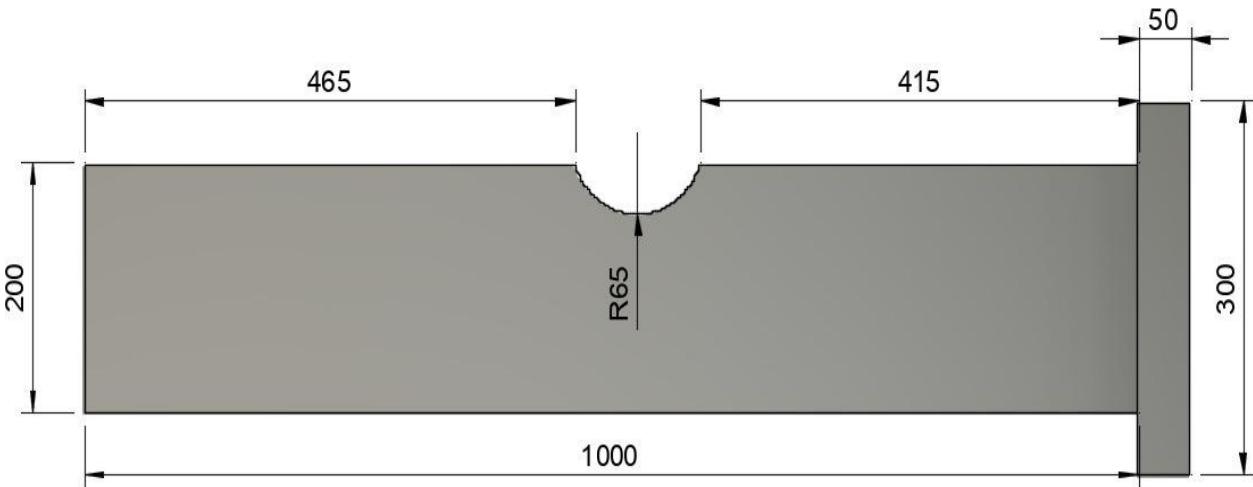
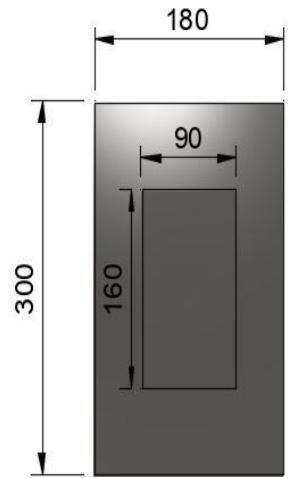


Criteria E

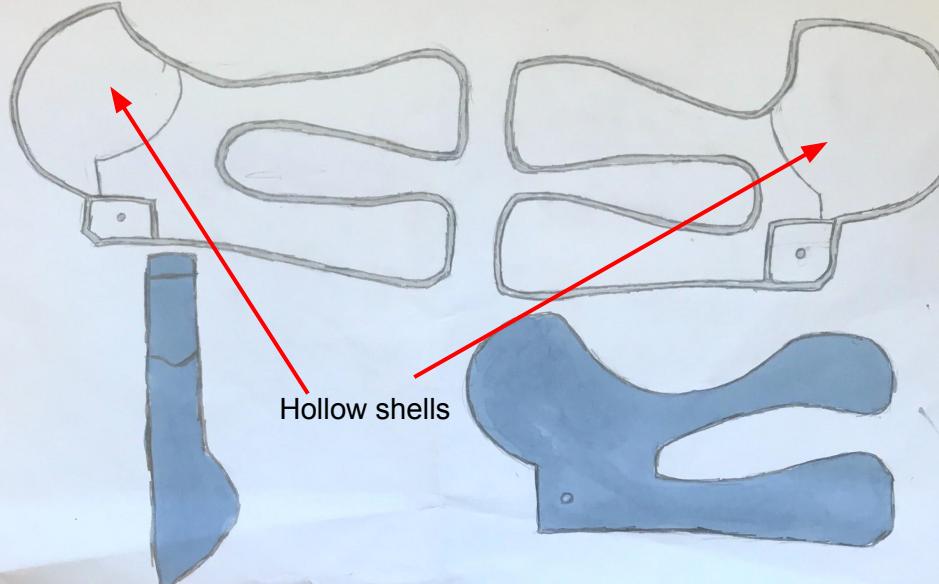
An alternative way of inserting knives would be to create handles which can be inserted into the design.



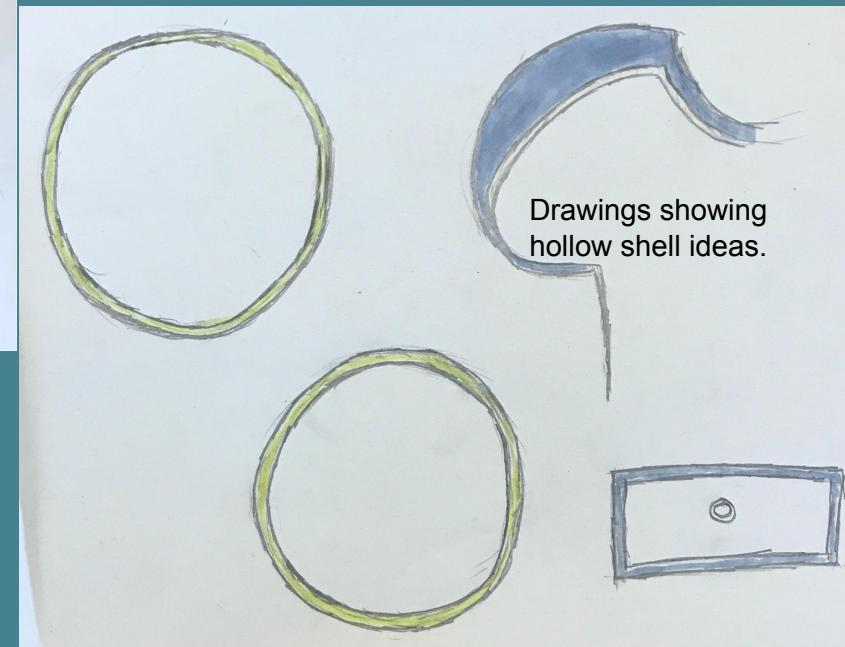
## CAD MODEL OF HOLDER

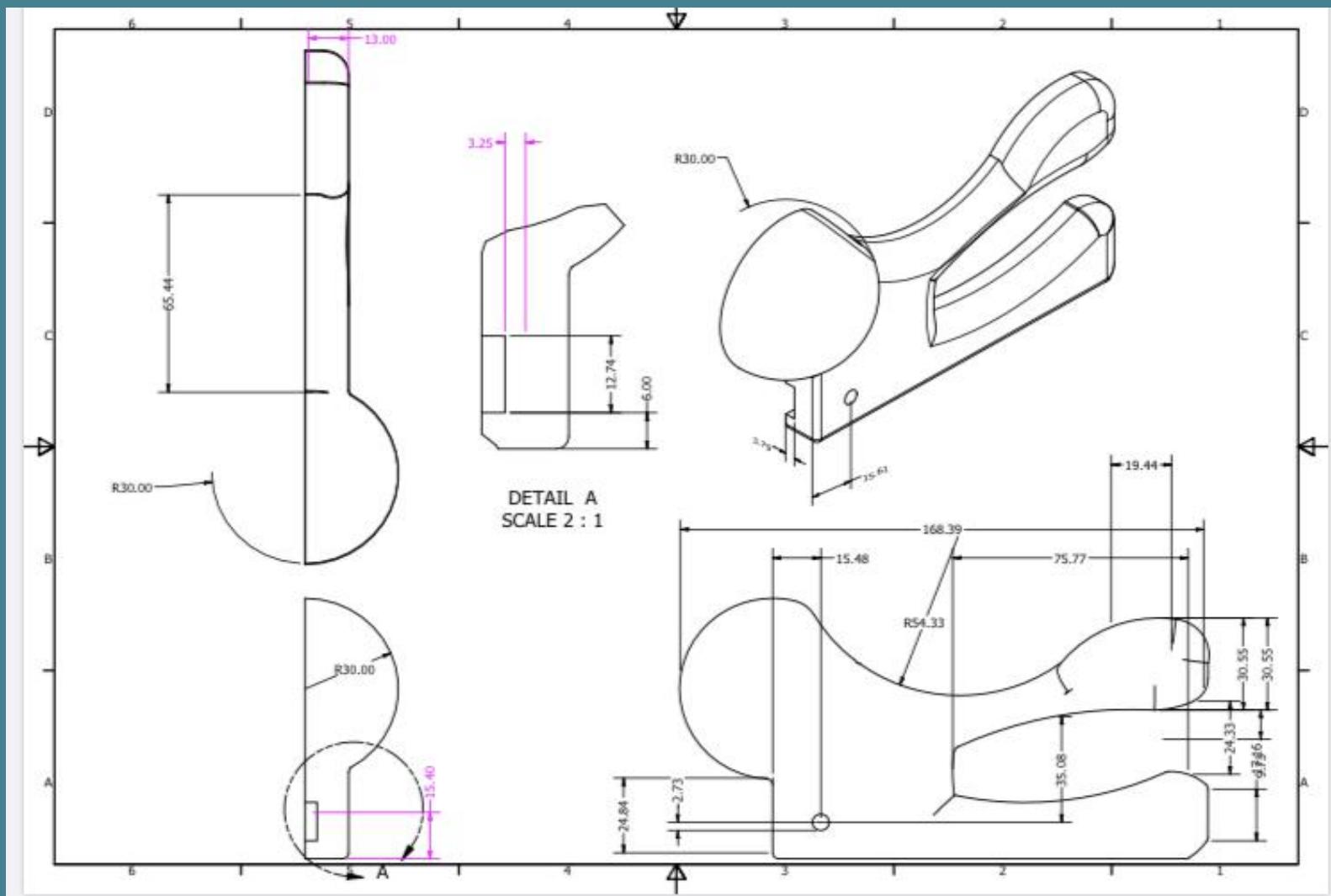


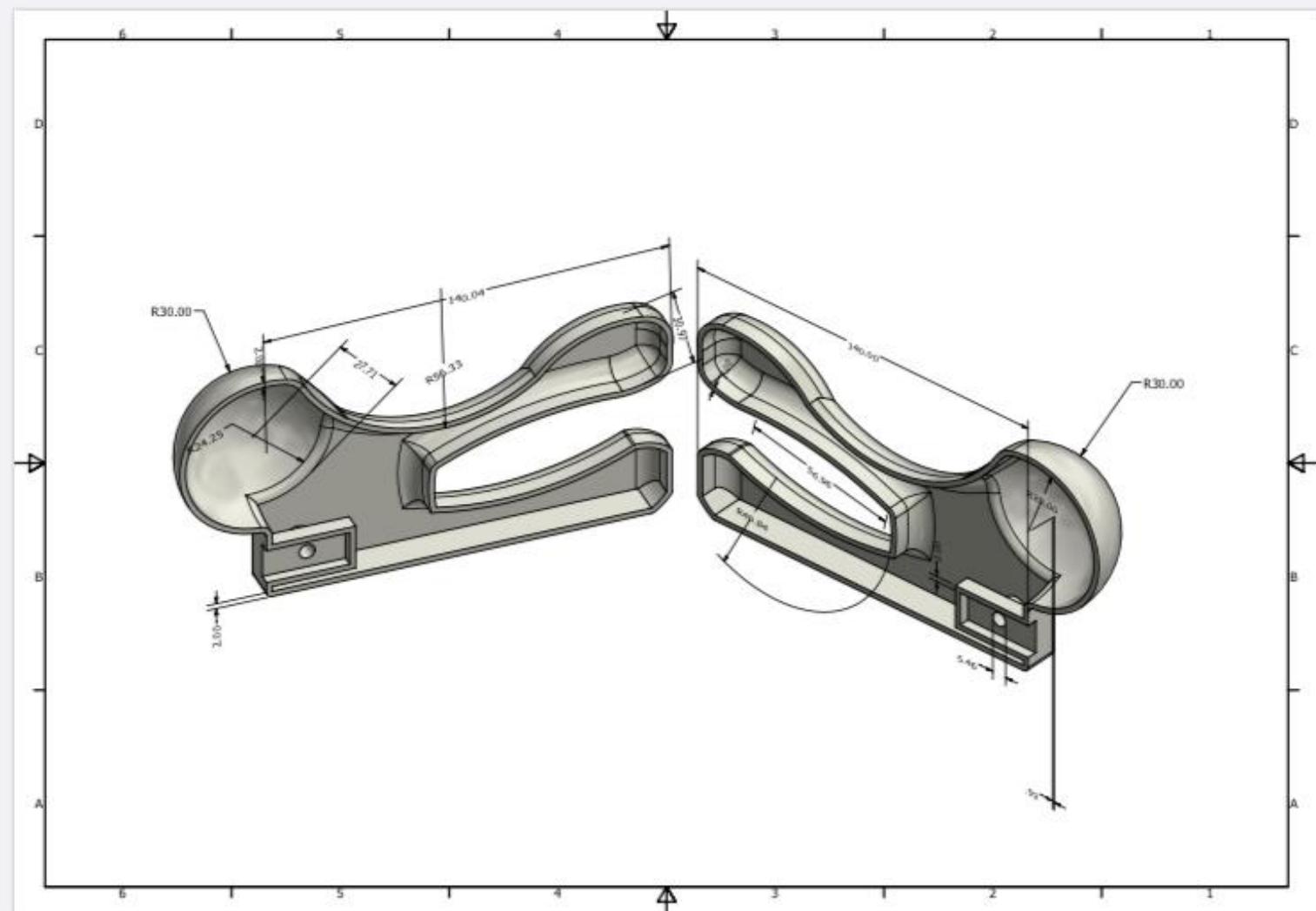
With regard to the height and length being unchanged, what is developed are two split parts of the design which can be glued or joined back together.



Initial ideas for the main product.







## Using a Thermoplastic instead of PLA for commercial Production

Criteria F

Although I enjoyed modelling my design with ABS and using it as a suitable material for my product, when thinking of commercial production, a much more better and suited material would be a thermoplastic such as Homopolymer which is good for kitchenware and can be easily injection moulded.

### Advantages of Thermoplastics<sup>3</sup>

1. Easy to mold and shape
2. Offers high strength and lightweight
3. Easy to manufacture high volumes quickly
4. Relatively low processing costs
5. Reduces waste and is more environmentally friendly
6. Chemically retardant and impact resistant

Thermoplastics, with the exception of polyester and polyimide film, have only recently gained popularity, especially in recent times for microelectronic structures. Advanced thermoplastics can now provide high melting points and exceptional stability polymers of early generation could not offer.<sup>4</sup>



### Manufacturing Techniques for commercial production

Although I 3D printed my mockup and prototype using Up-box, the amount of energy that it uses when working is what makes that method unsustainable. One of my objectives for my design is for it to use up as less material and energy as possible.

Therefore, if I aim to reduce carbon emissions and reduce impact on the environment, a much safer, cheaper and more efficient technique would be for the product to be Injection moulded. Thermoplastics can be injection moulded in a process in which they are melted and forced into a mould to fit the shape of the product. As for the components and connector, these can be injection moulded as well. One mould can be used to make much of the product and in this way material is being saved.

3:Soffar, Heba. "Thermoplastics Properties, Types, Uses, Advantages and Disadvantages." Science Online, 10 Sept. 2019,

4:"Home." Thermoplastic Materials | Thermoplastic Injection Molding | Elastomers,

Some other reasons why I chose Injection moulding as my manufacturing technique is because:

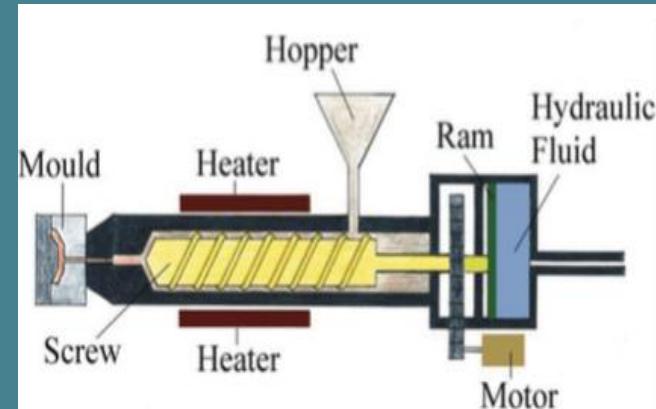
1. Very complex 3D can be produced
2. High volumes can be produced with constant quality
3. It is very fast as compared to other moulding processes
4. It has little labour costs
5. It has little waste
6. And lastly it has little to no finishing of the shapes produced.

### Volume and Scale of Production

For us to distinguish the scale of production, the potential market size should be known first. According to data released by the UK government, there are approximately 13.9million people living with disabilities in the country alone, while disabilities that affect hands and leg movement make up about 8 million.<sup>5</sup> I will be using the invention calculator to find the potential market size and have chosen the UK as the place to test out the product. Since my target audience is people with hand disabilities, the age range that could be used is people between the ages of 20 to 50 as this normally affects people in the older range. This brings the percentage of people to about 49%.

In adults who may have arthritis of the hands or rheumatoid of joints. Therefore, the product is aimed towards a niche market. For the large percentage, a test run of about 9000 products can be made from injection so as to check with various people on the market. As the product gains reputation and market presence, the number can be increased as it gets more success. I would choose for the product to be batch moulded as this is more effective and less costly when it comes to manufacturing.

Mass customisation can be a possible feat for the product in the future.



**Image**



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