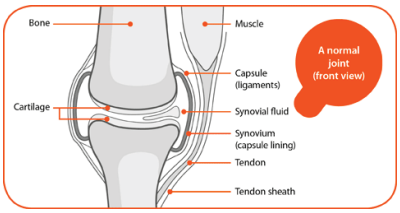
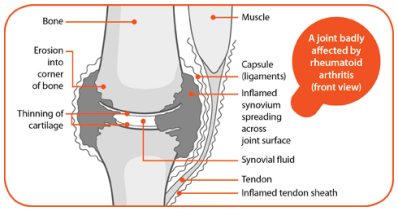
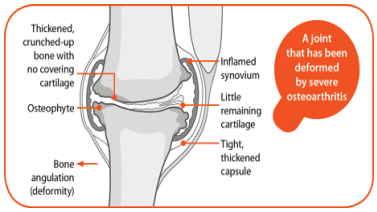
Criterion A: The Problem

Outlining the problem:

Approximately 10 million people in the UK suffer from arthritis *(http://www.nhs.uk/Conditions/Arthritis/Pages/Introduction.aspx)* most commonly suffering from osteoarthritis and rheumatoid arthritis. This degenerative condition makes daily tasks, such as opening bottles and cans and turning taps, painful and difficult. Arthritis is a condition where the cartilage in the joints becomes very thin, causing the bones to rub, which reduces dexterity and causes huge amounts of pain. Arthritis also causes the loss of strength in the affected area which impacts the level of grip that a person has when holding or trying to open a product. Arthritis most commonly affects the joints in the hands, knees, spine and hips (*http://www.arthritisresearchuk.org/arthritis-information.aspx*) The images below show how arthritis affects joints.







Market profile:

Approximately 10 million people in the UK suffer from arthritis who are affected at any age, although arthritis most commonly affects people aged from 45 years old *(http://www.arthritisresearchuk.org/arthritis-information.aspx).* The market for my product will be adults of both genders who suffer from arthritis in their hands and do not have someone at home who carries out the daily tasks that they struggle with for them. My target market will be those who struggle with opening bottles, especially ones with a safety cap on, and therefore require a product that helps them to open bottles easily.

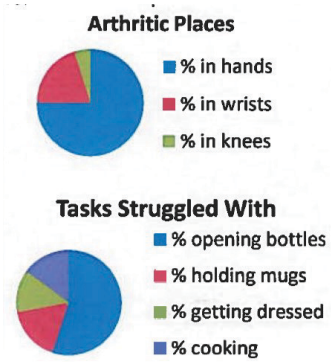
Figure 2: Arthritic hands

Figure one shows an arthritic hand: displaying how difficult it is to open bottles because the hand is deformed.

Questionnaire:

1.) What age are you? (20-30/31-40/41-50/51-60/61-70/70+)
2.) Where do you have arthritis?
3.) Are there daily tasks that you struggle with as a result of your arthritis? If so, what are they?
4.) Do you have someone at home that helps you with tasks that you struggle with?
5.) If you have arthritis in your hands, are there specific products that you struggle opening?
6.) Do you think that there are products readily available to aid problems caused by arthritis?
7.) Do you have any products that help with daily tasks? If so, what do you have?
8.) If you have such a product, how much did you spend on it?
9.) If you own a product that helps with daily tasks, where do you store it?
10.) Do you find the product useful? If not, what would make it more useful? (*https://www.surveymonkey.com/s/8XQWNKP)*

My questionnaire is to find out if there are specific tasks that people who suffer from arthritis struggle with. The answers to his questionnaire will help me decide what product I need to design in order to solve a genuine problem.



The pie charts above display the results of the two most important questions of the questionnaire: where the sufferer has arthritis and what task they struggle with most. The results how that the highest percentage of people suffer from arthritis in their hands and the teaks they struggle with most is opening bottles

Figure 1: My client, sufferer of arthritis in her hands

I conducted an interview with my client and spoke to her about what tasks she finds most challenging at home and what sort of product would be useful to her. She explained how opening bottles was certainly an issue due to her deformed hands and the pain she has when she tries to grip the lid. From this, I have discovered that there is a need for a product that aids people with arthritis with opening bottle tops.

5 exercises to improve hand mobility and reduce pain *(http://www.health.harvard.edu/pain/5-exercises-to-improve-hand-mobility-and-reduce-pain).* This newspaper article shows how there is a problem with hand mobility that is related to arthritis causing pain in your hands. This displays how there is a genuine problem with hand mobility that is painful for the sufferer, and how a product does need t be made in order to help with daily tasks.

Criterion A: Key findings

Research:	Justification:	Primary:	Secondary:
Existing products	In order to look at successful products that have been sold and to see how they are manufactured and the cost.	I looked at existing products, and at one in detail: testing it on bottles of ranging sizes, as well as feeling its weight and material texture. From this I investigated appropriate materials, price and weight.	Amazon.co.uk: Tap turners are a widely used solution, and are simple and cost-effective. (www.amazon.co.uk)
User Needs	In order to be able to design and appropriate and relevant solution to the issue.	I asked my client what they needed in order to solve the issue of not being able to open bottles easily.	I looked on arthritic forums and Facebook groups and discovered that difficulty opening bottles was a recurring problem. (www.artritisaction.org.uk)
Ergonomics	So that the dimensions of the design are appropriate to the user and the problem -> the product is not too big or too small for the user to hold and it is the correct size for opening a variety of bottle lids.	I measured the product that I tested in detail to get an idea of appropriate dimensions for holding and also for gripping the bottle tops	I looked at dimensions of existing products online (such as on Amazon) that solve problems for people with arthritis. In addition to looking at the dimensions of bottle lids so that I could make my product the appropriate size. (www.amazon.co.uk)
Materials	To make sure that the material, which the product is manufactured from, is appropriate to the user and for the problem.	I looked at the materials of the existing product that I tested to see which were effective in gripping the bottle lid and also what was comfortable to hold.	I looked at the materials of products online, in places such as Amazon and websites that sell products specifically for people arthritic hands. (www.lewtress.co.uk)
Construction	In order to look at how the product would be constructed so that it is strong and secure and has a long lifespan.	I looked at the way that the existing product that I tested was constructed.	I read reviews on existing products to see whether they have been made well and last a long time.
Function	To make sure that the design successfully and effectively solves the problem for the user and is easy to use	I asked my client about what device they might need in order to solve the issue of opening bottle lids.	I looked reviews online of how effective the existing product was at enabling the user to open a bottle easily. (www.focusondisability.co.uk)
Environment of use	To make sure that the product is designed so that it can e stored in its environment and it is of an appropriate size. As well as visually fits.	I asked my client where they would most use a product to help them open bottles: whether it be in the kitchen or the bathroom, for example.	Look at existing products and their intended environment of use. (www.lloydspharmacy.co.uk)
Safety/ legislation	So that the product can be designed according to legislation so that it is safe for the user to operate.	Not applicable.	I searched on the internet about legislation for a product that helps people with arthritis.
Constraints	So that the product can be designed within the constraints of the problem, the environment and user needs so that the product successfully solves the problem.	I asked my client about what the constraints are for them regarding a product to help them open bottles.	I looked at the constraints of existing products to get an idea of what the constraints for my product might be. (www.arthriotissupplies.co.uk)

The table to the left displays the diameter of the most com

Criterion A: Key findings

Product	Strengths	Weaknesses	Summary
IMAGE REMOVED FOR COPYRIGHT REASONS *www.betterlifehealthcare.com/view/betterlife-one-pull-can-opener/3960*	Hook easily fits under the ring on tins which makes it easy to use. Also it is small in size so it is easy to store and the product is very cheap which is ideal for elderly people with arthritis. It only costs £8.39	User still needs to be able to grip the handle which an arthritic person might find difficult or uncomfortable as their fingers are unable to bend around the handle. Made from hard, smooth plastic—uncomfortable to hold and gives no grip.	Not entirely appropriate for an arthritic person as it is not comfortable to hold.
IMAGE REMOVED FOR COPYRIGHT REASONS *www.amazon.com/Isabella-Dora-Jar-Opener-Marmalade/*	Silicone handle makes it comfortable for user to hold. Different diameter holes for different size jars. Flat and relatively small so easy to store. Only costs £10.77	User has to grip the handle tightly in order for it to function properly which may be uncomfortable for someone with arthritis in their hands or wrists.	Not particularly useful for an arthritic person because the user still has to twist their wrist to open the jar.
IMAGE REMOVED FOR COPYRIGHT REASONS *www.amazon.co.uk/One-Touch-Automatic-Jar-Opener/dp/B0015S2BBW*	It has a large area to hold so it is easily held whilst operating. It is operate electrically so it removes the need for the user to twist their wrist. It is adjustable to fit to different size jam jars.	Quite large so it might not fit in a kitchen drawer or storage area which is inconvenient for the user. Battery operated which is inconvenient for the user as they have to change the batteries. Difficult to do for someone with arthritis in their fingers. Costs £29.95 which is quite expensive.	It is very useful for someone with arthritis as the user does not have to twist their wrist, however changing the batteries may be difficult.
IMAGE REMOVED FOR COPYRIGHT REASONS *www.arthritislivingaids.com/dream-kitchens.html*	Colour coded to indicate water temperature to avoid accidental scalding with hot water. Silicone coating on the steel handle makes it more comfortable to hold. Long handle increases the turning force, making it easier to turn the taps. Unlikely to slip because the silicone adds resistance.	The plastic coating might perish after a while, uncovering the metal handle. On the hot tap, this could become hot and burn the user.	Very useful and appropriate for an arthritic person as it helps them turn on the tap and is secure so it will not slip off. Colour coded to indicate temperature of the water which is essential.
IMAGE REMOVED FOR COPYRIGHT REASONS *www.betterlifehealthcare.com/browse/gripping-and-turning/*	Long handle makes it much easier to turn the tap than a short handled lever. Colour coded with the water temperature of the tap to avoid accidental scalding. Gaps for the crosshead to fit in easily. Made of HIPS—perfect for a kitchen or bathroom environment as doesn't react with water. Made by injection moulding which means it can be made on mass scale. Only costs £2.79 which is very inexpensive.	The tap turner could slip off the tap easily as there is nothing to secure it to the tap. It is made from hard plastic which is uncomfortable to hold.	This product effectively solves the problem of turning taps, as well as showing the temperature of the water. However, it is not entirely secure.
IMAGE REMOVED FOR COPYRIGHT REASONS *www.arthritissupplies.com/grips-adapters-*	Large surface area of the handle which makes it easier to turn the key as well as to hold it. Handle made of silicone which is comfortable to hold and moulds more easily	It is quite small in the hand so the user still has to twist their wrist quite a lot which is uncomfortable for an arthritic person.	Makes it easier for an arthritic person to hold the key, but if the user has arthritis in their fingers, it is not appro

Criterion A: Key findings

Figure 3: Multiple jar and bottle opener

Materials: The jar and bottle opener is made from two materials; the grip is made from liquid silicone rubber, and the hand grip is made from polypropylene. The liquid silicone rubber allows the bottle of jar lid to be squeezed in order for it to be turned, so the jar or bottle can be opened. The polypropylene means that the user can hold the product easily and is easily gripped.

Figure 6: Item stored in intended environment

Construction/manufacture; This product could easily be constructed and manufactured on a mass scale through injection moulding. This is a very quick and relatively inexpensive method of manufacture which would make sure that the cost of the price is low.

Ergonomics: The product has been designed with indentations in the hand grip for the fingers to be placed in when gripping the jar or bottle. The total width of the hand grip is 5cm which is smaller than the average hand grip size so the user should be easily able to grip the product as the handle is not too big.

Figure 2: Plastic bottle with screw lid

Storage: The bottle opener has dimensions of 23x10x2.5cm so it can be easily stored in kitchen drawers as it is very flat and not too long. For example, figure 6 shows how the product can be easily stored in a kitchen draw.

Function: The lid of the bottle in Figure 3 has a diameter of 5cm which fits perfectly in the second largest hole in the product, which also has a diameter of 5cm, so the product fulfilled its purpose entirely as it made it very easy to open the bottle.

The lid of the bottle in figure 2 had a diameter of 3.5cm, and I successfully opened the bottle with ease, despite the lid having a small diameter. This is particularly useful as bottles with small lids are more difficult to open for someone with arthritis in their hands because they can not fit their hands around the lid.

Figure 5: Jar of spread

The bottle in Figure 1 has a child safety cap on it with a diameter of 4.5cm which fitted in the third largest hole and despite having a safety cap I was able to open it with the product. However, in order to do this I had to squeeze the opener relatively hard which may be difficult for someone with arthritis as it may be very painful.

The jar lid in Figure 5 has a diameter of 6.5cm so it is too small to fit in the largest hole of the opener, and it was slightly too big to fit in but I was able to open the jar very easily. I discovered it was easier to open the jar when the lid was too big for the hole, but I had to use a small force to place the opener around the lid.

Figure 1: Washing up liquid

Aesthetics: The product is fairly aesthetically pleasing as the designer has used two different shades of blue which makes it appear more attractive. Furthermore, all the edges are curved so it does not look obtrusive in the home as there are no sharp edges.

Cost: The cost of this product is relatively low because the materials it is made from are cheap, For example, Amazon.com is selling this product for £11-12.

User needs: The user need is to be able to open a bottle or jar of ranging sizes with ease. This product successful meets the user needs as it makes opening bottles and jars of a variety of sizes easy to do. However, in order to open the bottle in figure 1 with the safety cap, I had to squeeze very hard which may be painful for someone with arthritic hands. Therefore a product needs to be made that can easily open safety caps.

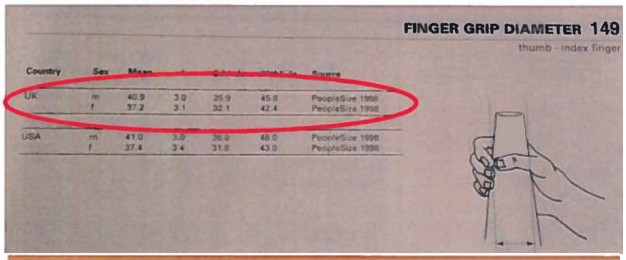
Figure 4: Wide screw lid

Type of Bottle	Diameter of Bottle Top
Standard Drinks Bottle	35mm
Standard Milk Bottle	40mm
Small Screw-Top Bottle	30mm

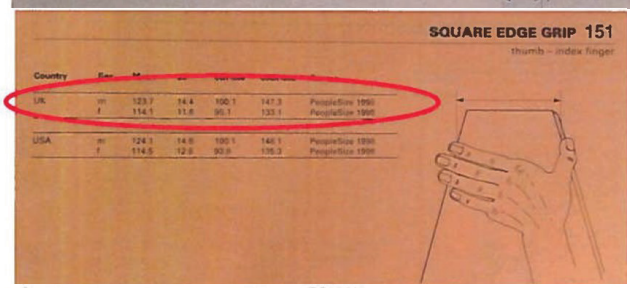
The table to the left displays the diameter of the most common bottle tops that elderly people would struggle with opening. As a result, I will design my product so that it can open the smallest screw top bottle which has a diameter of 30mm, as well as allowing the user to open standard milk bottles which have a diameter of 40mm.

Criterion A: Key findings

Constraint	Justification
Weight	The product must not weigh more than 1kg otherwise it would be painful for the user to use and if the user dropped the product it could severely damage their foot
Average human hand size	The handle for the product must not be larger than the average human hand size because otherwise the user may find it very difficult to hold, as their hand is not big enough. Furthermore, if the user's hand is too small to hold the product it may be painful for them whereas if the user's hand is bigger than the product it would not be uncomfortable. The average human hand sizes for grips are displayed in the pictures below.
Hand force	The product must not require more than the average hand force for a human. This is because the user may not be able to use the product as they may not be strong enough. Also, someone with arthritic hands will not have as much hand strength as the average human so the product needs to require indefinitely less than the average hand force.
Average kitchen drawer size	The product's dimensions must not exceed the average kitchen drawer size otherwise it will not be able to be stored in a drawer. I measured the width, length and depth of multiple kitchen drawers and discovered that the average dimensions were 500x450x92mm. Therefor the product must not exceed those dimensions.
Price	Having looked at existing products and their prices, the product must not be more than £20 because otherwise the user will not want to buy it as it will be too expensive. Very few products on the
Size bottles	The product must be able to open a wide range of bottles so the size of bottle grip must either be adjustable or the product has more than one grip that fits with different size jars and bottles. For in-



The image to the left displays the constraints of the user's finger grip diameter. The data circled in red is the measurements that I will use to ensure that my product is of a suitable size for someone to hold easily.



The image to the left displays the constraints of hand grip sizes. The data circled in red is the data I will use to ensure that my product can fit in the user's hand easily so t hat it is not uncomfortable for them to hold. It is important that I stay within these constraints because if the product is uncomfortable for the user to hold then the product will not fulfil its function.

The image to the left shows the space available for storage of the product. The product must be able to fit in a drawer this size (as this is the standard drawer size) and fit in alongside other utensils such as those shown in the drawer above.

Criterion A: Key findings

Existing products:

Having looked at existing products, and done a detailed primary analysis on a multiple bottle opener, I have discovered that existing products are generally made from a type of plastic, whether it be HIPS of polypropylene. Also, they have a different material that aids with grip of the bottle and for comfort in the hand, this usually is liquid silicone rubber. Therefore I have discovered that these materials would be most appropriate for my product to be manufactured from.

User needs:

I researched user needs and discovered that there is definitely a need for a product that aids someone with arthritis in their hands to open bottles. This is because 100% of the people who answered my questionnaire said that they struggled with opening bottles. Therefore my target user needs a product that can aid them in opening bottles.

Ergonomics:

Having carried out my research I have discovered that my design must not exceed 500x450x92mm because that is the average drawer size, so then it can be easily stored. I have also discovered that the handle of the product must not be wider than 45.8cm (95th percentile of finger grip diameter) and it must not be smaller than 35.9cm (5th percentile of finger grip diameter) in order for the user to be able to hold it comfortably.

Materials:

The product must be made out of hard wearing materials that do not perish quickly, for example it should not have a grip that is made of foam because foam disintegrates after approximately 5 years, and it can be easily damaged by other objects in a drawer. It could be made from polypropylene with a silicone grip.

Construction:

The product should ideally be made from injection moulding as then it can be made on a mass scale, and after the initial set up costs, the overcall cost is relatively low. Injection moulding is an appropriate manufacturing process because it is suitable for polypropylene or HIPS, which is what the product could be made from.

Function:

The product should successfully fulfil its purpose of aiding someone with arthritic hands to open bottles easier. It should be able to be stored in a kitchen drawer and should be easily cleaned due to the fact that its environment included food and drink.

Environment of use:

The environment of use is in a kitchen as that is where jars and bottles are most commonly opened. Therefore the product should be resistant to warm temperatures from cooking, and steam from boiling kettles etc.

Safety/legislation:

There is no legislation regarding non-electrical, blunt kitchen appliances. However, for the safety of the user, it should have no sharp edges and should not exceed the weight of 1kg, because if it was too heavy then it could damage the user's wrist or their feet if they dropped it.

Constraints:

The constraints involve hand sizes i.e. not wider than 45.8cm (95th percentile of finger grip diameter) and not smaller than 35.9cm (95th percentile of finger grip diameter) and environment of use, such as the drawer size as the product must be able to be stored. The constraints also include the diameters of the bottle lids: the product must not be designed so that it cannot open bottle tops of large diameters, such as a milk bottle, but must also be able to open smaller sized bottle tops, such as a standard screw cap water bottle.

Criterion A: Design brief

Target group: Both men and women over the age of 70 who have arthritis in their hands, meaning that they find it difficult and painful to open bottles and thus require a product to enable them to open bottles easier.

Design goal: To design a bottle opener that allows the user to open a variety of different size bottle tops, whilst being comfortable to hold and easily cleaned.

- In order to create a successful bottle opener that sells to the appropriate target audience, it needs to combine simple design with its function. The product will be aimed at people above the age of 70 years old who have arthritis in their hands. It will focus specifically on solving the problem of opening bottles.
- The product will be made to attract people who struggle with opening bottles and who do not have anyone at home who can help with this task, whether they are a carer or a partner. Therefore elderly people who live alone are the main target group because they are more likely to suffer from arthritis in their hands and also more likely to live alone than a younger person.
- The design goal is to increase the user's ease of living by providing them with a product that helps them carry out the everyday task of opening bottles, easily and painlessly.
- As a result of the already competitive market for products that aid people in opening bottles, jars, can, etc., it is vital that the main focus of the design is on the product being able to aid the user in opening a variety of bottles so that they only have to purchase one product. This may win many customers and a multifunctional product is very appealing.
- Because the target audience is the elderly, the price should not be too high and research has shown that the target audience would not spend more than £20. The target audience do not necessarily favour modern design, rather functional design and so my product will have a simple design that portrays the product's function.
- Because the product will be stored in a kitchen drawer it needs to be of an appropriate size so that it is not obtrusive in a drawer and easily fits among other utensils.

Criterion A: Marketing specification

Target Market:

The target market for my product is people who suffer from arthritis and need a product that helps them with daily tasks. The market sector for my product is people who struggle specifically with opening bottles. This is because my research and questionnaire results suggests that opening bottles is a task that many people struggle with and do not have a product that aids them with such task.

Target Audience:

My target audience is people in the UK who are over the age of 70 and suffer from arthritis in their hands. They do not have someone at home to help them with opening bottles, and so they need a product to help them, whereas my target market is purely people who suffer from arthritis.

Market Analysis:

Across the UK around 10 million people suffer from arthritis, the majority of sufferers are aged 45 and above. If I was to tap into 1% of the market, I would need to produce approximately 100,000 products. This would require the use of large batch/mass production manufacturing techniques such as injection moulding. Fixed costs include wages and the construction of the building as well as buying the machinery to manufacture the product. The variable costs include buying the materials as price of oil and demand fluctuates. The most expensive product on the market was an electric bottle opener at £29.95 and the cheapest was £2.79 which was a tap turner. Therefore my product should be between these prices in order for it to successfully sell. However, if I was to sell my product at retail price, it would be considerably higher and I would not receive the full difference between the manufacturing price and the retail price.

User Need:

The product must be able to successfully and easily aid the user with opening bottles without it being painful. It must also be easily and unobtrusively stored in a kitchen drawer so it fits in with its intended environment of use. The product must also not have any sharp edges or corners that may cut or harm the user, as the target user is over the age of 70 without a helper at home so it is highly important that the product cannot harm them. In addition, it must be easily cleaned so that it is hygienic and cannot harbour bacteria that could contaminate food or drink and cause the user to become ill.

Competition:

The competition for my product comes from brands such as Oxo and Joseph Joseph, as well as products available online from unknown manufacturers. The competing designs range in price from £29.95 at the most expensive to £2.79 at the cheapest. Oxo is one of the leading brands for kitchen utensils; they sell a jar opener for £7.50 which has the capability to open a variety of sized jars. Alessi is another leading brand for kitchen utensils but focuses more on aesthetics than the functionality and as a result the designs are not appropriate for people with arthritic hands.

Criterion A: Design specification

Aesthetic Requirements:

The product must be aesthetically pleasing to both genders and to a wide range of age groups because arthritis affects both genders and does not only affect elderly people.

Cost Constraints:

The most expensive product on the market is £29.95 and so the product mut not cost more than this otherwise it will not sell.

Customer Requirements:

The product must fulfil the customer requirements, so it must aid the user in opening bottles with ease and without it being painful. Therefore the product must be of a suitable shape so that it is natural for the user to hold and does not mean that the user's hand or wrist is in an uncomfortable position.

Environmental Requirements:

The product must be easily recyclable so it is not bad for the environment, and have a long life span to reduce waste. Therefore it must be made from recyclable material such as HIPS.

Size Constraints:

The product must not be larger than 500x450x92mm because that is the average size of a drawer and so it would not be able to be stored in a drawer. It must also not be wider than 45.8cm (95th percentile of finger grip diameter) and it must not be smaller than 35.9cm (5th percentile of finger grip diameter) in order for the user to be able to hold it comfortably.

Safety Considerations:

The product must have no sharp edges so the user does not cut themselves. The product must also not be heavier than 1kg because if the user dropped it, it could severely hurt their foot and the weight of the product could also be damaging to the user's wrist. Furthermore, the product must be easy to clean to reduce the risk of bacteria, because the product is used in a kitchen where it comes into contact with food and drink.

Performance Requirements and Constraints:

The product must aid the user in opening bottles with ease, meaning that they do not have to force their hand or wrist in an uncomfortable position. The performance constraints are the diameter of the bottle that needs to be opened, the strength of the user and also the leverage or mechanism of the product..

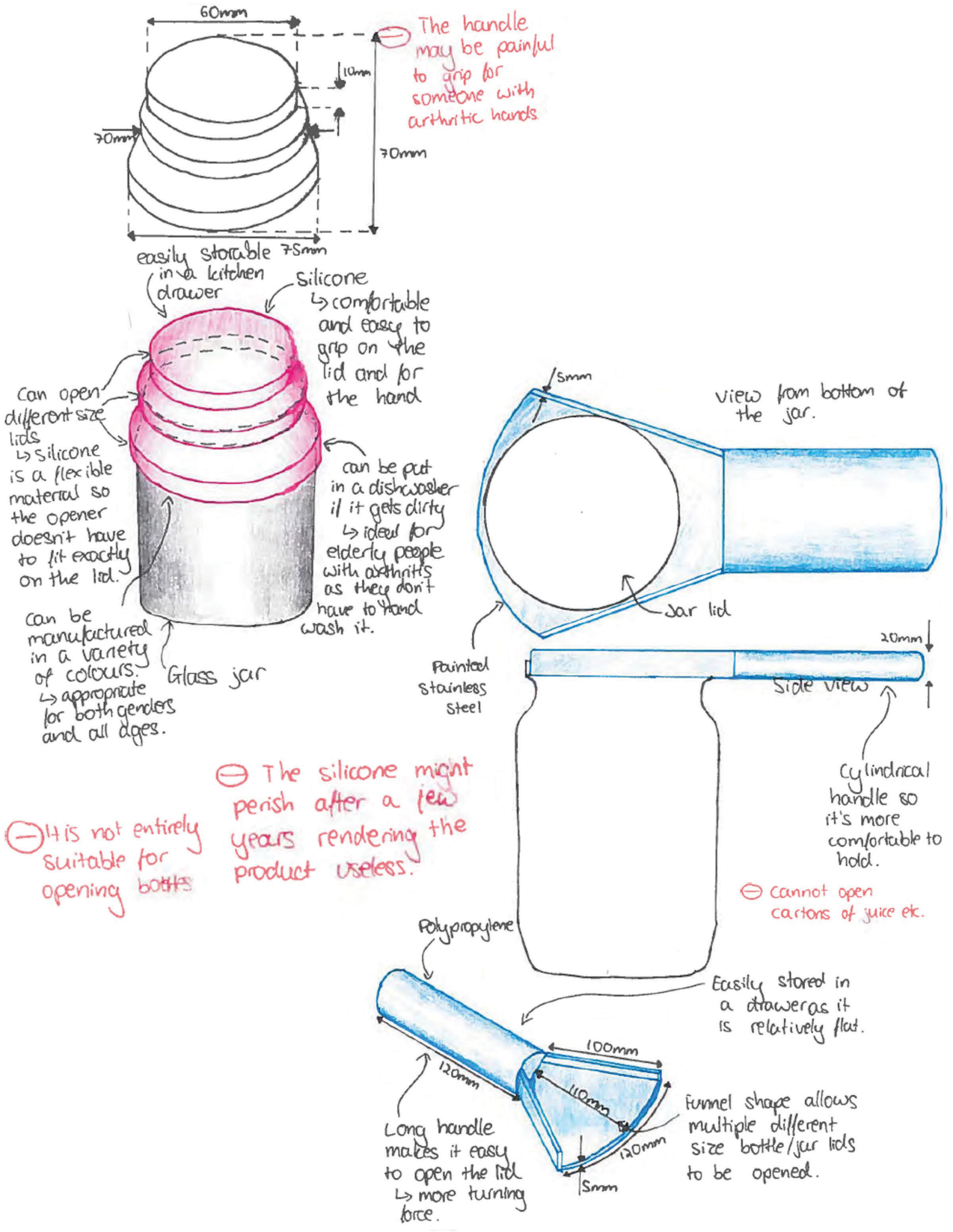
Materials Requirements:

The product must be made from materials that provide enough grip to be easily open a bottle (e.g. silicone) and of a long lasting and hard wearing material, (e.g. ABS) so that the product has a long life span. The materials also need t be suitable for appropriate manufacturing processes, for example HIPS is appropriate for vacuum forming.

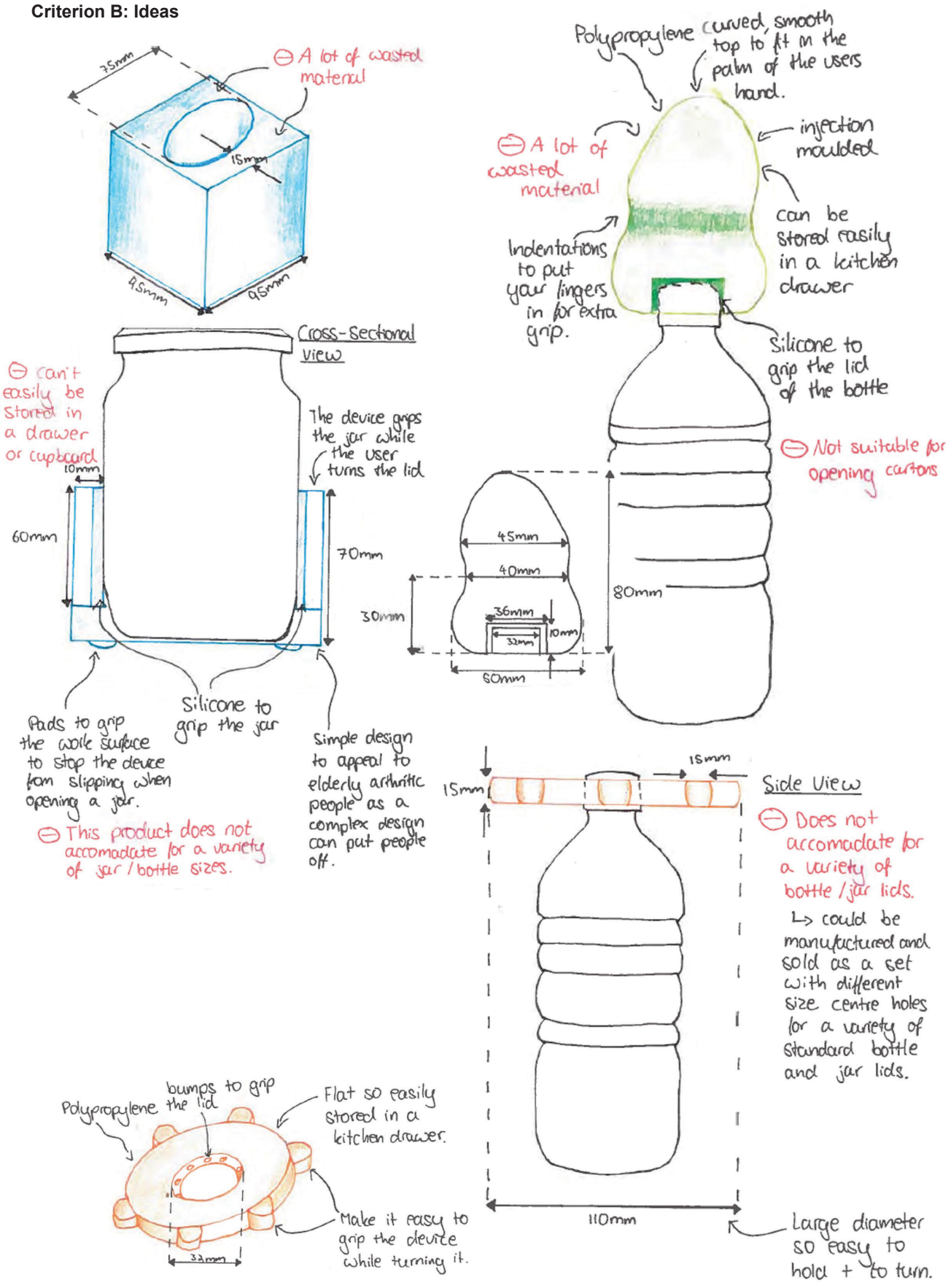
Manufacturing Requirements:

The product must be manufactured strongly so that it has a long life span, so that it is environmentally friendly. It needs to be manufactured on a mass scale because arthritis affects thousands of people, ideally injection moulding because the cost is low after the initial set-up costs. The manufacturing process also needs to be appropriate for the materials that the product is made from.

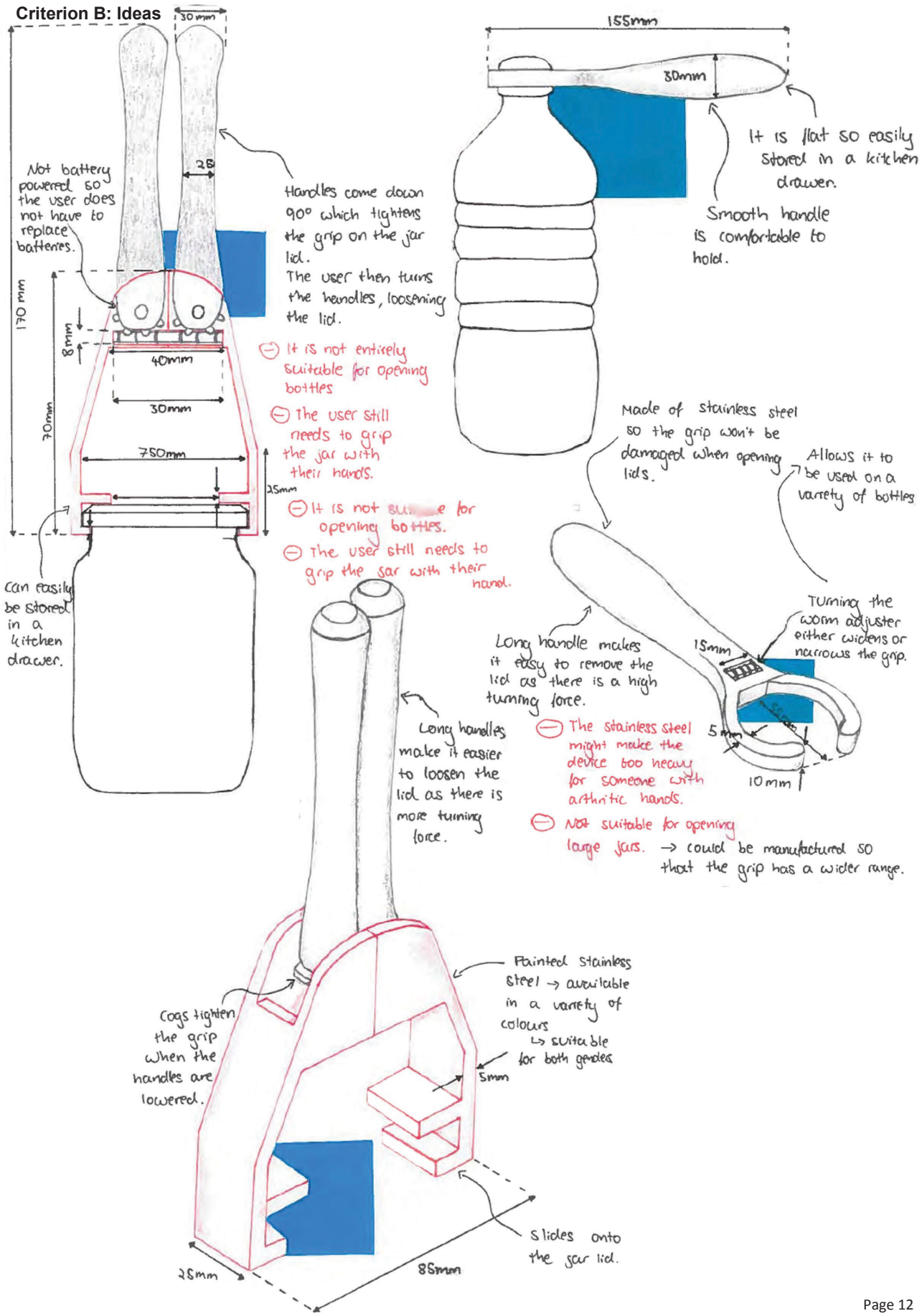
Criterion B: Ideas



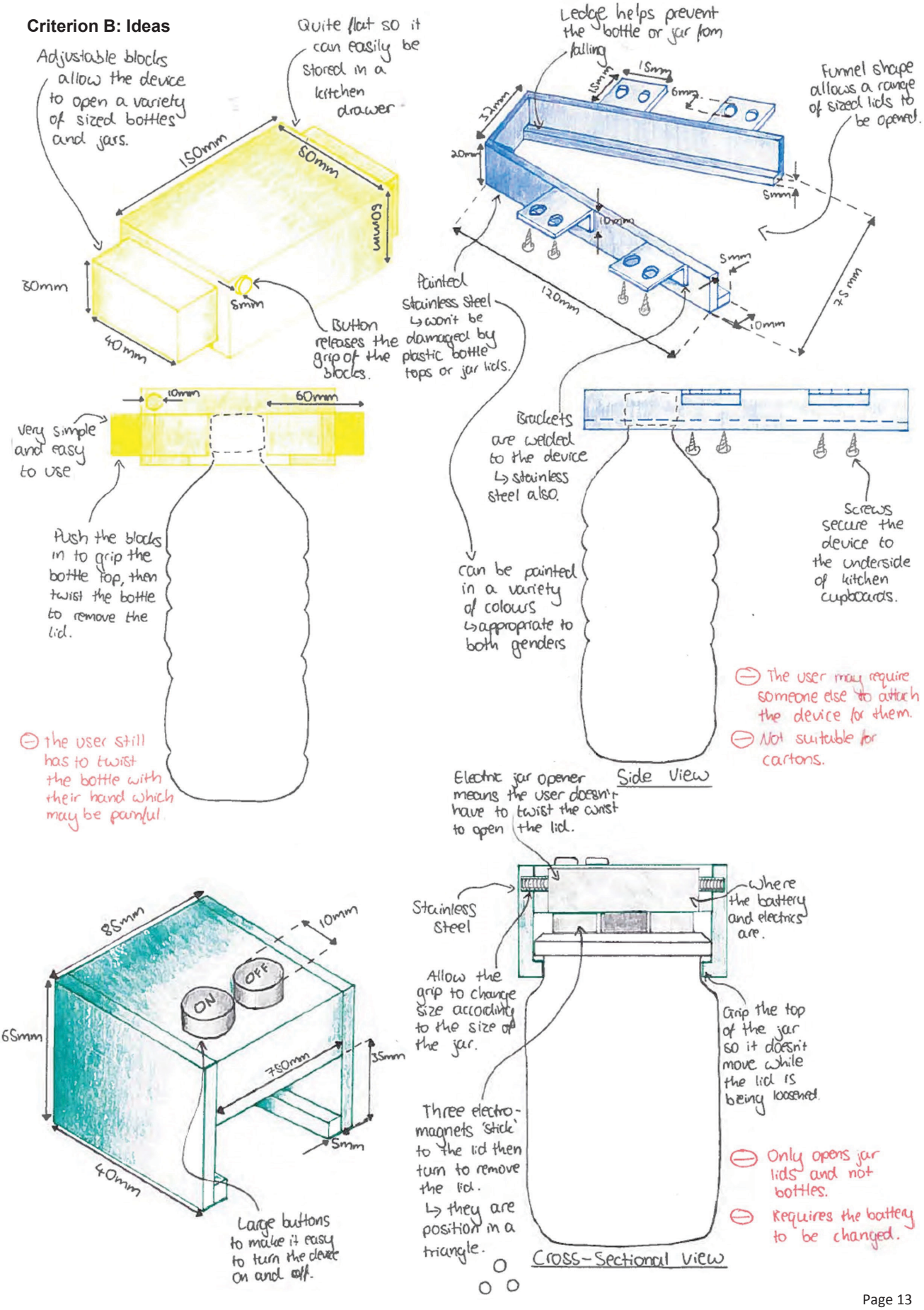
Criterion B: Ideas



Criterion B: Ideas



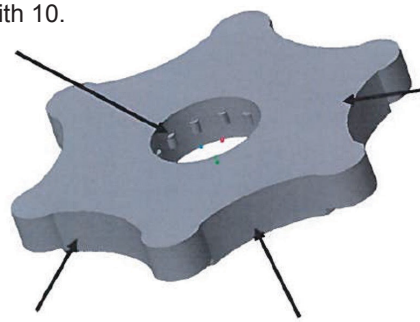
Criterion B: Ideas



Criterion B: Model Development

For the development of this design, I discovered that I would be limited in the variety of bottles that this product would be able to open because of the height of the product is a constraint. If I was to add more layers of acrylic with larger sized holes (to accommodate larger bottle tops) it would be that the design would become too large for someone to hold in their hand because the fingers would not be able to fit around it. This would compromise the comfort of the product and also its effectiveness as the user's grip of the product would be reduced.

I also looked at the concentration of the lumps in order to check that the current number of them would provide enough grip on the bottle top. Through testing my acrylic models, I discovered that there is the appropriate number of them as the models could successfully remove a bottle top. I chose not to increase the number of lumps because that would mean using extra material which would increase the cost of the product, and it wold be unnecessary as there is enough grip with 10.



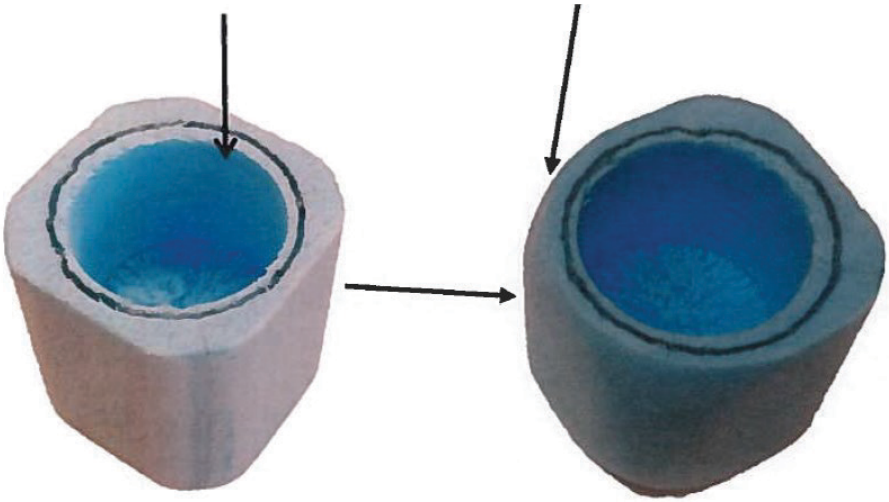
I created three different templates and tested them all with different people to see which size was the most comfortable to hold. I discovered that the edges cut into the user's funders, which was uncomfortable, and so for the production the edges would need to be smoothed, or covered with a softer material, so that it is comfortable to hold. The templates were also of three different thicknesses: 3mm, 6mm, and 9mm and through user testing I discovered that the most comfortable thickness for the user to hold was 9mm.

In order to make it more comfortable for the users to hold, I added places for the fingers to go, which would also increase the grip. However, to test this further, I modelled it in acrylic. From the testing of the acrylic models, I discovered that the indentations for the fingers to go in are not deep enough for it to be comfortable, and so when I manufacture my prototype, I will adjust the design to incorporate this flaw. Not only will the deeper indentations make the product feel more natural in the hand, it will also increase the users turning force on the bottle top because they will have a better grip of the product.

Criterion B: Model Development

Having modelled this design in foam I realised that it does not fit in your hand very easily. In order to make this product more comfortable, I chamfered the edges to make them more rounded and easier to hold in you hand. This would mean that it would be easier for the user to open a bottle or jar as they would have better grip of the product.

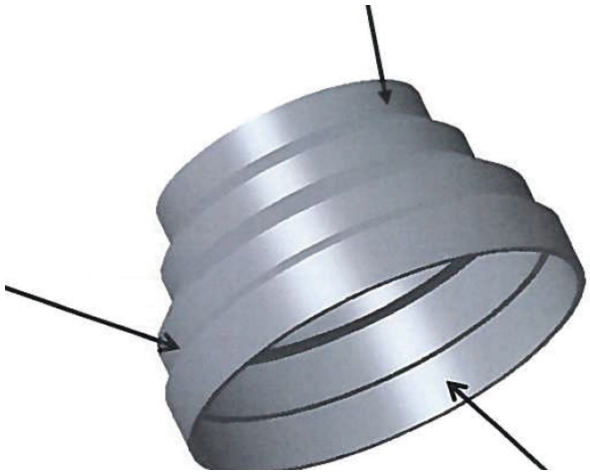
I further filed the corners to tailor the shape to fit in the hand better so that it is more comfortable for the user to hold. Not only does it make it more comfortable for the user, it also improves the grip.



However, having chamfered the edges to further increase the comfort in the hand I realised that it is not comfortable for the wrist: the wrist is held at an uncomfortable angle when trying to hold the product still. Therefore, through modelling this design I discovered that it is not appropriate for the product to cause discomfort in the wrist. Not only this, it also meant that the user did not have a strong enough grip on the product for it to effectively aid the user in opening bottles.

In order for this design to be able to be used for opening a variety of bottles, I added an extra layer to it. This enables it to open smaller bottle tops, such as the standard screw cap which is on the vast majority of bottles.

Modelling this design in CAD as also proved its feasibility as a design idea for a prototype because it can easily be designed on CAD and therefore can easily 3D printed or injection moulded, for example.

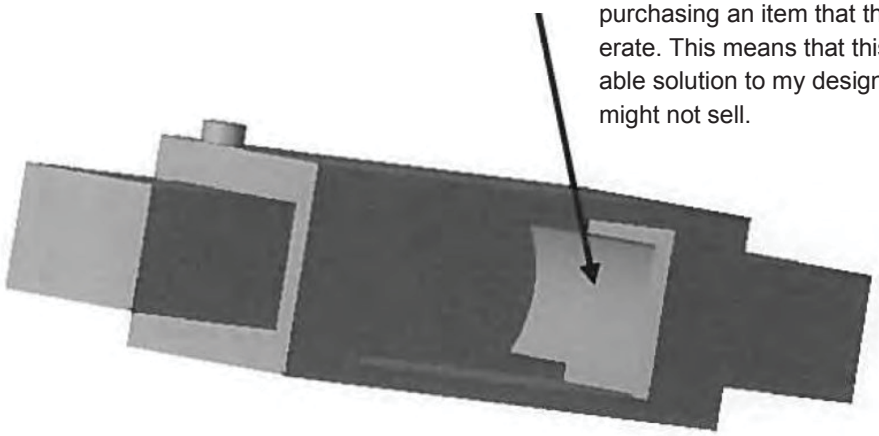


Having modelled this design in CAD, I have been able to see that it is an aesthetically pleasing design, which is essential for it to sell, and I have also been able to get an idea as to see its seize in comparison with other objects, showing me that it is an appropriate size and it does not overshadow other objects., which could further increase its attractiveness.

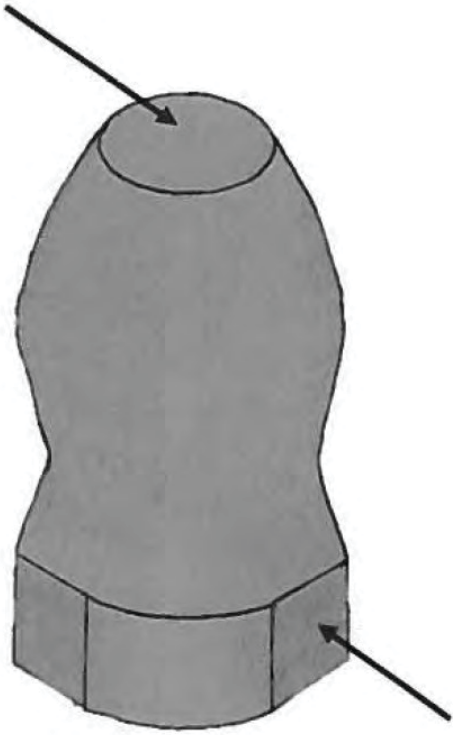
Criterion B: Model Development

Having modelled this design on CAD I realised that it would not grip the bottle very well and so I made the grip curved to increase the surface area. As a result of the increased contact area of the product with the bottle, the grip is increased and thus reduces the amount of force the user will have to apply in order to remove the bottle top.

However, as a result of my CAD model of my design I discovered that it is not particularly aesthetically pleasing which could reduce its selling prospect. Furthermore it is not a simple mechanism which might put elderly people off buying it as they often do not feel comfortable purchasing an item that they are not certain how to operate. This means that this design is not an entirely suitable solution to my design problem because the product might not sell.

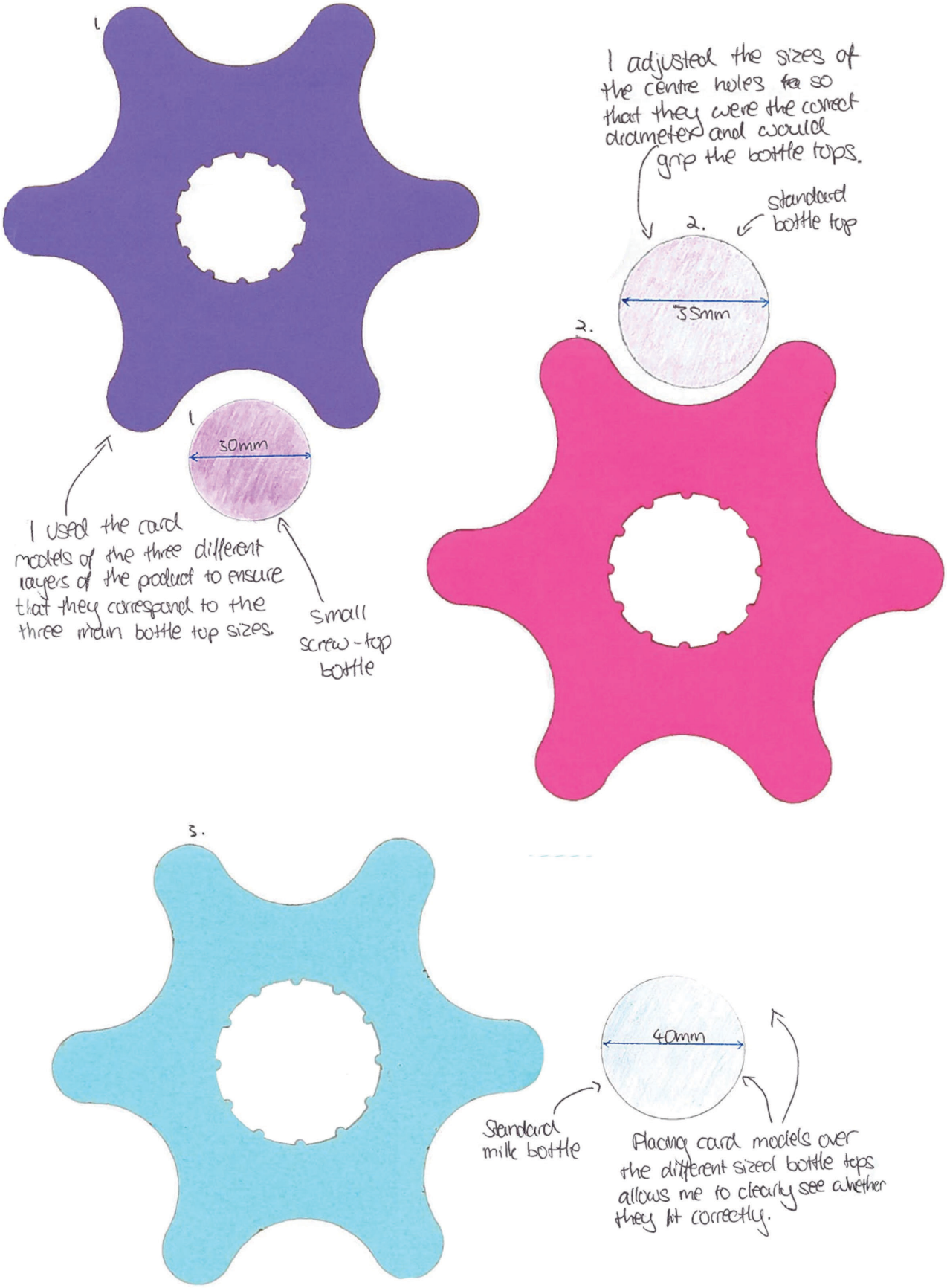


I adapted the design of this idea by flattening the top of the product so that it would fit better in the hand of the user, making it more comfortable for them. This would also increase the effectiveness of the product, as the grip that the user had would be increased as it fits better in the user's hand. Furthermore, in flattening the top of the design I have removed material thus reducing weight and cost, both of which are essential to my design specification. The product must be kept as lightweight as possible and the cost must be kept low, otherwise it will not sell..



I also changed the design in order to make it more flexible as a product, although the main purpose of it is to enable the user to easily be able to open bottles; I chamfered the edges so that it can also be used to open cartons because they do not have a flat top. Not only does it allow the product to be used to open cartons, it also allows more flexibility in the shape of bottles that can be opened with it.

Criterion B: Model Development



Criterion B: Design Justification

	Idea 1	Idea 2	Idea 3
Function /10	This idea can open a variety of jars and is comfortable in the hand. However it is not entirely suitable for opening bottles. 5/10	This idea can also open a variety of jars and can open large bottle tops. However it is not entirely suitable for opening bottles or cartons. 5/10	This idea allows the user to open the standard size jar easily. However, it does not allow them to open a variety of sized bottles as it is not adjustable. 4/10
Aesthetics /10	It is relatively aesthetically pleasing and would be available in a variety of colours. However, it is not entirely obvious from just looking at it what it is for. 7/10	It is relatively aesthetically pleasing and would also be available in a variety of colours. It is more obvious what the purpose of it is. However, it is not entirely attractive and might not stand out to the user to buy 7/10	It is quite aesthetically pleasing as it is a very simple design and would fit in very well with a kitchen environment. However, some might consider that it looks dull and boring. 6/10
Materials /10	It would be made from silicone which is a very flexible material—ideal for the purpose of the product. It can also be put in the dishwasher and is very comfortable to have in the hand. However, the silicone might perish after a few years, rendering the product useless. 8/10	The handle would be made from polypropylene and the part that grips the jar lid from stainless steel. This means that the grip would not be damaged by the metal jar lids. However, after a few years the polypropylene handle might perish and become sticky. 7/10	It would be made frm polypropylene with a layer of silicone where the jar fits in order to give adequate grip. However, after a few years the silicone and polypropylene might perish and make the product useless. 7/10
Ease to make /10	It would be made in a mould which would be very easy to make on a large scale. However, it would be quite difficult to make the mould initially. 8/10	Relatively easy to make the handle through injection moulding and the metal grip would be made in a mould so both can be easily made on a mass scale. However, it might be quick difficult to join the two parts. 8/10	Very easy to make as polypropylene can be injection moulded which is also easy to make on a mass scale. However, the layer of silicone would need to be attached to the inside of the product which may be difficult. 8/10
User needs /10	The idea fulfils the user needs to a certain extent as it enables them to open a jar quickly and easily. However, it does not enable the user to open bottles and cartons in particular. 5/10	It fulfils the user's needs to the extent that it enables them to easily open a variety of jars. It also allows them to open larger bottle lids. However it does not enable the user to open cartons or small bottles. 6/10	It fulfils the user needs as it enables them to easily open jars, large bottles and cartons. However, the size of the grip is not adjustable so it is not appropriate for smaller bottles.6/10
Cost /10	Silicone is a relatively cheap material and once the mould had been made there are very few running costs which would make the product quite cheap. However, it might cost a lit to make the mould and for the machinery to melt the silicone in order for it to be moulded. 8/10	It would be relatively cheap product to make as injection moulding is a relatively cheap process. Also, making the steel part in a mould is inexpensive. Furthermore, polypropylene and stainless steel are not expensive materials. However there might be high costs to melt the steel in order to pour it in the mould. 7/10	A very cheap product as the manufacture cost would be very low as injection moulding is a cheap process and polypropylene and silicone are cheap materials. Also, there is very little wasted material from the manufacture process. However, the process of attaching the silicone to the main section would increase the price. 9/10
Summary /10	Overall this idea is very good at what it would enable the users to do (i.e. open a jar), although it does not help the user open bottles of cartons which means that it only fulfils half of the user's needs. **41/60**	Overall this idea effectively enables the user to open a variety of jars and would be relatively cheap to buy. However, it does not help the user open bottles or cartons. **40/60**	Overall, this product would be suitable for the target user as it is very simple to use and is inexpensive. However, there is a lack of flexibility in its function which means that it cannot be used to open a variety of bottles. **39/40**

Criterion B: Design Justification

	Idea 4	Idea 5
Function /10	This idea allows the user to open standard bottles that have the standard bottle opening. Also, it has indentations for the user's fingers to go in and has a smooth top to fit in the palm for added grip and comfort. However, it is not suitable for opening larger bottles. 7/10	This idea enables the user to open standard bottles easily and quickly. Also, it has a wide diameter so there is a high turning force and it is more comfortable for the user's hands. However it does not accommodate for a variety of bottles. Although, it could be made as part of a set with different size centre holes for a variety of bottles and jars. 8/10
Aesthetics /10	This idea is quite aesthetically pleasing as it is quite abstract and does not have any sharp edges and corners. However it may not be entirely clear to an elderly person what its purpose is. 7/10	It is quite aesthetically pleasing as it resembles a cog and there are no harsh edges or corners. However it may not be entirely obvious what the purpose is which might prevent it from being bought. 7/10
Materials /10	It would be made from polypropylene as this is relatively comfortable to hold in the hand and provides a lit of grip. It will also have a layer of silicone on the inside where the lid fits for extra grip on the lid. However, again after a few years the polypropylene and silicone might perish making it sticky and uncomfortable to use. 8/10	It would be made from polypropylene which is quite comfortable to have in the hand which makes it more comfortable for the user to open the lid. It will be made entirely from polypropylene as there are bumps in the centre hole which grip the lid. However, as with all polypropylene products, after a few years the polypropylene might perish making the product useless. 8/10
Ease to make /10	It would be very easy to make (like the previous idea) as it would be injection moulded which is also very suitable for manufacture on a mass scale. However, this design has the same issue as the previous one as it might be difficult to attach the layer of silicone securely so that it does not come unattached. 8/10	It would be very easy to make as it is made from one material, polypropylene, which can be easily manufactured on a mass scale through injection moulding. However the mould has to be made in order to make the products. 9/10
User needs /10	The design fulfils the user's needs to a certain extent as it allows the user to easily and comfortably open standard bottle tops, which are very common. However, it cannot open a range of bottles. 6/10	This product fulfils the user needs to a certain extent as it allows the user to open the majority of bottles. The design is also quite flat so it can easily be stored in a kitchen drawer. However, it does not accommodate for a variety of jars and bottles. Although if they were sold as a set then the user would
Cost /10	This product would be quite expensive as 3D printing is an expensive manufacturing process. However, polypropylene and silicone are inexpensive materials which would mean that the majority of cost would be the manufacture process. However, just as with the previous idea the process of attaching the silicone to the main	The cost of this product would be very low as it is made from polypropylene which is a cheap material and is manufactured using injection moulding which is an inexpensive process. However, the product would be more expensive if they were sold as a set. 9/10
Summary /10	Generally, this idea fulfils the user's requirements as it enables them to easily and comfortably open the vast majority of bottles. However it does not enable them to open larger bottle lids. 43/60	Overall, this product fulfils the user's needs as it enables them to open the majority of bottles, and an even wider range of bottles if it's sold in a set. Also, it is comfortable to hold and does not put too much strain on the wrist or hand. 48/60

Criterion B: Design Justification

	Idea 6	Idea 7	Idea 8
Function /10	It enables the user to open a variety of jars and is very easy to use. However, it is not entirely suitable for opening bottles. 5/10	This design allows the user to open a variety of bottles and small jars quickly and easily. However it may not be entirely suitable for opening large jars. 7/10	Allows the user to open a variety of bottles quickly and easily. Has adjustable blocks that grip the lid of the bottle or jar, which can be easily released to reset the grip. However the user still has to grip the bottle and the device with their hands and twist at the same time which might be difficult and painful
Aesthetics /10	It is relatively obvious what it is for as it resembles a bottle opener. However it is not a very attractive product as it is quite angular. 7/10	This product is relatively aesthetically pleasing as it has smooth edges and curves. However it resembles a spanner which might confuse the user. 8/10	A very simple design, inspired by the cubism, may be attractive to a potential user. However, has harsh edges and corners which aren't aesthetically pleasing. 7/10
Materials /10	Made from stainless steel which would make it very robust and can be painted a variety of colours, However, being made from metal might make the product too heavy for the user to use and it might be painful for someone with arthritic hands. 7/10	Made from stainless steel which is a very strong material and would not be damaged by metal jar lids. However, it may be quite heavy for the user to hold which may be painful for them. 7/10	Made from stainless steel so is robust and isn't damaged by the lids of bottles and jars over time. However, this might make the product quite heavy and the bottle or jar quite unstable as the weight is at the to of it. 7/10
Ease to make /10	The main section and the handles could be easily made using a mould which is easy to manufacture on a mass scale. However it would be quite difficult to make the internal parts and to assemble the product.	Relatively easy to manufacture main section and the adjustable part of grip using die-casting. However, quite complicated to assemble as it is not all one part, and the adjusting mechanism is complicat-	Relatively easy to make through die-casting which would be easy to make on a mass scale. However it is made of many parts which makes it more difficult to manufacture as they have to be assem-
User needs /10	Fulfils the user needs as it allows them to open a variety of jars and large bottles. In addition, it can be easily stored in a kitchen drawer as it is relatively flat and is comfortable and easy to use. However, it is not suitable for opening smaller bottles. 8/10	Fulfils the user needs as it allows them to open the vast majority of bottles and jars, and can easily be stored in a kitchen drawer. However, there are limitations as to how the variety of jars and bottles it can open as large jars will not fit in the grip. 8/10	Fulfils the user's needs as allows opening a variety of jars and bottles easily. Also easily stored in a kitchen drawer as it is relatively flat. However, it may be painful for the user as they have to twist the product as well as the bottle or jar in order to open it. 7/10
Cost /10	Stainless steel is not an expensive material so the price would not be too high. Also, it would be made in a mould which is also relatively inexpensive. Although assembly would increase the price. 8/10	The cost would not be too high as die-casting stainless steel is relatively cheap. However, made from multiple parts which increases the cost of the product as it makes it complex to assemble. 7/10	Similar price to the previous design as die-casting stainless steel is relatively inexpensive. However, made from multiple parts meaning assembly would increase the price. 7/10
Summary /10	Overall it fulfils the user needs to a certain extent as it allows them to open a variety of jars and large bottles quickly and is very easy to use. However it is not practical for opening bottles. **41/60**	Overall, it fulfils the user's needs and it will not be too high a price as it is not made from expensive materials or by an expensive manufacturing process. Aesthetically pleasing so would sell easily.**43/60**	Overall, it fulfils the user needs to a certain extent as allows opening a variety of bottles and jars but may still cause pain in the user's wrist as they have to twist the product to open the bottle. **42/60**

Criterion B: Design Justification

	Idea 9	Idea 10
Function /10	It allows the user to open a large range of sized bottles and jars through the use of an electromagnet to turn the lid. However because it uses an electromagnet the product requires batteries which may be difficult for the user to change. 8/10	This design allows the user to open a variety of bottles easily. However, the user is still required to twist their wrist which may be painful. 8/10
Aesthetics /10	It is a very simple design which is aesthetically pleasing as it does not put a potential buyer off. However, there are harsh edges and corners which the user could harm themselves on. 7/10	The design allows the user to open a variety of bottles easily. However, the user is still required to twist their wrist which may be painful. 8/10
Materials /10	It would be made from stainless steel which is a strong material that has a long life so the user would not need to replace the product due to the materials perishing. However, because it is made from metal, it would make the product quite heavy which might be uncomfortable for the user to place on a jar lid. 8/10	It would be made from stainless steel which would make the product quite heavy but the user does not need to hold it. Furthermore, being made from stainless steel allows it to be attached firmly to the underside of the cupboard using screws. However, being made from stainless steel it is more expensive than if it was made from plastic. 8/10
Ease to make /10	The individual parts would be made by die-casting which is a relatively easy manufacturing process. However, the individual parts would need to be assembles which would complicate the manufacturing process as it is not made from on part. 6/10	It would be relatively easy to make as it is made from one part so it could be made using die-casting. However, it requires screws so they would either have to be manufactured or bought. 7/10
User needs /10	The design fulfils the user needs as it allows them to quickly and easily open a variety of jar lids without having to twist their wrist or hands. However, because the product uses an electromagnet to open the lid, it would not work on bottles because bottle tops are made from plastic. 7/10	This design fulfils the user needs as it allows them to open a variety of jars and bottles and it can be available in a variety of colours. However, it is not suitable for opening cartons and the user may require someone else to attach th product for them. 7/10
Cost /10	Due to the product being made from stainless steel, the materials would not cause it to be expensive, as it is a relatively inexpensive material. However, this product would be quire expensive as it includes an electromagnet and is powered by batteries. 5/10	It would not cost too much as stainless steel and die-casting are relatively inexpensive. However, the addition of screws to attach the device would increase the price as they would either have to be manufactured or bought. 8/10
Summary /10	Overall this product fulfils the user criteria as it allows them to open a variety of jar lids without having to twist their wrist (which is what most arthritic people find difficult or painful). However, it does not allow them to open bottles. **41/60**	Overall, this design fulfils the user needs as they are able to open a variety of jars and bottles easily, although not cartons. **44/60**

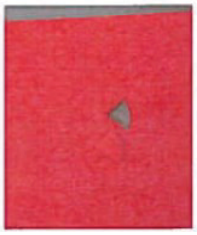
Having evaluated all my design ideas against my design specification, the design that I will be developing further into a working prototype, is my 5th design because it scores the highest and therefore fulfils the design specification the best. This is because it enables the user to open the majority of bottles, and an even wider range of bottles if it's sold in a set. Also, it is comfortable to hold and does not put too much strain on the wrist or hand.

I could also consider developing my 10th design idea as it scored the second highest in the evaluation (44/60) because it also enables the user to easily open a variety of jars, however bottles are limited. Therefore I am choosing to develop my fifth design because it is better at aiding the user in opening bottles.

Criterion B: Material Justification

I tested different finishes on acrylic to see which one gave the best finish. This image shows the finish produced by sanding the edges; it is very smooth so sanding is an appropriate method for finishing acrylic.

The image displays me sanding the edge of the acrylic in order to test whether this is an appropriate finishing method.



This image shows the results of the impact test that I carried out which shows that acrylic is quite brittle material and I would need t strengthen it for use in my product.

I tested different ways to cut acrylic and looked at the different finishes. This image shows the finish of a Hegner saw; I is fairly uneven so it wold need further finishing such as copper polish. Also, it is less precise than a laser cutter.

I tested the strength of the acrylic by bending it. It was less flexible than HIPS but it still did not snap. From a strength perspective acrylic is an appropriate material for my product.

This image displays finish after using the belt sander; it was melted. Therefore using the belt sander is not an appropriate finishing method for HIPS. I also performed a strength test on HIPS to test at what point it would deform or snap. After bending the material 90 degrees it does not break, but it does deform at the point where it was gripped by the vice.

I tested different ways to cut HIPS and the finishes they created. This image shows the finish after using the Hegner saw, which shows that t needs further finishing to smooth the edges.

This image shows the results of the impact test that I conducted on the thicker sheet of HIPS. The material did not entirely shatter but a dent was made: it is less brittle than acrylic.

I also looked at the finish produced by using the laser cutter to cut acrylic. The finish is good as it is smooth, but it can be improved using copper polish and sanding. Acrylic is appropriate for my product.

I tested the belt sander but the material melted, so this is not an appropriate finishing method for HIPS.

I tested different ways to cut the sheet of HIPS and the finish they produced. This image displays the finish of a Hegner saw; showing it's quite uneven and needs further sanding and finishing.

In order to test the strength of HIPS, I performed a bend test to see whether the material would snap. I discovered that the material does not break but it does deform slightly.

The bottom image displays the HIPS after bending it 90 degrees. This shows that from a strength perspective HIPS is appropriate for my product as it is unlikely that it would be bent at 90 degrees and for it to deform.

Criterion B: Materials and Manufacturing Justification

I tested the comfort of the acrylic in the hand but the feedback was negative so I decided that it needed to be made more comfortable.

I covered the acrylic with neoprene foam. 100% of the people I asked said that the neoprene covering not only made the acrylic more comfortable to hold, it also increased the grip of it in the hand.

Having tested the shape of the design I discovered that it needed t be adapted to be more comfortable to hold. Also there is a lot of wasted material which would be removed by adapting the design. The image displays the new design of the product. This allows a wider range of hand sizes to grip the product.

Having chosen to cover the acrylic with neoprene I had to test which adhesive was the most appropriate. I used araldite to glue the neoprene to the acrylic as it is a contact adhesive. Araldite was the most appropriate as glues such as acrylic cement could disintegrate the neoprene.

I also tested the most appropriate adhesive to glue acrylic together. I used acrylic cement which is strong and transparent. Therefore it is an appropriate method to join the sheets of acrylic.

Justification of materials:

Aesthetic:

Acrylic is the most appropriate material for my product because it can be manufactured in a variety of colours and has a smooth finish. Neoprene is also appropriate because it too can be manufacture in a many colours and is aesthetically pleasing.

Chemical

Acrylic nor neoprene contain harmful chemicals which makes them suitable materials for this product as it will be used in a kitchen so it is important that there are no harmful chemicals in the product that could harm the user.

Cost:

Acrylic and neoprene are appropriate materials because they are relatively inexpensive. This will keep the cost of the product low, which is ideal for the target user as they are elderly and unlikely to be willing to spend a lot of money on the product.

Physical: Acrylic is not a flexible material so it will not bend when the user applies force. This will also maintain the grip on the bottle as the product will not deform. Although acrylic is quite brittle and could shatter if enough fore was applied to it, or if it was dropped, however it will be covered with neoprene which will protect the acrylic. Neoprene is a flexible material so it will cover the acrylic easily and can also be attached to the acrylic with ease. Neoprene is also comfortable in to hold and increases the grip of the user. This is essential as people with arthritis might not be able to grip well.

Justification of Manufacturing process:

Laser cutter:

Laser cutting is a very accurate method of cutting acrylic and is also very quick, not only this, it produces a better finish that using the Hegner saw. This minimises the required level of finishing after the product has been cut.

Gluing:

Gluing is an appropriate joining method for acrylic as it neatly joins the sheets of acrylic together and does not alter the dimensions of the product as screws would. Gluing is also appropriate for attaching the neoprene to the acrylic as it is secure and is quick.

Sanding:

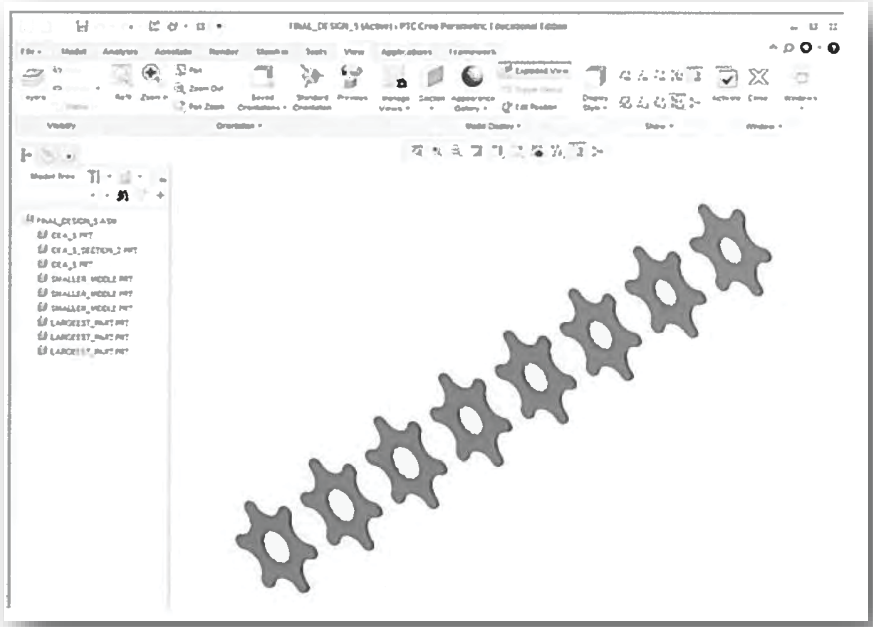
Sanding is the most appropriate finishing method for acrylic as it provides the best finish. To obtain the best finish, I need to sand the edges first with the belt sander, then use sand paper and copper polish if it is necessary.

Criterion C: Design Proposal

Having tested the design of the product using an acrylic model, I discovered that I need to cover the product in forma in order to make it comfortable to hold as it means that the edges of the acrylic do not cut into the users hand when gripping it. Therefore I will use neoprene to cover the acrylic because it is a lightweight material and is also inexpensive.

Due to the fact that acrylic was heavier that the HIPS, in order to ensure that the product did not become too heavy (as this could cause pain for the user) I changed the design to remove more material. I did this by increasing the depth of the grooves that the fingers fit into as this serves two purposes: one to remove the cost, and two to make the product more comfortable to hold as the product fits better in the hand when the places to have your fingers are deeper.

As a result of covering the acrylic with neoprene, I have adapted the manufacturing technique t accommodate for the added material. I will cut the neoprene out using the laser cutter so it fits the exact shape of the acrylic and I will attach the neoprene to the acrylic using araldite glue because acrylic cement would melt.



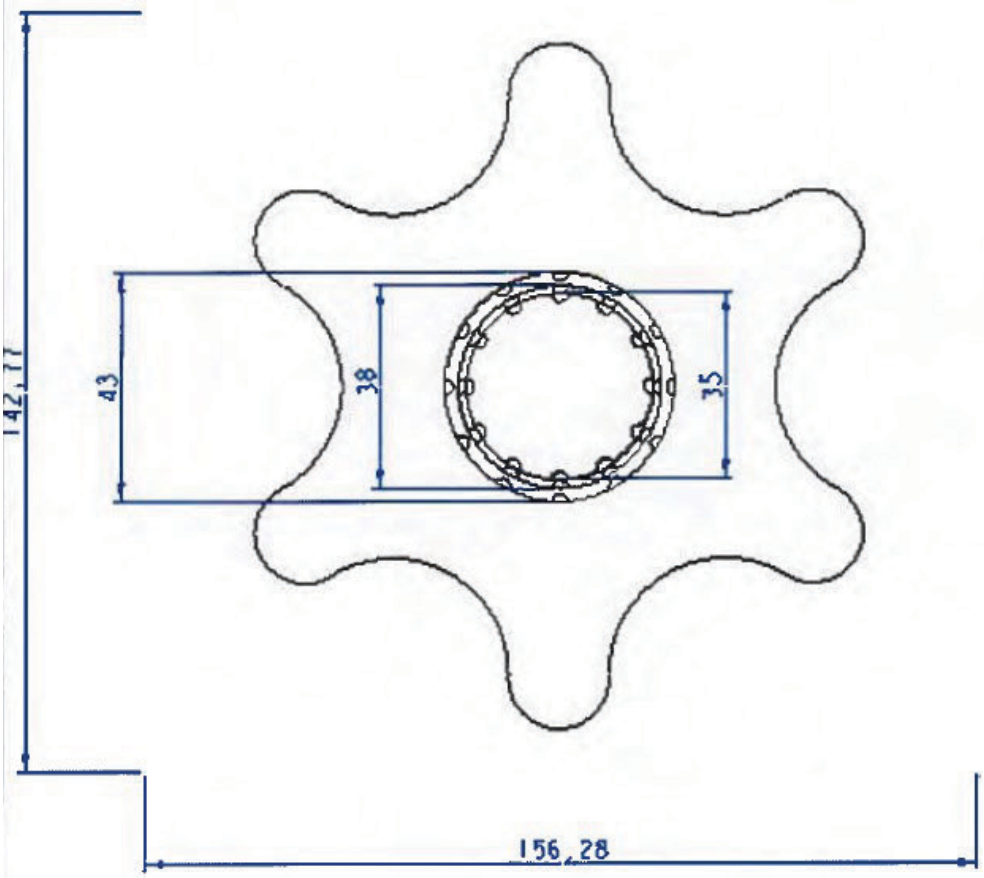
The image above shows the exploded drawing of my product, which displays how it would be manufactured. Each section is attached directly on top of each other using acrylic cement, so it is nota complex process. Once the acrylic sections have been assembled, the neoprene covers and side section are attached using araldite.

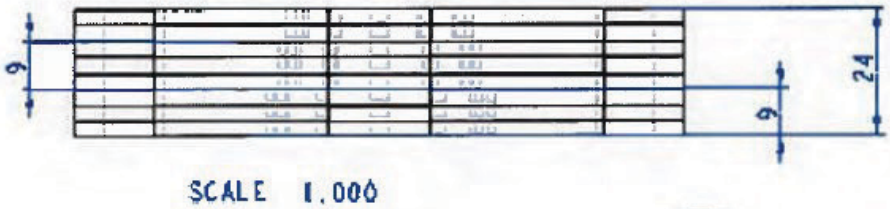
Cutting list

Part	Material	Dimensions (h x w x l)	Quantity
Bottom layer	Acrylic	5 x 130 x 130	1
Middle layer	Acrylic	5 x 130 x 130	1
Top layer	Acrylic	5 x 130 x 130	1
Cover	Neoprene	1 x 130 x 130	2
Side	Neoprene	1 x 18 x 500	1

Criterion C: Design Proposal

Working Drawings for Manufacture:





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Criterion C: Plan of Manufacture

Part	Smallest Acrylic section, Middle Acrylic section,	Neoprene Covers	Neoprene Edging
Tools/equipment	Laser cutter and acrylic	Laser cutter and araldite	Scissors/rule and araldite
Process	I designed the shapes on Creo Parametric and then had them cut out on the laser cutter to ensure that the shapes were precise	I used the same design for the acrylic sections to cut out the neoprene on the laser cutter so that it fits precisely on the acrylic sections.	I calculated the total width of acrylic sections and cut two strips of neoprene of that width to go round the edge. I used a pencil and ruler to mark out the size of the strips. I had to use two because the neoprene sheer was not long enough
Start date	25/11/15	27/11/15	25/11/15
Time allocated (mins)	5	5	5
Planned finish date	25/11/15	27/11/15	25/11/15
Actual finish date	25/11/15	27/11/15	25/11/15
Risk assessment	When using the laser cutter there are a few risks as the user cannot open the lid until the laser has finished. However it might be damaging to the user's eyes to look directly at the laser	When using the laser cutter there are a few risks as the user cannot open the lid until the laser has finished. However it might be damaging to the user's eyes to look directly at the laser	The user must be careful not ot cut their hands when using the scissors.
Quality control	Due to the fact that the edge of the product will be covered with neoprene, it does not matter that the acrylic edges do not have a high finish. However, I will score them so that the neoprene will stick better as the glue has a larger surface area to stick to.	The laser cutter gives a good edge finish and you cannot sand or file neoprene. However, I will check that there are no burn marks from the laser on the neoprene.	The edge of the neoprene is of a less high quality than that is produced by the laser cutter because I cut it out using scissors. However, the edges cannot be sanded so they are not of a particularly high quality but they are covered by the main pieces of neoprene.

Criterion D: Success of the Solution

Target market:

The solution is successful because it is suitable for the target market because it has been designed for people who suffer from arthritis and struggle with opening bottle tops.

Target audience:

The solution is also successful in relation to the target audience because it is suitable for people who have arthritis in their hands and who cannot open bottles with just their hands, they need a product to aid them.

Market analysis:

In relation to the market analysis, the solution is a success because it did not cost more that £29.95 to produce (which was the most expensive product on the market) or less than £2.79 (which was the cheapest product on the market) and so it is within the price range to successfully sell to the target market.

However, the solution was not entirely successful because it was not manufactured using mass production methods, such as injection moulding, and o it would not be easy to manufacture 100, 000 for the 1% of the market of 10 million suffers of arthritis in the UK.

User need:

The solution was successful for the user need because it could easily be stored in a kitchen drawer and it also allows the user to open bottles painlessly. Moreover, the solution did not have any sharp edges or corners that could harm the user and the neoprene grip was described as feeling 'natural' as well as 'making opening bottles easy'. The product 'gives plenty of leverage' and therefore fulfils the need of allowing the user to open bottles easily as they do not have to put in a lit of effort.

On the other hand, the solution is not entirely successful because it does not allow the user to open a wide variety of bottles due to the limited flexibility of the acrylic and there only being three different widths of holes to grip bottle tops. Furthermore, due to the materials that the prototype was made from it is not easily cleanable: neoprene cannot be washed very well and it can stain. As a result it is not entirely suitable for use in a kitchen environment and it might look dirty and old very quickly

Competition:

In comparison to the competition, the product is successful because it would not cost more that the most expensive product on the market (£29.95) and so therefore it should sell successfully. Furthermore, competing brands such as OXO and Alessi do not design their products that open bottle and jars etc., specifically for people with arthritis in their hands. This means that my product has a selling advantage over competing kitchen utensil brands as the design f my product is more suitable for the target market.

However, the solution is not entirely successful because there are products on sale that allow the user to open a wide range of bottle whereas my solution only helps the user open a limited range of bottles.

Criterion D: Success of the Solution against Design Specification

Environmental requirements:

The solution is successful in terms of environmental requirements as both acrylic and neoprene can be recycled.

However, it is not entirely recyclable because the neoprene and acrylic cannot be separated because of the araldite glue which reduces the recyclability of the solution. Also, due to the fact that neoprene is not a robust material, the solution does not have a long life span meaning that it will need to be replaced. This is bad for the environment because the materials will need to be sourced and more products will need to be manufactured, causing pollution and draining of resources.,

Cost constraints:

With regards to cost constraints, the solution is a success because it would not cost more than the most expensive product on the market (£29.95) and so therefore it should successfully sell.

However, the cost may be too low for it to be attractive to a potential customer as they may think the quality is low.

Customer requirements:

The solution is a success because it does aid the user in opening bottles without it being painful. It is of a suitable shape and it does feel natural for the user to hold. Furthermore, the user's hand or wrist is not in an uncomfortable position.

However, it is not entirely successful because it does not allow the user to open a large variety of bottles. Also, because the size or shape of the solution is not adjustable it may not feel natural to those who have a hand size in the 5th or 95th percentile as the product may feel too big or too small in the hand thus affecting comfort.

Aesthetic requirements:

The solution is a success because it is aesthetically pleasing: it is symmetrical and h as no harsh edges. It is all one colour so there is no colour clashing.

However, it is not entirely successful because the solution is covered with pink neoprene which is not gender neutral and so the product would not appeal to men.

Size constraints:

The solution is a success because it does not exceed the maximum size (500mm x 450mm x 92mm) and so it can easily be stored in a drawer. Furthermore, the solution is not smaller than 32.1mm, which is the 5th percentile of finger grip diameter in the UK, so it is suitable for the target user. The size of the product in relation to finger grip diameter is very important because it is aimed at people who have arthritis in their hands which reduces the grip of the user.

However, the product is wider than 45.8mm, which is the 95th percentile of finger grip diameter in the UK, which means that it may be uncomfortable for those whose hands are in the 5th percentile.

Criterion D: Success of the Solution against Design Specification

Safety considerations:

The solution is a success because it does not have any sharp edges and so the user cannot cut themselves on the product. This is very important because the product is aimed at elderly people who do not have someone at home to help them with daily tasks or to aid them if they are injured Furthermore, the solution does not weight more than 1 kg and so if the user dropped it, it would not severely hurt their foot as well as it not being heavy enough to damage the user's wrist..

However, the solution is not entirely successful because it cannot easily be cleaned. Neoprene can only be wiped bit it could harbour bacteria that could be harmful in a kitchen environment. It is important that the solution is hygenic because elderly people's health is often more fragile.

Materials requirements:

The solution is successful because it is made from materials that provide enough grip to be able to easily open a bottle.

However, it is not completely successful because it is not made from a long lasting and hard wearing material because neoprene can be easily be torn or stained, and so the solution does not have a long life span. Also the materials used to manufacture the prototype solution are not suitable for mass production.

Performance requirements and constraints:

The solution is successful because it does aid the user in opening bottles with ease and they do not have to force their hand or wrist in an uncomfortable position.

However, the solution is not entirely successful because it does not allow the user to open every bottle: so it is restricted by the diameter of the bottle top. Also, using the solution to open bottles does require a certain amount of force which some people with severe arthritis may not be capable of..

Manufacturing requirements:

The manufacturing process was suitable for the materials that the prototype was made from as acrylic is not suitable for injection moulding and neoprene is not suitable for over-coating. Also, the solution was manufactured strongly: acrylic cement does not come apart and the neoprene was attached firmly to the acrylic with the araldite glue.

However, the solution could not be manufactured on a mass scale because the gluing cannot be done quickly on a mass scale. It is important that the solution is produced on a mass scale because arthritis affects thousands of people.

Criterion D: Improvements of the Solution

Performance requirements and constraints:

In order to solve the issues raised by evaluating the success of the solution against the design specification, to ensure that the product can open all bottles, the product could have one hole, which size is adjustable, to fit all bottles up to a certain size. To solve this issue of the amount of force that is required to open the bottle the solution can be made automated so that it grips the bottle top and the bottle and turns, without the user having to use force.

Materials requirements:

The main issue regarding materials requirements that was identified whilst evaluating the success of the solution against the design specification was the robustness of the neoprene and acrylic. The issue can easily be solved through manufacturing the product from polypropylene with a liquid silicone grip so that the product is more hard wearing and is less easily damaged. Furthermore, these materials are suitable for mass production because polypropylene can be injection moulded and liquid silicone rubber can be attached using over-coating, both of which can be used on a mass scale.

Manufacturing requirements:

The only issue regarding manufacturing requirements that was raised was the fact that gluing (which was used t attach the neoprene to the acrylic) is not appropriate for use on a mass scale, which is vital for this product, so an alternative manufacturing process will have to be used. As an alternative manufacturing process, injection moulding could be used (instead of laser cutting acrylic) and over-coating could be used in #stead of gluing.

User need:

With regard to user need, the main issue that was identified through the evaluation of the solution against the market specification was the fact that the solution does not allow the user to open a wide variety of bottles due to the limited flexibility of acrylic and there only being three different widths of holes to grip bottle. This is a significant issue but in order to solve it I could make the product have one hole, the diameter of which is adjustable (as discussed in performance requirements and consideration). Another issue that was identified was the fact that the prototype is not easily cleanable because it was covered with neoprene which cannot be wiped and is easily stained. It is vital that the product is easily cleanable because it is used in a kitchen environment. To solve this problem, the product could be made from polypropylene, which has self-healing properties, and be covered with liquid silicone rubber. Both of these materials can be easily cleaned and due to the fact that polypropylene has self-healing properties, if it is scratched the material heals itself which means that bacteria cannot be harboured in any cuts, making the product hygienic.

Competition:

The only issue that was identified regarding product competition when evaluating the success of the solution against the market specification was the fact that there are other products on the market that allow the user to open a wide range of bottles, whereas the solution enables the user to only open a limited range of bottles. In order to solve this issue, I will adapt the solution so that it allows the user to open a wider variety of bottles but making the hole that grips the bottle e top adjustable so that it can be used on any bottle.

Criterion D: Improvements of the Solution

Market analysis:

The main issue that was raised regarding market analysis was the fact that the solution was not manufactured using mass production methods, making it difficult to manufacture 100,000 products for the 1% of the market of 10 million sufferers of arthritis in the UK. To solve this issue I will manufacture the commercial product using processes that are suitable for mass production: such as injection moulding and over-coating.

Customer requirements:

There were two issues identified when evaluating the success of the solution against the design specification. Firstly, the solution does not allow the user to open a wide range of bottle because the size of the holes are not adjustable. Also, as a result of the inflexibility of the product the product may not feel natural to hold t those who have a hand size in the 5th or 95th percentile as the product may feel too big or too small in the hand, this affecting the users comfort and grip. In order to solve these issues, I will make the product more adjustable so it can open a wide variety of bottles (as stated in 'user need') as well as making the grip more malleable in the hand by using liquid silicone rubber instead f neoprene.

Safety considerations:

The only weakness regarding the safety considerations of the solution was the fact that it cannot easily be cleaned. The neoprene can only be wiped, allowing bacteria to remain which can be harmful in a kitchen environment. In order to solve this issue, the commercial product will be manufactured from polypropylene and liquid silicone rubber: both materials are easily cleanable.

Environmental requirements:

The only issue regarding environmental requirements, which were identified, was the fact that the solution is not readily recyclable due the materials and manufacturing processes used, and the short life span of the solution. In order to solve these problems, I will manufacture the product from polypropylene and liquid silicone rubber which are both recyclable. Also, as a result of the materials used, the product has a longer life span which is better for the environment as materials do not have to be sourced regularly.

Aesthetic requirements:

The only issue identified with regards to the aesthetic requirements of the solution was the fact that it was pink, which is not a gender neutral colour. In order to solve this issue my commercial product would be available in a variety of colours so it is appealing to both genders.

Cost constraints:

The only weakness regarding cost constraints is that the cost may be too low which might cause the product not to sell as the customer might presume that because the cost is low, the quality is low too. To solve this problem I will ensure that the price of the product reflects the quality, and make sure the price is not too low.

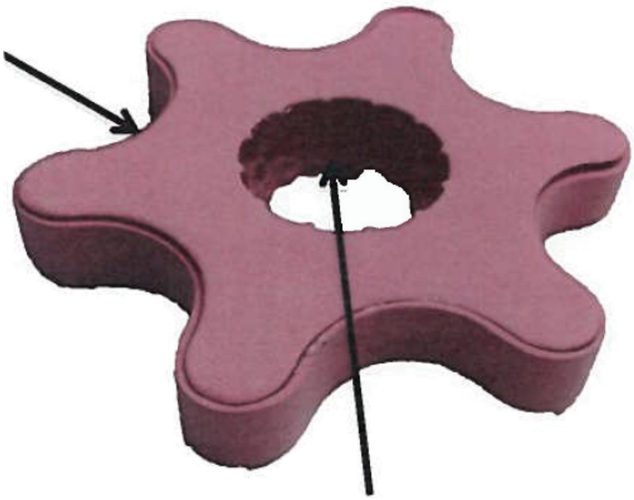
Size constraints:

The main weakness that was identified through evaluation of the solution against the design specification was the fact that the product is wider than 45.8mm (which is the 95th percentile of finger grip diameter in the UK) and so it may be uncomfortable for those hands her in the 5th percentile finger grip in the UK. To solve this issue I will adapt the design of the product so that the widest part of it is suitable for those whose hands are in the 95th percentile and the narrowest part of the product is suitable for the 5th percentiles of finger grip diameter.

Criterion D: Improvements of the Solution

Function:

Instead of there being three different size holes, there would be one hole, the size of which would be adjustable to accommodate for a variety of sized bottles. This could be done by making the product from two separate parts, and by then turning one part it would either widen or narrow the hole to grip the bottle.



Function/Manufacturing requirements:

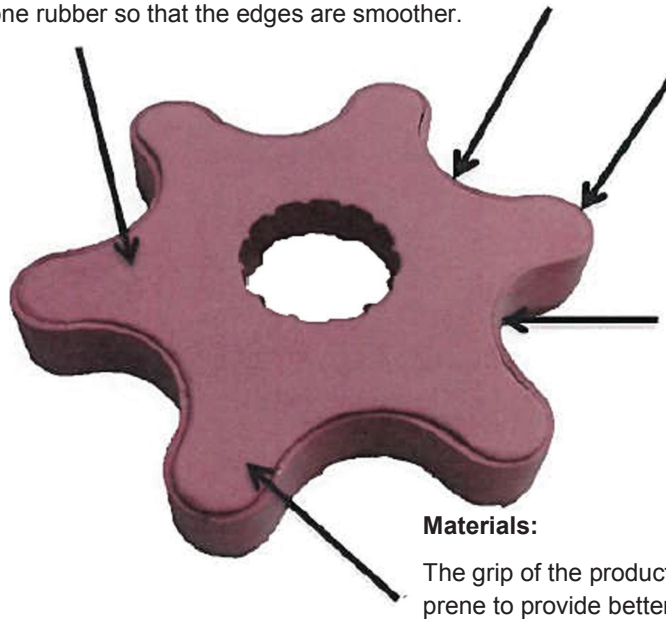
Instead of the core material being acrylic, to improve the solution it should be polypropylene because it a more appropriate material for the products function than acrylic. This is because polypropylene is more suitable for mass production manufacturing techniques, which are required to make the product for the target market.

User need:

The edges will be more rounded so they do not cut into the user's hand when holding the product, making it more comfortable to hold. This will be done by over-coating polypropylene with liquid silicone rubber so that the edges are smoother.

Ergonomics:

The widest and narrowest part of the product will be adjusted so that they are appropriate for both the 5th and 95th percentile of hand sizes. This will increase comfort and also grip as the user will be able to hold the product better.



Aesthetics:

To improve the solution form an aesthetic point of view, it can be made in a variety of different colours which are suitable for both genders, or manufactured in one gender neutral colour, such as black or grey.

Materials:

The grip of the product would be liquid silicone rubber instead of neoprene to provide better grip and also to ensure that the product has a longer lie-span because neoprene damages more easily than liquid silicone rubber. Furthermore, liquid silicone rubber is more suitable for mass production than neoprene because it can be attached to the core material quicker and easier than neoprene.

Summary of improvements:

To summarise, the materials of the solution would be changed from acrylic and neoprene to polypropylene and liquid silicone rubber because they are more suitable for mass production manufacturing techniques and their properties are more appropriate for the function of the product. The shape of t he product would altered slightly to make it more comfortable for the user to hold and the product would be produced in a variety of colours to suit both genders.

Criterion E: Materials for Commercial Production

Acrylic -> Polypropylene:

Instead of using acrylic as the main material, I would use polypropylene because it I s a more suitable material for mass production. Polypropylene is suitable because it is still a lightweight material and is lighter than acrylic, which is vital for the product because if it is too heavy then it might be painful for the user. Furthermore, like acrylic, it is a relatively inexpensive material and so replacing acrylic with polypropylene will not increase the price of the product, rather it will reduce the cost of it because polypropylene is cheaper than acrylic: acrylic is $2.7 per kg whereas polypropylene is only $1.8 per kg. Polypropylene is also suitable for commercial production because it can be mass customised because it can be coloured easily. Additionally, because this product is going to be used in a kitchen environment, polypropylene is particularly suitable because it is food and hygiene safe and it has self-healing properties. Meaning that if the product was scratched, the material would heal itself: lengthening the product life and meaning that the bacteria cannot get into the scratch which would make the user ill. Moreover, polypropylene can be injection moulded which is an ideal manufacturing method for commercial production as it can produce many items without sections having to be assembled: the product would be made from one part. This reduces the cost of the product as it reduces the length of time that it takes to make it because the sections do not have to be glued together. Also, producing the product as one part removes the need for a person to glue the sections together which further reduces the cost because there are no wages to be paid.

Low cost is essential for this product because the target market is elderly people and they would not spend a lot of money and so if it was expensive, then it would not sell. In addition, polypropylene can be recycled which is very useful for injection moulding because it means that any excess material can be reused, thus reducing waste and therefore cost.

Neoprene -> Liquid Silicone Rubber:

Instead of covering the acrylic with neoprene I would dip coat the polypropylene in silicone because that is more hard-wearing. Having tested the product in a kitchen drawer, with other kitchen utensils, I discovered that the neoprene is damaged by other utensils an could eventually cause it to become unstuck. This would mean that without the neoprene the product had reduced grip and would be less comfortable to hold. This also means that if the product was commercially produced with it covered in neoprene, the product would have a relatively short life as it does not take long for the neoprene to be scratched and cut by other utensils in the drawer, resulting in the user replacing the product, or buying an alternative product that has a longer life span.

I have chosen silicone to replace the neoprene if it was to be manufactured commercially because it would not be damaged as easily as the neoprene and it cannot become unstuck from the acrylic as a result of contact with other kitchen utensils. Furthermore, silicone also provides grip and comfort so the effectiveness and comfort for the user would not be compromised by replacing neoprene with silicone. Moreover, silicone can be dyed in a variety of colours which is ideal for mass customisation because the product will be suitable for both genders and for a variety of tastes.

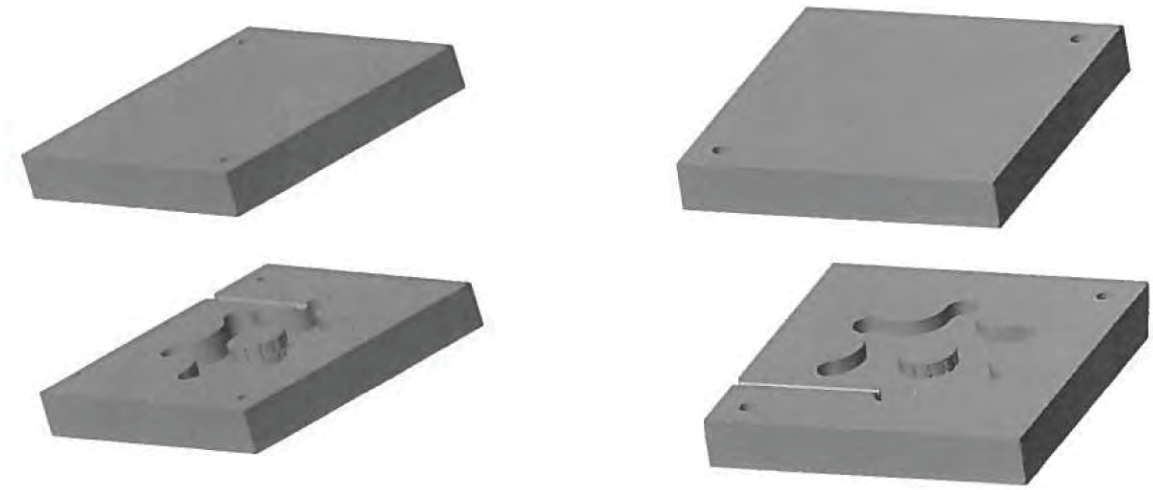
Criterion E: Manufacturing Techniques for Commercial Production

Araldite Glue -> Over-coating::

Due to the fact I have chosen liquid silicone rubber to replace the neoprene, over-coating will replace gluing as the manufacturing process because you cannot glue silicone to polypropylene. Over-coating is a more suitable manufacturing technique than gluing because it is stronger meaning that the covering is less likely to come off, which was a problem with using araldite to glue the neoprene. This is important because if the liquid silicone rubber comes unattached then the product might become useless because it loses its grip (in the hand) and it is also uncomfortable to hold. Moreover, over-coating is a much quicker process than gluing because it is occurs during the injection moulding process and it takes a long time to spread the glue on the acrylic. It is important when manufacturing the product on a commercial scale that time is not wasted because that can affect the profit and also the price of the product: f the product takes a long time to manufacture then the price is going to be higher, and if time is wasted then it costs money. Furthermore, multiple products can be over-coated at once, whereas with gluing, the number of products that can be glued at once is limited.

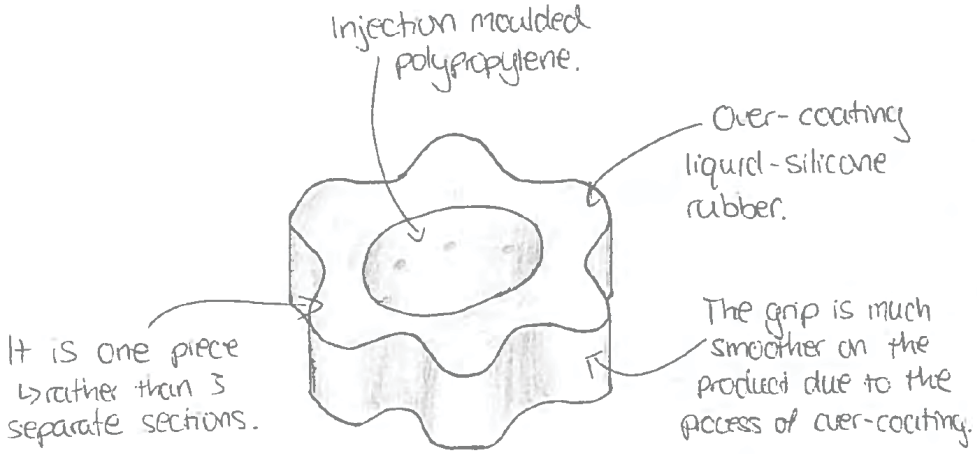
Laser Cutter -> Injection moulding

Injection moulding is more appropriate for commercial production than laser cutting because it produces the product as one part, rather than in separate sections that need to be assembled. This is key because it reduces the manufacturing time of each product, enabling them to be produced more efficiently. This reduced manufacturing time also reduces the cost of the product as it reduces the length of time that it takes to make it because the sections do not have to be glued together. Also, producing the product as one part removes the need for a person to glue the sections together which further reduces the cost because there are no wages to be paid. Low cost is essential for this product because the target market is elderly people and they would not spend a lot of money and so if it was expensive, then it would not sell. However, the cost of a mould would increase the price of the product, although the mould only has to be paid for once, so it is capital rather than a manufacturing cost. Below is a model of what the injection mould would look like:

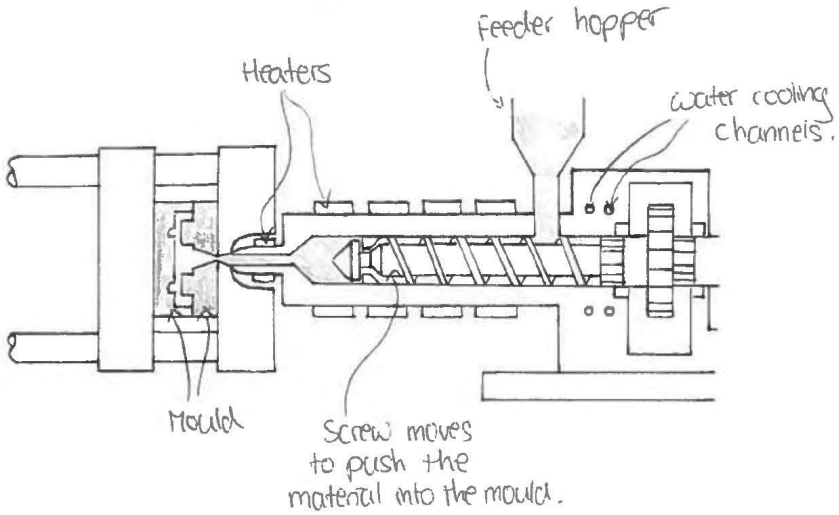


This image displays what the injection mould would look like, which verifies that this product can be injection moulded.

Criterion E: Design Modifications



The drawing above displays the final product, made from polypropylene and over-coated with liquid silicone rubber. This design means that the product is more compatible with the manufacturing techniques for commercial production because polypropylene is an ideal material for injection moulding, which is a commercial production manufacturing process.



Injection moulding is a more appropriate manufacturing process than laser cutting because it is suitable for mass production, which is vital for my product as there are thousands of people in my target market.

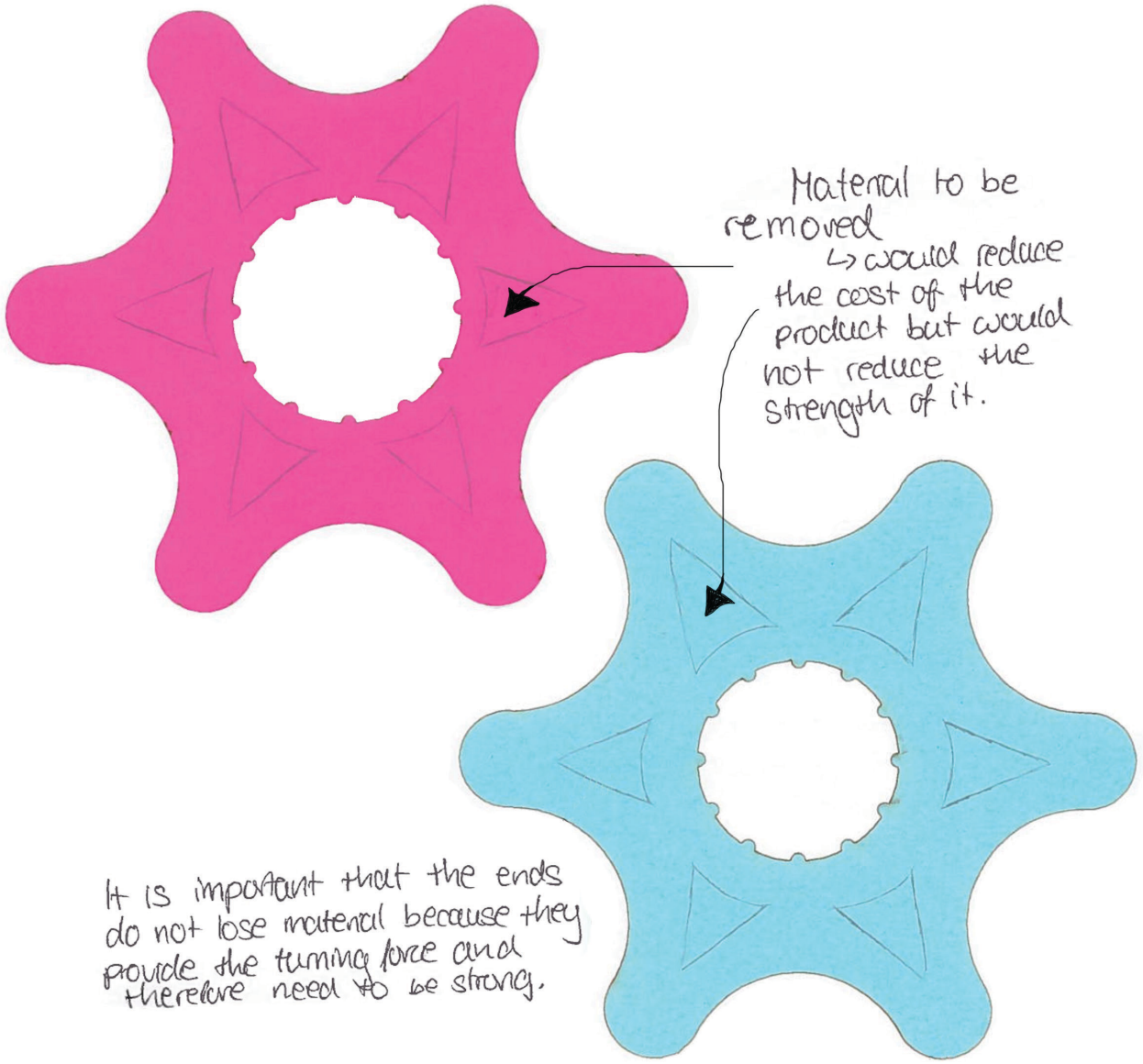
The process of injection moulding is suitable for my product because it is made from polypropylene and liquid silicone rubber.

Polypropylene is a common material that is injection moulded.

The modified design is now more compatible wit the design specification under both the materials requirements section and the 'manufacturing requirements' section. This is because it is now manufactured using polypropylene and liquid silicone rubber and instead of acrylic and neoprene which are more hard wearing and longer lasting materials, meaning that the product has a longer life span. Moreover, the design fulfils the manufacturing requirements section of the design specification because the modification allow the product to be mass produced more easily because injection moulding and over-coating are mass production manufacturing strategies.

Criterion E: Design Modifications for Commercial Production

In order to further make the product more viable for commercial production I could remove wasted material from the product. This will reduce the cost of the product as the materials used are the most expensive part, also it will reduce the weight of the product. Reduced cost and weight are very important as the lower the cost of the product the more profit can be made, or the lower the price of the product, and the lower the weight of the product the more comfortable it is for the user to hold in their hand. However, I would need to make sure that I did not remove too much material as that could weaken the product which could affect its turning force and therefore its function. The sketches below display what the layers of the product would look like with the excess material removed.



Criterion F: Target Sales Price

Sales Price Regarding Manufacturing Costs:

Market need:

The target sales price will reflect the market need for my product and because my product is imitative and not pioneering, the price cannot be too high. There are already multiple products on the market that successfully aid people who struggle with opening bottles and so the price of my product cannot be too high because there is not a high demand for it. Therefore my target sales prices will be £9.99 because it is similar to the prices of existing products, but it is not too low and therefore will not convey to prospective customers a low quality.

Cost of Commercial Product

Costs		Price
Capital costs	Injection mould	£3000
Material Costs	Polypropylene	£0.59
	Liquid silicone rubber	£0.20
Manufacturing costs	Injection moulding	£5.67
	Over-coating	£2.48
	Total cost:	£3008.94

Break—Even Point:

Given that the cost to produce the commercial product is £3008.94, the target sales price would have to be above £3.00 to make any profit (if I were to sell 10,000), because that is the break-even point. Therefore £9.99 is an appropriate price for my product as it means that I will make a profit of £6.99 per product.

Manufacturing Cost of Prototype:

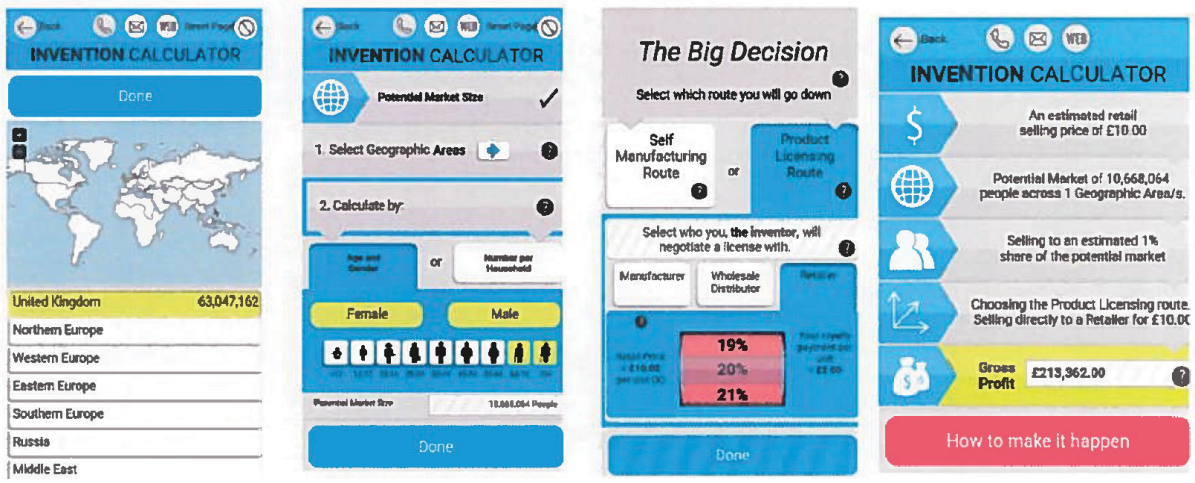
The manufacturing costs of my prototype are presented in the table below:

Material	Size	Price
Acrylic	(5x130x130) x 3	£1.62
Neoprene	(1x130x130 + (1x18x500)	£0.70
Araldite	-	£0.50
Acrylic cement	-	£0.20
	Total cost	£2.57

The cost of manufacturing the product at a commercial scale would be higher than the cost of manufacturing a prototype because the materials and manufacturing processes are more expensive, and this needs to be taken in to account when estimating a target sales price.

Estimated Profit:

In order to calculate the total profit that I could make if I tapped into the 1% of the market for people over 70 with arthritis, I used “Invention Calculator”, which calculates the amount of profit based on the geographical area it would be sold in, the age and gender of the target market and what level you would sell your product at (e.g. retail.). I would cost-plus pricing and competitor-based pricing strategies to sell my product so that I will have a set amount of profit and I will be able to compete with other companies.



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Criterion F: Target Sales Price

Sales Price in Comparison to Existing Products:

As part of my initial research I looked at existing products and their prices in order to gain an insight into what the cost of my product would be, and an appropriate price for the product in my design and market specifications, by judging what sort of prices people are prepared to pay. Having produced a working prototype of my product, I will compare it with similar products that are already on the market so that I can price my product accordingly, and not be out-competed in the market. I do not want to price my product too highly so that my target market will not buy it because they consider it too expensive. However I also do not want to price it so low that it does not sell, because my target market may think that the low price reflects a low quality and therefore purchase a product that they think is of higher quality.

IMAGE REMOVED DUE TO COPYRIGHT REASONS

The image can be found in this location:

https://www.amazon.co.uk/Premier-Housewares-Jar-Opener-Black/dp/B00IW4UGO6/ref=sr_1_8?ie=UTF8&qid=1474890380&sr=8-8&keywords=jar+opener

The image on the left displays a jar-opener that it available to buy from Amazon for £3.49. This product is very similar to what my final product would be, after altering the prototype to make it suitable for commercial manufacture. This existing product is made from polypropylene and liquid silicone rubber which are the two materials that my product would be made from when manufactured on a commercial scale. Due to the fact that my product is made from the same materials as this existing product, my product would likely be produced using the same, or similar, manufacturing processes as it. Therefore, the price for my product, for sale commercially, would be very similar to the price of this product which is £3.49 because the manufacturing costs would be very similar.

IMAGE REMOVED DUE TO COPYRIGHT REASONS

The image can be found in this location:

http://www.betterlifehealthcare.com/view/derby-tap-turners/4000/

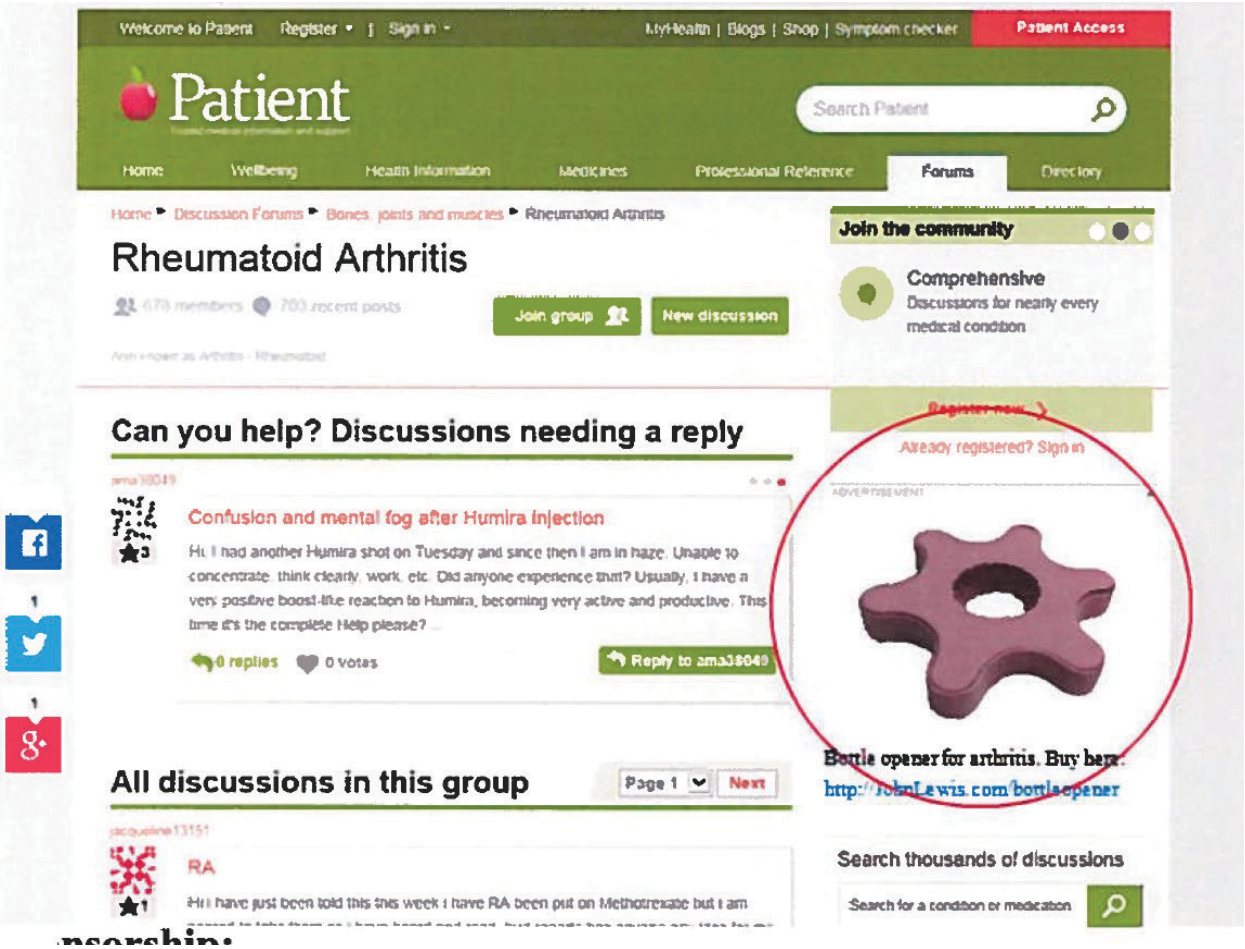
The image to the left displays another product that is available on the market for £13.99 from betterlife-healthcare.com. This product is also similar to what my final product would be, because it is manufactured by injection moulding, which is how my product would be manufactured on a commercial scale. However, my product is not just manufactured by injection moulding; it has a liquid silicone rubber grip that is attached by over-coating and so the price of my product would be higher than this product because of the extra manufacturing process. The price of my product Would also be higher because the cost of the additional material: the liquid silicone rubber whereas the existing product is made purely from HIPS.

Criterion F: Promotional Strategies

My promotional strategy is to increase business by giving away my product through the NHS, to attract attention to it. Then once many people are using it I will advertise it for sale on arthritis forums, such as the one below. I will sell the product through large stores, such as John Lewis as they are widely spread across the UK and elderly people can go into the store and purchase the product—they do not have to buy it online. This is important as many people over the age of 70 are technophobes or are techno-cautious. Once the product is successful, I could create a product family: adding products that aid people in opening jars and also carton tops.

Advertising/Sales Promotion:

The image below is an appropriate sales promotion strategy as my product is being advertised on an arthritis forum and so it is likely to sell because people who have arthritic hands will see the advertisement and then purchase the product. Not only will this product be available to the target market, people who are younger than 70 years old will be exposed to the advertisement and may then purchase the product. However, my target market may not have a computer because not all elderly people do, and they may not visit arthritis forums and so my target market may not be exposed to the advertisement. However, even though people who are over 70 may not have a computer or regularly visit forums, such as this, a friend or relative may see the advertisement and inform the person of the product as a solution to the issue of opening bottles.



Sponsorship:

In order to fund the production of my product I could gain sponsorship from programmes such as 'kick-starter' where I pitch my idea and persuade sponsors to pitch money. This is an effective way to raise money for the production of my product as many people have had great success on Kick-Starter and many young people are also affected by arthritis and so they are likely to pledge money towards a successful solution.

Criterion F: Promotional Strategies

Internet Marketing:

Selling the product on the website of John Lewis is an appropriate internet marketing strategy because it is a well-respected company and sells a wide variety of products. Furthermore, John Lewis is appropriate for my target market because the elderly are accustomed to John Lewis as a store, because it has been in business for over 100 years, and so they are likely to buy my product if it was to be sold there. Moreover, John Lewis stores are very widespread across the country and so for the elderly people who do not like to travel far, John Lewis is an appropriate store to sell my product because most people live within fairly close proximity of a John Lewis store. However, internet marketing may not be entirely appropriate because my target market is people over 70 and they may not have a computer and thus do not have access to the internet. Also, the elderly do not tend to shop online like the young do, although my product would be stocked in store. The image below displays what the webpage would look like if John Lewis were to sell my product.