hex-A-mod

the modular
garden seat/shelving unit

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= VIDEO

= Picture

Design Brief

Problem Area

The current market is very limited when it comes to garden seating. With homes becoming more and more modern I believe there is a need for a garden seat that matches the current look of homes.

Design Brief

My target by the end of the year is to design and make a modern garden seating arrangement. It should be able to fit most if not all gardens and provide comfortable seating for all ages.

Marketability

There are many areas I need to look into when trying to make my product marketable. Is it original? Does is stand out and catch the eye? Is it interesting? Is it of a reasonable price? Does it perform well in its own function? These are the main factors that I will need to think about throughout the design process in order to make my product sell.

After looking at seating options first hand and over the internet I came up with 3 main areas that I would look to improve on when designing my product.

1. Aesthetics

The factor I need to keep in mind the most through out is the modern look of the seat as that is the reason I have chosen this task. Most of the options I looked at were either very bland looking or old fashioned. Even when I did come across a modern alternative it seemed to have some down side whether that be the size, shape or even the price.

2. Size

A lot of garden seating arrangements are limited to one size. For example benches are a solid structure that cannot be altered for individual gardens. I therefore want to make my product modular in order to fit all shaped and sized gardens.

3. Function

The product needs to be functional in all weather. This means not having areas in which water can build up. All the materials also need to be weather proof so the product has a long life. A lot of garden seats on the market need cushions in order to be comfortable or even need to be protected in wet weather, for example being stored away in doors or have an umbrella over the top.

Client

My client is a **modern home owner** with a garden, 670cm in diameter. This is much smaller than the average sized garden which means if I model my product to fit the shape of this garden it should fit most if not all gardens around the UK. My client is 51 years old which makes him older than the average home owner at 31. My target market are home owners not people of a specific age meaning I will have to take into account the needs of people of different ages. As my client is older I will need to be careful about the weight of my product and how it will be packaged. The product needs to be easy and quick to manoeuvre or/and assemble as my client works full time.

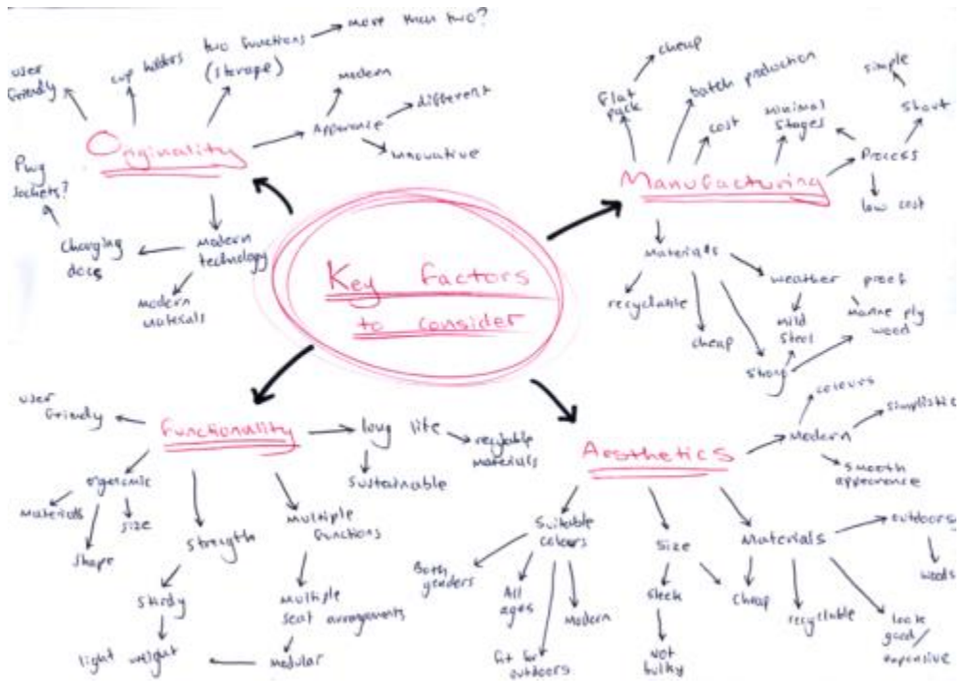
The average GB garden size is **14m²**.
Average garden size for consumers aged 25-44 is **12m²**.
Average garden size for consumers aged 45+ is **15m²** .

(All pictures taken my me)

Government forecasts seen by *The Daily Telegraph* show the percentage of households with gardens is expected to have fallen from 91.8 per cent in 1995 to 90 per cent by next year.

By 2020, the just 89.5 per cent of households are likely to have a garden.

With the percentage of house holds with gardens falling I think it is a good idea if I was to add another function to my product such as some sort of a storage system or shelving unit. This would widen the market for it and could allow homeowners to use it in doors as well as out.



Primary Design Inspiration

In order to find the latest designs in cheap garden seating I visited the IKEAs in both Reading and Milton Keynes. While I was there I was able to take pictures and measurements of seating and shelving units to help with making my product.

IKEA isn't famously known for its benches. However, I did discover a similar pattern in the measurement of the seating.

Anthropometric Data

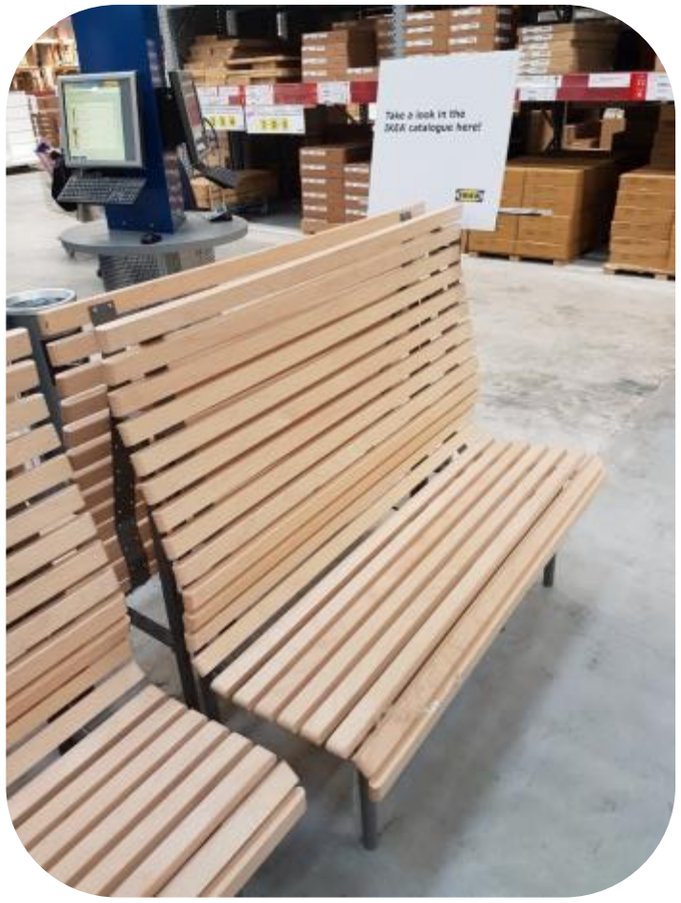
All of the seating I measured, in doors and out stood between 400 and 450mm off the ground. This provides a good guideline for my product.

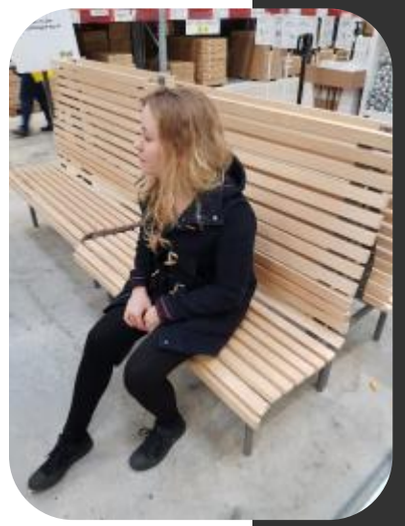
The benches I measured did also not go less than 1200mm in length. This leaves enough room for three people to sit comfortably. If you were to narrow this down it means you should leave at least 400mm width for one person to sit.

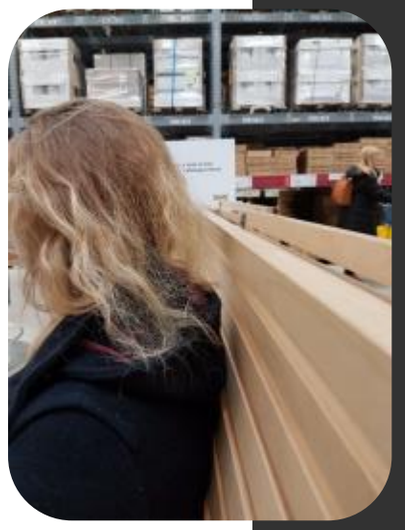
All of the benches I saw were designed to allow the user to sit back comfortably on the back rest. To do this some of the benches, for example the one in the bottom right, has a curved surface so the seating position was more natural.

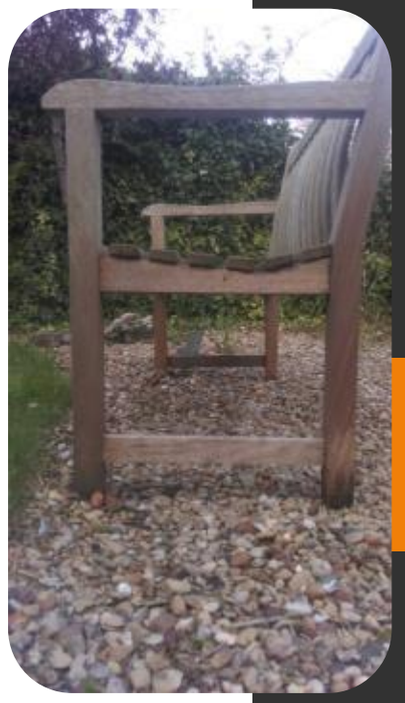
As the seat I am going to make will not have a back rest, I do not need to go into as much detail with the ergonomics as there will be multiple ways to sit on my product.

If I were to change the shape of the seat surface to ergonomically fit the shape of a person then it would limit the seating possibilities and consequently affect the modular aspect.







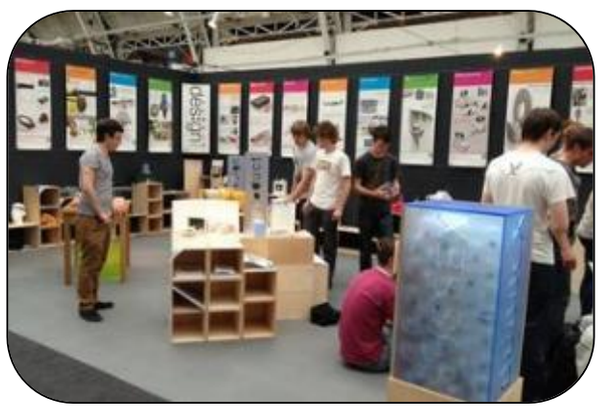


Primary Design Inspiration



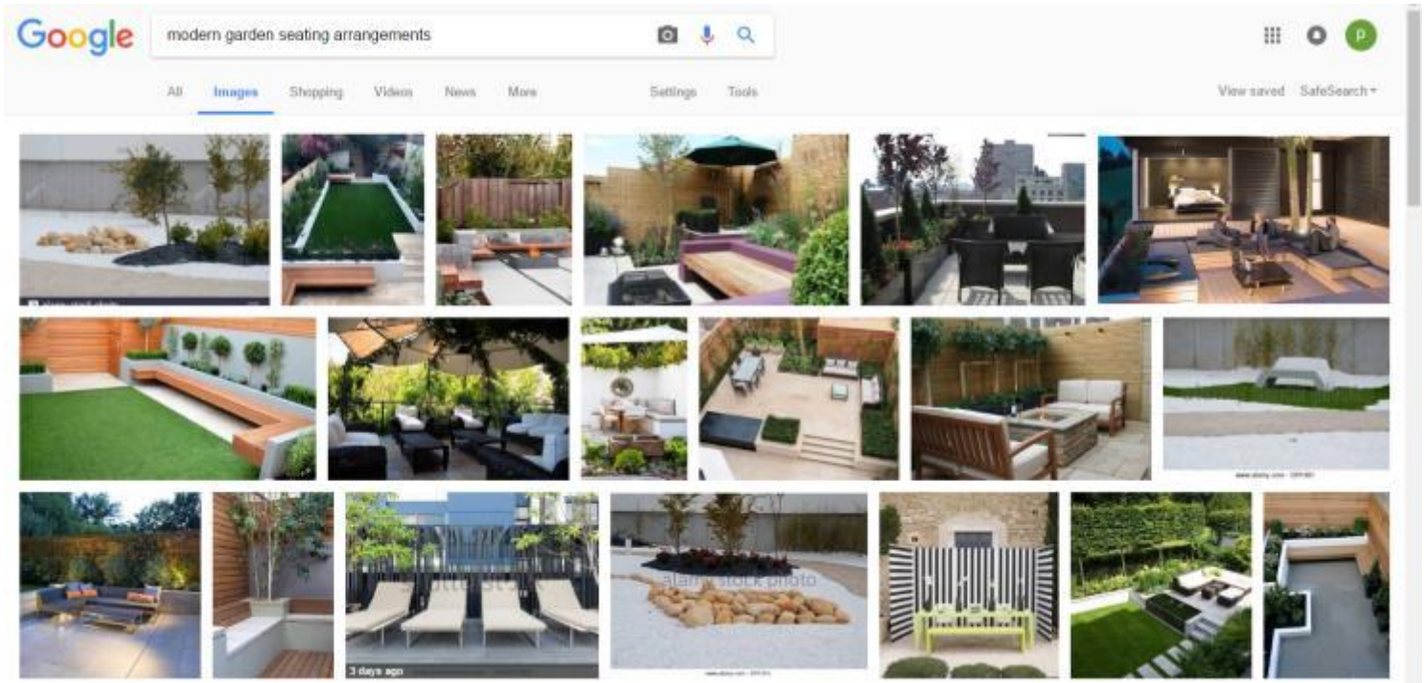



As I was at IKEA I decided to take some pictures of some of the other products that may be relevant to my design. This included tables, chairs and shelves. The idea was to see if I could find any pattern in the trends and look of each of the products. The simplicity of the designs stood out as well as the use of wood to make the designs look professional yet remaining cheap to manufacture.

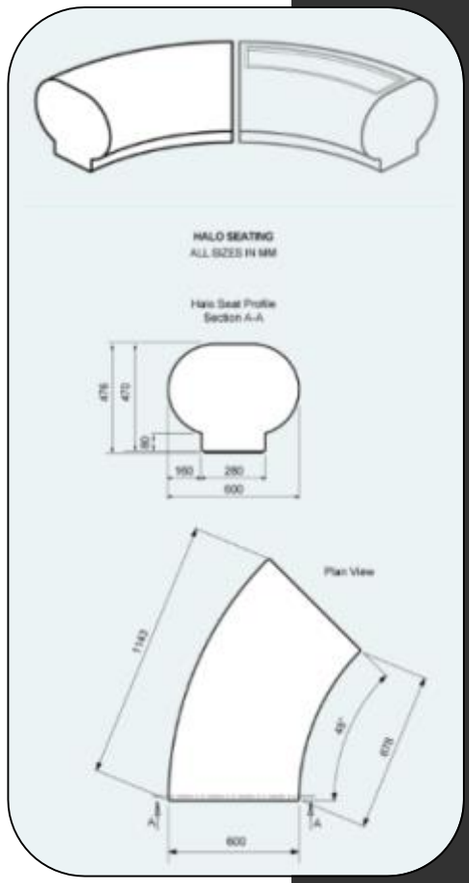



I also visited the new designers exception in London. This was my second time going where I was able to explore the ideas students had from different universities across the country. Here I was able to talk to people about their designs which gave me inspiration as to what I could design my self.
The exception covered all areas of design, from big electrical creations to little aesthetically pleasing products. This meant I was able to grasp a range of ideas.

Secondary Design Inspiration



I googled ‘modern garden seating arrangement’ to get a quick idea of what's on the market and what people are looking for. A lot of what I found was all about fitting a seating area into a small space which otherwise would have gone unused. As my product will be modular, it will be able to fit into different sized spaces to fit as many gardens as possible.



I came across this design company called ‘GEOMET’.
They produce modular furniture for both indoors and out. The units are made with fibre glass which is a strong material with a professional finish. Fibre glass is a popular material for boats which obviously means it is very durable. It is however far more expensive than wood resulting in a smaller profit and may not appeal to everyone.

IKEA Research

After researching about IKEA I found that ‘Much of the furniture is self-assembled’. They state this is to reduce cost due to the transportation and packaging. They specify furniture because it is the larger of their products meaning the cost will be a lot larger to transport and package than a much smaller product such as a bed-side table. For a product like mine, therefore, which is very large, making it flat packed could save money as the transportation cost will be more. However the cost of this could be saved elsewhere such as in the manufacturing process.

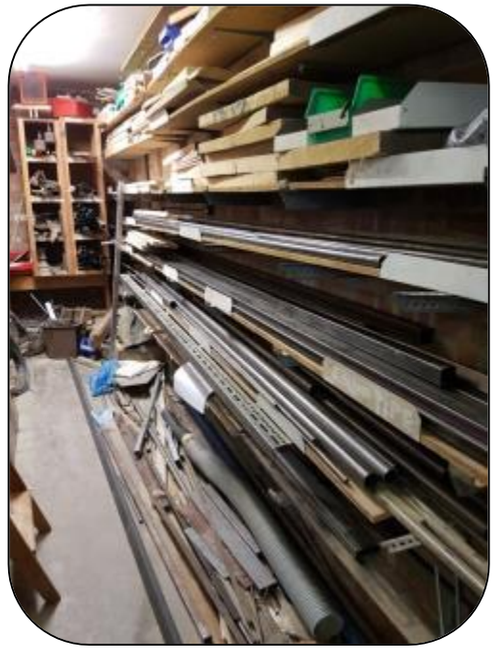
Manufacturing costs of IKEA are reduced by the products being manufactured in developing countries. It also states ‘The final assembly of the product is done by the user’. This means although the transport costs may be high due to the fact that they are being manufactured in different countries, they are reduced as the fully built product is not transported. Of course with my product I will not be mass producing it, although if I were to, I would use the approach of IKEA to reduce manufacturing costs and increase profits.

IKEA have done as much as they can to reduce the costs of manufacturing processes and materials whilst still keeping the same quality and strength. The use of MDF or ‘particle board’ is a cheap ‘engineered wood with superior strength that is resistant to warping’. This would be a perfect material for the wood I want to use in my product as it is cheap and strong. Also the fact it is warp resistant means it would not be affected by the wet weather that it will face as a garden product.

Materials

I will use both wood and metal to build my product. The metal will be used to provide a strong main structure while the wood will be used for the surfaces used for seating and possibly storage. This will be the best option to keep the product strong yet as light as possible. Using the wood as the area to sit on will also provide a comfier surface than if I was to use only metal.

The metal I will be using is **mild steel.** I have chosen to use this material because it is strong, durable and light enough to move about. It is also relatively cheap compared to other popular building metals such as aluminium. It can be powder coated or galvanised to get its weather proof properties and can be braised to easily create my required structure.



The school offers a lot of shapes and sizes of mild steel. From the options I had I think a regular shape such as a square or circle based pipe would work best for the frame of my product.

The tubing also comes in different thicknesses ranging upwards from 1mm. I want to keep the frame as light as possible but still strong enough to hold a lot of weight and have a life time guarantee. Although it seems like a small difference, the 1.5mm seemed a lot stronger and didn't add too much weight. A lot of past projects I saw also used this thickness of material.

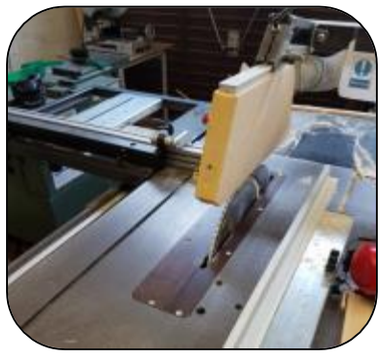
All the materials need to be weather proof so once I have my finished structure braised together and cleaned, I will send it off to be powder coated. This creates a better finished look compared to how it would look galvanised.

NATURAL

MAN-MADE

The wood I choose has to be strong enough to hold a person's weight. It also has to maintain this strength over its life time meaning it has to be durable through all types of weather. The strength will come from the type of wood as well as the thickness. All these factors must be met in the lightest way possible which is why I will most likely use a man-made option such as plywood rather than a natural option with the same properties.
The wood I will use is probably to be some variation of **plywood**. Plywood is designed so that the grains of wood run in opposite directions creating a light but strong material. Marine plywood fits all my criteria for performance as it is strong light and weather resistant. However it is much more expensive than regular ply wood, costing up to 5 times as much per sheet.

Circular saw used to cut wood



Circular saw used to cut metal

Specification

Function

The function of the design is probably most important. It has to perform well as a chair, and therefore, ultimately I need to consider comfort, size and aesthetics as key areas

Customer

The design needs to fit the customer and be comfortable when seating. To achieve this I need to make the materials ergonomically friendly. For example I would make the seat out of wood as it provides give. This however could put a limit on the materials I use.

The design needs to be adaptable to different sized gardens so the product can be used equally by different customers.

My product has to be low maintenance and be easy to manoeuvre. This will open it up to a larger market (age range). To achieve this, I will need to be careful about the size and weight of the product.

Aesthetics

The product must have a suitable appearance for both genders and all ages (anyone who has their own home) to make the product appeal to everyone and make it more marketable. This could however make it difficult to advertise as the product needs to suit a wider audience.

It have a modern look to it so it is more suited to todays market. Going down this route though, could have a limiting effect on who it appeals to.

Ergonomics

The design needs to not only look the part but also has to fulfil the function of a garden chair. This means the materials have to be ergonomic to the user and the shape of the chair has to be comfortable to sit on. I have to be careful to keep the product looking good though and not focus so much on the ergonomics that the design looks bad, I need to find a balance.

Safety

The design has to be safe around children- children usually play in their garden in summer which is when the seat will be most used. This means the edges of the design need to be smooth as the seat is the ideal height for little children to run into so I need to minimise that risk as much as possible. Although this could create more work for me and possibly increase the cost of the product, the outcome will be worth it.

The seat has to withstand the weight of a person or two so it does not collapse under pressure. This means I need to find a way of addressing this without the design looking too bulky.

If the product is too heavy it could cause strain on people when lifting it or putting it together. This needs to be taken into account when I pick the materials and decide how large I will make the product.

Manufacturing

The product should ideally be flat packed to make it easier to manufacture and transport.

Costs of manufacturing need to be kept low meaning materials and the processes it undergoes need to be controlled.

Cost

The overall cost of my product needs to be significantly more that the manufacturing cost to obtain a profit. I mainly need to consider the costs of materials, manufacturing and shipping costs. I need to be wary of competitors too and the costs of other similar products in the market now.

Material

The material of the design is key as it has to be comfortable, look good, be cheap and most importantly, be suitable for a garden seat. This means it has to be able to withstand weather and be strong while keeping the costs low.

RED-POINTS I NEED TO ADDRESS AND TAKE INTO ACCOUNT

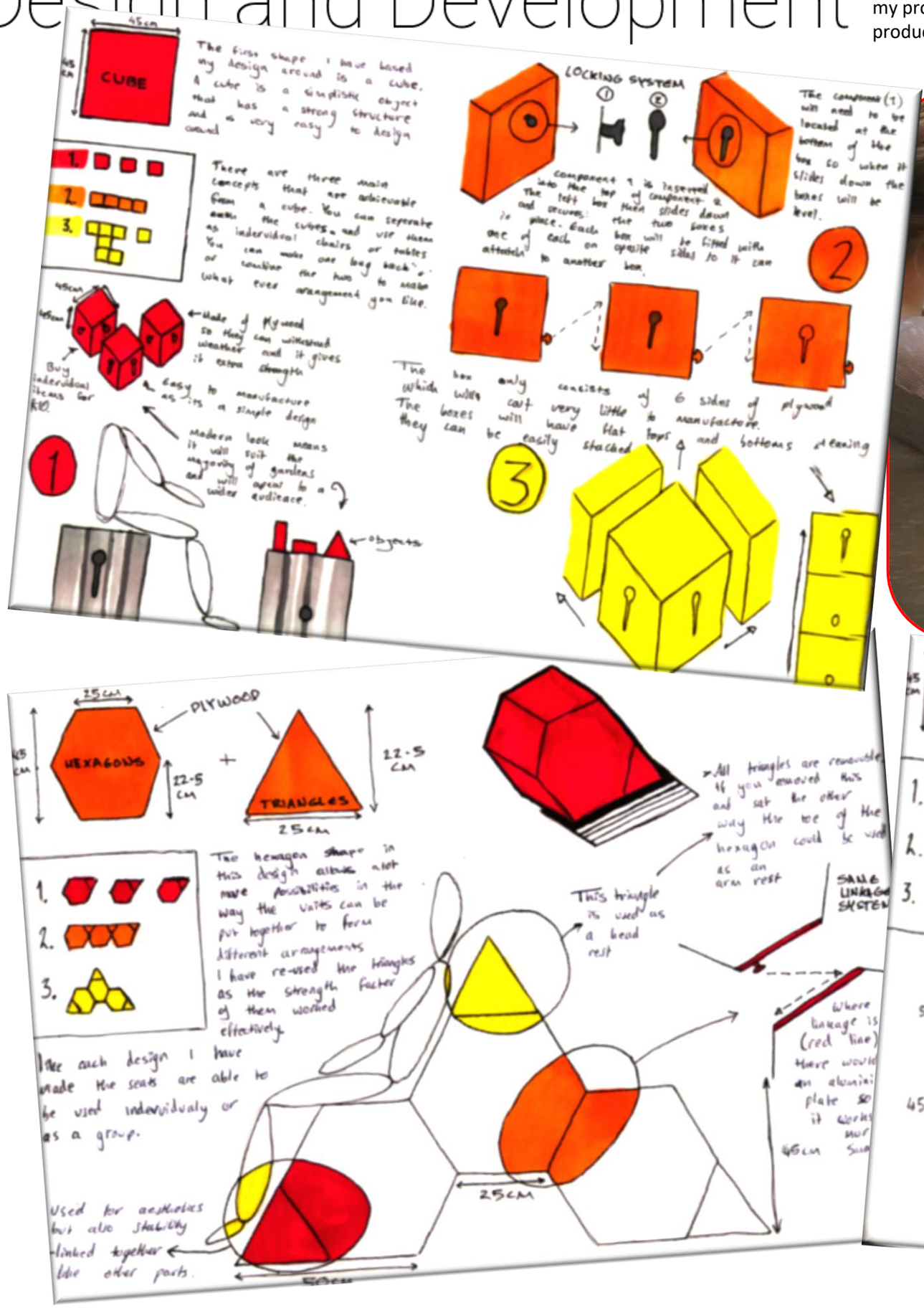
- Difficulty of advertisement (has to suit a large market)
- Modern look may have a limiting effect on the market.
- I need to be sensible with costs and be aware of competitors.
- The materials could be limited
- Balance of ergonomics and appearance
- Cost of adding safety elements
- I have to keep the design from looking too bulky meaning finding a strong shape or structure.
- I have to make the size realistic to what a seat usually is.

Size

The product must be a suitable size; it has to be large enough to make a comfortable seat and look the part but small enough so it can be sat on at a reasonable height. Also the size will determine how much of each material is used and the overall cost of the product. Sticking to these guide lines means I have a limited range of sizes and shapes I can design my product around.

Design and Development

To start my designing off I brainstormed some shapes and connecting methods I could use for my product. This aim of this was to get my ideas on paper to get a better understanding of the product I wanted to create and was also able to get feedback on my initial thoughts.



Design Feedback

For my initial ideas, I asked other design students what they thought about the concept and ways I could develop my ideas.

The majority supported the original shapes such as the hexagon and thought including a triangular shape for added strength would work well. The locking system I have used throughout was also praised by everyone as an innovative design.

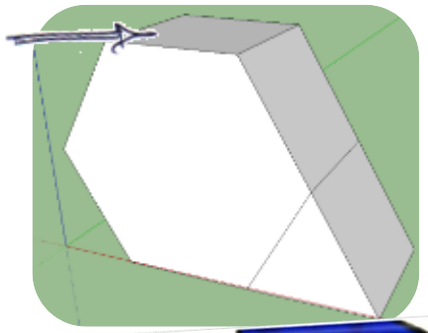
My design has to be low maintenance and be easy to assemble. The volume and type of material I have used was said to be a possible drawback to the weight, cost and manoeuvrability of the product so will have to be addressed when designing further.

Design and Development

When getting feedback from my client I game him 2D prototypes, as shown in the video, so he could see in more detail what the product is about

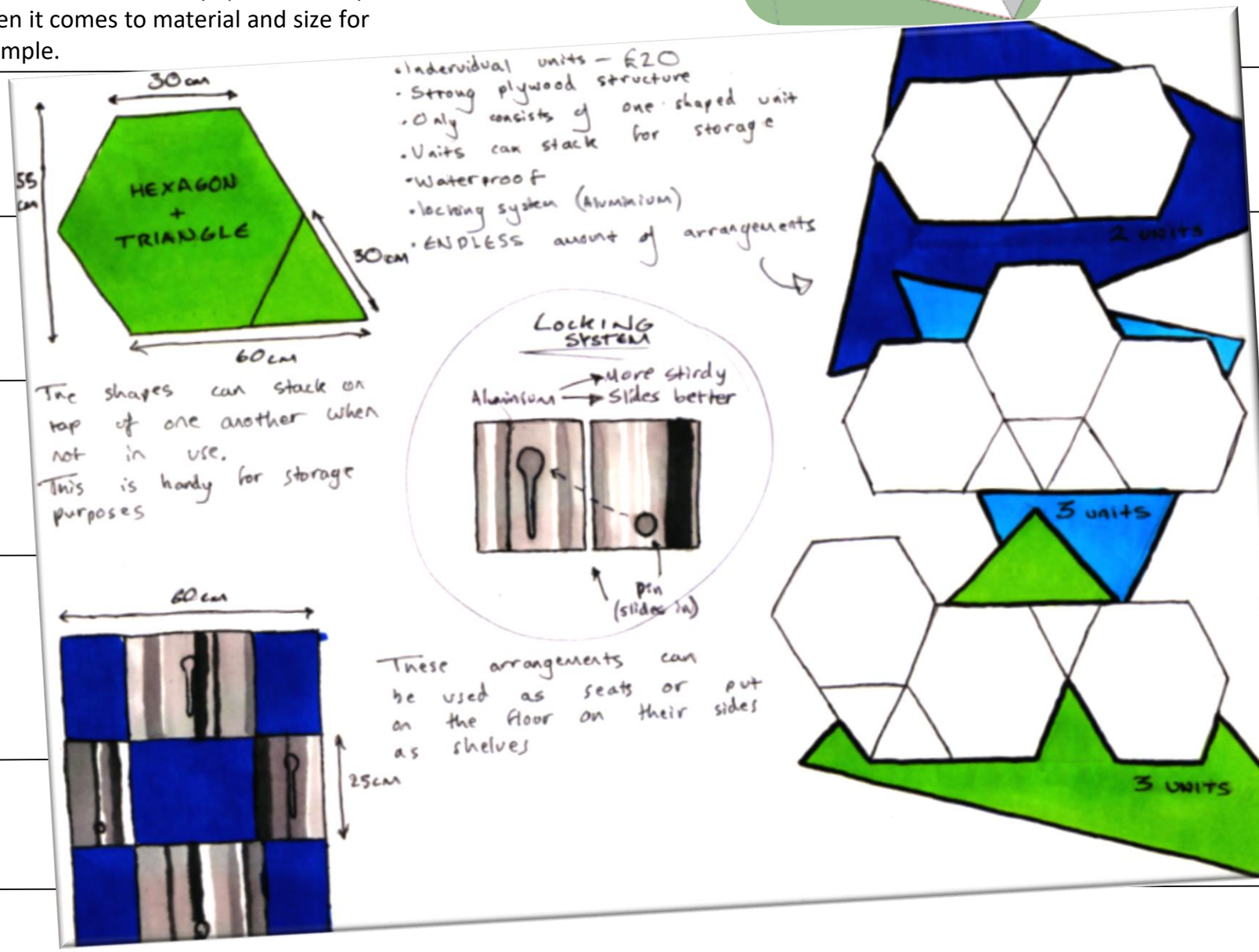
I decided to carry forward the hexagonal design as it received the most praise from my client and I have combined this with the strength of the triangle. I have also brought though the best points from the other two pages such as the locking system.
Now I have settled on the shape of the product I can focus more on my specification points when it comes to material and size for example.

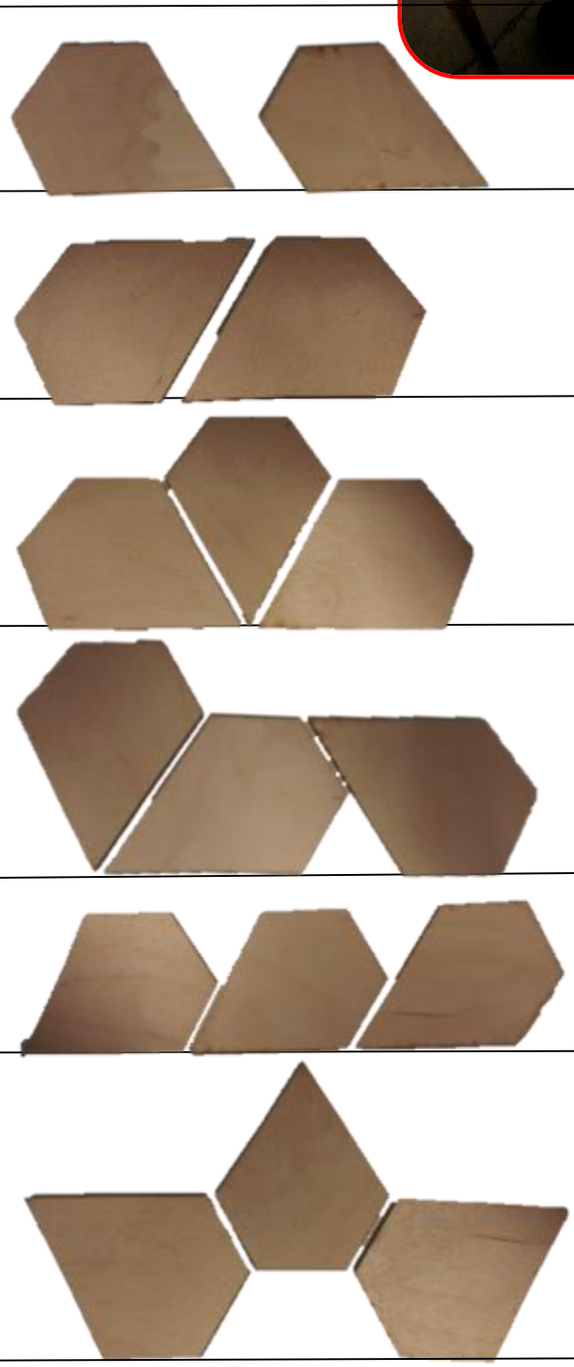
Made In Google Sketchup



My client loved the modular system and the range of forms that could be created. He also liked the locking mechanism saying it looked ‘neat’.

The weight and material was still a problem however as my client said it would be difficult to manoeuvre. This is a major issue as the weight and manoeuvrability was mentioned as part of my specification to be wary of.



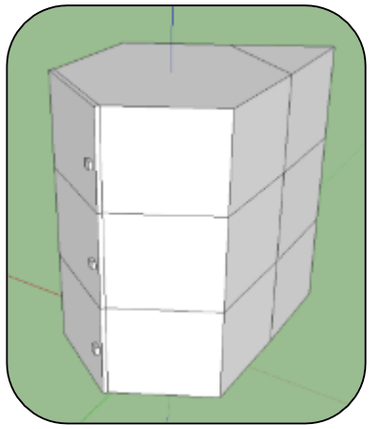


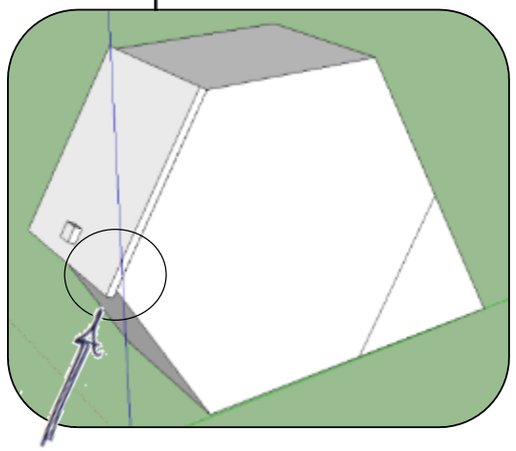
I used the laser cutter to produce three side on views of 3 units of my design. When I sell my product the customer will be able to choose how many units they want to buy and the more they buy the more arrangements can be made. This provides an extra incentive to buy the product as you not only get more singular units you get more possibilities as to what you can make. This fact alone makes the product unique.

Although there are many more possible combinations, I have laid out some of the most practical and basic designs to give an idea of the forms that can be made.

Design and Development

After settling on the shape and appearance of the product I decided to add more features to the design. I thought adding a storage aspect to the design would bring something extra and would appeal to more people. This would also make use of the wasted empty space that would have been inside the module.



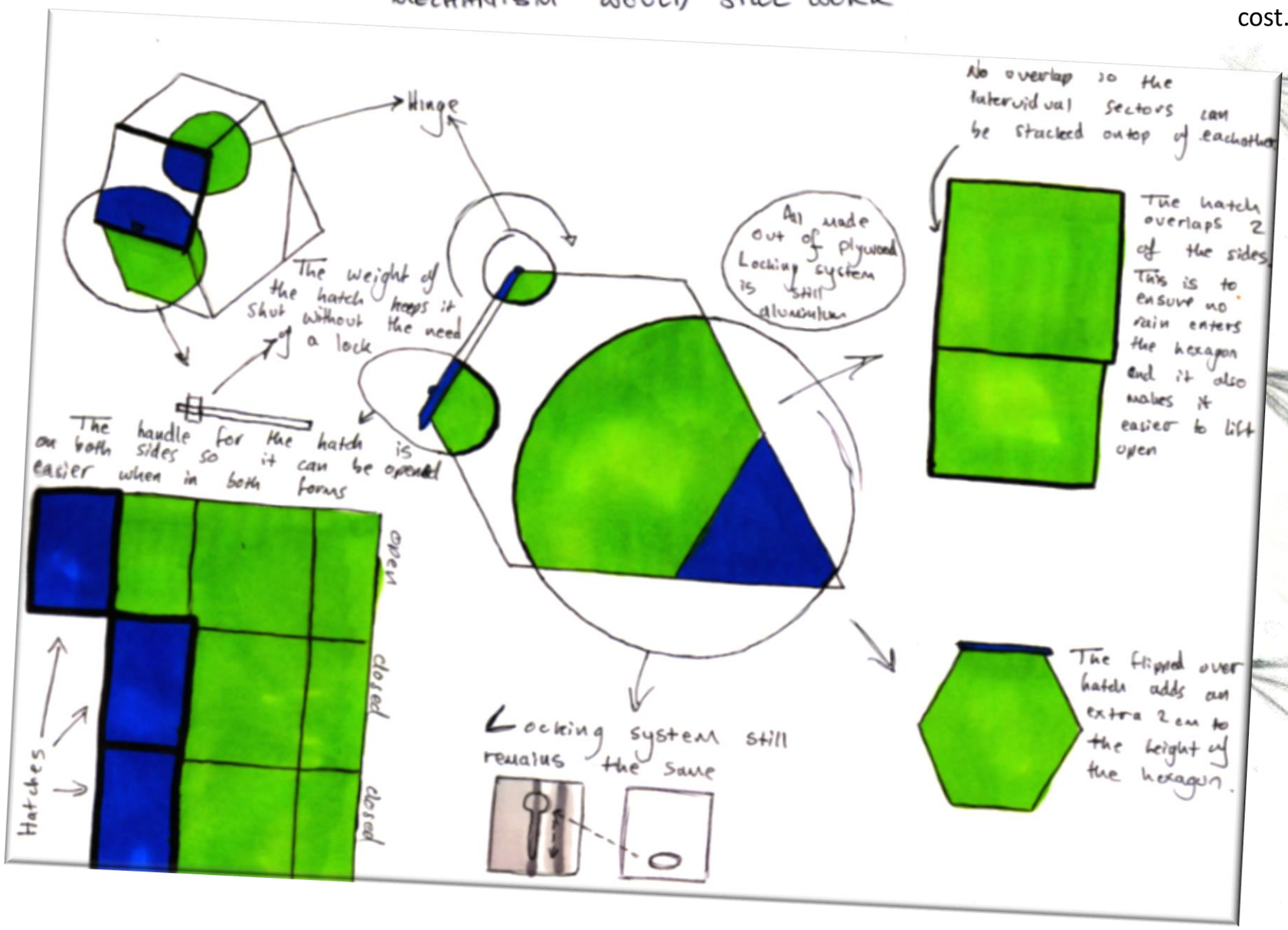


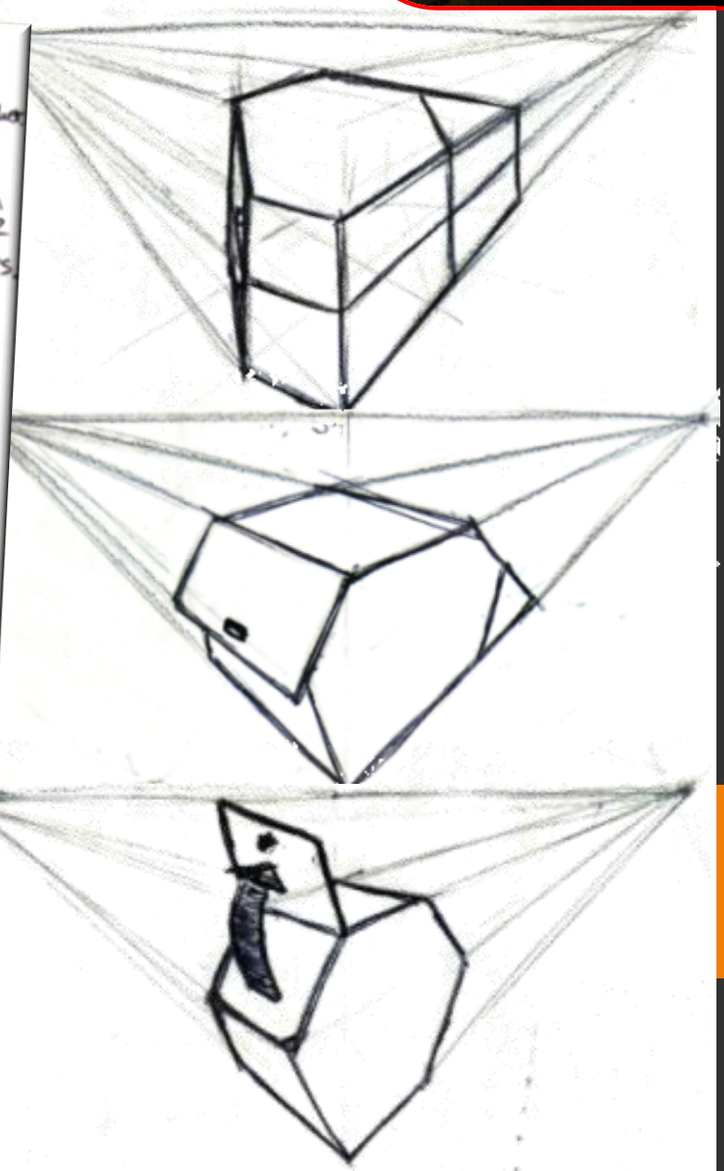
HATCH ONLY OVERLAPS ON THE BOTTOM SO THE STACKING MECHANISM WOULD STILL WORK

As it was such a major part of the design I asked my client for his opinions on incorporating a storage aspect to the product.

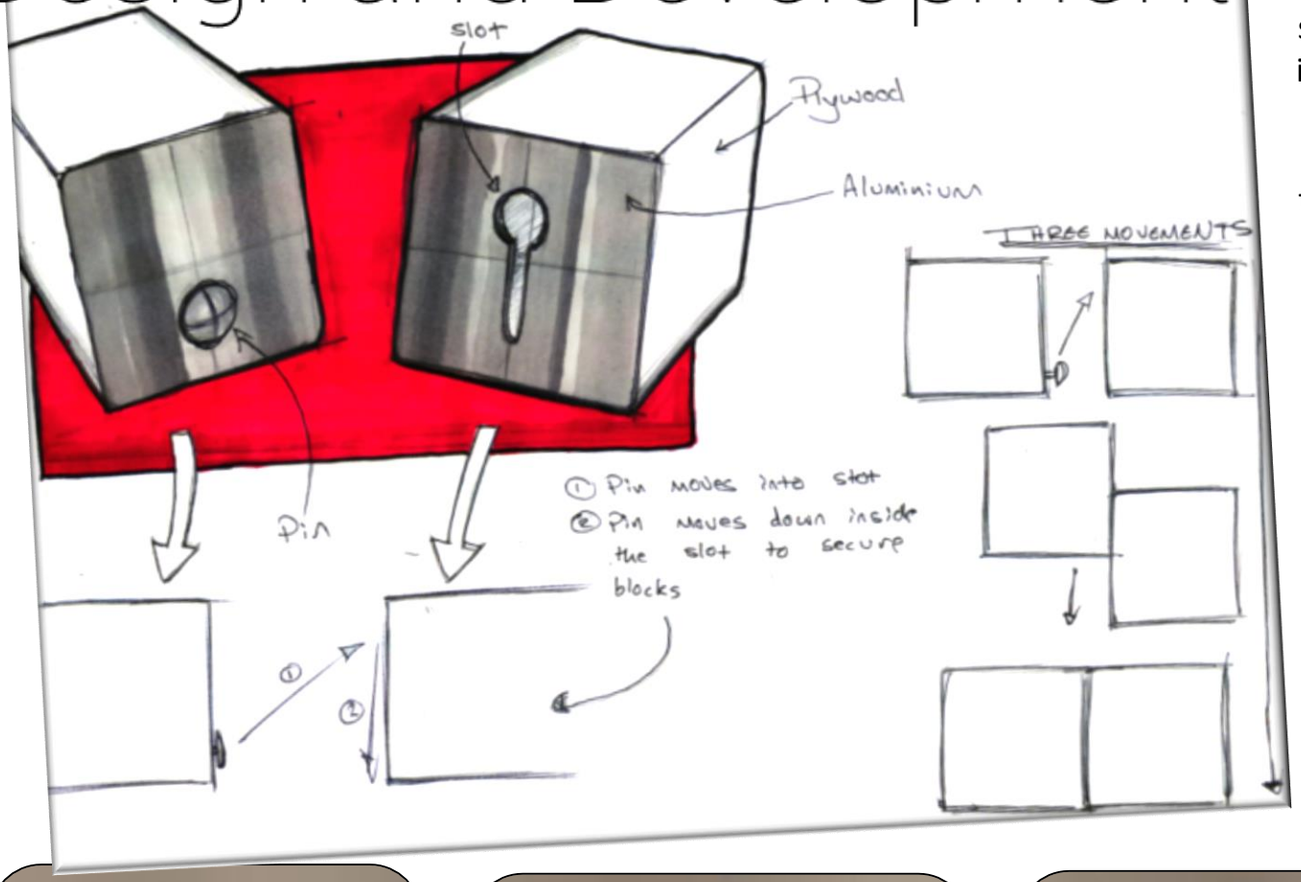
The idea of the storage aspect went down well as it uses up empty space and makes use of the extra material.

However, the overlapping sides to the hatch would not work with the stacking mechanism. This is something I have altered on the CAD work on the left although this could affect how water tight the unit is.
Adding this hatch would also add further complication to the manufacturing side and once more would have a negative effect on cost.



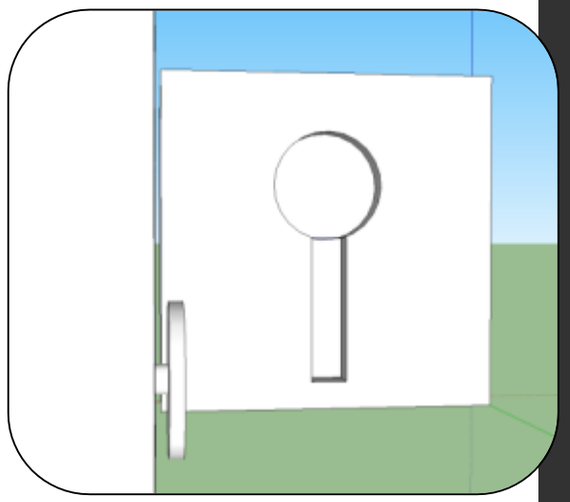


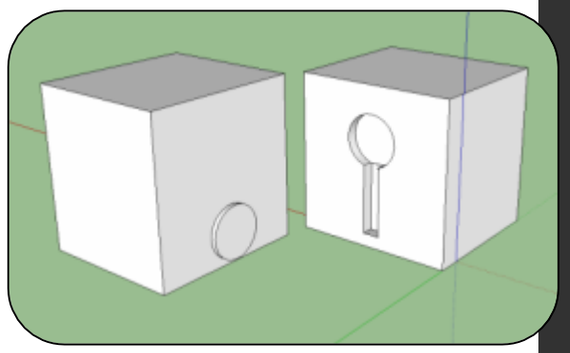
Design and Development



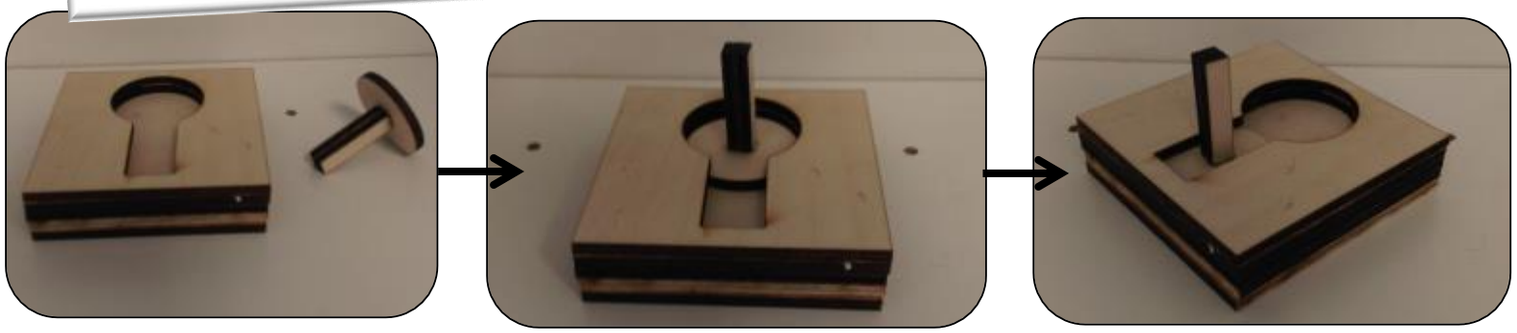
The mechanism works by a pin sliding into a socket and locking itself. In the top picture you can see there is a gap between the surface and the pin. This is so that when it is inserted into the second piece it can slide down and interlock.

The pin is located to the bottom of the block and the socket is at the top. This is so that when locked together they slide down to be level with each other shown by the sketch on the left. If the pin were to be at the top then the boxes would not be level when they were slid into place.

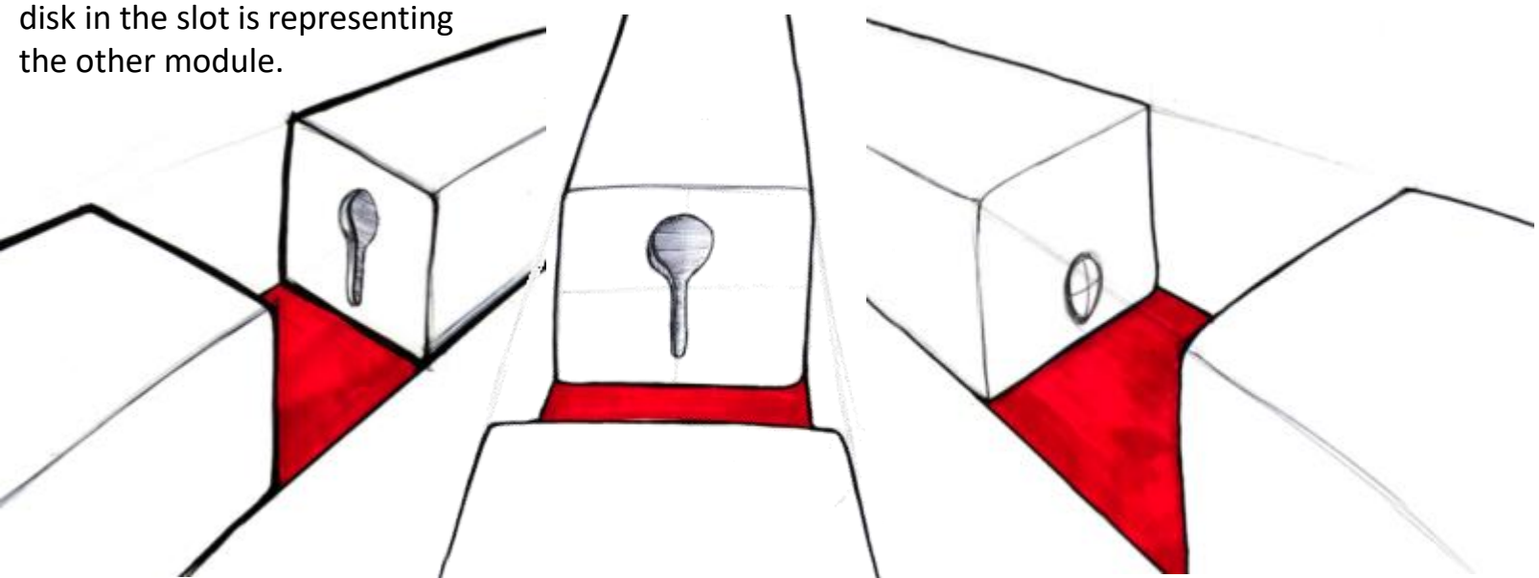




For the mechanism I decided to get feedback once more from other design students as they could give me a better idea of things I could improve on.



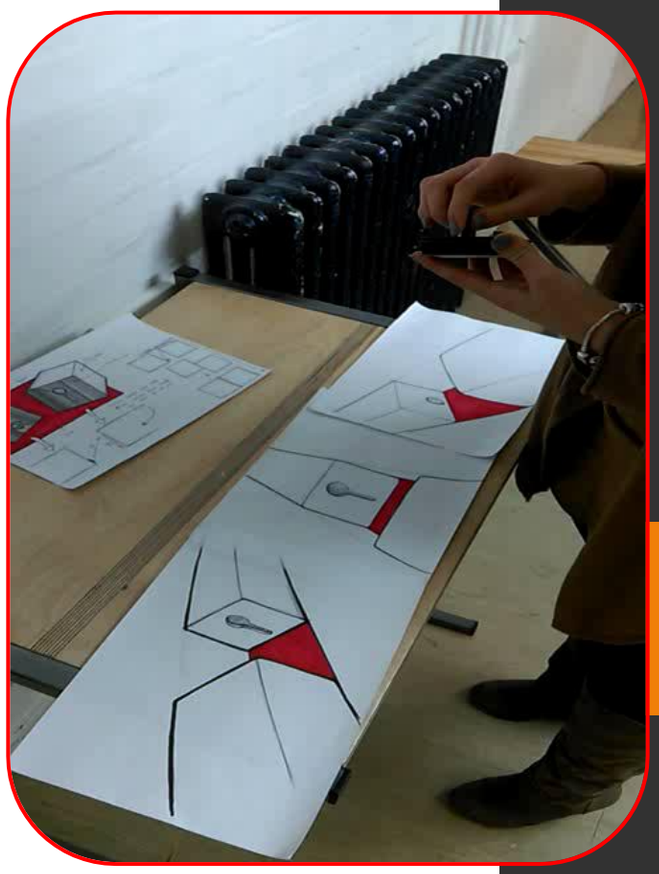
The stick that attaches to the disk in the slot is representing the other module.



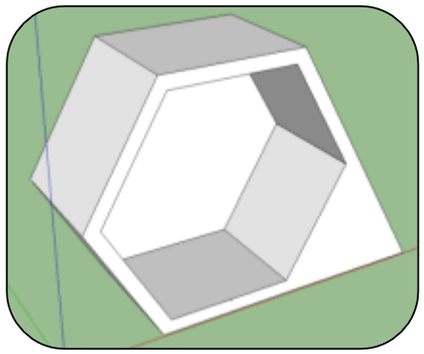
The mechanism as a whole came across as smooth and would make the units quick to assemble.

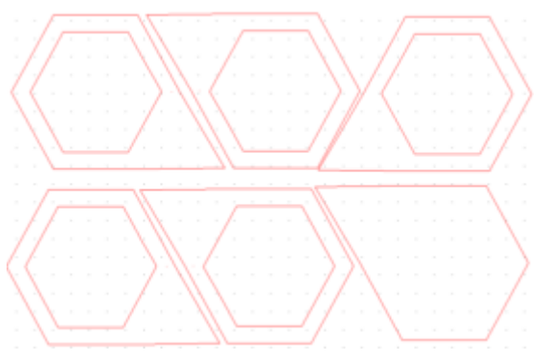
Despite this the amount and type of material needed would amount to too much money and weight for me to achieve.

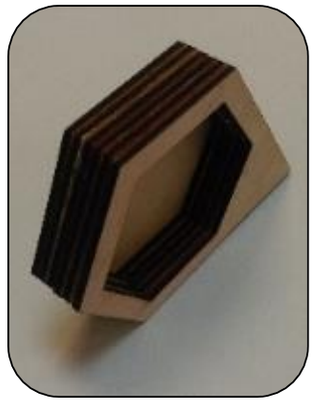
In order to use this mechanism I would be using a lot of material elsewhere in the product which would not be following my specification in both the areas of cost and customer.

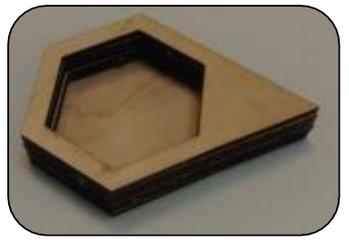


Design and Development



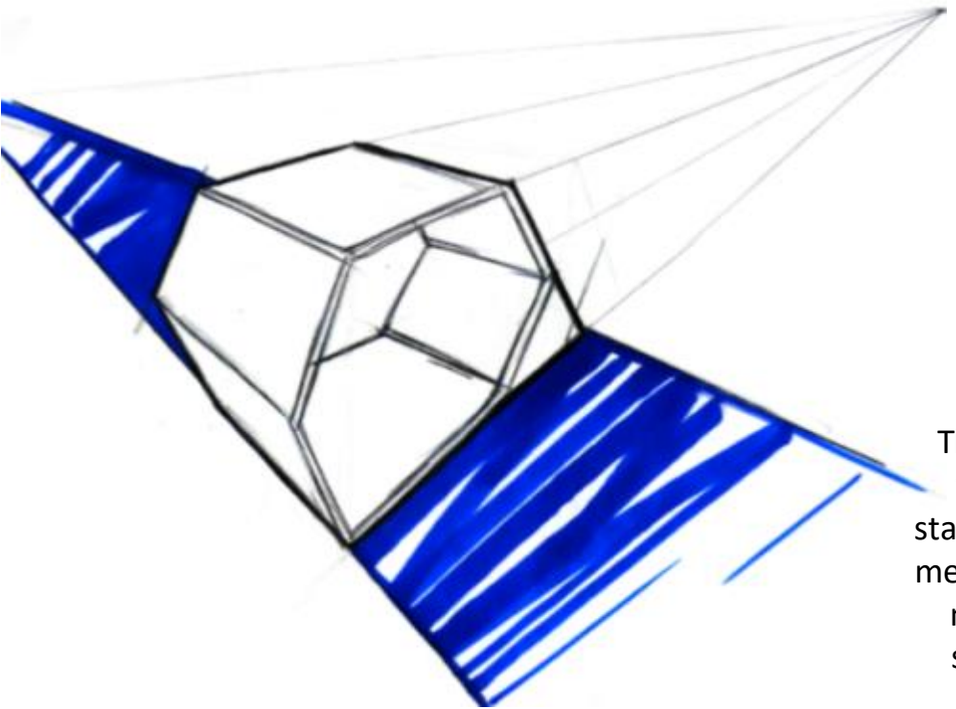




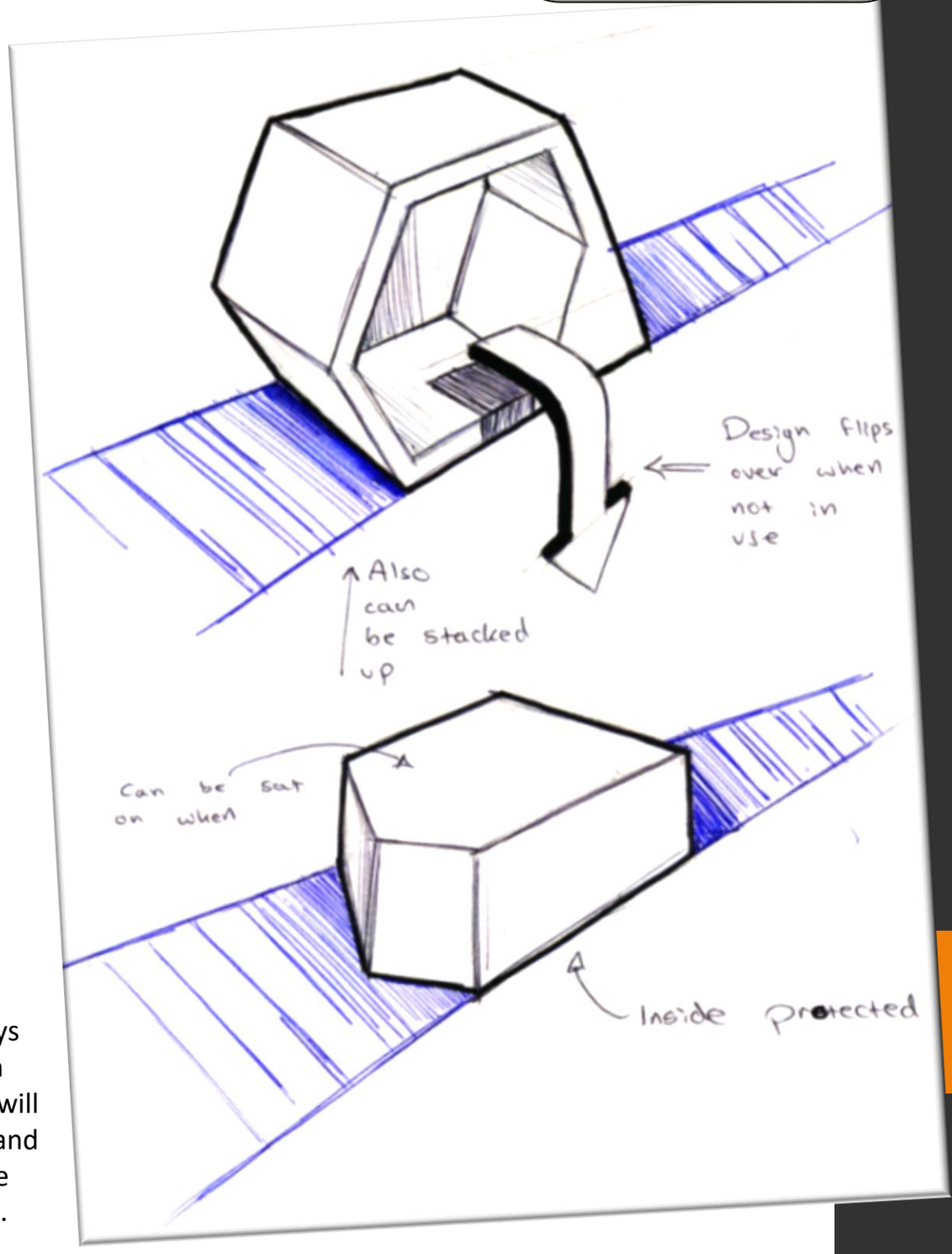


A key part of my specification was to minimise material. This is because it can lead onto further problems involving cost, weight and aesthetics. By removing the hatch idea I have eliminated many of the problems encountered previously. Items stored in the product would be garden items such as plant pots or shovels for example. These would most likely be decorative and would not be affected by rain water.

This idea was preferred by my client for a few reasons. He said the items stored would be easier to access which would make it easier for the older generation. Minimising the material is also always going to be a positive wherever I can do so.
One of the negatives that was pointed out was the weight distribution. As there is a side missing, the back will be heavier and could be unstable. This could therefore have a knock on effect on the safety of the product.



The sketches represent the ways the product can be used, both standing up and on its side. This will mean more seating possibilities and make it easy for the units to be stacked on top of one another.

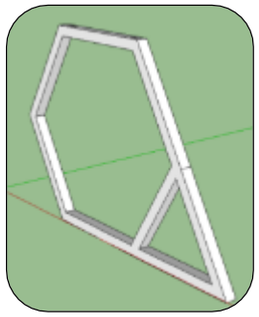


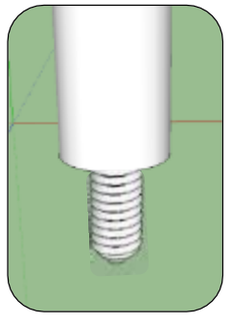
Design and Development

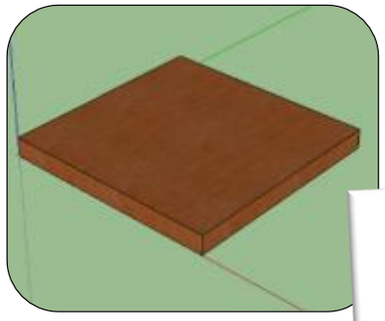
MATERIALS

Mild Steel- I chose this metal because it is very strong while still being malleable. It is easy to work with so I will be able to get a better shape and make it look better aesthetically. It needs to be strong so it can withstand multiple people sitting on each frame. The tube it comes in is hollow too, making it very light and perfect for a design like mine.
I will add a powder coating to the metal to give it an extra finish and also make it weather proof. This means it will not rust and become weaker.

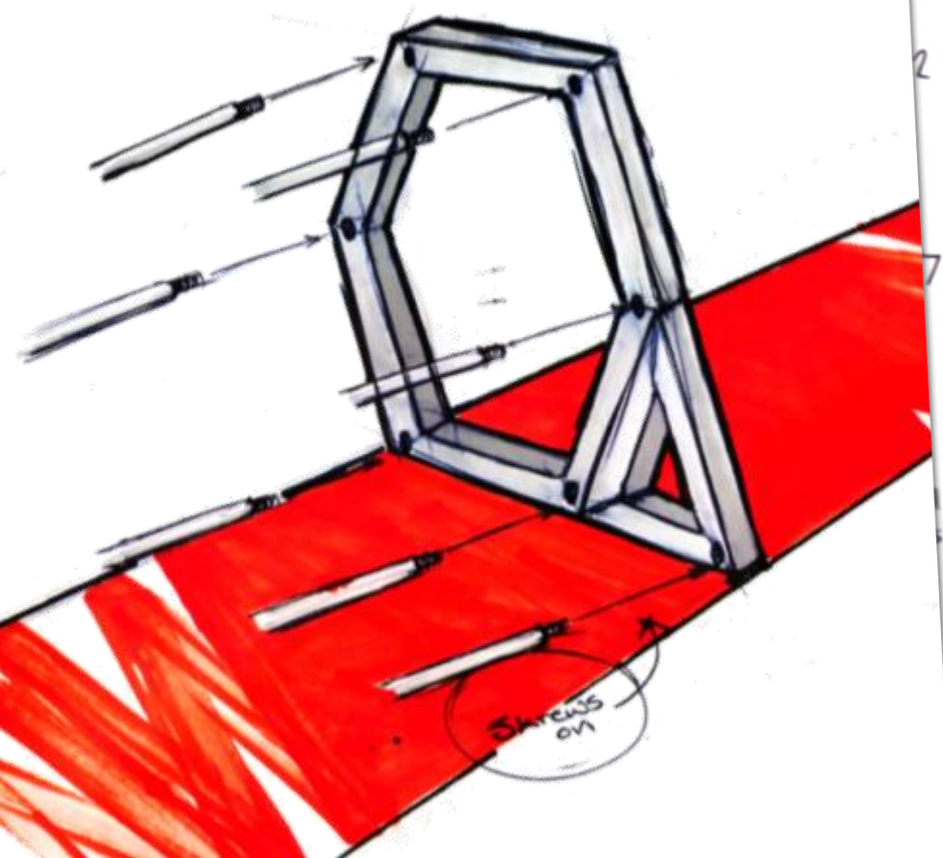
Marine Plywood- This wood is made to be weather proof so it will remain the same aesthetically and not get damaged by water. Also because the pieces of wood in this design are removable, they could easily be replaced if they were to get damaged.

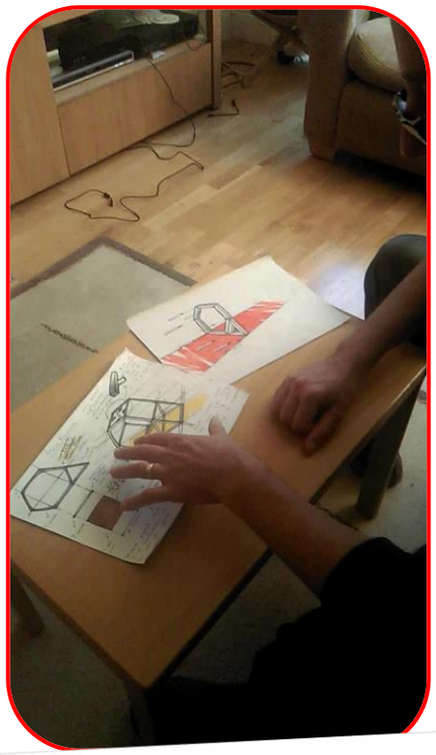






The whole product (can be flat packed when delivered) can be put together by the customer. This will save packaging material and cost making it more convenient.

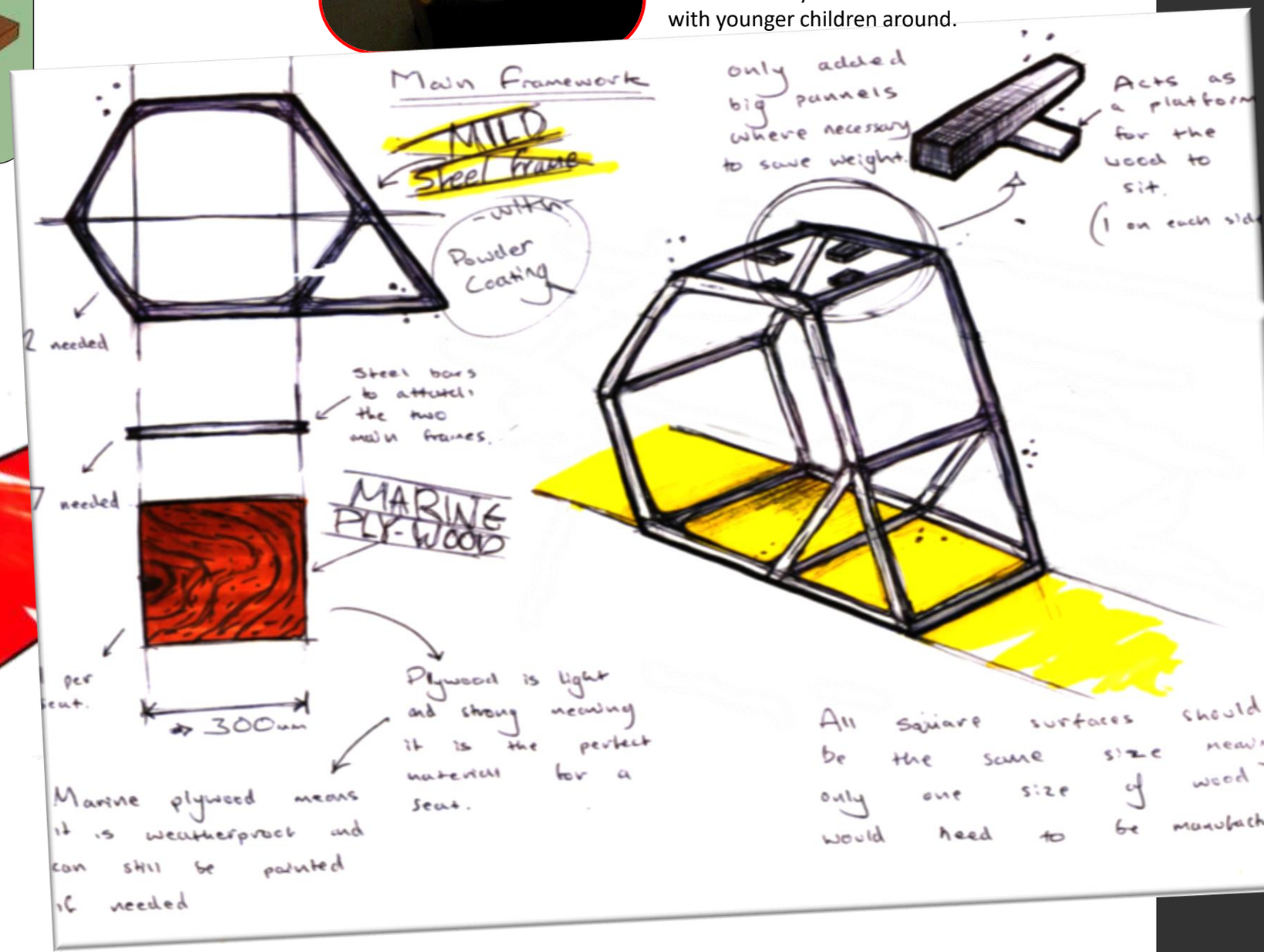




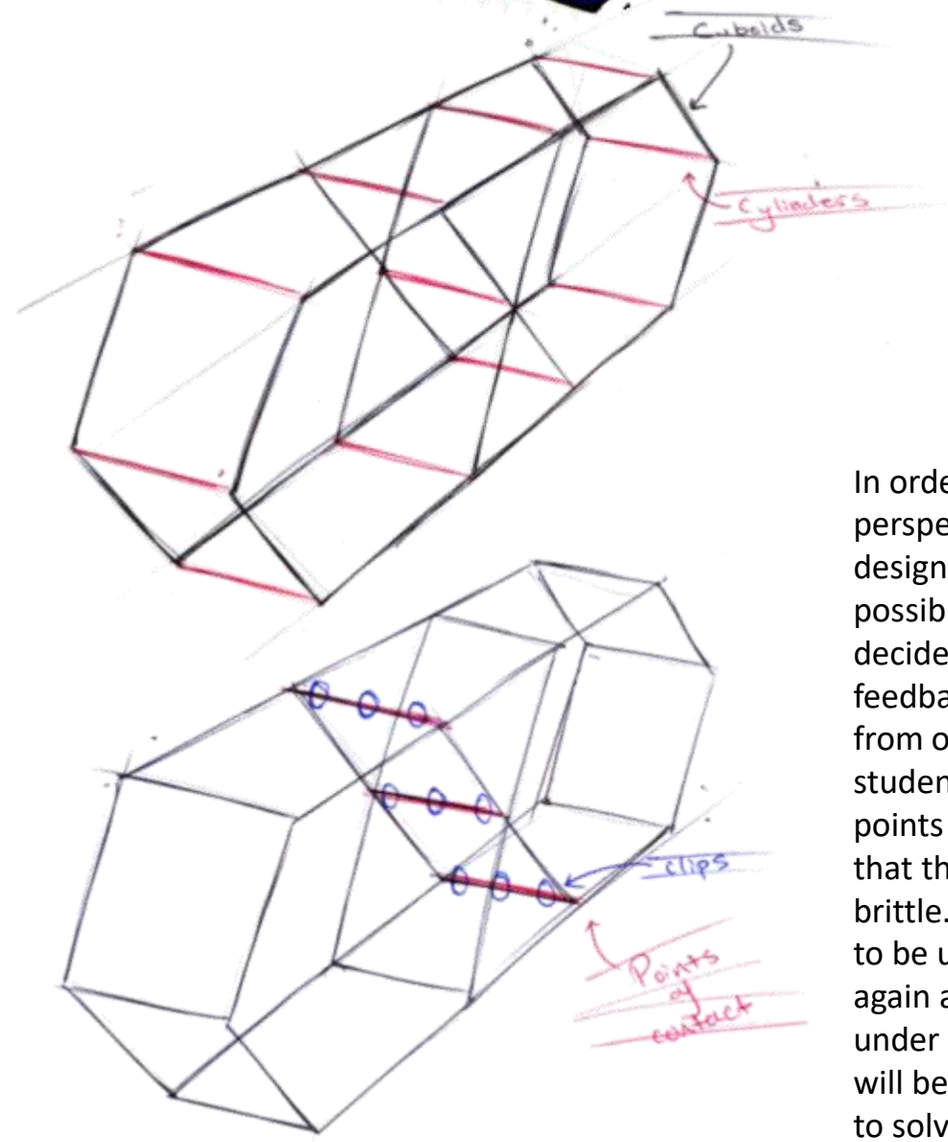
To prevent a bulky look and unnecessary material use I have dispensed with of the panels all together.
This creates a platform for my wooden planks to sit on and the product will still meet all of the specification points listed.

My client much preferred this design saying it was more elegant. He pointed out it would also be much easier to manufacture as it is a simpler concept and will appeal to a larger market.

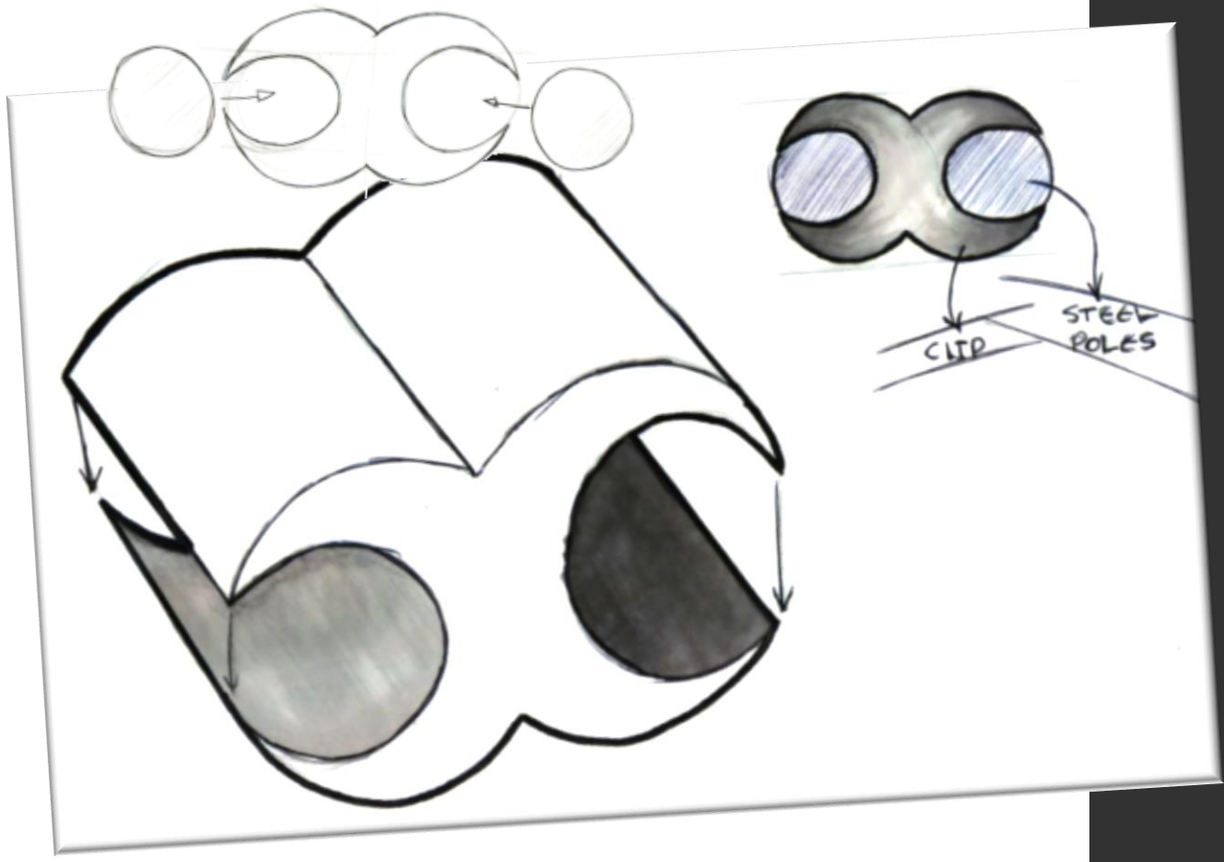
My client did however point out a fault with the screwing mechanism. This is because when I skew the beams into one panel the other would not be able to attach. He also said the platform I designed for the wood to sit on could be easily bent and could also be unsafe with younger children around.



Design and Development

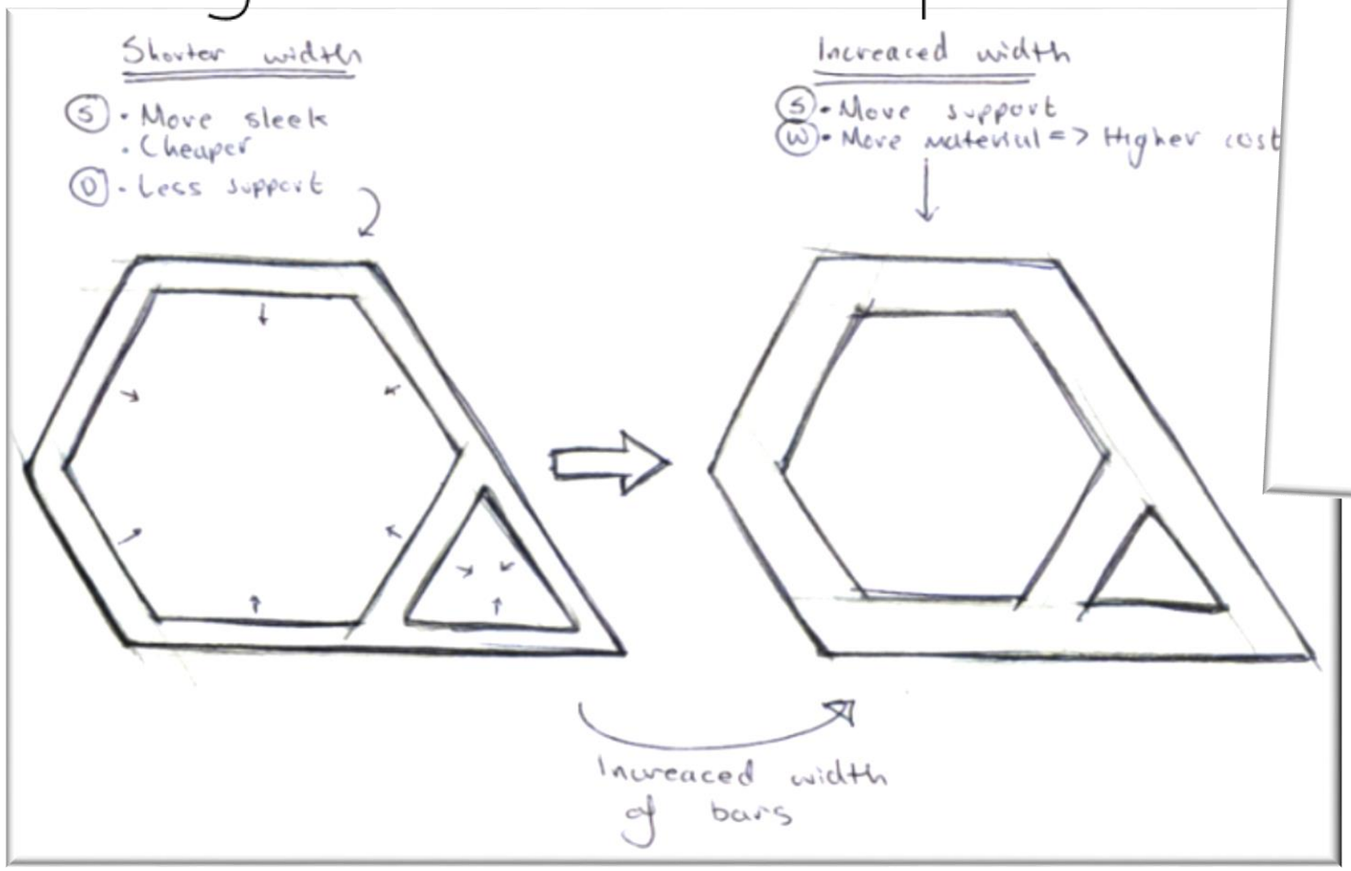


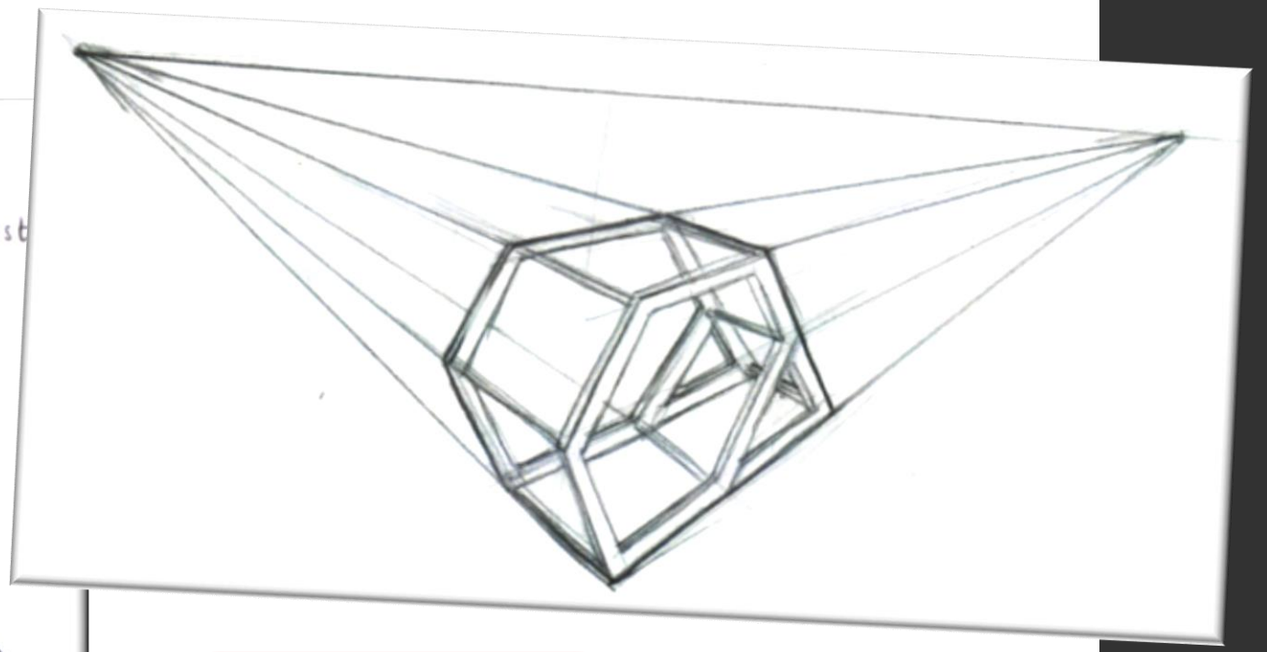
I had to find a different way of connecting the two structures together now that I have lost the faces from the design. This means that I can no longer use the locking mechanism I designed before.
The design I came up with is a plastic clip that is pushed onto the cylindrical bars on the modules. The clip, as seen on the left, has two sockets for two different bars, one clicking in either side.

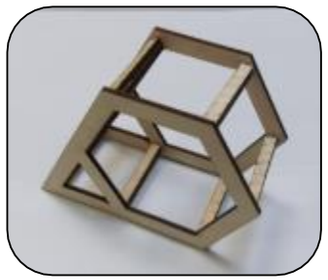


In order to get another perspective into my design and uncover possible problems, I decided to get some feedback on the clips from other design students. One of the points highlighted was that the tips could be too brittle. As they are going to be used time and time again and probably put under a lot of stress, it will be a problem I need to solve.

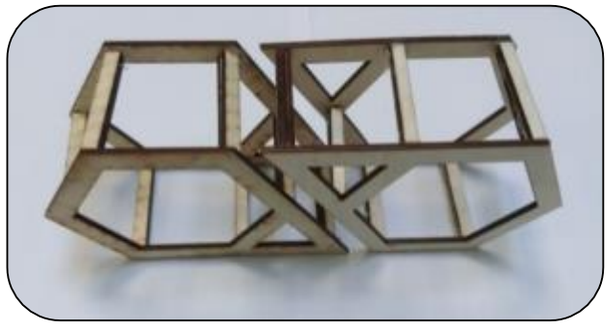
Design and Development

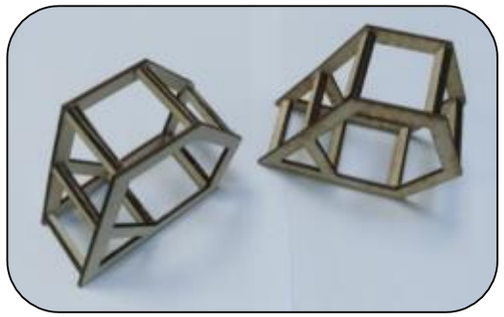


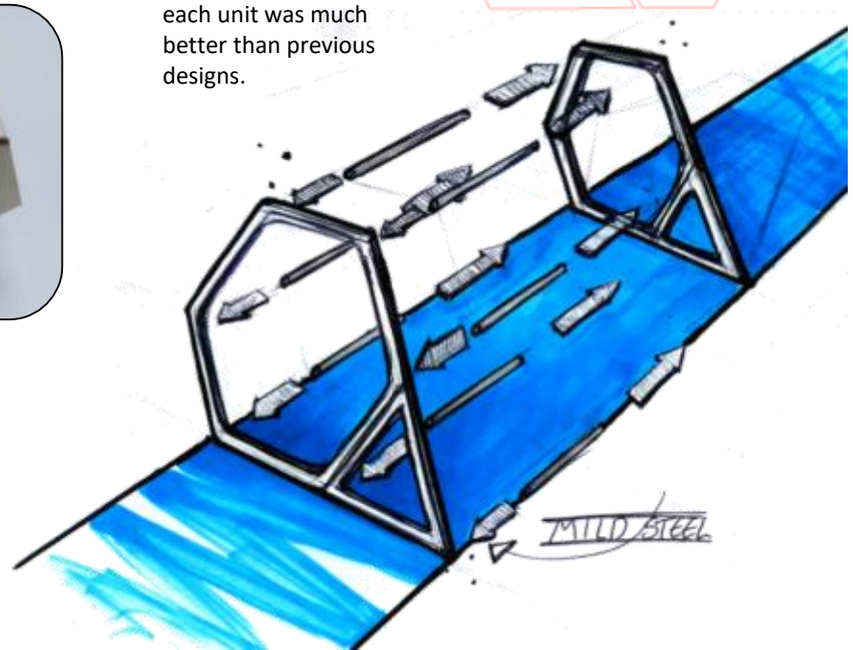




These models are all made on the laser cutter. The red outline is the template I designed for the model on 2D design. This was then laser cut onto plywood and I built the prototypes.
I found the stability of each unit was much better than previous designs.



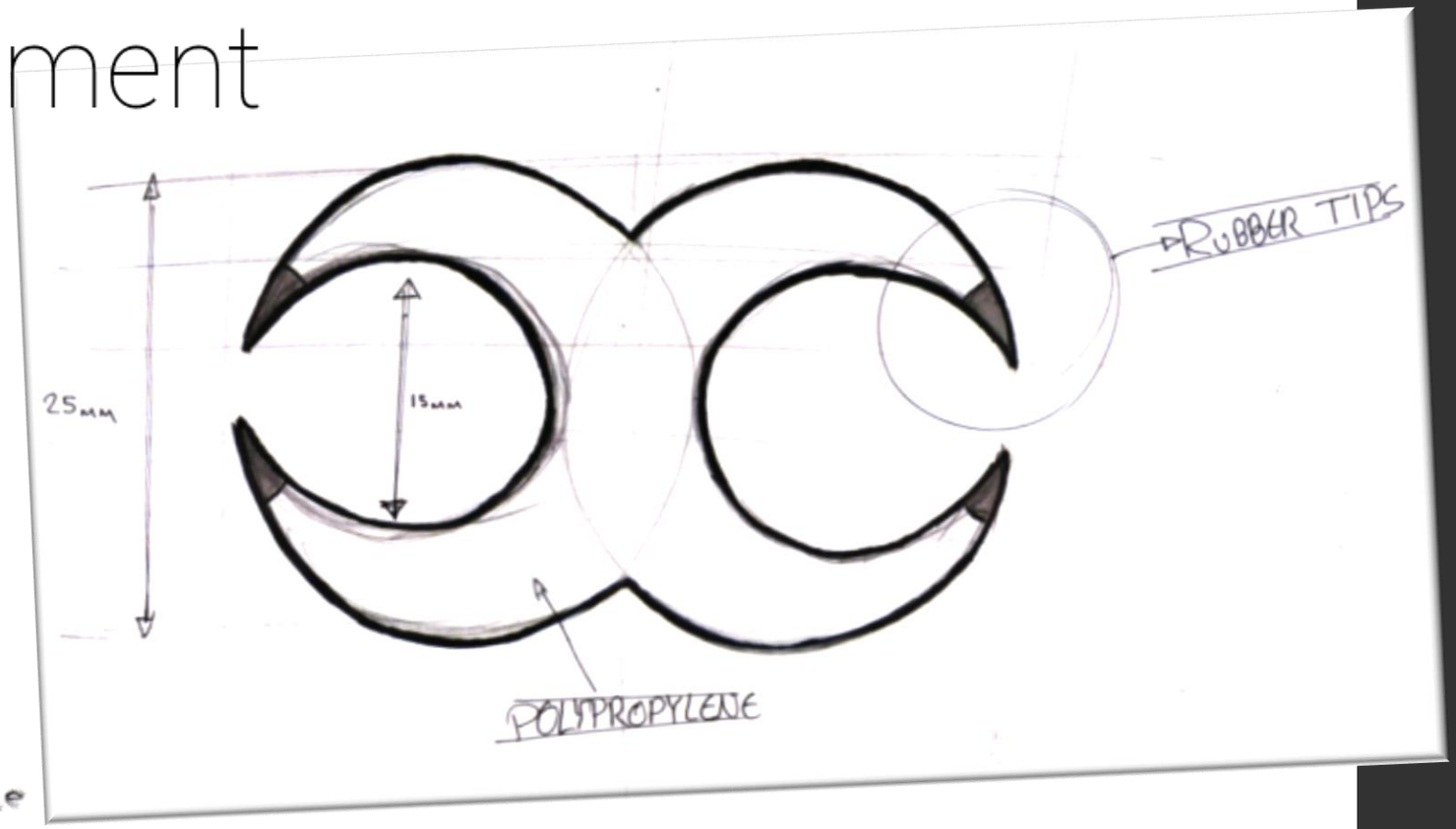


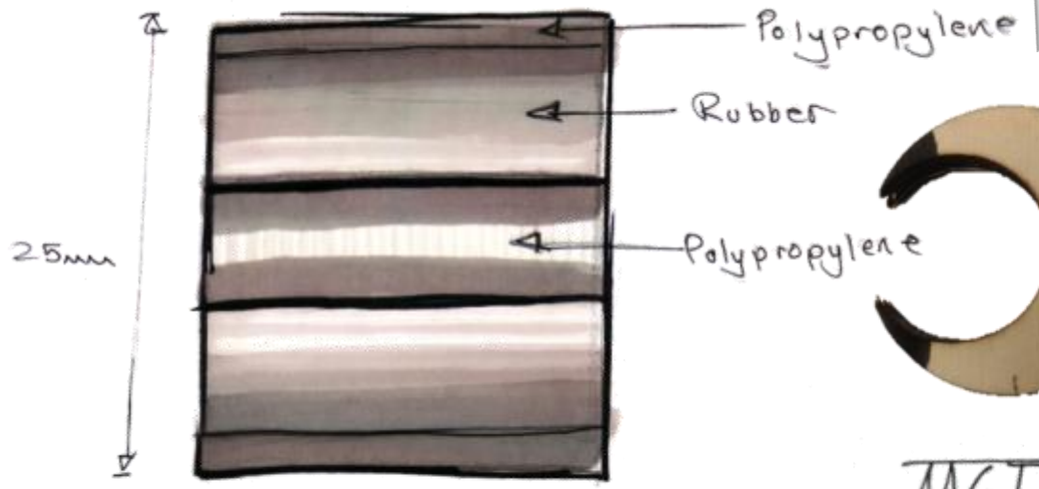


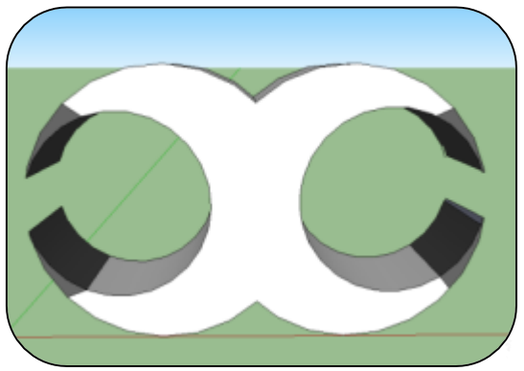
My client liked what I did with the width of the beams as it provides extra strength and durability. This does however make the product less aesthetically pleasing so when I come to making it and using real materials I can test the strength of the beams to see what width would work for both strength and appearance.
The powder coating was agreed to be a good idea as it will make the product weather proof.

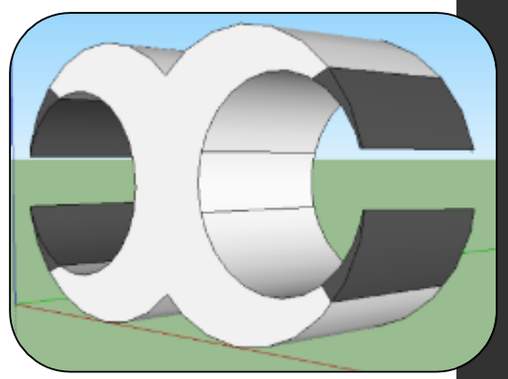
Design and Development

In my previous clip design, my client liked the idea of the shape being ergonomic to the bars of my main product. I have therefore kept this shape when developing my clip. Also doing this will maintain the use of little material. This will keep costs low and make it easier and cheaper to manufacture.
The main negative aspect I needed to act on from the original clip was the fact that the tips of the clip could be quite brittle and could possibly snap off. Instead of changing the material of the whole design I improved the tips so this problem could be avoided. I kept the plastic as polypropylene as it is flexible enough to bend slightly in order to let the bars slot in. So this plastic combined with the rubber tips should avoid any problems.

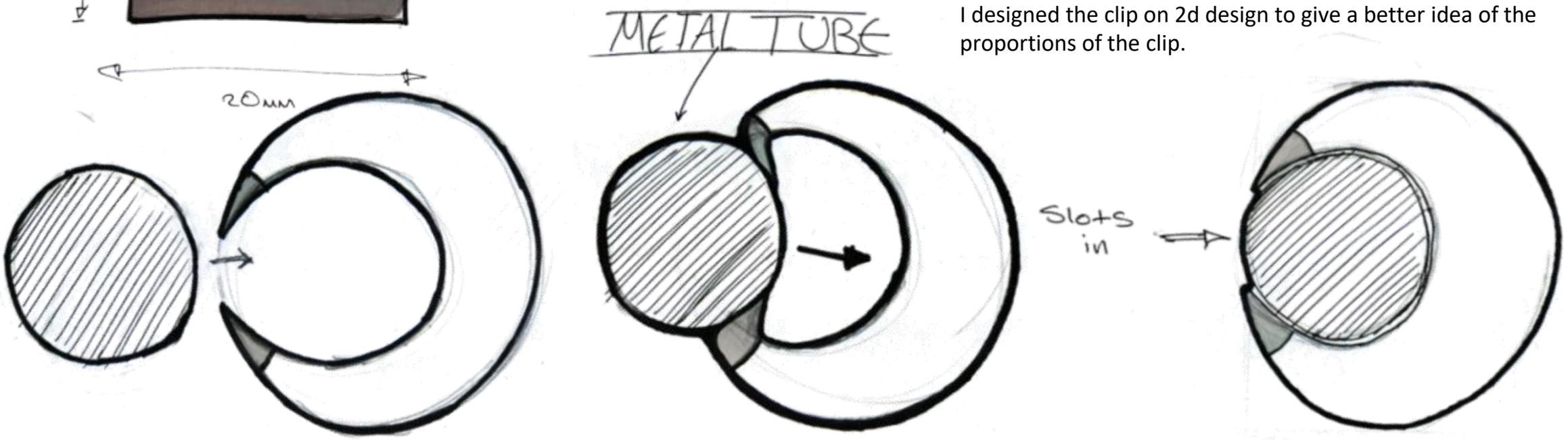








I designed the clip on 2d design to give a better idea of the proportions of the clip.

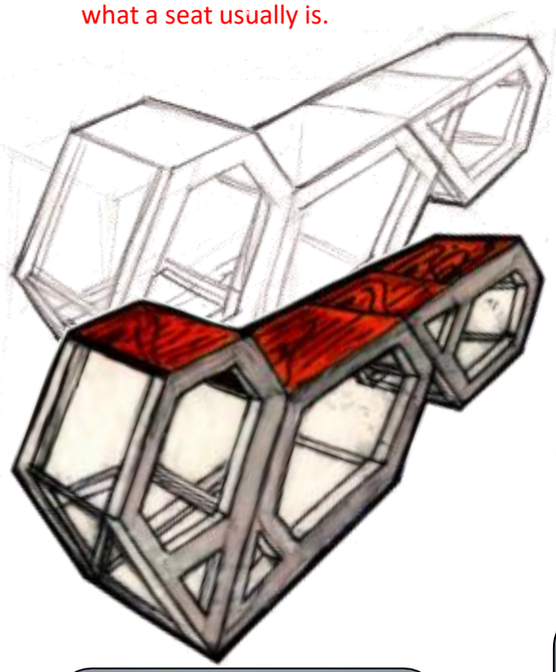


Design and Development

For my completed product I have tried to meet all specification points considering feedback from my clients.

RED-POINTS I NEED TO ADDRESS AND TAKE INTO ACCOUNT

- Difficulty of advertisement (has to suit a large market)
- Modern look may have a limiting effect on the market.
- I need to be sensible with costs and be aware of competitors.
- The materials could be limited
- Balance of ergonomics and appearance
- Cost of adding safety elements
- I have to keep the design from looking too bulky meaning finding a strong shape or structure.
- I have to make the size realistic to what a seat usually is.



The spec points on the left are taken from my specification as they were the main points I needed to consider while designing my product.
The first point is about advertisement. I believe I met this as my product has no specific colour so it can appeal to all ages and genders which of course makes it easier to advertise. Also this factor combined with the hexagonal shape allows it to fit in with the current trends.

Cost was a big issue at the start of the project but I have adapted my design to use less material and make it easier to manufacture resulting in a cheaper product.

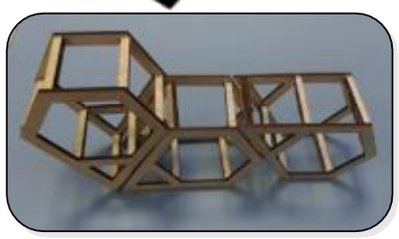
The balance of ergonomics and appearance was all about how thick the bars were which I discussed in a separate slide.

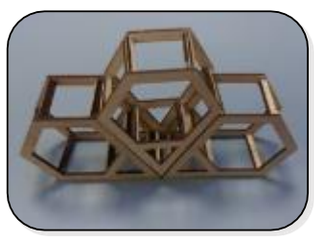
I had to find a balance between strength and appearance and I have settled with 25mm cuboid bars for the main frame. They will be made out of mild steel so I get as much strength as I can.

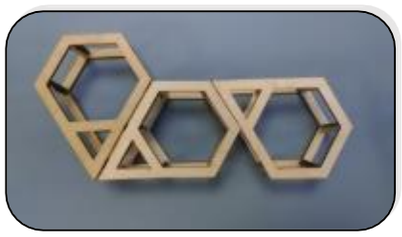
The weight of the product will ensure it stays firmly in place and cannot be knocked over. This makes it much safer for children.

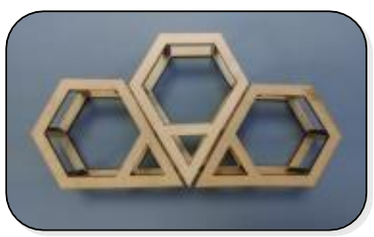
The wooden slab combined with the two cylinder widths will be 400mm^2 as it is a good size for a seat whilst still keeping the amount of material low.

The seat will not be flat packed as it is all metal and I cant design it to screw together.









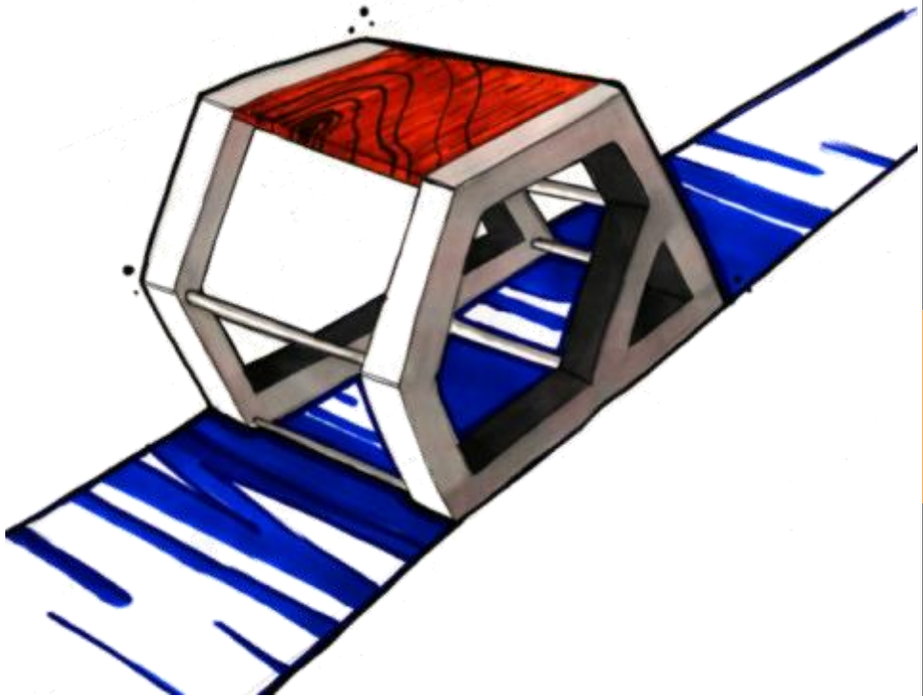
For my final design page I got both my client and other design students to give me video feedback on the good aspects of my design and any further developments they had for it. I also went to a garden centre called Root One where I got feedback from their manager who happened to be a former chair designer.

My client loved the final design saying it looked naturally right and was very versatile.

When I asked other design students about what they thought of it they said that they loved the minimal use of material and how secure the product was as a unit. I did get suggestions that I should use the product as a shelving unit as well as a bench. This could be done by slotting wooden planks over the metal bars to create the required structure. This would be a lot simpler to the original method.

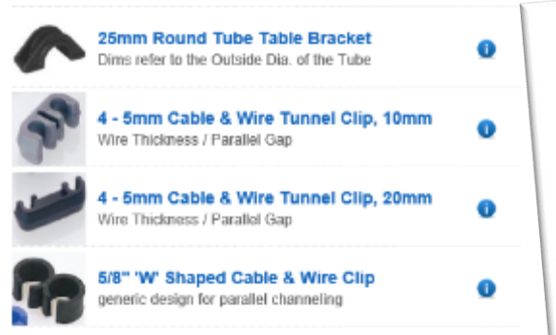
The manager at the garden centre loved the modular design and how the product looks as a whole. He said it was original and that there was a definite place in the market for such a product.

As a former designer he suggested a table that could go down the middle to link two units together.

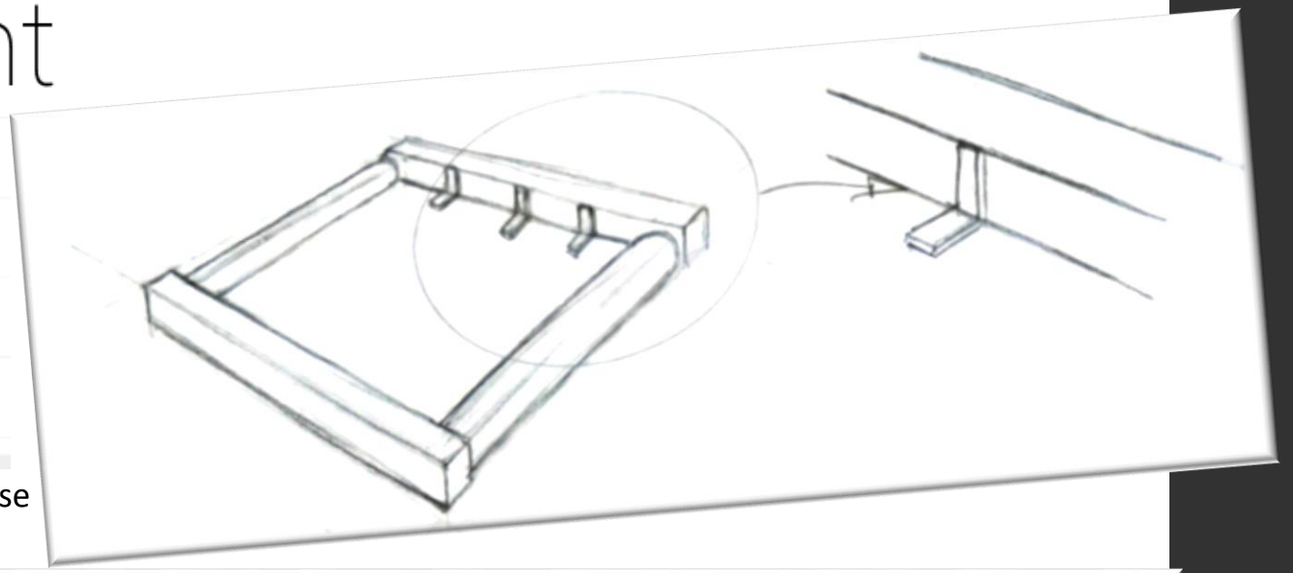


Design and Development

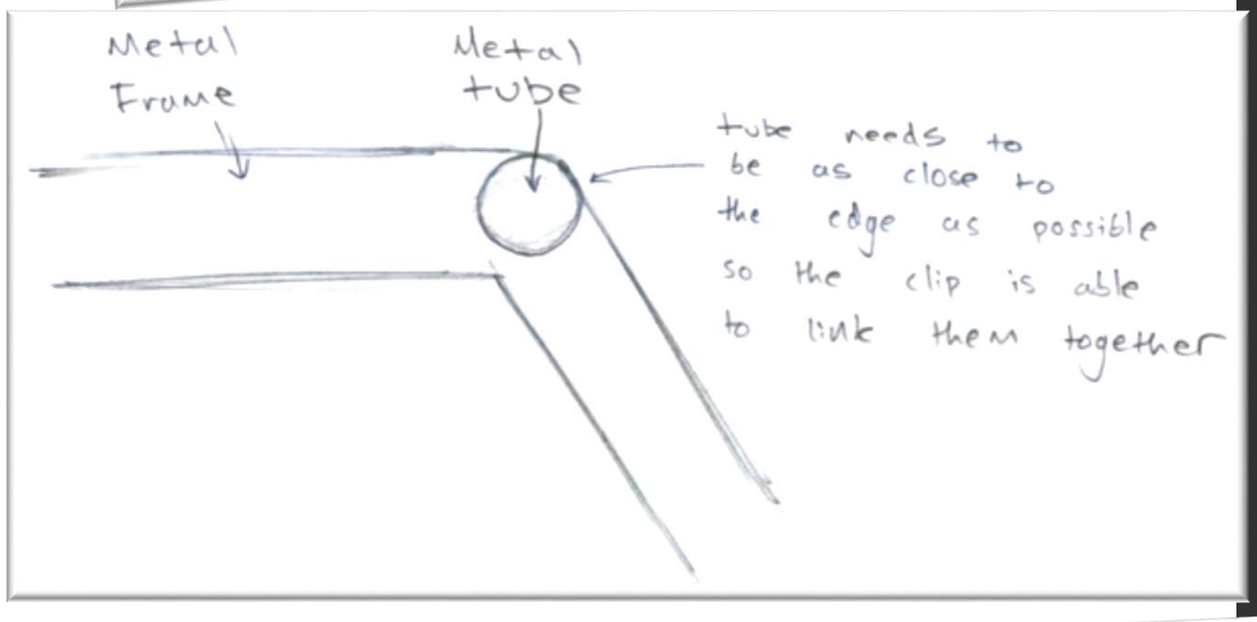
After researching connecting mechanisms I came across bar connectors that I could easily use for my design.
I also found chair clips, used to prevent chairs from sliding around on floors. These have very similar characteristics to my clips so I could adapt them and use them in my final design. This will also save me having to make a brand new clip for the design.



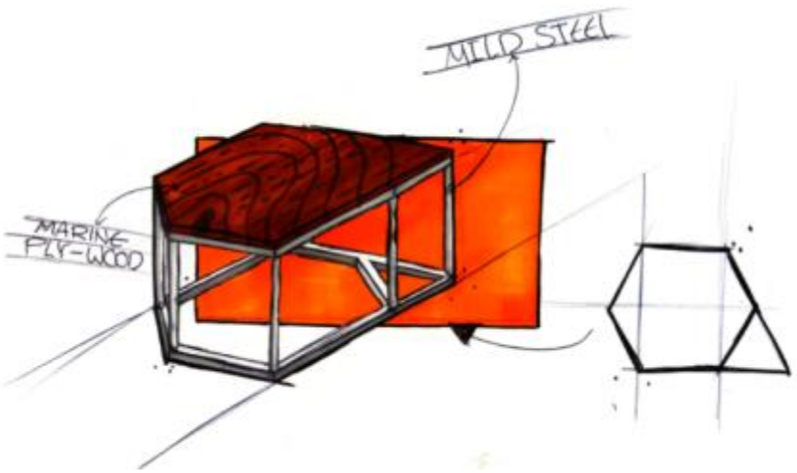
Lots of alternatives for clips I could use

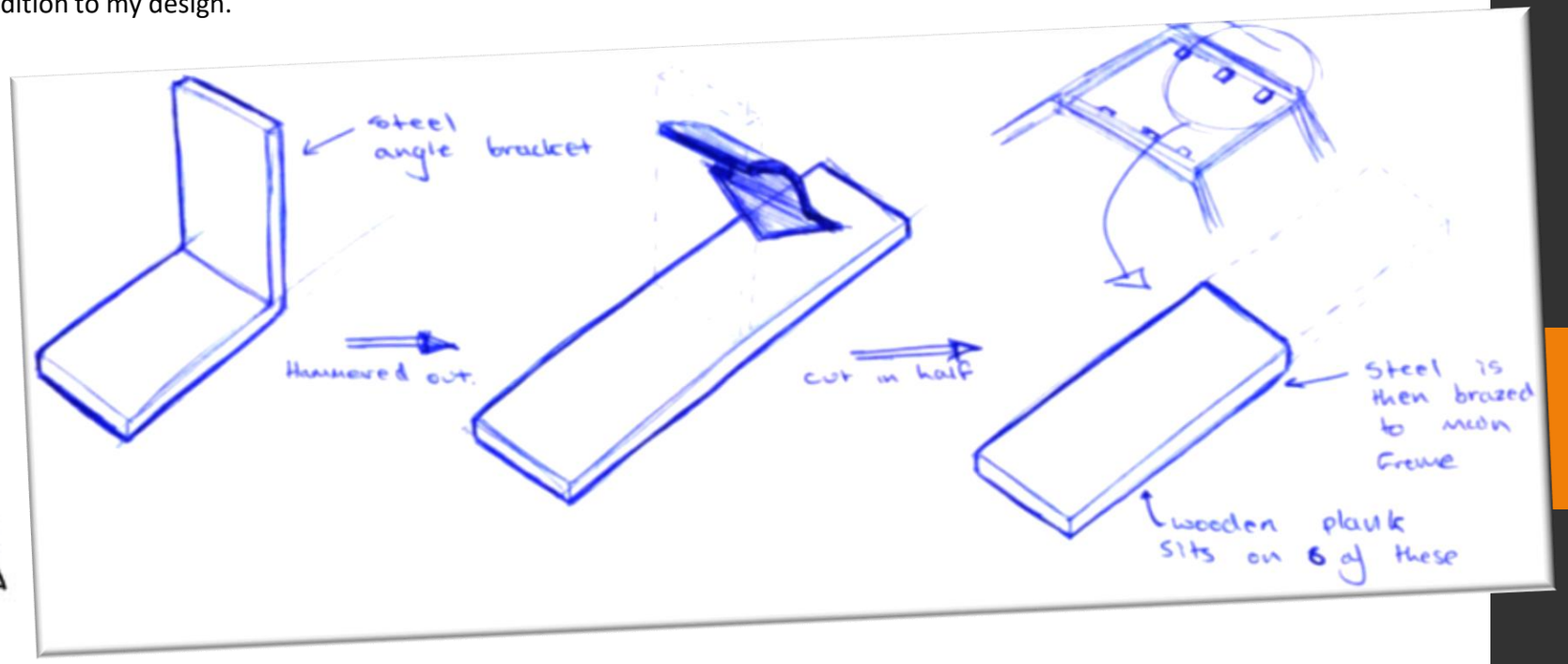


The chair clips come as separate forms but if I stuck two together back to back it replicates my clip design. The design also has a plastic pin that slots into the metal tube. This means the clip remains secure which would be a great addition to my design.



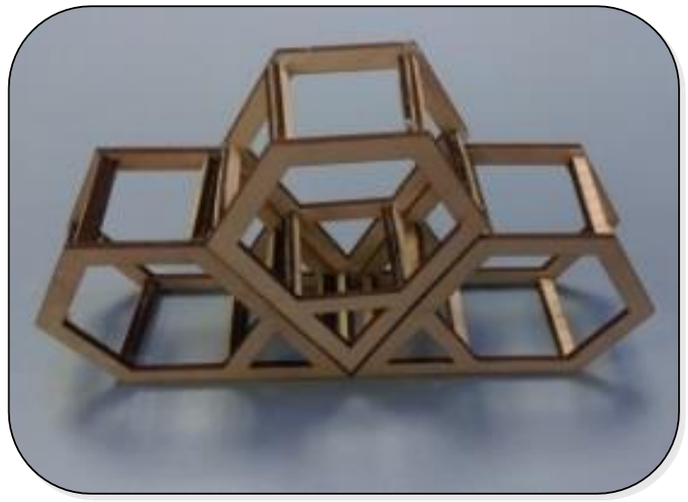
I could design different shaped wooden planks and the design could be turned on its side and used as a table





Plan of Making

Before starting any of the making process, I created prototypes of my model on 2D design to get a better understanding of the appearance of the real product. Once this was created I could then see what the strengths and weaknesses were aesthetically and structurally allowing me to improve the design.



= QUALITY CHECKS

Week 1

STAGE 1
Create a 2D design drawing of the actual size of my product. This will act as a plan to look back whist making my product to remember sizes and measurements.

Making sure all angles and sizes are identicle.

STAGE 2
Cut all metal beams for the hexagon end panels to size with a circular saw. I will need 24 in total for the 4 hexagon sides.

STAGE 3
Build wooden jig for the end panels so that all 4 units are identical when brazed together.

This will ensure the jig is not burnt when brazing

I will use the jig for tacking and then braze when the metal is out of the jig.

STAGE 4
Braze together the 4 end panels using the jig I had made in stage 3.

Week 2

I may need more than one jig for differeat corners of the panels.

STAGE 5
Similar to stage 2, I will need to cut all 14 of the cylindrical horizontal bars that will hold the end panels together. I can refer back to stage 1 for measurements when doing this to ensure all 14 are cut correctly and are identical

STAGE 6
Create a small wooden jig for my horizontal bars. This is so all the beams are in exactly the same place on each corner

Wooden jig needs to be glued properly so blocks stay put.

STAGE 7
Brazing the bars onto the first end panel. This should be simple enough and I should end up with 2 hexagonal faces, each with 7 bars attached

Making sure all bars are straight using a spirit level

STAGE 8
The other 2 end panels will then be connected to the two previous structures. I will need to use the jig formed in stage 6 in the same way as before so the bars are all brazed in exactly the right place

Week 3

STAGE 9
Cut all the wooden planks needed for the two units referring back to stage 1 for measurements.

STAGE 10
Using angle brackets, cut 36 small metal supports for my wood to rest on using a hand held metal saw

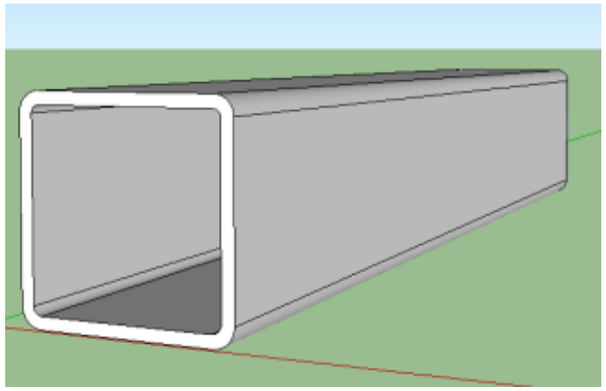
STAGE 11
Braise each individual support onto the required surfaces on my two units.

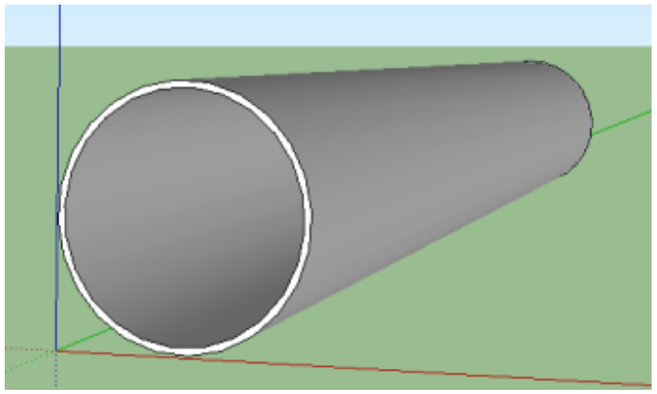
Making sure all supports are horizontal so the wood will not slip off.

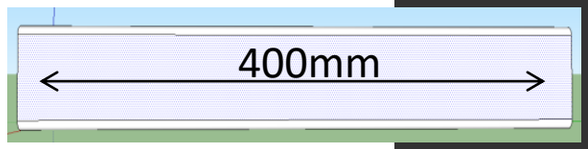
STAGE 12
After both metal units are fully brazed, I will use an angle grinder over the whole thing to ensure every surface is smooth and ready for powder coating. Similarly with the wood, I will file and varnish for finish

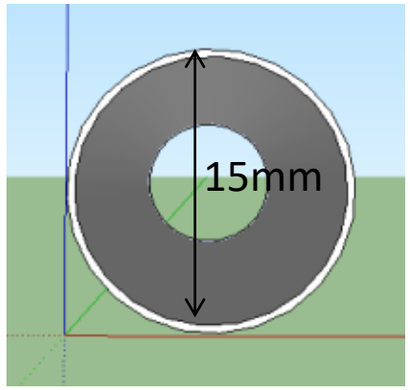
These 12 stages are all I can do before I send it off to be powder coated. I set my self 3 weeks to complete all 12 however this isn't taking into account possible problems I may encounter

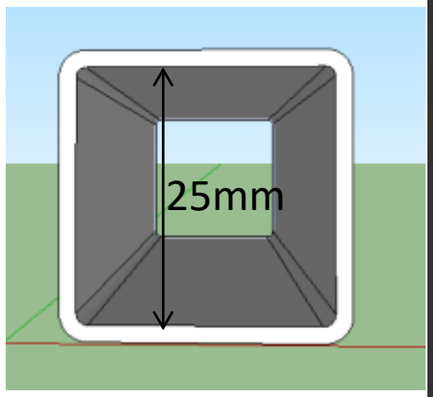
Design and Development - Making

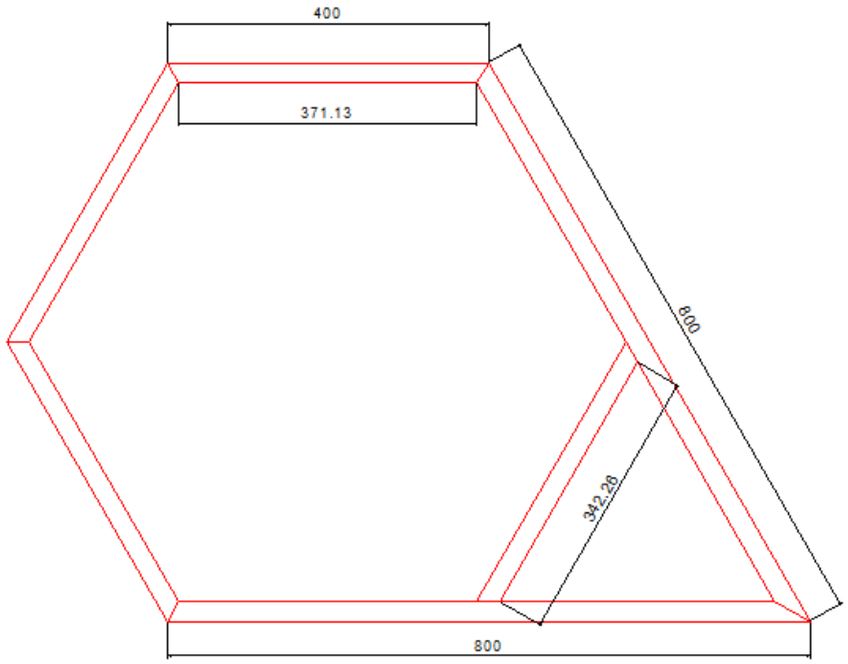


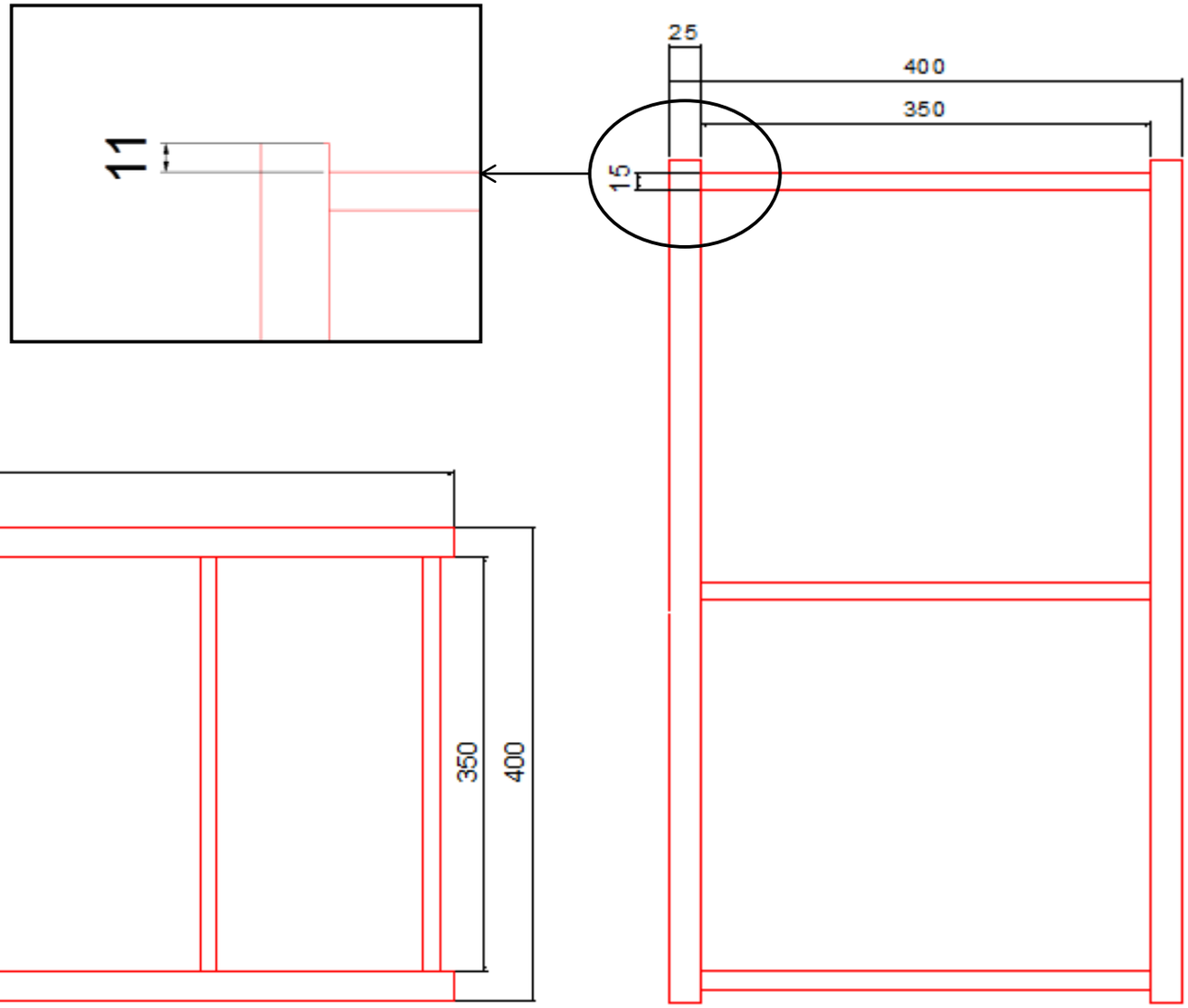


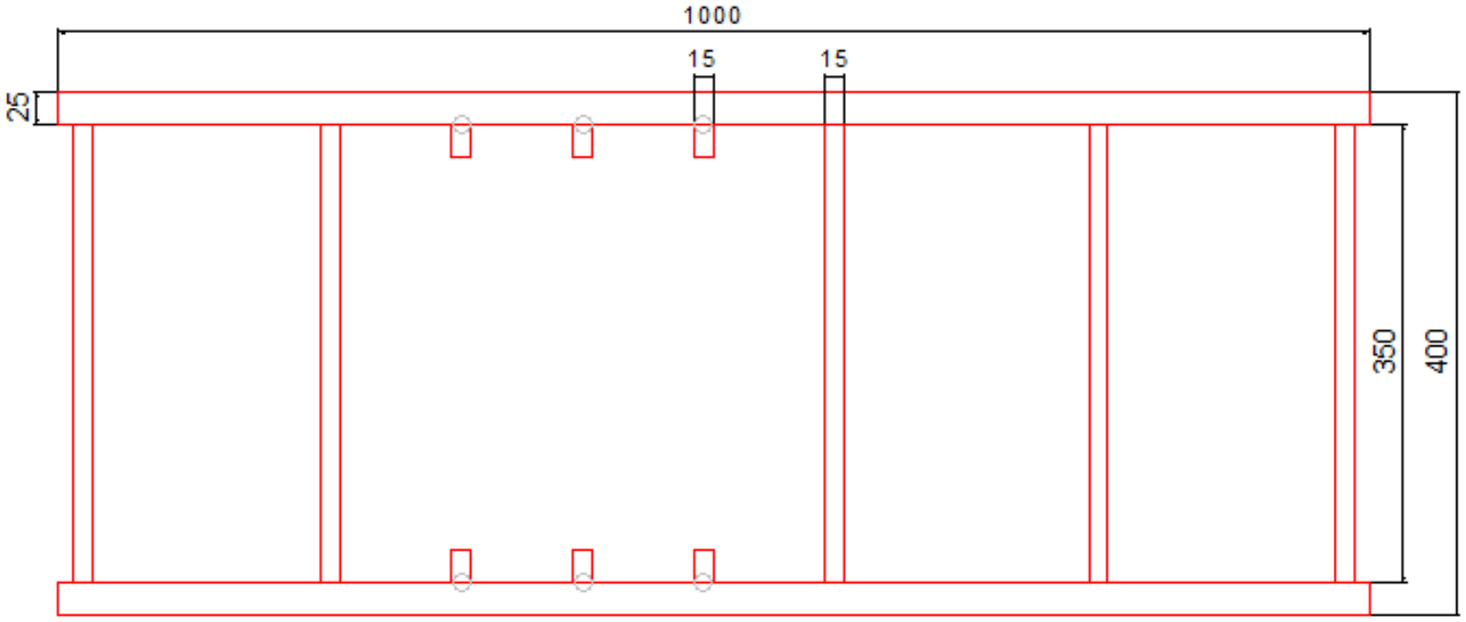






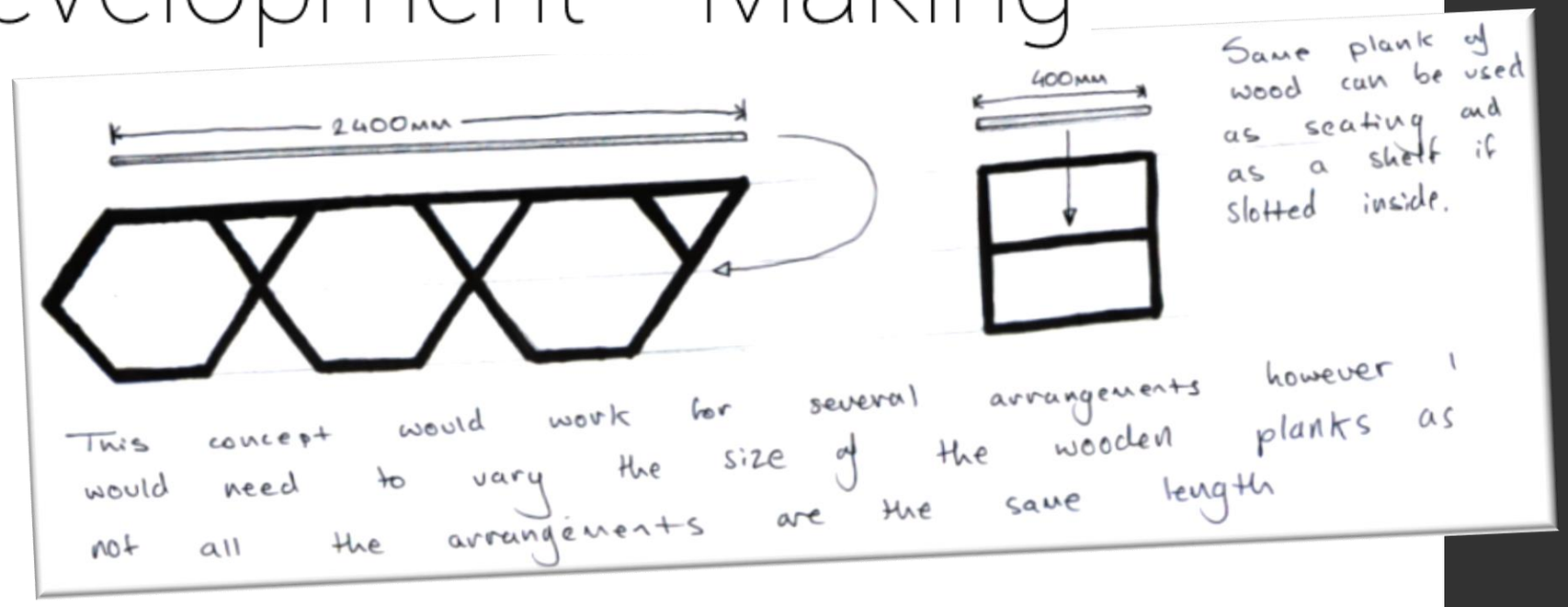




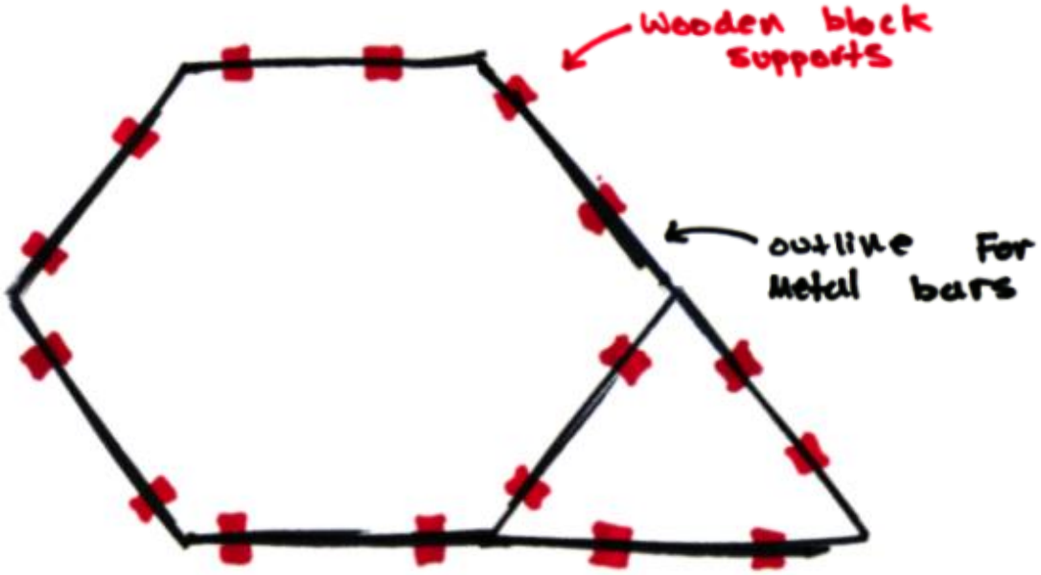


Design and Development - Making

In the end part of this video, one of the other design students suggests that I could have a plank of wood that can be used on top as a bench or slid in the middle of the product to create a shelving unit. This would mean It could have another function and could be used indoors.



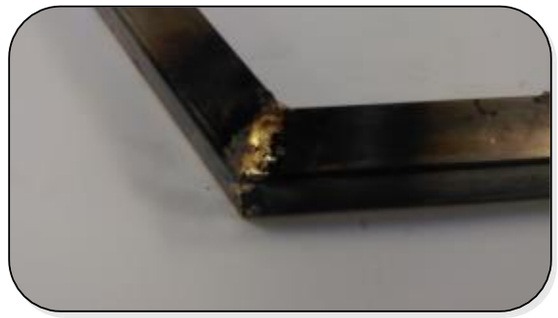
In order to make my product in reality, I will first make a wooden jig to support and map out my hexagon/triangle frame. To do this I will map out the exact shape I will need the metal to go in on the wood and glue blocks of wood on either side of the drawn frame. I can then place my metal frame in this and tack it together using brazing. Making a jig like this allows me to reuse it time and time again to get identical frames for my product.

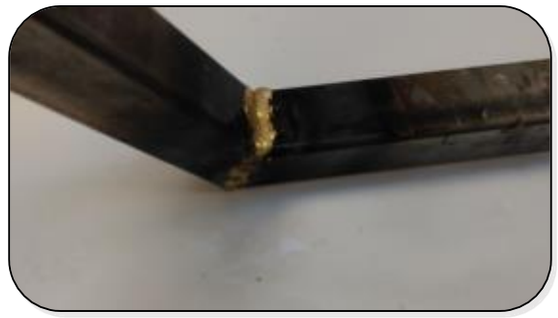


After I have made the jig, I will use a chop saw to cut out each individual metal support to match the measurements of the jig. I can then place all the metal components into the jig and tack them together. This means brazing them just a little between each connection so the whole structure holds together.

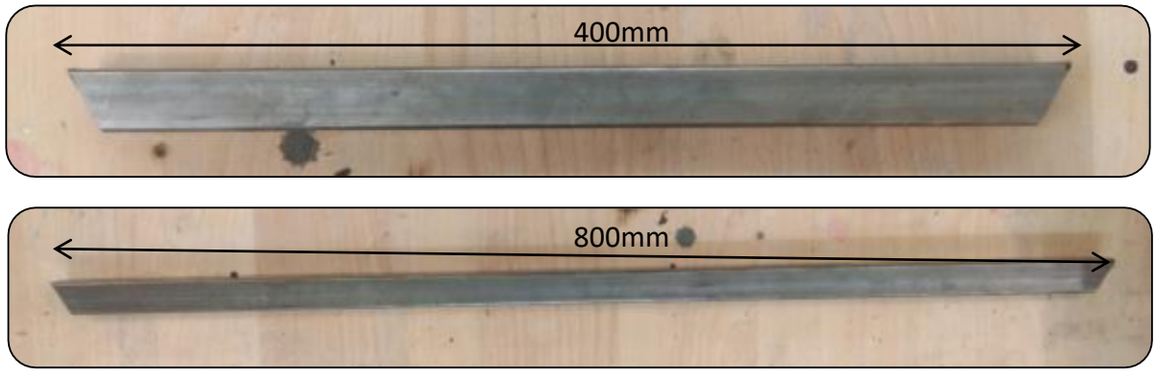
Once I have done this, I can then braze the whole structure, sealing any gaps that I might see. I can then repeat this until I have two main side pieces which I can then braze together with the cylindrical bars.

I did some practice at brazing before going onto the actual model. I have to make sure I seal all the gaps so water does not get in to the metal as it could rust and make it heavier too.



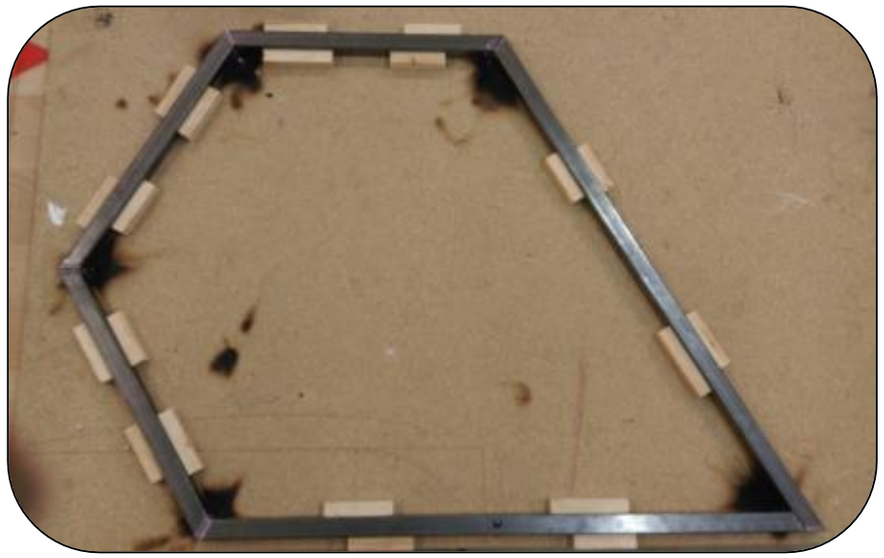


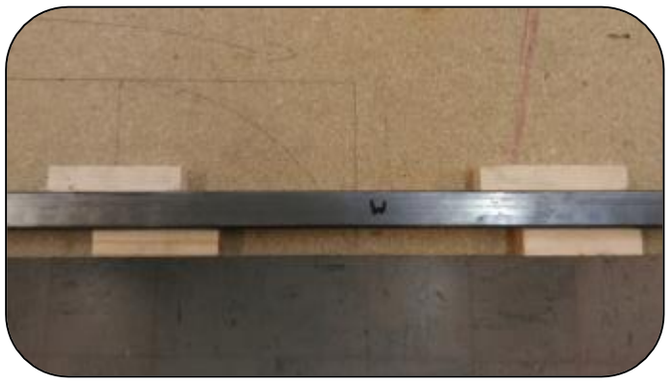
Design and Development - Making

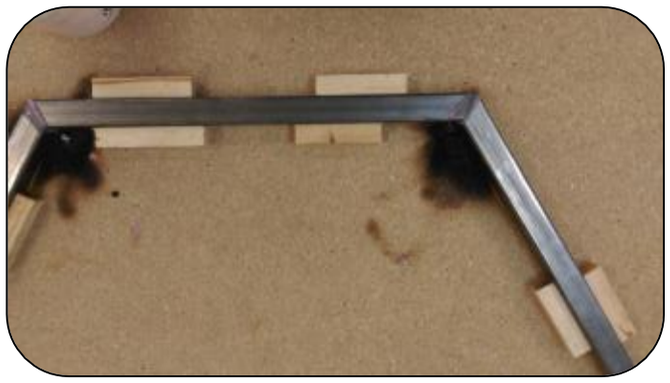


I used the circle saw to cut my metal, as it cuts to the perfect angle and length. If this were to be manufactured professionally then a similar method would be used but on a larger scale and in batches.

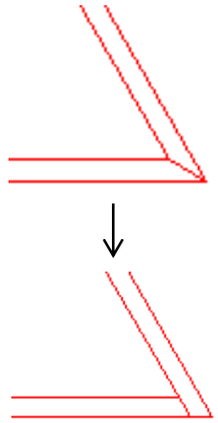
After cutting all of the metal, I assembled my jig, which I could then use for all of my frames. I lay out all of the metal in the arrangement I wanted, checking each of the angles for accuracy and then used glued wooden blocks to hold everything in place.





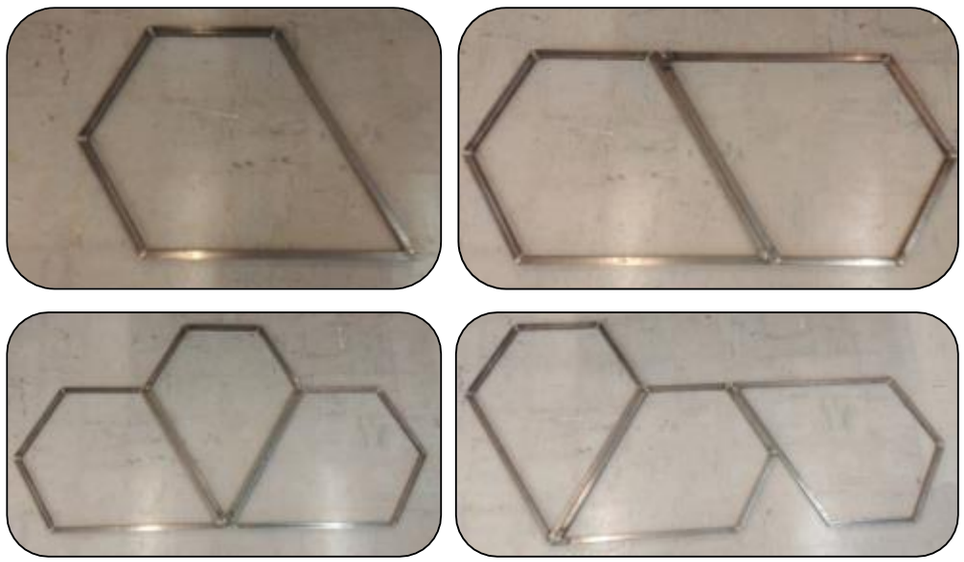


When all the metal was in place, I was able to tac the pieces together with a brazing rod. This is so I could then remove it from the jig in one piece. Once this was done, I could braise it all together. I didn't tac in the corner piece of metal as I can slot and braise that in after the frame is formed.

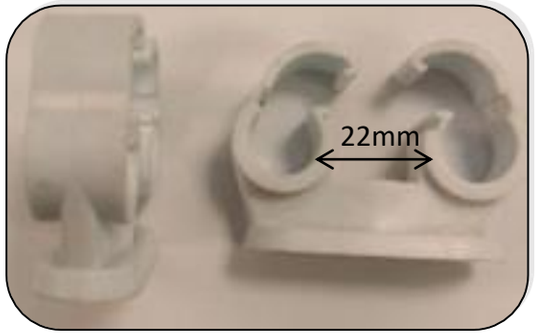


From my CAD drawings, I could get accurate measurements of the lengths I needed to make each of the pieces of metal. I cut each piece individually on a circle saw, which meant I could get the length and angle I needed. One problem I faced when doing this was the fact that the saw was not able to cut at a 30 degree angle. This was key for the sharp corner of my design, so Instead I made two different length pieces and cut them at a 60 degree angle as shown.

After I had brazed all 4 frames, I could lay them out to see exactly how big the arrangements would be once finished.

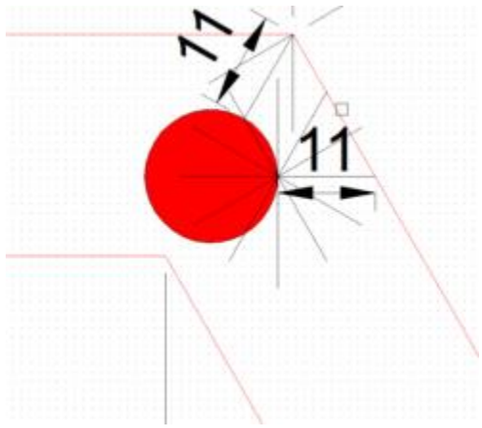


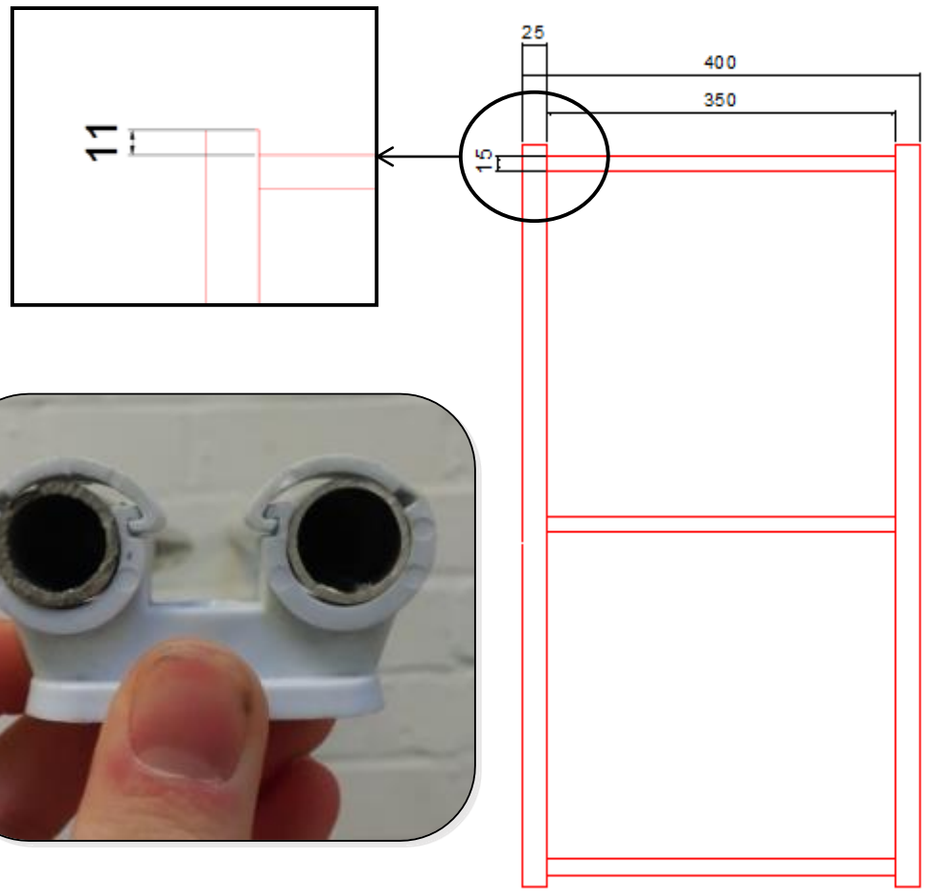
Design and Development – Making



The clip I have settled on using has two compartments to it, one for each bar. The gap between the two compartments is 22mm. Because I need my two units to sit flush with each other, I have to have a 22mm gap between the two cylindrical bars. This was a big problem and drawback in the making as I had to find the perfect position for the bars to fit the clips.

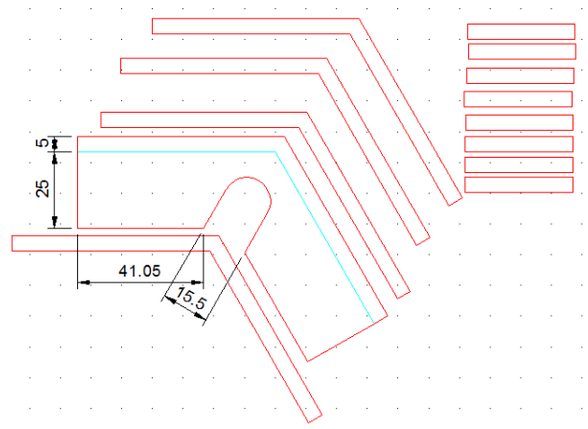
When trying to find the perfect position for my bars, I found out that because of the 120 degree angle of the corners of the hexagon, the distance from the corner to the bar (11mm) would be same as the edge to the bar if the bar was sat symmetrically on the frame as shown in the CAD drawing to the right.

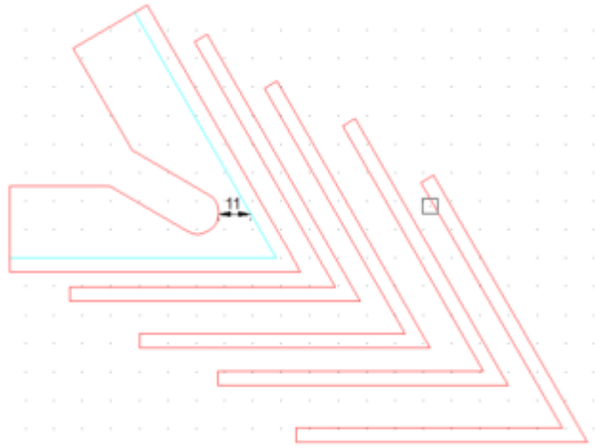




Having discovered where to put the bars I was able to design two corner jigs that would allow me to braise the bars on with perfect accuracy.
I had three corners that the jigs had to fit;

1. The regular 120 degree angle
2. The sharper 60 degree angle
3. The corner where the two bars meet



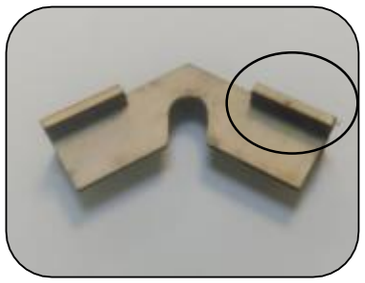


1. 

2. 

3. 

On the first image out of the three and also the two photos at the bottom left you can see the blocks of wood I added on either end. This meant I was able to turn the jig over and use it for the third corner I mentioned as seen in the third image

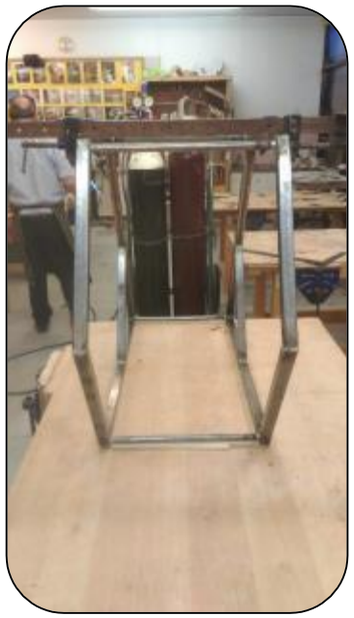


After making the jigs I was able to line up the poles in the right position before getting on to the next step of brazing them in.

Design and Development - Making

The next step was to braze in the horizontal bars between the two frames. I used my jig to map out where the bars would go and then used two magnetic spirit levels to get the bar perfectly vertical

I brazed 4 beams in each corner of the frame before I rested the other frame on top and lined it up with the angle jigs I had made before. I could then tack this into place to make a more stable structure.



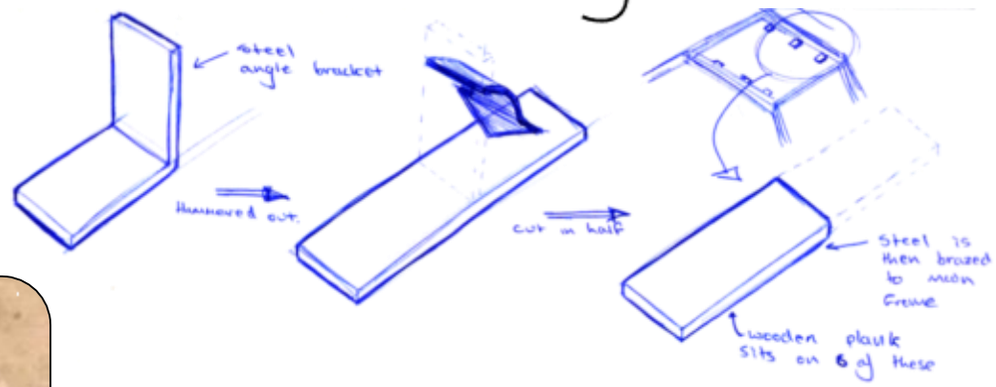
Once it was on its base, I could use clamps to push the two frames together and get rid of any gaps that were there.

To get the last beams in the gaps left between the frames I cut strips of wood 11mm in height to rest the beams on and this, combined with my jigs, meant I could get them in the perfect position to then braze them in.

After I had all my frames tacked together I then went round every corner and edge and brazed any areas that would let water into the frame. This is very important as the powder coating is only going on the outside so if water goes in the middle it will rust away and become weak. It will also add to the weight as the water will be trapped inside.

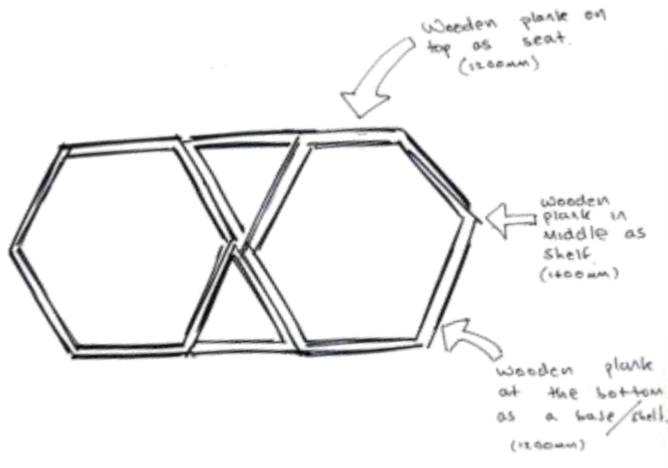
Design and Development - Making

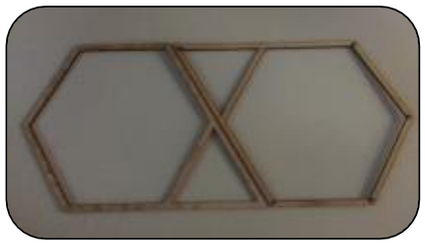
I followed the guide on the right that I drew to get the ledge for my wood. I needed 6 ledges on each square surface which meant I was to have 18 ledges on each unit. To get this I cut 18 angle brackets in half to get 36 ledges using the process below.

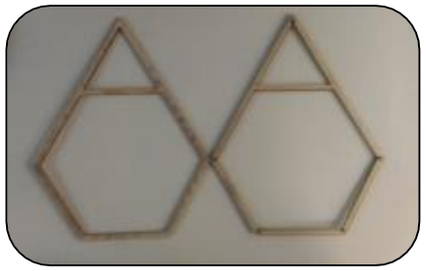


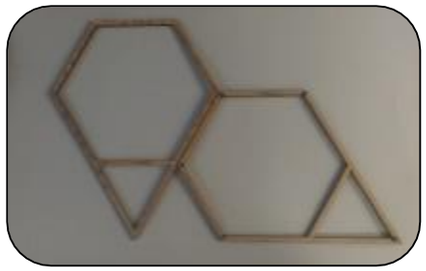
(Test with some random planks of wood)

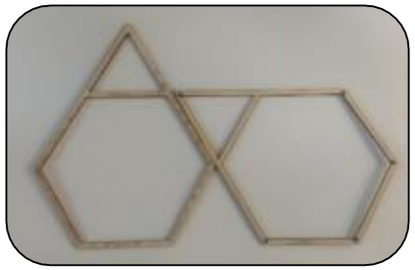
After cutting all the brackets I realised it would be much simpler just to lay the planks of wood on top without the supports. This would save time, material and would also eliminate a safety issue brought up previously.
Deciding to carry this idea out, I laser cut two wooden frames to test out the different formations I could create. This would then give me all the measurements of wood I would need for the two units.

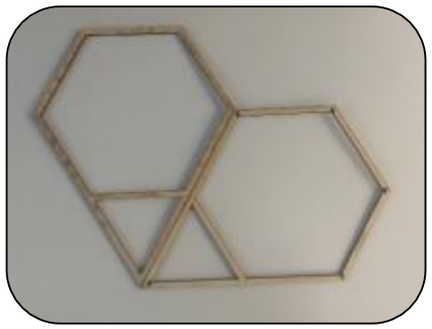


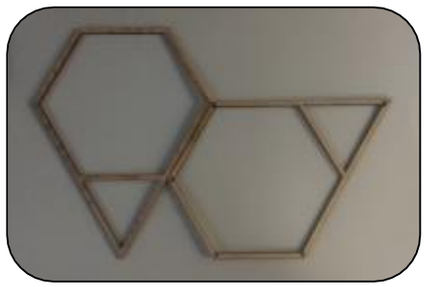


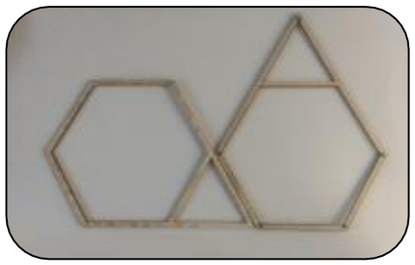


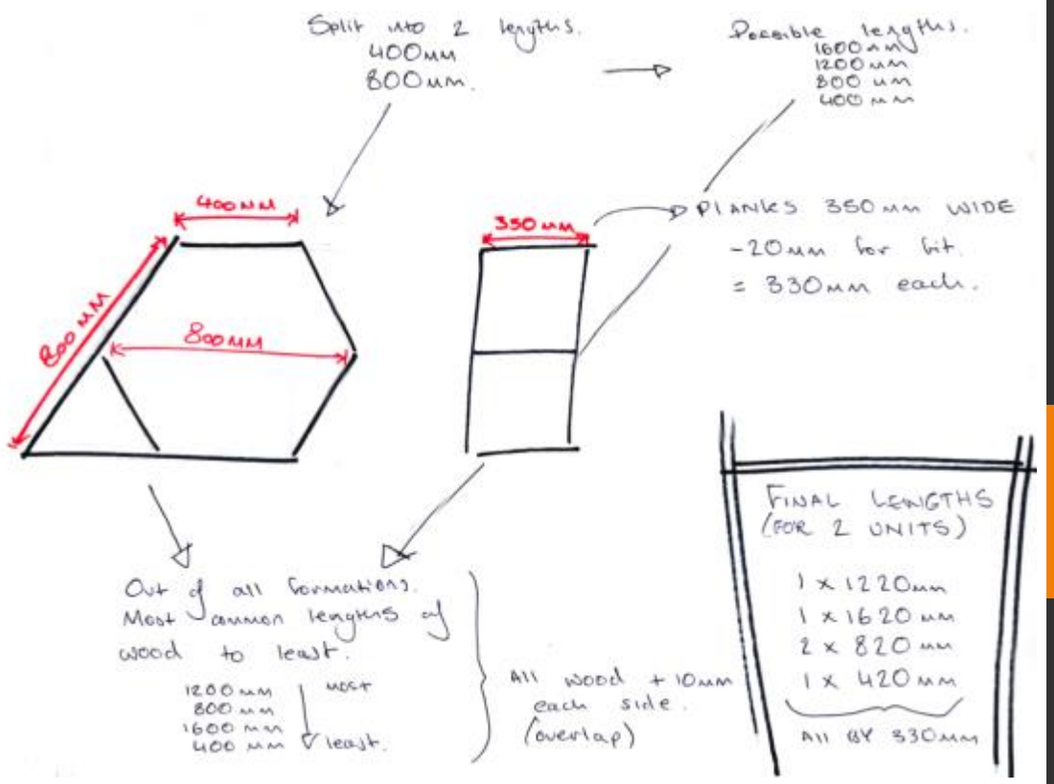






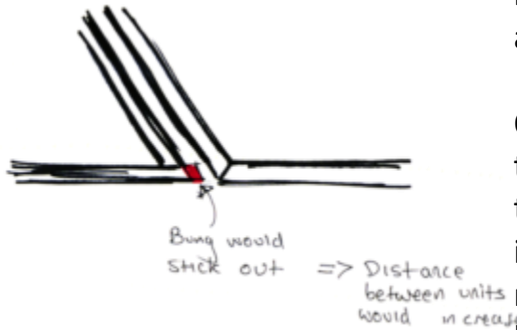






Design and Development – Making

Because of the earlier problem about the circle saw not cutting at a 30 degree angle, I was left with 2 holes in the end of each unit. These obviously have to be covered up so no water gets in. The first method I tried was to use plastic bungs that we cut to shape the pipe. We had to cut them at an angle to sit with the slant on the pipe. This however would not work as there would still be the end of the bung sticking out and I need both units to sit flush with each other so the clip works.



The only other way I could fill this hole is to braze another piece of metal over the top to seal it. I used the same bung and cut it to fit tight just inside the hole. I then placed a piece of newly cut steel on top and was able to tack this in place without the plastic melting. I could then braze over the top of the steel and make it smooth for me to clean up with the angle grinder.

After I had brazed the holes up I could get on with cleaning up every surface with the angle grinder. This makes all the surfaces smooth and takes off the grease from the steel. This is all necessary as it gives a better finish when powder coated. It is also necessary to smooth out any sharp corners that could be a hazard. For example the two 30 degree angles on each unit have a sharp corner that I rounded off with the angle grinder.

After deciding to carry through the idea of shelves on each level and having worked out the wood lengths needed, I decided to use exterior plywood instead of marine. If I were to manufacture my product professionally I would provide an option to the customer between marine and exterior ply. As marine is a higher quality wood, it comes at a much higher price that not everyone would want to pay.

Once I had cut the appropriate lengths and numbers I needed I cut out two wedges, 27mm by 72mm (1mm added each side for accuracy) from the planks of wood lengths over 820mm. This is so the wood does not interfere with the clips I am using. The clips will go where two modules meet which is why only planks 820mm and above are going to need holes as they are the only length of plank that will span across two modules. I cut the holes half way down on the 1620mm piece of wood as it will span across two units and the link will be in the middle. On the 1220mm plank I cut the holes 820mm down so they once again line up with the linkage.

To finish off the wood I cut thin pieces of exterior plywood 330mm in length. I stuck one piece of wood either end of each plank of wood with weatherproof wood adhesive that is stronger than the wood itself. These would appear on the underside of the wood and slot in just in front of the metal bars that span across. This is so the wood stays in position.

Review of Making Plan

Week 1

STAGE 1
Create a 2D design drawing of the actual size of my product. This will act as a plan to look back on whist making my product to remember sizes and measurements.

This worked well and proved to be a big help throughout

I needed a slight alter in two of the bars angles.

This is because the circular saw was unable to cut at the angle I needed. (30 degree)

I therefore altered the design which resulted in having a hole showing at one end which I resolved later on.

STAGE 2
Cut all metal beams for the hexagon end panels to size with a circular saw. I will need 24 in total for the 4 hexagon sides.

STAGE 3
Build wooden jig for the end panels so that all 4 units are identical when brazed together.

I checked the angles 3 times to make sure I brazed them in correctly. This is because I only had one shot.

I tacked the structure together before brazing so I could take it out of the jig to do so.

STAGE 4
Braze together the 4 end panels using the jig I had made in stage 3.

Week 2

NO issues encountered.

STAGE 5
Similar to stage 2, I will need to cut all 14 of the cylindrical horizontal bars that will hold the end panels together. I can refer back to stage 1 for measurements when doing this to ensure all 14 are cut correctly and are identical

As it turned out I did end up needing two jigs for the different corners

STAGE 6
Create a small wooden jig for my horizontal bars. This is so all the beams are in exactly the same place on each corner

I had to make them so that the bars were the correct distance away from the side for my clips to work. This was the biggest problem I encountered however, I found the solution in the end.

STAGE 7
Brazing the bars onto the first end panel. This should be simple enough and I should end up with 2 hexagonal faces, each with 7 bars attached

I used two magnetic spirit levels to get the bars perfectly straight while I got a helper to tack the bars on for me.

When adding the last 2 end panels I needed to use clamps to push the two sides together.

This kept them in place while I brazed them

STAGE 8
The other 2 end panels will then be connected to the two previous structures. I will need to use the jig formed in stage 6 in the same way as before so the bars are all brazed in exactly the right place

Before cutting my planks of wood, I tested some others to see how the product would look.

This is when I realised the supports were unnecessary and I could simply lay the wood on the bars.

Week 3

Cut all the wooden planks needed for the two units referring back to stage 1 for measurements.

I also needed to cut little holes in the wood so the clips would not interfere.

STAGE 10
Using angle brackets, cut 36 small metal supports for my wood to rest on using a hand held metal saw

STAGE 11
Braise each individual support onto the required surfaces on my two units.

These two steps were not needed.

STAGE 12
After both metal units are fully brazed, I will use an angle grinder over the whole thing to ensure every surface is smooth and ready for powder coating. Similarly with the wood, I will file and varnish for finish

The time I saved here proved valuable because of some previous knockbacks.

Testing and Independent Evaluation

REVIEWING SPECIFICATION

MET NOT MET

Aesthetics

The product must have a suitable appearance for both genders and all ages.

The finished product I created has got a powder coated grey finish to the metal and I have left the wood untouched. This is so it appeals to all kinds of people and everyone can enjoy it. If it were to be manufactured professionally however, the buyer would be able to choose the colour of both the metal and the wood.

Aesthetics

The product must have a modern look.

The hexagonal shape looks very modern along with the structured frame look. It looks professionally made.

Cost

The overall cost of my product needs to be significantly more that the manufacturing cost to obtain a profit.

The final price of making the product was not high considering the material I had used along with the powder coating. The idea of making the structure a frame and not a solid unit meant that the cost was cut down significantly as well as making the product look more aesthetically pleasing. This means I will be able to sell the product for a much larger profit.
I would aim to sell the product for between £125 and £150 per unit

Customer

The product needs to fit the customer and be comfortable when seating.

The product is a good height off the floor and is a comfortable height. Having stuck to wood which is the normal bench material the seat is comfortable to sit on and also remains strong enough to hold a large amount of weight on the shelves.

Customer

The product needs to be adaptable to different sized gardens.

Because of the many formations that the units can be made into the product is suited to fit in just about any environment no matter how big or small. You can also choose how many units you want meaning the size is completely customisable.

Ergonomics

The design needs to not only look the part but also has to fulfil the function of a garden chair.

The hexagonal shape is very appealing and also provides a good base to sit on due to the flat sides. The different formations also mean it changes into different sized and shaped chairs.

Size

The product must be a suitable size for everyone.

The height of the seat makes it comfortable for most ages and the different formations make the size customisable to the user.

Wallingford SCHOOL

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Telephone: 01491 837 115 Fax: 01491 825 278
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Headteacher: NJ Willis
Email: head.4140@wallingfordschool.com

22nd April 2016

Product Design Practical Project Costs

Project – Modular Seating

Student – Peter Callow

Material	Cost per Metre	Total
6m 25x25mm Mild Steel Tube	£5.50	£33.00
4m 15mm Diameter Mild Steel Tube	£4.35	£17.40
1 sheet 18mm Exterior Ply	£33.35 per Sheet	£33.35
Powder Coating (External Supplier)	£50.00	£50.00
Grand Total to pay		**£133.75**

Payment should be made by either cash or cheque. Cheques should be made payable to Wallingford Schools Academy. If you wish to pay using Parent Pay then please let us know and we will arrange for the amount to be set up for you.

Thank you,

Mr Holden
Team Leader – Design & Technology

Safety

The product has to be safe around children and withstand the weight of a person or two.

I have used the angle grinder to remove any sharp corners that would pose a danger as well as sanding down the wood to reduce the change of splinters for example. The wood I have used is 17mm thick meaning it can withstand a lot of weight and the horizontal bars across the units provide a strong base for the wood to rest on.

Material

The material of the product is key as it has to be comfortable, look good, be cheap and most importantly, be suitable for a garden seat.

For the metal frame I have used a combination of 25mm mild steal square tubing and 15mm mild steel cylindrical tubing. This is a very strong metal and because I have then powder coated it, it is waterproof which is perfect for a garden bench.
For the seat I have used 17mm exterior plywood which can withstand a lot of weight as well as being water proof.
I have also used plastic clips which can hold the two units together with great strength and without any chance of breaking.

Function

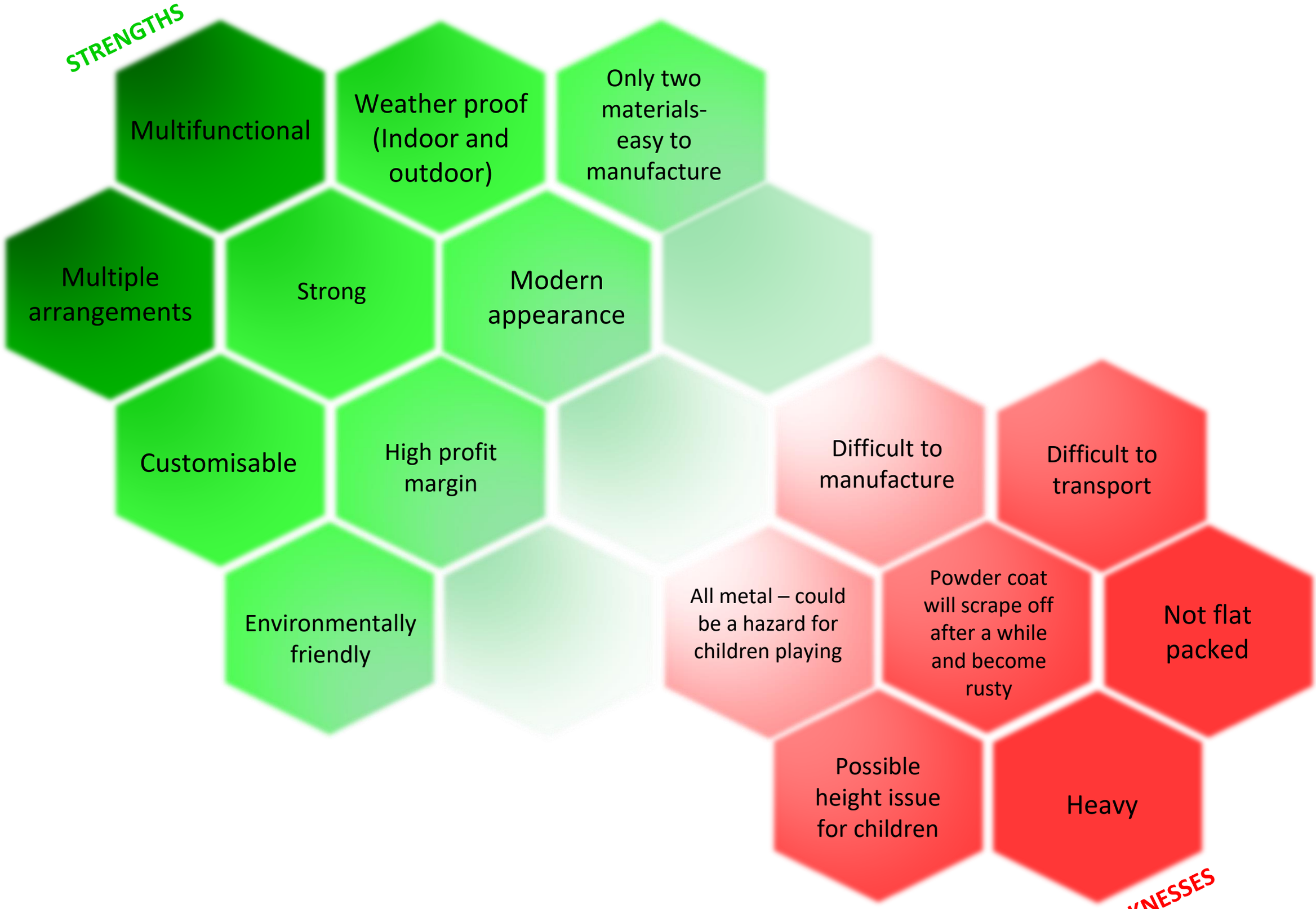
The product has to perform well as a garden bench.

This involves all of the previous specification points I have covered. Seeing as I have met them all I can safely say that my product performs equally well as a bench or a shelving unit.

Testing and Independent Evaluation

Now I had my finished product I was able to explain in depth how it worked to my clients and was able to get feedback from 'Root One' garden centre. I spoke to the manager of 'Root One'. He thought the product was 'ingenious', 'clever' and 'well made'. He also said there was definitely a gap in the market for it in a more modern and larger garden centre. This is good to know as it gives a wider possibility of places I could sell it and means I could focus on that target market a little more. He mentioned a better finish on the wood which I would do anyway if it were to be made professionally as the customer would be able to pick the colour and type of wood. He said that the structure was superb and it was a great idea. If I were to manufacture it professionally, I would therefore keep the structure very similar to what it is now if not the same and focus on making it lighter through the material rather than the structural shape.

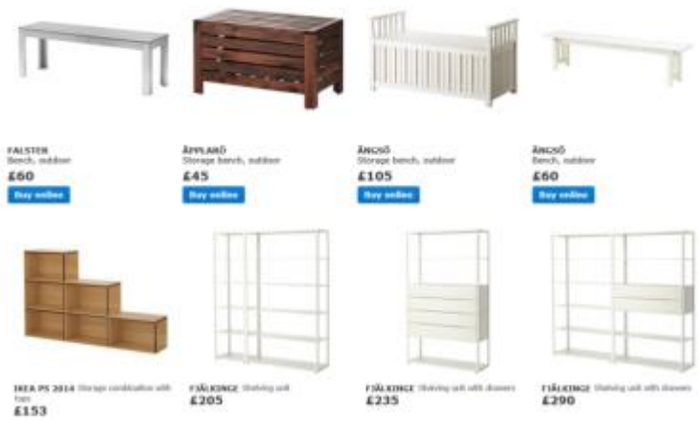
Testing and Independent Evaluation



Marketing and Presentation

Unique selling proposition

My product has two unique selling points; the modular system and the versatility of being able to use it as a shelving unit and seat, indoors and out. This will result in a larger market for me to sell the product especially as it provides a modern alternative.



In order to find the perfect price for my product I did some research into the prices IKEA are selling products at as they are a world renowned company. The prices varied a lot depending on the design and size however they were all lower than the price I had in mind. As my product is made of metal as opposed to wood it is a better quality and build, it therefore would most likely not be sold at IKEA and would be valued at a higher price

Because of this, I did some research into some companies that were a lot more specific to my product. I went back to GeoMet which is a company I have spoken about previously. Seeing as they do not give a direct price of their products I contacted them to get a rough idea of the prices.
They said that the price ranges from £410 to £1005 depending on the size of the module. Because their products are fibre glass they would be more expensive than mine. However this does give me a better idea of my price.

Wayne Surry <wayne.surry@suigeneris.co.uk> 25/04/16 at 2:10 PM
To peter.calow@yahoo.co.uk

This message contains blocked images. Show Images Change this setting

Hi Peter,

The prices range from £410.00 for the cube up to £1005 for a 3m bench if you used £500 as an average guide you would be close.

Hope the project goes well for you.

Kind regards,

Wayne Surry

4 P's of marketing

Product

It is vital to be specific and concise about what the product is. It must come across clear about the purpose of the product and the USPs of it.

Price

The price of the product is key to the success of the company that sells it. Too high and it would struggle for sales, too low would not create a large enough profit margin which creates further problems for the seller. It would be a good idea to start the product off at a discount to get it noticed and in the public eye before selling it at the normal price.

Promotion

When promoting my product there are many ways in which it can be advertised such as creating articles to go in magazines, on leaflets or have pictures on billboards. With the world modernising so quickly and my product also being very stylish, advertising electronically would be the better option. This could involve social media, TV and computer adverts or email marketing. Selling my product under a well recognized company, such as IKEA would be a great way to enhance sales and raise awareness for the product.

Place

The place the product is promoted is key to sales. The advert needs to target as much of my audience as it can. For example, with my garden seating product I would place the advert in a home furniture or gardening magazine as opposed to a beauty one. This works the same electronically as I would have a TV advert on a channel that is most viewed by my target audience.

Packaging of my product

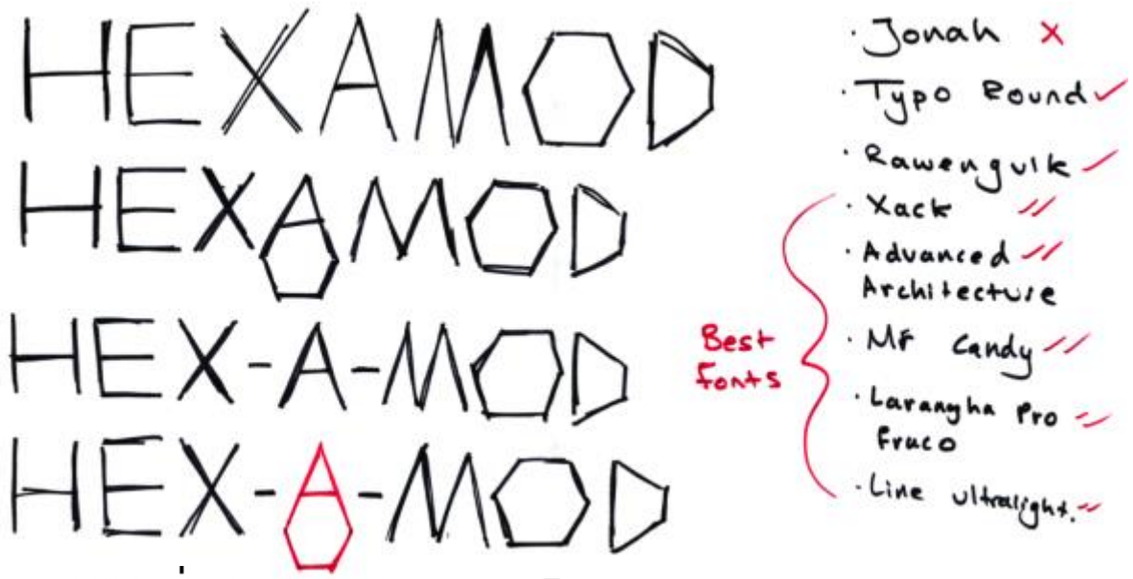
Seeing as my product cannot be flat packed it makes it very difficult to deliver at low costs and with little material. The fact that my product is built for strength however helps a lot in the transport as it wouldn't need much protecting. For the individual metal frames they would simply be wrapped in bubble wrap or a thin foam sheet. This will barely come at any cost therefore not affecting profit. The wooden planks will need more protection as they are more delicate. These would be packaged in cardboard boxed also protected by foam sheets. The plastic clips will just be bagged up and put in with the boxes.
Having everything in different boxes means that they can be transported a lot easier as things can be moved around to fit different peoples' cars. It will also save space in the warehouse.

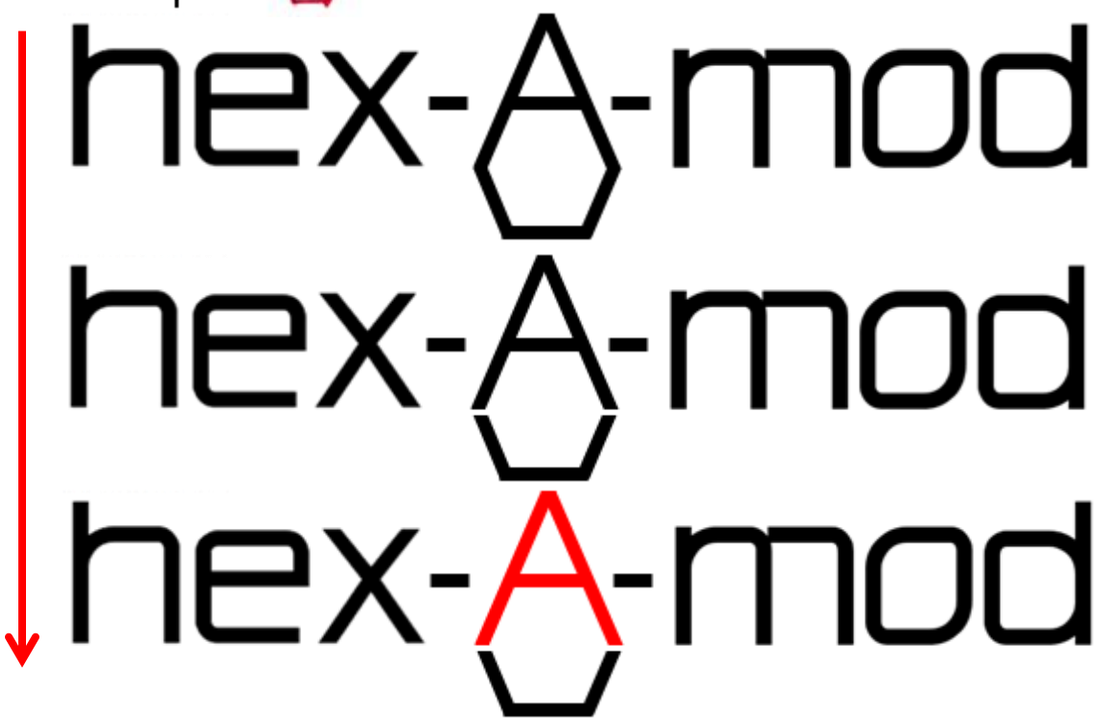
My price

From my research I have decided on the following prices.
The individual metal units (with clips and without wood) I will price at £125 however if you were to buy more than one in one go the following units will each receive a further 10% off. For example:
1 unit(s): £125 2 unit(s): £125+£112.5=£237.5 3 unit(s):£125+£112.5+£100=£337.5
Doing it this way will encourage customers to buy more than one unit. They also get the benefit of more arrangements with the more units they buy. The wood would be sold separately and at different prices for different lengths. They come in 4 sizes each with a 400mm difference in length. I would price the 420mm planks at £20 and add £20 for every increase in size.

Marketing and Presentation

To think of a name for my product I wrote out the key words that would really express what my product is: ‘hexagon, multi, modular, custom, modern etc’ and tried to connect two words together.
I figured that I could use the ‘mod’ part from modular and modern and incorporate that with the ‘hex’ from hexagon.
I came up with ‘HEXAMOD’ which I think is a catchy and memorable name. After I had settled on the name I thought about how it could be presented. I quickly sketched out some ideas of what it would look like and then used ‘dafont.com’ to select a font.





I was looking for a crisp and easy to read font. So that wherever it is displayed people can read it with ease and it is easily recognisable. For example if it were on a bill board on a motorway I don’t want it to be a complex and difficult to read font other wise people might not be able to read it at the high speeds and more seriously, could get distracted from the road.

I narrowed my font choice down to 5 and wrote the start of my name in each. I decided on the second one as it was the one that caught my eye the most initially. It also is the boldest out of the choices meaning it will stand out the most. The font is unavailable in capitals but I think the lower case makes it look more professional.

I then took this font (advanced architecture) forward and created the logo I had previously sketched.

I started with this design as I wanted to incorporate my product into the logo somehow. I decided it looked more like ‘Hexmod’ than ‘Hex-A-mod’ so I separated the bottom of the A. I then chose to make the ‘A’ red to add a bit of colour to the logo and also make it catch the eye a bit more.

To make it clearer to the public what the product was, I added ‘the modular garden seat/shelving unit’ in small font underneath the ‘hex’. I used a clear and legible font for this as it would have to be quickly read on a billboard for example and I wanted to keep the logo looking crisp and modern so I had to make it small.

Marketing and Presentation

To promote my product I will focus mainly around visual ways so that the customer can see the product and logo. This will include TV adverts, adverts in magazines and newspapers, posters , website adverts, billboards etc. I have focused a lot around the aesthetics of my product and the main selling point is the fact that it is customisable. For this reason I think it is vital that I show the product when advertising.

Using TV adverts is the most costly but effective way for advertising. They display both sound and picture to the customer meaning you can get across exactly what you want to get across. Another pro about TV ads is that you can target a certain audience with where and when you show the ad. For example I would most likely show an ad for a product like mine at around 7 or 8pm on a channel such as the BBC or ITV. I want my product to target modern homeowners who don't mind spending £200 - £300 on a product. Showing it at this time of day means it would target working people who have finished their day's work. The cost does build up rapidly however as most companies want to show there ads on the main channels at peak times which would get pride of place over mine and make me pay a lot more. This is another reason why it would be good for me to sell my product under a large well known company such as IKEA as it may come at a cheaper price and I would be more likely to be accepted to show the ad. Adverts are very difficult to make though and need professional work which is why promotion via magazines or online websites may be the better option.

Using website adverts is similar to TV adverts in the way that you could use images and sound to display the product. It is possible to either use video ads or still ones. The issue with these is that people may just ignore them and a lot of people don't use sound on their computers meaning the videos may be put to waste. It is possible to target a certain audience by making the ads pop up now and again if you see the person has visited a certain site, for example if they were looking at garden tables on amazon, your product may pop up the next day and could attract their interest.

Using magazines and newspapers means the advert is permanently there and the owner can review it multiple times. For this reason you will also be able to get more information across as you are not limited to a certain time period. It is also easier to target your audience as you can place the advert in gardening magazines, for example. Obviously though there is no sound so you would have to get across all the information in text and photographs which may prove to be more difficult.

Another example I have was billboards. These are questionable for my product as they are usually passed by cars quickly on motorways for example. They could however be placed on high traffic areas such as outside an IKEA store where people can stop and have a good look at the advert. The advert needs to be clear and legible so it can be read quickly without causing any danger to road users.

For my advertisements I will use one of two pictures in each design. I will either use the landscape one for billboards for example and the portrait one for posters. Web adverts or TV adverts would most likely be a video or several pictures possibly including these to show the versatility.

I have also edited one of the pictures on photoshop to get a split of colour. This outlines my product and leaves a black and white area above which creates an easier background for information to be seen. This could be used on posters or in magazines for example.

When I design my adverts I need to include key information such as the product logo, a picture of the product, the multi purpose and the idea of the different arrangements as these are all key in the selling of the product. Depending on what my advert is, I might display the cost as well. As I have a starting price for one unit I could add this to a poster for example and it would encourage consumers to research the product if interested.

If I was advertising my product online I would leave the price off and would add a link where the viewer could find further information. This is where they would be able to find the price.

Marketing and Presentation

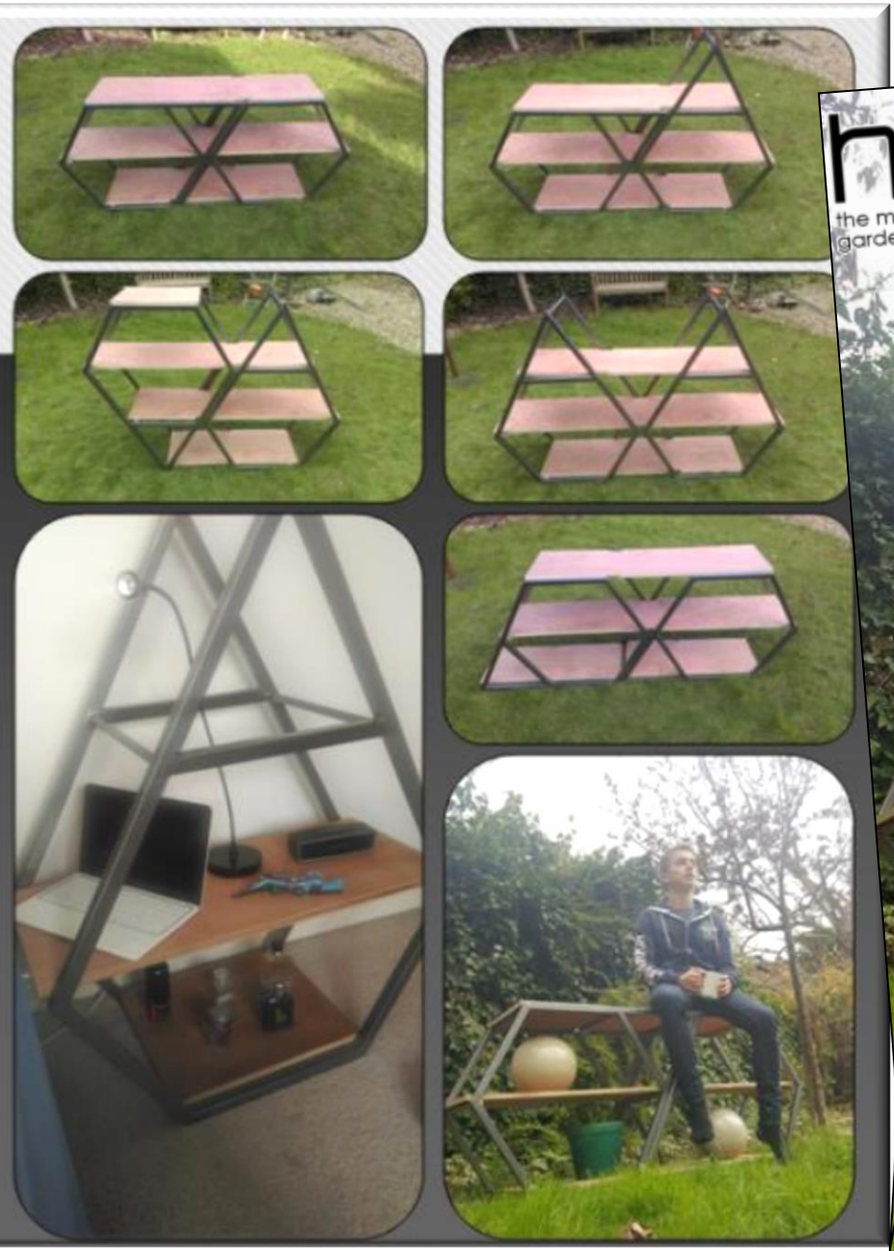
The design on the left would be used as posters, on websites and would be put inside magazines. The design displays all the factors of my product I wanted my adverts to promote. I have used this image as it leaves a white top to display my product name and then the picture is a clear representation of what the product is. As a poster this would be used alone without any information. This keeps it simplistic and if the public like the design they can search the name for details without having to stop and read all about it. If it were used in a magazine or newspaper however there would be detailed explanation of what the product is and the uniqueness of it. If it were to be used on a website this picture would be used as a link that could be clicked on to take the customer to a website where the product would be sold. This website would include pictures of all the combinations of two units together so the customer can see what they're buying. It will also show the product in different environments and being used in different ways such as a garden seat, an indoor shelving unit (living area), storage system in a garage etc.

For my billboard I will use a landscape picture of a similar photo. This is so I can make the image larger on the board which means it is easier to see. The products logo I will put in large across the top on a white background so it can be read easily even at high speeds. I have also added a bit of CAD work at the bottom to show the modular system and some of the different arrangements possible.

hex-A-mod

the modular
garden seat/shelving unit

- USE IN DOORS AND OUT
- LIFETIME GUARENTEE
- ENDLESS POSIBILITIES



When presenting my product to the class I used the PowerPoint slide above. I chose a modern background so my product comes across as professional. The slide contains the key features of my product and I explained the design in more detail

This design above is also the same design I would use for a front page of a website. It displays enough information to entice people to look further into the product.

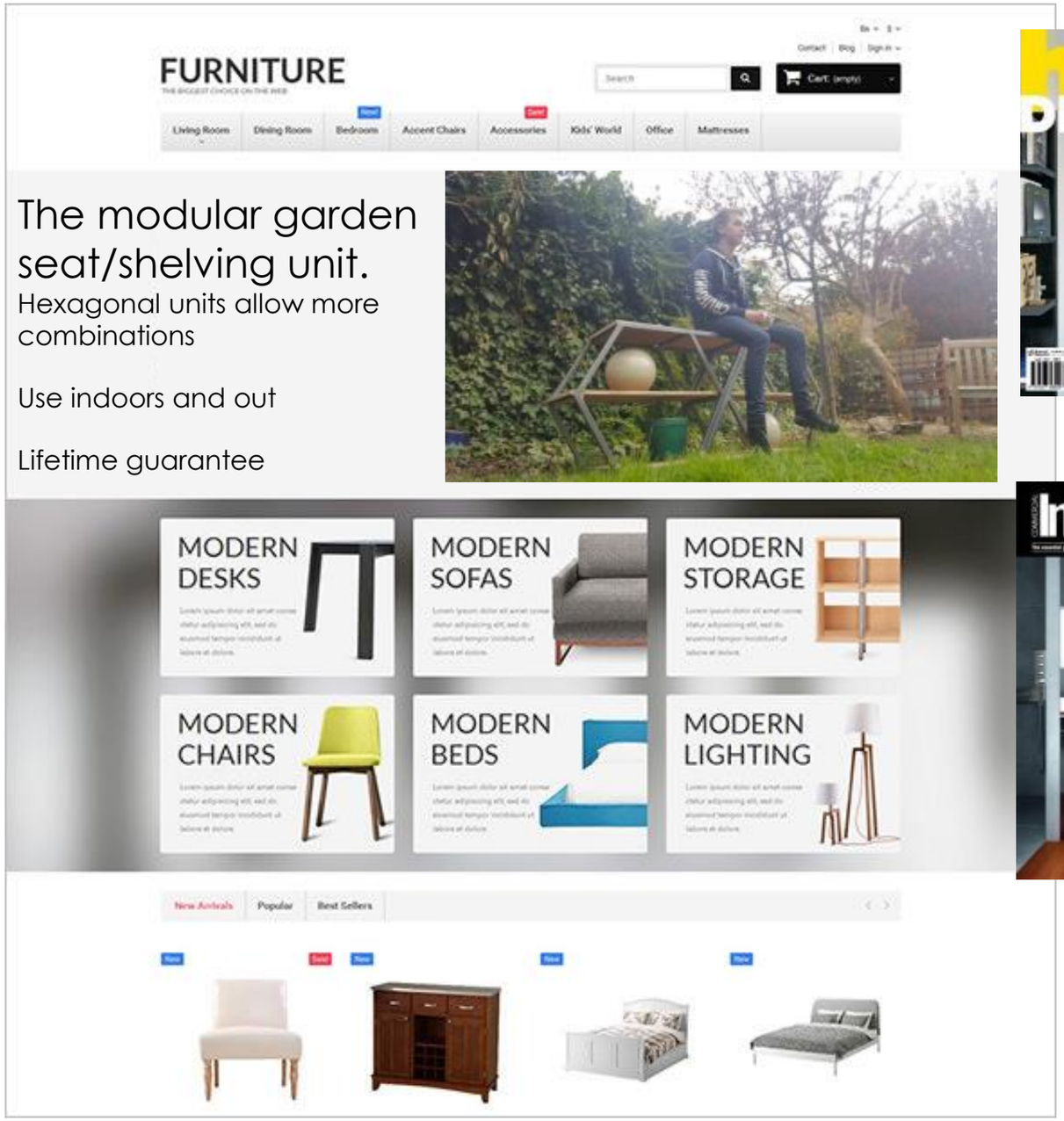
I handed out flyers to the class with photos and information on , similar to what I would use for posters in public.

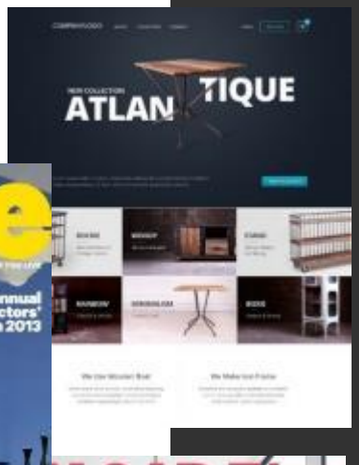
Marketing and Presentation

After researching some poster and website layouts for design companies, I found a lot of similar features when it came to presentation.

- The main background is always one picture that represents the content of the article.
- Big, easy to read font is used on the cover for captions that entice the audience.
- Bright colours to catch the eye

I could use all these effects when marketing my product to attract as much of my target audience as possible. As many of my target audience will be of the older generation, magazines will still be a good way of marketing my product.





Review and Reflection

Design Brief

My target by the end of the year is to design and make a modern garden seating arrangement that can fit any shape or size of garden and provides a different alternative to the basic benches and chairs on the market at the moment. The product should be modular and easy to assemble whilst staying light but strong.

Reviewing my design brief I think my product has been a success. The hexagonal shape gives a modern appeal while also adding a lot of strength. The modular aspect of the design means it can fit in near enough any area, indoors or out. It is not as light as it could be due to the thick ply wood and steel however it is still light enough for one person to assemble. It is also very strong due to the material and shapes used in the design.

Problem Solutions

My three main problems I had to address with a normal garden bench were the aesthetics, size and delivery. Aesthetically I think I have succeeded as I achieved the original modern look I was going for. The market at the moment is very confined for garden benches so I definitely think there is a gap in there for my product. The size and shape of my product is the strongest factor as it can fit in a range of environments which a normal bench cannot do as it is fixed as one shape. The delivery side of things still needs work for my product as it is not flat packed. I did aim to make it flat packed at the beginning but I decided it would have affected the strength and appearance of the design too much. Because the product is so strong however, it does not need a lot of protection when being transported. The modular aspect means that it can fit in most cars.

Design and Making Process

Once I had come up with a solid design brief and idea of what I would design and make it was quite enjoyable to go through and brain storm ideas of what to make. Considering my product was a garden bench it was easy to get feedback on each of my designs from my parents and other clients. This helped me to improve my ideas throughout. Having a specification when designing was very helpful to refer back to when improving my designs. I was able to use CAD to give a better representation of what the designs looked like and also use it to make prototypes on the laser cutter. This was better way or showing how components worked through pictures and videos.

Once I had designed my final product I went to a garden centre to get professional feedback from them. This proved effective as I got feedback from a previous chair designer who now works there. Before making the product I made a full CAD drawing of all the measurements and angles I needed so I would hopefully be able to make it without any significant problems. At this time I hadn't thought about how I would clip the two units together which proved to be a problem further on.

I made the frames from the jig without a problem and got to the stage where I could lay the frames out to see the different formations. By this stage I had found the clips I was using which were my first set back. Because they had a space in-between them I had to alter the way I attached the poles. This used up a lot of time as I had to create jigs and work out the distance I had to leave for each pole. This taught me that I should have everything ready before I start making and not start before I have a solid plan. After I has solvbed the issue about the clips the rest seemed pretty straight forward although I did change my idea towards the end. I originally was going to have brackets that hold pieces of wood on each surface. I then changed the idea so I had planks of wood that slotted in on each surface. This ended up saving me a lot of time and improved the product. I then needed to clean up every surface with the angle grinder so I was able to powder coat it. Because I needed the clips to link the units together I needed to create gaps in the wood so they fit over the clips. This, combined with the wooded stoppers I put on either end, created good stability for the wood.

Life-Cycle Analysis

My product is made up of two materials, mild steel and exterior plywood. Mild steel is made from iron ore, most of which is sourced from Australia. This means it has to be shipped over to Britain creating a lot of pollution. Most plywood comes from trees like southern pine or Douglas fir in America or birch trees in China. Either way it has to be transported a long way. Getting wood from England means there are no air miles and therefore pollution from planes. The cutting down of the trees obviously uses a lot of energy and is bad for the environment. The sourcing of both of these materials uses energy and will inevitably have by products. The packaging of the products I have explained previously and does have room to be improved as the product is not flat packed. This could result in more pollution being created seeing as there would need to be more trips to transport the product if it were not flat packed. Because both materials are weather proof, the life of the product will be extended. The powder coat will protect the steel from rusting. However if it were to be used outdoors on concrete, for example, the powder coat could scratch off, leaving the metal exposed to weathering.

The wood is weatherproof but is still vulnerable to damage caused by knocking it for example. In terms of repair and replacement of the products the metal could be re powder coated now and again but this would cost a lot of money. The wood would be difficult to repair but could be replaced by ordering again.

When disposed of both materials could be recycled. The steel can be smelted down and reused and the wood can be easily recycled but both of these processes take time and energy.

Moral and Ethical Issues

The product is perfectly safe to use however may cause strain when being put up as it is heavy. This could be a problem for the older age group. The height of the product could be an issue for some people too. There is nothing that would effect someone wanting to use it so there are no ethical issues.

When manufacturing it could be hard to create this product using batch production which could be bad economically and could affect the profit margins.

Review and Reflection

The market at the moment for garden seating is still very confined to a few simple designs. For this reason I think there is a huge gap for my type of product. You have to go a long way to find a modern looking garden seat and when you do come across one you will most likely be getting a lot less than you're paying for. Not only does my product perform as a seat but also a shelving unit. This means there is a much larger market than if it were just a garden seat. Likewise the fact it can be used both indoors and out will draw more customers in.
Due to climate change a lot of new products coming into the market are all about sustainability and being environmentally friendly. The fact my product is only two materials means it can be made without having a lot of negative impact on the environment. Both materials can also be re-used or recycled and are very strong which guarantees a long life.

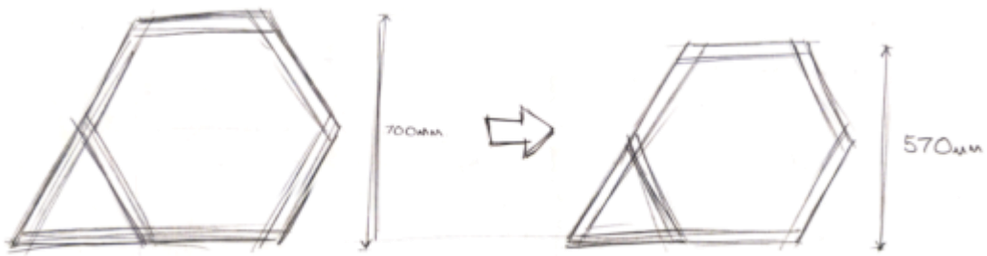
Development-Industrial/Commercial

Metal or Alloy	Kg /Cu. Mtr
Aluminium	2600
Brass	8580
Phosphor Bronze	8850
Cast Iron	7300
Copper	8930
Steel	7850
Titanium	4500
Tungsten	19600
Zinc	7135

I did some research on materials for the metal frame as my most common improvement suggested was weight orientated. The steel I had used comes in at 7850kg per cubic metre. If I were to use aluminium this would improve my weight by three times. Aluminium is also more malleable than steel and easier to work with. This would mean it is easier to manufacture and therefore would take less energy to do so. Another pro is that aluminium does not rust meaning it will not require any coating which would scratch and wear off. This means it will have a longer life than steel and I could use this when selling it as I could give it a life time guarantee.
The price of steel and aluminium is fluctuating as it is based on global supply, demand, fuel costs and the availability. Despite this, aluminium is always going to be more expensive even without the need of a powder coating.

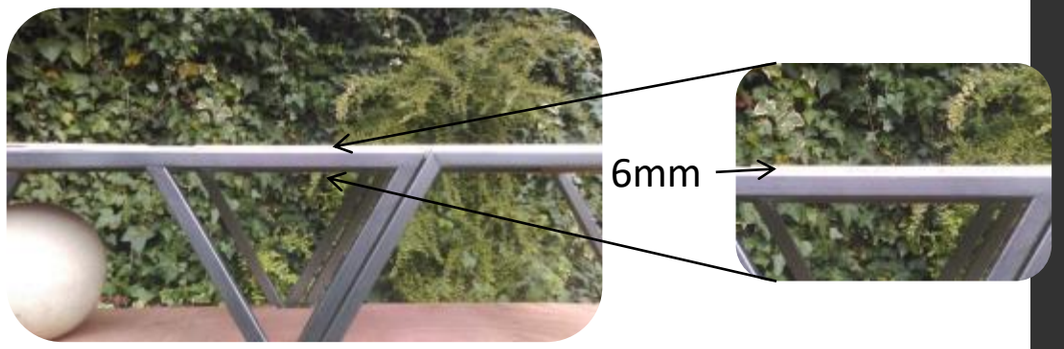
As mentioned in a previous slide, if I was to produce this product professionally I would probably opt for marine ply rather than exterior. This is because marine ply is of a much higher quality and also exterior is made entirely for outdoor purposes. Marine plywood is a lot dearer which is why I didn't use it for my model. However if I were to make it professionally I could order the marine ply in bulk which I would get at a cheaper price. I could then manufacture this to fit my product. Because of marine ply's higher quality the finished product would then sell on at a higher price increasing profit margin.

Development-Aesthetics/Design Variations



Apart from the weight there were a few changes I could make that would improve the quality of use of the product. A single unit is 700mm of the ground. I am 180cm tall which is just under 6 feet with my leg length being about 100cm. When I am sitting down there is around 20cm room between my feet and the floor. This feels like a good height. However most garden seats you can sit on with your feet touching the floor. Considering I am quite tall and fully grown I am able to base the height of my product on my self even though I am not who the target market would be. If I were to manufacture this product professionally, I would change the height to be 570mm of the ground. This would mean my feet would be just touching the floor which would remain comfortable for people my height and taller. People shorter than me would most likely not be touching the ground. However I was able to test this for comfort as that is what the product is like now and it is very comfortable.

If I wanted to keep the shape a perfect hexagon, a down side to reducing the height would mean the whole unit becomes a size smaller. This would mean each square side would shrink resulting in less room to sit and store objects on the shelves as the unit would be narrower.



Another small improvement would be to use 11mm thick plywood. This would mean there would be no excess plywood sticking out and it would give a cleaner finish. This would also save material as at the moment the plywood is 17mm thick. This would therefore save cost increasing the profit margin. However decreasing the width means it will affect the strength of the wood and it could get damaged more easily and not withstand so much pressure.

Finally, the manager at the garden centre suggested a better finish for the wood. I explained to him after that I would do this if It were to be mass manufactured and I would also change the ply wood to marine for the reasons I have stated above. Like I have said before the wood would also be able to be painted, having the colour chosen by the customer