EDEXCEL

GCE Design and Technology: Product Design (A2) (Resistant Material Technology)

EXEMPLAR MATERIAL 1

Title: Portable Outdoor Artist's Easel

UNIT: 6RM04

A2 Design Technology
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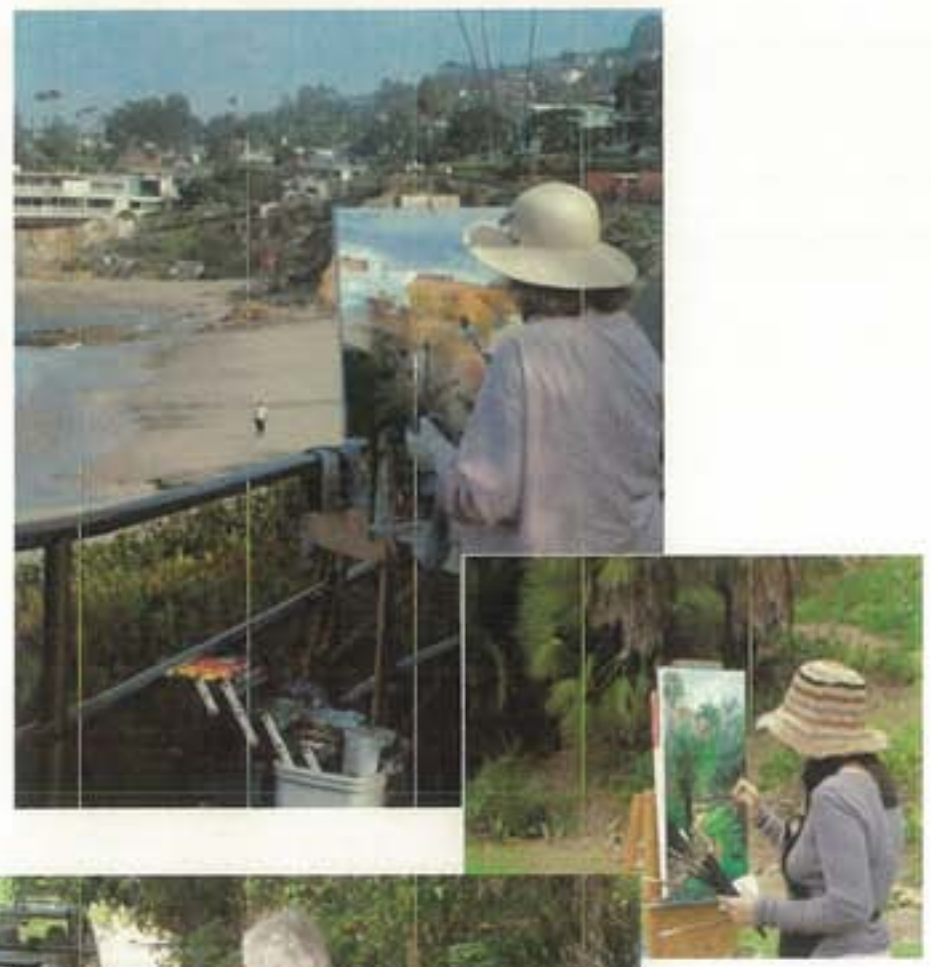
Problem

The art department at school currently do not offer any solutions to painting outdoors. Students always struggle when painting outdoors because they have no easy access to their drawing/painting equipment and often have to use make-shift solutions.

Design Brief

To design and manufacture a device that aids in painting outdoors, which allows for easy access to the drawing/painting instruments.



Client

Miss Lister, art department

User Groups

Students and teachers who wish to paint outdoors

Research and Analysis

Client User Discusion

Me: What are the most important aspects to painting outdoors ?

Miss Lister: I think portability is important since people would need to carry it to the place where they want to paint.

Me: What are the biggest problems you find with painting outdoors?

Miss Lister: Not having a place to store the brushes and paints while painting this a easel can be irritating since you can lose focus as you have to continuously search for your brush from the floor.

Me: What age group in school would generally paint outdoors?

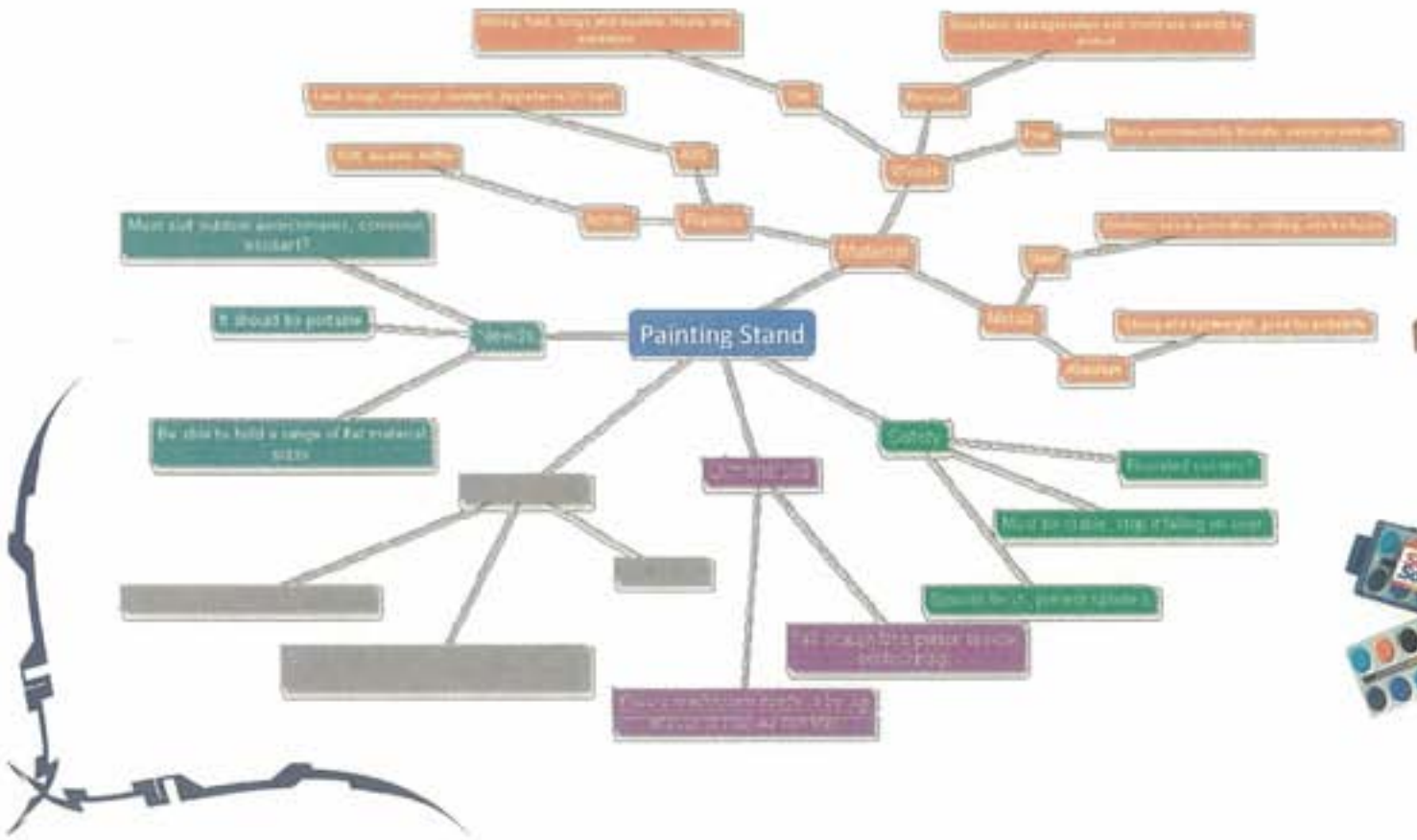
Miss Lister: We would expect that it would be the older years who paint outdoors From year 10 upwards to the upper sixth since they get coursework and some people like to paint outdoors for their project work.

Me: A storage unit of some sort could be incorporated into the design to hold the painting tools; what kind of equipment is normally used?

Miss Lister: Well, you need a brushes and paints for starters. A pencil could be used to sketch out the initial outlines for the painting and you would need a pot to hold water. Then there's the mixing tray, but often people like to hold that in their hand. Also depending on the type of paint being used, you may need a palette knife.

Me: What kind of materials do you paint on? Also what size material would you need the easel to accommodate?

Miss Lister: Normally we would be using canvas or paper which has been mounted to a board. I think A2 would be the biggest size that would be workable outdoors, but a range of sizes are used.



Sumary from discusion

- Portability is vital so that the product can be transported easily.
- Not having storage for painting tools is inconvenient so some kind of storage unit should be incorporated into the design.
- Tools used for painting include: brushes, paints, pencil, water pot, palette knife and a mixing tray
- Canvas and paper mounted on a board are the most common painting media.
- The largest size used would be A2.

Equiptment used when painting

Paints-acrylic and oil paints comes in large and small tubes. Normally for painting outdoors, the smaller tubes are used. Watercolour can also come in small tubes, alternatively they come in solid blocks which tend to be cheaper.
Brushes-used for applying paint, there are a variety of different brushes and many are at the same time.
Pencil-used for sketching the image.
Water pot-holds water to clean the brushes and also for use with watercolour.
Palette knife-used for mixing paints, can be used for artistic techniques.
Mixing tray-used to mix paints, often handheld and easily washable.

Research and Analysis

Similar Products

Camera tripod:

A camera tripod is used to hold a camera still so that any pictures taken are clear and free from motion blur. It is designed with portability in mind which I evident from the minimalistic look of the product. Since it serves a similar purpose to what my product will do, I believe analysing this product will help me to develop my product and possibly incorporate similar features.

The three legs are held in place with a hinge near the top and are then connected to a support connected to the central column. This means that each leg are evenly spaced, resulting in greater stability. They are normally made from aluminium or an alloy of aluminium as it has a strong weight to strength ratio and resistant to weathering. Extrusion was probably used to create the initial shape and then machined to finish it. Alternatively the legs could be made from sheet material by bending the material in a mould.

Additionally, each leg is extendable and fixed in place by quick release pressure mechanism. The quick release mechanism works by the user pushing a level which applies pressure to grip the inner section of the leg. A plastic material (like ABS) is used to make the gripping component of the quick release because it is has superior grip and flexibility compared to metal.

A large footprint means that the tripod is very stable, this should be taken into consideration when I design my product because it would need to be able to support the drawing media without falling over.

Attached to the bottom of the legs are rubber feet that swivel to gain maximum contact with the floor. The rubber feet have small circle patterns on the bottom which results in a high coefficient of friction, therefore it is less likely to slip.

On the top half of the tripod, there is a revolving handle what allows accurate adjustment of the height of the tripod head unit. The revolving handle is used in rack and pinion system. The head unit is then secured using a twist lock mechanism.

There is a handle attached to the middle section of the tripod that allows it to be easily carried. This along with the extendable legs means that it is a very portable item.

Rack & pinion mechanism

Quick release mechanism

Music stand:

Music stands are used to hold up sheet music.

The central column is adjustable and once the height is correct, a hand screw applies pressure and locks it in place. This mechanism is used because it is more cost effective than a quick release mechanism. It is suitable because the user in theory would not often need to move the stand very far so having a quick release mechanism would give no benefit. The central column could have been manufactured by extruding through a mould and the material used is likely to have been aluminium or even steel. Depending on the material, it would either be powder-coated or anodised.

There is a relatively small footprint compared to the tripod, but since the stand is not designed t o hold anything that is heavy it does not need a large foot print.

Weight is kept to a minimum by removing material from the head unit which also serves as an aesthetic point since it gives the product more character.

Compared to the camera tripod, it has a small footprint because sheet music is very light so less stability is required. Canvas, card and paper are relatively light, but we would require greater stability since the user would not want the medium to move at all while they are painting on it since it could cause mistakes while painting.

Like the tripod there is a support fitted on the legs which connects it to the central column to give it greater stability. The top part of each leg is connected to a plastic component that slides up and down the central column; this allows for the legs to be spread evening, resulting in a perfectly upright stand. Additionally this allows for the legs to be folded up close to the central column meaning that it is compact for transport.

Research and Analysis

Similar Products

Folding table:

A table takes up a lot of room space even when not in use. One method of overcoming this problem is to have it fold up and move it away. The table folds about a pivot across the centre of the table. There is a supporting rod that connects the table legs to a pole that is offset from the centre of the table. This causes the table legs to fold towards the table as the table top is folded meaning that it that it can all be done in one swift motion. Folding the table causes the table to have a high centre of mass that is not very stable and prone to falling over. To resolve this issue, the designers have bent the table legs halfway outwards at a 90 degrees angle which creates a larger footprint. As the tabletop is made of wood, it would be impractical to move by lifting as it would be relatively heavy; so wheels have been attached to the bottom of the legs. The wheels having a locking mechanism to secure the table so that it does not move around when not required. The metal used for the framework and the legs are likely to have been made from stainless steel as it is tough and does not suffer from rust like mild steel would.

I believe incorporating a folding mechanism in one of my designs might work well as it would reduce the overall space required when not in use and hence good for transportation. Using wheels would probably be unnecessary as I do not want my product to be so heavy that wheels are necessary. Stainless steel could potentially be used as my product needs to be used outdoors, so being corrosion resistant is a advantage. Unfortunately stainless steel is very hard to cut so manufacture with the limited tools in the technology department may be difficult.

A typical wheel with a pressure locking mechanism

Keyboard Stand:

The stand is designed to hold a keyboard in a horizontal position. It is likely to have been made from steel which has been powder coated to give it colour and to protect it from rust. Alternatively, it could have been made from anodised aluminium making the product lighter and easier to lift. Each leg has poles that are attached perpendicular to the main frame to give the product a large footprint which results in greater stability. At the end of each feet, there are rubber attachments that give greater grip to the floor so that the stand does not move when the user is playing the keyboard. Additionally the rubber feet raises the feet poles so that they do not touch the floor which prevents scratching to the surface. In my design I would consider using rubber feet as I do not want by product to move around when the user is painting, so rubber feet may be a good solution.

When not in use, the stand can be folded about the central pivot to make it easier to transport. To fix the stand in place when it is being used, there is a "pin and hole" mechanism to lock it in place. The mechanism consists of a plate with holes that have been drilled in it and then there is a spring loaded pin fixed into the adjacent frame. To lock it in place, the pin to pulled out and then the stand is moved into the desired position ; once this is done the pin is inserted into the plate. The advantage of this mechanism is that it is a very strong mechanical lock and is near impossible to separate without braking the stand. It also has the advantage that it can be locked in several different positions which adjusts the height of the stand to suit the user, though it only allows it in discreet increments. An alternative method could be to use a plate and a calliper to apply pressure in order to hold it in place. This method would allow for a continuous range of heights, but at the expense of being slightly less secure.

Though my design needs to hold the drawing medium in a near vertical position, there are some design elements that I can take from this horizontal keyboard stand. I could base a design on the minimalistic look of this stand as I this that having a painting stand that is unobtrusive would be good for painting as it does not distract from the scene that is being painted. Additionally the "pin and hole" mechanism shows a lot of promise due to its strong locking feature.

Research and Analysis

Useful Mechanisms

Since the product needs to be portable, a folding mechanism or similar would be a ideal way to make it more portable.

Sliding/folding mechanism:
This design utilises a sliding pole which when opened, acts as a support and gives a strong structure. It is most likely made from stainless steel which has good tensile strength and is tough; additionally when metal is properly finished it becomes extremely smooth. This allows the pole to slide across the guide easily due to the low coefficient of friction. Potentially could be used to hold a folding platform for the painting equipment.

Pin and hole:
The mechanism comprises of two hollow tubes which are made from metal, normally steel or aluminium. One has a series of holes cut into it, while the other has a spring-loaded pin which locks into one of the holes. This mechanism allows the length of the pole to be adjusted relatively easily, but to use it regularly can be frustrating since the stopper can sometimes be difficult to push down if the spring is too strong or if it is too small. Due to the design of the mechanism, it can only be lock at discreet intervals which would limit its usefulness for clamping down a variety of size of painting material. This would not be an issue if it were to be used as part of the legs because it would not require that degree of adjustment.

Quick release mechanism:
Quick release consists of a either a metal or rubber ring with a cut out section, this is then wrapped around a pole. The ring is held in place by a shaft connected to a lever. The lever when pushed down applies pressure to the gap which in turn tightens the ring around the pole. It is possible to adjust the amount of pressure by rotating the lever when it has been released, this is because there is a screw thread on the shaft. This could be incorporated in my designs in the form of telescopic legs or possibly adjustable mounts to hold the painting medium. It would be difficult to manufacture this kind of component in the workshop so it would likely be bought in as a standard component.

Physical Size

Human Dimensions:
After looking at the height of students in year 10 up to sixth form and including teachers, I estimate the average height of the user group to be around 1700mm (1.7m) tall. Therefore my solution should be usable by people close to this height (approx ±150mm).

Canvas Sizes:
Canvas comes supplied in a variety of sizes ranging from small A4 210mm × 297mm, to A2 420mm × 594mm sizes. The stretcher, otherwise know as the wooden frame, has a typical depth of around 20mm. The depth will vary from frame to frame so it is important that my design accounts for depths up to around 30mm to be safe. Additionally, my design has to hold material up to A2 size, 420mm × 594mm.

Car Boot Size:
If a student was to take the painting stand outdoors, it will be likely be transported in a car. It is therefore important that the painting stand when it is in its "transport" state that it fits comfortably in a boot. The smallest cars are hatchbacks so I will base my boot dimensions on them, this ensure that the stand will fit in a range of car sizes. Based on a typical Vauxhall Corsa I measured the boot dimensions to be 940*500*500mm without pushing the back seats down. This can only be taken as a approximation because of the shape of the boot is not a perfect cuboid and will vary from car to car.

Where will it be used?

Painting outdoors covers a large variety of different environments from concrete land to sandy beaches. Due to the fact that this product will be designed for the art department and hence be used by students, the primary locations that my solution would be use are Bournemouth and Poole. Within these areas it is primary concrete floor with bits of green land and beaches. This would mean that my product needs to be able to resist corrosion (e.g. oxidisation) which means I could either use a non corrosive material like aluminium, or I could finish the product in a protective layer (e.g. varnish wood). I need to primarily consider how to prevent damage from exposure to the sun and moisture damage.

Product Specification

Purpose:
- Provide a area for artist to mount their painting medium and hold a variety of painting tools.

Form:
- Have a modern style that deviates from traditional wooden frames.

Function:
- Hold canvas and paper/card mounted on a board up to A2 size.
- Hold brushes and a water beaker during use.

User requirements:
- Be portable and light-weight (less than 10kg) so that it can be easily transported.
- Hold at least 3 brushes and a water beaker
- Be suitable for people 1700mm tall (±150mm)

Performance requirements:
- Hold the drawing medium securely so that it does not move during painting.

Material and components:
- Must not use wood for the product
- Be finished to protect from sunlight deterioration, rain and wet or damp conditions.

Size:
- Dimensions have to be less than 940*500*500mm to fit in the boot of a car.
- Painting surface should be held a suitable height to suite an average size student.

Safety:
- Not have sharp corners or edges that can cause injury.
- Should not weigh more than 10kg to ensure it is relatively safe for someone to move.

Quality:
- Use materials and components that follow British Standards so that they are reliable.
- Be manufactured using a suitable range of quality control procedures that will ensure a high quality outcome,

Scale of Production:
- A one-off production.

Cost:
- The cost should be less than £150.

Sustainability:
- More than 80% of the product should be recyclable.

In consultation with my client, a specification was drawn up for the product to ensure that the product will meet the core requirements of the users.

Purpose (Justification):
- This is what the client wants the product to do.

Form (Justification):
- After looking at other easels, I realised that there needs to be something that differentiates my product from the tradition wooden easels.

Function (Justification):
- My research showed that the largest size used outdoors is A2
- A issue that was brought up by the client during a meeting.

User requirements (Justification):
- Since this product is going to be carried around , it would reduce the strain on the client if it was lightweight.
- Issue that was brought up by the client.
- Average height of user group is around 1700mm.

Performance requirements (Justification):
- It would be impossible for the client to paint if the medium wobbles and would induce stress.

Material and components (Justification):
- Wood is traditionally used so by avoiding it, my product should have a more modern feel..
- The product will be used outdoors, so it must be suitable to outdoor environments.

Size (Justification):
- The user group will likely take the product home from school and car is the most common type of transport used by students.
- Students vary in height , so the product must be able to accommodate for a whole range of people

Safety (Justification):
- Having sharp edges would be unsafe for the user and people close by.
- If it was too heavy, then it may cause spinal damage to the user.

Quality (Justification):
- By using quality raw materials, we can ensure that the quality is good from the very beginning.
- Using quality control procedures allows us to ensure that the quality of the product is good throughout the manufacturing stages.

Scale of Production (Justification):
- It is not a commonly used item in school so only one is required.

Cost (Justification):
- If the cost is too high, it would be preferable to buy commercial stands.

Sustainability (Justification):
- As raw materials become scarce, we want to be able to reuse the material after the useful life of the product.

Product Specification

Purpose:
- Provide a area for artist to mount their painting medium and hold a variety of painting tools.

Form:
- Have a modern style that deviates from traditional wooden frames.

Function:
- Hold canvas and paper/card mounted on a board, for painting on with acrylic paint.
- Hold brushes and a water beaker during use.

User requirements:
- Be portable and light-weight so that it can be easily transported.
- Hold a variety of painting instruments.
- Be suitable for people 1700mm tall (±150mm)

Performance requirements:
- Hold the drawing medium securely so that it does not move during painting.

Material and components:
- Avoid using wood for the majority of the construction.
- Be finished to protect from sunlight deterioration, rain and wet or damp conditions.

Size:
- It should be easily fit into the boot of a car (boot dimensions 940*500*500mm).
- Painting surface should be held a suitable height to suite an average size student.

Safety:
- Not have sharp corners or edges that can cause injury.
- Should not weigh more than 16kg to ensure it is relatively safe for someone to move.

Quality:
- Use materials and components that follow British Standards so that they are reliable.
- Be manufactured using a suitable range of quality control procedures that will ensure a high quality outcome,

Scale of Production:
- A one-off production.

Cost:
- The cost should be less than £150.

In consultation with my client, a specification was drawn up for the product to ensure that the product will meet the core requirements of the users.

Purpose (Justification):
- This is what the client wants the product to do.

Form (Justification):
- After looking at other easels, I realised that there needs to be something that differentiates my product from the tradition wooden easels.

Function (Justification):
- My research showed that paper and card were also used with easels, not just canvas.
- A issue that was brought up by the client during a meeting.

User requirements (Justification):
- Since this product is going to be carried around , it would reduce the strain on the client if it was lightweight.
- Issue that was brought up by the client.
- Must be suitable for the user groups height otherwise it would be difficult to use.

Performance requirements (Justification):
- It would be impossible for the client to paint if the medium wobbles and would induce stress.

Material and components (Justification):
- Wood is traditionally used so by avoiding it, my product should have a more modern feel..
- The product will be used outdoors, so it must be suitable to outdoor environments.

Size (Justification):
- The user group will likely take the product home from school and car is the most common type of transport used by students.
- Students vary in height , so the product must be able to accommodate for a whole range of people

Safety (Justification):
- Having sharp edges would be unsafe for the user and people close by.
- If it was too heavy, then it may cause spinal damage to the user.

Quality (Justification):
- By using quality raw materials, we can ensure that the quality is good from the very beginning.
- Using quality control procedures allows us to ensure that the quality of the product is good throughout the manufacturing stages.

Scale of Production:
- It is not a commonly used item in school so only one is required.

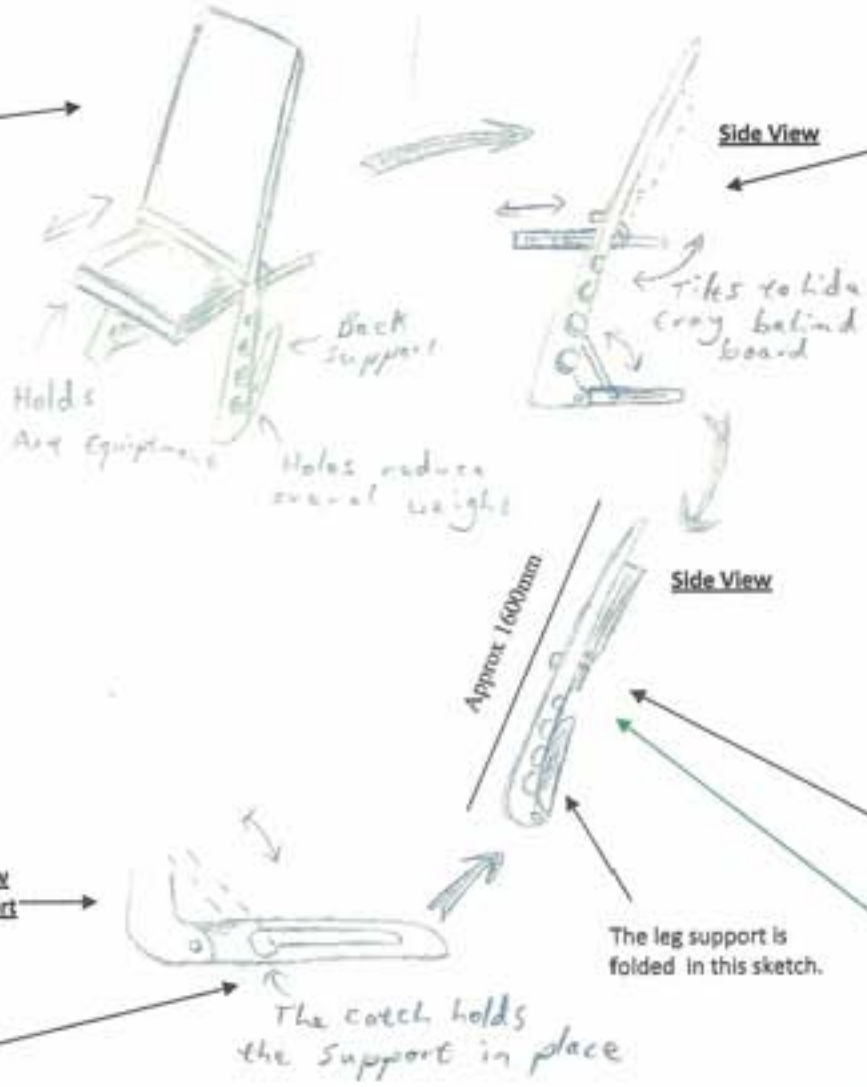
Cost:
- If the cost is too high, it would be preferable to buy commercial stands.

Design Developement

Design Ideas

This design is very similar to a traditional wooden easel, but the construction of this idea would be mainly aluminium which is environmentally friendly since it can be easily recycled. The recycling process only requires 5% of the original energy used to extract the metal from the ore.

The stand has a ledge for holding the canvas or card. With this it is possible to cater for a range of sizes of material and. Paper is normally mounted on a card and then mounted on a stand because paper needs a hard backing that most stands would not have. This means that with this design you can directly attach the paper to the stand with outside having to carry around cardboard to mount it. Unfortunately by only having one side of the canvas supported, it means that the material is not secure and may wobble when being painted on. If I was to develop this idea any further then I would be to rethink how the painting medium is secured.



The tray is used to hold all the drawing equipment, and it is are attached to rails. This allows the user to only pull out the tray when they need to which means that there is minimal intrusion to the user's work.
Could be made from a light metal such as aluminium or ABS. To help organise the storage of equipment, a plastic tray could be made that separates the equipment into categories such as brushes and paints.

The feet can be folded away, so that the product can effectively be flat-packed. As the support is folded open, there is a catch which holds it in place. This component would have to be made from metal because plastic is not tough enough. Could be manufactured from sheet aluminium and then cut using a hack saw. After ward it would be bent and then finally smoothed using a file.

The leg support is folded in this sketch.

The legs of this design could be made by cutting aluminium sheets and then bending them around a jig to create the shape. If this product was to be made in small batch production the same manufacturing techniques can be applied.

Concept
Flat-Packed

The concept revolves around minimising the profile of the stand when not in use. This has the benefit that it can be stacked while in storage so less space is required.

During transport, the tray slides to the back and then is tilted on a swivel so that it is parallel with the back piece. There needs to be some way of holding it in place while its in this state, so a locking mechanism is needed. A simple bolt style mechanism could be used.

Client Feedback:
After reviewing this idea with Miss Lister, she felt that this product does not hugely differ from more traditional products. She also questions about the portability of the product when folded up because it would still be very tall and the lack of anywhere to grab hold of the product would makes it difficult for transport.

To make this idea more portable, it may be possible to somehow have a folding mechanism which connects to the legs and the main piece. I have concerns about the stability of the item if this was done and I need to deviate from traditional painting mounts. Adding a handle or similar would make the product more easily carried.

Theses holes are not only used for stylish effect, but are also to reduce the overall weight of the stand.
To further reduce weight, the inside could be made hollow. By reducing the weight it makes it easier for one to carry around.

Environmental Points:
Since it is flat packed, it is good for the environment as you can store more of them in a truck. Less fuel is used which results in less carbon dioxide emissions.

Design Developement-

Design Ideas

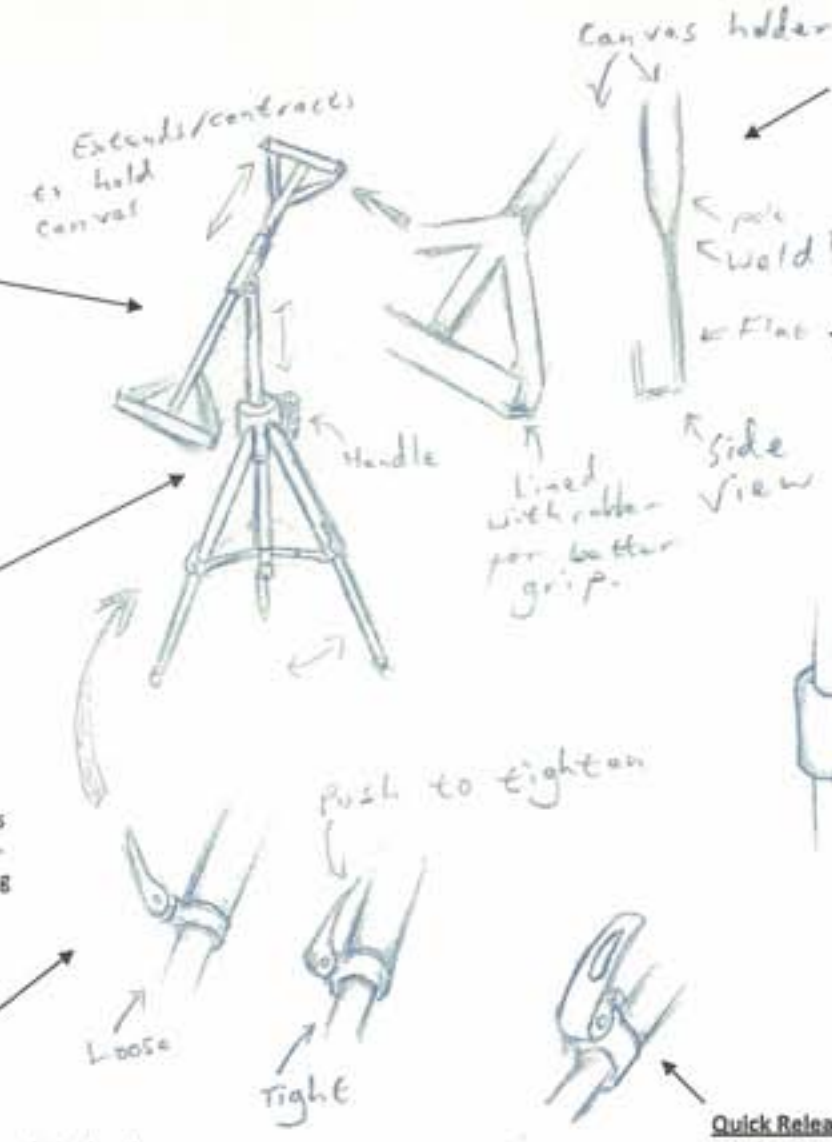
This idea revolves around the idea of minimalistic design. By keeping materials used to a minimum, we reduce the weight of the product which covers one of the specification points.

The design incorporates an adjustable mount for the canvas, so a range of sizes can be used. It adjusts by sliding the top half into the bottom part which can either be held in place by a quick-release mechanism, or possibly a rack and pinion could instead for greater precision. To prevent the canvas or card from slipping, a patterned rubber strip could be stuck to the inside of the "grip slots".

There is a handle attached to the central component which means that it can be carried easily.

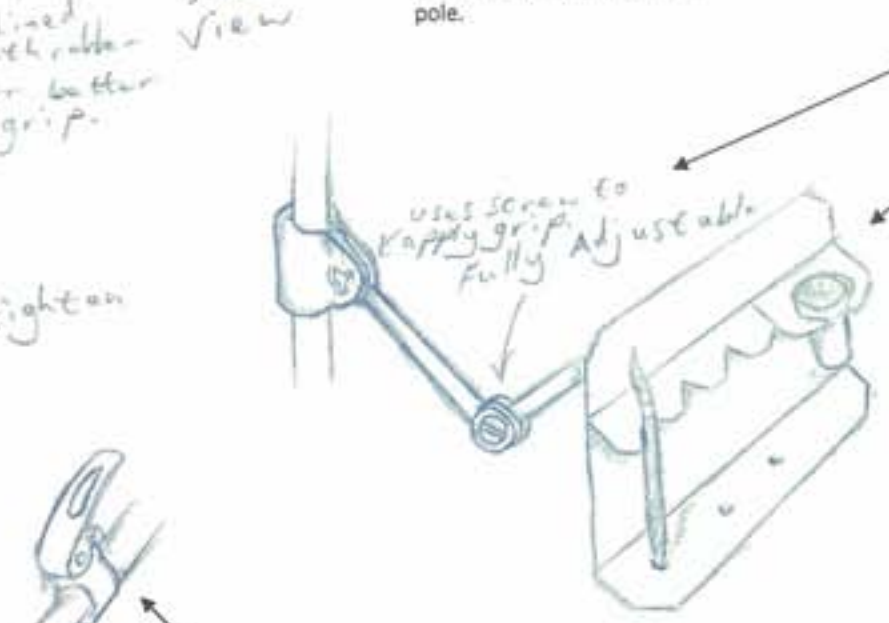
Aluminium would be an ideal material as it has a high strength to weight ratio. Also it is corrosion resistant, due to a thin oxide layer, making it suitable for outdoor use.

Quick release mechanism works by apply pressure/gripping the inner pole then pushed down. With this type of mechanism you can adjust the amount of pressure my rotating the lever since it is attached to the ringed area with a screw.



Side View

If constructed from aluminium then MIG (Metal Inert Gas) welding can be used to join the flat material wit the pole.



There is a separate attachment which holds brushes and a water pot. The brush holder has a rotating joint which means that it can be used by a range of size of people.

The storage component can be made from sheet low carbon steel which is cut using a hack daw and then subsequently bent into shape. Alternately it can be laser cut, but this would require external manufacturing facilities such as from a manufacturing company since the in-house cutter cannot cut metal.

Quick Release Mechanism

Environmental Points:
Recycled aluminium can be used to reduce impact to the environment. Producing the material from scrap metal needs temperatures of 660°C, while refining from ores using the Hall-Heroult process needs 900°C.
The difference in energy needed saves fossil fuels and using recycled materials reduces the amount thrown into land fills.

This design is suitable for batch/mass production as many of the components can be manufacture autonomously by machine. For example as the majority of this product is made from bar material, the cutting can be done on a mechanical hacksaw with a bar feeder system.

Concept

Trebuchet

Concept naturally revolves around the typical camera tripod. Tripod have great stability which makes the design suitable as a painting stand. Additionally, the tripod is a very portable design which once adapted, will meet the specification set out.

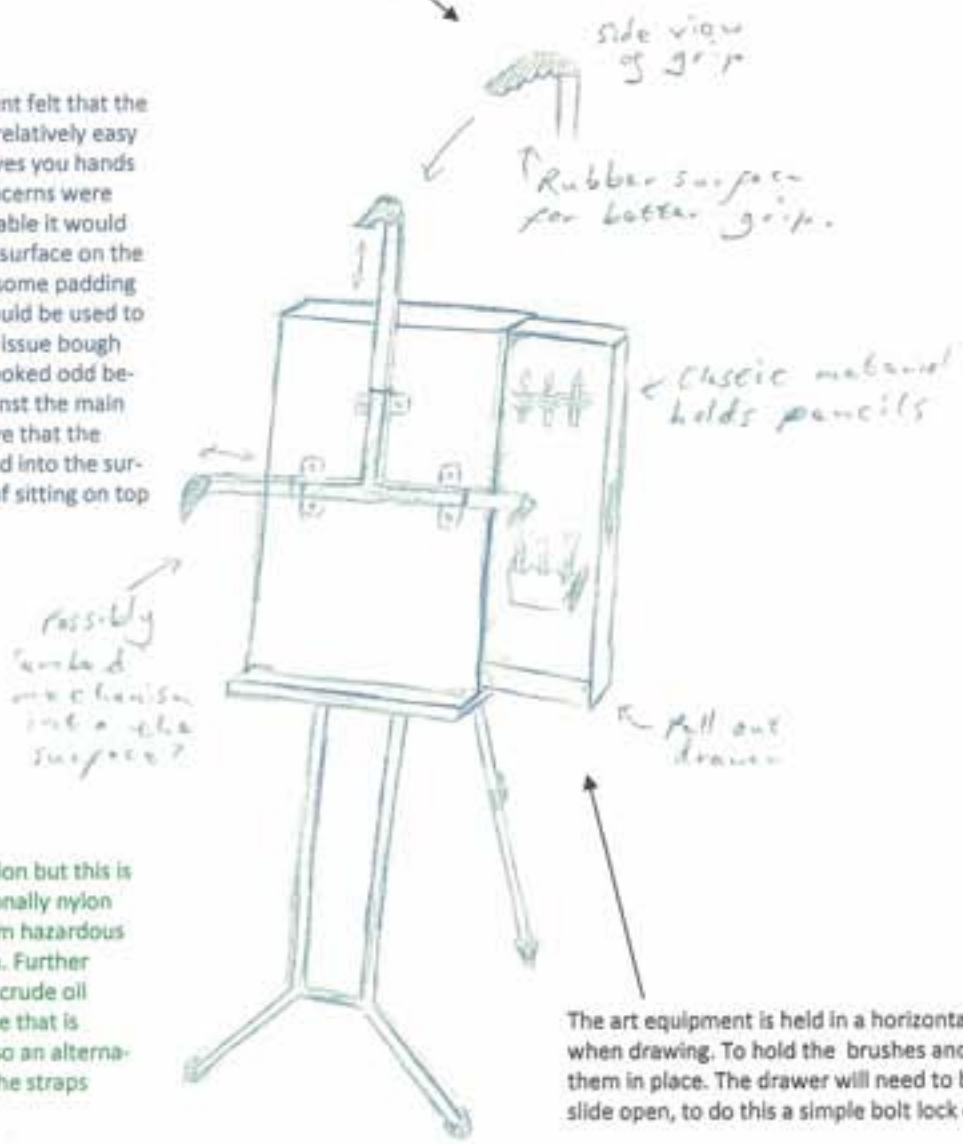
Client Feedback:
Feedback overall was positive but says that the design lacks originality. The client felt that the product would work relatively well because tripods are a tried and tested shape which is highly stable. Miss Lister mentioned that we thinks she has seen a similar product in shops.

Design Developement:

Design Ideas

In order to secure the canvas, there will be adjustable "claws". One method securing these claws would be to use a ratchet style system which releases when a button on the claws is pushed in.

Client Feedback:
After a discussion, the client felt that the bag style stand would be relatively easy to carry around and it leaves you hands free which is a bonus. Concerns were made about how comfortable it would be to use due to the hard surface on the base unit. To resolve this some padding material, such as foam, could be used to improve comfort. Anther issue bough up was that the "claws" looked odd because they are raised against the main surface. Therefore I believe that the claws should be embedded into the surface of the unit, instead of sitting on top of it.

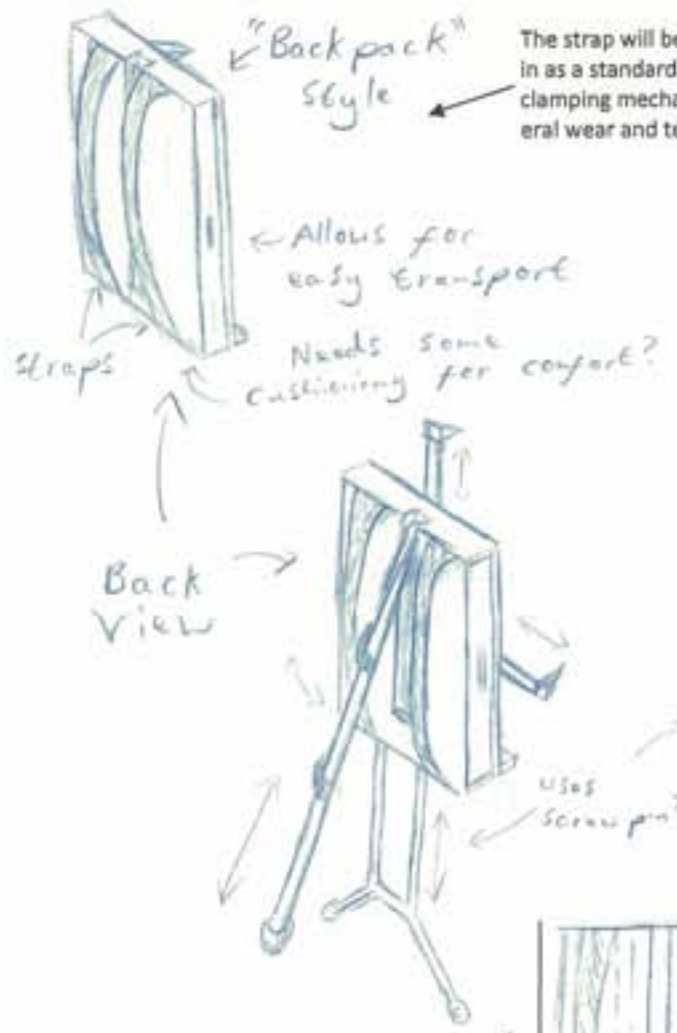


Environmental Points:
It is possible to recycle nylon but this is not very common. Additionally nylon breaks down in fire to form hazardous smoke, toxic fumes or ash. Further more nylon is made from crude oil which is a natural resource that is quickly becoming sparse so an alternative material for making the straps should be considered.

The art equipment is held in a horizontal sliding drawing which allows for easy access when drawing. To hold the brushes and pencils there will be small elastic slots to hold them in place. The drawer will need to be secured during transport so that it does not slide open, to do this a simple bolt lock could be incorporated into the design.

Concept Backpack

The idea behind this design was to maximise the ease of portability. To achieve this I decided to incorporate straps so that it can be carried around on your back. This would be especially useful if you need to hike to the place where you wish to paint.

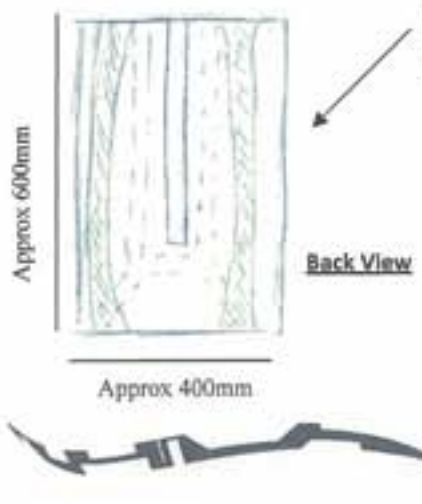


The strap will be made from nylon or a similar material and will be bought in as a standard component. To fix the straps to the stand, I will use a clamping mechanism. This means that if the straps get damaged from general wear and tear then they can be easily replaced.

A skeletal frame would be made from aluminium and joined by MIG welding. After the flat panels can be riveted onto the frame. It would be viable as a batch production product as shapes involved are relatively basic meaning that identical products can easily be manufactured.

The back support will be telescopic comprised of 3 parts. On the hinge of the back support, there will be a tab to fix the inclination at a angle of 45 degrees. There is a slot on the back of the base unit so that the back support does not jab into the user's back when being transported.

In addition, the front legs will be retractable into the base unit resulting in a compact shape when not in use. The front legs will be locked in place by a hand screw once the required height is set.



Back View

Design Developement-

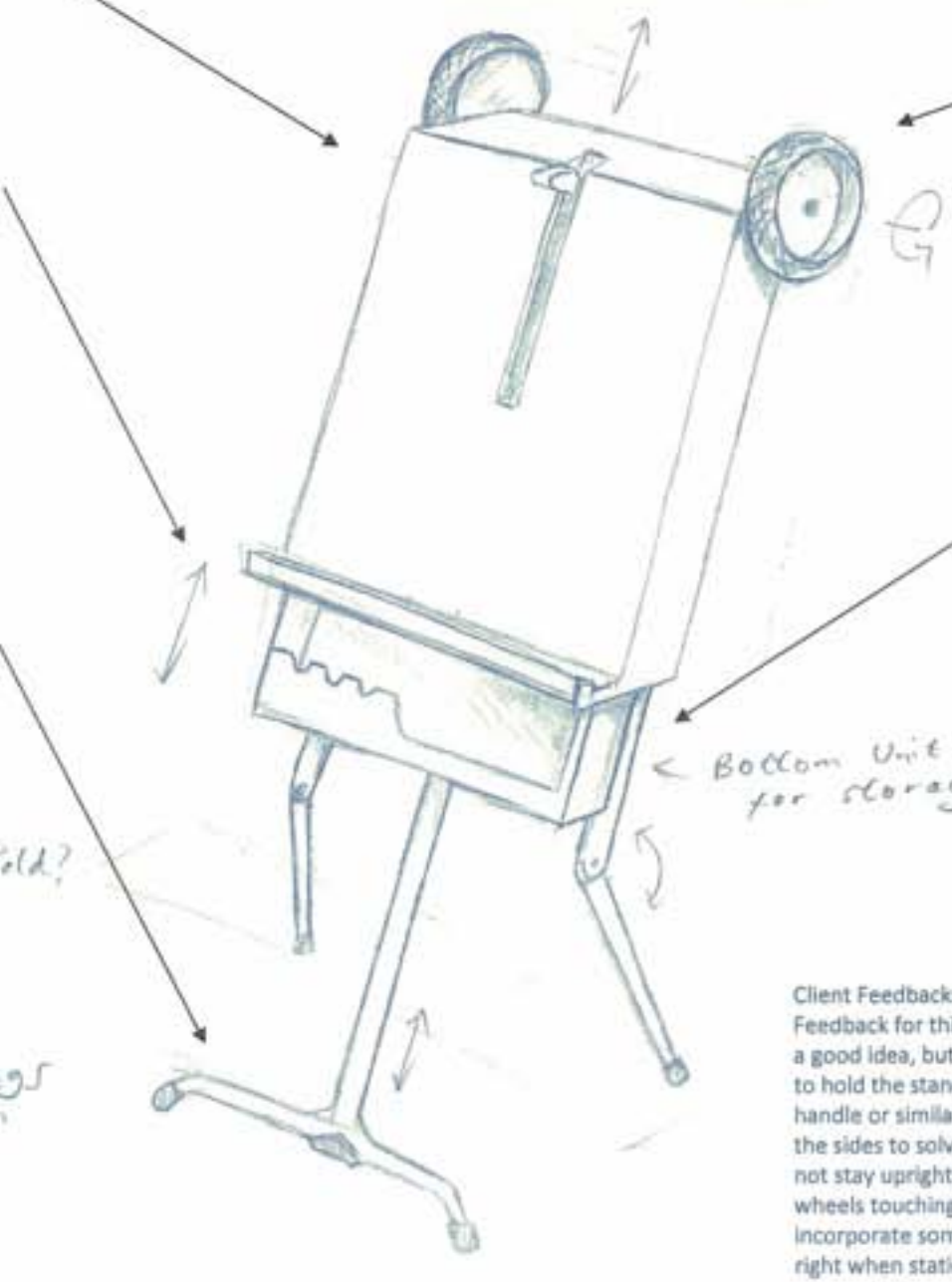
Design Ideas

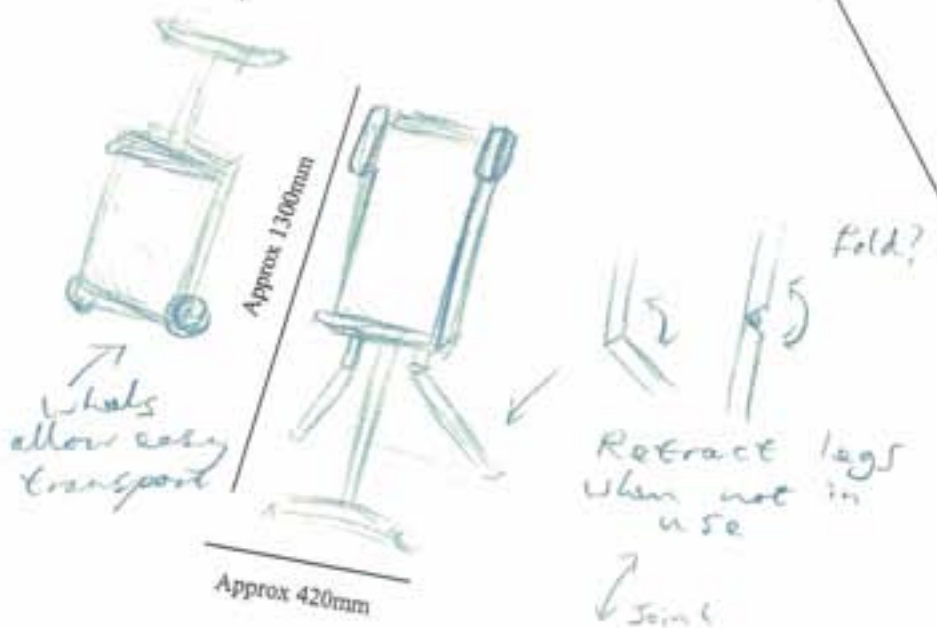
To hold the canvas or card, there is a fixed slot at the bottom to act as base. This is then secured by a clamp at the top which is adjustable. The clamp slide up and down a pole which is secured with a quick release style mechanism. It is embedded into the surface of the stand so that it allows the canvas to lie flat, meaning that its more secure, and because it looks more aesthetically pleasing.

There is a storage drawer at the base of the unit which can be pulled down. To prevent the drawer from falling out I will use metal rails (much like the type found in desks). A handle that rotates which s slides bolts into the side of the main unit will secure that drawer when not in use.

The frontal leg can be used as both a handle for pulling the stand along using the wheels and a leg when its been flipped over. There is a button which is used to release the leg to adjust the height and store it away. One method of achieving this could be using spring loaded pin which locks into a series of pre-cut holes and the button pulls up the pin. Due to the fact that it will be used on the floor, I believe that it is necessary to raise the sides and fit them with rubber ends. This means that only the ends will be dirty and avoid the user having to get their hands dirty.

For the manufacture there will be a mild steel frame welded together and then the outer plates would be riveted on. As a result this would be easy to batch manufacture as cutting the bar material for the frame can be done autonomously with a mechanical hacksaw fitted with a bar feeder. The plating can be cut with a laser cutter resulting in a quick turnover.





Concept

The Wheelie

To make that stand portable I decided to add wheels as this would mean that the stand can simply be dragged along instead of being carried by hand. This concept is loosely based on the luggage bags with wheels that are used during vacation. By having the handle serve as the leg unit for when the stand is in use, we reduce the amount of material needed, also this in turn reduces weight.

The wheels will be mounted either side of the top of the unit when its being used. They will be components that are bought it and I estimated that wheels with a diameter of 250mm will sufficient. To ensure that they do not get in the way of mounting the canvas or card, I will attach them towards the back of the stand. It would be possible to have the wheels nearly flush with the side surface of the base unit , but at the cost of some stability when they are being used.

For the rear retractable legs, there will be a hinge which tights with a hand screw so that you can adjust the angle of inclination of the stand when it is being used. The leg as a whole will be locked by a pin on the back of the base unit which fits into holes in the legs itself and releases the legs when you pull them.

Environmental Points:
Mild steel can be recycled which means there is less material being thrown into landfills. Also only a small fraction of the energy required to extract the iron from its ore is used in the recycling process.

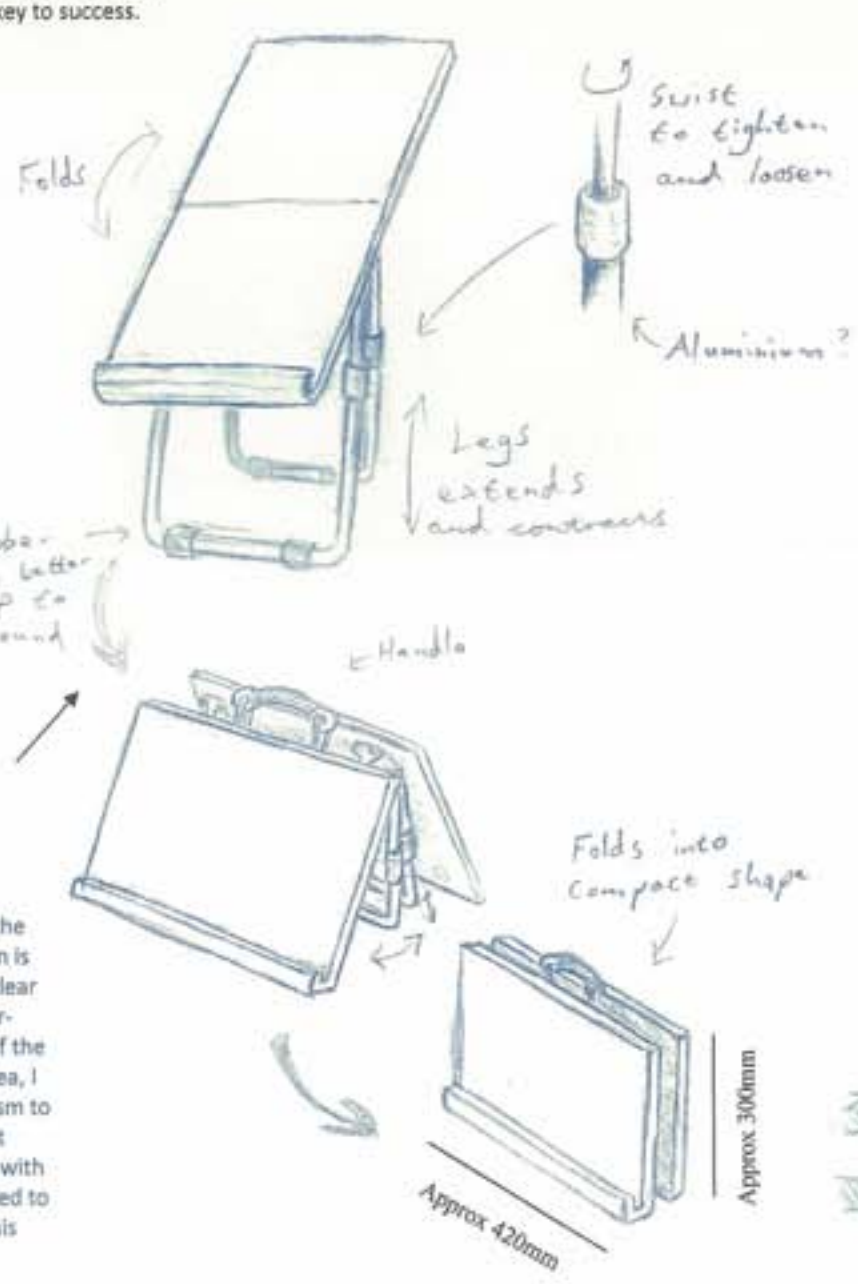
Client Feedback:
Feedback for this design overall was positive. She felt that it pulling it along the floor is a good idea, but would be difficult to lift into the boot of a car as there is no clear area to hold the stand when it's in its compact form. After hearing this I released that a handle or similar could be easily fitted to one of the sides to solve this. Additionally the product will not stay upright when it has been flipped with the wheels touching the floor. To resolve this I need to incorporate some small stumps to help keep it upright when stationary.

Design Developement

Design Ideas

This idea may not be very suitable for batch production as a lot of manual work is required to made the legs so it would be very time consuming in an environment where speed is key to success.

Environmental Points:
This product will likely have a long life cycle as none of the materials used will degrade quickly so I estimate that the product could easily be used for upwards of 20 years. Though there is a high environmental cost initially (high levels of energy used to extract the aluminium), the product will last for a long time so the user will not need to buy another which is turn uses more energy. Additionally aluminium can be fully recycled so to further reduce the carbon footprint the product could be manufactured from metal that has been recycled.



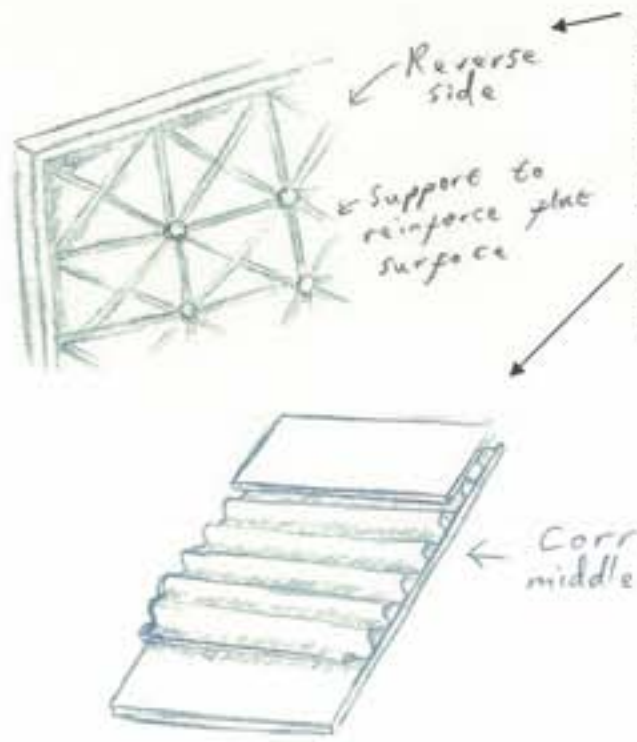
The legs can be cut with a band saw and then a file can be used to remove any burs from the cut. After it can be bend by packing the insides with sand, heating up and bending around a jig.

Client Feedback:
After showing the idea, my client thought the idea was very original. The briefcase design is very practical to carry around, but lacks a clear way of mounting the canvas securely as currently the canvas would simply sit on top of the bottom "ledge". To further improve this idea, I would need to develop a suitable mechanism to secure the canvas. Also currently I have not gone into create detail about how the legs with be locked in position so that would also need to be developed if I decide to proceed with this idea.

Concept

The Briefcase

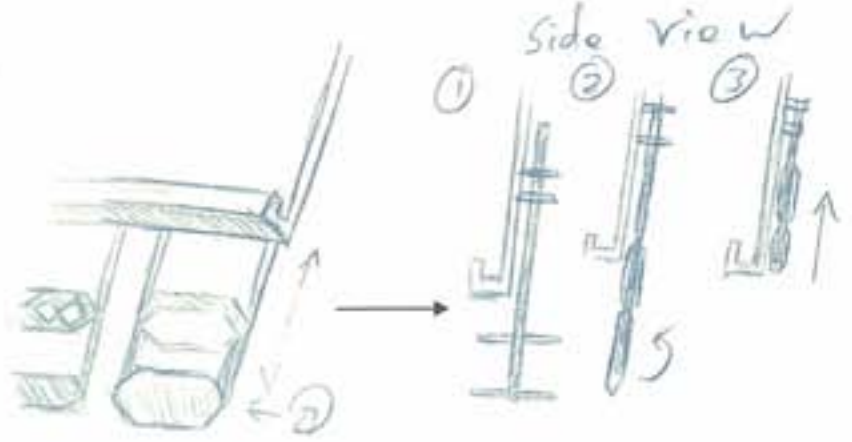
The concept for this idea is to have a paint stand which can be transported in similar fashion to a normal briefcase. My initial idea stemmed from the folding table because I think that the flat surface of a the tabletop could be great for mounting canvas and paper.



The flat pieces can be made from ABS which has been treated to be resistant to UV-degradation. ABS is tough and hard, so the surface will not wobble when your paint on top of it, additionally we can reinforce this by having little support beams. It has a good surface finish and is self colouring which means that it does not need any finishing.

Alternatively, if it were to be made from aluminium then it could be reinforced by having a corrugated middle section which is plated either side.

At the bottom of the stand there are retractable holders for painting equipment. When not in use, the holder is flat parallel to the main flat piece and hidden behind it. Material such as acrylic can be used to make the slots for holding the equipment as it can be laser cut out. The part that swivels could be made from some kind of bearing with a tab to lock it in place.



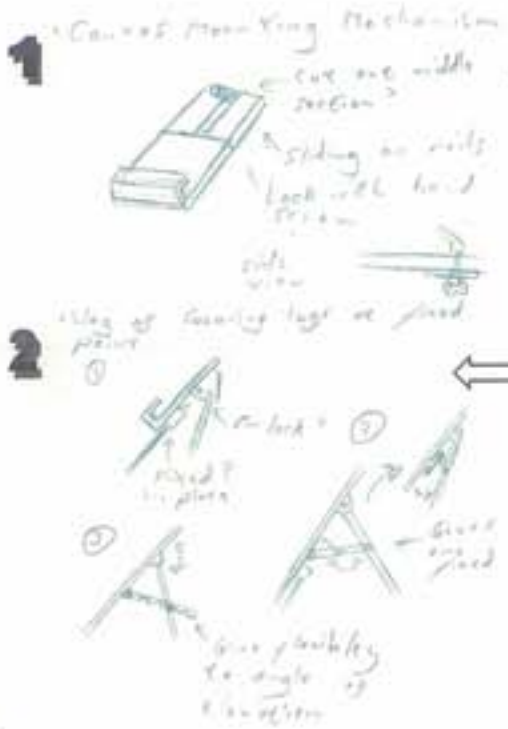
Design Developement-
Review

	Concept - Flat Packed:	Concept - Trebuchet:	Concept - Backpack:	Concept - The Wheelie:	Concept - Briefcase
Form	The product is supported entirely by the two front legs which extend towards the back to provide support, this makes the product feel slightly abstract and less traditional. Unfortunately the other aspects of the form factor still feels aged.	It very minimalistic in its form and deviates from a more traditional bulky frames.	Very different from what traditional wooden frame offers. Whilst the backpack has a recognisable form factor it has not been used as a stand which differentiates it.	It has a similar design to travel suitcases and aesthetically it is rather bland as the focus is on the practicality and function of the product.	Aesthetically this design looks pleasing to the eye as there is a level of complexity to it which is hidden in the other designs.
Function	The painting medium is simply laid onto a ledge which means that a large variety of sizes and mediums can be used, unfortunately this comes at the expense of the ability to secure the material. A tray allows brushes and equipment to be held.	In this design the painting medium is held by two arms that are extendable meaning a variety of sizes can be used. Additionally there would be a separate	A trio of extendable arms secures the painting medium with the painting instruments being held in a compartment what is opened from the side of the stand. This allows the user easy access to their instruments whilst painting.	In order to hold the canvas there is a fixed support that holds the bottom half of the canvas which is then secured with extendable arms that grip the top part. Painting instruments are held in a slot that pulls down from the bottom of the stand.	There is a strip across the bottom part of one of the sides for the painting medium to rest on. Behind this there are retractable holders for the painting instruments for when the stand is in use.
Performance requirements	Would not meet this requirement as there is currently no mechanism to secure the painting medium which may wobble when painting. To resolve this without changing the design much, a rubber surface could be added.	The painting medium would be secured by clamps at both top and bottom. To prevent the horizontal movement of the medium, there will be a rubber strip attached to the clamps to grip the medium firmly.	As the design has "clamps" which secure the canvas/board both horizontal and vertically, in theory the medium would be the most secure with this design out of all the current designs.	There is a wide support so that the whole length of the bottom part of the medium is supported meaning that it is unlikely that the medium will topple over . Additionally the support has a bend in it that will prevent the medium falling forwards.	As the canvas simply rests on the bottom support it is not actually secured so currently it would not meet the performance requirements.
Material and components	Could be made from a variety of materials. Plastic would make this design look childish so metal would be used. Aluminium would be the optimum choice as it is both light weight and corrosive-resistive.	A alloy such as duralumin could be used as it is both light weight and very strong but would have a high material cost. Additionally with this design quick release mechanisms would need to be sourced.	As this needs to be carried on the user back it is vital to have a light material such as aluminium otherwise it may strain the user's back and potentially cause long lasting damage to their spine.	As the product is dragged across the floor the weight of the product is not as big a factor as for the other designs. As a result I can use materials like mild steel for the frame and then use aluminium sheets for the plating.	Keeping weight to a minimum is important so a lightweight material is needed. Aluminium is a good choice as it has a high strength to weight ratio.
Size	Due to the design, even once folded up, it will have a tall profile. This would mean that it would be difficult to fit in a car without having to fold down the rear seats in the car; even then it would likely struggle to fit.	The size should be comparatively small when in a "storage state" meaning that it should easily fit into a car boot. Additionally compared to the other designs it is the most compact.	The size will be approximately 600*400mm when "packed" so that it will not be too large for someone to carry on their back.	This design would have dimensions of approximately 420mm*700*175mm which is small enough to fit in the boot of a typical hatchback but still takes up a large amount of room compared to the trebuchet and briefcase designs.	The dimensions of this design should be relatively minimal and I estimate that it would have approximate dimensions of 420*300*100mm which will easily fit in the boot of any car.
Safety	The majority of this product is smooth curves so there should be no sharp corners. The rails for the tray could potentially be sharp and someone could trap their fingers which can be a hazard. Additionally it should be light as it will be made from aluminium.	As the whole resign revolves around telescopic poles to make the stand compact there is a high risk that the user catch their finger as they are sliding the poles together. To minimise the risk the gap between the inner and outer pole need to be small enough that fingers cannot get caught.	A major concern with this design is that it may damage the user's back if it is too heavy so weight must be kept to a minimum. Additionally the back face should be cushioned to help absorb impact from simply moving around with the stand on the user's back.	There is a potential hazard with the wheels as the user may catch their finger between the main construction and the wheel itself. In addition there is a risk that they may cut their hand if the edges of the equipment drawer is not rounded off.	My main hazard with this design is that the user may get their hand caught in the middle of the two sides as its being opened up. Additionally the sides may be sharp and cause cuts if they are not rounded off properly.
Cost	Aluminium can be a expensive material compared to steel which means the costs could potentially be relatively high. This product would use primarily sheet aluminium which costs approximately £25 for 2 square feet 0.06 inch thick	The cost should may be quite high if an alloy like duralumin is used and there is a high third part component cost as a large number of quick release mechanisms need to be bought in.	Overall cost of this product will be high as aluminium is expensive to purchase. The bag straps themselves would either be bought in whole or made from fabric which is relatively inexpensive.	As we can use mild steel for the basic frame we can save on cost as mild steel is much cheaper than aluminium which most of the other design relies on. The wheels would be a standard component that is bought separately	Again in this design aluminium is used as a consequence the material cost is likely to be relatively high. Additionally quick release mechanisms need to be bought and they can be quite costly which further contributes to the cost.
Environmental Points	As this product could be "flat-packed", this will save on the amount of transport required (if made in batch) and hence reduce the fuel needed. Also aluminium can be recycled so most of the components can be recycled	This product should have a long life span meaning that the user would not need to buy another (which would use up raw materials). Additionally duralumin is recyclable which further	As this product can be made from recycled aluminium the majority of this product is environmentally friendly. If the straps were made from a material like nylon then it can also be recyclet	Mild steel used to construct the main frame can be recycled as well as the aluminium plating. Depending on what material the wheels are made of it may or may not be recyclable...	As the main material used will be aluminium this product is hugely environmentally friendly as it requires very little energy to process. Recycling uses only 5% of the energy used to process aluminium from raw materials (bauxite ore)
Client feedback	• Feels that it feels very traditional. • Not look easily portable. • Interesting use of tray system.	• Very compact design • Can be a bit time consuming to set up as there are a lot of components.	• Very convenient to carry around when compared to the other designs. • Worry the weight may harm the user when carrying around.	• Easy to move the stand around. • May be quite bulky.	• Most aesthetically pleasing out of all design ideas. • Easy to carrying around short distances.

Design Developement

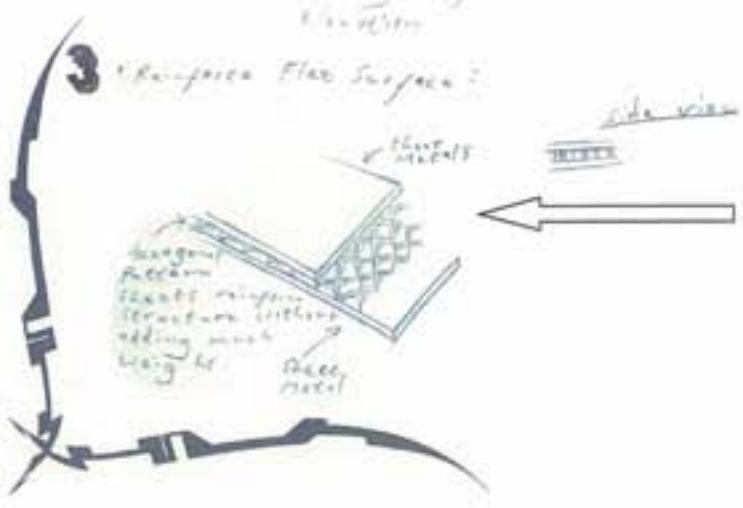
Develop

Aesthetically this design looks very attractive, but there are various issues with it that must be over come. For example there is currently no way to secure the canvas onto the stand itself as it currently would simply rest on the canvas support. This is a major issue when uses outdoors as mounted canvas can be very light and have a large surface area, this combination can lead to the canvas being literally being blown away by the wind in a outdoor environment (e.g. At a beach). Therefore in my development I will aim to resolve these issues with the design.



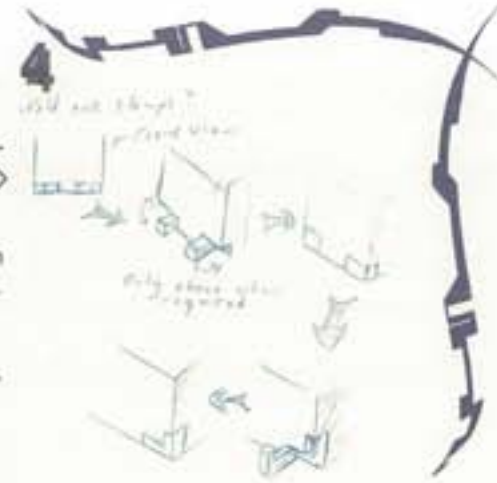
A method is required to ensure that the canvas does not fall off the painting stand and this is especially paramount as this product will be used outdoors. One method of securing the canvas would be to have a arm that clamps it down by applying pressure to the top. A slot could be cut down the centre of the flat area and the holder sandwiched in the slot and a screw can be used to lock it in place.

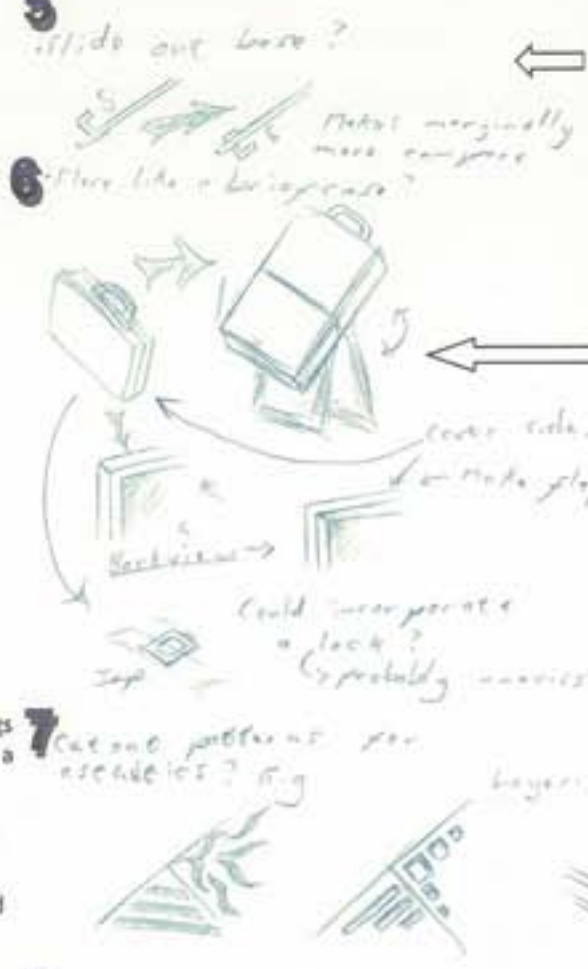
There are a variety of methods that can be to secure the legs into the correct position. The first method would be to use a bracket with holes drilled into it at fixed points, the legs would then be secured with a pin. You would end up with a very strong joint but it limits the degrees of adjustability of the legs. The second method would be to use two support bars what are free to swivel. This would be the simplest and quickest to use but it can only be fixed into one position which can be frustrating for the user. A third alternative would be to have a support bar with notches cut at regular intervals which slot in a pin on the leg. This would give a wide range of adjustment to the level of elevation, but is the least secure out of all the methods as the there is a possibility that when knocked, the notch may disengage.



If the sides are to be made from metal then thinner sheets would need to be used otherwise the product will be too heavy. To resolve this we can sandwich a hexagonal mesh between two thin sheets of material. By doing this we get both structural rigidity and lightness. The downside to this method is that it would increase the thickness of the sides considerably. I estimate that when its in its portable state that by using this design I would be adding around 20mm to the width (10mm for either side) and this is a considerable amount when you consider that the product will be held at your side.

Instead of having a fixed canvas holder it may be worthwhile considering a design which have the component fold away when not in use. To achieve this I would have a cut-out area on the lower panel and then have a component which swivels out on a thread locked bolt or similar. The downside to this design is that the lower panel has to be relatively thick to be able to do this.

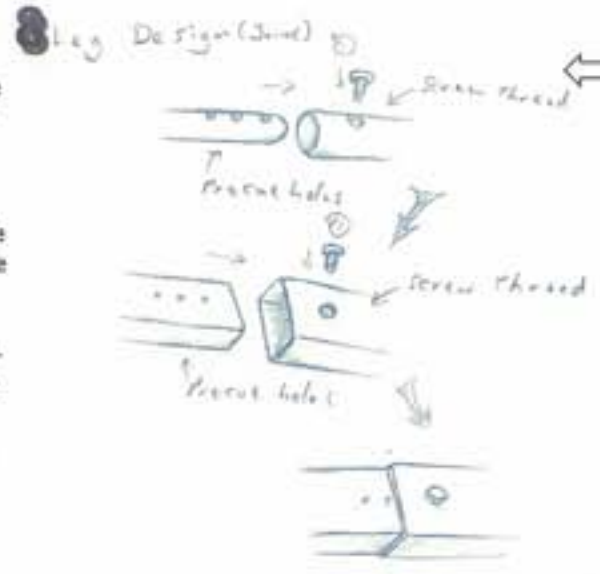




An alternative method of achieve this would be to have the whole base slide in and out of the sheet area through a slot. This idea is advantageous because it allows for a variety of sizes of materials to be used easily where's with the previous idea you would need regular notches across the whole lower area to support a variety of sizes. It would be difficult to manufacture as it would be near impossible to put the second bend in the component after putting it in the slot so an alternative method would be need to hold it in place.

Currently with the design all the internal components are shown which from a purely aesthetical point of view can be both ugly and good looking at the same time. My concept is that everything should be enclosed and one way of changing the design with that idea in mind would be to have "flaps" that cover the sides when not in use. Aside from improving the product aesthetically (in my opinion), it also means that dust gathered from being in storage will only be on the outside of the stand which is turn results in it being easier to clean. This is important as the stand will be likely stored in the art department for long periods of time as my client tells me that only a few people every year choose to paint onto canvas.

To further try to make the product a more atheistically pleasing a layer of thin acrylic (1mm thick) could be stuck to the sides. It would be possible to engrave a variety of images/patterns onto the acrylic as well as giving the product some colour. I would have to use a adhesive agent like epoxy resin to glue acrylic to sheet metal because there is a danger that drilling holes into the acrylic and securing with a screw will cause the material to fracture as it is very brittle.



Ideally this product would use telescopic legs which are secured by a quick release mechanism but these can be difficult to source. An alternative method of securing telescopic legs it to have a series of holes cut into the inner bar/pole and single threaded hole on the outer bar/pole which a machine screw threads into. I believe a M5 size screw will be needed to ensure that it does not sheer off. This means that a wall thickness of 2mm at least will be required to tap a sufficiently strong thread. As a result this would raise the overall weight of the product considerably which is a issue as the stand is intended to be portable. Additionally I believe steel would need to be used as aluminium is very soft and a M5 thread would not be strong in a mere 2mm thick material meaning that there is a high chance of deforming under stress. My client raises the issue that it may be frustrating to the user if they are struggling align the holes to secure the legs.

Design Developement

Develop

• Variation of Design ?

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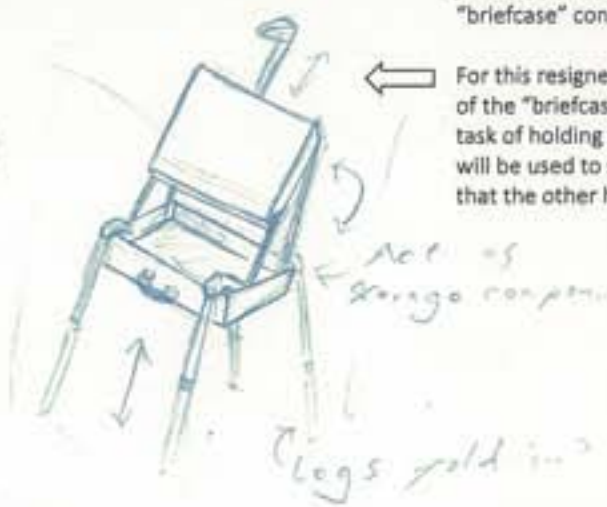

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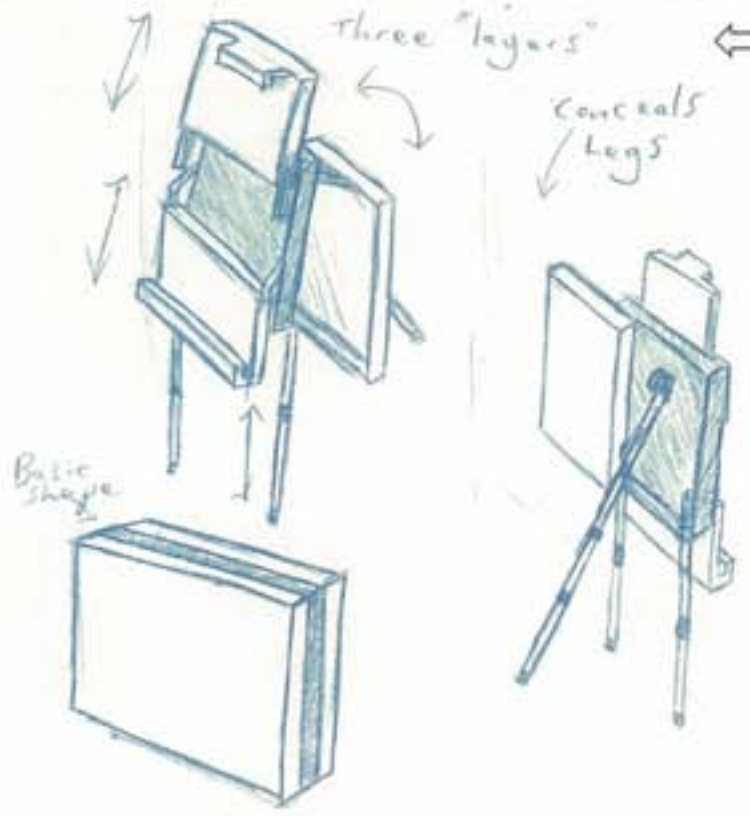
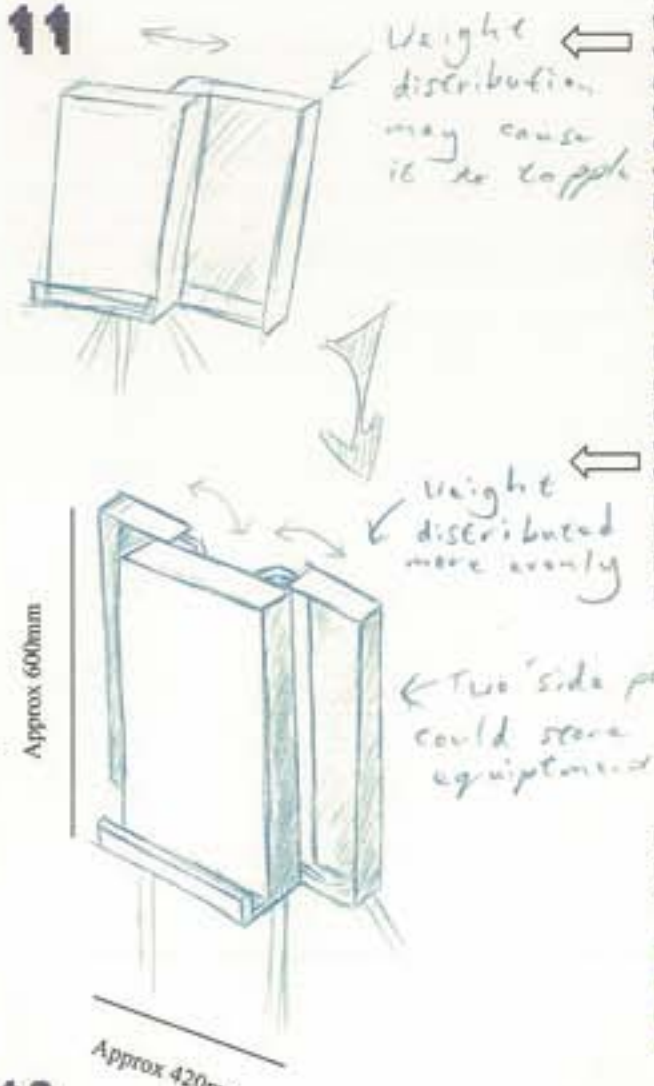


⇦ As there are many issues surrounding the original design that cannot be easily solved through small design changes I feel that it would be better to look at more major changes to the design whilst still keeping the "briefcase" concept.

⇦ For this resigned, instead of relying on both flat surfaces of the "briefcase" I have elected to only use one for the task of holding the canvas. An extendable arm at the top will be used to secure the painting medium. This means that the other half can be used as a tray effectively for holding the art instruments whilst painting. The two "halves" would be connect by collapsible arms. The legs would be telescopic and secured with a bracket. Initial concerns with this idea is that canvases with smaller dimensions may not be compatible and that it would be time consuming to manufacture the brackets that the legs mount onto.

⇦ My second design was based around a 3 layer idea. The front layer would be used to actually mount the canvas whist the seconds lay acts as the main frame which the legs and everything else is mounted to. A double hinge system it used to lower the bottom half of the front frame into a fixed position whilst the top half is connect by a railing system so that it can be moved freely up and down. This is so that it can hold down the canvas securely but the downside with this setup is that it wouldn't be able to hold canvas sizes which are too short (such as A5). The third layer his hinged which functions as a back cover to hide the legs when not in use as well as a area where the art equipment can be held as holder can easily be incorporated. Whilst this design looks interesting it will result in a very thick product that would be difficult to carry

11



⇦ My third incarnation of the briefcase concept tries to take a more simpler approach in which the canvas is held on the outside of the stand which guarantees that all canvas sizes will fit (up to A2 hence the 420*600mm dimensions). Initially in this concept I decided that that there would be one door which can hide the legs and provide area for holding instruments right hand side as it is more ergonomic to the user (assuming they are right hand which is very likely as statistics show that approximately 92% of people are right handed).

⇦ I quickly realised that the stand would become very unstable as all the mass is thrown to one side. To resolve this I redesigned it so that there was a two door configuration which would distribute the weight evenly between the two sized. The canvas holder would be fixed permanently in place as the less moving parts there are the simpler the product is to use as well as being less likely to fail. My client initially said that the end product would be rather large so it might be difficult to carry around. After a little discussion we felt that the increase in length is justifiable as there would be a decrease in width which we felt is more important. Additionally with a tall stand it means that there is more space for the legs, as a result they do not need to be made into as many telescopic components compared to the other designs, this should mean greater stability and is more user friendly.

This design will be constructed from mild steel main frame and aluminium panels. Both these materials can be recycled hence minimising damage to the environment.

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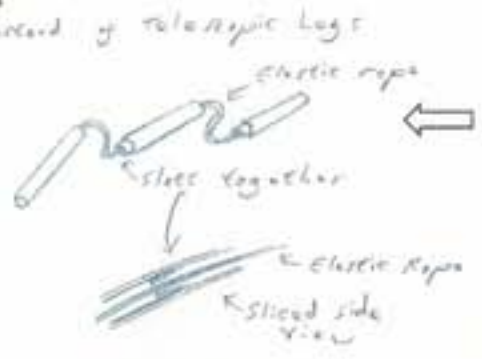

⇦ As an alternative to having telescopic legs I considered alternative methods. One of my ideas was to connect to leg parts by having one cylinder having a smaller inner part which slots into the other part. This can be easily be manufactured in house with a lathe and hollow aluminium bars which helps keeps the weight down to a minimum. An elastic cord could be stuck inside so that the components are constantly being pulled together meaning that they would be secure and it also means that individual leg components can not be lost. Unfortunately with this design it is not possible to adjust the length of the legs meaning that it would not be suitable for a range of users with variable heights.

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⇦ The product should be convenient to carry around so I considered incorporating a bag strap which means that it would be easier to carry around. A metal latch could be added to the sides of the stand and the strap itself would be sourced. By reason for not using this idea would be that the strap would have to be fairly long and there could easily get trapped with the door hinges.

Design Developement

Develop

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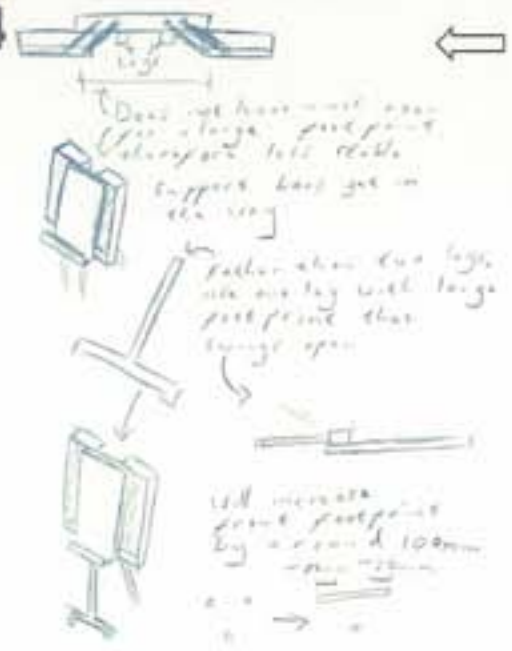

To achieve the largest foot print possible the front legs would be ideally mounted on the edge most parts of the main frame. Unfortunately this is not possible as the hinges get in the way so the legs would not be able to fold out. My proposed solution is to have one front leg that has a wide base. This not only allows me to achieve a larger footprint (as the door hinges would not get in the way of the leg folding out), but it also makes it simpler for the user to set up as they are only dealing with one front leg as opposed to two. The shape would be made from metal bars and then welded together as welding will provide the product joint. Due to workshop limitations this means that I would have to use steel to make the front leg as we are unable to weld aluminium (which would have been my first choice of material as it is very light compared to steel making transport easier).

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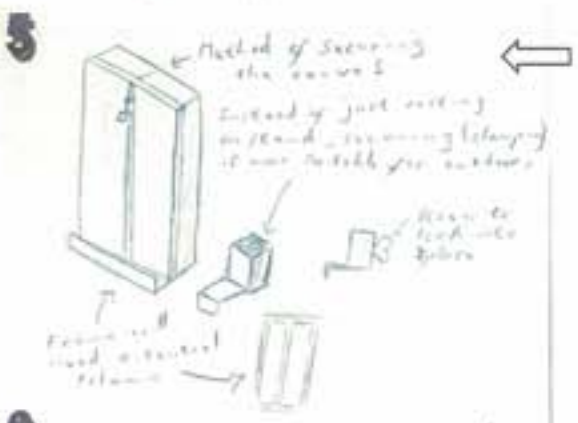

As I stressed earlier on in the design phase I believe its vital for the success of this product for it to be able to secure the canvas . In response to this I incorporated a central column in the frame. This allows me to have a component which can slide up and down the entire length of the canvas support meaning that all sizes of material can be used. For the bottom half of the canvas holder it will be made from a sheet of steel which is then bent and pop-riveted to the frame. For the sliding top component it will simply be made from a hollow bar with a piece of bent steel that is welded on; this component would have to be attached to the frame before the frame has been welded together or it cannot be attached at a later time. A hole would be drilled into the back with a thread tapped into it, this would allow the user to attach a screw that will secure the slider in place when it is in the correct position.

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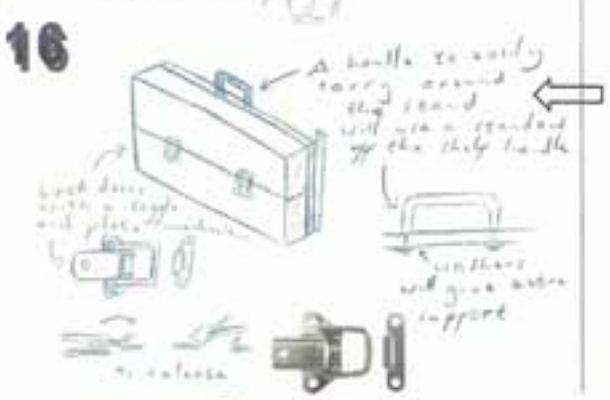
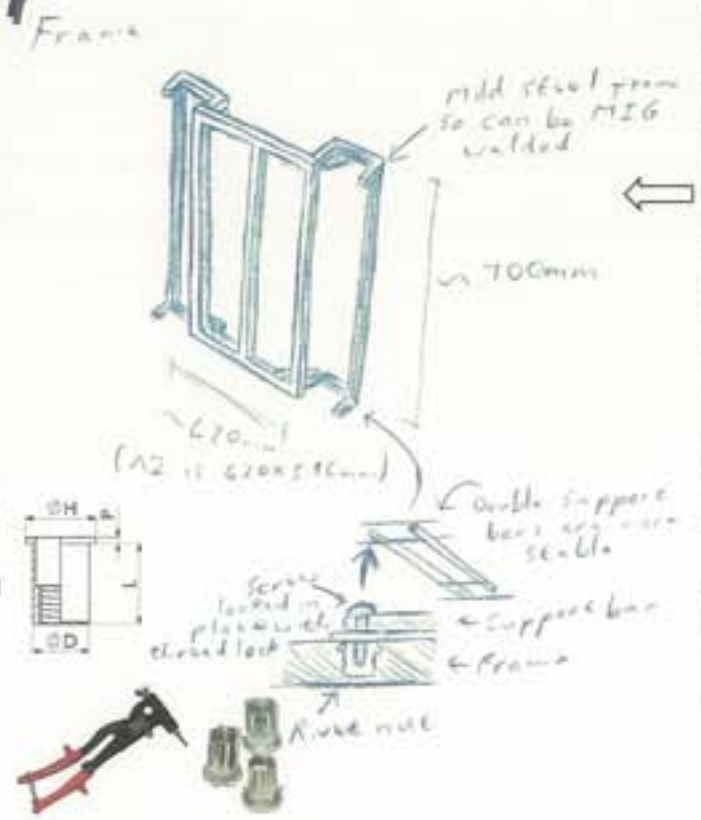


In order to carry the stand around I will incorporate a handle that is attached to the mains frame as most of the weight will be concentrated the main frame as the door and the legs are attaches to the main frame. Due to time limitations I believe it would be better to buy a commercially available handle instead of manufacturing one in house.

Also a method is required to keep the doors closed and initially I considered a sliding bolt mechanism but whilst it would be very secure it would look very unsightly. In the end I decided on using a toggle & plate mechanism which is both easy to use and looks reasonably attractive. The combined effect of having the toggle plates and handle makes the form look more natural as it looks like a briefcase which is a form that people are accustomed to. The client agreed that this combination makes the product feel more intuitive as the form is recognisable (it looks like a briefcase and people understand instinctively that it holds something inside, in this case the thing inside would be the stand 's legs).

17



Developing on from the initial design shown in point 11, the mechanism used to open the door will be a set of double hinges as they will the inside part of the doors facing the user. This allows me to incorporate the art holders into the doors. Also if I ensure that the hinges are fairly stiff when I do not need another mechanism just to keep the doors open . If I were to using something like rails then I would likely need a separate mechanism to keep the doors open as most commercial rails are designed to slide open and shut smoothly .

To attach the support bars to the frame M4 rivnuts and screws will be used . To actually secure the screws as they are likely to coming out after a while due to the turning motion of opening and closing the doors, I will use strong thread lock white will keep the screw in place.

As the frame needed to be welded together I will be using mild steel for the manufacture of my product. I have elected to use 13*13mm bar with a thickness of 1mm in my prototype to keep the overall weight down.

18

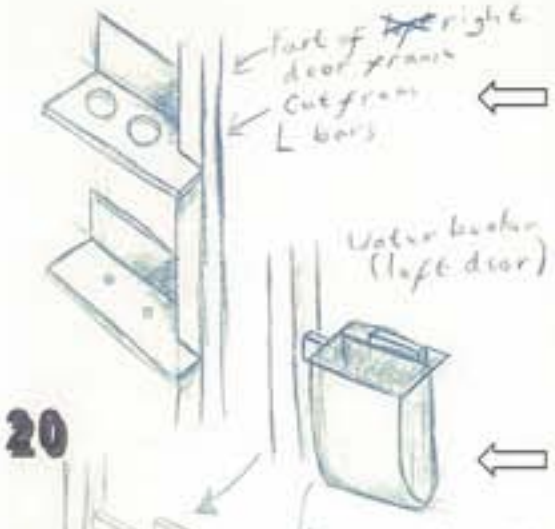
Modelling the Door Hinges

As it was difficult to visualise where the support bars should be I decided to use some modelling to help me decide that length of bar I should use as well as where the y should be attach to the frames. I started by marking up the frame and door (from a top view) on a 1:1 scale which I then cut out. I used some push pins to secure the bars in the area where I thought they should be positioned. In the end I select a length of 115mm between the centres of the two holes for the screws. Also I chose to have the bars 35mm apart from each another . Due to the fact that I used a 1:1 scale it was easy to transfer the dimensions to my design drawings

Design Developement

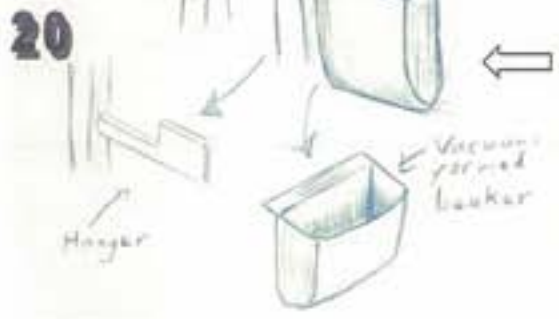
Develop

19



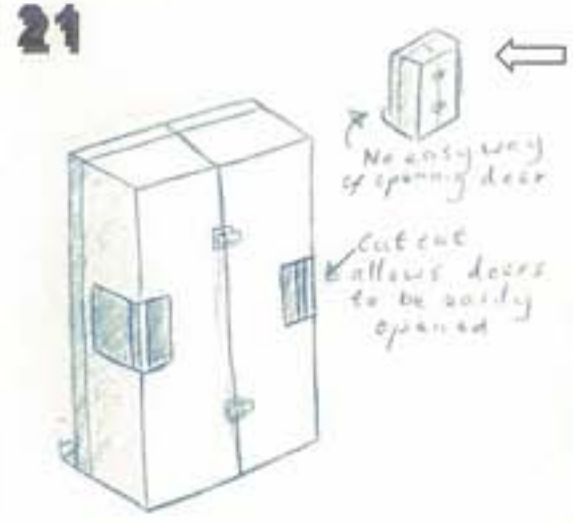
In my specifications I stated that the final product should have some method of holding the art instruments so to satisfy this my design incorporates a little brush holder component which is welded directly to the right hand door. It would be cut from a extrude L shaped bar of mild steel and the holes would be drilled with a pillar drill. The top part will have a diameter of 12mm which is sufficient to accommodate larger brushes and the lower one will have a diameter of 5 which is wide enough for the brush to sit in the whole but without falling through. I chose to create a product which only holds paint brushes because according to my client brushes are the most common instrument used with canvas so rather than waste space and increase the weight by trying to accommodate for a large variety of equipment I felt that it would be better to target brushes.

20



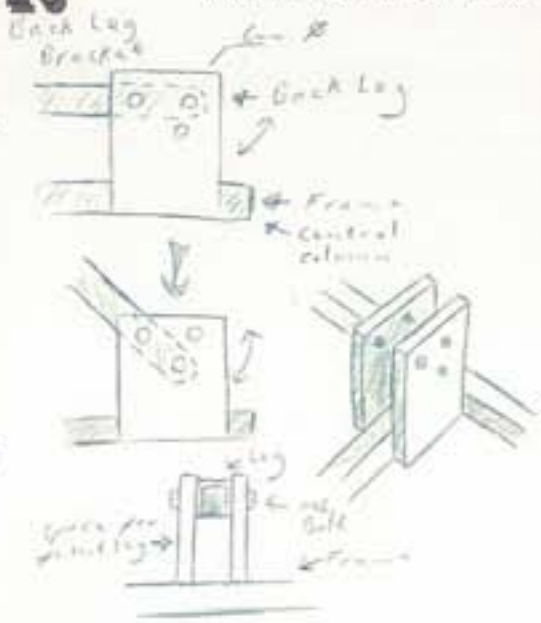
On the left side door there will be a beaker holder. The hanger would be made from a sheet of 2mm thick mild steel and then welded on. The beaker unit itself will be made by vacuum forming a sheet of 1mm PVC over a mould. A craft knife will be used to cut off the excess and also create the slot for the hanger to hold the beaker. I chose to manufacture my own water beaker because it allows me to minimise the width of the beaker hence I can minimise the overall width of my product.

21



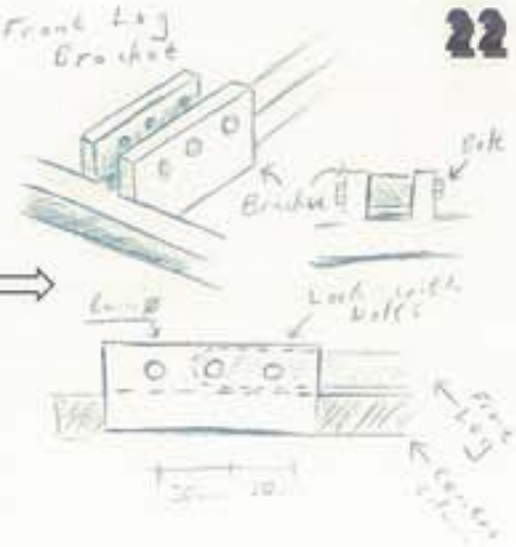
Currently as the product stands there is no easy way to open the "doors" and the user would need to grip the top and bottom of each door to open it. This is not practical and can be frutrating for the user. Rather than adding external handles which would make the product larger I chose to using the existing infrastructure of the doors. My solution was to simply cut out a area on the doors panels so that the user can grab a hold of the door frame itself and open both doors with a single motion. The downside to this that it makes the product look less aesthetically pleasing but the trade off is the it is much more practical. After speaking to my client we decided that it would be better to have the product look slightly less appealing than to have a product that was not practical. For the manufacture it is necessary to cut out the area before bending the material.

23



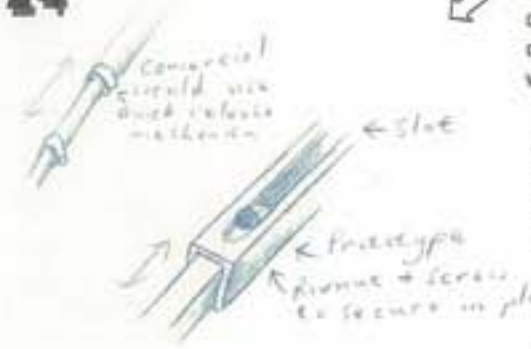
To attach the front leg there will be a simple bracket attached to the bottom half of the central column of main frame. The frame consists of two 5mm thick sheets which are welded on to the central column. Because the main frame will be made from 13mm*13mm bars and the front leg from a 16mm*16mm bar, spacers will be needed so that the brackets are the correct distance apart from each another to accommodate the front leg. The centre whole would be the one that the front leg rotates on whilst the other two holes are for securing the product in place.

22



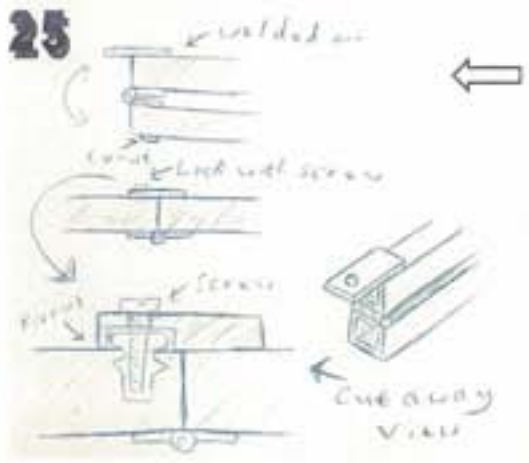
For the back leg the bracket will be situated on the top half of the central column. Just as before, due to the 13mm width of the central column, spaces will be required so that the distance between the brackets is 16mm for the back leg to fit. The holes for the back leg will be raised to that there is room for the front leg to fold away and then the back leg (when not in use) will rest on top of it.

24



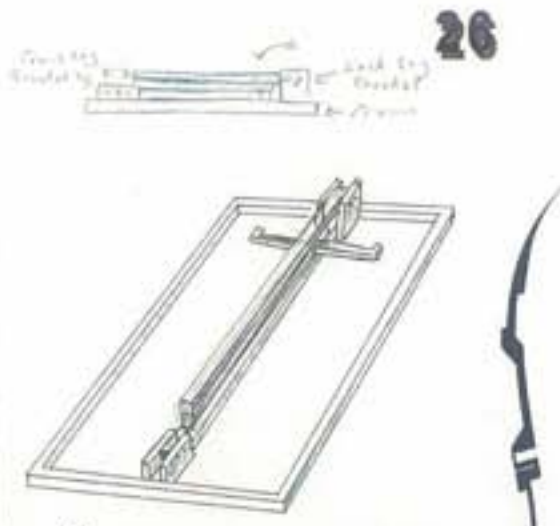
The metals for the stand will be telescopic and instead of having fixed points where you can secure the legs (see point 8) I decided on having a machined slot so that the user is given a greater degree of adjustment. To secure the leg there will be a rivnut attached to the inner leg and a screw will pass through the slot and will tighten a washer against the outside edge of outer leg. In my prototype I will be using a ordinary M4 screw so a screwdriver will be needed to secure it, but if there is enough time I will manufacture some wing-screws which can be tightened by hand.

25



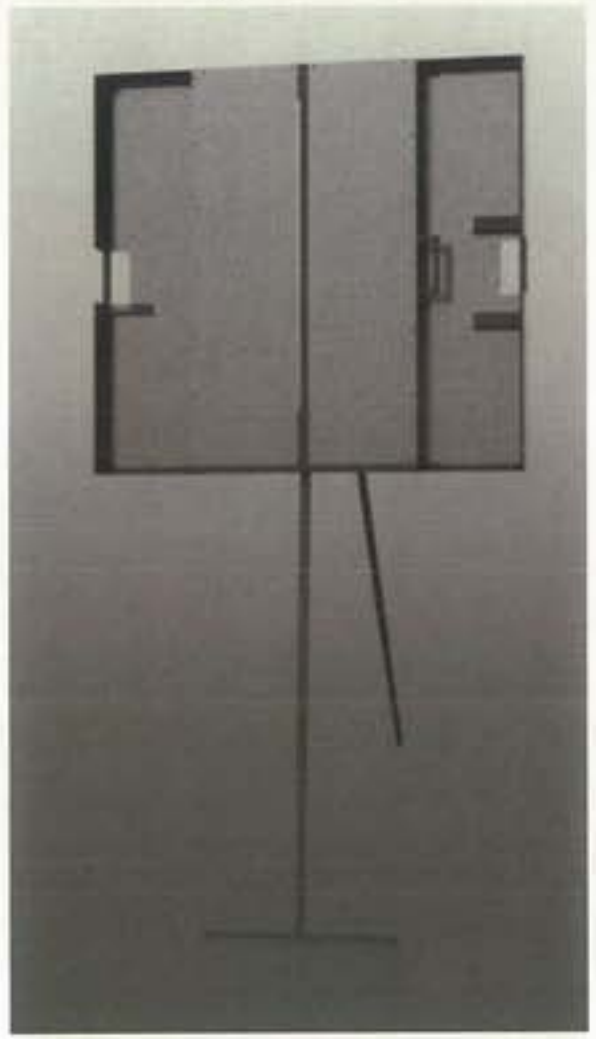
A limitation of the slot method of securing telescopic legs is that you can not have a three piece telescopic setup. The back leg will need a 3 piece leg setup to ne long enough to hold the stand upright so to overcome this issue I designed a hinging system so that one part of the leg can be folded under the other when not in use. The protruding plate has to be milled so that the rivnut is flush with it when in use so that the leg is straight. This is not a ideal solution but it is a prototype to show whether the overall design works. If manufactured commercially then the legs would be fully telescopic and secured with quick release mechanisms like in a tripod.

26



This is a quick sketch to demonstrate what the main frame with the legs attach looks like when they are not in use.

Design Developement
Computer Aided Design

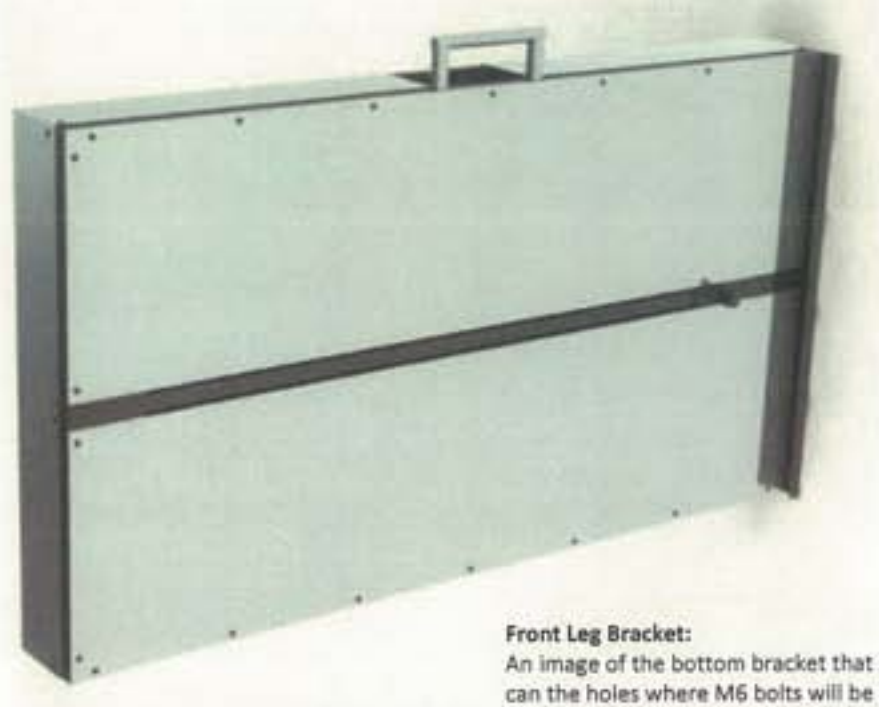


Front View When Opened:
This is a CAD rendering of what the prototype would look like when its in use. The panels are a different colour because it would be made from aluminium as it is much lighter than steel. Unfortunately do to the limitations of the workshop we are only able to weld steel so the frame itself is made from mild steel which is then coated in a black paint.

Environmental Points:
This design is very compact so if it was to be made commercially it would help reduce fuel as more can be stacked in a lorry at any one time. Additionally both the aluminium and mild steel in the product can be recycled with only a only a fraction of the energy cost (5%) compared to extracting from ore.

Front View When Closed:
When the product packed away it will resemble a briefcase and the design is minimalist meaning that it is very easy to store away.

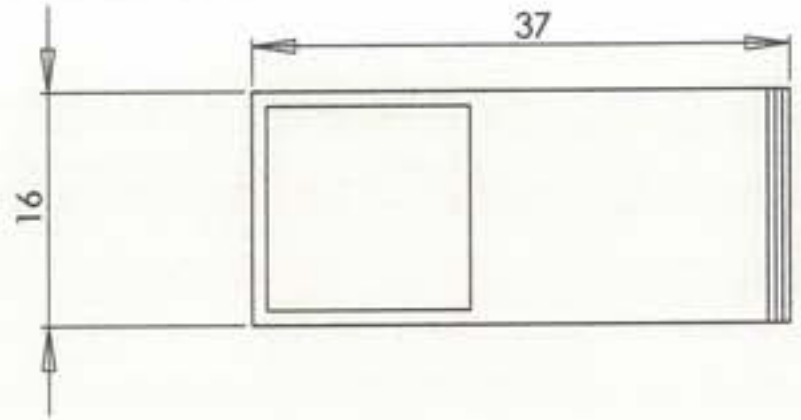
Back View When Opened:
A view from the back of what the stand will look like when in use.

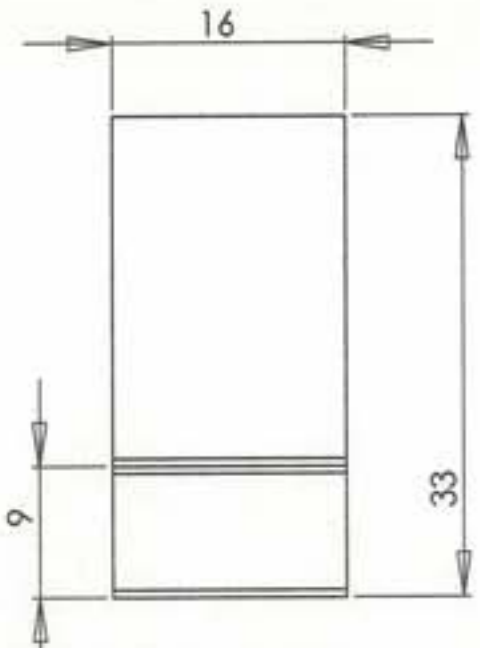


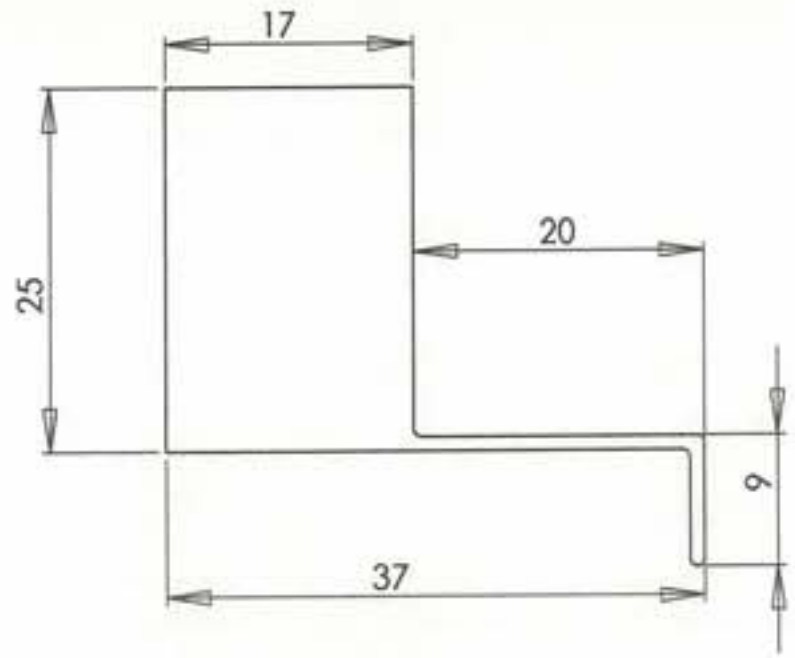
Front Leg Bracket:
An image of the bottom bracket that secures the front leg. You can the holes where M6 bolts will be used to secure the leg.

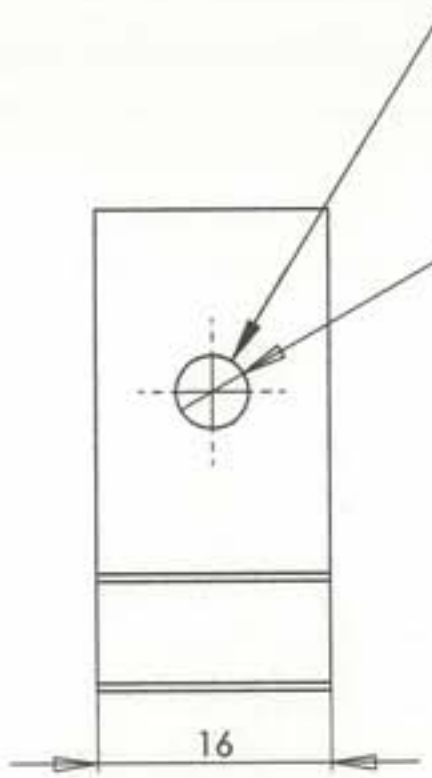
Door Hinge Mechanism:
A rendering of the hinging mechanism what will be used to open and close the doors.

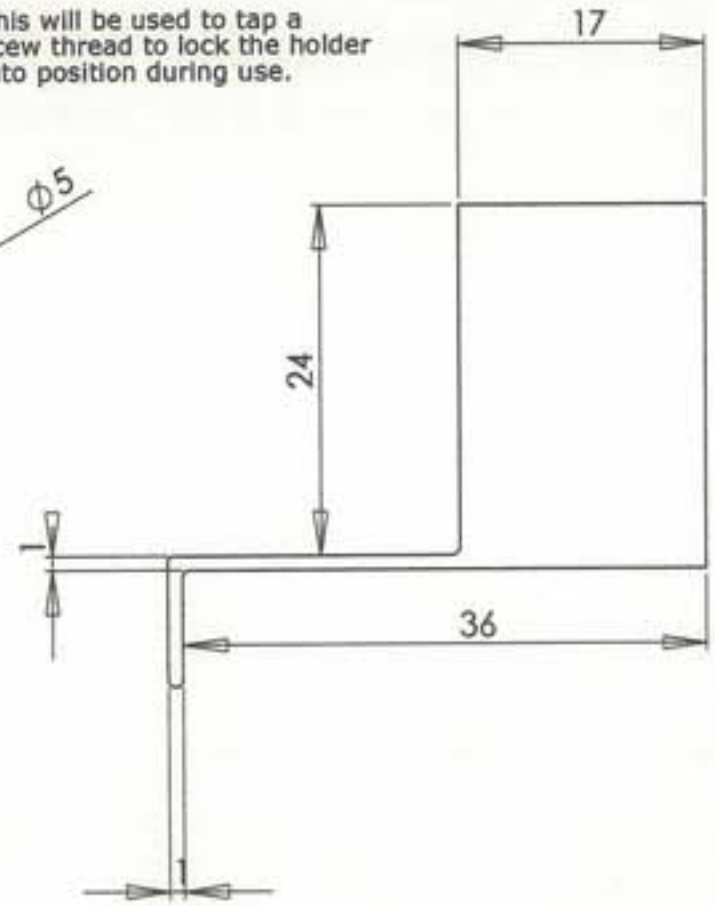
Back Leg Bracket:
This is the top leg bracket that is used to secure the back leg in place.

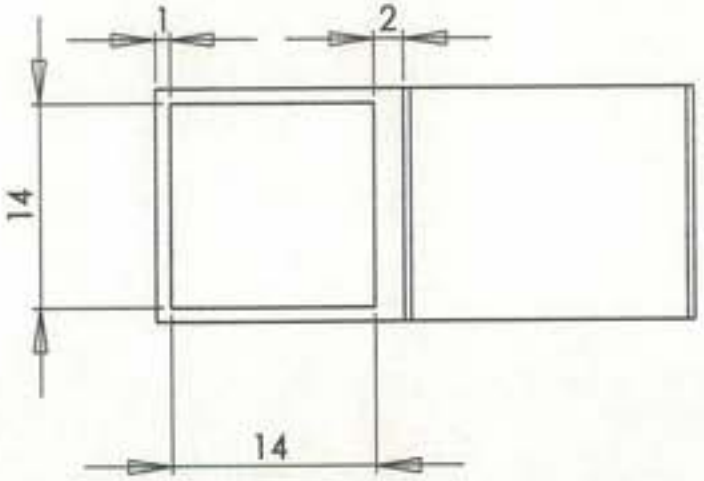


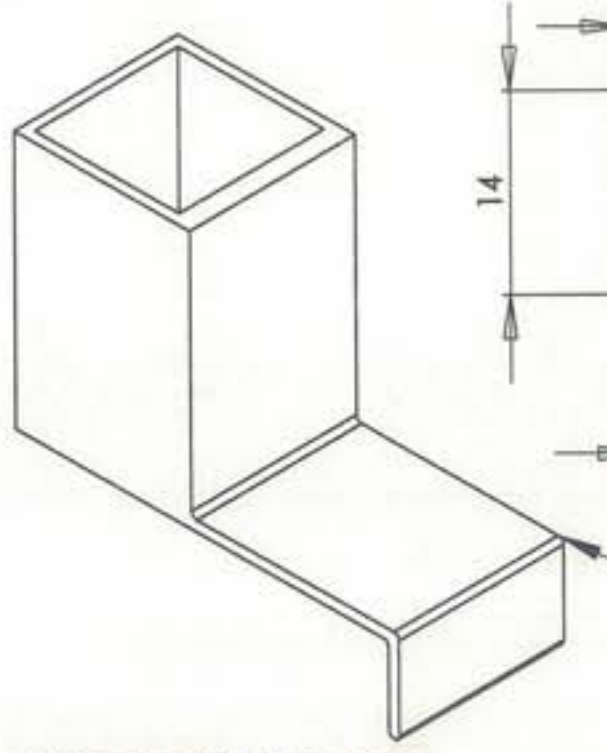












This section that extends out will be made from sheet steel (1mm thick) and then welded onto the hollow bar.

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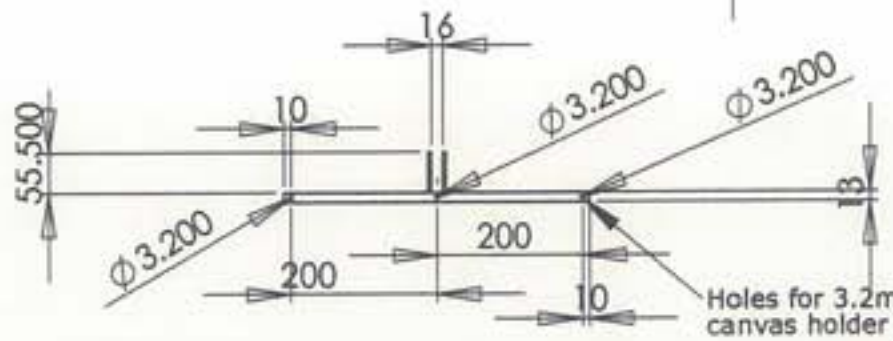
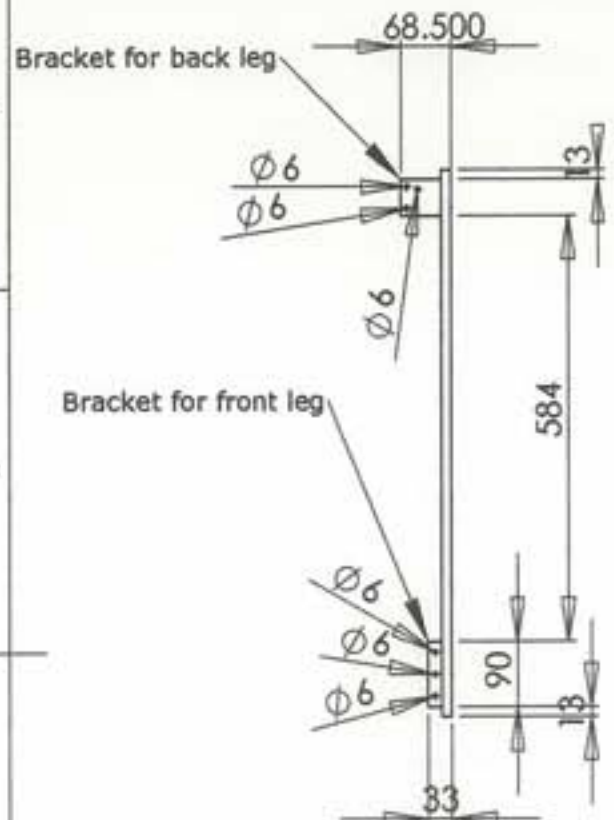
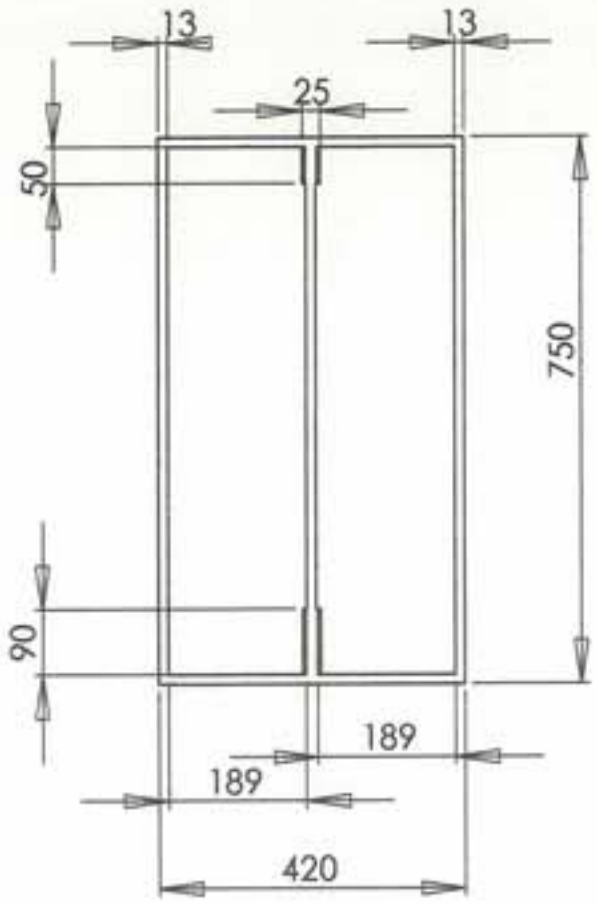
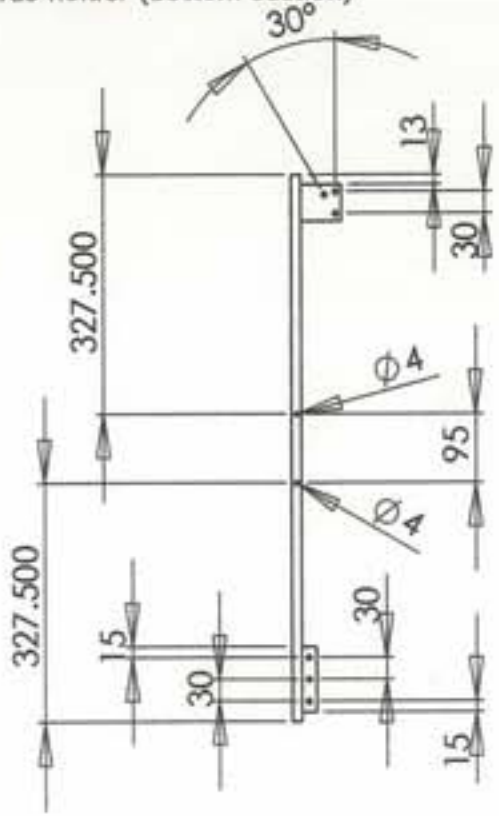
CHK'D						
APPV'D						
MFG						
Q.A				MATERIAL:		DWG NO. A3-1
				WEIGHT:		SCALE:2:1 SHEET 1 OF 1

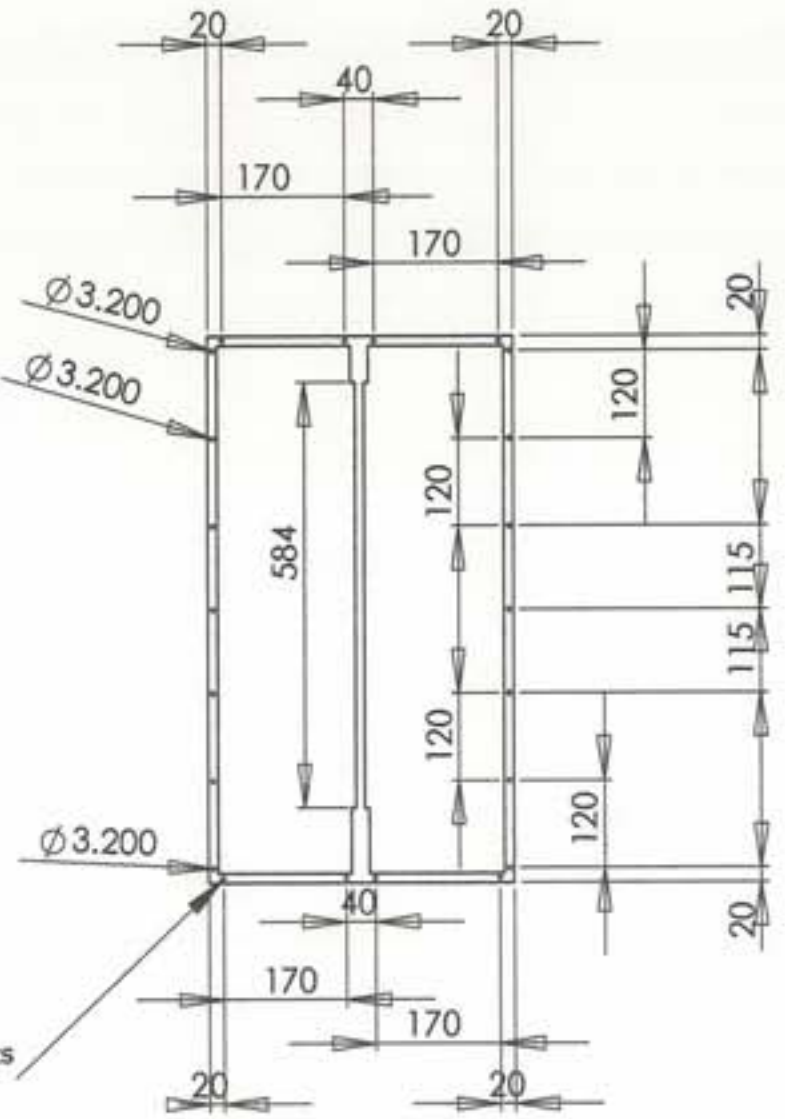
Canvas Holder Top Part

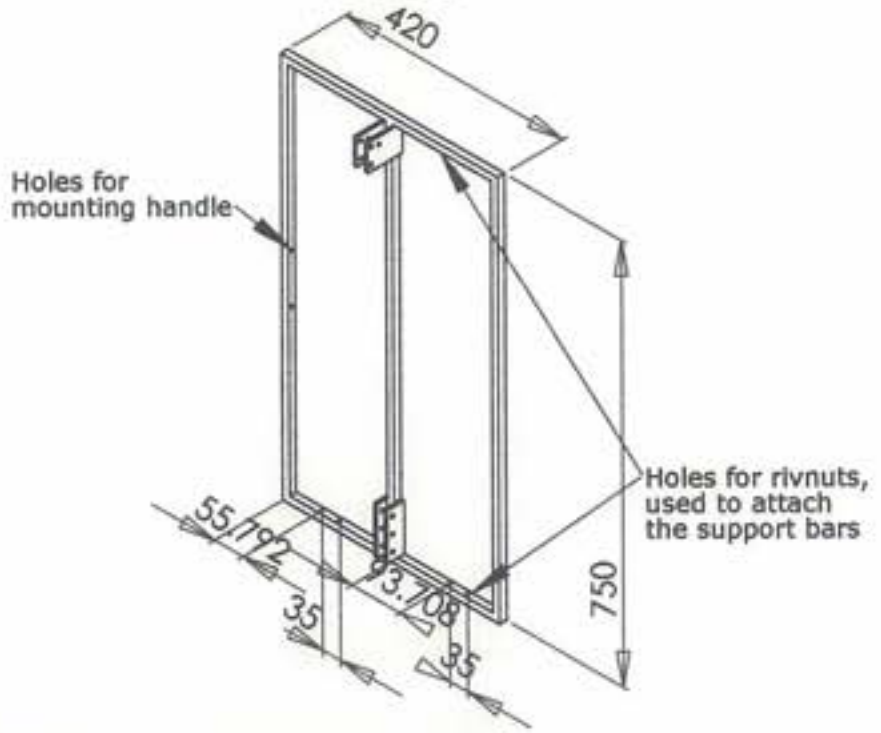


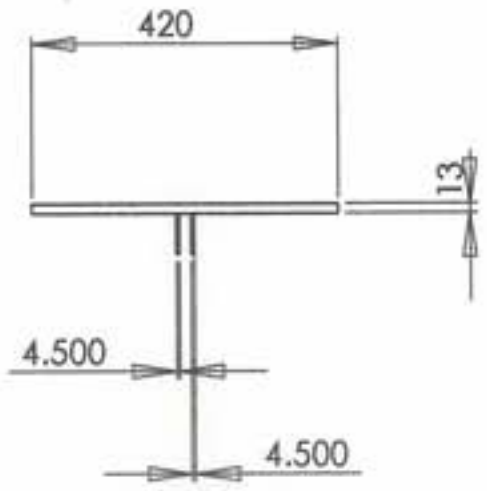












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DRAWN			
CHK'D			
APP'VD			
MFG			
Q.A.			

MATERIAL:

WEIGHT:

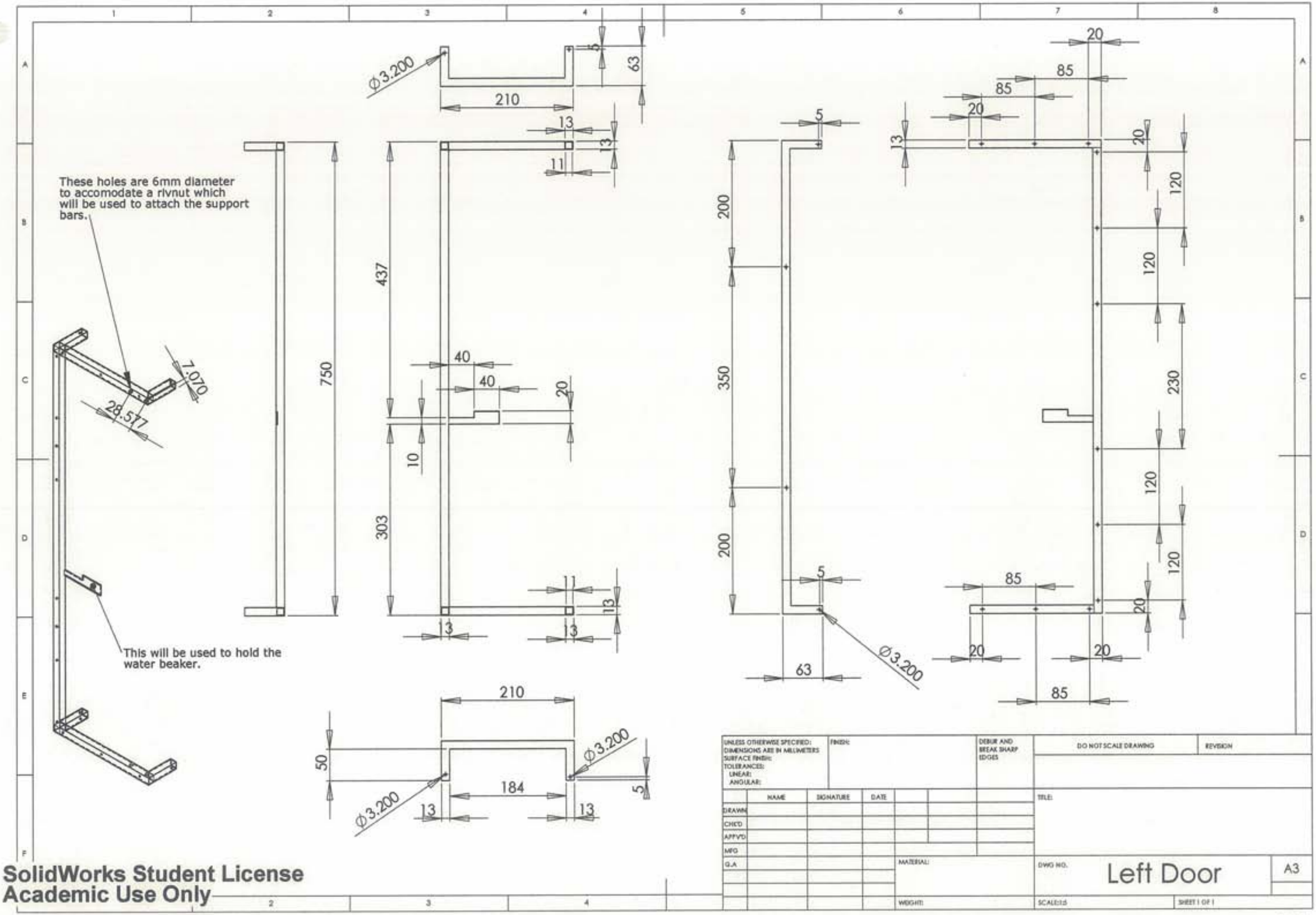
TITLE:

DWG NO. Main Frame

A3

SCALE:1:10

SHEET 1 OF 1



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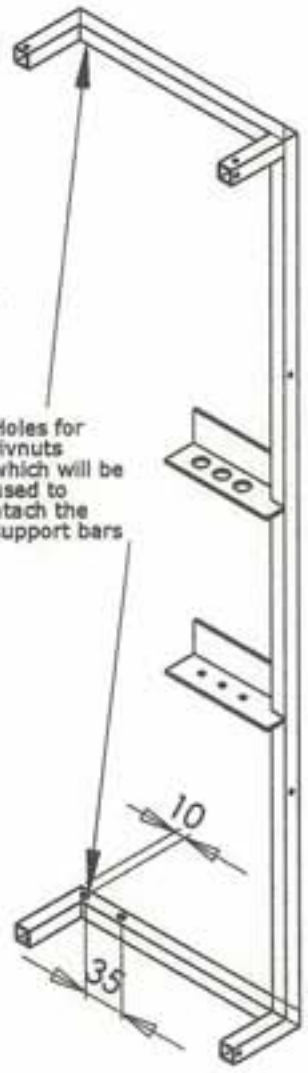
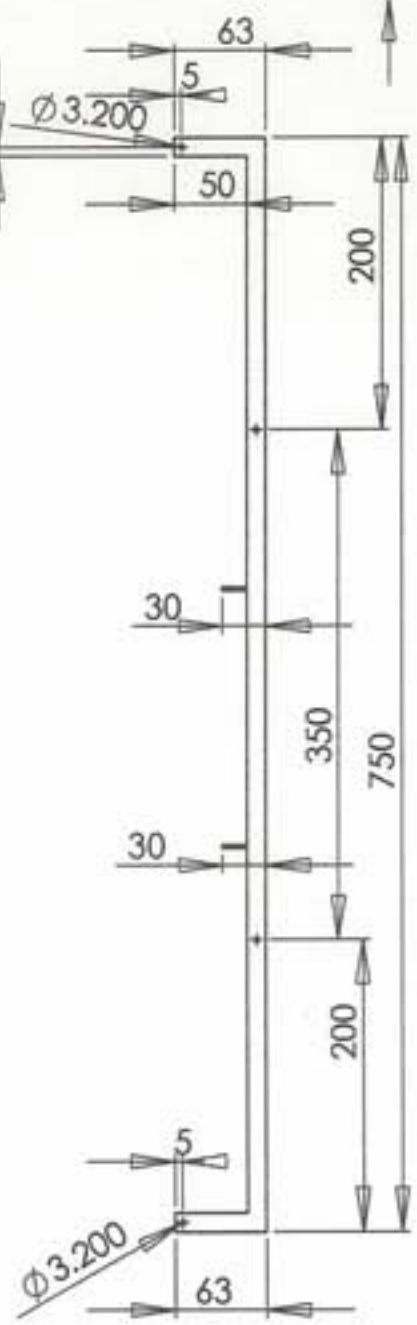
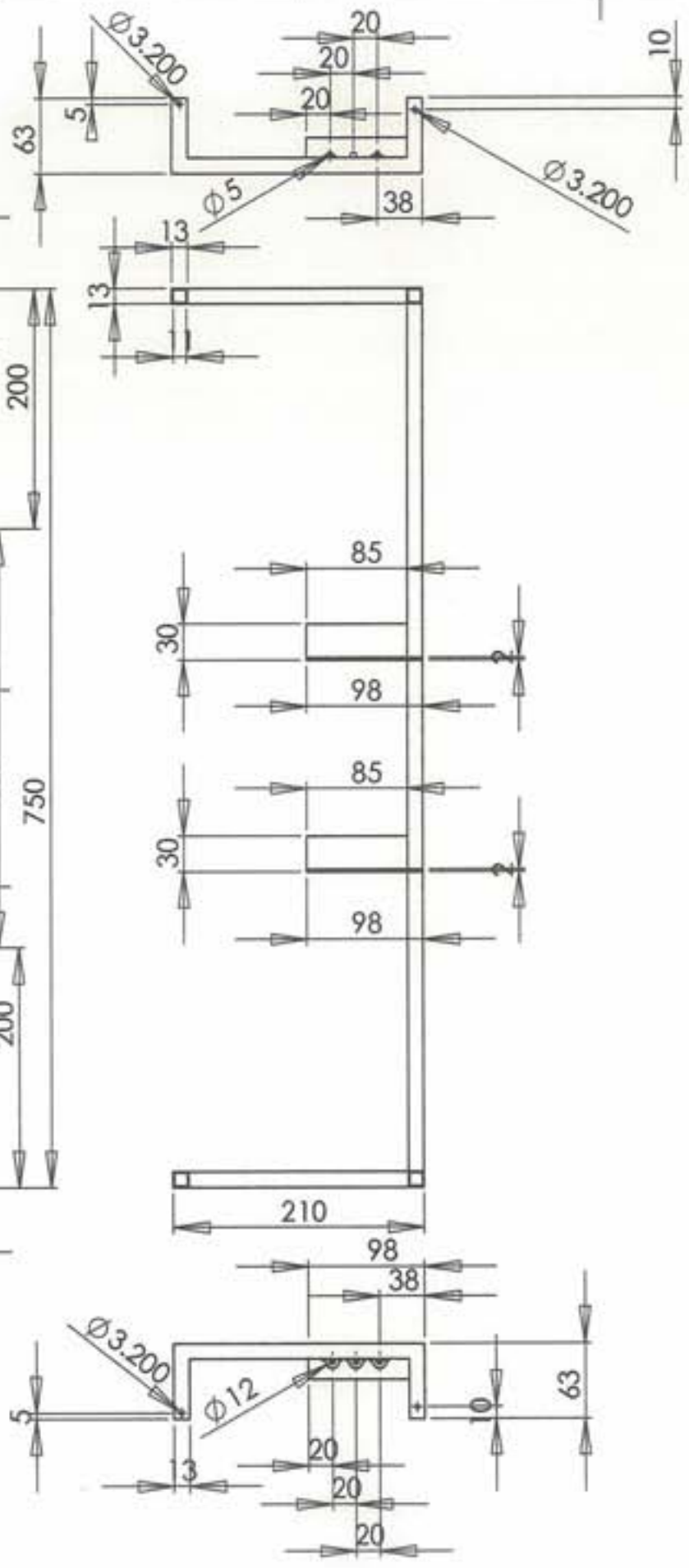
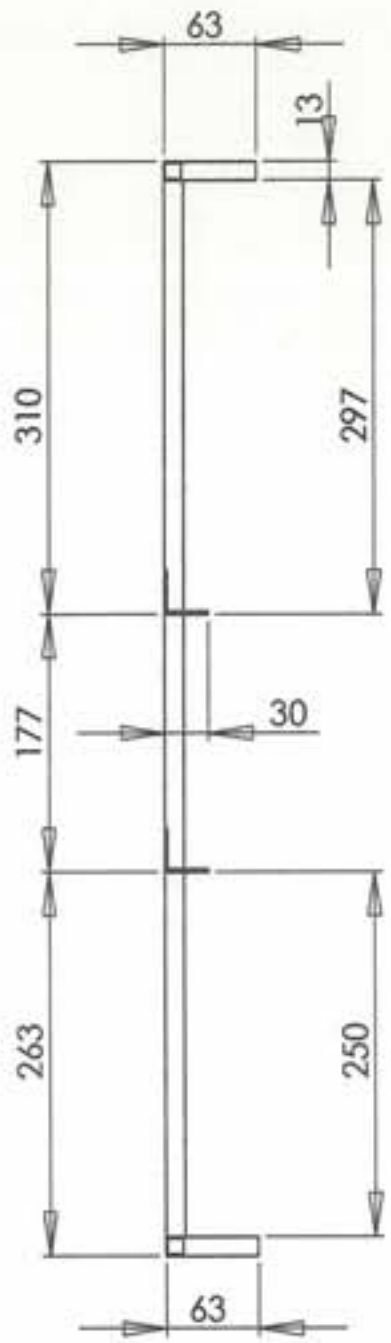
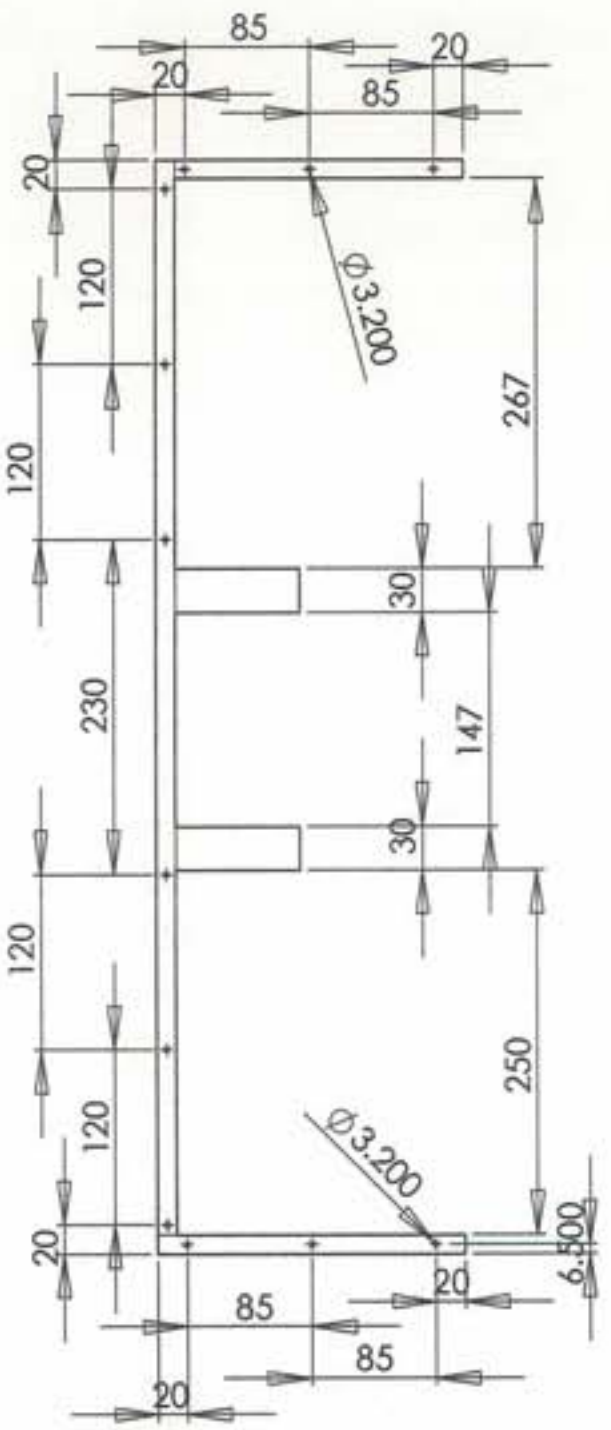
DRAWN							
CHK'D							
APP'D							
MFG							
Q.A				MATERIAL:			DWG NO. Left Door
				WEIGHT:			SCALE:1:5 SHEET 1 OF 1











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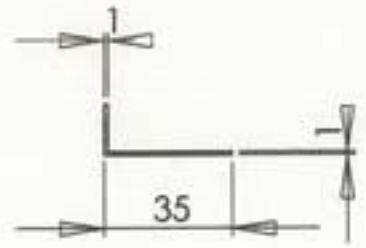
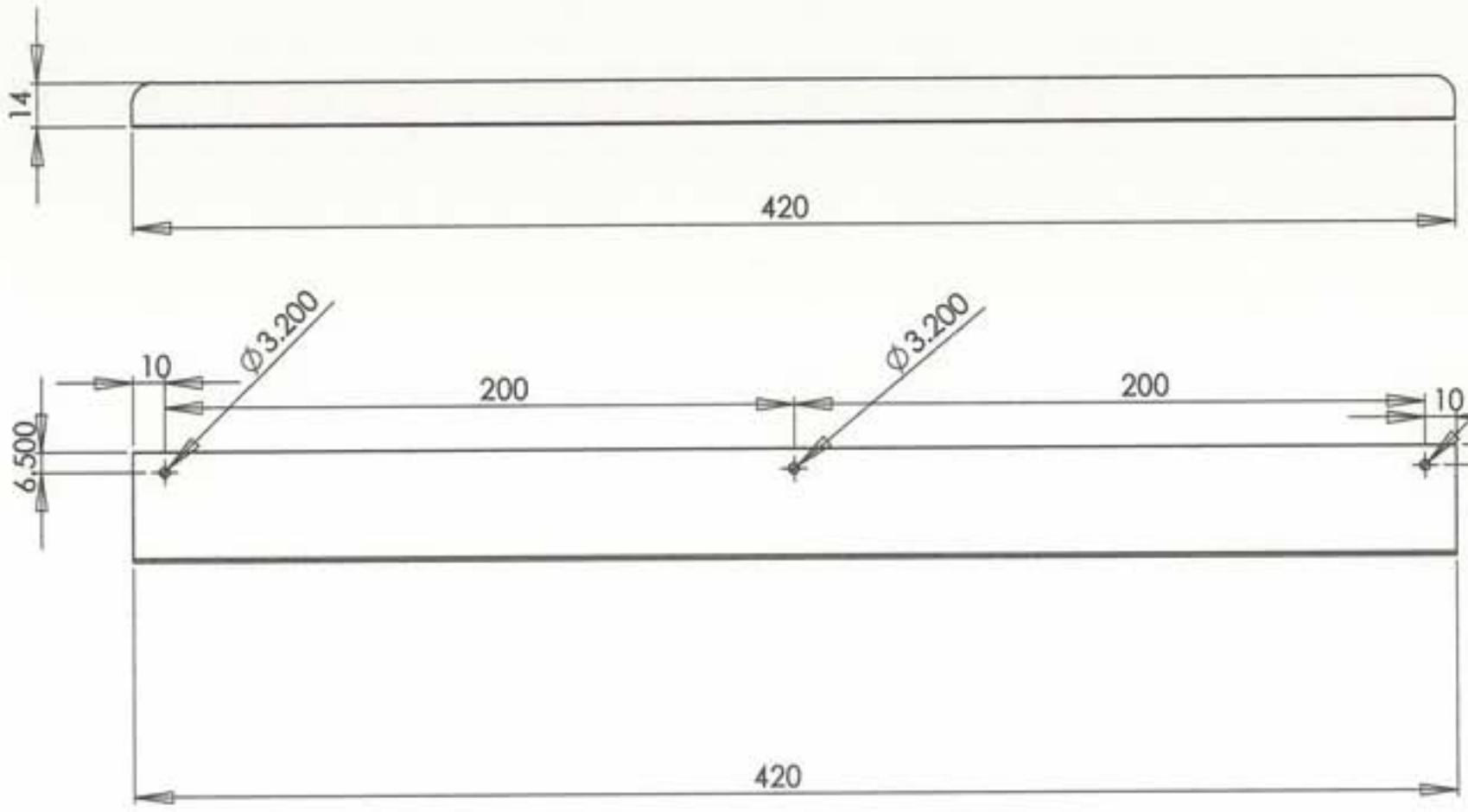
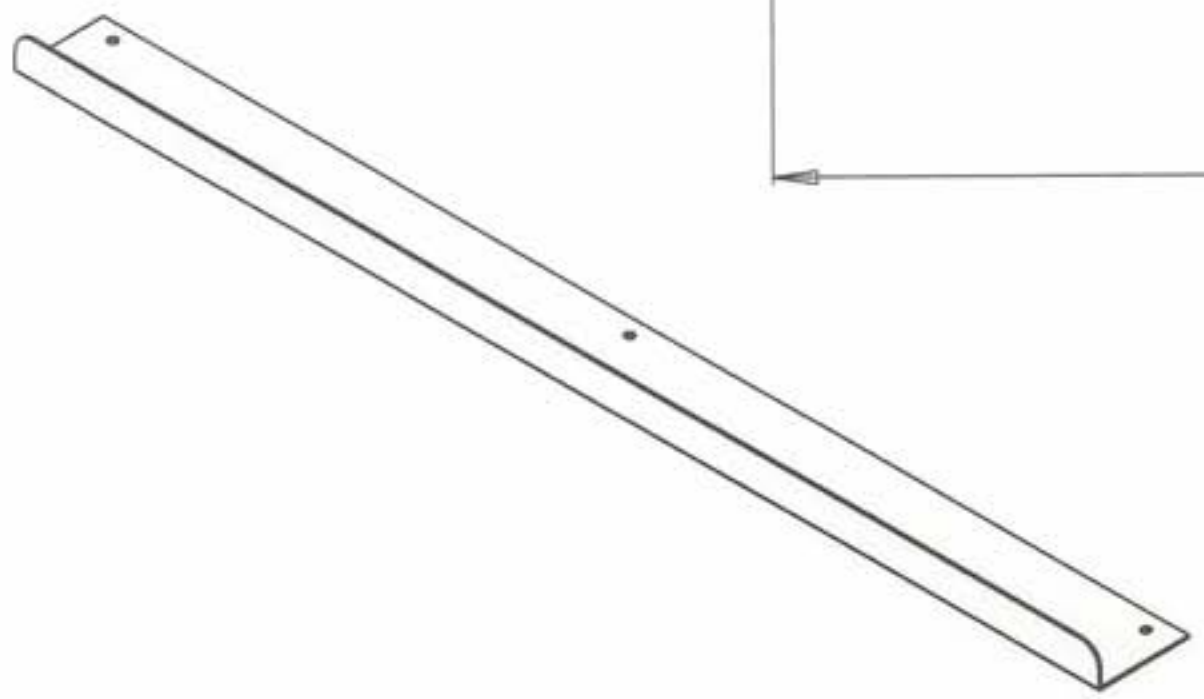
CHK'D				
APP'VD				
MFG				
Q.A			MATERIAL:	DWG NO. Right Door A3
			WEIGHT:	SCALE:1:3 SHEET 1 OF 1







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	NAME	SIGNATURE	DATE
DRAWN			
CHK'D			
APP'VD			
MFG			
Q.A			

MATERIAL:

WEIGHT:

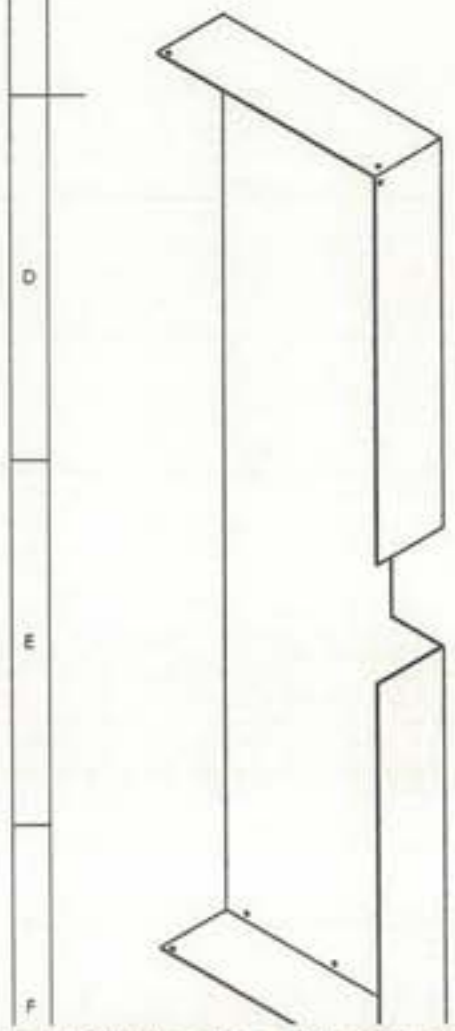
TITLE:

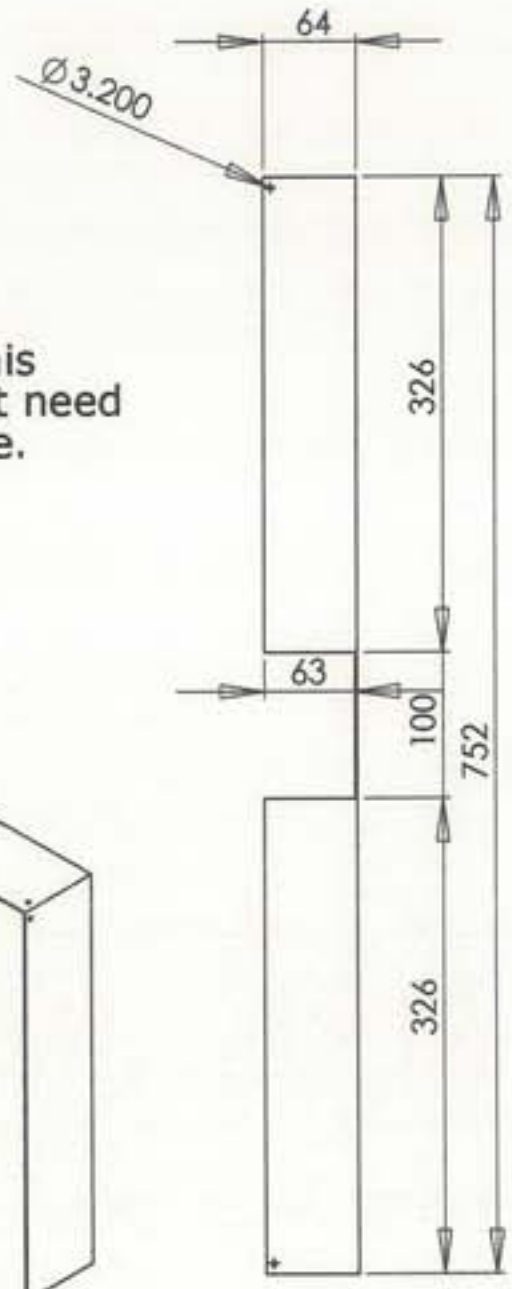
DWG NO. A3

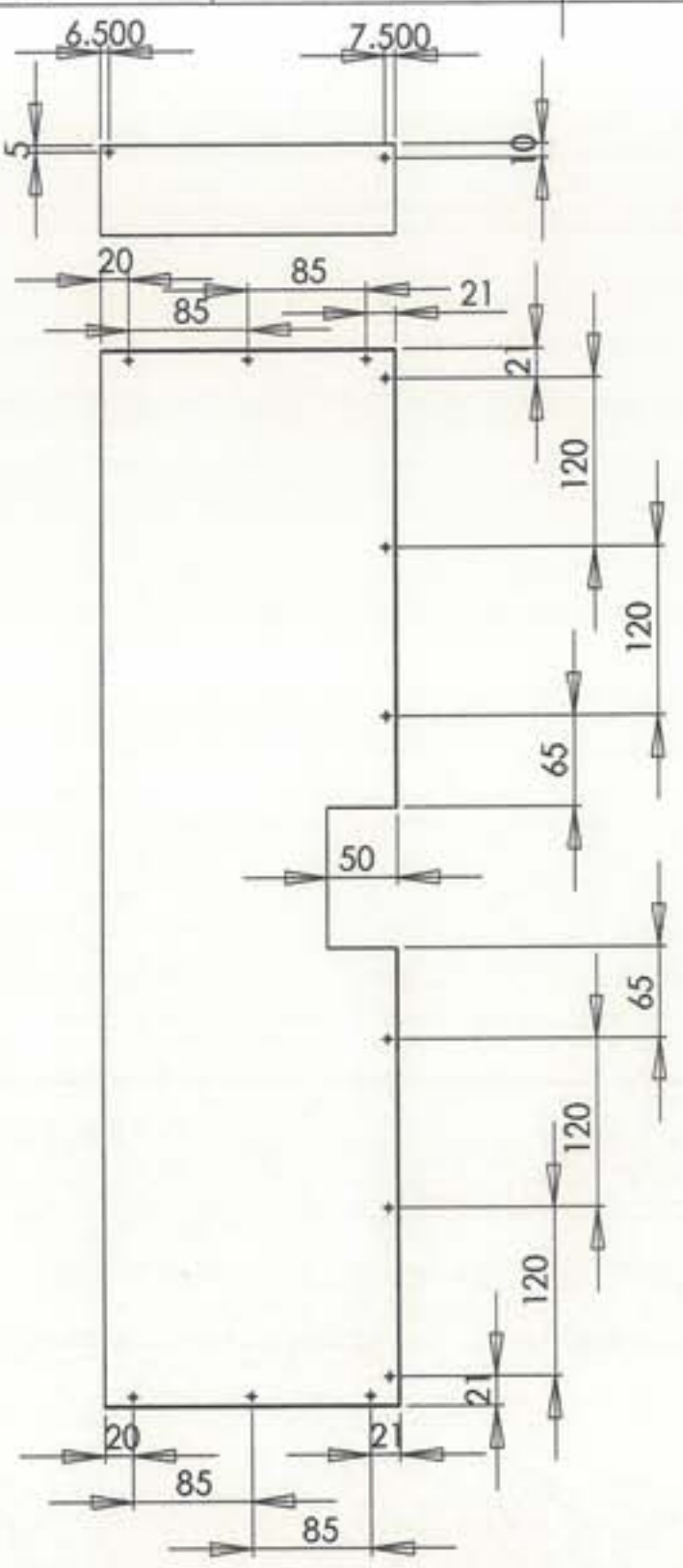
Canvas Holder Bottom

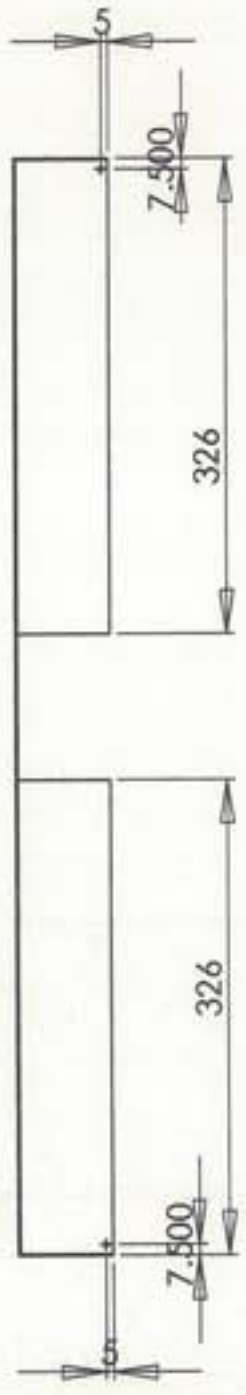
SCALE:1:2 SHEET 1 OF 1

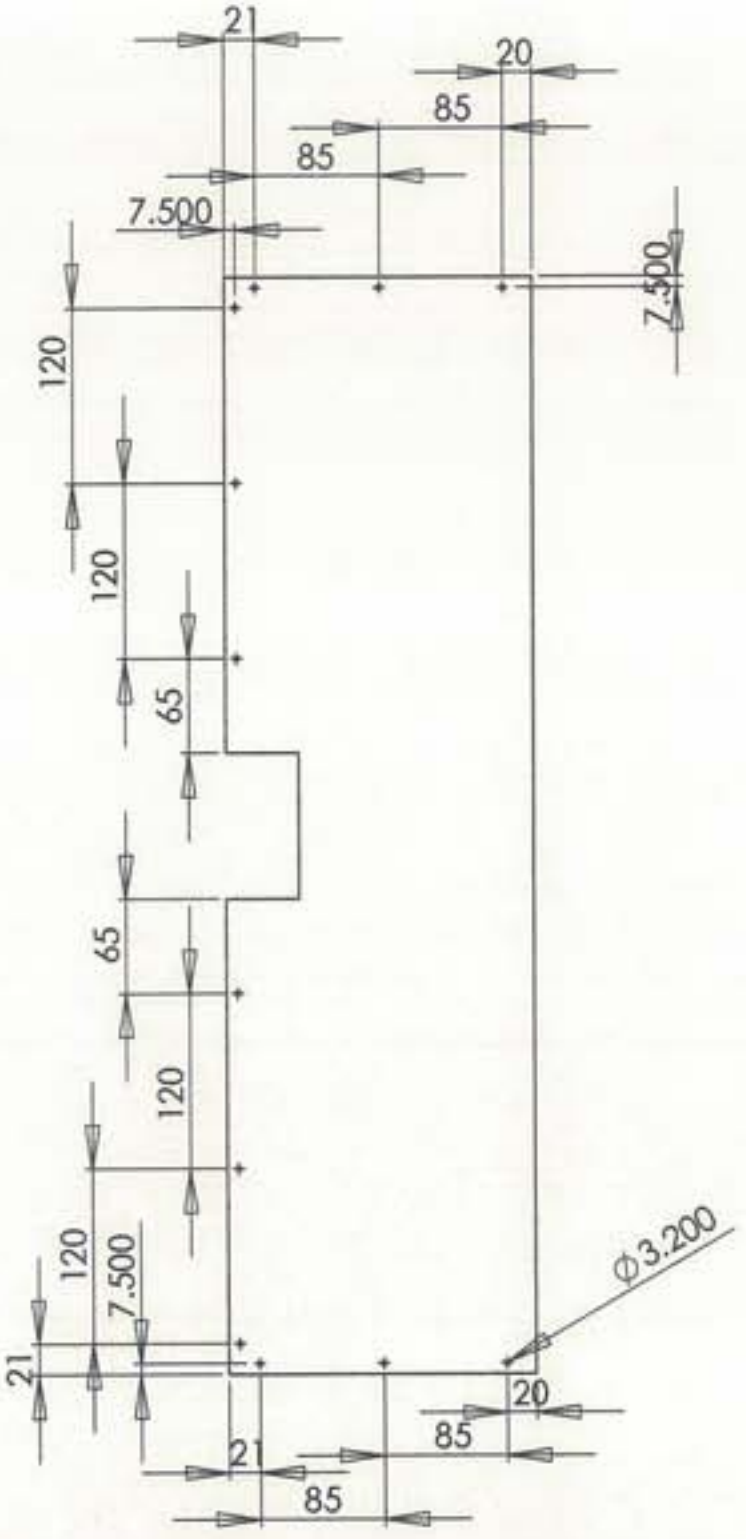
2 lots of this component need to be made.

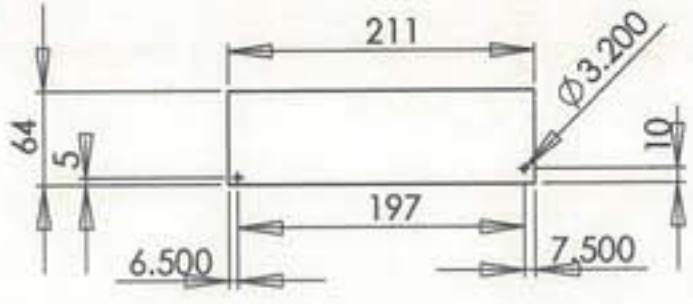












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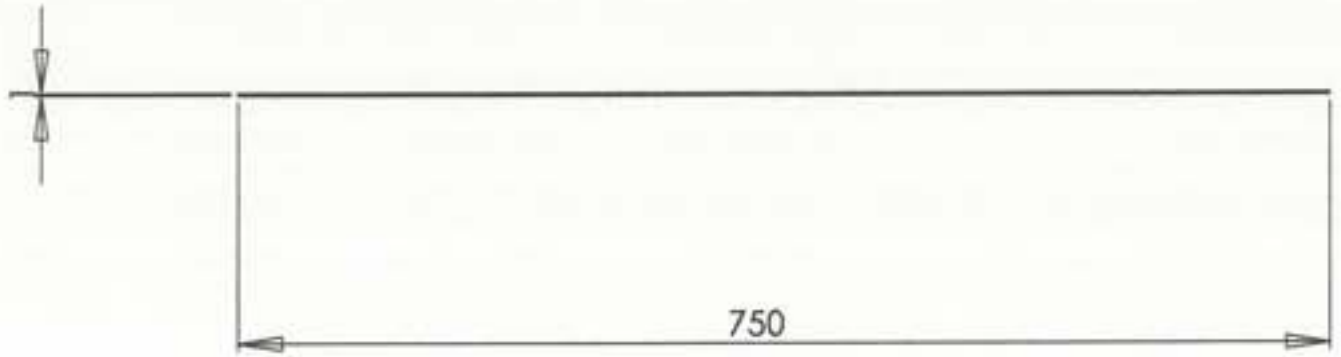
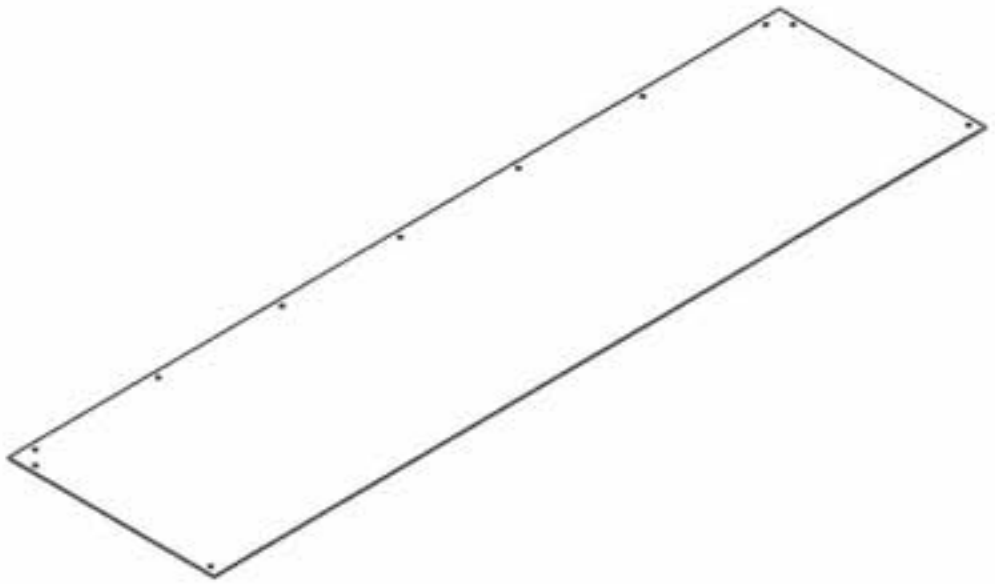
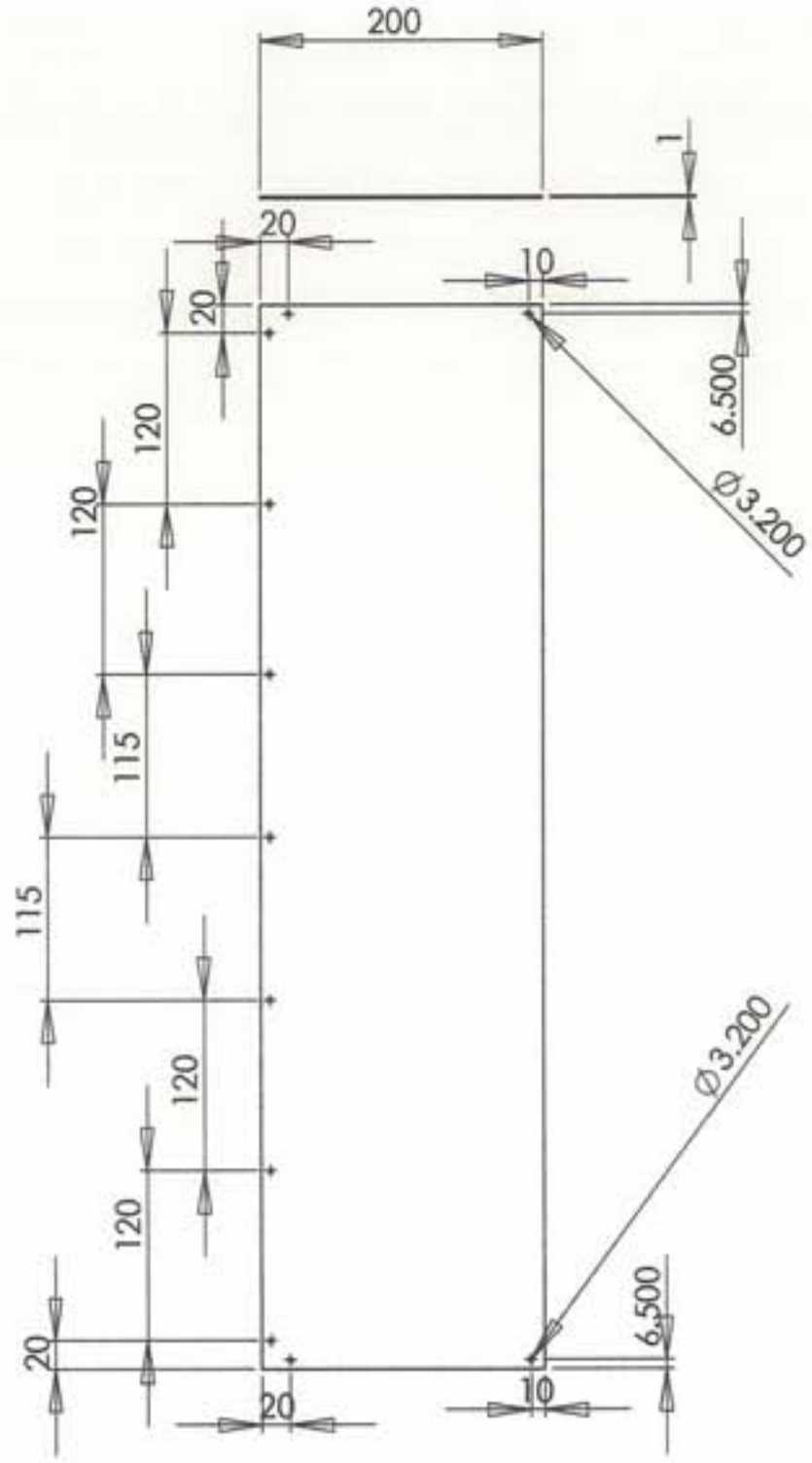
CHK'D						
APPV'D						
MFG						
Q.A				MATERIAL:	DWG NO. Door Panel	A3
				WEIGHT:	SCALE:1:5	SHEET 1 OF 1

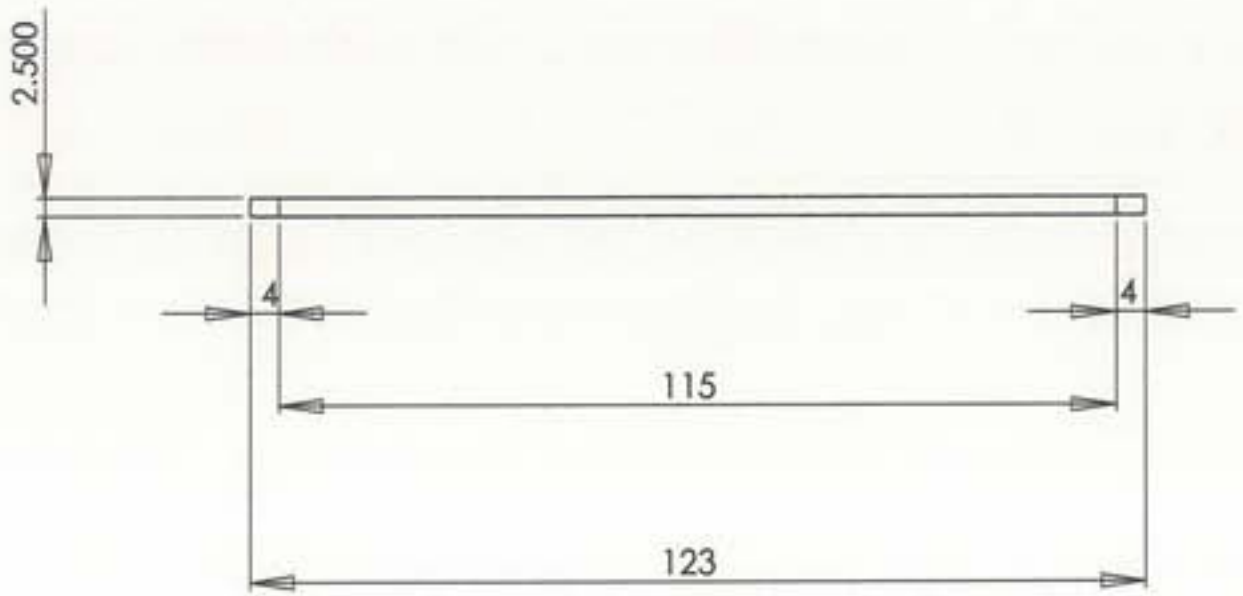


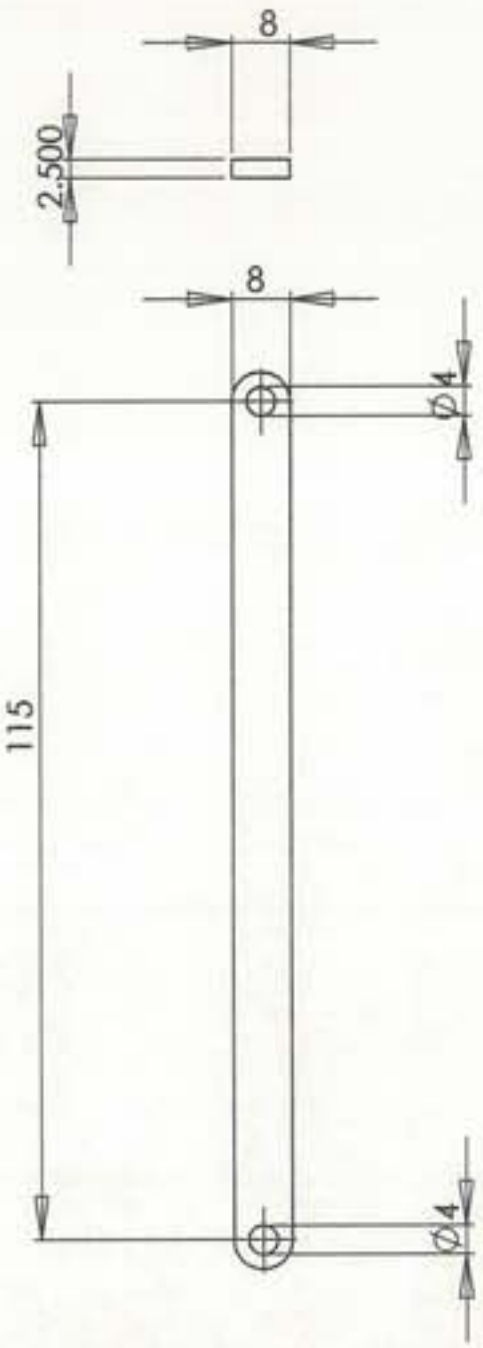


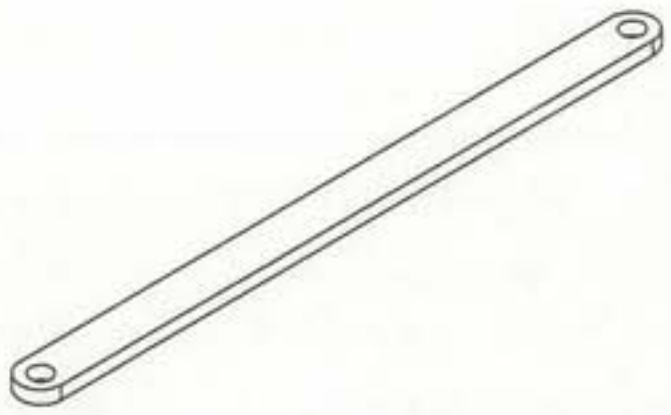


Two lots of this part will need to be made.

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:		FINISH:				DEBUR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE				TITLE:	
DRAWN								
CHK'D								
APP'VD								
MFG								
Q.A.				MATERIAL:			DWG NO. Front Panels	A3
				WEIGHT:			SCALE:1:5	SHEET 1 OF 1

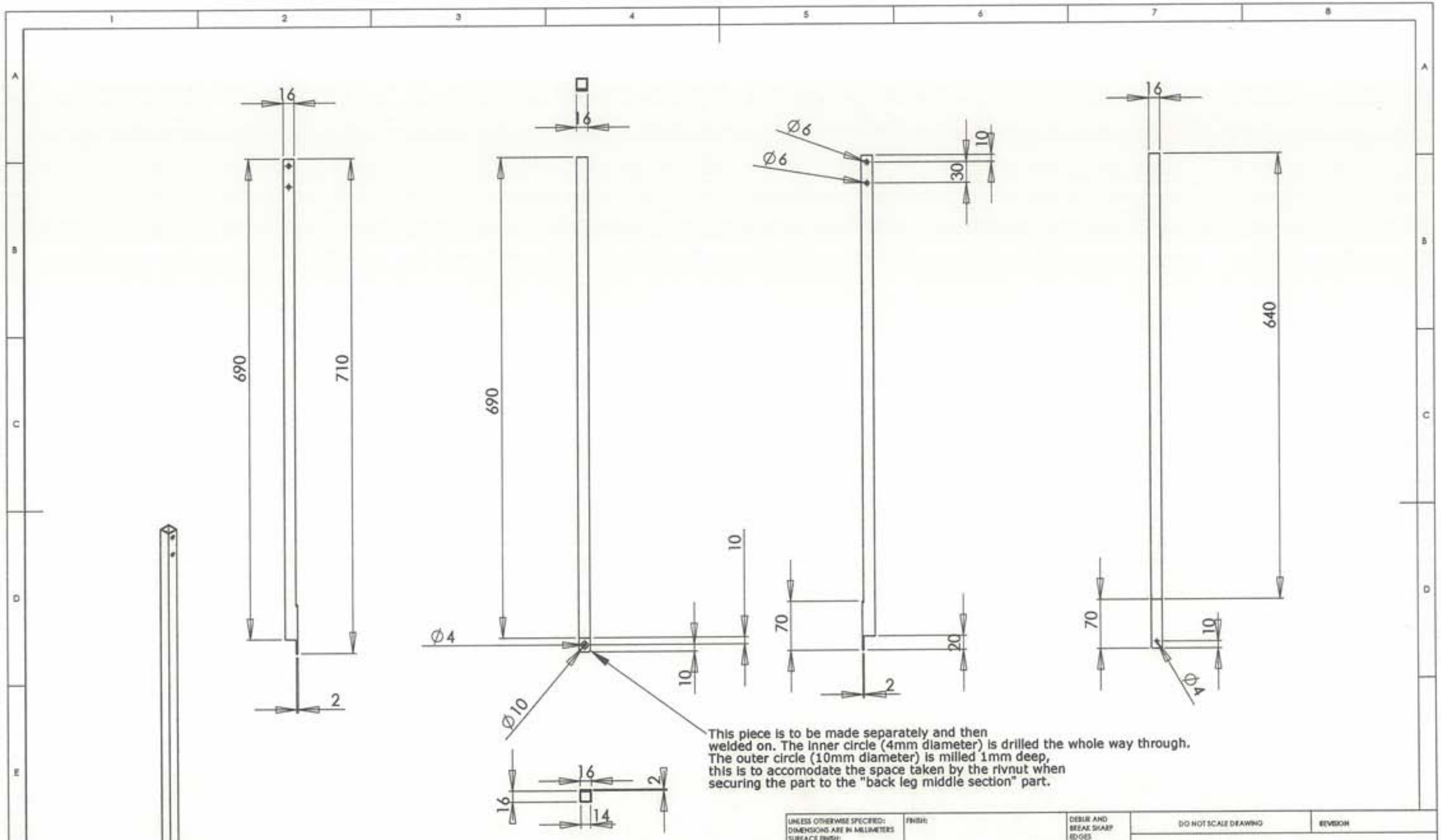






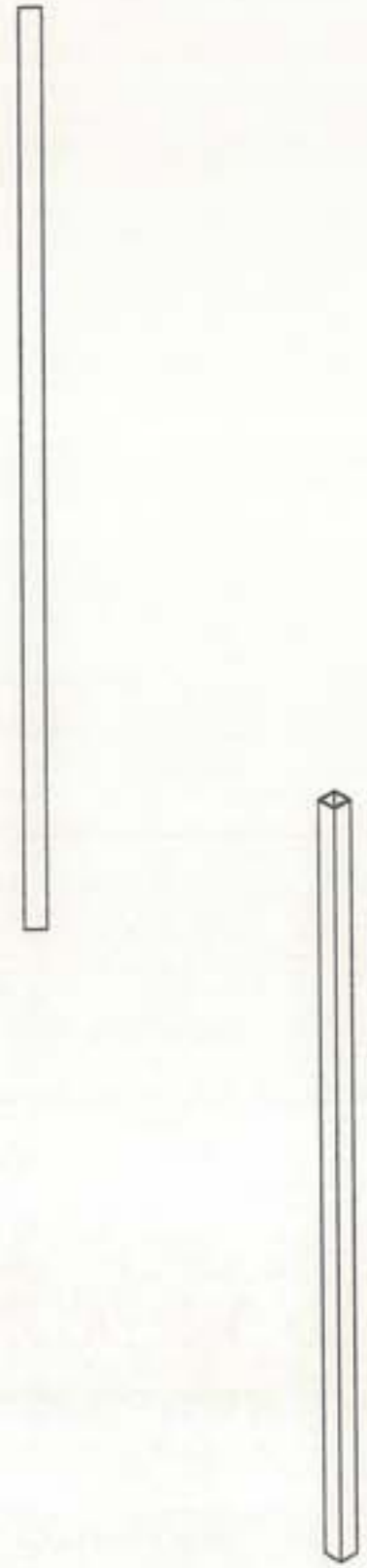
8 support bars need to be made.

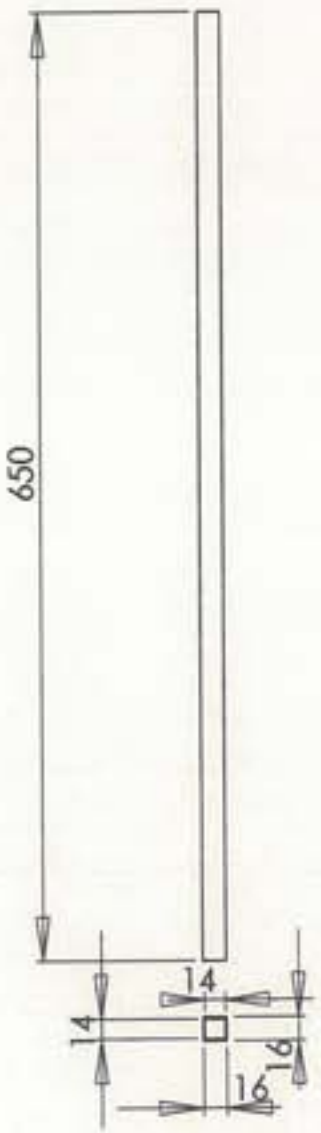
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:		FINISH:			DEBUR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING
	NAME	SIGNATURE	DATE			TITLE:
DRAWN						
CHK'D						
APP'VD						
MFG						
Q.A.				MATERIAL:		DWG NO. Support Bar A3
				WEIGHT:		SCALE:1:1 SHEET 1 OF 1

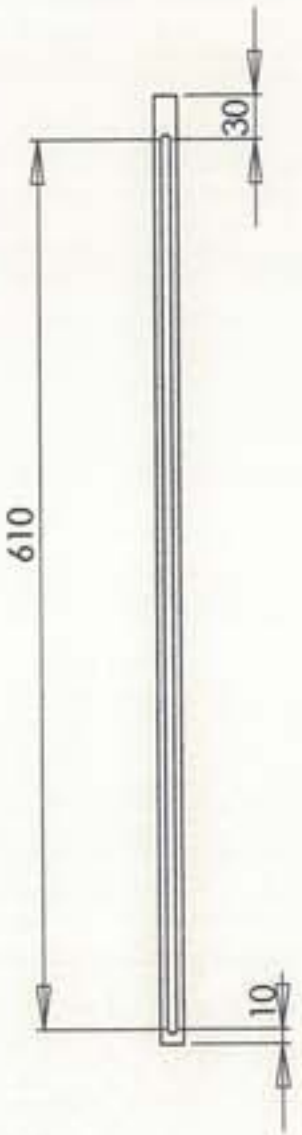


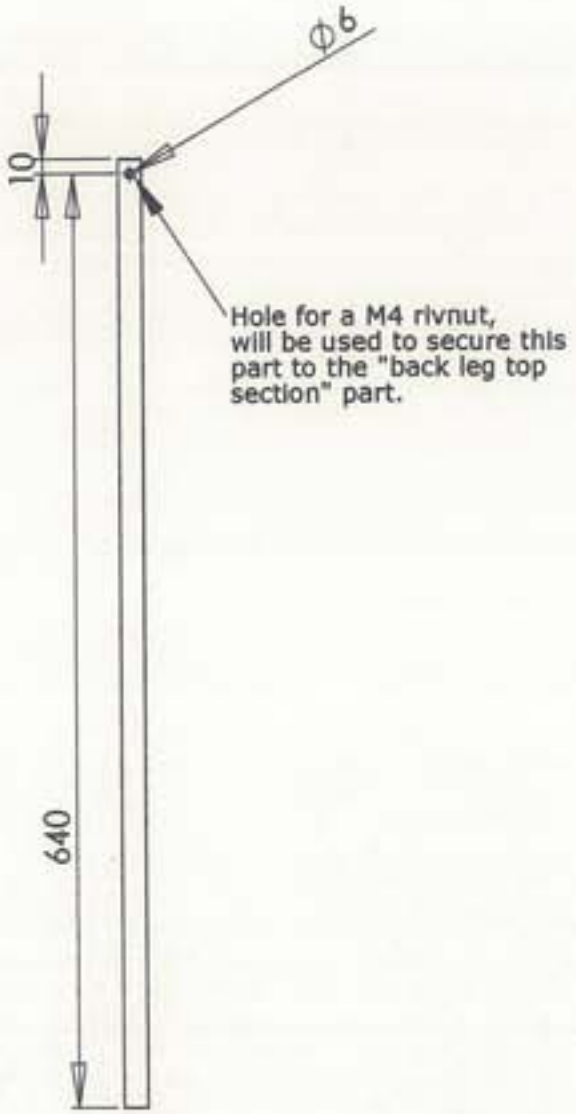
This piece is to be made separately and then
welded on. The inner circle (4mm diameter) is drilled the whole way through.
The outer circle (10mm diameter) is milled 1mm deep,
this is to accomodate the space taken by the rivnut when
securing the part to the "back leg middle section" part.

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:	FINISH:				DEBUR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING
	NAME	SIGNATURE	DATE			TITLE:
DRAWN						
CHK'D						
APPVD						
MFG						
Q.A				MATERIAL:		DWG NO. Back Leg Top Part A3
				WEIGHT:		SCALE:1:5 SHEET 1 OF 1









UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:	FINISH:	DEBUR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION

	NAME	SIGNATURE	DATE
DRAWN			
CHK'D			
APP'VD			
MFG			
Q.A			

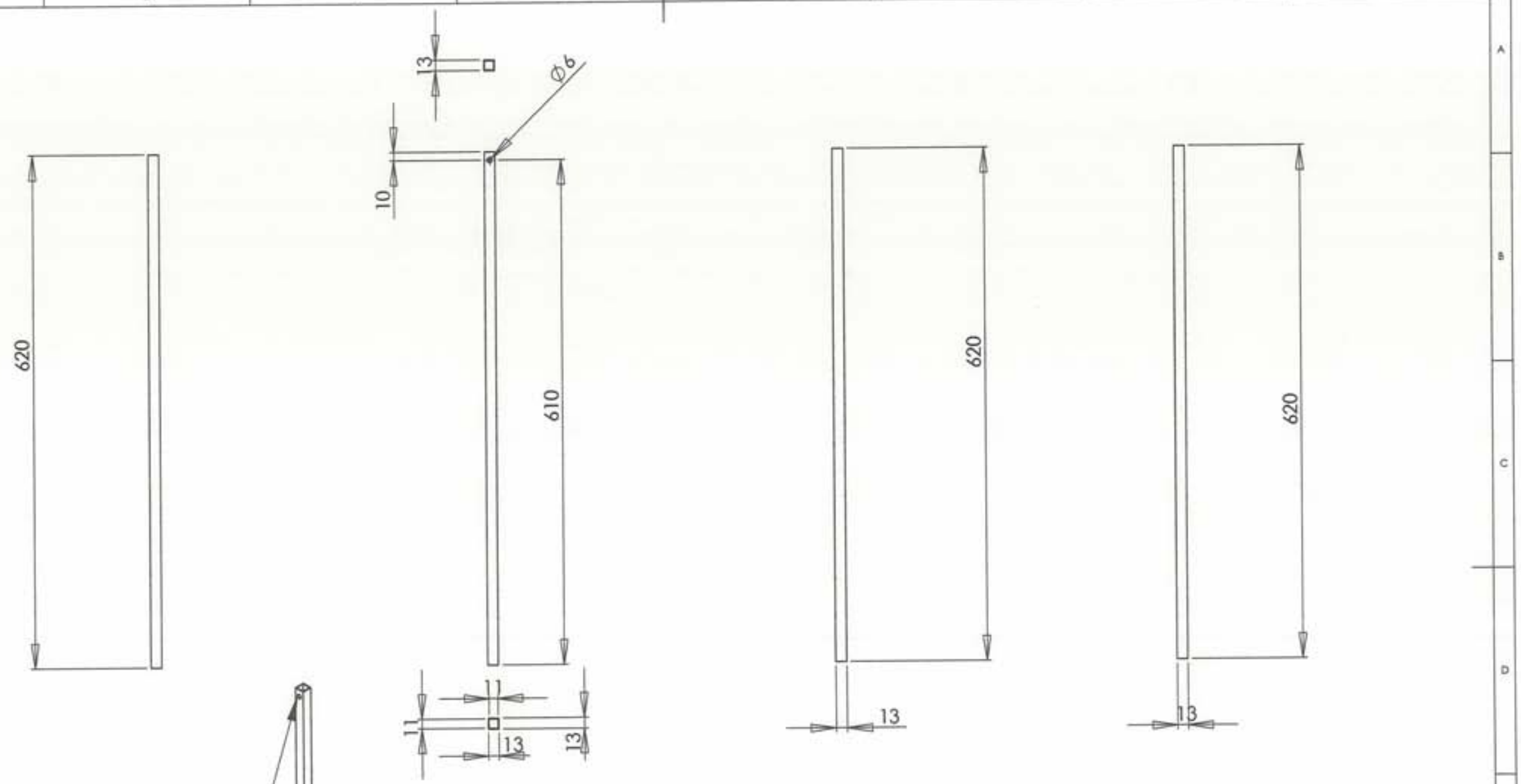
MATERIAL:

WEIGHT:

TITLE:

DWG NO. Back Leg Middle Part — A3

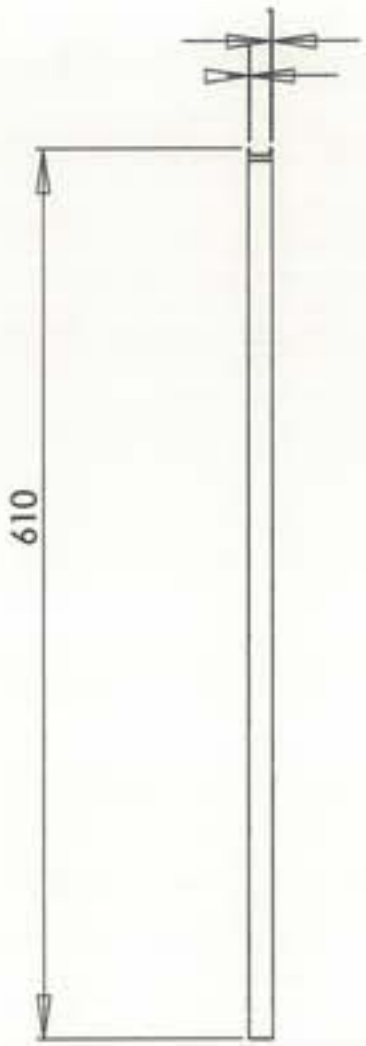
SCALE:1:1 — SHEET 1 OF 1

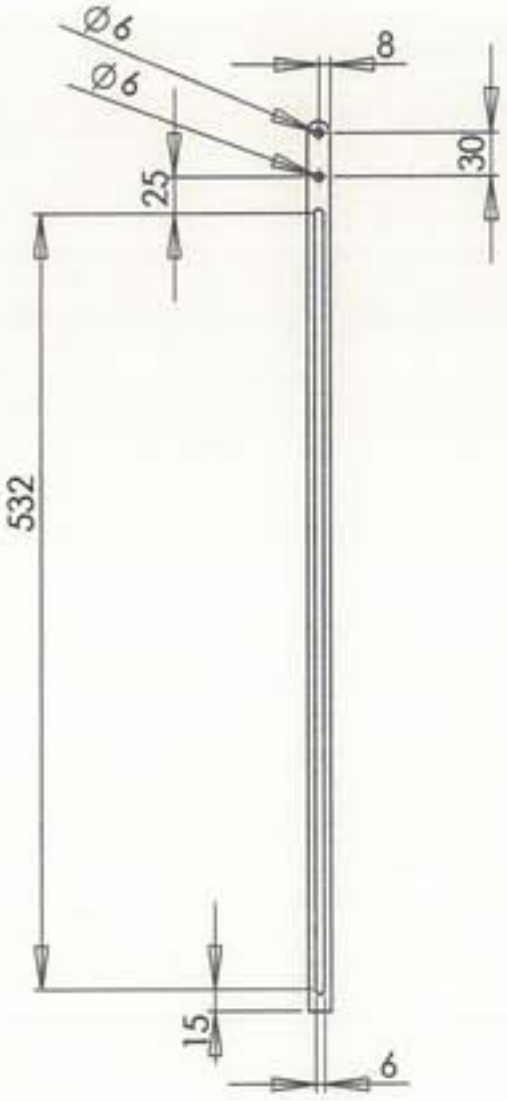


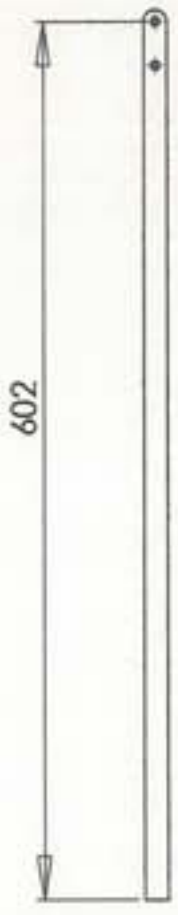
Hole for a M4 rivnut, must ensure that the rivnut does not protrude more than 1mm above the surface of the material so that this part can fit inside the "back leg middle section" part.

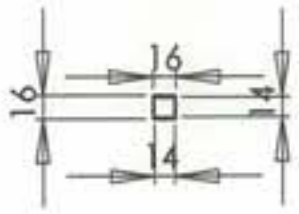
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:	FINISH:				DEBUR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING
	NAME	SIGNATURE	DATE			TITLE:
DRAWN						
CHK'D						
APP'VD						
MFG						
Q.A				MATERIAL:		DWG NO.
				WEIGHT:		SCALE:1:5
						SHEET 1 OF 1

Back Leg Bottom Part

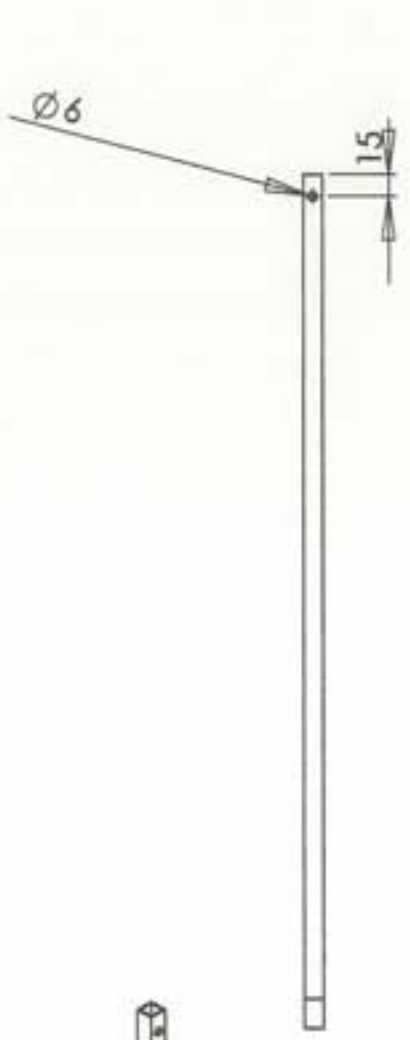


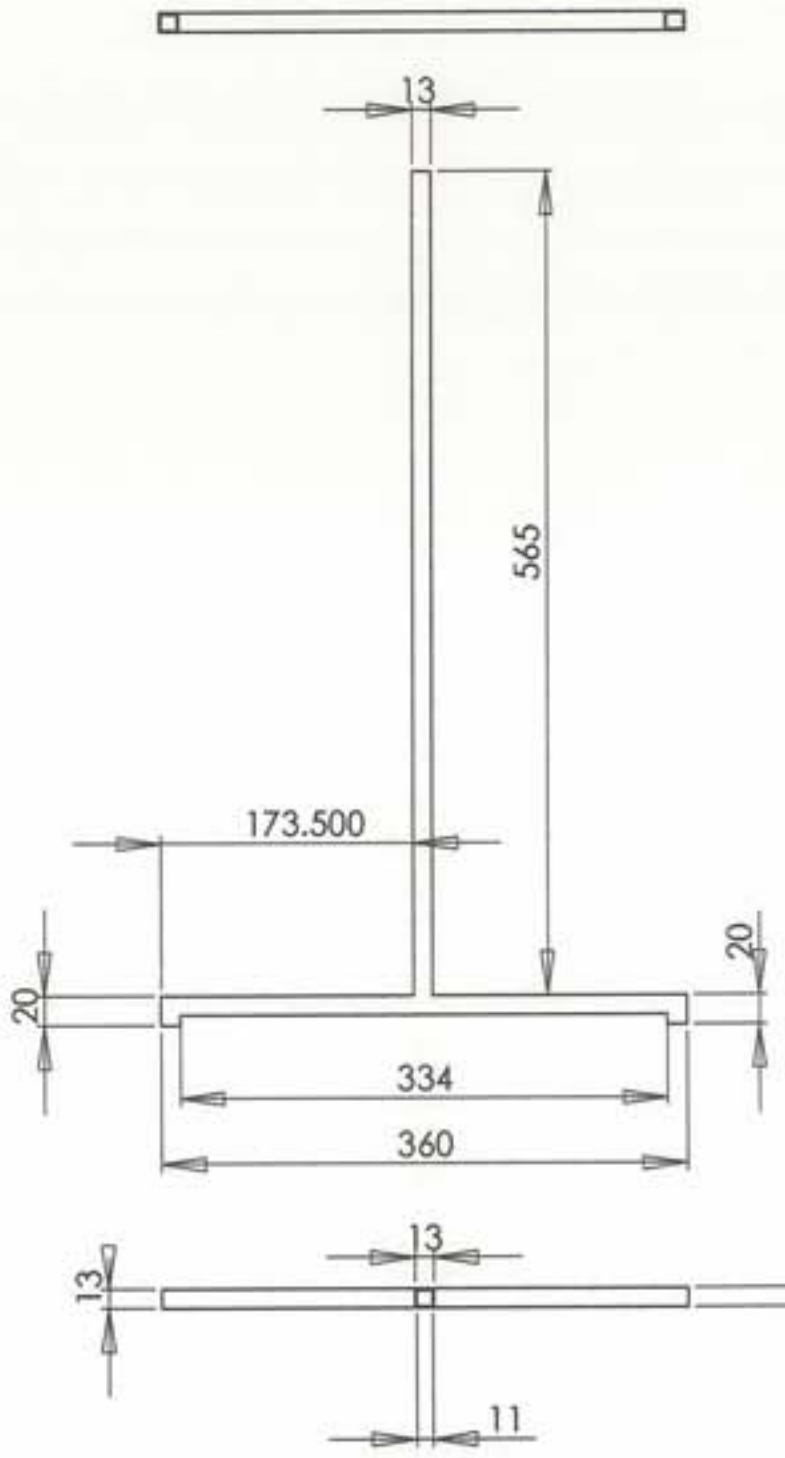


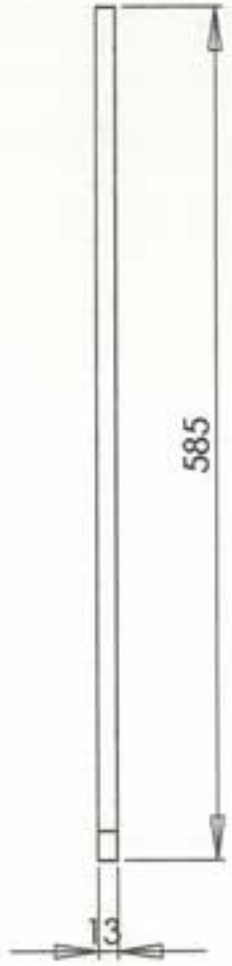


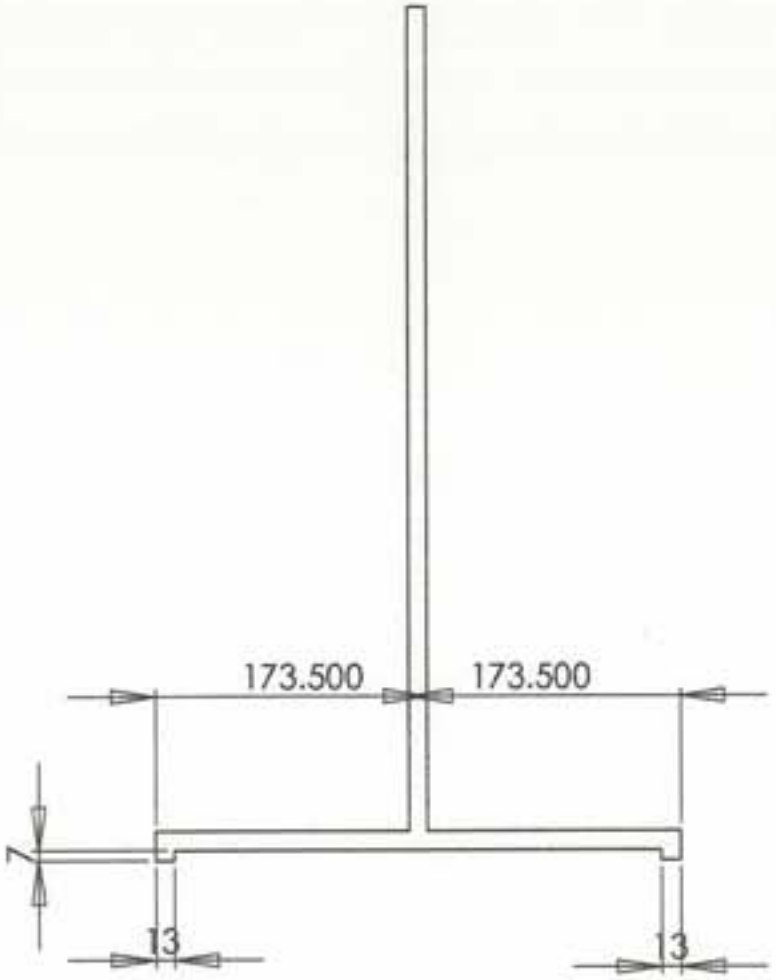


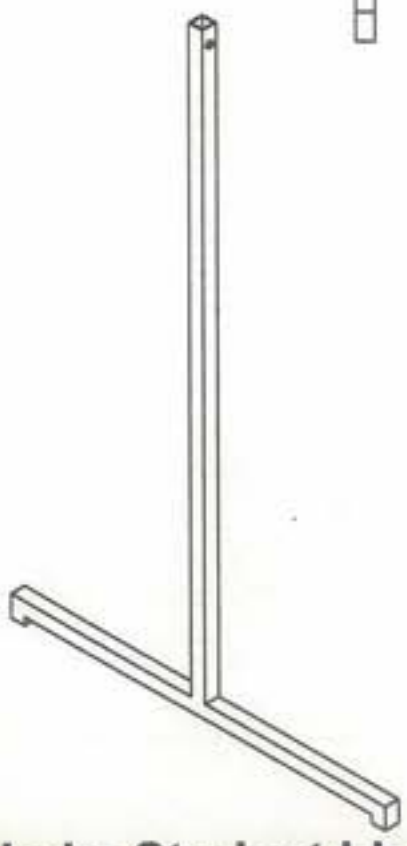
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:	FINISH:					DEBUR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE				TITLE:	
DRAWN								
CHK'D								
APP'VD								
MFG								
Q.A				MATERIAL:			DWG NO. Front Leg Top Half	A3
				WEIGHT:			SCALE:1:5	SHEET 1 OF 1





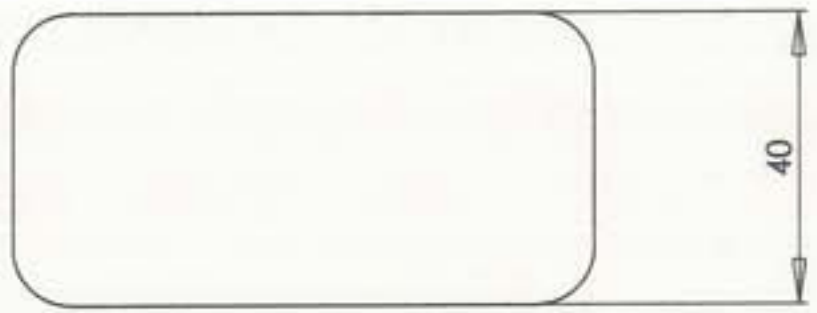


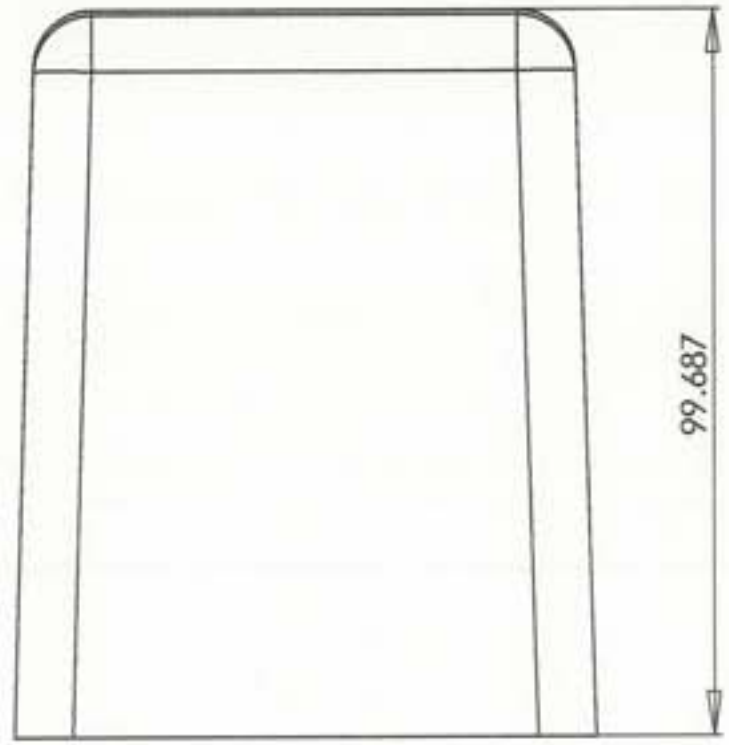


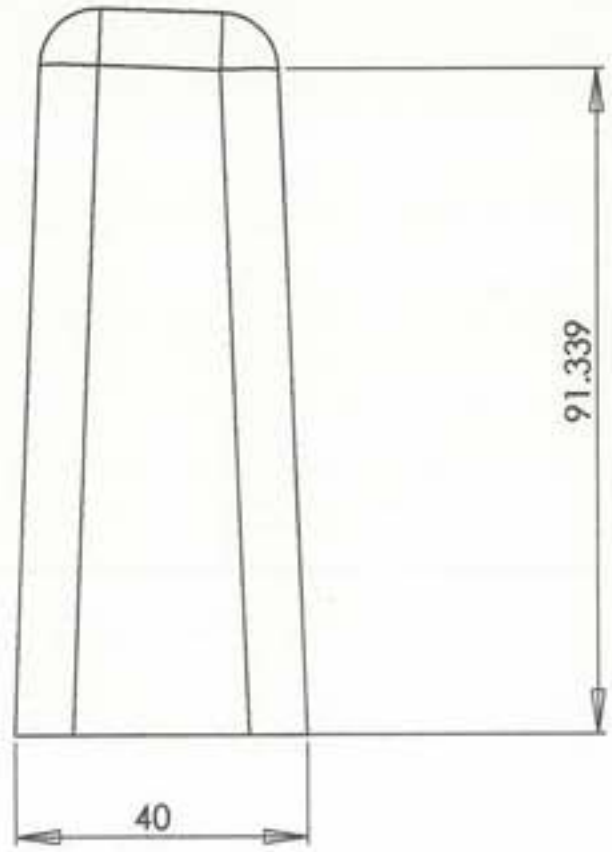


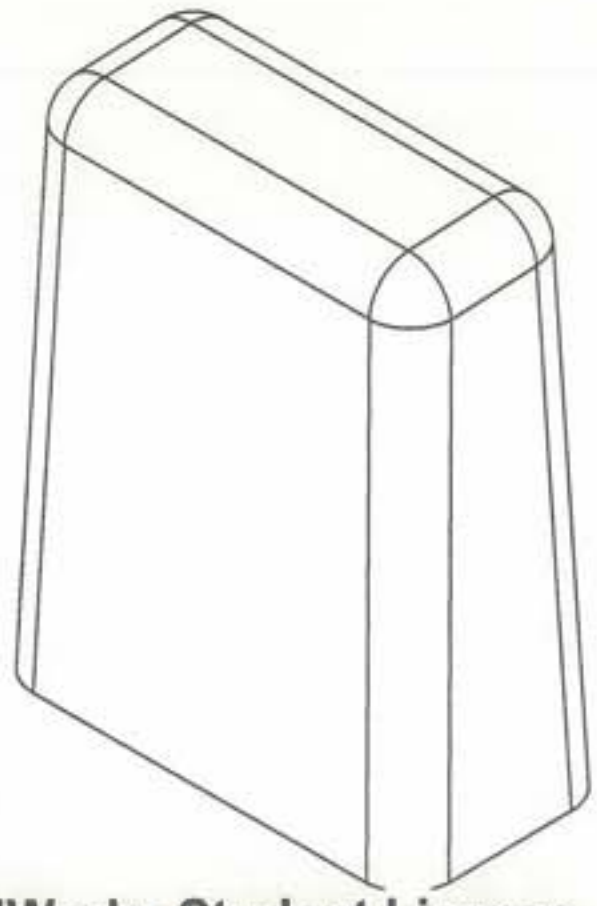
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:		FINISH:		DEBUR AND BREAK SHARP EDGES		DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE			TITLE:	
DRAWN							
CHK'D							
APP'VD							
MFG							
Q.A				MATERIAL:		DWG NO.	A4
						Front Leg Bottom Half	
				WEIGHT:		SCALE:1:5	SHEET 1 OF 1

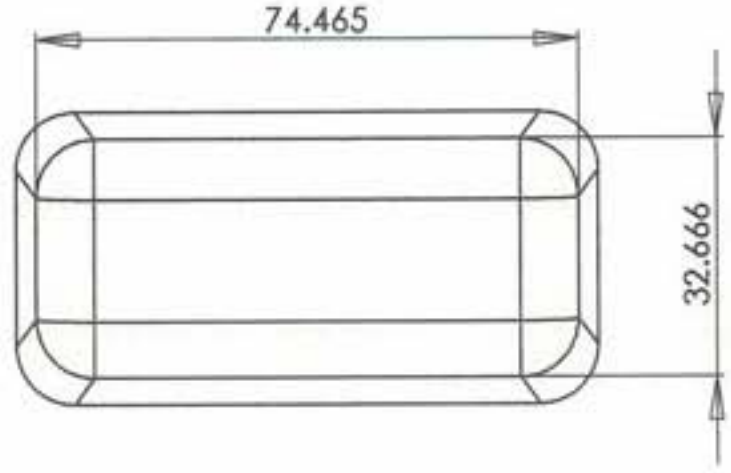
This is the mould for the water beaker. It will be used to vacuum form the water beaker which will then be cut out with a scalpel.





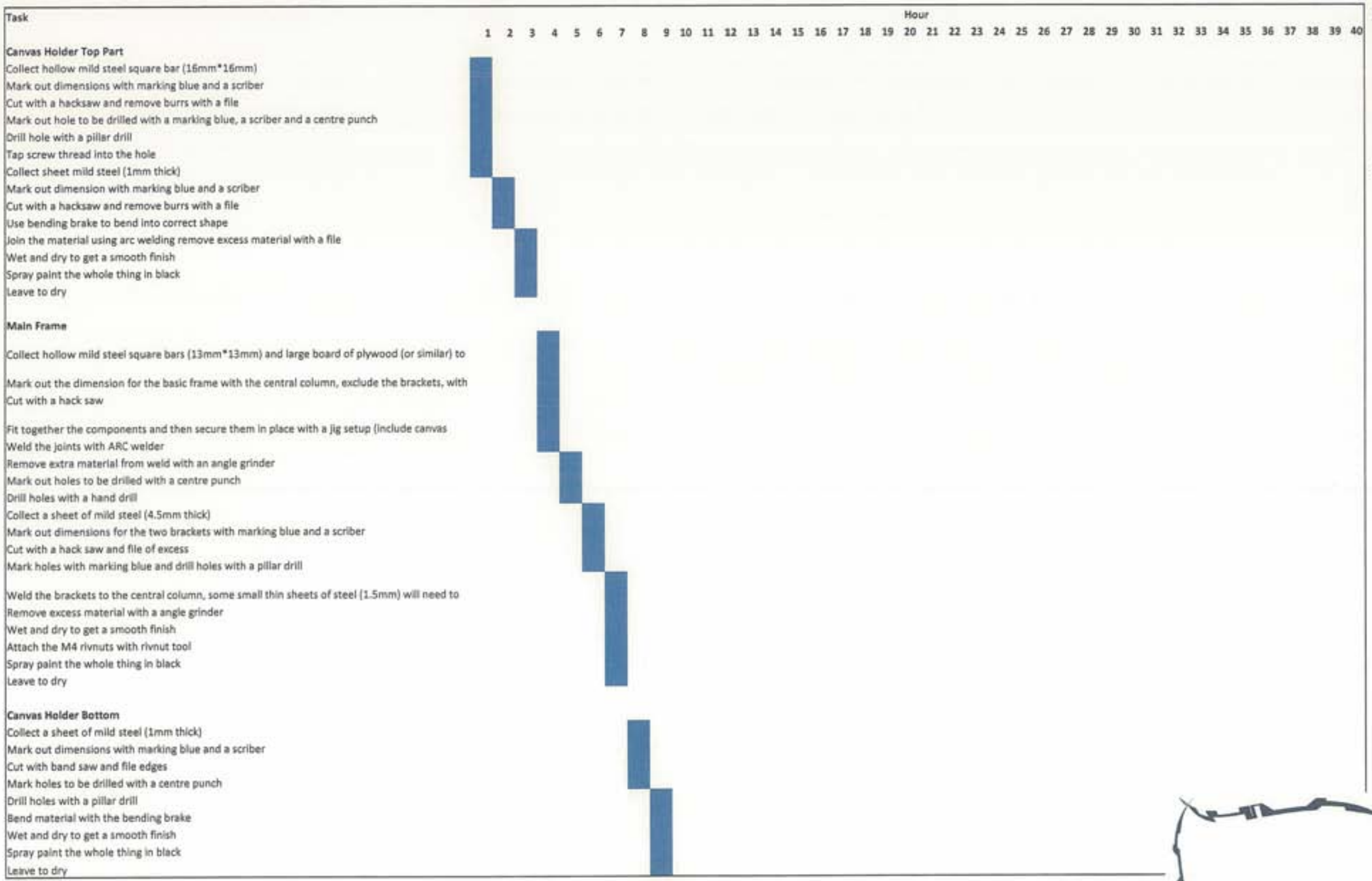




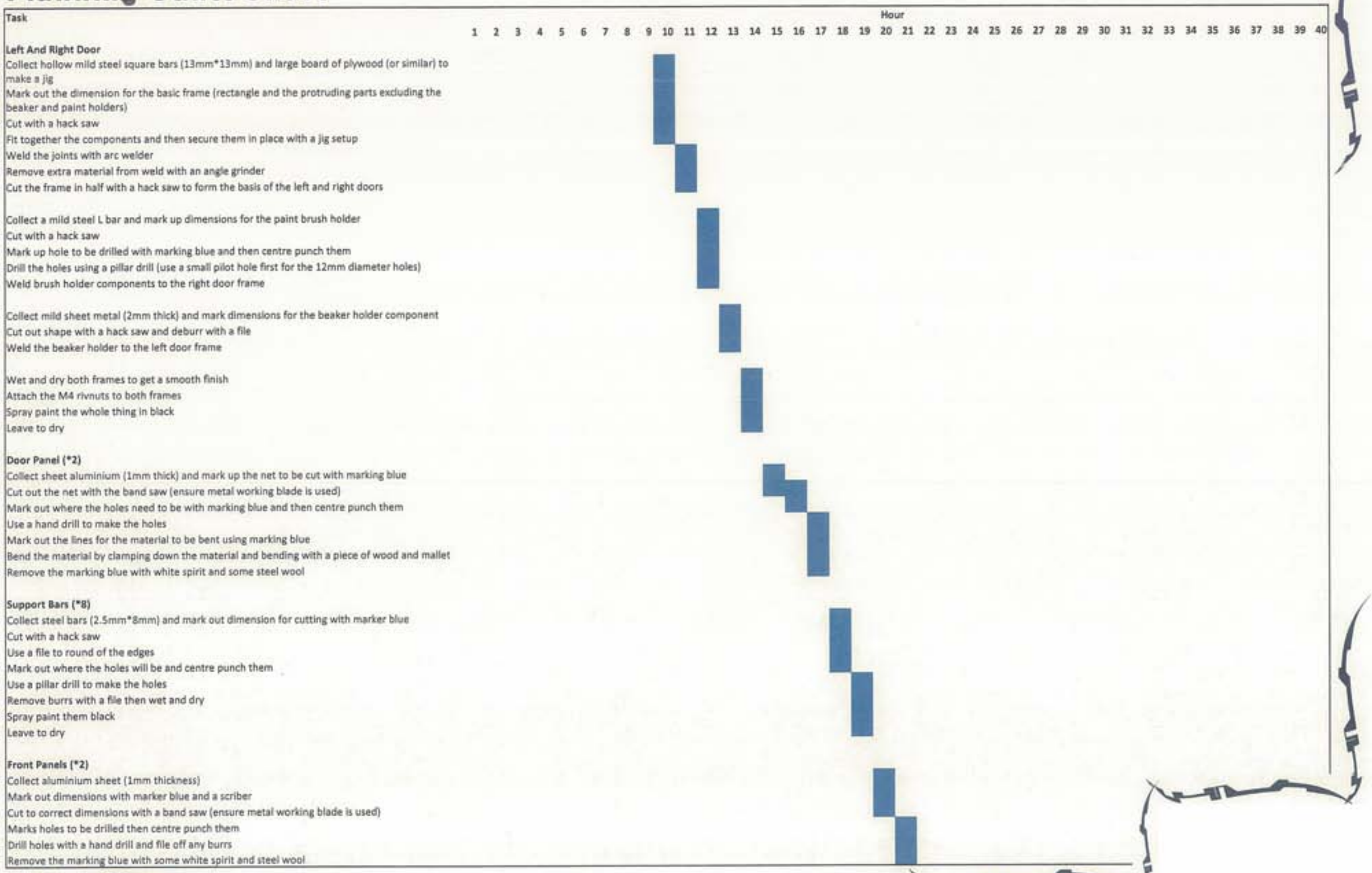


UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:		FINISH:		DEBUR AND BREAK SHARP EDGES		DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE			TITLE:	
DRAWN							
CHK'D							
APP'VD							
MFG							
Q.A				MATERIAL:		DWG NO. Mould for beaker	A3
				WEIGHT:		SCALE:1:1	SHEET 1 OF 1

Planning-Gantt Chart



Planning-Gantt Chart



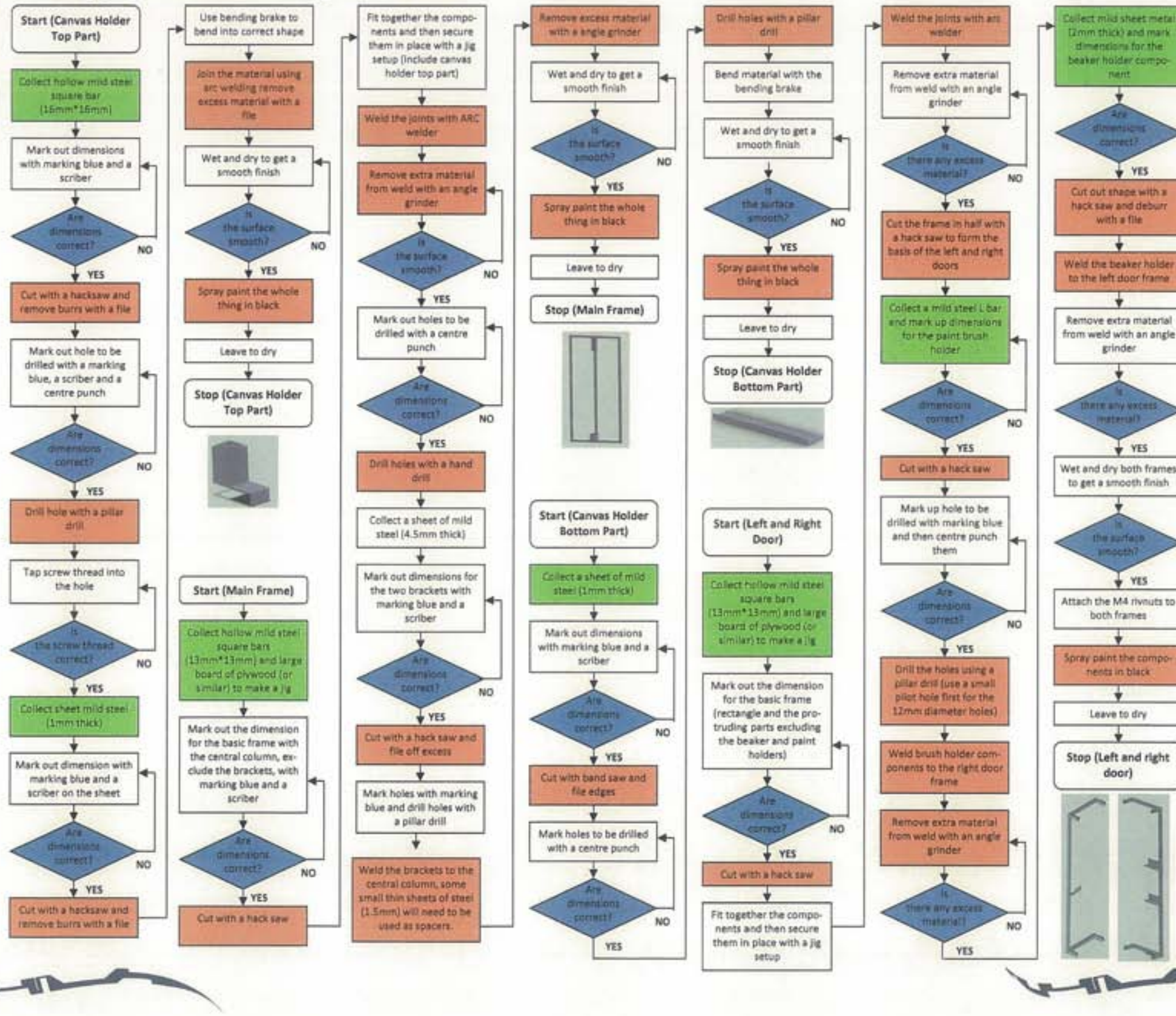
Planning-Gantt Chart

Task	Hour
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
Front Leg Top Half	
Collect mild steel square bar (16mm*16mm)(1mm thickness)	
Mark out dimensions with marker blue and a scriber	
Cut with a hacksaw and then file off burrs	
Mark out holes to be drilled then centre punch them	
Drill holes using the pillar drill	
Mark out the area that needs to be milled	
Remove material with the milling machine	
File off any burrs and then use wet and dry paper to finish the surface	
Spray paint the component	
Leave to dry	
Front Leg Bottom Half	
Collect mild steel square bar (13mm*13mm)	
Mark out dimensions to cut	
Cut with a hack saw	
Mark and drill hole for rivnut	
Arcweld the components together	
Remove the excess material with angle grinder	
Attach rivnut	
Spray paint the component	
Leave to dry	
Back Leg Top Part	
Collect mild steel square bar (16mm*16mm)(1mm thickness)	
Mark out area to be cut with marker blue and a scriber	
Cut the material with a hacksaw	
Mark area for drilling with marker blue and then centre punch them	
Drill holes with a pillar drill then remove burrs with a file	
Collect steel bar (16mm*2mm)	
Mark dimensions with marker blue	
Cut with a hacksaw	
Mark area to be milled	
Mill 1mm into the material with milling machine	
Centre punch the centre of the milled circumference	
Drill with a pillar drill	
Weld the two components together	
Remove excess material with an angle grinder	
Back Leg Middle Part	
Collect mild steel square bar (16mm*16mm)(1mm thickness)	
Mark out dimensions to be cut with marker blue and a scriber	
Cut the material with a hacksaw and remove burrs with a file	
Mark area to be drilled and centre punch it	
Drill with a pillar drill	
Mark out area to be milled then remove material with the milling machine	
Remove burrs with a file	

Planning-Gantt Chart

Task	Hour
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
Back Leg Bottom Part	
Collect mild steel square bar (13mm*13mm)	
Mark out dimensions to be cut	
Cut the material with a hacksaw and remove burrs with a file	
Mark area to be drilled and then centre punch	
Drill with a pillar drill and then deburr with a file	
Attach rivnut	
Combining the top and middle section of the back leg	
Mark out area to welded	
Arc weld the hinge to both components	
File off any excessive material	
Spray paint the whole component	
Leave to dry	
Water beaker	
Collect pine wood (at least 100mm*40mm*80mm)	
Mark out dimensions to be cut to create mould with a pencil	
Cut with the band saw	
Smoothen the edges with the belt sander	
Wax the surface with steel wool and wood wax (makes it easier later to remove the mould)	
Collect black a sheet of black PVC for vacuum forming	
Vacuum form the beaker	
Cut out beaker with a scalpel and a cutting mat	
Leg to main frame bolts (*4)	
Collect M6 machine screws with an unthreaded length of at least 25mm	
Use a M6 die to add thread until there is 25mm of unthreaded material	
Cut with a hack saw so that the length of the screw (excluding head) is 30mm	
Assembly	
Attach the support bars to the main frame with M4 screws and thread lock	
Attach the support bars to the left and right doors with M4 screws and thread lock	
Rivet the back door panels onto the back doors	
Mark out area to drill for attaching the toggle & plate mechanism on the back door panels	
Drill hole and attach mechanism with rivets	
Rivet the front panels onto the main frame	
Rivet the "canvas holder bottom part" to the main frame	
Insert the "front leg bottom part" into the "front leg top part" and secure with a M4 screw	
Attach the front leg to the main frame with the bolts and nuts	
Insert the "back leg bottom part" into the "back leg middle part" and secure with a M4 screw	
Attach the back leg to the main frame with the bolts and nuts	
Attach handle with screws	

Prototype Manufacturing Flowchart



Quality Control: the product will be checked regularly to ensure that it is made to a high standard.

Quality Assurance: the materials are to be checked for defects so that only high quality material is used for the product.

Health & Safety: at all times health and safety precautions will be taken into consideration during the manufacture. This is to ensure that there is no injury to myself and others. Precautions include :

- Wearing goggles then using machines (milling machine, belt sander etc)
- Using solvents (such as spray paints) in well ventilated areas to avoid poison or suffocation.
- Being aware of all possible dangers to self and others around the area you are working (e.g anything that could be tripped over)

Quality Checks

Checks will involve using the vernier to ensure the dimensions for the chess pieces are correct. The dimensions will be checked regularly with a ruler and it will be tested to ensure that the components fit each another. Visual checks will be made throughout, this is to ensure that there are no defects in the material and that they don't develop (for example during storage).

Coloured boxes indicate the following:

- Quality Control Applied
- Quality Assurance Applied
- Health and Safety Applied

Prototype Manufacturing Flowchart

Start (Door Panel *2)

Collect sheet aluminium (1mm thick) and mark up the net to be cut with marking blue

Are dimensions correct? NO

YES

Cut out the net with the band saw (ensure metal working blade is used)

Mark out where the holes need to be with marking blue and then centre punch them

Are dimensions correct? NO

YES

Use a hand drill to make the holes

Mark out the lines for the material to be bent using marking blue

Are lines for bending correct? NO

YES

Bend the material by clamping down the material and bending with a piece of wood and mallet

Remove the marking blue with white spirit and some steel wool

Stop (Door Panel *2)

Start (Support Bar *8)

Collect steel bars (2.5mm*8mm) and mark out dimension for cutting with marker blue

Are dimensions correct? NO

YES

Cut with a hack saw

Use a file to round of the edges

Mark out where the holes will be and centre punch them

Are dimensions correct? NO

YES

Use a pillar drill to make the holes

Remove burrs with a file then wet and dry

Is the surface smooth? NO

YES

Spray paint them black

Leave to dry

Stop (Support Bar*8)

Start (Front Panels*2)

Collect aluminium sheet (1mm thickness)

Mark out dimensions with marker blue and a scriber

Are dimensions correct? NO

YES

Cut to correct dimensions with a band saw (ensure metal working blade is used)

Marks holes to be drilled then centre punch them

Are dimensions correct? NO

YES

Drill holes with a hand drill.

File off any burrs

Remove the marking blue with some white spirit and steel wool

Stop (Front Panels*2)

Start (Front Leg Top Half)

Collect mild steel square bar (16mm*16mm)(1mm thickness)

Mark out dimensions with marker blue and a scriber

Are dimensions correct? NO

YES

Cut with a hacksaw and then file off burrs

Mark out holes to be drilled then centre punch them

Are dimensions correct? NO

YES

Drill holes using the pillar drill

Mark out the area that needs to be milled

Are dimensions correct? NO

YES

Remove material with the milling machine

File off any burrs and then use wet and dry paper to finish the surface

Is the surface smooth? NO

YES

Spray paint the component

Leave to dry

Stop (Front Leg Top Half)

Start (Front Leg Bottom Half)

Collect mild steel square bar (13mm*13mm)

Mark out dimensions to cut with marking blue

Are dimensions correct? NO

YES

Cut with a hack saw

Mark hole for the rivnut

Are dimensions correct? NO

YES

Drill Hole for rivnut with a pillar drill

Arc weld the components together

Is the welded joint strong? NO

YES

Remove the excess material with angle grinder

Attach rivnut

Leave to dry

Spray paint the components in black

Leave to dry

Stop (Front Leg Bottom Half)

Start (Back Leg Top Part)

Collect mild steel square bar (16mm*16mm)(1mm thickness)

Mark out area to be cut with marker blue and a scriber

Are dimensions correct? NO

YES

Cut the material with a hacksaw

Mark area for drilling with marker blue and then centre punch them

Are dimensions correct? NO

YES

Drill holes with a pillar drill then remove burrs with a file

Collect steel bar (16mm*2mm)

Mark dimensions with marker blue

Are dimensions correct? NO

YES

Cut with a hacksaw

Mark area to be milled

Are dimensions correct? NO

YES

Mill 1mm into the material with milling machine

Centre punch the centre of the milled circumference

Drill with a pillar drill

Weld the two components together

Remove excess material with an angle grinder

Stop (Back Leg Top part)

Start (Back Leg Middle Part

Collect mild steel square bar (16mm*16mm)(1mm thickness)

Mark out dimensions to be cut with marker blue and a scriber

Are dimensions correct? NO

YES

Cut the material with a hacksaw and remove burrs with a file

Mark area to be drilled and centre punch it

Are dimensions correct? NO

YES

Drill with a pillar drill

Mark out area to be milled then remove material with the milling machine

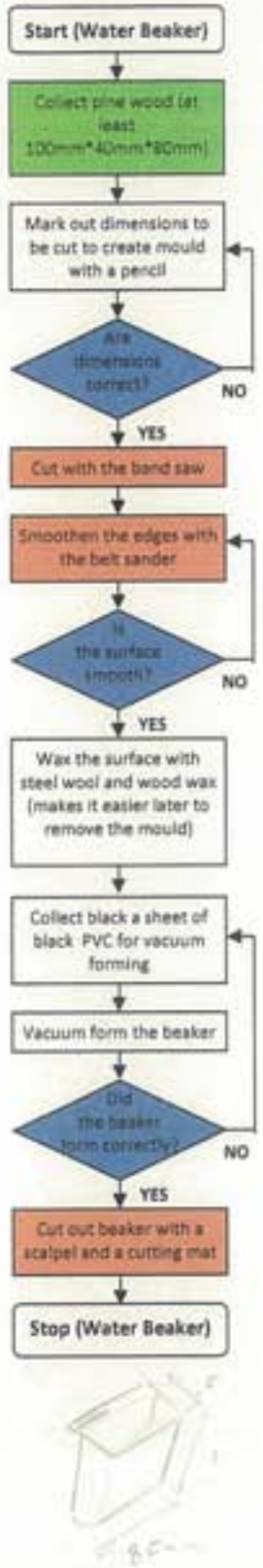
Are dimensions correct? NO

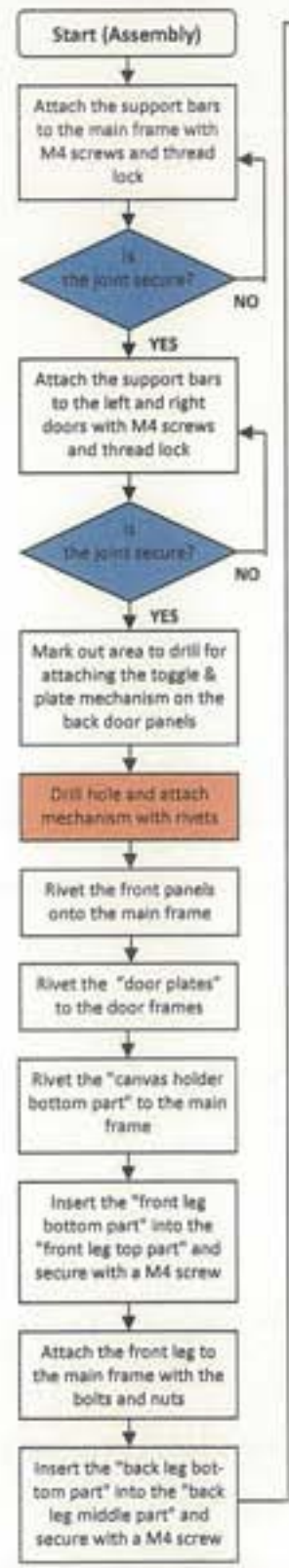
YES

Remove burrs with a file

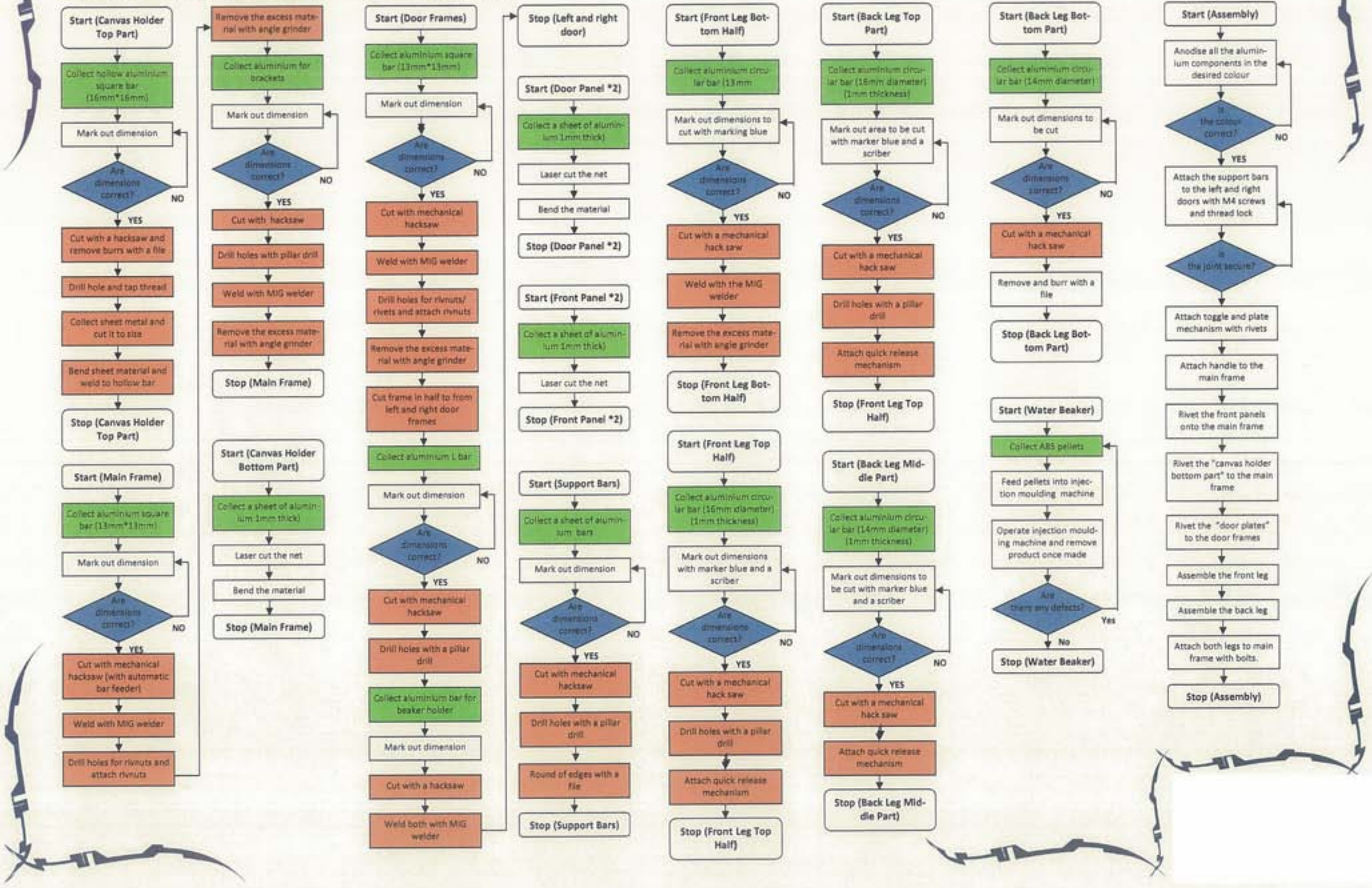
Stop (Back Leg Middle Part)

Prototype Manufacturing Flowchart





Commereial manufacturing Flowchart



Health and Safety During Manufacture

Health and safety is a major factor to take into consideration during the manufacturing process. There are legal requirements to make the work place safe such as the "Health and Safety at Work Act" and the "Personal and Protective Equipment at Work regulations".

Hazard	Risk	People at risk	Control measure
Band saw	Cut to hands Dust and debris being propelled to eyes	User User/Others	Use push sticks Wear goggles
Belt Sander	Cuts/abrasions to hands Dust and debris being propelled to eyes	User User/Others	Use sliding guard Wear goggles
File	Cuts/abrasions to hands	User	File away from the body Ensure due care.
Milling Machine	Cuts to hand Flying debris	User User/Others	Keeps hands away from drill bit Wear goggles and ensure material is secure in vice
Pillar Drill	Cuts to hands Debris being propelled to eyes	User User/Others	Keeps hands away from drill bit Ensure correct drill settings are used, use drill guard and wear safety goggles
Wet and Drying	Abrasion to hands	User	Ensure due care
Hand Drill	Cuts to hands Debris being propelled to eyes	User User/Others	Keeps hands away from drill bit Ensure correct drill settings are used, drill perpendicularly to the material and wear safety goggles
Arc Welding	Burns Inhaling fumes Damage to eyes	User User/Others User/Others	Wear heatproof gloves and apron Use ventilation Wear welding mask, make others aware of when your about to weld.
Spray painting	Inhaling fumes	User/Others	Use ventilation, wear face mask
Vacuum forming	Burns	User/Others	Keeps hands away from heating element.
Angle Grinder	Cuts/abrasions to hands	User/Others	Keep hands away from the rotating disk.
Using white spirit	Inhaling fumes	User/Others	Use in a well ventilated area, wear a face mask.
Hacksaw	Cuts/abrasions to hands	User	Ensure due care
Riveting	Trapping fingers	User	Keep hands away from the rivet when using the tool.

What is COSHH?

COSHH stands for the Control of Substances Hazardous to Health and is a set of regulations that means employers have to make an assessment of risks for work that involves hazardous substances. This means that steps have to be taken to prevent or adequately control the exposure of these substances to employees and others around. Under COSHH regulations employees have to :

1. Assess the risks to health from the hazardous substances
2. Decide what precautions are needed
3. Prevent or adequately control the exposure
4. Ensure that control measure are used and maintained
5. Monitor the exposure

Relevance of COSHH to the current project

During the manufacture of the prototype there will be a variety of processes used, some which include hazardous substances.

Arc welding produces fumes when the arc is struck and the high intensity of the heat causes some of the metal to vaporise. Due to this it is necessary to have a ventilation system to remove these fumes as these fumes can cause both long term and short term health damages if inhaled.

Additionally throughout the project I will be using white spirit to remove marking blue from the components. Whilst the risks are not as great as other hazardous substances, prolonged exposure is not good and paper towels used to remove the white spirit should be sealed in a plastic bag or similar as the substance will continue to evaporate.

Spray paint will be used to finish the product and this would need to be done indoors with a ventilation system or done outdoors. Face masks should be worn further prevent the inhalation of the fumes and also the if it was to be done outdoors then it should be during a time when there is very little wind otherwise the paint may be blown back at the user.

General Safety Measures

Whilst there are specific health and safety measures that should be taken for specific tasks and processes , there are a range of measures that should **always be taken into account during any manufacturing session.** These measures include:

- Always have a supervisor/teacher around.
- Be aware of people around your working area as they may not be aware of what you are doing (e.g. when welding you should tell people around you not to look to prevent damage to their eyes)
- Ensure that there is nothing that you can trip over, or anything that can be a hazard whilst you work (e.g. a trailing cable on the floor).
- Never use tools/machines without permission of teacher.
- Be aware of how to quickly stop a machine in the event of an emergency (e.g. locate the stop button for the machine)

Safety Equipment

Goggles-Prevent damage to eyes from flying debris, important for tasks such as drilling and milling when material is being removed.

Heatproof Apron-Protect against hot sparks from welding and angle grinding. Covers the majority of the body and usually made from leather.

Heatproof Gloves-Prevent burns to hands from sparks during welding. Also protects from being burned by hot objects.

Safety Ear Muffs-Constant loud sounds can damage the ear drums so it is important to protect against it. For example when cutting sheet metal with a band saw a loud of noise is made so ear muffs should be worn.

Manufacture Processes Record

Canvas Holder Top Part

Cutting the bar material with a hack saw. For safety goggles are worn to prevent any debris from getting into eyes.

Drilling into the material with a pillar drill after centre punching. Goggles were worn for this process

Tapping into the hole to create the tread so that the component can be fixed into place during use.

Testing that the correct thread has been tapped by putting a M5 screw in it.

I used a normal screw and attached a wing nut onto it with hot melt glue. This is to model the piece that would actually be use commercially.

I did a test piece (the centre one) to ensure that it would not penetrate too deep into the material whilst still retaining the strength of the join. If the penetration is too deep then the component will not fit the main frame.

Text Colour Key:

Black: General annotation

Red: Health and safety point

Blue: Quality control point

Note that due to the availability of materials and tools, some of the manufacturing has been completed in a different order than originally planned, but the end result is the same.

Main Frame

After cutting the bars I arranged them on a sheet of plywood.

I used magnetic right angle knee to ensure that they were at 90°.

I hammered small pieces of wood onto the board to create a jig.

The finished jig for welding the main frame

Arc welding the steel bars together. A welding mask was worn to prevent damage to the eyes. Gloves and heatproof overalls were also worn to prevent burns.

A joint after welding the material.

I used a file to attempt to remove the excess material.

I realised it was quicker with an angle grinder. A pair of goggles were worn to protect the eyes from sparks and bits of flying debris

Making jig component for the central column.

Grinding the joints on the central column after welding. Goggles are worn to protect the eyes.

Centre punching the areas where holes need to be drilled.

Drilling the holes with a corded hand drill . Goggles are worn to prevent bits of flying metal getting to the eyes.

Testing by inserting a 3.2mmø rivet into the holes to ensure that they fit.

Using marking blue and a scriber to mark up the dimension for the brackets.

Cutting through the metal with a hacksaw.

Using a file to remove the burrs and smoothen the edges.

Using a pillar drill to drill the holes in the brackets. A pair of goggles are worn.

The brackets are welded on and then smoothened with an angle grinder. I then testing that they were the correct distance apart by fitting a piece of material that would be used to create the leg to ensure that the fit was correct.

Manufacture Processes Record

Canvas Holder Bottom

Using the band saw to cut the sheet metal. Goggles were worn and extra caution was needed.

A hacksaw was used to finish the cut because the it would not fit in the band saw lengthways

Filing down the excess material

Clamping the sheet metal between two pieces of wood then bending.

A picture after the bending of the metal.

Marking and centre punching where holes need to be drilled.

Drilling the holes with a pillar drill. Goggles were worn at this stage.

Left and right door

Welding the frame using the same jig as the main frame. Welding mask and heatproof gloves are worn.

I held the pieces with a right angle knee and then welded these pieces onto the frame.

I cut out the brushes component holder from a L bar with a hacksaw.

Drilling the holes for the brushes holder with a pillar drill. Goggles are worn.

Testing that the holes are large enough to accommodate the brushes.

After welded with brushes holder onto right door frame.

Cutting the beaker holder component with a fret saw.

After welding the beaker holder onto the left door frame

Attaching the rivnuts onto the door frames with the rivnut tool.

Door Panels

Marking the dimensions with marking blue and a scriber.

Checking that the plate with fit the door frames.

Testing that the holes match up with the door frame holes by inserting rivets through the holes.

Removing the marking blue with white spirit, and steel wool. Should be done in a well ventilated area as the fumes are hazardous.

Water Beaker

Cutting out the mould out of wood with the band saw. Goggles and caution are needed.

Waxing the mould with wood wax and steel wool so that the mould is easier to remove from the formed plastic.

Cutting out the mould with a Stanley knife.

The water beaker after cutting

Manufacture Processes Record

Support Bars

After cutting the support bars I filed down the edges.

I held the support bars together with masking tape before drilling the holes with a pillar drill to save time and reduce error as I would need to mark the area to drill fewer times.

Front Panels

Marking the dimensions with marking blue and a scriber

Cutting the front panels with the band saw. Extra caution was required as the blade is hazardous and goggles were worn .

Front Leg Top Half

Milling the slot with the milling machine. Goggles were worn to protect the eyes.

Drilling the holes for the joint with a pillar drill. Eye protection was worn.

Rounding of the edges with a file.

I tested that the holes were aligned by attaching it to the main frame.

Front Leg Bottom Half

Welding the bars together which are held together with right angle knees.

After attaching the rivnut I slotted the bottom half into the top half to check that they fit.

Back Leg Top Part

Drilling holes into the material to reduce the overall weight of the

Measuring the length of the bar.

After milling I placed a rivnut in the grove to ensure that the depth was correct.

Back Middle Part

Milling the slot with the milling machine. Eye protection was worn.

Attaching the hinge to the back leg top and middle part

Using a test piece to ensure that the hinge can be welded.

The hinge after welding. Unfortunately I could not find a hinge that was small and strong enough so I compromised

Surface finishing

Spray painting the support bars.

Spray painting the frames and legs with smooth black Hammerite metal paint. Ventilation is required as the fumes are hazardous.

Assembly

Marking area to drill holes for the toggle and plate mechanism.

Riveting the toggle and plate mechanism to the back doors.

Adding the tread lock onto the M4 rivnuts to secure the screws.

Attaching the aluminium panels to the frame and then riveting them in place.

Finished

Finished Product Images

Front view of the product when fully "unpacked"

Top bracket with the legs packed away.

Left door with the water beaker on the "hanger".

The locking mechanism for the back leg top and middle part. A M4 screws is used to secure the leg in place.

Back view of the product with the doors closed.

Front view of the product with the doors closed

Picture of the support bars for the left hand side door.

Top bracket with the back leg secured with M6 bolts and nuts.

A image of the product outdoors in use by a 6th form artist.

Bottom bracket with the legs packed away.

Left door with 2 brushes in the holder. Note that 3 brushes can he held at anyone time.

Slotting mechanism of the back leg, it is used to adjust the overall height.

Image of canvas holder and some of the support bars can be seen.

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Slotting mechanism of the back leg. It is used to adjust the overall height.

Image of canvas holder and some of the support bars can be seen.

Testing, Evaluation & Modifications

Comments from the client:
The final design looks professional and has a modern look which is good as we wanted originally to avoid having anything that looked too traditional. I have some concerns about the stability of the product as the front leg seems rather small. I think the stand is quite weighty but since it was made for year 10 to 6th form students they shouldn't have much trouble carrying it around. Currently the prototype would appear to take a considerable amount of time to setup but I would image with a few small adjustments that a commercial version would be easier to set up. Overall I think that this is a high quality stand and could definitely be used by artists from school.

Aesthetics :
Aesthetically the is very simple and attempts to be minimalistic so that the user is not distracted by the stand itself whilst painting. I think the simplistic colour scheme of black and metal work well but when we tested the product outdoors on a sunny day there was a lot of light being reflected at the user. In order to overcome this issue I propose that a matt colour be anodised onto the aluminium plates.
I feel that the product has a modern style in that it is very functional and not overly intricate which you find more with older artistic movements.
Whilst I like that simple colour scheme of the product, there were issues with sunlight being reflected off the metal surface. This definitely needs to be addressed because it can be irritating and does not help when your trying to paint.

Portability :
The most important factor I considered with portability is the weight of the product. With this in mind I used the smallest bars of material I could and I drilled a series of holes in the top part of the back leg in order to try to reduce the overall weight. Despite my attempts to reduce the weight the overall weight of the product is still high and weighs 9kg which is still portable but not ideal. As this is a prototype I used mild steel for the majority of the construction due to limitations of the workshop, but in a commercial environment aluminium would be used and I estimate that it will be 70% lighter which is significantly less making it more portable. I tested that the product will fit into the boot of a typical hatchback (as they are small and the typical type of car a student would have) by actually putting it in the boot of a Vauxhall Corsa. The product fit in without an issue and there was still room around the side to easily take the stand out afterwards.
The stand is relatively portable despite its size but if the student had to walk a long way then it could become strenuous as it is quite heavy. A shoulder strap would probably be a good idea but if a commercial version is going to be significantly lighter then this is probably not needed.
If I had to carry this stand for a long way, for example the town centre to the beach, then I would probably feel a strain on my arm after a while. Though comparing this to wooden easels it is comparatively light so I would rather use this stand over a bulky wooden one.

Function :
I ensured that the stand would be compatible with A2 material by getting a sheet of A2 paper and mounting it on the stand. There were no issues with size and we also mounted some canvas that was 20mm thick and it fitted well. I checked that the water beaker would not leak by filling it with water and I place brushes in the holder to check that it would be able to hold them.
It will accept a variety of canvas sizes which is good and it is simple to secure it in place with the sliding clamp. Having a detachable water beaker is good because it means that the user can change the water easily.
The stand does what its supposed to do and there's not much else to be said. Though I have one minor point and that is that with the brushes holder is might be a good idea to have the brushes further apart.

Stability:
When we were testing the product outdoors we found that there were some stability issues. The first problem was that the stand would "wobble" marginally due to the brackets not being quite as tight as I would like. Additionally due to the shot length of the "T" section of the front leg the foot print of the product is not particularly large meaning there is a danger that the stand will fall sideways. This issue is worse when the stand is raised as the centre of mass is even further up meaning that its even more likely to tip over. Unfortunately the wind makes things worse as the back door panels act as a huge buffer which all attributes to the product being unstable. To resolve the wind problem I would remove the back door panels as they do very little for the product 's functionality and is purely aesthetic. Even with the door panels removed I believe the product would still look good as the innards would add a level of complexity to the design. To resolve the issue of increased instability as the product is raised I would have two front legs that are pointed away from each other. This means that as the stand is raised, the footprint increases proportionally.
After seeing the stand being set up and could immediately tell that there would be some stability issues as the front leg was so small. To improve the stand I definitely think that the front leg section should be redesigned to make the product more stable.
As we were testing the product outdoors I noticed that the stand seems to be swaying a little and might even get tipped over from the wind pushing it over. This is a big problem for painting because if the canvas moves then there will be mistakes in the painting.

Quality of outcome :
I feel that my product has been manufacture to a high quality and precision and I have taken every care to ensure that it is the best I can make it. I have filed down all the welds and remove all the burrs. The only problem I have with my product is that the spray paint I applied seems to scratch easily, I found this especially evident with the telescopic legs so a modification I would make to this product is to use some nylon on the joints so that the paint does not rub off so easily as nylon is self lubricating.
The quality of the stand is very high and it is finished very nicely. All the joints are fairly tight fitting and I could see this being a commercial product.
I was impressed by the product's quality and the spray paint finish is good, but I think spray paint is not long lasting enough as you can already begin to see where there are scratches. Other than that all the bits line up and is a quality product.

Safety :
The biggest possible safety hazard with my product us that the user may catch their hand on the doors when opening/closing them. This should not be a problem though because I designed it in mind so that the user can open both doors in one motion so both hands are away from the metal panels and joints. Additionally if the user shows due care then it should not be a problem. One minor hazard is that after a long time the panels may become sharp if there are deep scratches on the surface so again due care should be used.
I don't think that there are any major hazards that being sensible won't solve. As the students using this will be 15 years of age and upwards I would expect them to not be careless and have a degree of awareness when using the stand.
For me I would say that the biggest hazard would be the stand falling over and then tripping up when you go to catch it as it falls. Aside from that I don't think that this stand is dangerous.

Conclusion :
Overall I believe that this design is good and with a few modifications it can be viable as a commercial product. As this is a prototype it has pitfalls what the final product would not have, for example the material used would be aluminium which solves the issue of the weight.
The stand is rather different from the sorts of solutions I initially envisioned, but in a good way. I like that everything is enclosed in one convenient package and that it is different from the old wooden frame easels. If there was one thing I would change then it would be the front leg because its unstable in its current form.
I think that this stand is very good for someone looking to paint on canvas outdoor and I can see people using it. It would not replace a indoor easel but as portability is the important thing with painting outdoor I think it is brilliant.

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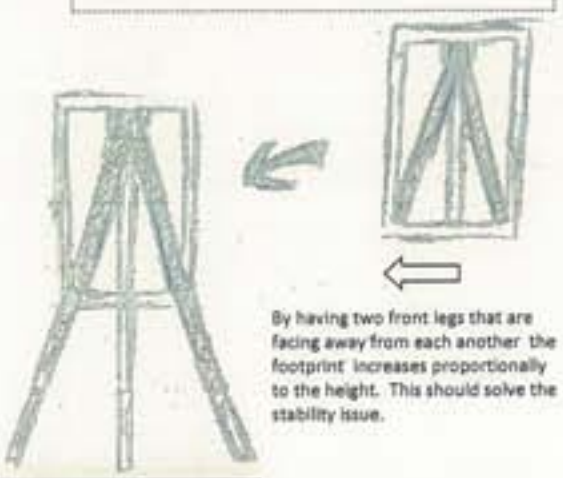

By having two front legs that are facing away from each another the footprint increases proportionally to the height. This should solve the stability issue.

Render of product with matt coloured front panels to ⇦ com-

A example of the quality of the product. The panels match up the frame exactly.

⇧ A 6th former carrying the stand

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Portability :
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IMAGE OF PRODUCT IN CAR BOOT

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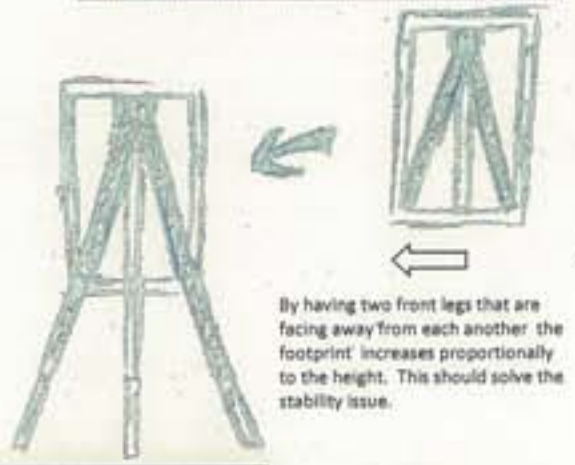

By having two front legs that are facing away from each another the footprint increases proportionally to the height. This should solve the stability issue.

Render of product with matt coloured front panels to compact glare and the back panels removed.

A example of the quality of the product. The panels match up the frame exactly.

A 6th former carrying the stand

Evaluation Against Specification

Purpose:

- **Provide a area for artist to mount their painting medium and hold a variety of painting tools.**

There is a tray that the painting medium sits on which is then secured with a slider that clamps onto the top of the medium. On the door sections there is a holder for brushes and a beaker.

Form:

- **Have a modern style that deviates from traditional wooden frames.**

The product deviates from traditional wooden frames because where's traditional wooden frames are bulky I took advantage of the properties of metal and designed a product that is much more minimalistic. Additionally my choice of colour scheme is because one of the most common modern colour schemes is black and silver. By having a modern colour scheme it immediate deviates it from traditional wooden product at a glance.

Function:

- **Hold canvas and paper/card mounted on a board up to A2 size.**
- **Hold brushes and a water beaker during use.**

The painting medium is held on a supporting tray and then secured with a sliding clamp. To test that this indeed does work I mounted some canvas onto the stand without any issues, additionally I got some A2 paper and mounted it to ensure that it will fit sizes up to A2.
There is a brushes holder on the right hand door and will hold 3 brushes at any given time. On the left door there is a hanger for a custom made vacuum formed beaker. I tested that the beaker is water tight by filling it with water and checking it for leeks. To improve the product I think it would be good have a method of allow the user to fix their own beaker to the stand because not everyone may like the beaker that comes with the stand. Alternatively the beaker should be made by injection moulding for commercial production as it will allow me to create a more structurally sound beaker.

User requirements:

- **Be portable and light-weight (less than 10kg) so that it can be easily transported.**
- **Hold at least 3 brushes and a water beaker**
- **Be suitable for people 1700mm tall (±150mm)**

I tested the portability of the product by having student carry the stand around for a while and then comment on it. Most people said that it was relatively easy to carry around but is a bit weighty so it would not be suitable for carrying by hand over a large distance. To improve upon this a commercial version would be manufactured from aluminium predominantly and would reduce the weight by around 70% I estimate. A paint brushes holder is built into the right hand door with support for up to 3 brushes. I tried placing a variety of sizes of brushes in the holder with no issues. I think to improve upon this I should include more slots for brushes as I think some people could easily be use 4 or 5 brushes at one time. I asked students with various different heights to test the product to see if it was suitable for their height. The test showed that the product is easily suitable for people 1700mm (±150mm) tall, but with this iteration of the design the product became increasing unstable as the height was raised.

Performance requirements:

- **Hold the drawing medium securely so that it does not move during painting.**

A variety of sizes of drawing mediums was mounted onto the stand and then secured in place with the sliding lock. I found that whilst the medium was secure enough for painting on, the medium could still be moved if you try to applied enough force. To resolve this I recommend incorporating a rubber strip that will be glued onto the canvas support since rubber has a high coefficient of friction it will help keep the painting medium secure.

Material and components:

- **Must not use wood for the product**
- **Be finished to protect from sunlight deterioration, rain and wet or damp conditions.**

The product is entirely made from mild steel and aluminium so there is no wood in the product. Aluminium naturally forms an oxide layer that will protect in from the outdoor elements so no finish was used, but mild steel on the other hand is sceptical to rust. To protect the mild steel I applied multiple layers of Hammerite spray paint onto the surface. This would protect the mild steel from oxidisation as the air cannot make contact with the metal due to the layer of paint. Unfortunately the paint scratches off easily which is especially evident with the telescopic legs. A commercial version would not use mild steel in the construction and would be made entirely of aluminium hence avoiding this problem, but a anodised finish to the aluminium would improve the aesthetics of the product.

Size:

- **Dimensions have to be less than 940*500*500mm to fit in the boot of a car.**
- **Painting surface should be held a suitable height to suite an average size student.**

The basic dimensions of the my prototype when closed up is 752*420*103mm which easily fits within limits of 940*500*500mm. To further prove that the product will fit comfortably in the boot of a small car, I put the product into the boot of a Vauxhall Corsa which is a small hatchback and found that there was plenty of space.

Safety:

- **Not have sharp corners or edges that can cause injury.**
- **Should not weigh more than 10kg to ensure it is relatively safe for someone to move.**

By aligning the panels for the front and the back door frame I have reduced areas where the panels may stick out and cause a potential hazard. Unfortunately a problem with my design is that the area I have cut out for the user to open the doors (see where I have circled the image) there are sharp right angle part to the panel which can easily cut the user is they catch their hand between it and the main frame as they are closing the door. Whilst this can be avoided with some general awareness from the user, I should have rounded the edge in my prototype. As mentioned in a earlier part of my evaluation, I believe that removing the back door panels altogether will improve the product as it would reduce drag from wind and additionally it would remove the sharp corner.
After weighing my product I discovered that it weighed 9kg which is only 1kg short of the limit set by the specification. Whilst my prototype meets the requirement for this particular specification point I believe that 9kg is still too heavy and after carrying the product around for a long while I found that it was fairly straining on the arms so a weight reduction is definitely required. A commercial version would be made from aluminium so I believe that this would solve the weight problem of this product. Additionally I would incorporate a series of small milled slots into the legs in order to further reduce weight (much in the same way I drilled holes into the *back leg top part* component to reduce the weight whilst still keeping the structural strength).

Quality:

- **Use materials and components that follow British Standards so that they are reliable.**
- **Be manufactured using a suitable range of quality control procedures that will ensure a high quality outcome.**

All material used in the prototype was sourced from a reputable British based company so all materials used comply with British Standards which contributes to the quality assurance of the product. Throughout the whole of the manufacturing process I repeatedly check every dimension, surface finish, joint strength and a host of other aspects to ensure that I produce a quality outcome. I expect the similar checks will be used in a commercial run of this product (e.g. A coordinate-measuring machine could be used to check dimensions of the support bars).

Scale of Production:

- **A one-off production.**

My design is intended to be a bespoke piece, but has the capacity to developed for batch production if there is a market for this product. For example in a batch production environment the panels could be quickly laser cut and the bars for the frame be cut with a autonomous circular saw fitted with a bar feeder. Various parts would be processed by hand (such as riveting and assembly), but the turnover time would be fast and could be made in batches of 5 to 20 at a time I estimate.

Cost:

- **The cost should be less than £150.**

I estimate that the material costs of my prototype to be £90 which is less that the limit of £150 stated in the specification. In the commercial product I intend to use aluminium which is significantly more expensive than mild steel but I believe that it will still be under the £150 mark. Additionally if this product was produced in batches then we are able to purchases the aluminium at a cheaper price per gram as we would have economy of scale.

Sustainability:

- **More than 80% of the product should be recyclable.**

As the product is made entirely from aluminium and mild steel the product is 100% recyclable which is a good achievement. Both steel and aluminium are commonly recycled materials so we can expect there to be a facility to recycle the product no matter where in the country the product is taken. The production model would also be 100% recyclable as it would be made completely from aluminium which is even more environmentally friendly as it requires only 5% of the energy needed to extract aluminium from its ore (through electrolysis) during the recycling process.

Evaluation Against Specification

Purpose:

- Provide a area for artist to mount their painting medium and hold a variety of painting tools.

There is a tray that the painting medium sits on which is then secured with a slider that clamps onto the top of the medium. On the door sections there is a holder for brushes and a beaker.

Form:

- Have a modern style that deviates from traditional wooden frames.

The product deviates from traditional wooden frames because where's traditional wooden frames are bulky I took advantage of the properties of metal and designed a product that is much more minimalistic. Additionally my choice of colour scheme is because one of the most common modern colour schemes is black and silver. By having a modern colour scheme it immediate deviates it from traditional wooden product at a glance.

Function:

- Hold canvas and paper/card mounted on a board, for painting on with acrylic paint.
- Hold brushes and a water beaker during use.

The painting medium is held on a supporting tray and then secured with a sliding clamp. To test that this indeed does work I mounted some canvas onto the stand without any issues, additionally I got some A2 paper and mounted it to ensure that it will fit sizes up to A2.
There is a brushes holder on the right hand door and will hold 3 brushes at any given time. I think to improve upon this I should include spaces as I think some people could easily be use 4 or 5 brushes at one time. On the left door there is a hanger for a custom made vacuum formed beaker, I tested that the beaker is water tight by filling it with water and checking it for leeks. To improve the product I think it would be good have a method of allow the user to fix their own beaker to the stand because not everyone may like the beaker that comes with the stand. Alternatively the beaker should be made by injection moulding for commercial production as it will allow me to create a more structurally sound beaker.

User requirements:

- Be portable and light-weight so that it can be easily transported.
- Hold a variety of painting instruments.
- Be suitable for people 1700mm tall (±150mm)

I tested the portability of the product by having student carry the stand around for a while and then comment on it. Most people said that it was easy to carry around but is a bit weighty so would not be suitable for carrying by hand over a large distance. To improve upon this a commercial version would be manufactured from aluminium predominantly and would reduce the weight by around 70% I estimate.

Performance requirements:

- Hold the drawing medium securely so that it does not move during painting.

Material and components:

- Avoid using wood for the majority of the construction.
- Be finished to protect from sunlight deterioration, rain and wet or damp conditions.

Size:

- It should be easily fit into the boot of a car (boot dimensions 940*500*500mm).
- Painting surface should be held a suitable height to suite an average size student.

Safety:

- Not have sharp corners or edges that can cause injury.
- Should not weigh more than 16kg to ensure it is relatively safe for someone to move.

Quality:

- Use materials and components that follow British Standards so that they are reliable.
- Be manufactured using a suitable range of quality control procedures that will ensure a high quality outcome.

Scale of Production:

- A one-off production.

Cost:

- The cost should be less than £150.

Aesthetics :

Aesthetically the is very simple and attempts to be minimalistic so that the user is not distracted by the stand itself whilst painting. I think the simplistic colour scheme of black and metal work well but when we tested the product outdoors on a sunny day there was a lot of light being reflected at the user. In order to overcome this issue I propose that a matt colour be anodised onto the aluminium plates.
I feel that the product has a modern style in that it is very functional and not overly intricate which you find more with older artistic movements.
Whilst I like that simple colour scheme of the product, there were issues with sunlight being reflected off the metal surface. This definitely needs to be addressed because it can be irritating and does not help when your trying to paint.

Life-cycle Assessment (LCA)

My life cycle assessment will be for a commercial production of the design.

Raw materials

Aluminium is extracted from mined ore such as bauxite through the process of electrolysis. Electrolysis requires a large amount of electricity which in turn using us fossil fuels to generate the electricity. Additionally the ore has to be mined and then transported to be refined which uses large amounts of fuel, this is especially true when you consider that the ore is often taken to a entirely different country to be refined. Therefore there is a large amount of carbon dioxide being released into the atmosphere from the extraction of aluminium.

Bauxite ore

Manufacture

One major process that will be used during manufacture will be laser cutting for the panels. Laser cutting is typically 5% to 15% efficient so an alternative method would be to use a band saw as it is more energy efficient, but would not offer the same degree of accuracy nor automation. MIG welding is a form of arc welding and uses a large electric current to heat and fuse the metal meaning that there is a high energy cost. A more energy efficient alternative would be to join the materials with a adhesive or screw, but the joints would not be as strong as a weld and lack a professional finish. Drilling is used through the whole manufacturing process, but there is no suitable alternative that would achieve the same result.

Laser cutting

Distribution

The product would be made in small batches so to transport the product in a commercial environment, vans would be used. My design already have very compact dimensions and it would not be possible to make the product any smaller without serious major changes to the design. Additionally aluminium would be used for the product so the product is relatively light hence saving fuel. To further make the product lighter I would have to use expensive alloys (such as Duralumin) which would increase costs significantly and hence not justifiable.

Transport van

Use

The product will last a long time (approx 10 to 20 years) so there will be no need to replace the product often. There is no easy way of repairing the product but certain components such as the legs can easily be replaced as they use only semi-permanent joints (nuts and bolt). We could use the fact that the product is environmentally friendly to market the product and make it seem appealing to people that are environmentally aware.

Product in use

End-of-life

As the commercial product will be made fully from aluminium, it will be 100% recyclable. Additionally it only uses 5% of the energy used to extract the raw material is used during the recycling process. Sourced components such as the bolts may be made from steel, but this is also recyclable meaning that the product is 100% recyclable so nothing ends up in the landfill.

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