EDEXCEL

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

EXEMPLAR MATERIAL 3

UNIT: 6RM01

Hi

Investigation

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Product Design

Resistant Materials Technology – 6RM01

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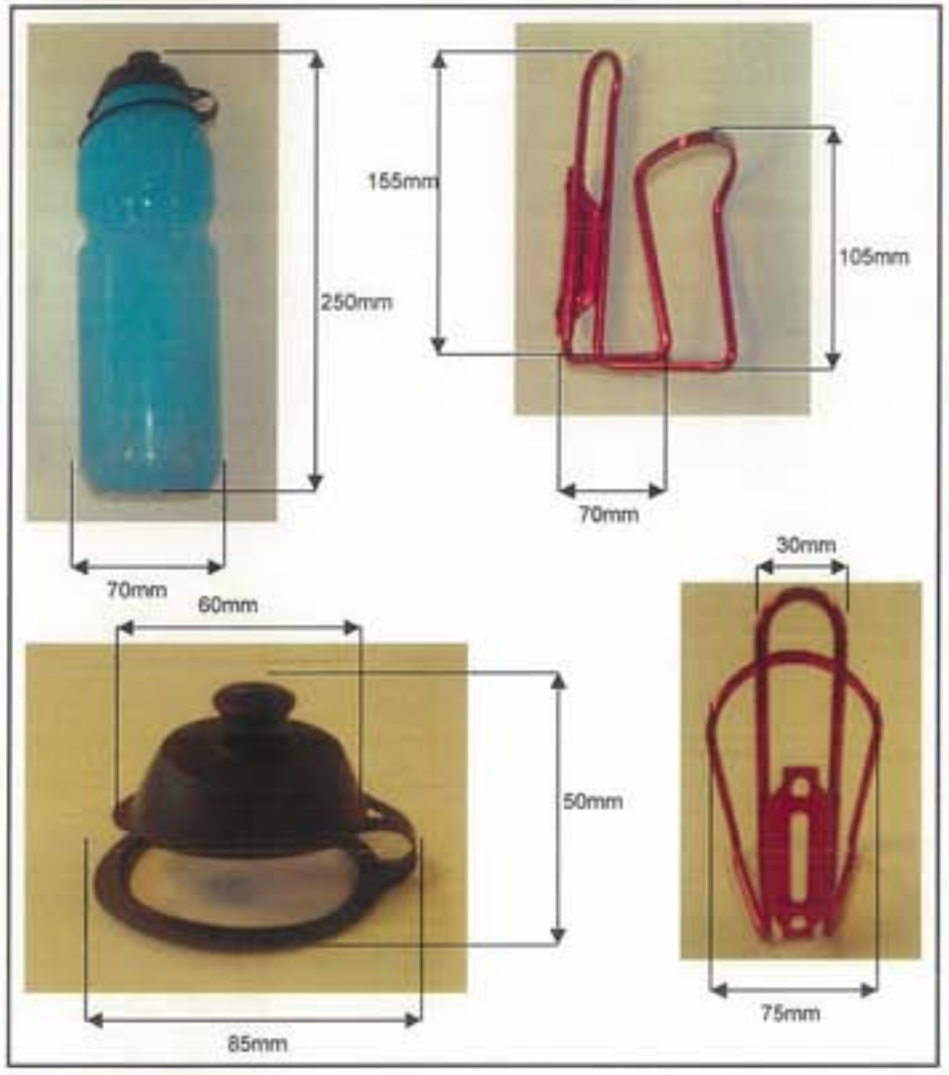
Chosen Product and Alternative

Chosen Product

- Basic Dimensions



(Fig: 1)

• As a unit this bottle and frame fit together as shown in Fig: 1. The bottle simply slides into the frame which is a reasonably tight fit. This friction fit ensures that the bottle is held firmly in place and will not come loose even during vigorous movement and even light impacts. However it is still fairly easy to remove which is essential when the user needs quick easy access to the bottle.

(Fig: 2)

(Fig: 3)

• Fig: 2 and Fig: 3 shows how the bottle cap attaches to the bottle. There is a small indent on the exterior of the bottle which the cap fits into. It can then be opened and closed without being removed from the bottle. This is a useful addition as it prevents the lid being lost while refilling and emptying the bottle. From this position the lid can simply be snapped shut with a friction fit onto the top of the bottle.

(Fig: 5)

• Fig: 5 and Fig: 6 Show two more close-ups of the bottle cap. It is possible to see from these pictures that the cap is made from two pieces. The actual cap itself and the small pressure top that allows liquids through. Both the cap and the top are likely to have been injection moulded from HDP (High-Density Polythene) and assembled afterwards by hand.

(Fig: 6)

(Fig: 7)

• Fig: 7 shows the bottle itself with the water level markings and company logo printed on the side. You can also see that the shape of the bottle has been designed with ergonomic and anthropometric needs in mind. There is an indent in the side of the bottle that allows it to be gripped easily and it is not too wide to stop a hand easily holding it.

(Fig: 4)

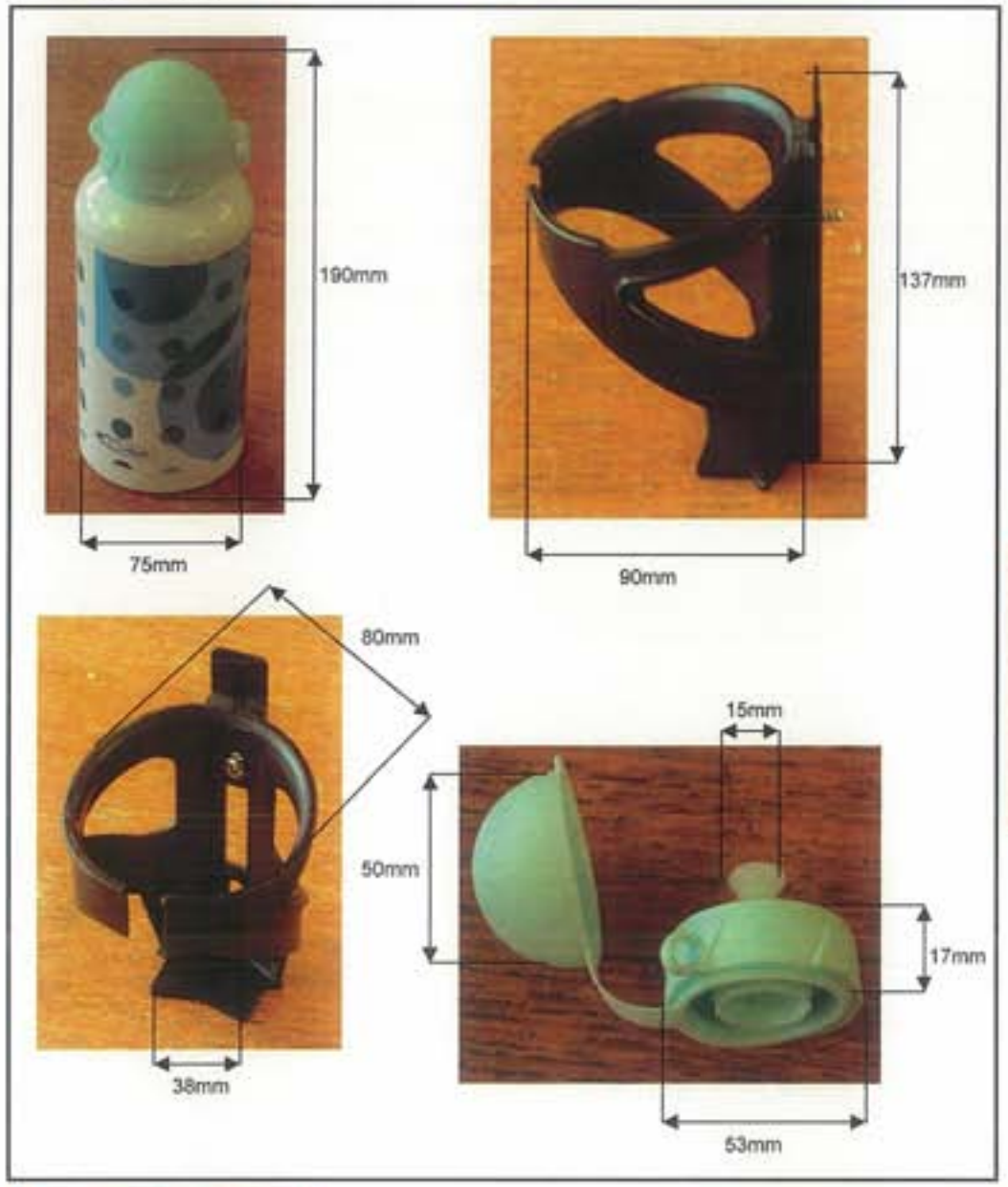
• Fig: 4 is a simple close-up of the bottle cap showing the mechanism for drinking from the bottle. The cap has a small pressure top that can be opened and closed to allow fluids to be sucked from the bottle.

(Fig:8)

• Fig: 8 shows the Aluminium alloy frame. The frame is manufactured from two Aluminium rods TIG welded together with another back piece. The rods would have been line bent and the TIG welded to the fixing sheet which would've been pressed. The completed frame would've then been anodized and the manufacturers logo printed on the front.

Alternative

- Basic Dimensions

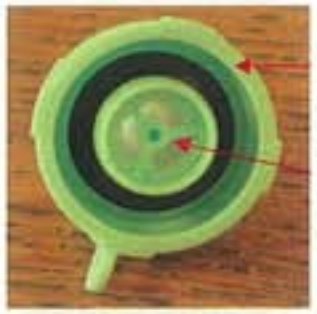


(Fig: 1)

• When assembled this bottle and frame fit together as shown in Fig: 1. The bottle slides into the frame and is held by the friction of the plastic arms. This ensures the bottle is held firmly in place and will not come loose while cycling. However it is still relatively easy to remove the bottle from the frame.

(Fig: 2)

Fig: 2 shows the bottle with the lid unscrewed. From this picture it is possible to see how the metal bottle has a thread inside the neck which the lid screws onto to ensure a secure, watertight fit between the lid and the bottle. This helps to prevent leaking. In this picture you can also see the top of the bottle has been removed from the lid to show how it fits on. The small plastic ringlet fits onto the bottom of the lid just below where it meets the bottle and it can be snapped shut over the lid and pressure cap when not in use. This helps to prevent the pressure cap getting dirty and it adds to the hygiene of the bottle.



(Fig: 4)

Fig: 4 shows the underside of the bottle lid. From this picture it is possible to see both the screw thread that allows the lid to be screwed onto the bottle and also the bottom of the pressure top that can be opened and closed to allow fluids out.

(Fig: 3)

Fig: 3 is a close up of the bottle lid and top which shows how the top ringlet fits onto the bottle lid.

(Fig: 5)

Fig: 5 shows the plastic frame from behind. From this view it is easy to see the screw that allows the frame to be attached to the bike. This would provide a secure base for the unit and it would be fairly compact. However it may be difficult to adjust the unit once attached and it could also be difficult to remove the unit should the user want to transfer it to another bike.

(Fig: 6)

Fig: 6 shows the lid of the bottle without the cap. From this picture you can see how the pressure top works differently to the chosen products bottle. Instead of having a small top that pops open the entire top pulls up to let liquid out. This means it is slightly easier to open and close than the chosen products bottle.

Product Analysis 1

Specifications / Criteria	Chosen Product 	Alternative product 	Analysis
Purpose 1) To hold a standard sized water bottle and attach securely to the majority of bikes. 2) Hold a suitable volume of water without leaking. 3) Allow easy drinking access from the bottle and have the ability to reseal to be watertight. **Function** 1) To hold a standard sized water bottle securely but allow it to be removed and replaced. 2) To be able to fix securely as a unit to the majority of bike frames but have the ability to be removed and replaced if necessary, e.g. switching the unit from one bike to the another. 3) To fit the majority of bike frames while staying upright in place during vigorous shaking and motion. - Possibility of being adjustable to fit other bike frames outside the normal dimensions. 4) To last a reasonable length of time before degeneration even with heavy use. E.g. being corrosion resistant and fairly tough. **Form** 1) To fit in with the aesthetics of a bike -Possibility of manufacturing different colours to suit different tastes. 2) To have a streamlined shape to provide a low wind resistance. 3) To have a compact shape to allow the unit to fit easily onto the frame of the bike without being cumbersome and taking up too much space or protruding outwards very far. 4) To display the manufacturers logo clearly somewhere on the unit. 5) The bottle must be shaped with ergonomic and anthropometric data in mind so gripping the bottle is easy and it will not slip. **Performance** 1) Must be able to open and re-seal to be watertight effectively and easily. 2) Must be able to hold the bottle securely but allow it to be easily removed and replaced quickly. 3) Must be tough and be able to withstand light impacts and be corrosion resistant while still being lightweight. 4) Bottle must be easy to empty and refill. 5) The bottle must be easy to clean. **Safety** 1) The bottle must not be manufactured from toxic or irritant materials, especially the bottle. 2) The bottle must be easy to clean to avoid risk of poisoning through contamination from old liquids. 3) The unit must have no protruding sharp edges that could cause an injury while cycling. 4) The bottle must be made from a non-shatter material to avoid injuries should the bottle get impacted during a crash.	**Purpose** 1) The frame encompasses the bottle easily and can be attached to a bike easily. 2) The bottle holds over 700ml of water and does not leak when the lid is on firmly and the pressure cap is down. 3) The pressure cap is easy to open and once open it is easy to suck fluids out of the bottle. **Function** 1) The frame holds the bottle securely and it Is relatively easy to remove the bottle. 2) The unit can be easily attached and removed from the majority of bike frames. 3) The frame can be attached to a bike frame securely so it will stay upright during use. 4) Both the frame and the bottle are made from tough and reasonably durable materials. The frame is also anodised to reduce corrosion. **Form** 1) The bottle and frame as a unit would fit in well on a bike frame. 2) The unit does not have a particularly streamlined shape and so may not be suitable for certain types of cycling. 3) The unit is fairly compact when assembled and could easily fit onto the frame of a bike without being cumbersome. 4) Both the bottle and the frame have the manufacturers logo displayed clearly on them. 5) The bottle has a moulded groove on it to allow for an easy grip. **Performance** 1) The bottle is a bit stiff when opening it and cleaning the inside thoroughly could be difficult. 2) The bottle when in the frame is held securely and can be removed and replaced quickly. 3) The unit is fairly tough and robust. 4) The bottle is easy to empty and refill. 5) The bottle may be difficult to clean thoroughly inside. **Safety** 1) The bottle is manufactured from corrosion resistant, non-toxic plastic and the frame is anodised with a not toxic layer. 2) The inside of the bottle is potentially difficult to clean thoroughly. 3) When assembled the unit has no sharp points or edges that could cause injury. 4) The bottle is manufactured from a non-shatter plastic.	**Purpose** 1) The frame encompasses the bottle easily and can be attached to a bike relatively easily. It may be difficult to remove however once attached. 2) The bottle holds roughly 500ml of liquid and it doesn't leak when the lid is firmly on and the pressure top is down. 3) The pressure cap is very easy to open and close and it is easy to fluids out of the bottle. **Function** 1) The frame holds the bottle securely and it is very easy to remove the bottle. 2) The unit can be easily attached to the majority of bikes frames but it may be difficult to remove the unit should the user want to change bikes. 3) The frame can be attached to a bike frame securely so it will stay upright during use. 4) Both the frame and the bottle are made from tough and durable Materials. The bottle however could be prone to denting should it experience any reasonable impact and the frame could possibly snap if overexerted or after frequent and prolonged use. **Form** 1) The bottle and frame as a unit would fit in well on a bike frame. 2) The unit doesn't have a particularly streamlined shape and so may not be suitable for some types of cycling. 3) The unit is quite compact when assembled and could fit easily onto a The frame of a bike without it being cumbersome. 4) The bottle displays the manufacturers logo clearly but the frame has no indication of the manufacturer. 5) The bottle has no particular adaptations that improve its grip. The slippery coating and lack of grooves on the bottle mean it could be difficult to grip properly, especially when wet. **Performance** 1) The bottle lid is easy to unscrew but the bottle neck is very thin so It would be very difficult to clean the inside especially if there is anything stuck to the inside of the bottle. 2) The frame holds the bottle securely but it can still be removed and replaced quickly. 3) The bottle is very tough and robust but the frame could have a tendency to snap or shatter under certain impacts. 4) The bottle is easy to empty and refill. 5) The bottle would be very difficult to clean thoroughly inside due to the narrow opening and neck. **Safety** 1) The bottle is manufactured from an Aluminum alloy and it is painted increase its resistance to corrosion and the frame is non-corrosive, non-toxic plastic. 2) The inside of the bottle would be very difficult to clean thoroughly. 3) When assembled the unit has no sharp points or edges that could cause injury. 4) The bottle is manufactured from an Aluminium alloy and so will not Shatter but could be prone to denting.	**Purpose (Chosen)** • Under purpose the chosen unit is definitely more successful in achieving the specifications. Both units allow easy drinking access and can reseal easily but the chosen product can hold far more water than the Alternative product and the Alternative could be potentially difficult to remove from a bike frame once attached. **Function (Chosen)** • The chosen product is also better under the Function heading in that it meets all the necessary specifications while the Alternative product has some flaws. Firstly it could be difficult to remove from a bike frame once attached and secondly the bottle, which is made from an Aluminium alloy could be prone to denting under certain impacts which decreases the lifespan of the product. **Form (Chosen)** • The chosen product beats the Alternative product under Form as the Alternative product has no adaptations to make it easy to grip and the frame doesn't show the manufacturers logo anywhere. However both units fail the specification of having a relatively low wind resistance so this might warrant a potential change to the design. **Performance (Chosen)** • The Chosen product is better at achieving the specification points under the performance heading as although it would be difficulty to thoroughly clean the inside it would be much harder to do so with the Alternative. The chosen product however does have a slightly stiff lid which may need altering. **Safety (Chosen)** • The Chosen product and the Alternative product are both quite effective at carrying out the safety specifications, however the chosen product is slightly better as the Alternative products frame could be prone to snapping or shattering.

Product Analysis 2

Specifications / Criteria	Chosen Product 	Alternative product 	Analysis
Materials and Manufacture 1) Materials must be corrosion resistant and waterproof. 2) Materials must be easy to clean to prevent contamination of fluids in bottle. 3) Materials must be non-toxic and non-irritant, especially the bottle. 4) Materials must be tough and able to withstand reasonable impacts, e.g. light crashes. 5) Materials must be lightweight so as not to slow down the bike. 6) Materials must be suitable for mass production. 7) The frame materials must be suitable for simple line bending techniques./injection moulding. 8) The frame materials must be suitable for welding techniques (Chosen only) 9) The bottle materials must be suitable for blow moulding/pressing. 10) The bottle materials must be suitable for injection moulding. (Lid only for Alternative). 11) The unit must be able to be manufactured at a relatively low cost in large batches. **User** 1) The bottle must be made with ergonomic and anthropometric data in mind to suit the majority of peoples grip. 2) The mechanism to open and close the bottle should be quick, easy and non overly complicated. 3) The bottle must be manufactured with a mechanism which allows people to drink easily from the bottle without having to open it fully. 4) The bottle frame should allow the bottle to be removed easily and quickly without much force being applied. 5) The bottle frame should hold the bottle securely when not in use.	**Materials and Manufacture** 1) The bottle is made from corrosion resistant plastic and is waterproof while the frame is anodised to protect it and make it waterproof. 2) Both the bottle and the frame materials would be easy to wipe down and clean. 3) Neither the bottle or the frame materials are toxic or irritants. 4) Both the bottle plastic and the frame Aluminium alloy are tough and robust. 5) The unit is very lightweight when assembled. 6) The materials would be suitable for mass production. 7) The frame materials are suitable for line bending. 8) The frame materials are suitable for welding. 9) The bottle materials are suitable for blow moulding. 10) The bottle materials are suitable for injection moulding. 11) The unit could be manufactured at a relatively low cost. **User** 1) The bottle has a groove to help people holding it and its circumference is small enough to grip easily. 2) The pressure cap on the bottle is simple and easy to open and close. 3) The bottle has a pressure cap which allows people to drink from the bottle without taking off the lid. 4) The bottle frame allows the bottle to be removed relatively easily. 5) The frame holds the bottle securely in place while not in use.	**Materials and Manufacture** 1) The bottle is made from an Aluminium alloy and is painted with a waterproof and corrosion resistant paint. The frame is manufactured from a corrosion resistant plastic. 2) Both the bottle and the frame materials would be easy to wipe down and clean. 3) Neither the bottle or the frame materials are toxic or irritants. 4) The bottle is very tough and robust but the frame could be susceptible to shattering. 5) The unit is fairly lightweight when assembled. 6) The materials would be suitable for mass production. 7) The frame materials would be suitable for injection moulding. 8) Only for Chosen Product. 9) The lid materials would be suitable for injection moulding. 10) The bottle materials would be suitable for pressing. 11) The unit could be manufactured at a relatively low cost. **User** 1) The bottle has no real adaptations to improve its grip. 2) The pressure cap on the bottle is simple and easy to open and close. 3) The bottle has a pressure cap which allows people to drink from the bottle without taking off the lid. 4) The bottle frame allows the bottle to be removed easily. 5) The frame holds the bottle securely in place when not in use.	**Materials and Manufacture (Chosen)** • The chosen product has an advantage over the Alternative product is this section as the Alternative products frame has potential problems with shattering or snapping under stress. All other criteria were met by both products. **User (Chosen)** • The chosen product beats the Alternative product in this category as the Alternative product has no design additions to make the bottle easier to grip while the chosen product has groves to make holding it easier. All other criteria were met by both products.

...aterials and Components

Chosen Product

• The chosen unit is made up of three components, the Lid, the Bottle and the Bottle Holder. The list of materials for each of these components is below along with the materials properties, how the material suits the chosen environment and the reasons for its choice.

The Bottle

• The bottle is manufactured from the Thermoplastic Polyethylene terephthalate (PET) which is commonly used for fizzy drinks bottles.

Advantages:

- Good Alcohol and Oil barrier.
- Chemical resistant.
- High impact resistance.
- High tensile strength.

Disadvantages:

- Has a tendency to discolour.
- Needs to be specially treated when used in conjunction with foodstuffs to prevent problems with taste.

These properties make PET suitable for the drinks bottle as it is tough enough not to break during vigorous activity and also it will not be corroded by the acids in certain drinks. The bottle does however have to be specially treated to stop it contaminating the taste of the liquids.

Fig 1: A plastic bottle made from PET.

Fig 2: PET plastic pellets, as they would appear before the blow moulding process.

The Lid

• The Lid is manufactured out of the Thermoplastic High Density Polyethylene (HDPE) which is normally used to make buckets, bowls and water pipes.

Advantages:

- Good electrical insulator.
- Chemical resistant.
- Flexible.

Disadvantages:

- Colour tends to fade over time.
- Can break under stress.

The fact that the lid is chemical resistant makes it useful for this product as it will not be corroded by the acids in some drinks. However it can break under stresses which may occur in certain facets of cycling. Despite this though the lid is less likely to break as it is a small component that is reasonably thick and tough.

Fig 3: Some bottles manufactured from HDPE.

Fig 4: HDPE plastic pellets, as they would appear before the injection moulding process.

The Bottle Holder

• The Bottle holder is made from an Aluminium alloy. Aluminium is normally used in the Aircraft industry.

Advantages:

- Lightweight.
- Corrosion resistant.
- Good conductor.

Disadvantages:

- Can crack under stress and requires constant annealing while being worked.
- Does not withstand great loads.

This Aluminium alloy is perfect for the drinks bottle holder as it is lightweight and so will not weigh down the bike too much but also it is corrosion resistant and so will not corrode when it gets muddy or wet which is highly likely. However it is liable to crack and so could break or deform it impacted.

Fig 5: A car rim manufactured from an Aluminium alloy

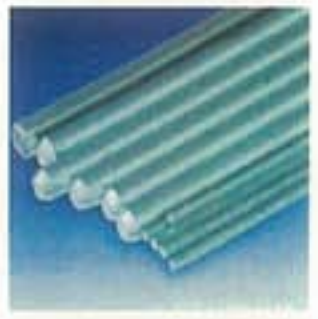


Fig 6: Pure Aluminium rods.

Alternative Product

• The Alternative unit is also made up of three components. The Lid, the Bottle and the Bottle Holder.

The Bottle

• The Bottle for the alternative product is manufactured from an Aluminium alloy. However this alloy is likely to be slightly different from the one used to make the bottle holder for the chosen product.

Advantages: See 'Bottle' for Chosen Product

Disadvantages: See 'Bottle' for chosen product.

Aluminium is a good material for use in manufacturing the bottle because of its resistance to corrosion. This will prevent it from being worn by the acid in drinks. Also Aluminium is tough and so the bottle is fairly resistant to wear that it might experience after heavy use.

For Aluminium examples see 'Frame' for Chosen Product.

The Lid

• The Lid on the Alternative product would be manufactured from the same material as the Lid on the Chosen product. High Density Polyethylene (HDPE)

Advantages: See 'Lid' for Chosen Product

Disadvantages: See 'Lid' for Chosen Product

HDPE is a good material for the bottle lid as it is fairly tough and so will increase the products lifetime.

For HDPE examples see 'Lid' for Chosen Product

The Bottle Holder

• The Bottle Holder on the Alternative product is made from High Density Polyethylene (HDPE). However it would be prepared in a different way to the HDPE that was used to make the Lid of the unit.

Advantages: See 'Lid' for Chosen Product

Disadvantages: See 'Lid' for Chosen Product

HDPE would be a good material for the Bottle Holder as it is tough but flexible so it will resist wear and tear but will also allow the bottle to be easily removed and replaced. HDPE can break however if too much stress is applied so the holder may be liable to snap should it receive a heavy impact.

For HDPE examples see 'Lid' for Chosen Product

Chosen Unit fully assembled (Left) and Alternative Unit fully assembled (Right)

Industrial Manufacture

Chosen Product

• The chosen product comprises of three parts. The actual bottle, the lid and the bottle holder. Each of these parts would be made in a different way in industry due to the material choices and also their shapes. Also there are different specification points relevant to the manufacturing processes that need to be addressed for each component.

The Bottle

• The bottle component would be manufactured using a blow moulding process. This method of manufacture is primarily used for plastics to create hollow object, but is also viable for some metals. Firstly plastic pellets are melted down and made into a Parison or Pre-form. In the bottles case this would be a open ended cylinder. The Parison is then lowered into the mould and the bottom end of the Parison is squeezed shut when the mould closes. This creates an air tight seal with the Parison hanging in the mould from the extruder. Once the end of the Parison is sealed air is then blown in from the extruder into the Parison. This forces the sides of the plastic Parison out to fill the mould cavity. The air pressure is maintained until the plastic cools to ensure a consistent thickness of the walls of the product. The moulding is then removed as the desired hollow shape.

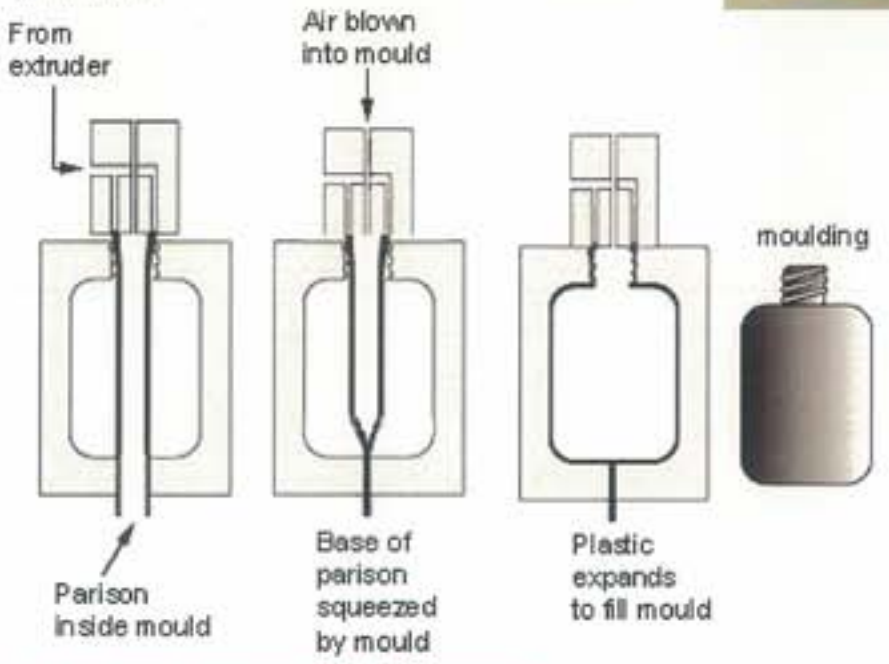


Fig 1: Diagram depicting the Blow moulding process.

Fig 2: An Industrial Blow Moulding Machine.

Fig 3: A selection of products manufactured using Blow moulding techniques.

The Lid

• The Bottle Lid component would be produced by Injection moulding, a process that is commonly used for a wide range of plastics and metals to produce small but intricate and complicated components. The injection moulding process is in three main stages. For the bottle lid the first stage after the mould has closed is the melting of the plastic pellets as they are fed automatically into the machine. Next the now molten plastic is forced into the adjoining mould under very high pressures to make sure that all the cavity is filled. This is achieved by a rotating screw that winds and unwinds to create and release the pressure. Finally the moulding is rapidly cooled and the pressure is released once its set. The moulding is then removed as the complete shape and any burrs or deformities are removed.

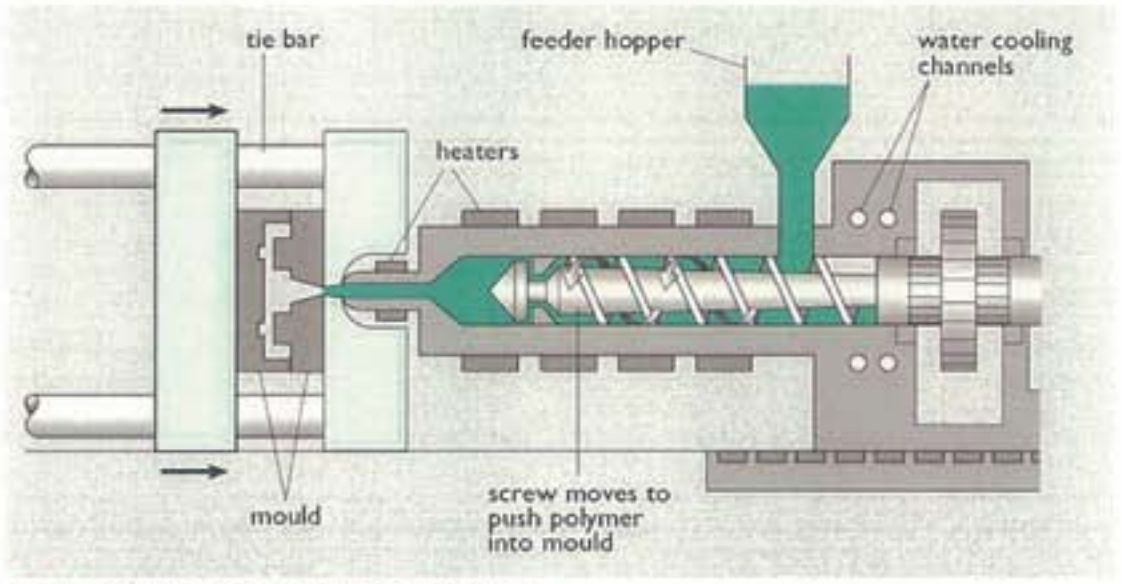


Fig 4: Diagram depicting the Injection Moulding process.

Fig 5: An industrial Injection Moulding machine.

Fig 6: Some Plastic Injection Moulded products.

The Bottle Holder

• The Aluminium Bottle holder would have been simply line bent and then painted. Aluminium rods of the required diameter would've been bought in bulk and then bent to the required shape using a line bending machine. Line bending machine simply heat up the metal untill it is semi-molten and malleable. The metal is then bent to the required angle and allowed to cool. In Industry the frame would be fed into a line bending machine that would bend the frame to exactly the same angles every time using a jig. In the case of this frame it is likely that the Aluminium rods would have been cold formed where they are not heated but just bent using formers and pressure into the right shapes. This is possible as the rods are quite thin. Also it is made as one continuous piece of metal. This is achieved by bending one long rod and placing a small weld to join them.

Industrial Manufacture (Alternative)

Alternative Product

• The Alternative product has three separate components that fit together in the completed unit. The Aluminium bottle, the Frame and the Lid/ pressure cap. These components all require manufacturing processes that not only differ from each other but also in two of the three components differ from those used to create their counter-parts on the chosen product.

The Bottle

• The Aluminium bottle for the Alternative unit would be manufactured by a deep drawing process. This manufacturing process uses high pressures to force sheet metal into cavities to create certain shapes, these can then be sealed or joined with other components to create hollow products. The process in this bottles case comprises of three steps. First the sheet Aluminium would be loaded into the machine and punched into an open ended cup shape. Next the open end of the bottle undergoes a spinning process where the metal is slowly rolled to bend it round and create the bottle neck. Finally the thread is added after the bottle neck has been spun. This process is relatively cheap and very quick so a large quantity of bottles can be produced as a result.

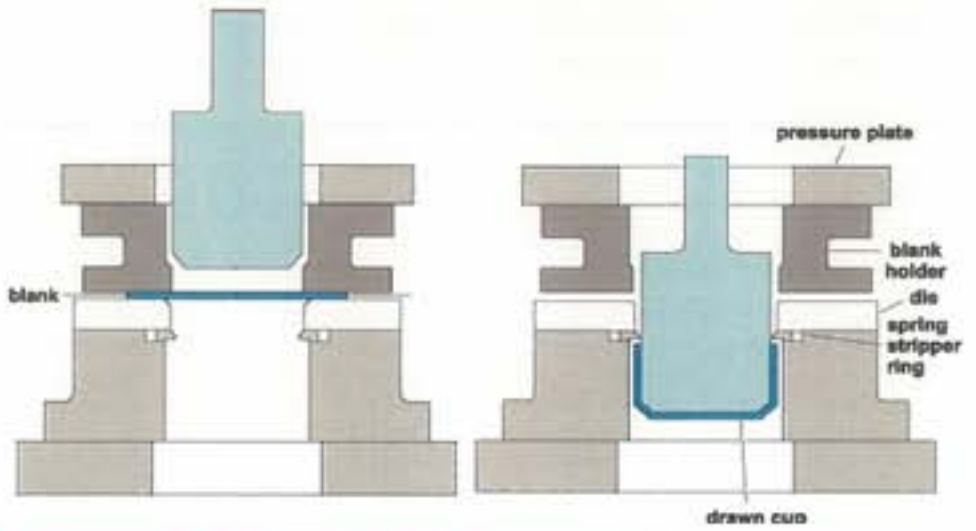


Fig 1: Diagram showing the first stage of the Deep Drawing process.

Fig 2: An industrial Deep Drawing machine.

Fig 3: A CNC spinning machine.

The Lid

• The Bottle Lid/ pressure valve component would be made by the same process as the chosen products lid, Injection moulding. The injection moulding process is in three main stages. For the bottle lid the first stage after the mould has closed is the melting of the plastic pellets as they are fed automatically into the machine. Next the now molten plastic is forced into the adjoining mould under very high pressures to make sure that all the cavity is filled. This is achieved by a rotating screw that winds and unwinds to create and release the pressure. Finally the moulding is rapidly cooled and the pressure is released once its set. The moulding is then removed as the complete shape and any burrs or deformities are removed.

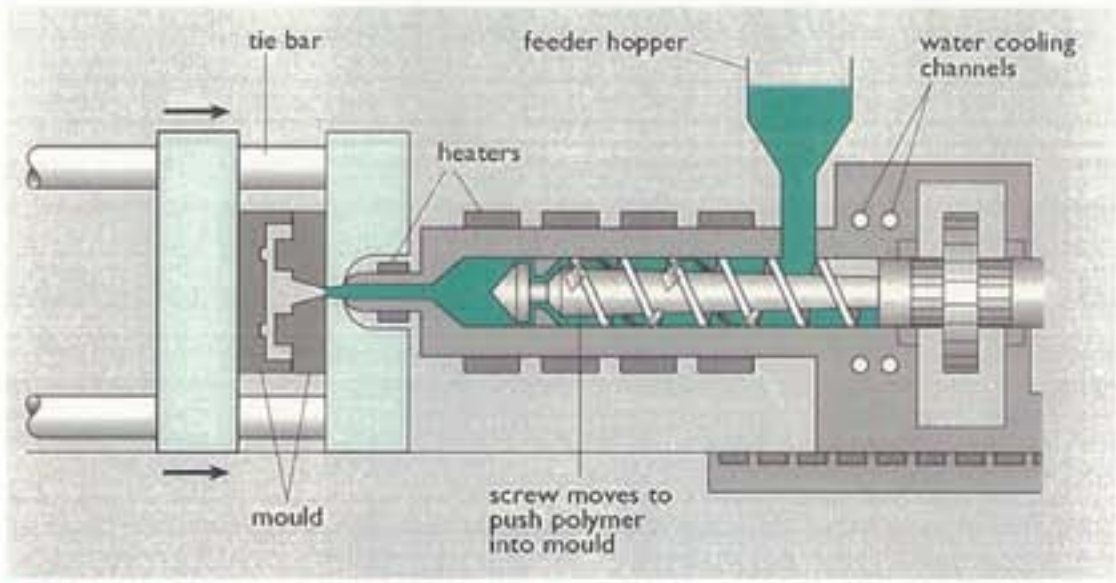


Fig 4: Diagram depicting the Injection Moulding process.

Fig 5: An industrial Injection Moulding machine.

Fig 6: Some Plastic Injection Moulded products.

The Bottle Holder

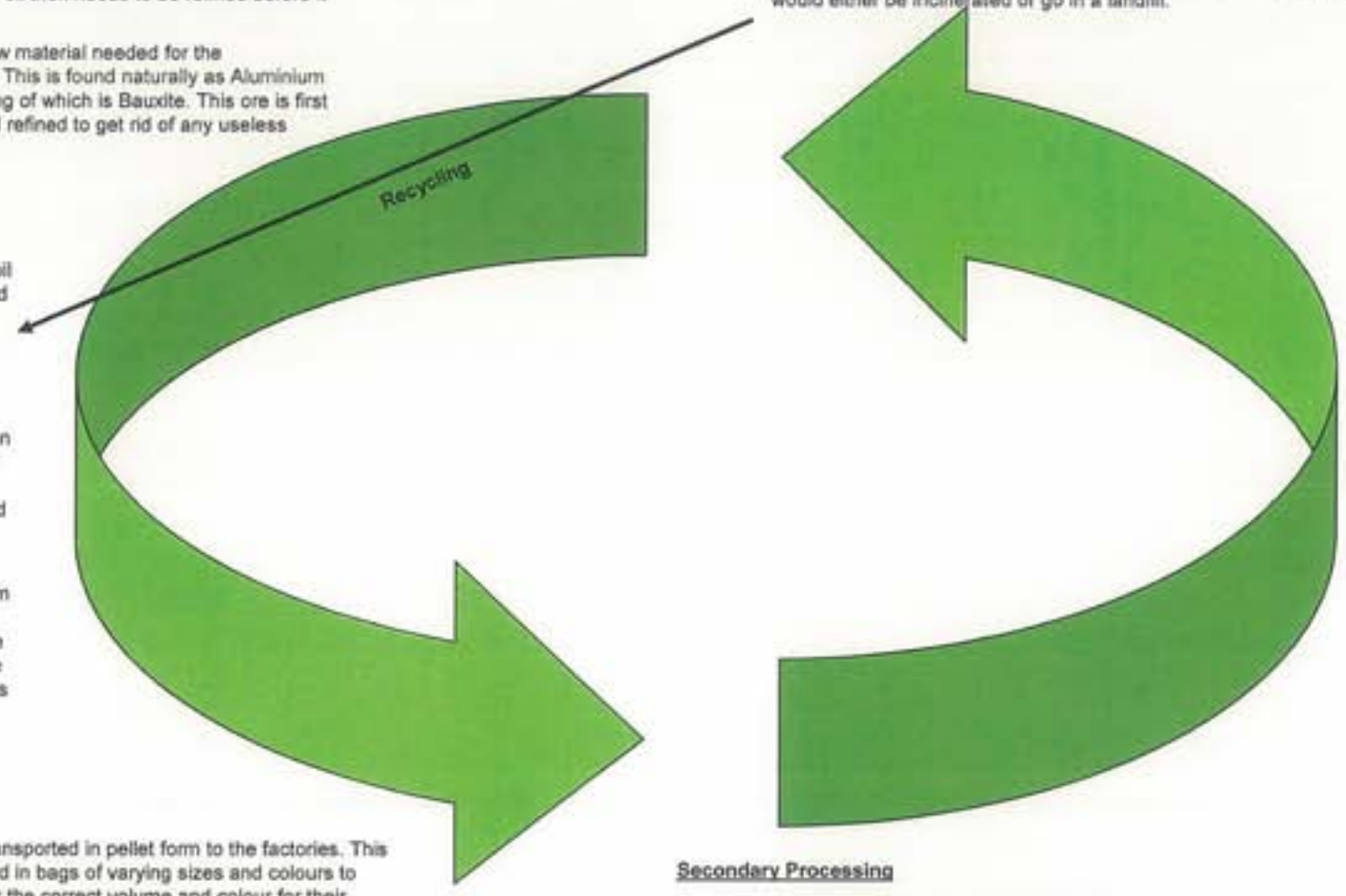
• The plastic bottle holder for the Alternative product would also be manufactured by injection moulding. For more detail on the Injection Moulding process itself see the paragraph on 'The Lid' manufacture.

Evaluation, Justification and Sustainability (Chosen Product)

Process	Evaluate +'s and –'s	Justify	Alternative's	Sustainability
Blow Moulding (Bottle)	• Blow moulding is fast and is a suitable process for batch and mass production. • There is almost no waste from the blow moulding process. • The initial cost of machinery for the process is expensive. • Once the mould is purchased there is only one type of bottle shape that can be produced.	Blow moulding is an excellent process for the production of the bottle as it is suitable for batch production and can produce products very quickly. Also it is a process that would require very little manpower and there is virtually no wastage.	An alternative to blow moulding could be impact extrusion or injection moulding. However these process would not produce the same quality of bottle as blow moulding and they would likely be more expensive due to the equipment having to withstand high pressures necessary for the processes.	Blow moulding is a batch process but it is one that can be engineered to produce products very quickly. This makes it a process that would suit the material as HDPE would be bought into the factory in batches.
Line Bending/ Cold Forming (Bottle Holder)	• The process is very simple and requires no major machinery other than a jig. • There is zero waste from this process. • The nature of the process combined with the material used means that there may be problems with cracking. So the Aluminium may need to be constantly annealed during the process.	Line bending around a jig is a quick, simple process that will produce quality components at very little cost and without the need for expensive maintenance. This makes it a good process for the manufacture of the bottle holder.	An alternative to line bending could perhaps be punching/ pressing or injection moulding but these processes would only be suitable if the design and the material of the bottle holder was modified to make it viable for the process.	Line bending requires no major energy inputs and there is zero waste, so it is a very sustainable and environmentally friendly process.
Injection Moulding (Lid)	• Injection moulding can produce very accurate and intricate moldings that would otherwise be too complicated to create. • The process is relatively quick and so is suitable for batch production. There is also relatively little waste and this can be recycled. • The machinery necessary for the Injection moulding process is very expensive and so the initial set-up costs would be high. • The high pressures exerted by the machines during the process make it quite dangerous and so extensive safety measures have to be made to reduce the risks.	Injection moulding is a process that allows very detailed and intricate castings to be created. This is ideal for the lid as it is quite a complicated shape. Also injection moulding is a process that is suitable for batch production.	Due to the shape of the lid there aren't really any alternative processes other than injection moudling that could create it. However if the material used to manufacture the lid was changed to one of the alternative materials then there could be other methods of manufacture. For example an Aluminium lid could be gravity die cast and then turned on a lathe, although the design may need to change slightly.	Injection moulding is a process that requires a large energy input and so is a fairly unsustainable process. This makes it expensive and it has a negative effect on the environment in terms of greenhouse gas emissions from fuel consumption. However there is very little waste from this process and the waste that is produced can be recycled.

Material	Evaluate +'s and –'s	Justify	Alternative's	Sustainability
High Density Polyethylene (Bottle and Lid)	• Good electrical insulator. • Chemical resistant. • Flexible. • Colour tends to fade over time. • Can break under stress.	HDPE is a good material for the bottle and lid as it is chemical resistant and so will not be corroded by the drinks that it would hold. It is also flexible, tough and shatter resistant so it would be able to withstand any physical impacts or compressions that it may undergo.	Alternatives to HDPE for the bottle and lid would be an Aluminium bottle. A second alternative material could be PET (Polyethylene terephthalate) but this would not be as well suited to the product as HDPE or Aluminium are.	HDPE is a plastic derived from crude oil through a process called cracking and so it is a finite resource. However as it is a thermoplastic HDPE can be melted down and recycled. This makes it slightly more sustainable than it otherwise would be.
Aluminium Alloy (Bottle Holder)	• Lightweight. • Corrosion resistant. • Good conductor. • Can crack under stress and requires constant annealing while being worked. • Does not withstand great loads.	Aluminium is a good material for the bottle holder as it is corrosion resistant and so will last for a long time in wet and muddy conditions where other metals would fail. Also it is lightweight and relatively strong and tough so it will be able to withstand any knocks or impacts that it may experience.	An alternative to Aluminium would be to have a HDPE bottle holder or one manufactured from ABS. However neither of these materials would posses the toughness or durability of an Aluminium bottle holder.	Aluminium is mined and extracted from the earth before being purified so naturally it is a finite resource. However Aluminium can be melted down and recycled which presents an opportunity to expand the sustainability of this resource.

Life Cycle Analysis (Chosen Product)



Raw Materials

Bottle and Lid: Crude Oil is the raw material that is eventually used in the manufacture of the plastic bottle and lid. Crude oil is a finite resource that is extracted from deep underground wells or in pockets under the sea. These need to be drilled and tapped before the oil can be pumped out and utilised. This oil then needs to be refined before it is of any use.

Bottle Holder: Aluminium the raw material needed for the manufacture of the bottle holder. This is found naturally as Aluminium ores the most commonly occurring of which is Bauxite. This ore is first mined and then later purified and refined to get rid of any useless material.

Primary Processing

Crude Oil: The first step of processing crude oil is distillation. The crude oil mixture is separated out into its various fractions in a fractional distillation tower. Some fractions then undergo a process called cracking. This allows the manufacturers to produce a higher volume of certain fractions that are in high demand from those fractions that are less in demand. To then make the plastic from the appropriate crude oil fractions, manufacturers use a process called polymerisation. This produces the unprocessed plastic in pellet form that is then transported to the factory.

Aluminium Ore: Once extracted the Aluminium ore is refined in a blast furnace. This removes any impurities that would make the metal brittle and useless. Electrolysis is then used to create pure Aluminium that is then moulded into ingots to be transported to the factory.

Transport

Plastic: The plastic is transported in pellet form to the factories. This plastic form would be sold in bags of varying sizes and colours to allow companies to order the correct volume and colour for their products.

Aluminium: Aluminium is transported in stock sizes and shapes (mostly rods) to factories that order specific sizes and grades of aluminium.

Figs 1,2,3: (Top Left) Bauxite ore, (Above) An Aluminium roll ready for transport, (Left) An open cast Aluminium mine.

Disposal

The Unit: Once the unit has surpassed its useful life time it would either be disposed of or recycled. Both the Aluminium frame and the Plastic bottle could be recycled and they would be melted down to help manufacture other products. If not recycled it is likely the product would either be incinerated or go in a landfill.

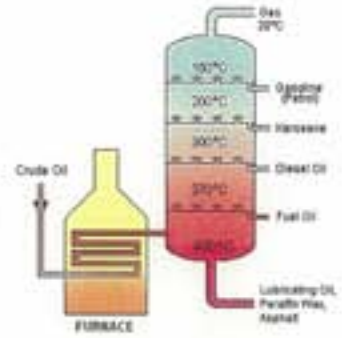
In Use

The Unit: As a unit the bottle and holder should last for a reasonably long time due to its robust materials and relatively secure design. There are few weak points in the shape and it would take a lot of use before the materials would start to wear.

Secondary Processing

Plastic: Once at the factory the plastic pellets would be melted down and placed into a blow moulding machine. The blow moulding process would then use a cavity to inject in high pressure air forcing the plastic out into the desired bottle shape. For the lid injection moulding would be used.

Aluminium: To create the bottle holder the Aluminium ingots would be melted down and drawn out into long spiels of rod. These would then be sold to the factories in standard sizes. The appropriate sized rod would cold formed into the desired shape to create the bottle holder.



Figs 4,5,6: (Top Left) A north sea oil rig, (Above) Diagram showing the fractional distillation process, (Left) A crude oil processing facility where the fractions are cracked.

Quality Control, Checks & Standards

Q.C. Checks

During the Manufacturing processes of the unit several Quality control checks will be carried out on the product to ensure it reaches the standards set out in the units specifications. These checks are either destructive or non-destructive and would test everything on the unit from its compression strength to whether the decals are properly attached. This testing would be carried out on random units selected from each batch and units that do not pass theses tests would be discarded. The destructive tests would allow the manufacturers to find the products breaking and shattering points or elastic limits. This is useful as it allows them to state the sort of stresses and strains that the product is designed to withstand. Furthermore they can guarantee that up to these thresholds the product will perform as expected but that above them the failure of the product is not due to any fault on the manufacturers part.

The Unit

For this unit specific tests would be to test the strength of the joins on the bottle holder, to ensure that the bottle thickness is uniform, to test that the bottle top provides a watertight seal on the bottle and to check that the bottle looks aesthetically as it should. There would also be several destructive tests on randomly selected units from various batches. These would test the units impact and compression strength and also their shatter resistance.

Quality Assurance

Kitemark

To ensure users that the product has undergone and passed the Q.C. checks and standards set by the manufacturers, a kitemark is placed on the underside of the bottle and on the bottle holder. This shows that the product has reached the minimum British manufacturing standards necessary for it to go on sale. This ensures the user that the product will perform as expected. Any products that do not meet the minimum standards would not receive the kitemark and so would not benefit from the quality assurance that it provides for customers.

Fig 7: The kitemark symbol is used in Britain as a sign that a product will perform to a minimum standard.

Fig 8: A fire extinguisher with the kitemark symbol.

Design Brief

Public seating has had a mixed reception over the years. Some examples are functional and robust but do not add aesthetically to the built environment. While others can be stylish and pleasing to the eye but are often vandalized or look tired with weathering effects.

An existing bench manufacturer is asking you to design a new seating solution for public areas. They would also like you to suggest a location that could be explored for the placement of the seating solution. They are willing to invest in new manufacturing processes provided you have justified the use of specified processes with in your design proposals. They have however specified a few basic requirements to fit in with the company ethos of producing good quality products.

Design Specification

Purpose
- To provide seating for three to five people in a public environment.

- Function
- It must seat at least three people.
- It should be a tough durable seat to withstand day to day use.

-Form
- It should reflect a modern styling suitable for today's market.

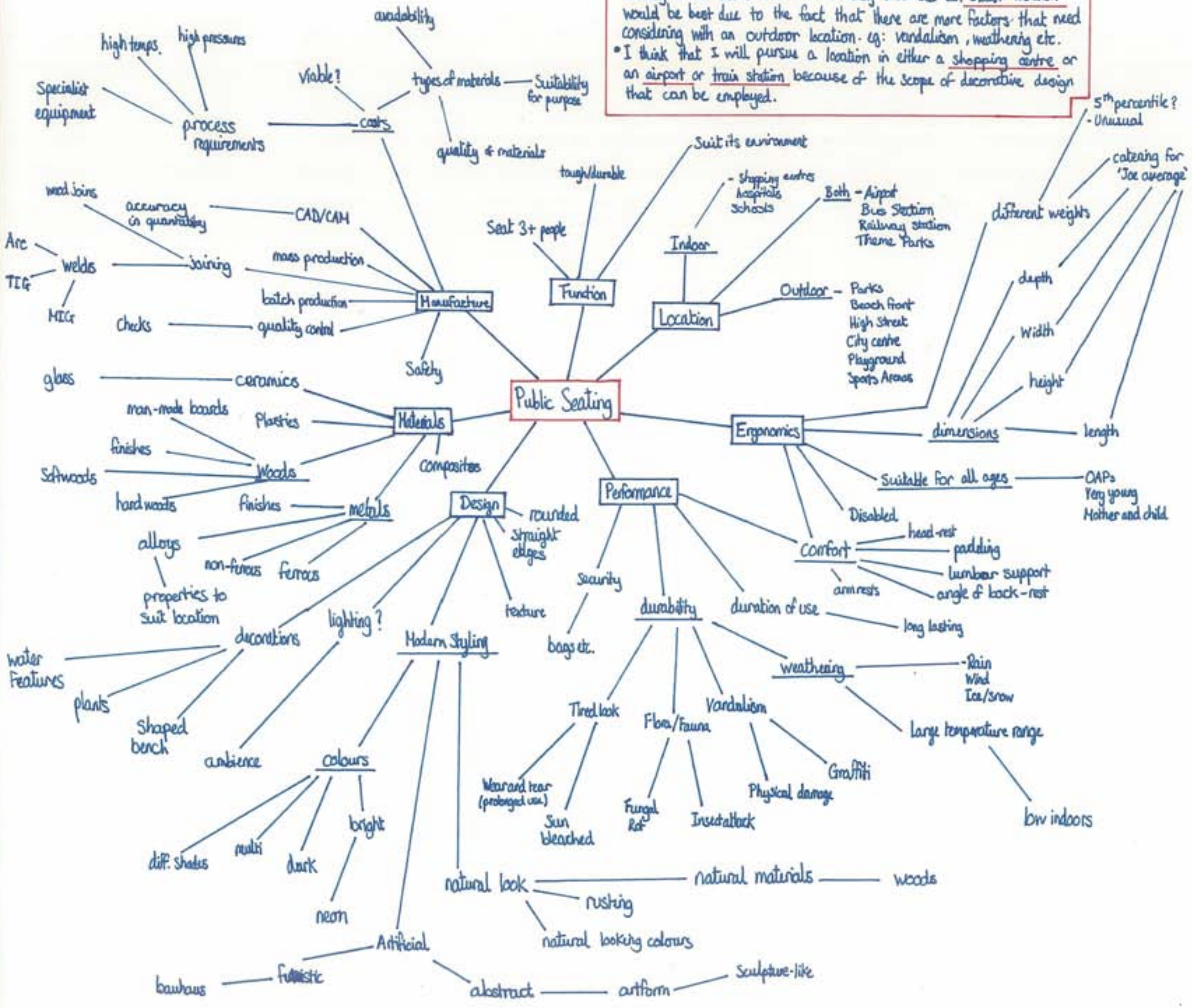
-Performance
- It should be comfortable when sitting for the expected period of use.

-Safety
- It must be safe for a range of users both young and old.

-Materials & Manufacture
- It must be suitable for batch production.

Problem Analysis

Location
- Looking at the factors involved I definately think that an indoor location would be best due to the fact that there are more factors that need considering with an outdoor location. eg: vandalism, weathering etc.
- I think that I will pursue a location in either a shopping centre or an airport or train station because of the scope of decorative design that can be employed.



Inspiration Page

Bauhaus

• I like the simple Bauhaus style of designing as I think it gives a very clean, smooth look to a product. I think that this style would suit an modern indoor location like the lobby of an office block or a waiting room etc. Also designing in this way means that the final product is actually fairly structurally simple and so would probably be reasonably easy to batch produce or to manufacture in bulk.

IPOD Adverts

• Although these apple Ipod adverts do not relate directly to design I do like the way that simple bright colors are used so effectively to highlight the desired shapes. The use of the dark silhouette against the bright background is very effective and it could be incorporated into a bench design to highlight key parts or even just to create an engaging aesthetic effect.

Modern Public Benches

• These public benches show that even incredibly simple designs can create fantastic aesthetic effects that couldn't be achieved by more complicated designs.

Cardiff (St David's 2 Project)

• The St David's 2 project in Cardiff to revitalize the city centre has produced a lot of very interesting designs. I especially like the way that many of the new buildings incorporate curves and a lot of glass work into their structure to create a very modern style with an open, spacious feel.

The Golden Gate Bridge

• The design of the Golden Gate Bridge in San Francisco, USA is particularly interesting due to its suspension cables. This idea of support could potentially be integrated into a bench design which would not only increase structural strength but also would add to the aesthetics of the product.

• This bench could be easily adapted into several different styles to suit different environments as shown in this overlay sketch.

• In this picture I have highlighted the particular feature that I like. I think the way that it is one continuous piece adds to the aesthetics of the bench.

Power Balls

• These exercise power balls also show how light combined with transparent materials can create very aesthetically pleasing effects. Ambient lighting could potentially be used to great effect when designing a bench, especially if the bench was designed for a specific location where ambient lighting could add to the aesthetics of the room.

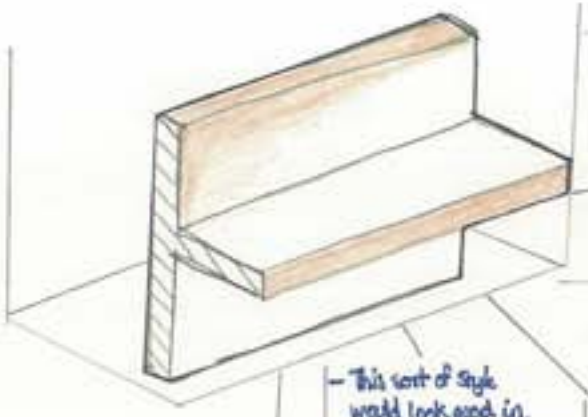
Modern Sculptures

• Some modern sculptures can also be used for inspiration as they provide an interesting way in which different shapes can be used to create eye-catching patterns and styles.

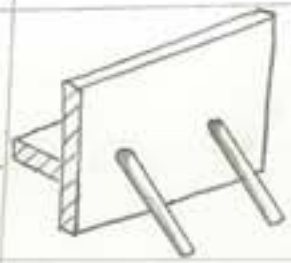
Audi R8, Kawasaki Ninja

• The Audi R8 and the Kawasaki Ninja bike are two great sources of inspiration for metal working. The smooth lines and curves incorporated into both of these designs creates eye-catching aesthetic effects.

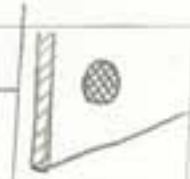
...dial Sketches 1



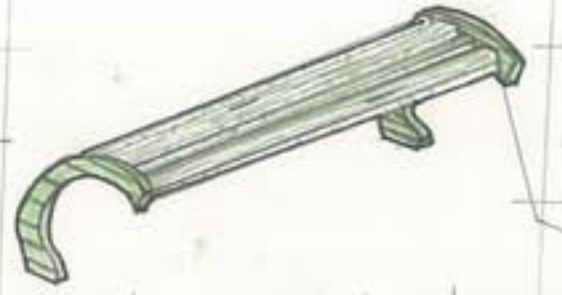
- This sort of style would look good in metal or plastic.



- This hook shape would be suitable to a park type environment. It is simple and could be made from woods which would make a 'natural' looking product.



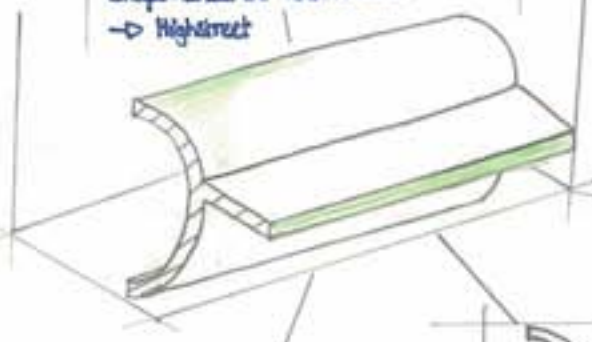
- Speakers could be added for ambient music. Lights could also be used as an alternative or a combination. This could fit in well with a shopping mall environment for example.

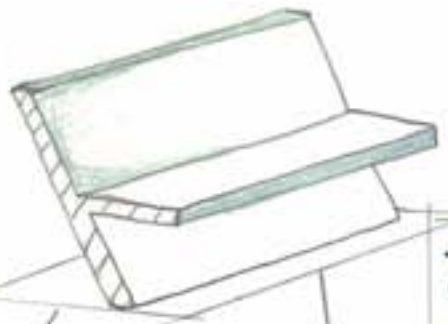


- A simple mortise and tenon joint could be used to affix the planks to the bench legs.

- The sculpture shown here shows how natural materials and 'curved' stone blocks can be used to blend a piece into its environment. This sculpture could easily be adapted to have seats and could fit in extremely well in a 'Park' environment.

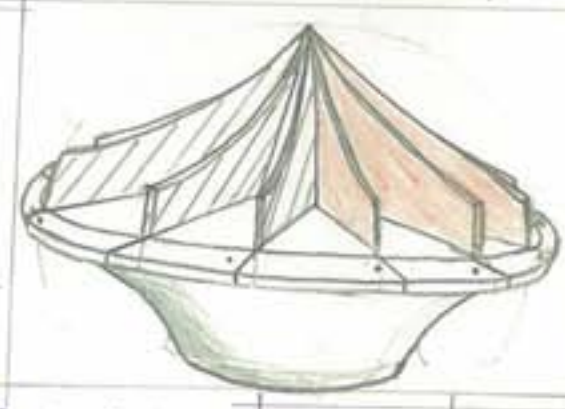
- This is an interesting and eye catching shape. Could be used outside.
→ Highstreet





- Support for this could take a number of forms.
→ eg: ball, plane wing, simple poles.

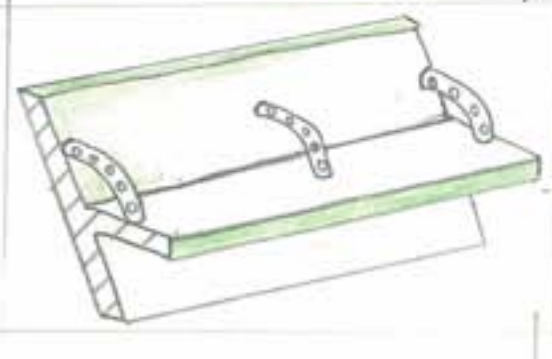
The bottom of this design lends itself to be sand cast. Possibly in bronze?

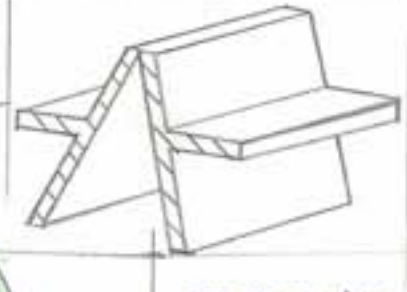


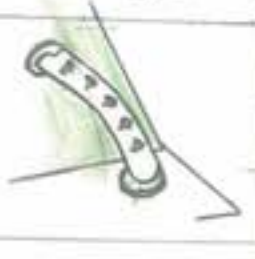
A Tongue and groove joint would be ideal to fit the horizontal screens.

- Padding for added comfort is an option, but it would have to suit the style eg: colour, texture.

- Laminates?







- Arm rests are also a possibility, they can add alot to the design.

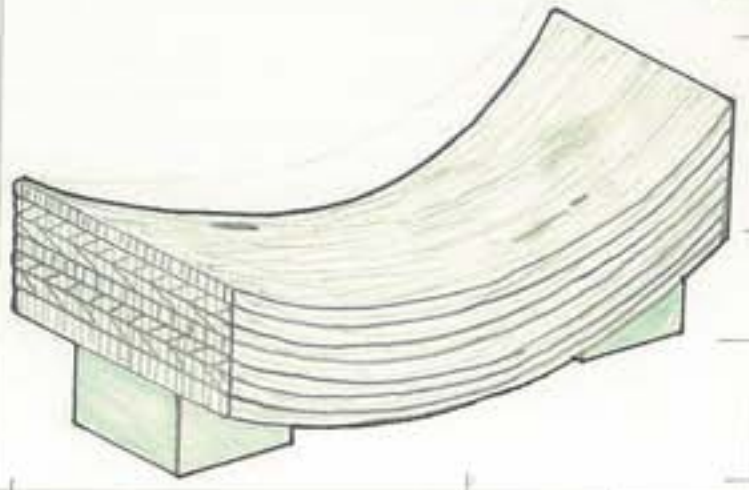
- This sculture is also useful in showing how simple shapes, structures and colours can be created to make very eye catching effects.

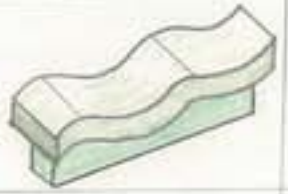
- This picture shows how simple the bench could be while still being appealing to the eye and functional. The basic design can also be altered to make it slightly more complicated as above.

- This design can be easily manipulated to give a different product with a completely different feel.

Initial Sketches 2

- Laminated wooden boards with wood glue could be easily formed to make this bench shape.





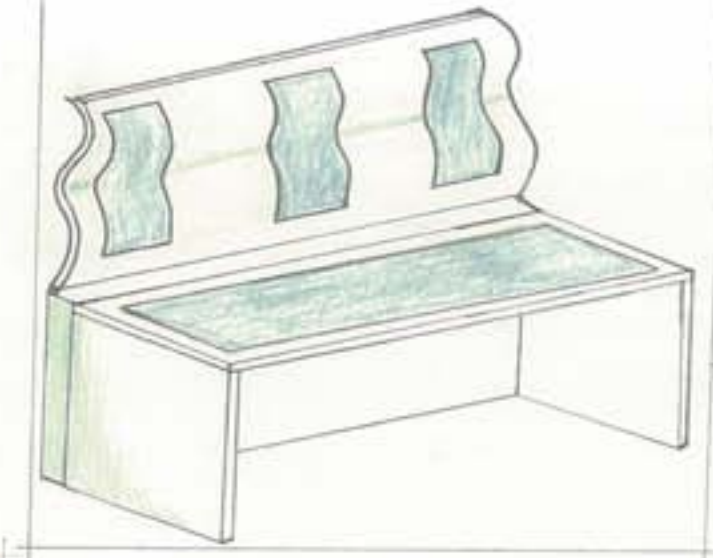
- Screens for privacy?

- This laminated 'bent wood' style is effective as a simple bench. It can also be extended or altered to give a different feel.

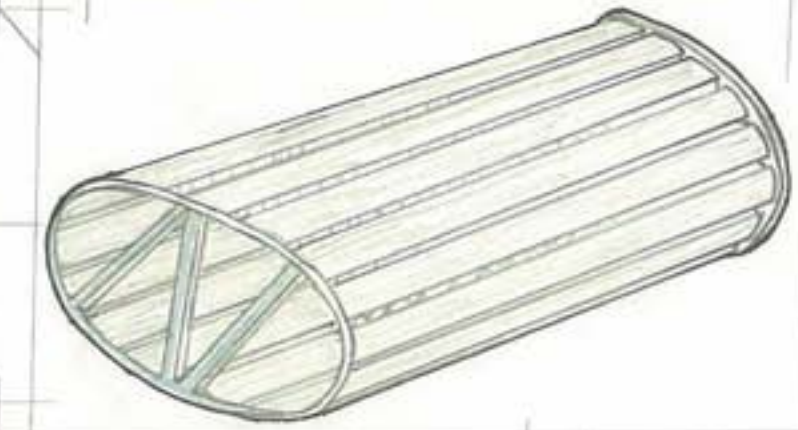
- This picture shows how curving the edges and traditionaly straight parts of a bench can create interesting styles.

- Welds could be used to join the frame together.

- The frame could be made from mild steel bars.

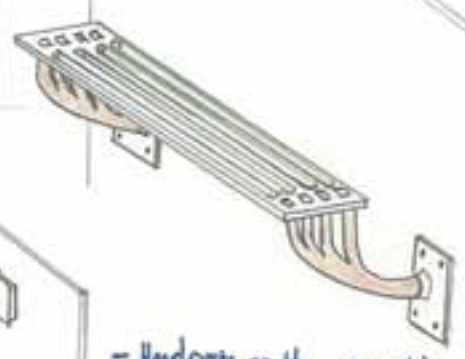


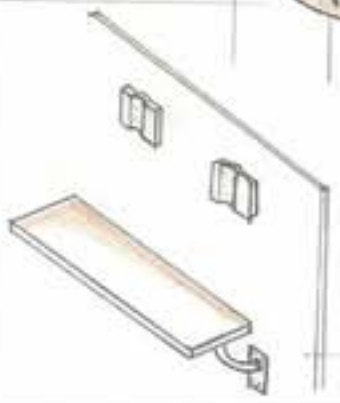
- The rolled bench style shown below adds a different shape to a product that is often faidly angular. Sturdiness could be a potential problem though.



- This picture gives another insight into the many completely different designs that can be used to create a product with the same function as a simple bench.

- Wall mounting a bench adds a completely new aspect to the design task and some interesting looks can be achieved.





- Headrests on the supporting wall could add a level of comfort.

- Arm rests are also a possibility. It also prevents people from sleeping on it: eg: Bus stops.

- The wall mounted design could be easily adapted to go both inside and outside adding a degree of adaptability.

- This is quite a strong shape but it may need adjusting to enable it to be properly fixed to the ground.

- This design could also be adapted to create a bench with a full back.

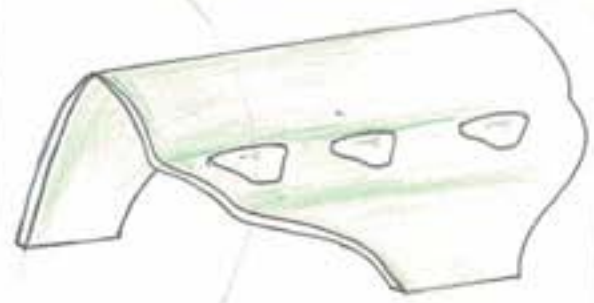
- This bench is very bare and simplistic with the metal being left bare. It has a modern and almost space-age look.

- This design is meant to try and achieve a minimalist look with simple shapes and colours. The curved backboard and padding adds comfort.

- The sculture shown here also adheres to a combination of smooth curves and sharp corners and edges to create an eye catching look.

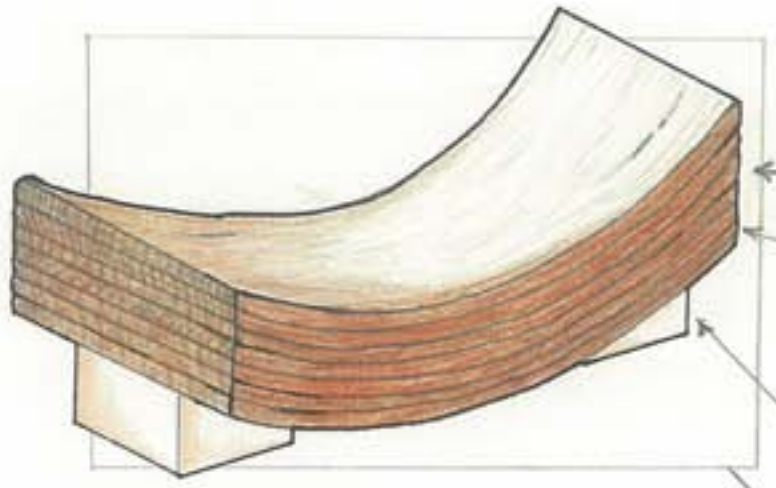
- The picture below show plastic chairs that combine smooth curved surfaces with sharp straight lines. The contrast makes them quite appealing to the eye and they appear very modern and stylish.

- Back View.



- Bent plastic formed in a vacuum mould can look very modern and stylish. It also can be formed very accurately to the contours of the body and so could be very comfortable.

Initial Ideas 1



Bent laminated wooden boards form seat.

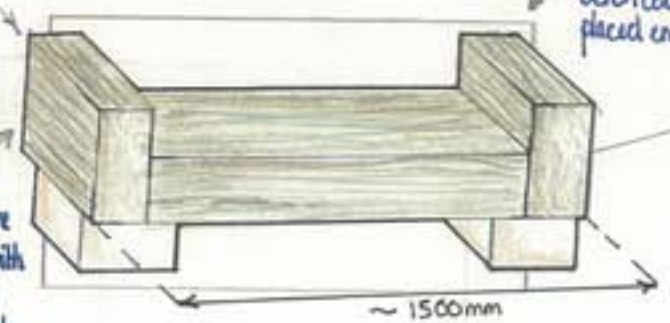
Curved shape forms primary seat of bench. Could be continued.

Simple block bases for support, concrete?/metal?

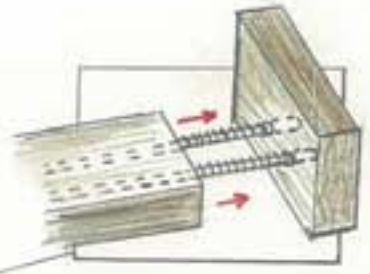
Darker, heavier wood - Oak possibly to give a more solid look.

Straight edges rather than curved give a different style. Also potentially gives more room.

Losing the curved edges gives armrests. + the bench could be placed end on end



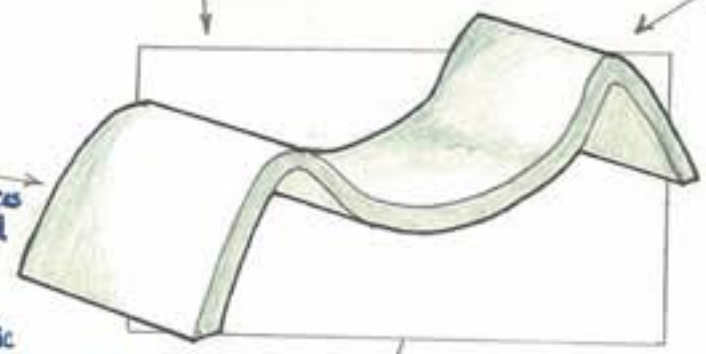
Thicker more 'block' feel with rectangular treated billets.



- The edge piece of the seat could be attached with Mild steel rods. The rods may need to be plated by electrolysis with Aluminium to avoid corrosion.

Folded sheet metal could be used to create a different feel.

The sheet metal could be cut and formed or could alternatively be sand cast as a solid piece on its side.

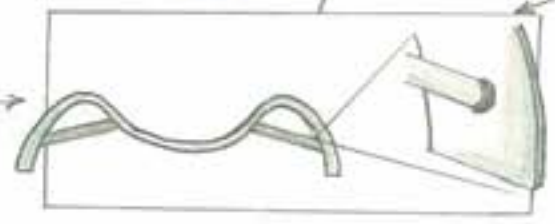


A continuous 'flowing' shape eliminates the need for boxes and gives a different look. This could be implemented with plastic but reinforcement would be needed.

Steeper angle makes a 'horse shoe' shape. Could be used as a sculpture /bench to improve an environment.

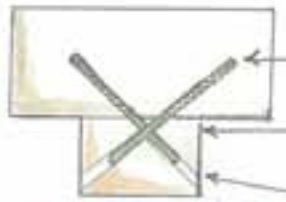
- Pressed laminates could be pressed with glue in a power press and then formed in rollers. The formed sheets could then be cut to provide the correct shapes.

- Extra support may be needed



Steel rods could be MIG welded to the frame to provide support and stability as well as improving the rigidity of the design.

The welds on the steel rods could quite easily be carried out by machines working off CAD blueprints and drawings.



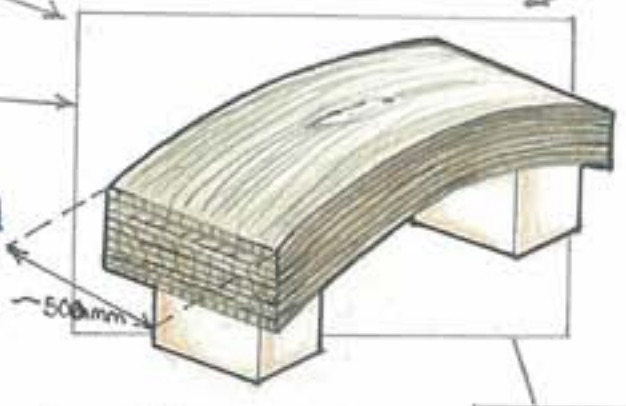
Knurled friction fit rods (mild steel) hold seat in place.

Cast concrete base, (could be bolted to floor).

- Cut-away view showing possible joinery of seat and base.

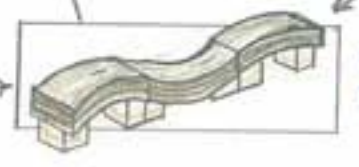
Holes drilled from concrete base up at angle through wood.

Man-made boards such as veneered MDF or veneered block board could be laminated with epoxy resin in a power press. This could be performed on a large scale with wide sheets being pressed and then cut and formed through specialised machinery.



The top seat could be reversed to give a different feel to the product. This design is useful as very few changes would be needed in terms of joints, materials or manufacturing processes.

These designs could be co-manufactured to create a wave like effect that adds another level to a relatively simple product.



This could fit in well in a shopping centre hall where there is a fair amount of open space.

• Specifications and Evaluation

- Specifications can be seen on the Problem Analysis page.

↳ **Purpose**

- Could easily seat three people - curvature of bench could inhibit space. - lower angle?

↳ **Function**

- Stable shape - no loose parts to vandalise - will need finish however. - Dependant on materials.

↳ **Form**

- Modern shape and style.

↳ **Performance**

- Would be comfortable - Backrest /armrests possible.
- Prevent people sleeping.

↳ **Safety**

- Suitable for young + old - no shattering materials.

↳ **Materials + Manufacture**

- Batch production suitability - pressing wood laminates then cut shapes.

• Anthropometrics

- Basic seating has 3 major measurements relative to body shape.

Ⓐ - Popliteal height

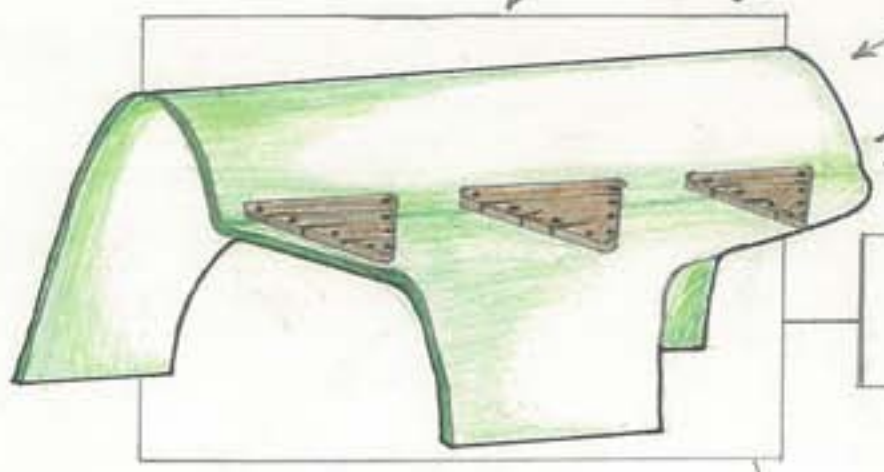
Ⓑ - Popliteal length (Buttock)

Ⓒ - Hip breadth
↳ Will be less relevant in this project as designing a bench for several people.

- Designs must take into account these measurements in order to be comfortable, (within reason).

Measurements (mm)	5th %, 95th %	
Ⓐ	Male: 395, 490	Female: 355, 445
Ⓑ	Male: 440, 550	Female: 435, 530
Ⓒ	Male: 310, 405	Female: 310, 435

Initial Ideas 2



Potentially double-sided. Three-legged could be placed back to back.

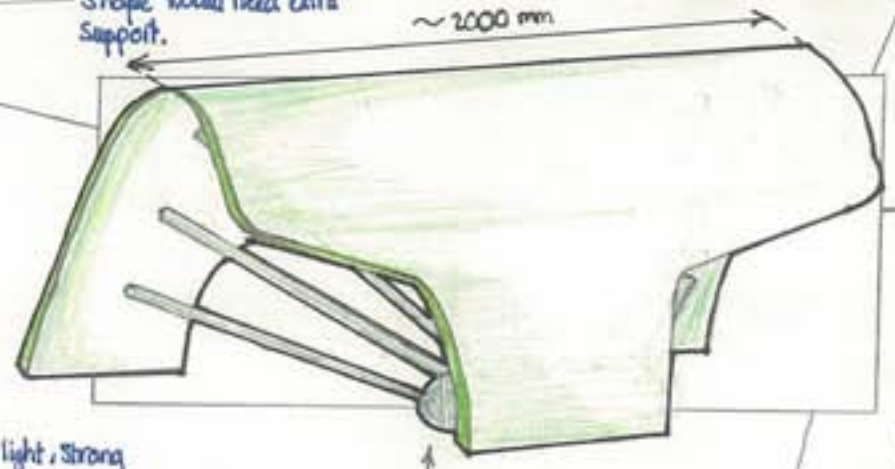
Scope of materials means different colours could easily be implimented.

Seats could be a number of materials. eg- wood, carbon fibre, glass etc.

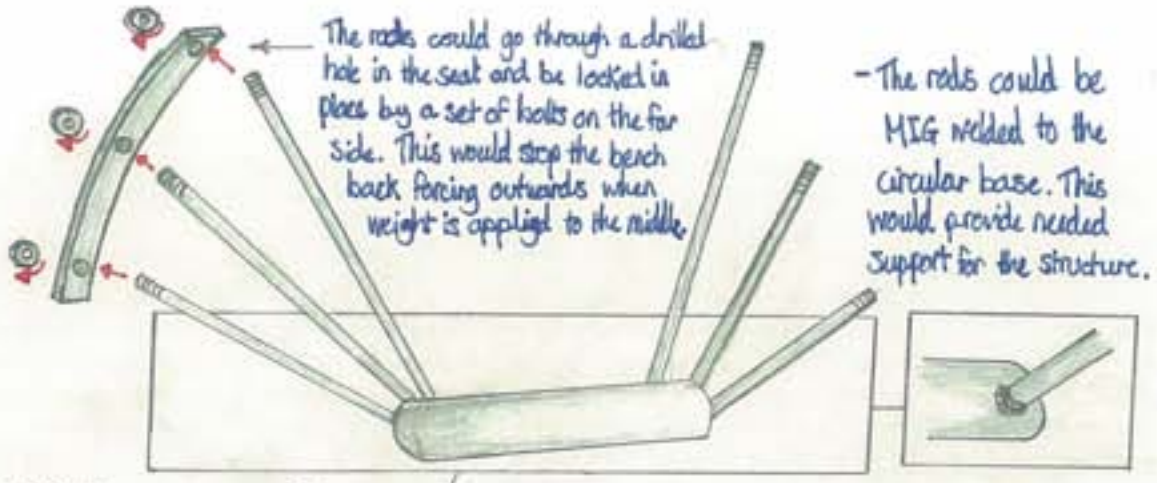
Formed plastic or metal to produce eye catching shape.

Shape would need extra support.

Curved Bauhaus-like style.

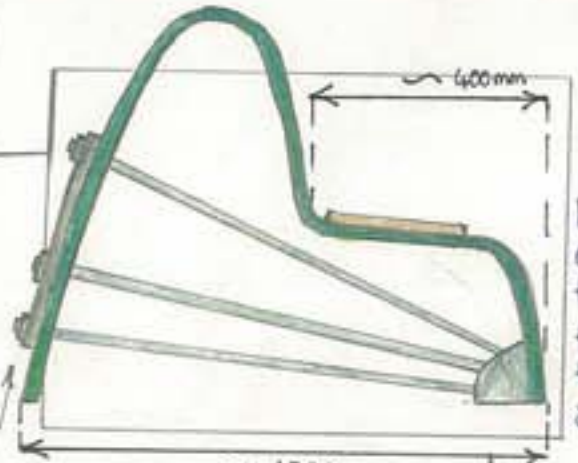


~2000 mm



The rods could go through a drilled hole in the seat and be locked in place by a set of bolts on the far side. This would stop the bench back forcing outwards when weight is applied to the middle.

- The rods could be MIG welded to the circular base. This would provide needed support for the structure.



~600 mm

~1500 mm

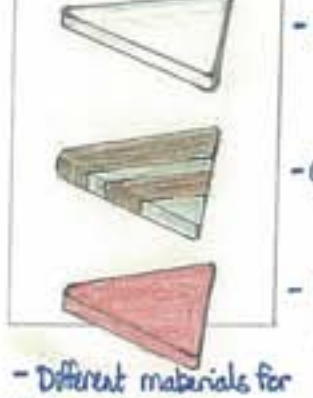
- The rods would spread out horizontally an vertically for support throughout the entire structure.

- Carbon Fibre - light, strong

- Glass - stylish but easily vandalised.

- Combination eg: wood, metal - aesthetically pleasing.

- Plastic - cheap but can look tired.



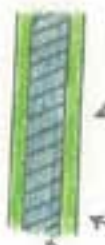
- Different materials for seat construction.

Possibility for support. Mild Steel or Aluminium rods.

Using ribs along the inside of the formed plastic shape would greatly increase its strength and ability to withstand weight.

The nuts on the back of the bench would need to be tamper proof to avoid vandalism by people unscrewing them.

The seat itself could have two ABS skins with an unexpanded polystyrene core. This would add to the rigidity to the seat.

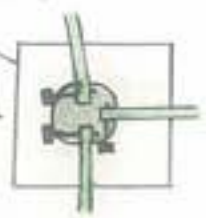


ABS skin.

Unexpanded Polystyrene core.

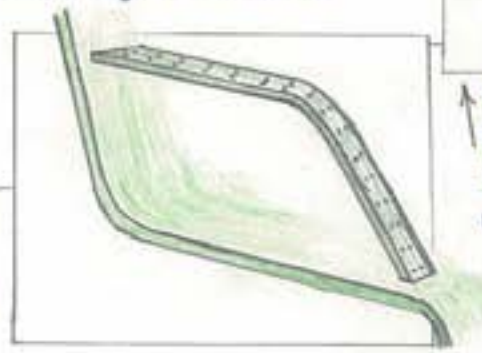
Also slight alterations Structurally wise like adding an extra leg as below could significantly bolster the designs strength and rigidity.

This shows how the three or potentially two parts of plastic could possibly be joined with a grooved metal bar running along the base of the seat. The plastic could then slot in and be bolted underneath and at the back, out of sight.



- All of these methods of strengthening the bench could be combined to create a stylish but stable and structural strong chair.

Arm rests could add a new look to the bench as well as stability.



The arm rest could be bolted to the seat from the back and underneath.

- Specifications and Evaluation
  - Specifications can be seen on the Problem Analysis page.

↳ Purpose
- Could seat three people and be extended to seat more. Also is potentially double sided?

↳ Function
- Potentially fragile shape - will need strong materials + extra support? - Needs strengthening, supports.

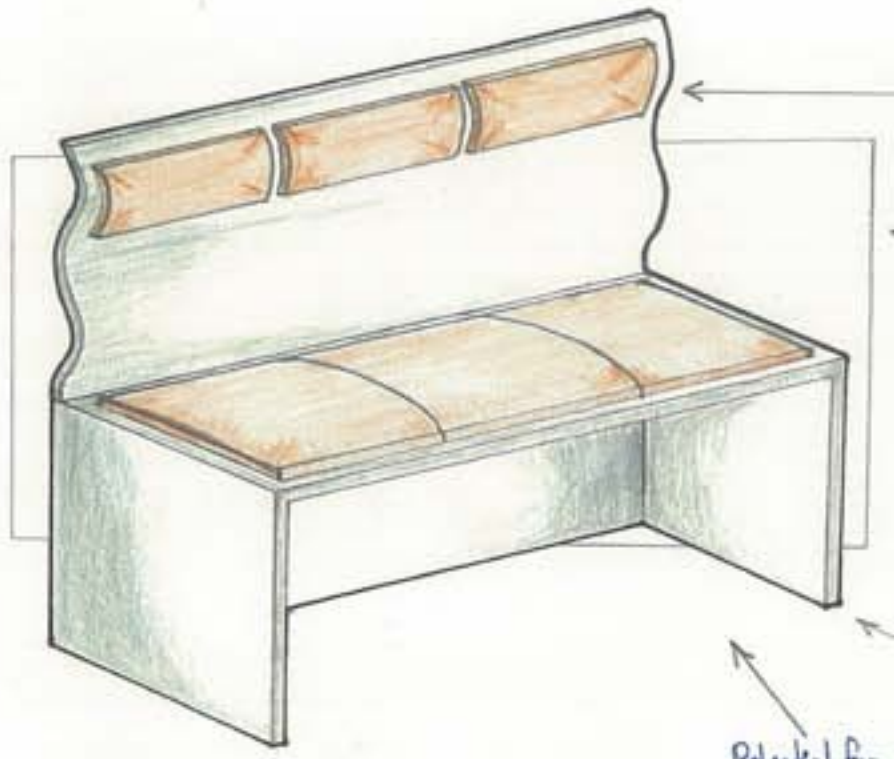
↳ Form
- Quite modern Bauhaus style.

↳ Performance
- Would be very comfortable. - Armrests/Backrests?

↳ Safety
- Shape may need reinforcing.

↳ Materials + Manufacture
- Would suit metals or plastics - carbon fibre maybe glass for certain parts. Would need to take into account suitability for batch production eg: vacuum forming for plastics or pressing for metals.

Initial Ideas 3



Curved backrest adds style to the design but should still provide a comfortable seat.

Padded backrest for comfort.

Padded seat for comfort.

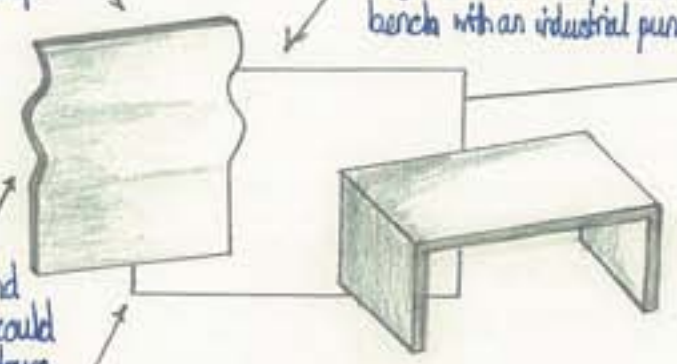
Manufactured in Metals for strength and a modern stylish appearance. However potential for plastics to be used instead.

Rectangular base with open front for bags etc.

Potential for a footrest to be added.

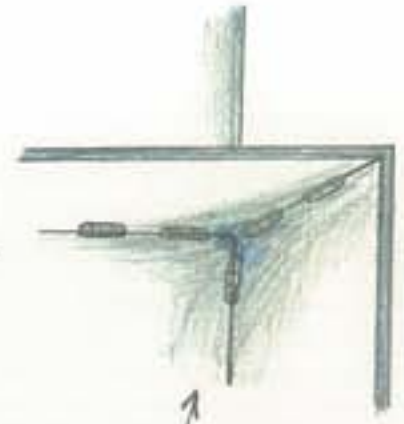
This two part manufacture would lend itself to batch production much more than making the bench as a single shape would.

The padding could be stitched together and then pinned to the bench with an industrial punch.



The base and backboard could be different colours or materials to add an aesthetic contrast.

The bench could be manufactured as two parts of sheet metal. The base could be live bent and the backrest could be press-formed.



This sketch shows how the two parts of the bench could be joined. Spot welds underneath the seat would be a discrete but effective way of firmly joining the bench together without detracting from the bench's aesthetic appeal.

A tough material such as leather or a synthetic fabric should be used for the padding to avoid vandalism.

The paddings outer material could be based on and folded round a sheet of man-made board which could then be pinned through the base of the bench to secure the padding in place.

- Specifications and Evaluation
  - Specifications can be seen on the Problem Analysis page.

↳ Purpose
- Could seat three people with extra room for baggage etc. - Could be extended at both ends or back to back?

↳ Function
- Three people could easily be seated and the strong rectangular shape especially if manufactured from hardwearing and durable metals should easily be able to withstand day to day use.

↳ Form
- Modern style with a combination of curved surfaces and sharp lines.

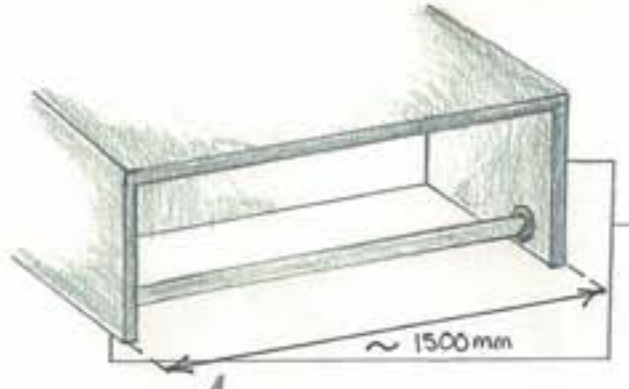
↳ Performance
- Padded seat and backrest would add comfortable places to sit provided that the backrest is correctly shaped.

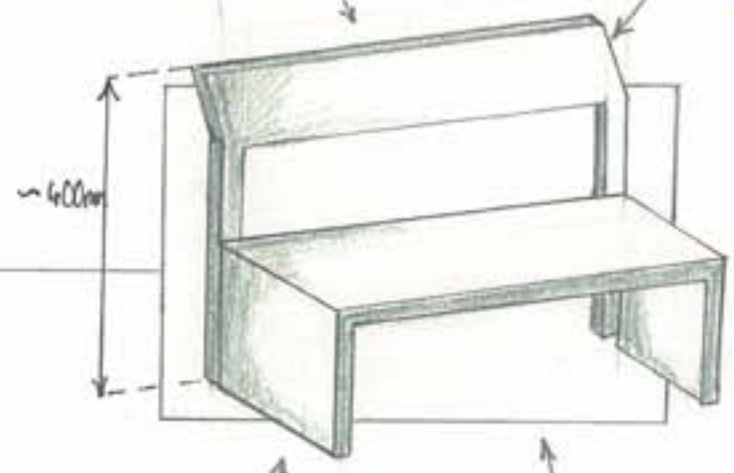
↳ Safety
- Sturdy shape should be safe however sharp corners could be a potential hazard especially to young children. - Sharp corners are a hazard.

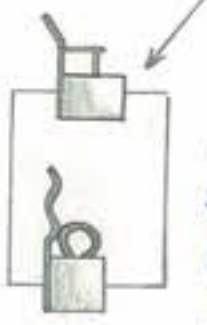
↳ Materials + Manufacture
- This design would best suit metals with perhaps leather or imm itation leather for the padding. Curved backrest may be unsuitable for batch production.
  - Backrest unsuitable for batch production?

As an alternative to a curved backboard the bench could have an open base with a single backrest.

The bench would properly need a minimal finish as its aimed for an indoor location however it could be painted which would add a level of personal preference for the buyer.







Different styles of armrests could also be used to add to diversity of the product. This would also add comfort.

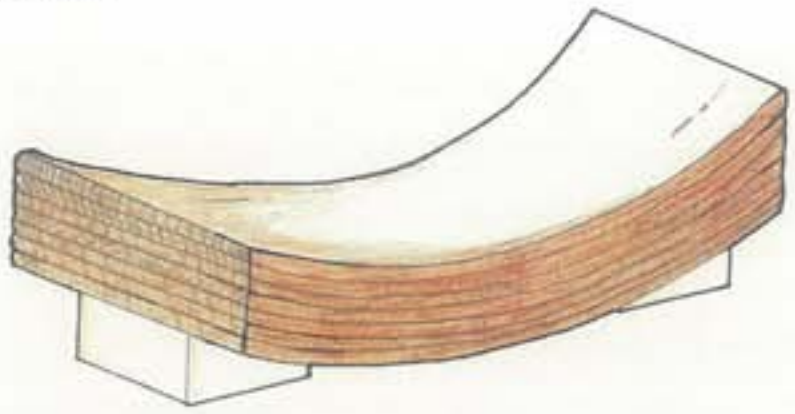
A foot rest could quite easily be added to the bottom of the bench. Alternatively a plate could be affixed to the pole and extended outwards for a more substantial foot rest.

Mild steel or an Aluminium alloy would be suitable materials for the bench.

The bench could have two possibilities for indoor and outdoor with the indoor model having padding and ~~shiny~~ stylish metal finish while the outer version has an open back and protective paint.

Evaluation of Initial Ideas

Initial Ideas 1



Evaluation on Specifications

• This bench could easily seat three people and could even be extended to seat more. Several benches of this type could be placed next to each other to create more space and an interesting wave effect. However the curvature of the bench could potentially limit space.

• The bench has a stable shape with no loose parts to vandalize, however due to the nature of the materials used it would almost certainly need some kind of finishing in order to maximize the products lifetime.

• The bench has a fairly modern shape and style and so could fit in with most new, modern environments.

• This bench would definitely be comfortable for a short period of time, however due to the lack of a back rest or arm rests this bench would not be ideal for places where a prolonged stay is necessary. Also this bench's shape would mean that people could potentially sleep on it which may be seen as a problem in certain environments. E.g.: Airports or High streets (preventing homeless people camping on them).

• This would be suitable for most ages. It is especially suited to young children as there are no shatter hazards and the corners could be rounded to reduce the risk of injury. There are also no removable parts that could cause damage. The elderly however may not find this bench helpful if in use for more than a short period due to the lack of a backrest.

• This bench has a relatively simple design and as a result is suitable for batch production. The design could also be adapted to be made from different materials to suit different environments or the satisfy a certain criteria. E.g. fireproof.

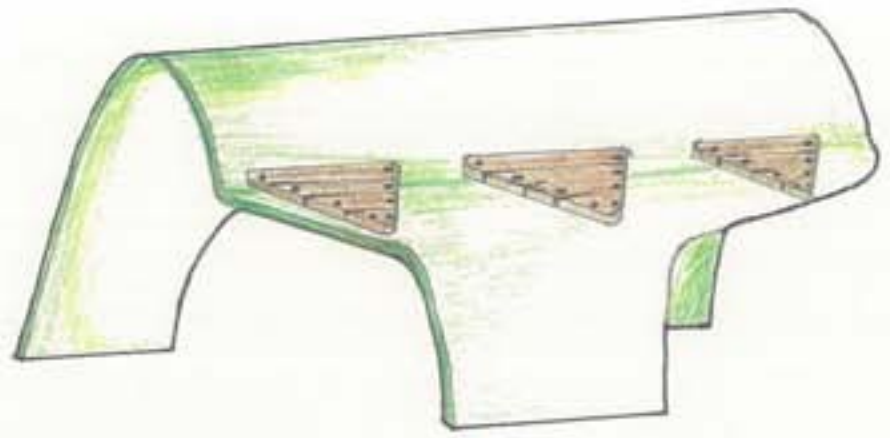
Opinions

- Personally I think this design is a fairly good idea. Its simplicity would make it relatively easy and probably cheap to manufacture (partly dependant on materials used). I also particularly like that given the right finish this bench could fit in with nearly any environment due to its simplicity and shape. There is also the fact that because the bench is relatively plain it could be adapted to suit other materials or colour schemes. For the chosen environment I think this bench would quite easily meet any criteria that it needed to.
- Despite these positives however I feel that this bench is lacking an element of personality. The advantages given by its simple materials and shape also mean that it could be seen to lack character. It would fit in well with most environments but probably wouldn't really stand out if it were on its own. This potentially limits where the bench could be used especially in wide open spaces where each piece of furniture needs to have its own distinct impact to fill the space. Also the materials chosen for this bench mean that, dependant on where this bench is going to be placed, it will almost certainly need a finish of some sort. Several finishing processes may even be needed for some environments.

Conclusions

Overall this design is very successful at achieving the necessary requirements set out in the specifications however it doesn't particularly stand out or achieve a very eye catching look. If finished it would be fairly appealing but only as an add on to an already themed environment. If this product were to be used on its own it could suffer from being a bit minimalistic and plain.

Initial Ideas 2



Evaluation on Specifications

• This design could seat three people but extending it to fit more would cause structural problems. A solution to this would perhaps be to make the bench double sided, however this would detract from the aesthetics of the design.

• This design has a fairly fragile shape. It would need significant reinforcing if it were to be manufactured in order to take the weight of people. It may also need to be made from specifically selected materials to increase the products strength.

• This design has a very modern curved style and is pleasing to the eye. However the fact that is has such a modern style may limit the number of suitable environments.

• This bench could potentially be very comfortable due to the body fit shape, however the absence of armrests could detract from the comfort of the bench. The shape of the bench also would prevent people from sleeping on it which would make it suitable for areas where this is not desired. E.g: Bus stops.

• The bench on its own would not be very safe for structural reasons. If it were to be manufactured its shape would need considerable strengthening and supports would need to be added. This problem could be addressed in a number of ways but it would definitely be a necessary step should it go into development.

• This shape would suit most material types bar woods. It could be manufactured from a range of metals or plastics and could even be made from composites like carbon fibre. It would also suit having different materials used for different parts of the product. The seats for example could be set into the bench and be made from glass.

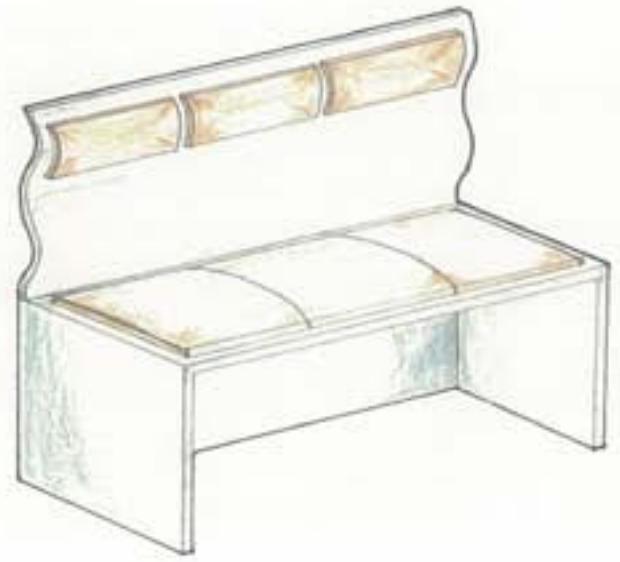
Opinions

- I particularly like this design due to its appealing shape and the scope it provides to experiment with relatively new and unusual materials. Also I think that this design provides lots of scope into how it could be potentially developed and manufactured. I think there are a range of potential variations that could be implemented into this design which would allow for different types.
- The main problem with this design is its inherent fragility. The thin material and curved shape mean that a lot of pressure would be placed on certain parts of the frame that would need strengthening. Supports would need to be added and specialist materials may need to be considered. This would lead to problems in the manufacture. The fairly unorthodox shape coupled with the fact that it may need special equipment to prepare the frame (E.g. a mould for the main body that could create ridges in key areas of weakness) would mean that it could be unsuitable for batch production and would probably be costly to manufacture.

Conclusions

Looking at this design I think that it has the potential to be a very interesting and appealing product, however I also think it would need a lot of development to make it into a product that could be manufactured and sold as a safe, functional bench. So it has plenty of scope for improvements but also has a lot of problems that would need to be addressed should this design go into development.

Initial Ideas 3



Evaluation on Specifications

• This bench could quite comfortably seat three people and could also provide room for baggage etc. underneath. It also has the potential to be extended either outwards or to be doubled up back to back.

• This design is quite a strong simple shape with would be fairly durable and would be difficult to vandalize. There would be little difficulty in this bench withstanding heavy duty and frequent use in busy locations such as an Airport or a fast food restaurant.

• This bench has a reasonably modern style but it would be relatively simple to adapt this design to fit in with a more rustic environment.

• This bench would be extremely comfortable to sit on due to the cushions and the shaped backrest. Also due to the simple structure it would be easy to add armrests in to make it more a comfortable place to sit for an extended period of time. Correctly positioned arm rests would also limit the ability of people to sleep on the bench.

• This bench has a very sturdy shape and it would suffer no structural problems. However its sharp corners could be a potential hazard especially to young children. This could be addressed by altering the design but it may take away from the aesthetic appeal of the product.

• This design would best suit metals due to its shape and structure. Plastics would not have the I inherent strength necessary for such a design and most woods would lack the ability to create the curved backboard unless especially steam treated or laminated, but then they also would be weak at the join. Metals also allow for strong permanent joining processes like welding that are unavailable to other materials such as woods and plastics. The shape of this product however (namely the curved backrest) may make it difficult to batch produce.

Opinions

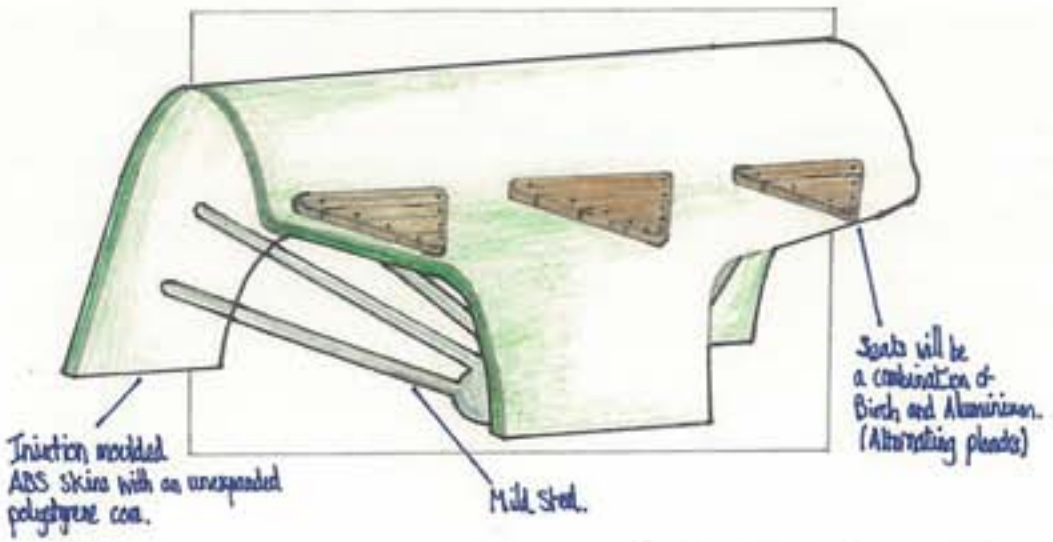
- I think this bench would be well suited to a busy area where it is likely to come under a lot of wear and tear. Its relatively strong shape would made it sturdy and able to withstand extended or repeated use and the choice of materials would also add to the durability and ability of the product to remain in good condition despite frequent and heavy use. I also like the fact that this bench design provides a lot of room for enhancement. Its simple box-like design means that a number of aesthetic additions could be made to increase the appeal of the product.
- I think this design has relatively few obvious flaws other than that it could be considered to be fairly dull and uninspiring, however due to the scope of the product for improvement it could quite easily be made to be more eye-catching or deliberately be left plain and simple to suit the environment (E.g: waiting rooms).

Conclusions

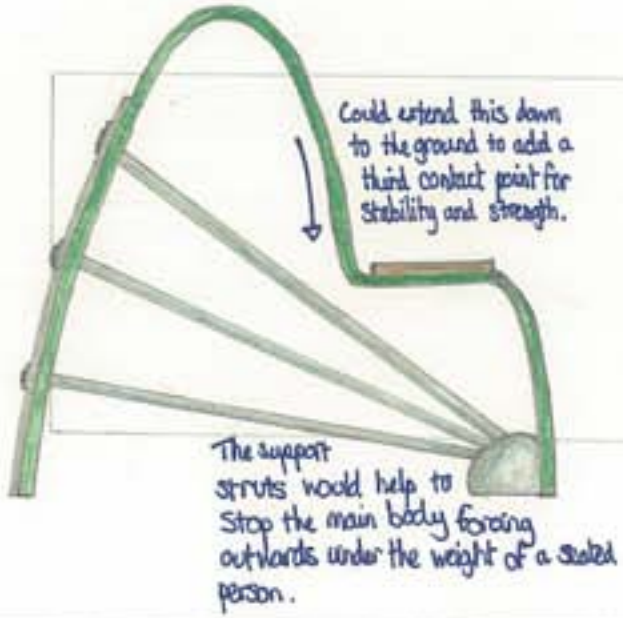
I think this design is a fairly open ended one with lots of room for development. Its simple shape and style could be altered facilitate a number of extra functions or looks. It also could be deliberately left to be plain and simple in order to blend in with the environment. Taking this into account I think that if this design were to go into development it would first be necessary to decide exactly what is needed of the product (specifications) and what would be suitable to add in for its intended location (indoors – shopping center or mall).

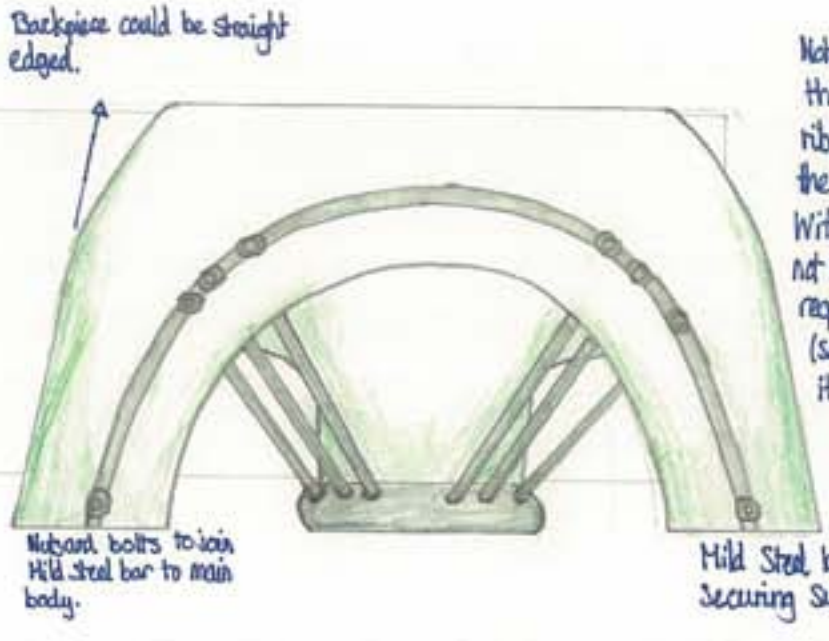
Development Of Initial Ideas

Initial Idea ②



• Basic Shape / Proportions





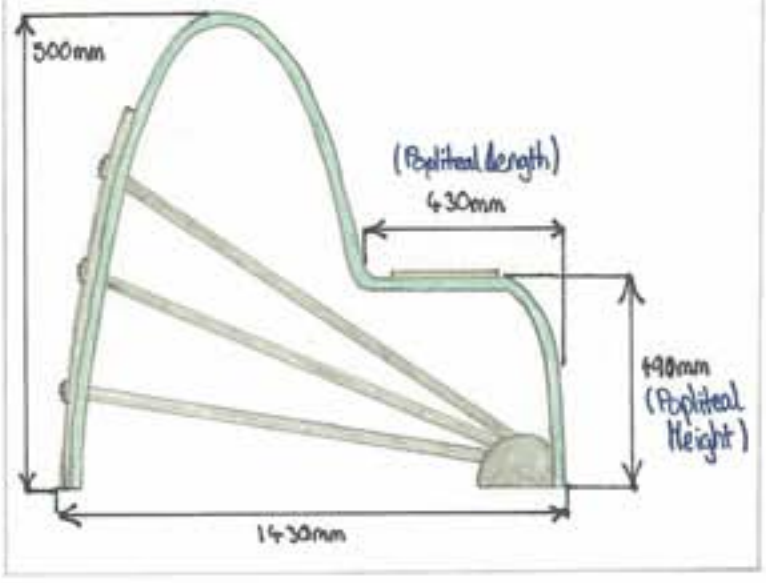
Note: Due to strength problems this bench would need both ribs and a layered skin for the main shape of the bench. Without this the bench would not be able to withstand the required number of people (set out in specs) sitting on it.

• Problem Areas

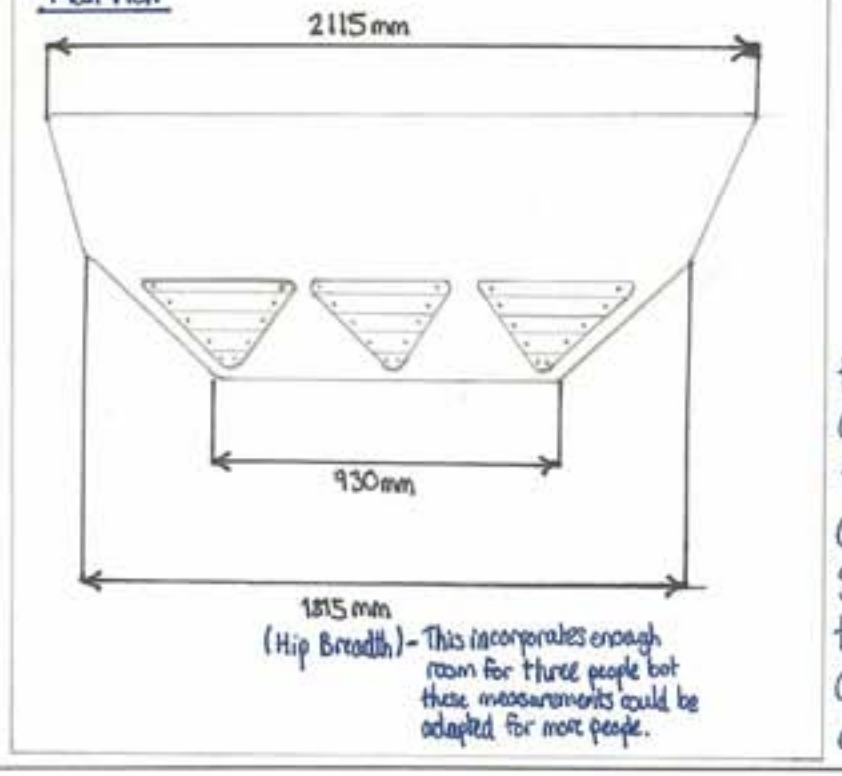
- Establish height of seating ledge from Anthro data.
- Establish the width of seats and the breadth of the seating ledge. Could the seats alternate? eg: △▽△▽.
- How will seats secure to the bench?
- Finalise manufacturing processes for the main body and decide methods of manufacture for the seats and the support struts.
- Finalise joining methods for support struts to metal base and also for metal base to the plastic main body.
- Consider options for armrests.
- Decide on final shape for plastic main body.
- Consider extra options for bench, eg: bin, storage space, ambient lighting.
- Develop bench for batch production.
- Consider finishing options, eg: colours, sizes to meet necessary criteria.

• Basic Dimensions

- Side View

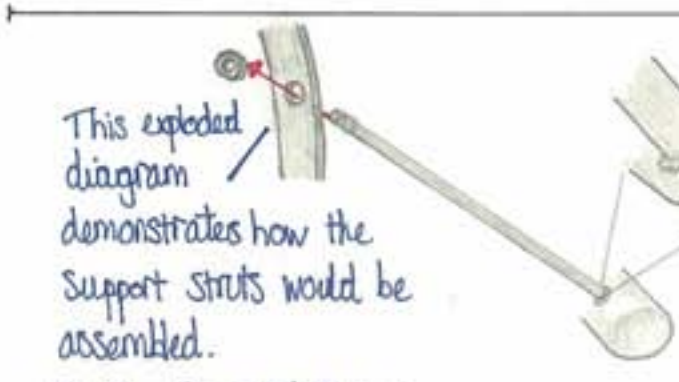


- Plan View



This incorporates enough room for three people but these measurements could be adapted for more people.

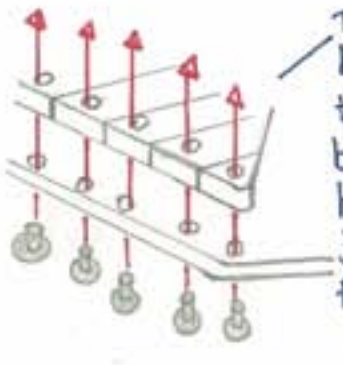
- The measurements stated in these diagrams are rough estimates based on some of the ergo and anthro data set out briefly in the initial ideas. (eg: Popliteal Height, Popliteal Length, Hip Breadth). I have set the Hip Breadth to incorporate three people with a gap of 150mm between each seat and at each end to allow for the extra width of people shoulders and arms (when sat side by side). In practice this gap may be too large or too small but it can be easily adjusted or extended to fit more seats. Finaly the length of the front of the bench to the back is adjustable and can be easily changed. (so long as the popliteal length stays constant).



This exploded diagram demonstrates how the support struts would be assembled.

• Adaptions for Batch Production

The strut could be welded to the metal base. This would be a quick way of joining the two parts that would be suitable for batch production.



The seat could be snap riveted to the plastic main body. This would help to ensure a secure join but also enabling this to be mass produced.

- The main problem with making this bench batch producable is the manufacture of the plastic main body which would require complex patterns or dies depending on how it would be manufactured.

..odelling Page

- 6:1 model of initial bench design. Intended for Shopping Centers, Airports or Train Stations.

- Evaluation of Model

- Positive Points

• The design is very aesthetically appealing and could fit well into the intended environments.

• The design is quite robust and could be modified aesthetically to produce different effects to suit slightly different environments. This means there is a fairly large scope for adjustments which would provide a wider choice and range of styles for people to choose from.

• The design fits 95% of the population in terms of ergonomics and anthropometrics. E.g. Popliteal Height, Length etc.

• There is a lot of scope for the selection of materials with this design. The main body could be made from a number of plastics or metals which means that there is a good selection of materials allowing the manufacturers to find a material with the desired aesthetic and physical properties.

• This design could be adapted to suit alternative environments other than the intended ones relatively easily.

- Negative Points

• The design has a lot of structural weaknesses which would need to be addressed before the product could be taken further.

• The shape and style of the design mean that it is potentially very difficult to manufacture and would require specialist processes and machinery that would greatly increase the cost of manufacture.

• The product may need adjustments in order to make it more suitable for batch production.

• The design would need some adjustments in order to make it tougher and more resistant to vandalism.

- Points To Consider

• Looking at the positives and negatives above the main points that need considering with this design appear to be the problems with structural strength and support. There are several points on the design that will be inherent weak spots due to the very shape of the product. There are also parts of the structure that will come under far more strain weight wise than others. This is again due to the shape of the product and how the weight of a person is distributed through the structure. In order to correct this the design needs to be altered to provide it with a sturdier base and a stronger frame. This could be tackled in a number of ways. One idea is shown in the photographs of the model I constructed above. The wooden dowels would be metal rods on the actual product and the ribs would be built into the main body piece to provide it with extra rigidity.

• A second problem to look at is the fact that this product may not suit batch production due to its complicated shape and its need for specialist machinery and production techniques. However this problem can be easily solved by simply selecting the right materials for the product and if necessary slightly altering the design to suit batch production processes.

• Finally one minor point is that due to the locations selected for the placement of this product there is a problem with vandalism. As it is the product would be reasonably resistant to vandalism provided that it was manufactured from tough, durable materials that are difficult to damage. Slight alterations may need to be made to the shape of the design but these will probably fall under the same alterations that would be made to strengthen the product structurally. The only remaining problem would be graffiti, but the only measure that can be taken against this would be to manufacture the product out of materials with a resistance to most chemicals which would allow the local council to clean the bench should it be covered.

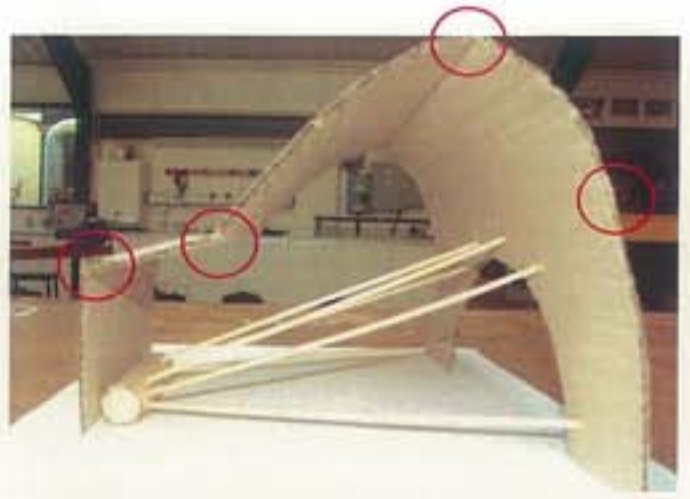


Fig: 1. This picture shows the model in its early stages with the basic shape and the struts added. This is the shape and stage I will work from in terms of trying to address the structural weaknesses of the product by finding different ways to strengthen it. The main weak points have been highlighted on the picture.

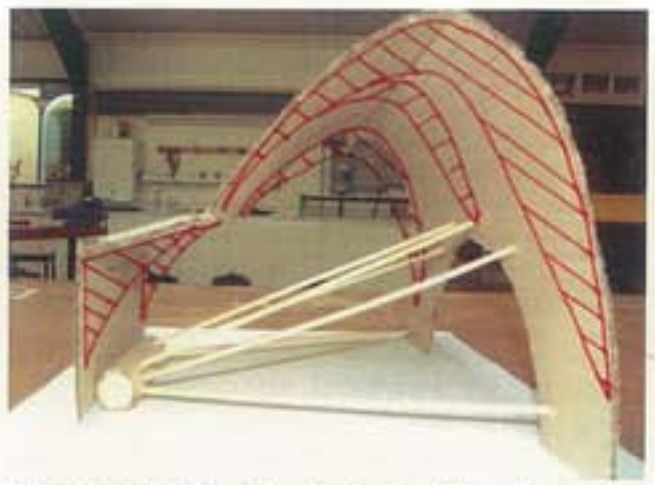


Fig: 2. One idea to strengthen the structure of the product would be to include ribs like those shown in the model pictures above. These would provide rigidity to the main body of the bench and would give it the support it needs to withstand the weight of a at least three seated people.

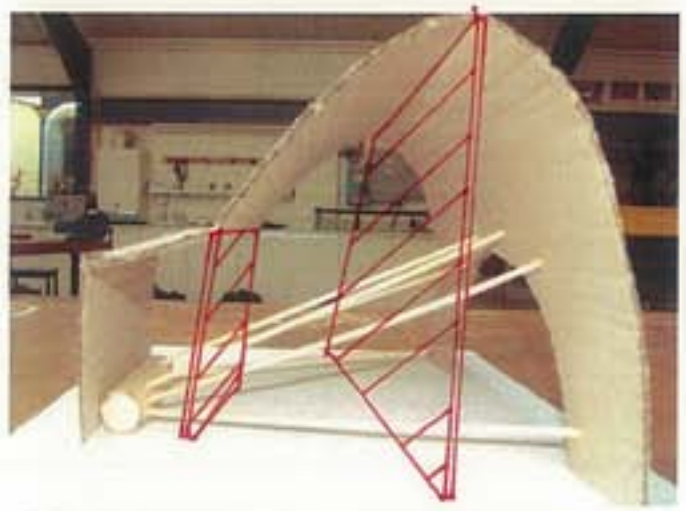
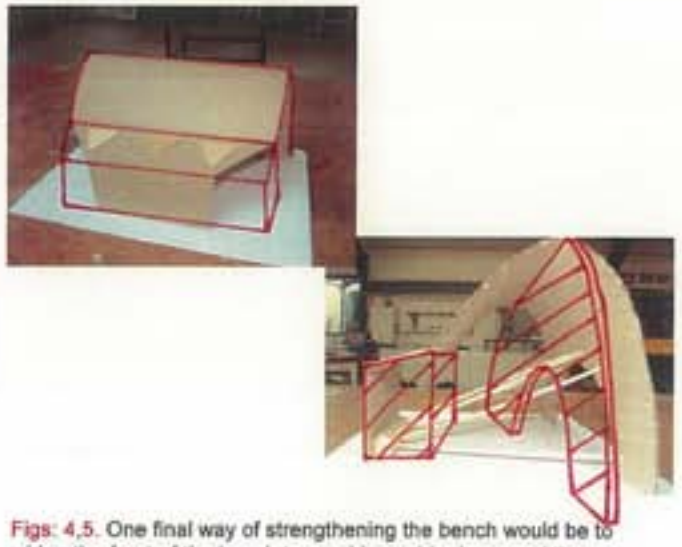


Fig: 3. An alternative to Ribs would be to change the design of the bench to have extra supports. This would take strain off the bend of the seat and the top of the bench. It could also be incorporated into the aesthetics of the bench to create a different style.



Figs: 4,5. One final way of strengthening the bench would be to widen the front of the bench to provide a wider base and then perhaps fill the bottom section. This would mean that the seat part of the bench would be much stronger. To strengthen the arch of the bench another arch perpendicular to it. This could also have struts and it would fit in well with the aesthetics of the bench.

Possible Methods of Manufacture

• The main body of the bench, if made from metal, would likely be manufactured by means of pressing the shape in a hydraulic press. Metal Sheets would be placed into the machine and pressed into shape. This method would allow the main body to be produced fairly quickly in large batches as several bodies could be pressed quickly from one sheet of metal.

• If the body was made from plastic there would be two options for manufacture. The first would be rotational moulding and the second would be injection moulding. Rotational moulding would use a rotating mould to spread hot plastic round the inside of the cavity. The plastic would then be cooled and removed in the required shape. Injection moulding would inject hot plastic into a high pressure mould. Once filled the mould would be quickly cooled and the body would be removed.

A Hydraulic Press Machine

A Rotational Mould Machine

An Injection Moulding Machine

...odelling Page 2

Problems With Design

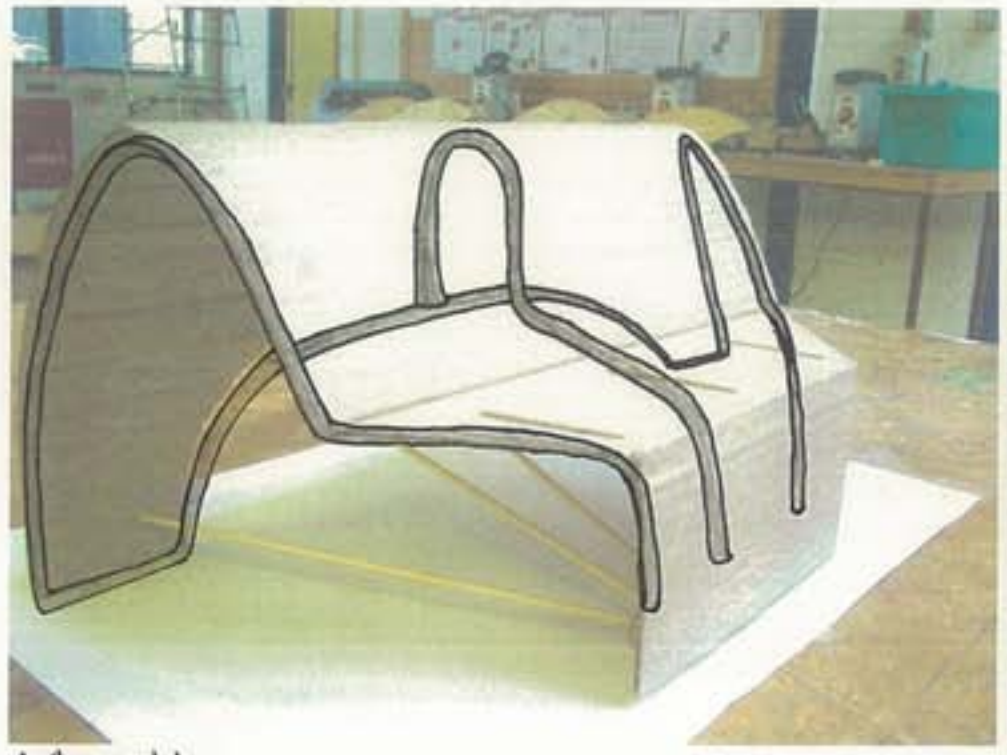
For this design there are several structural problems that need addressing. These flaws need to be recognized and solutions to them need to be implemented before this design can be pushed further and methods of production can be considered. Once these problems have been ironed out I can settle on a final design.

• The pictures (left and below) show where there is an inherent structural weakness in this design. The join between the seating shelf and the main arch will be put under a lot of pressure when people are sat on the bench, and due to the nature of the design it is an area that has very little support. This makes it a structural weakness and in order to make it strong enough to hold the required weight extra support would need to be positioned under this area. There are several possible solutions to this problem. Firstly ridges could be implemented running under the seating shelf and following the contours of the arch underneath the bench. This would lend much needed support to the design. A second solution would be to have the arch continue down to the floor rather than stop at the join. This would provide downward support for the seating shelf.

• The next structural problem would also be caused by the seating shelf-arch joint. As people sit on the bench and apply weight to this joint it would drag the top and front side of the arch down and inwards in a motion that would act to collapse the bench in on itself. In order to stop this from happening some sort of support is needed to bolster the arch and keep it rigid. This could be done by placing ridges under the arch to keep its shape. This could also be done by inserting a sub-structure of mild steel rods to support the bench. The sub-structure or Skelton could run around the contours of the bench with several support rods running up under the arch and horizontally across the design at crucial places. This would strengthen both the arch and most other weak points on the structure. It also would not interfere much with the overall design of the product and so it could retain its aesthetic appeal.

• This picture shows how ridges could be implemented into the design to support the arch and the seating shelf-arch joint. They also are fairly aesthetically appealing. This is one possible solution, the second would be the mild steel rod sub-structure which would do a similar job to the ridges but may provide slightly more support, making the bench stronger and more resistant to vandalism.

Solutions To Design Faults



• The pictures (left and below) show how the mild steel sub-structure could be designed and how it would help to strengthen the design. It could be a closed piece of metal welded onto the base at the foot of the bench. This would provide excellent support for both the arch and the seating shelf-arch join as well as holding the bench together firmly. It would also eliminate the need for ridges which would make the manufacturing processes easier, cheaper and faster.

Anthropometrics

- Basic Seating has 3 major measurements relative to body shape.

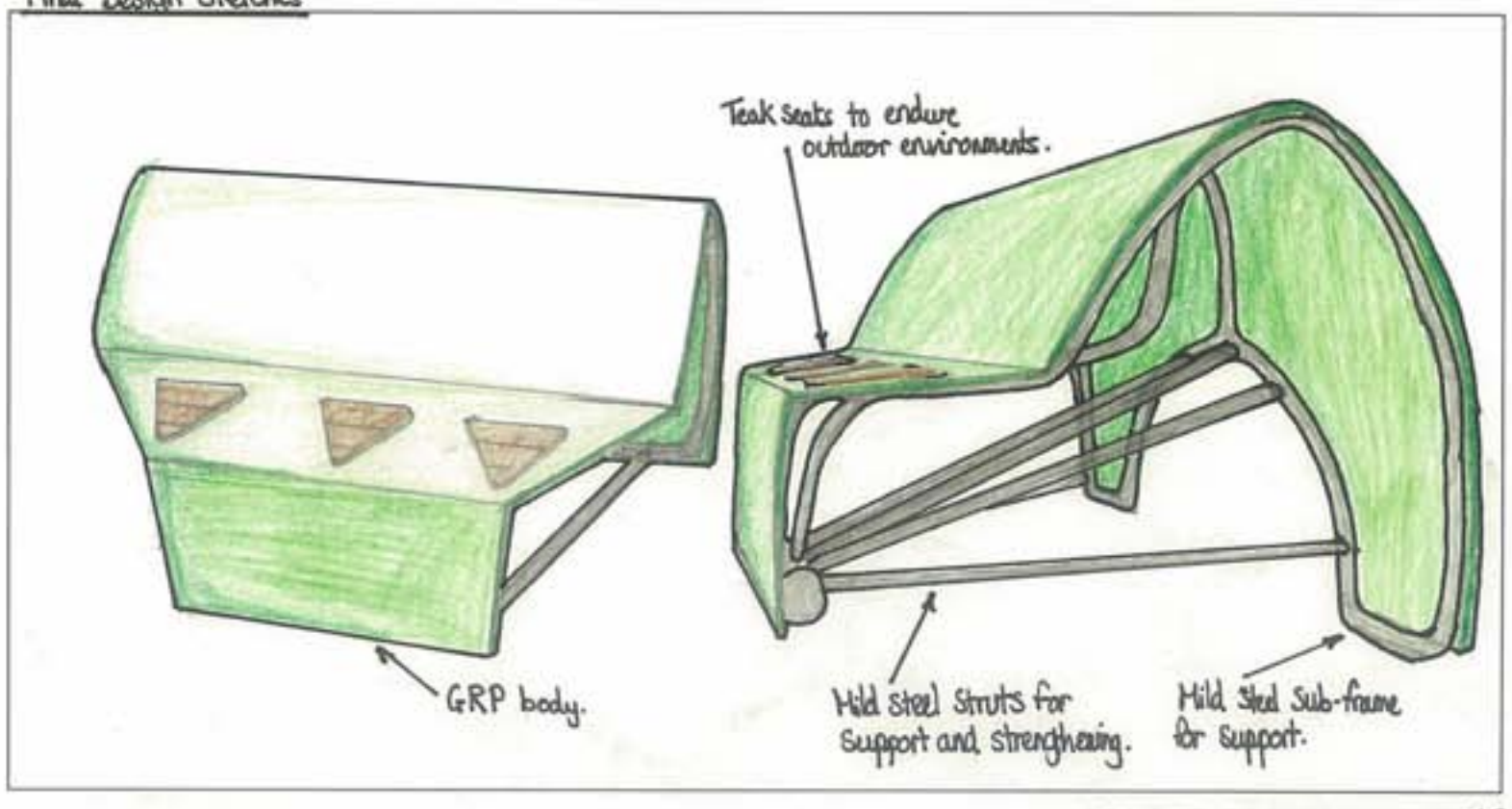
Ⓐ - Popliteal Height
Ⓑ - Popliteal Length

Ⓒ - Hip Breadth

Measurements (mm) 5th %, 96th %

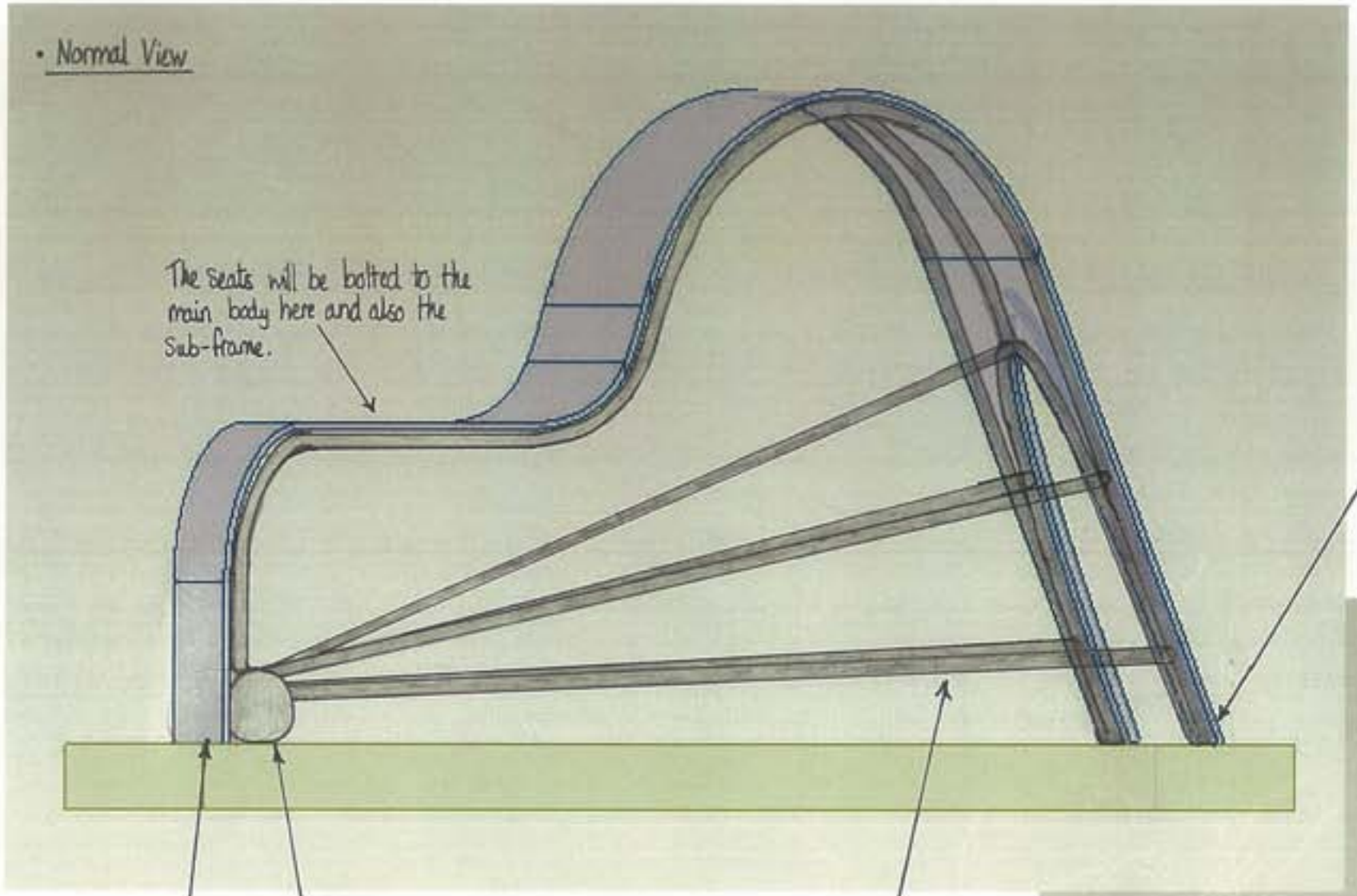
Ⓐ Male: 395, 490 Female: 355, 445
Ⓑ Male: 440, 550 Female: 435, 530
Ⓒ Male: 310, 405 Female: 310, 435

Final Design Sketches

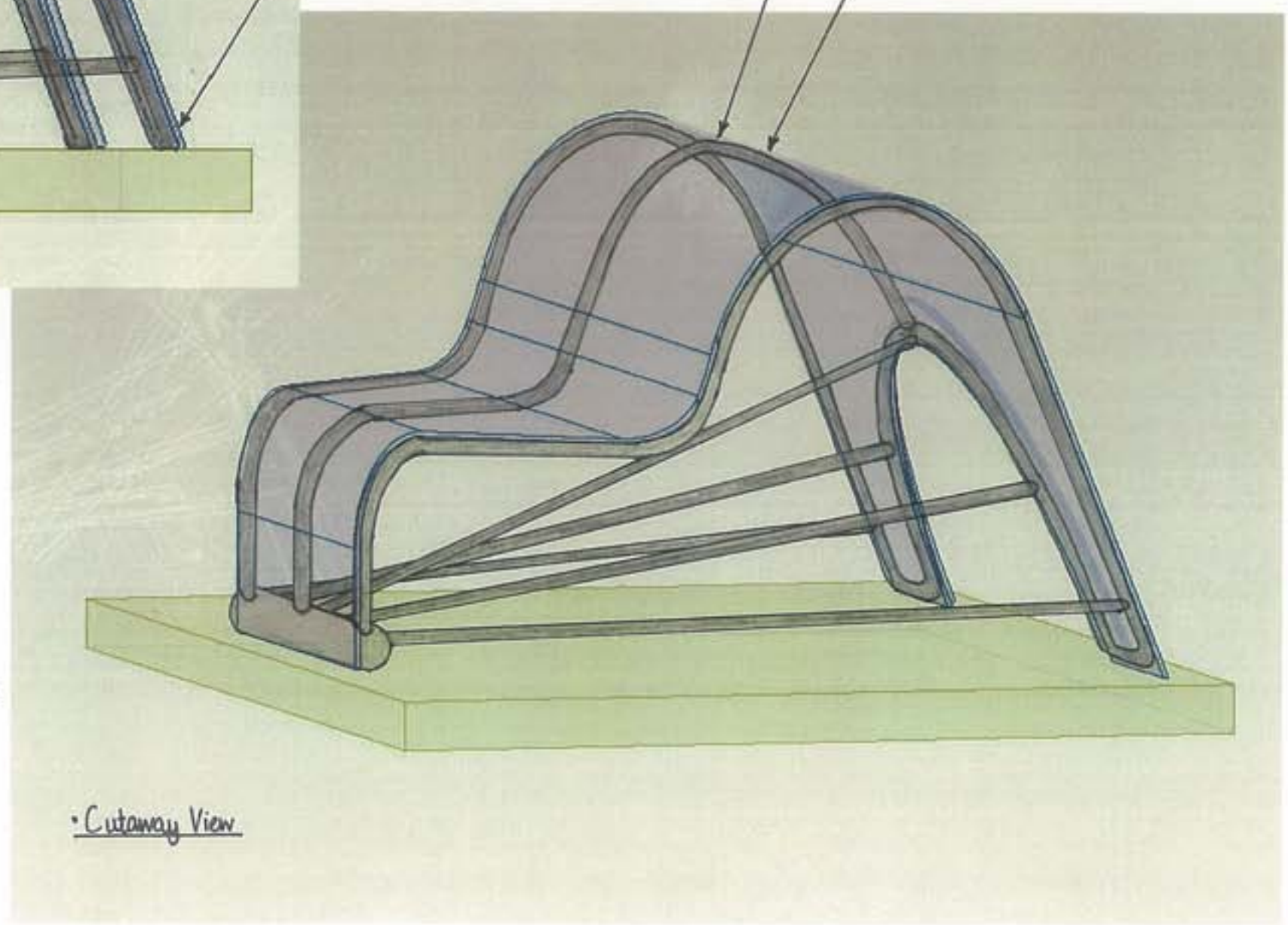


Final Design

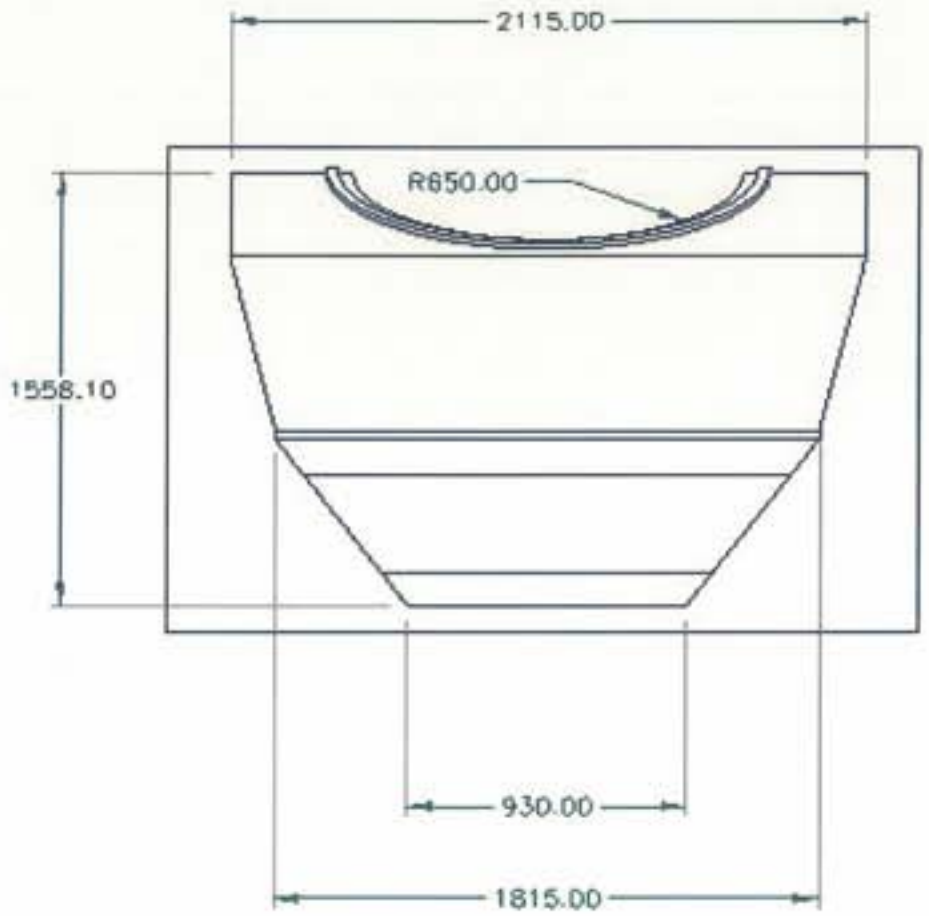
- Normal View

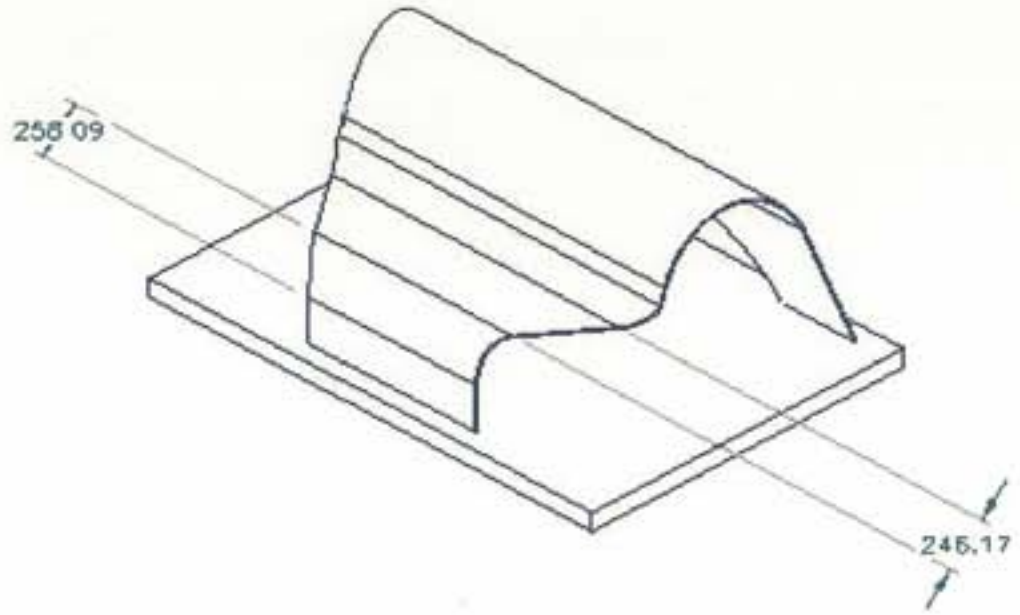


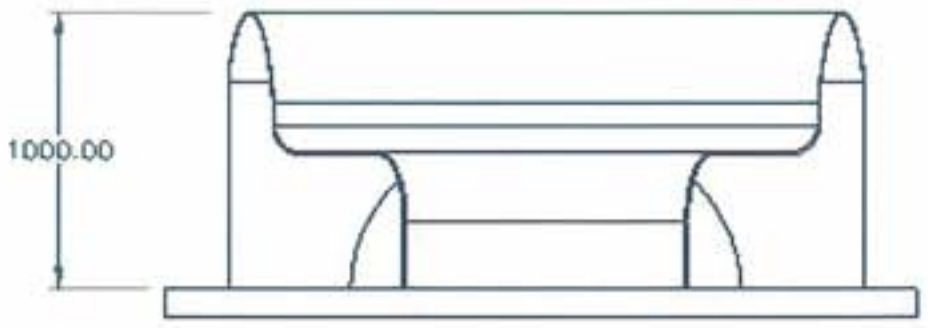
- The two images on this page show a cutaway view of the product as it would be completed and assembled.

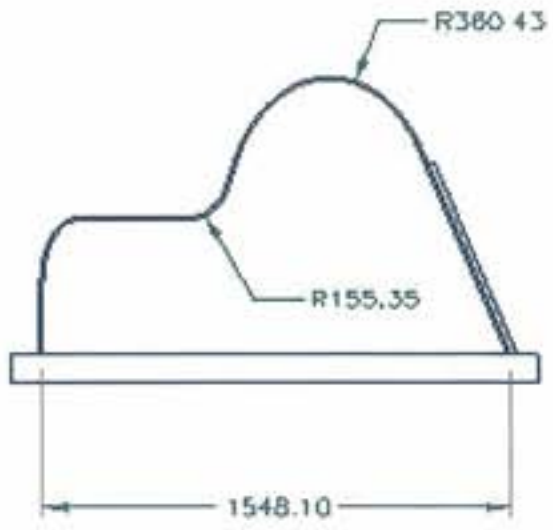


- Cutaway View









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	CHECKED BY		
	APPROVED BY		
PROJECT NUMBER	DRAWING NUMBER		

Manufacture Of Design

Components/ Quantity	Material and Finish	Justification of Choice	Alternative Materials	Production Process/ Health and Safety	Quality Control
1. Main Body – 1	GRP (Glass Reinforced Plastic), the shell surface is self-finishing as a result of the use of a gel coat.	GRP is a strong, lightweight material with a very high impact resistance. It also is resistant to corrosion and self-finishing so it's suitable for the outdoor locations that its intended for.	An alternative to GRP would be ABS plastic or Acrylic, both of which could be injection molded into the required shape.	The body would be manufactured out of GRP and so the gel coat would be laid down in a female mould before being coated in GRP. Once cooled the finished component would be removed. The main health and safety concern would be the heating of the GRP and this could be made safe by ensuring operators stand well back from the mould when in use.	During the GRP manufacture process it would be important to check that the mould is clean and the surface is not damaged. Also once the molding is removed it would have to be checked for any deformities or warping that could occur in the mould.
2. Seats – 3	Teak would be a good material for the seats as it is resistant to weathering and it finishes well. However Teak is a tropical hardwood and so would not only be expensive but it would need to be procured from an environmentally and legal source. There is scope for recycled Teak to be used however from discarded garden furniture. It would need to be oiled or varnished with a protective waterproof coat however to increase its lifetime.	Teak is a tropical hardwood that is resistant to corrosion and so is appropriate for use in outdoor locations such as those this product is intended for. It also finishes very well and is easily workable making it a suitable material for the seats.	Scots Pine would be a good alternative material for the seats as it also weathers and finishes well. However it lacks the appealing colour of teak and is not as easy to work. It also has a tendency to warp.	The seats could easily be manufactured from planks dowel joined together and then cut to shape from a pre-set jig. This would allow the seats to be produced quickly in batches to the exact same measurements each time.	A jig could be used to ensure that the seats are manufactured to within the agreed tolerances each time. For the finishing on the seats it could be manually checked for flaws to ensure a good quality finish.
3. Mild Steel Frame – 1	The sub-skeleton frame of the bench would be manufactured from Galvanized Mild Steel.	Mild steel is a suitable material as is it is tough, durable and has a very good bending strength which makes it ideal for supporting the bench. Also mild steel can be welded and can be finished to make it suitable for outdoor conditions. Both these properties make Mild steel a suitable material for this project.	An alternative to a Mild Steel frame would be to have an Aluminium alloy frame. This would also be suitable for outdoor locations and would require no finish. However it would not be quite as strong as Mild Steel.	The Mild Steel frame would be produced from two Mild Steel rods that are first bent into shape around a former and then welded together. Once the main frame, base and the struts are manufactured and assembled, the frame could then be welded to the base. The main safety concern with this component would be the welding process. However this would likely be carried out by automated machines that work over a jig so this hazard would be eliminated.	To ensure that the frame is manufactured within tolerances the mild steel rods used would be bought in to the factory in standard sizes. They would then be bent round a former. Once the rods are bent into shape they would be checked to ensure they are in the correct shape and that there are no flaws or cracks in the rods. The next checks would come when the frame has been welded together and Q.C. would be carried out to ensure that the welds are secure and that the rods are properly joined.
4. Mild Steel Base – 1	The base would be manufactured from Galvanized Mild Steel.	Mild Steel would be a suitable material for the base as it is strong, durable and is suitable for welding. Also Mild Steel can be used in outdoor locations once finished.	An alternative to Mild Steel for the base would be an Aluminium Alloy. This would be strong, suitable for welding and would not need to be finished. However it would not be quite as strong as Mild Steel.	The Mild Steel base would be produced impact extrusion and then both ends would be rounded and sealed to produce a hollow shape with rounded ends. This process required high pressure hydraulics which could be very dangerous if the machinery used is not properly maintained and monitored. However if it is operated correctly and regularly checked for faults the risk is significantly reduced.	To ensure that the base is manufactured to within tolerances the base would be checked once extruded. Also randomly selected units from each batch would be tested to destruction by compressing it until it gives way. This would allow the manufacturers to check that the base could take the required pressures that would be exerted through the struts when the base is in use.
5. Support Struts - 6	The support struts would be manufactured from galvanized Mild Steel.	Mild Steel is a good material for the support struts as it has a very good bending and compression strength. Also it can be galvanized to make it suitable for outdoor locations such as those set out in the brief.	An alternative to Mild Steel would be an Aluminium alloy as it is resistant to corrosion and tough. However it would not have as good a bending strength as Mild Steel.	The mild steel rods would be bought into the factory as standard components in standard sizes.	The bought in components would already have undergone Q.C. checks at their place of manufacture. As a result when the factory purchases them it is assured that the rods will reach a certain minimum standard and will perform as expected.

Materials and Components

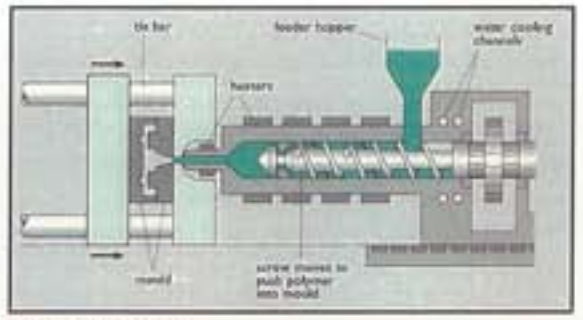
- Main Body

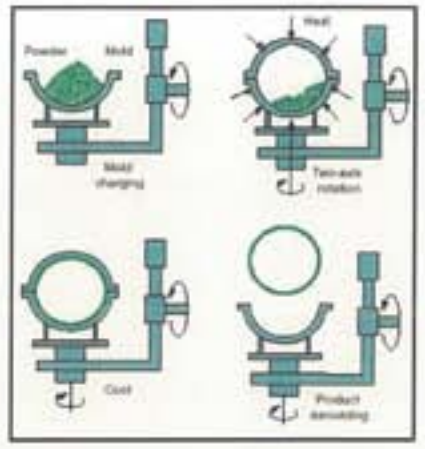
- Main Body – ABS (Acrylonitrile Butadiene Styrene)

• The main body shape is likely to be manufactured from ABS plastic by either injection or rotational moulding. ABS has been chosen for a number of reasons. Firstly it is suitable for both injection and rotational moulding which means that the main body could easily be batch produced, the need for which is outlined In the specifications. Secondly it is stiff and it is available in a variety of colours. It is also impact resistant, chemical resistant and fairly hard which means it will be able to endure vandalism and can be chemically cleaned if covered in graffiti. Unfortunately ABS is not UV-light resistant but it can be finished in a number of ways to overcome this difficulty. So ABS as a material meets all the necessary requirements for it to be used in my chosen locations.

Fig: 1. ABS plastic in pellet form.

Fig: 2. ABS plastic safety helmets.





Figs: 3, 4. Injection Moulding and Rotational Moulding diagrams.

- Methods Of Manufacture

- Injection and Rotational Moulding

• Injection moulding is an industrial process that uses high pressures to force molten material into a mould. This is a very useful industrial process as it allows complex intricate parts to be created. It is especially useful for when large quantities of a fairly complex part are necessary as they can be manufactured quickly in bulk. Rotational moulding uses a mould that rotates on two axis to cover the inside of the mould in molten material. The mould is then cooled while still rotating and the hardened product is removed. This is very useful for creating symmetrical hollow shapes. However one setback for both of these processes is that due to the nature of the machinery required to carry them out, it is only economically viable if multiple copies of the product are required. It would be very costly and inefficient to try to use injection or rotational moulding to create a one-off product.

Basic Components

- The Plastic main body shape (with ribs).
- The Metal support struts.
- The Metal strut base for the supports.
- The Wooden triangular seats.
- The Metal, semi-circular support strut fixing bar.
- Various Nuts and Bolts for fixing the seat to the main body and the support struts to the fixing bar.

Fig: 3. Injection Moulding machine.

Fig:4. Rotational Moulding machine.

- Metal Supports (Struts, Base, Fixing Bar, Nuts and Bolts)

- Metal Support Struts – Mild Steel

• The Metal support struts will be manufactured from Mild Steel rods which can be brought in at standard diameters and lengths and then cut to size at the factory. This is an ideal material for the struts as it is often used for structural work due to its inherent strength and toughness. It is also suitable for a number of finishing processes which means it will be able to be finished to suit the aesthetics of the bench. This also allows for the bench to be manufactured in a number of styles to suit the users tastes and it can be finished in a way that protects it from weathering which it may experience in some outside locations.

- Metal Strut Base – Mild Steel

• The Strut Base will also be manufactured from Mild Steel for similar reasons to the support struts. It is a strong, durable metal with several finishing options to protect it from weathering. Crucially for the Strut Base Mild Steel is also suitable for MIG welding which means the struts can be easily joined to the base. This is useful as means that the support struts can be easily assembled to the base on a production line. This helps it to be more suitable for batch production.

- Semi-Circular Fixing Bar – Mild Steel

• The Semi-circular fixing bar will be manufactured from mild steel because it is strong, tough and durable. Also, key to the manufacture of the fixing bar, Mild Steel is malleable which means it can easily be shaped. This will allow the bar to be rolled to the correct angle without cracking or breaking. Mild steel is also easy to work which is ideal for the fixing bar as the holes for the struts to locate have to be drilled and this process would be easy to carry out with Mild Steel. Finally Mild steel can be finished in a number of ways to be suitable to the environment.

- Nuts and Bolts – Stainless Steel

• The Nuts that will fix the struts to the Fixing bar will made from Stainless Steel. These parts are most likely to be bought in components that are simply purchased from an independent manufacturer in range of standard sizes. They would be bought in bulk by the factory in the desired size and implemented into the products during assembly. Stainless steel is an ideal material for these as it is corrosion resistant and so is suitable for any environment. Also stainless steel is very hard which means it would be resistant to vandalism. One particular point to note would be that the buts and bolts used would have to be specialised tamper proof components to avoid vandals undoing the nuts and damaging the bench.

Fig: 5. Mild Steel flat bars ready for export.

Fig: 6. Chrome plated Mild Steel office chair.

Fig: 7. Mild Steel welding rods.

Fig: 8. MIG welding a Mild Steel frame.

Fig: 9. Stainless Steel rods.

Fig: 10. Stainless Steel Nuts and Bolts

Fig: 11. An example of some tamper-proof Nuts and Bolts. These specialised components prevent vandalism and would be particularly useful for this bench as it is designed for public areas where vandalism can be a problem.

- Bench Seats

- Wooden Triangular Seats – Teak

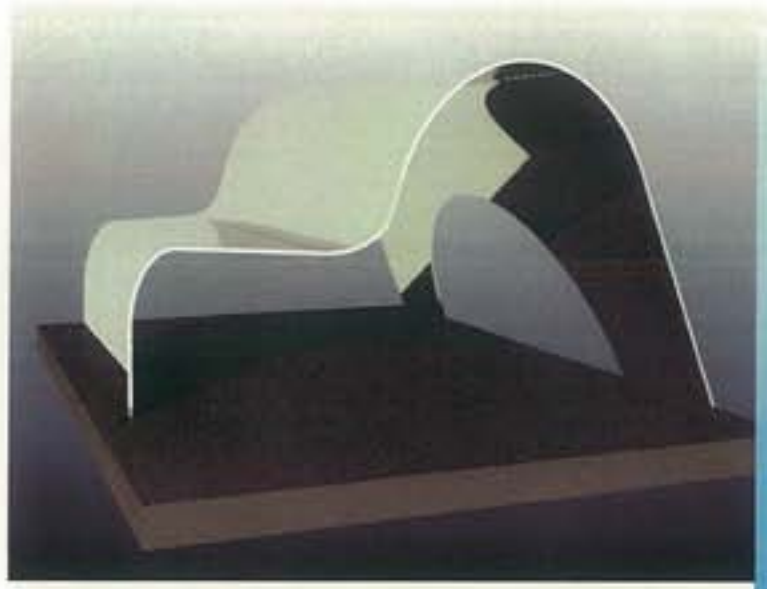
• Teak is a suitable wood for the seats of the bench as it has an excellent resistance to decay and so is suitable for both outdoor and indoor locations. It also finishes well and is relatively easy to work making it suitable for the batch production that would be necessary in the manufacture of this bench. Finally teak does not react with metals and so is a suitable wood to be bolted to the main body. The seats would likely be cut from planks and then spray finished before being assembled with the rest of the bench.

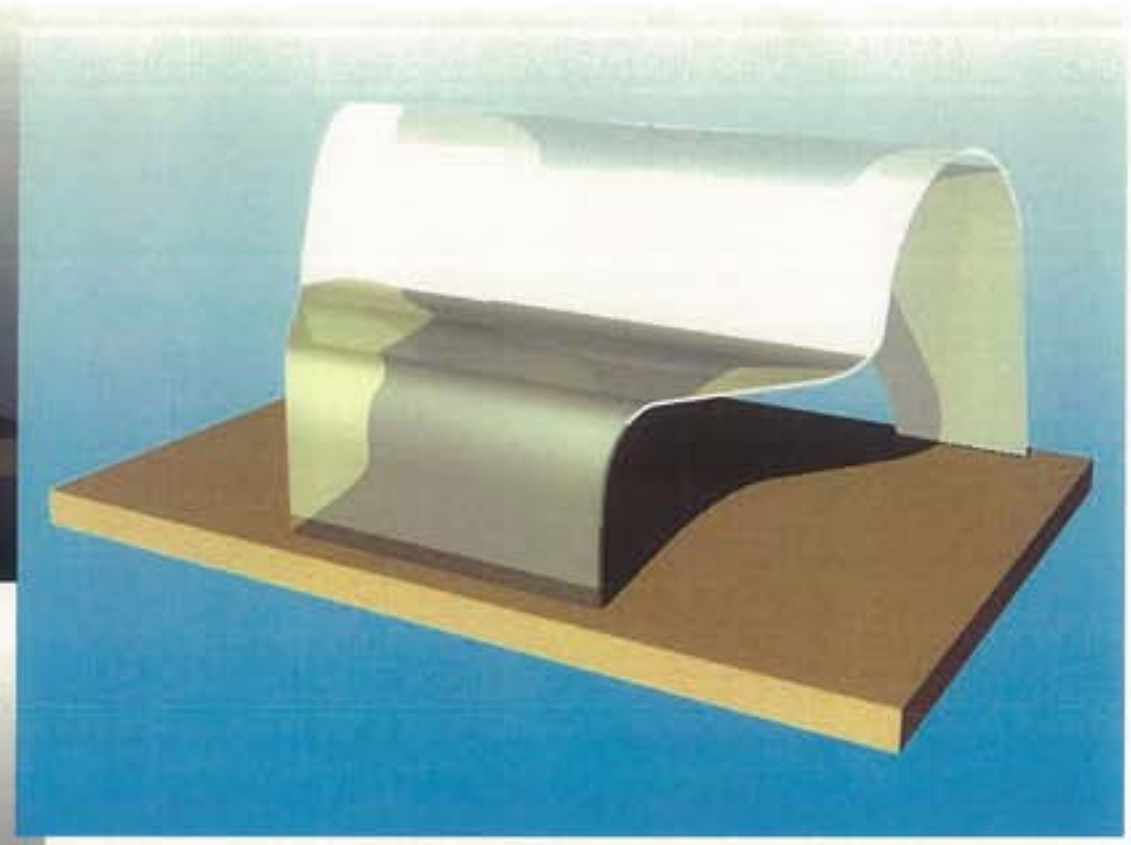
Fig: 12. A Teak tree in Indonesia.

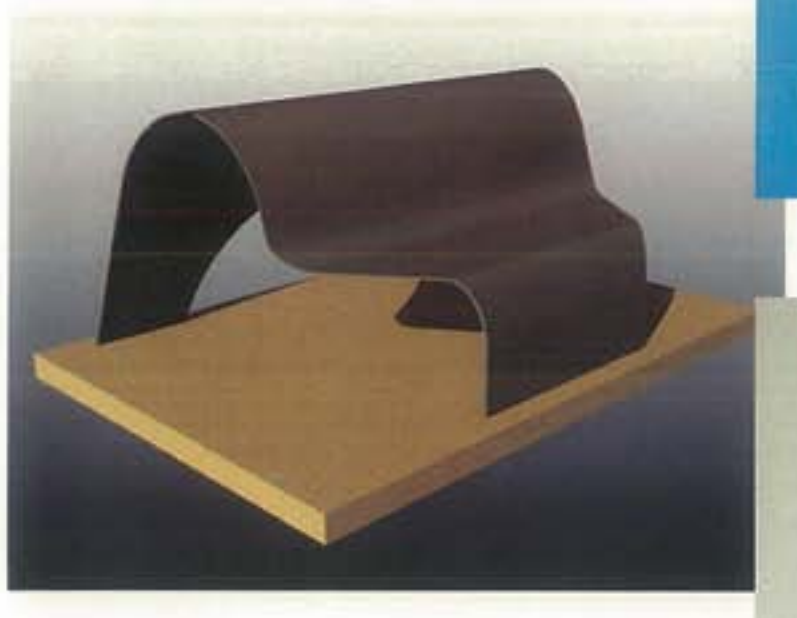
Fig: 13. Large Teak Planks ready for export.

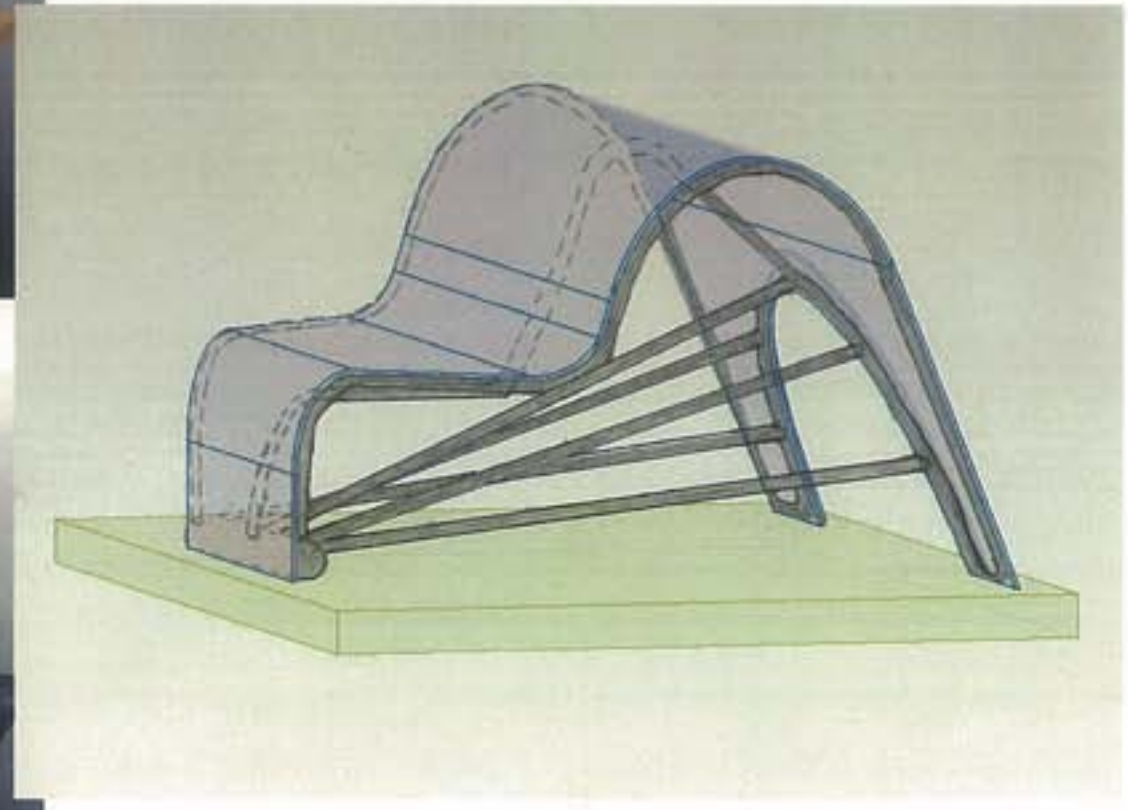
Fig:14. A finished Teak outdoor chair.

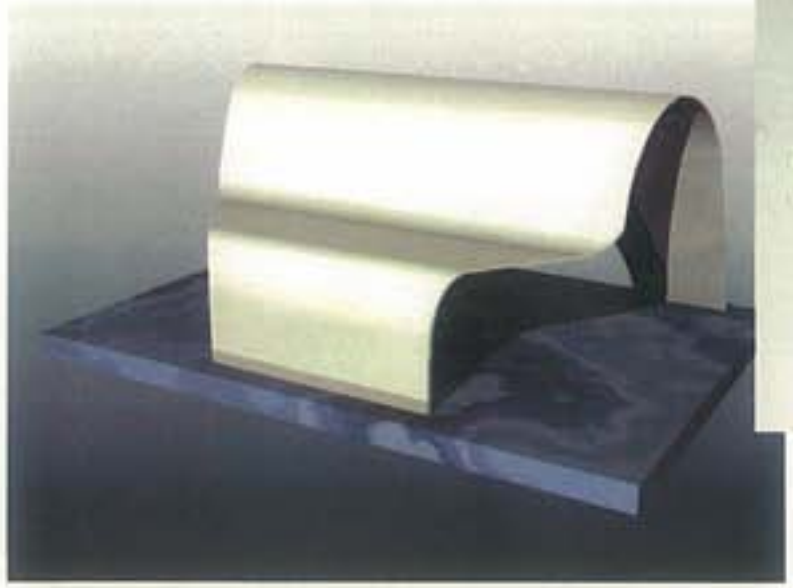
Graphical Presentation











Evaluation Against Specifications

• **Purpose**

-To provide seating for three to five people in a public environment.

This bench design provides seating for up to three people. If the manufacturers decide that this design is a success it would be easy to modify it to accommodate five or more by simply lengthening it and adding more seats.

• **Function**
- It must seat at least three people.
- It should be a tough durable seat to withstand day to day use.

The bench can seat three people and could be easily modified to seat five. Also with the seats sub-frame and support struts the bench would be tough a fairly durable. It would be strong enough to hold the required weights and also would be resistant to vandalism due to its tough materials.

• **Form**
- It should reflect a modern styling suitable for today's market.

This bench design has a very modern style with smooth curves and an aesthetically pleasing shape and it would fit in well in many different locations. It is especially suited to modern locations such as new shopping centers or high streets.

• **Performance**
- It should be comfortable when sitting for the expected period of use.

This bench would be very comfortable for people sitting for expected periods of use. It is designed with average ergonomic and anthropometric data in mind and has a smooth curve that would be accommodate a sitting person comfortably. One problem that may arise for this bench is that it could be used by the homeless to sleep on but this problem could be monitored and controlled relatively easily. The design could be modified to include arms rests if this proves to be a serious problem which would stop people lying across it.

• **Safety**
- It must be safe for a range of users both young and old.

This bench has no real safety issues and is designed so that it has no sharp edges or corners. However children should still be supervised when around the bench.

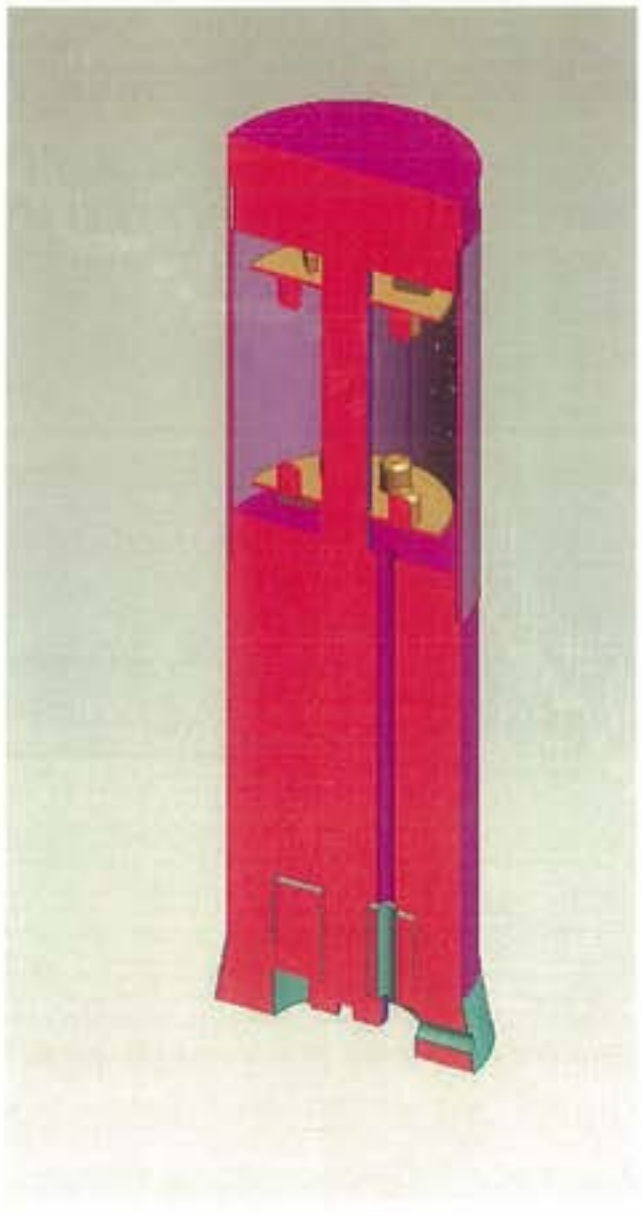
• **Materials and Manufacture**
- It must be suitable for batch production.

This bench has been carefully designed to enable it to be suitable for batch production. The main body will be molded in batches and the frame and support struts are both assembled from bought in components. The base is produced via impact extrusion and then rounded and sealed at both ends. The product would actually only need a few minor modifications to make it suitable for mass production.

Bedside Table Lamp

Brief

A large hotel chain is in the process of building a new outlet and is asking you to manufacture a run of 500 lamps. They have already approached a design company to produce the initial drawings for the lamp units who have worked closely with the interior designer for the project. The design drawings have been supplied with the initial design specification.
The new hotel will be a modern building incorporating many green features to reflect the changes in the way consumers view the impact of their travel. Although this is an ideal the modern consumer demands that ease of use and practicality are vital. The Lamp unit must both be functional and aesthetically styled to fit in with the décor chosen by the interior designer.
It is envisaged that a run of five hundred units will be produced initially, with the option to extend this if further hotels are opened in the future.



Specification

•**Purpose**
To provide a light source placed beside the beds in hotel rooms. It should reflect the décor which will be natural while maintaining clean crisp modern styling.

•**Function**
It must provide adequate light to be able to move safely about the room with a single light unit in use.
It should provide sufficient luminosity to be able to read while in bed.
In should be easy to turn off and on.
In line with the low power ethos of the hotel it should have a low power rating.
Maintenance should be kept to a minimum.
It must be stable to avoid toppling if knocked accidentally.

•**Form**
Maintaining a modern yet natural look is very important to the hotel management.
Natural woods must be used in the major components.
Clean Modern styling is important while maintaining the natural feel of the product.

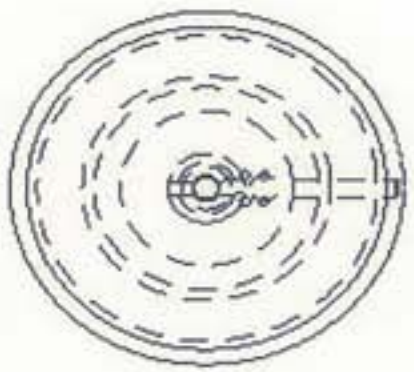
•**Safety**
The product must comply with current EU regulations for electrical safety.
The product should be designed with fire risks in mind to comply with the tighter regulations for hotel use.

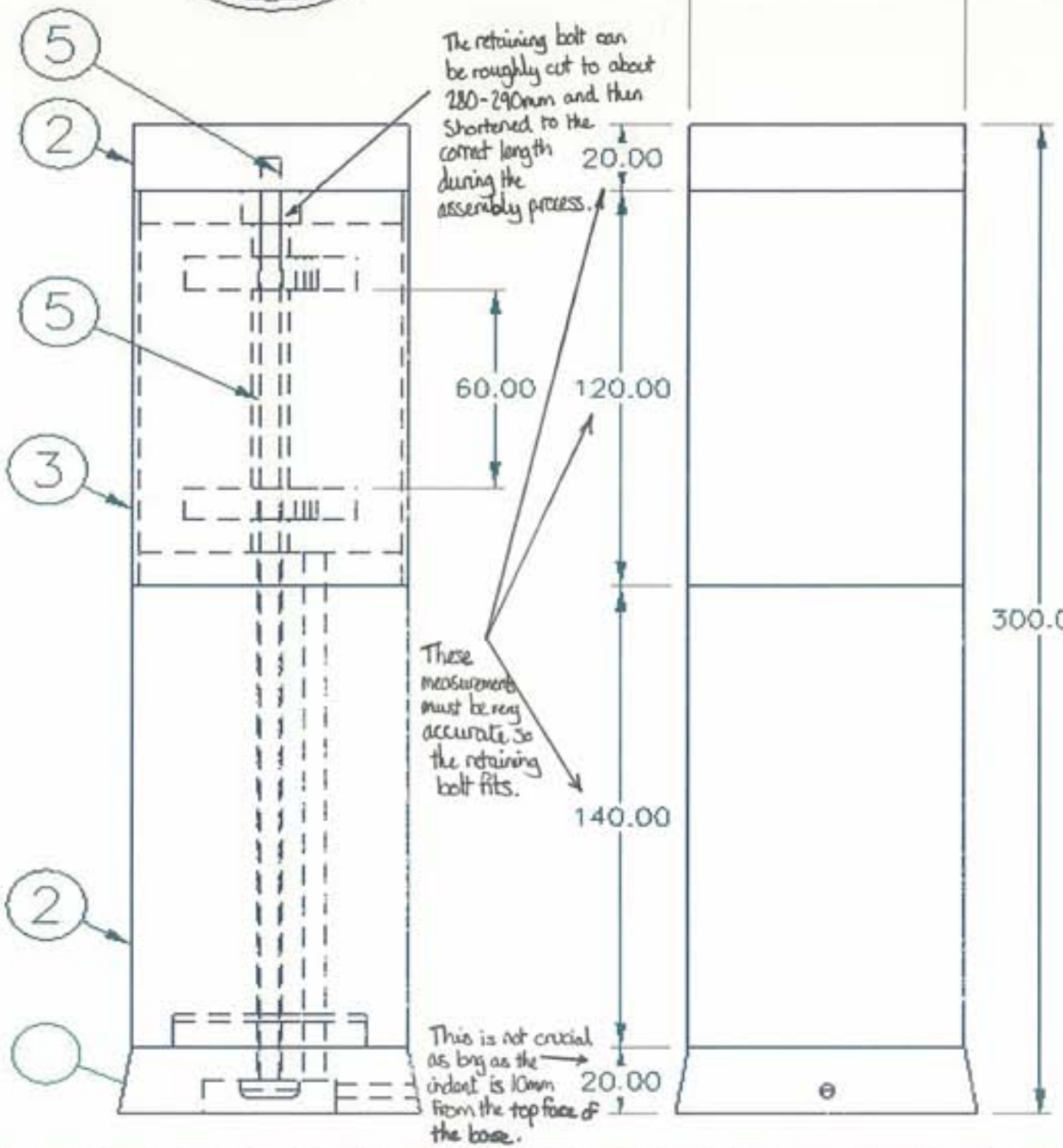
•**Cost**
It is envisaged that each unit should be supplied at a price below fifteen pounds.

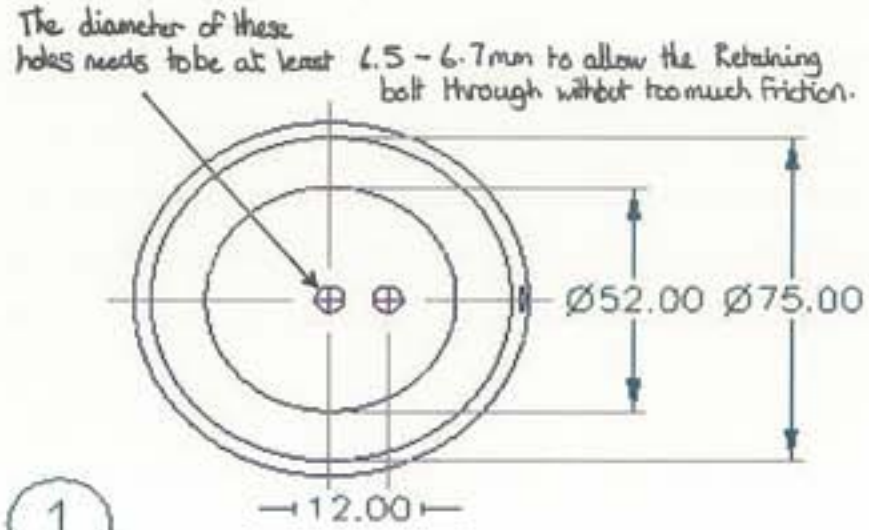
•**Manufacture**
The product must be suitable for batch production.
A prototype product must be supplied for assessment by the board by 31st October 2008
The units must be manufactured to the tolerances as stated on the production drawings.
Any detail that has not been specified is open to interpretation provided the aesthetics and function of the product are not impaired.

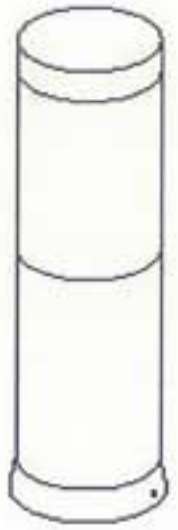
•**Market**
The client is a hotel chain opening a modern hotel.
The lamp unit must be easy to operate
It should provide enough light to read a book while lazing in bed.
It should have a small footprint and allow other items to be placed on the bedside area.

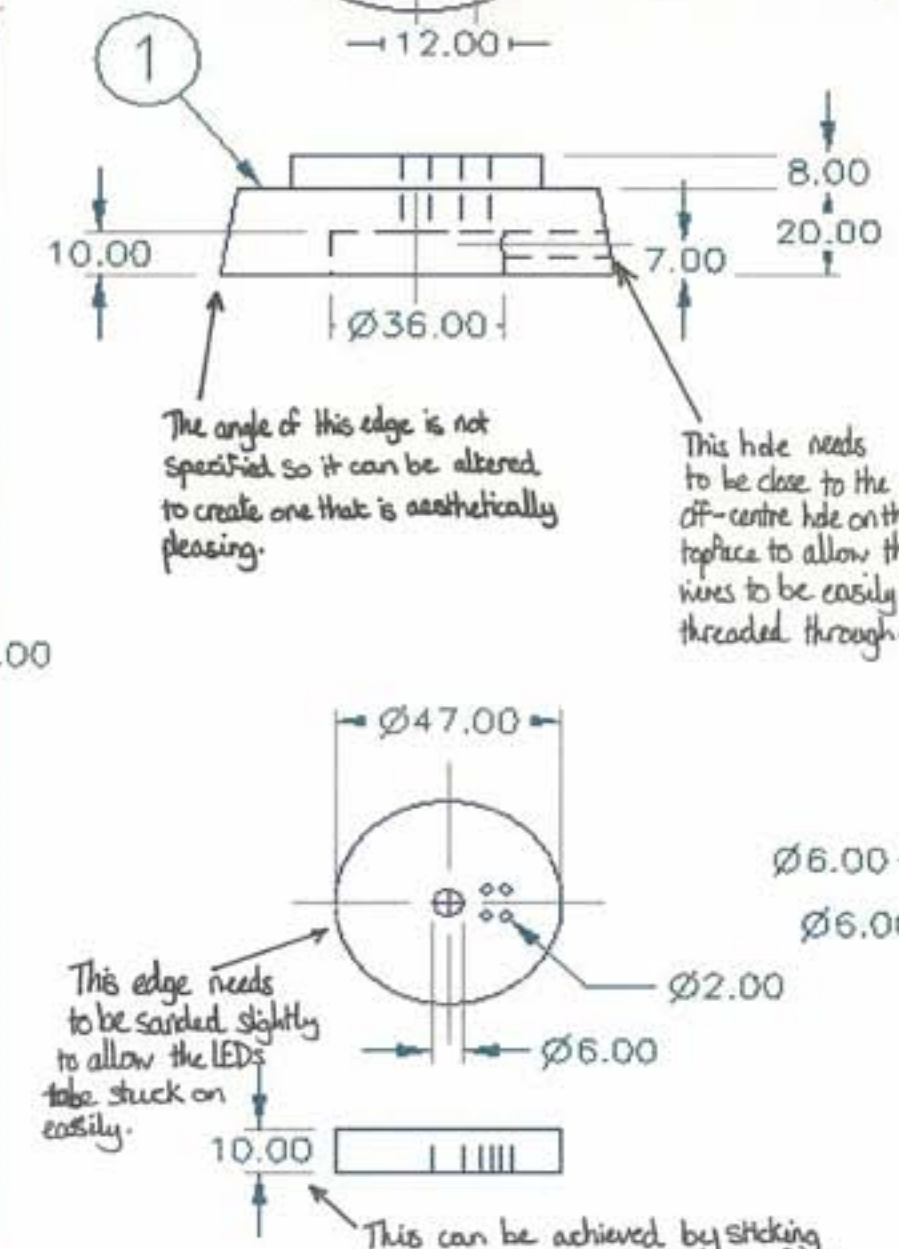
Orthographic Drawings

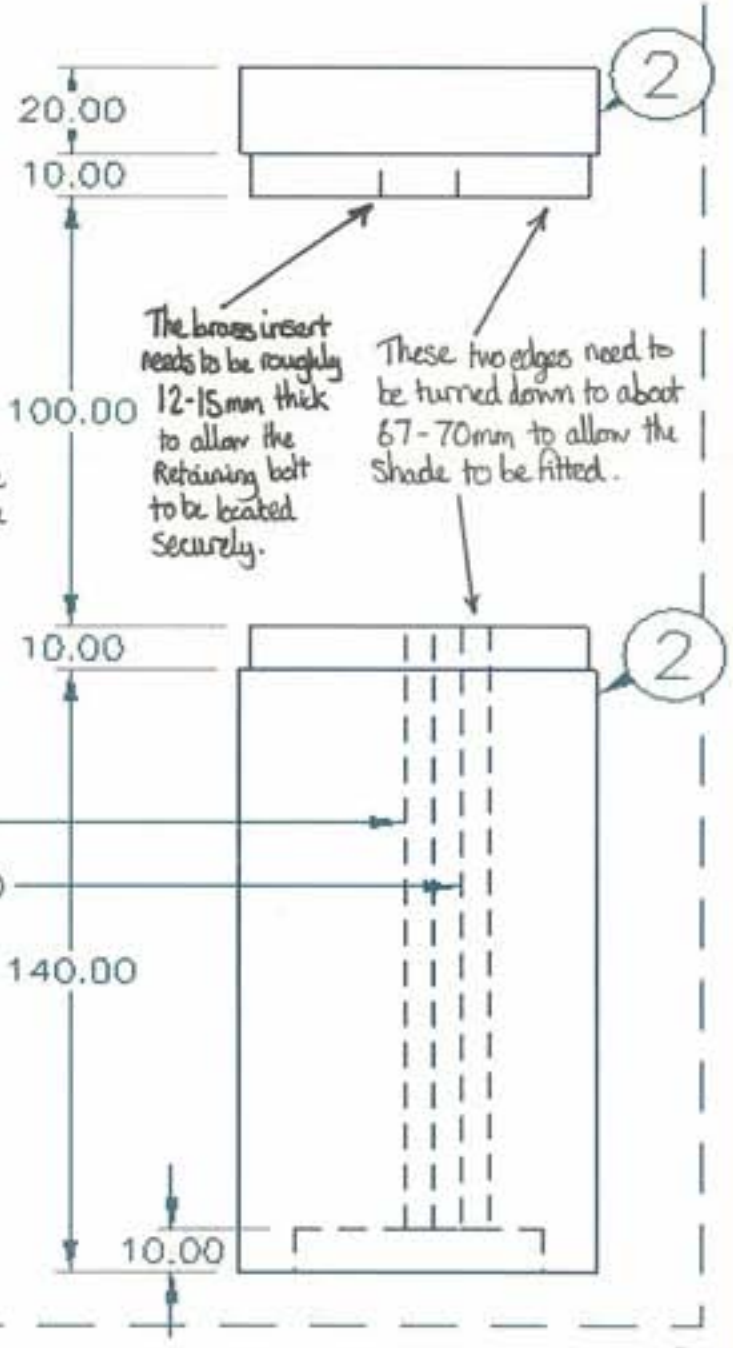






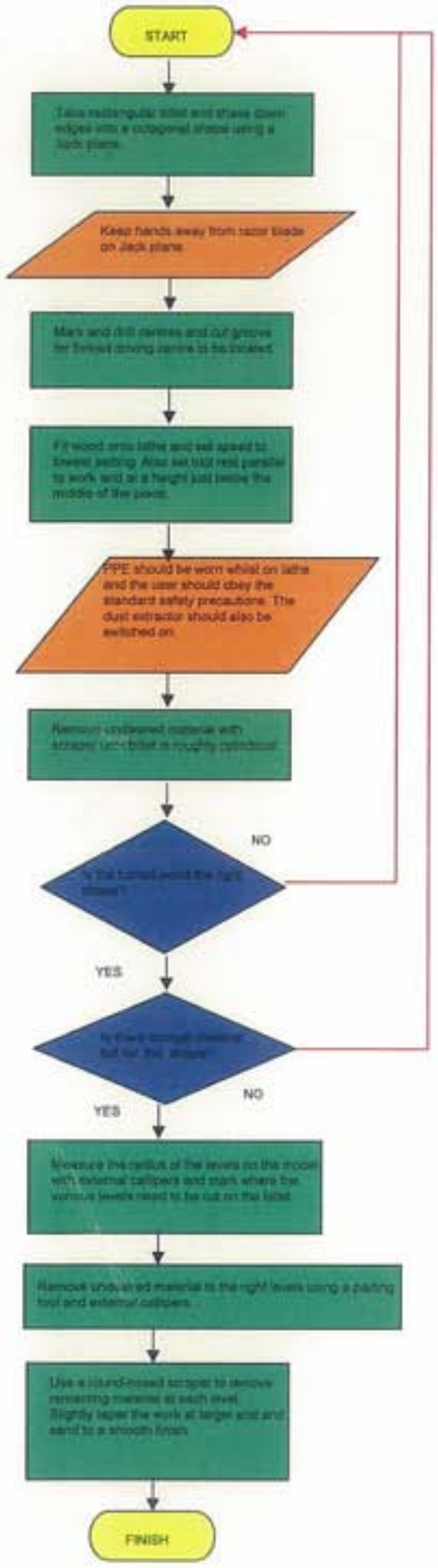




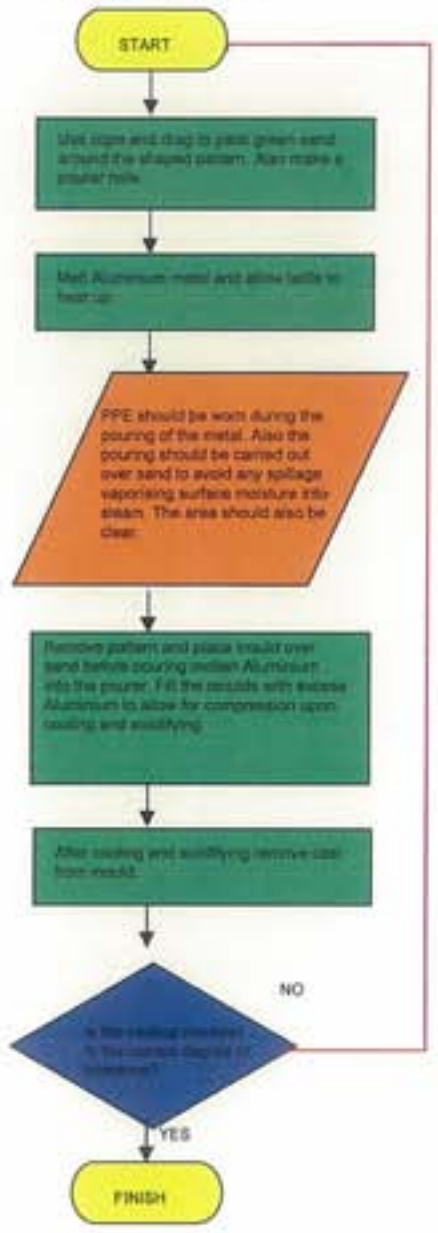


low Diagrams

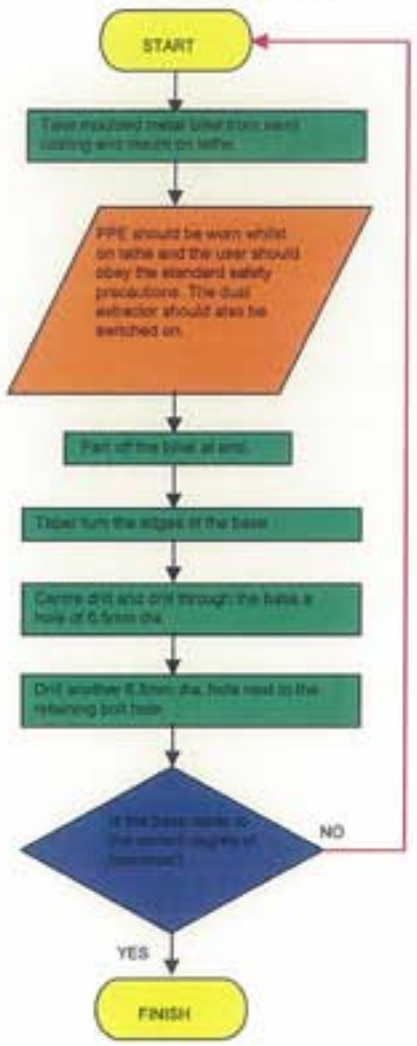
Billet Production



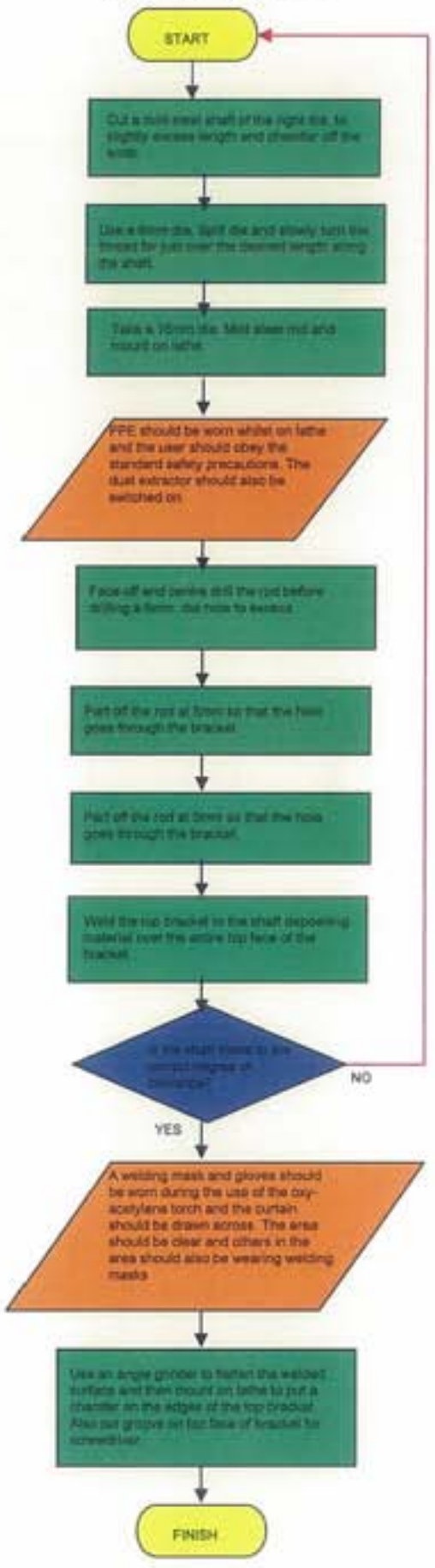
Open Sand Casting



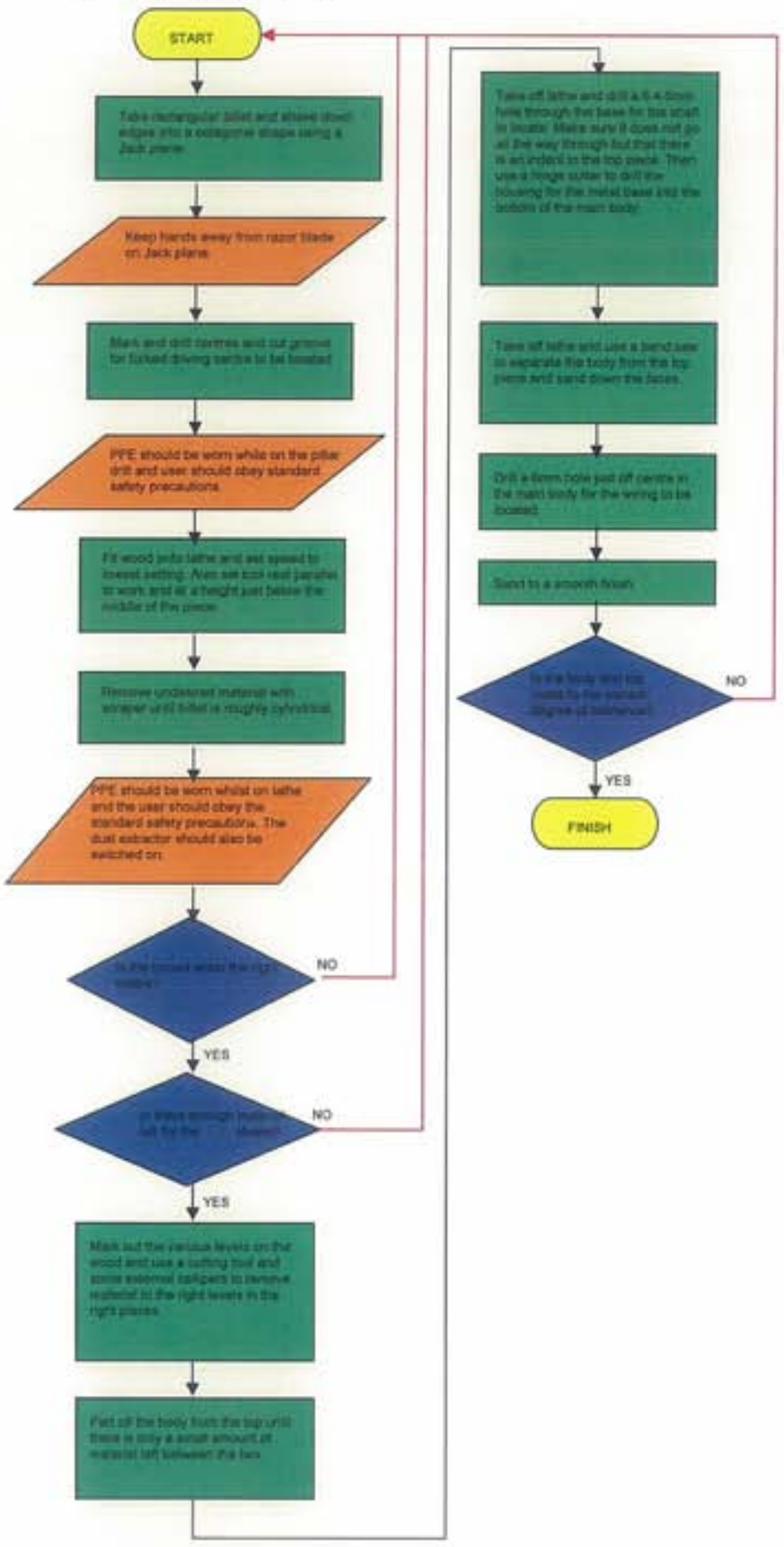
Aluminum Base Turning



Retaining Bolt Production



Main Body and Top Production



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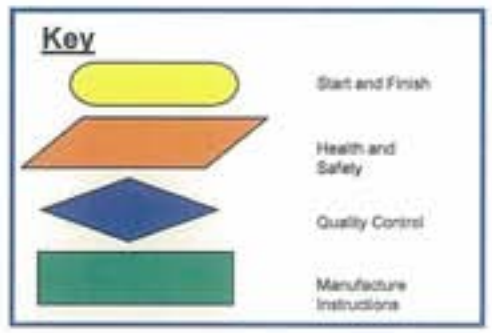
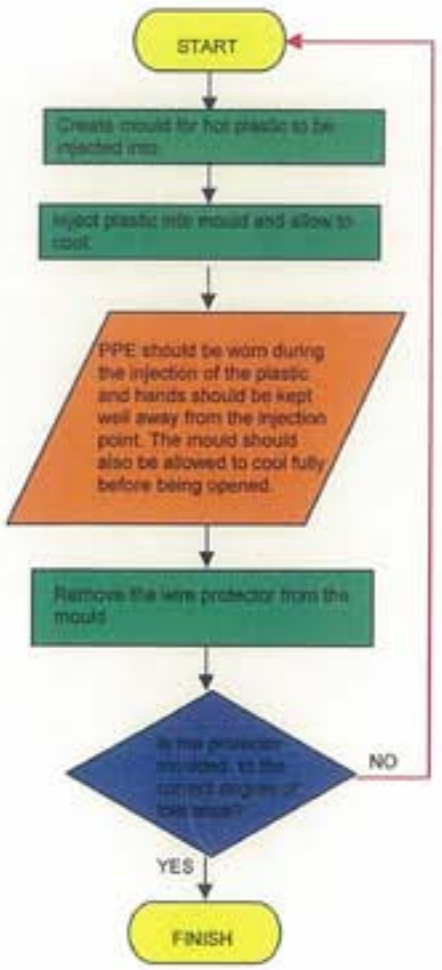
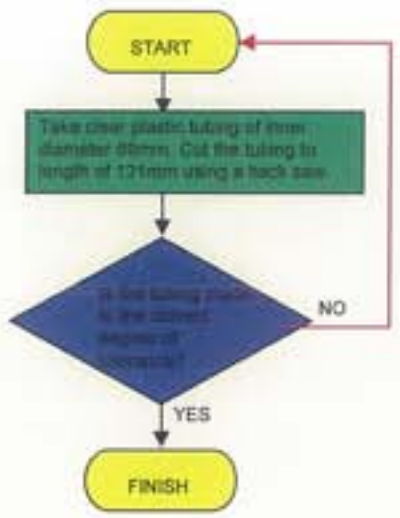


Flow Diagrams

Wire Protector

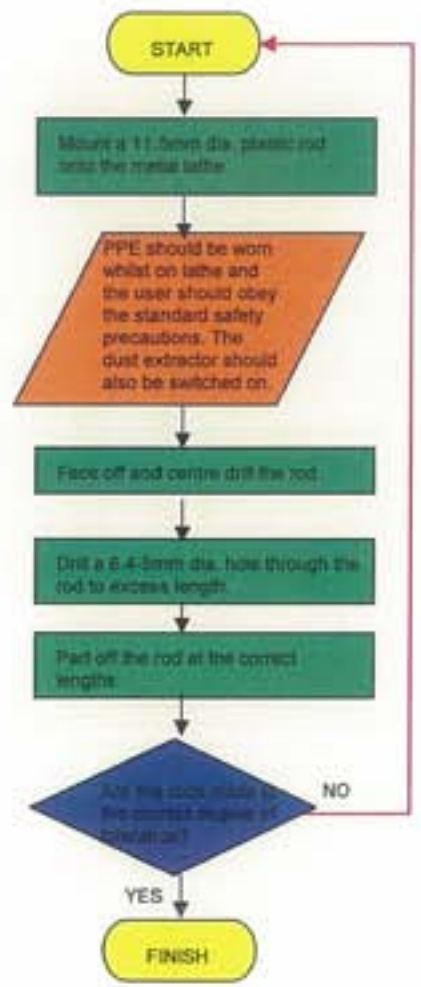


Shade Manufacture

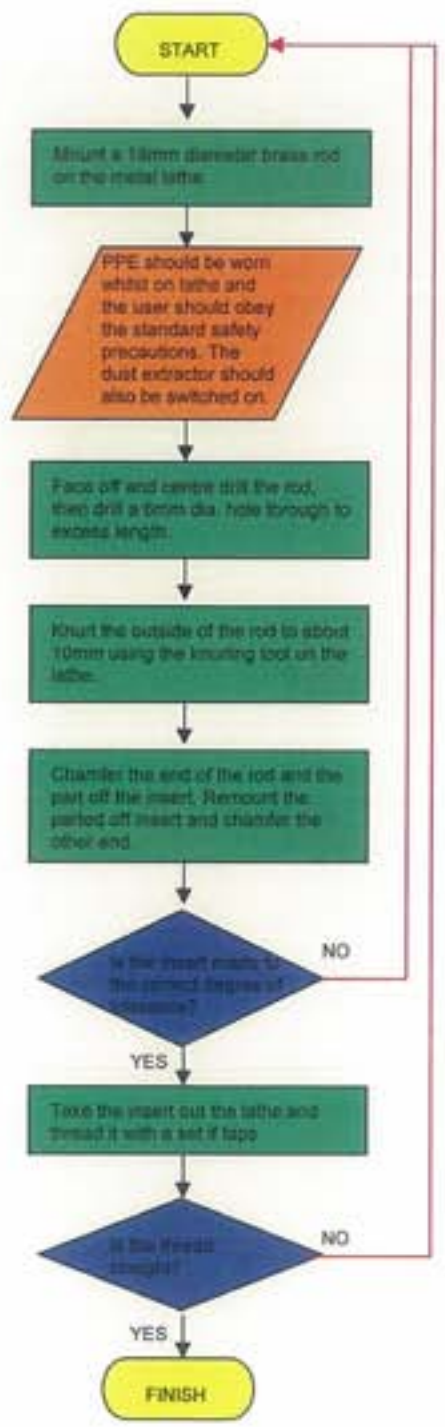


Light Unit Manufacture

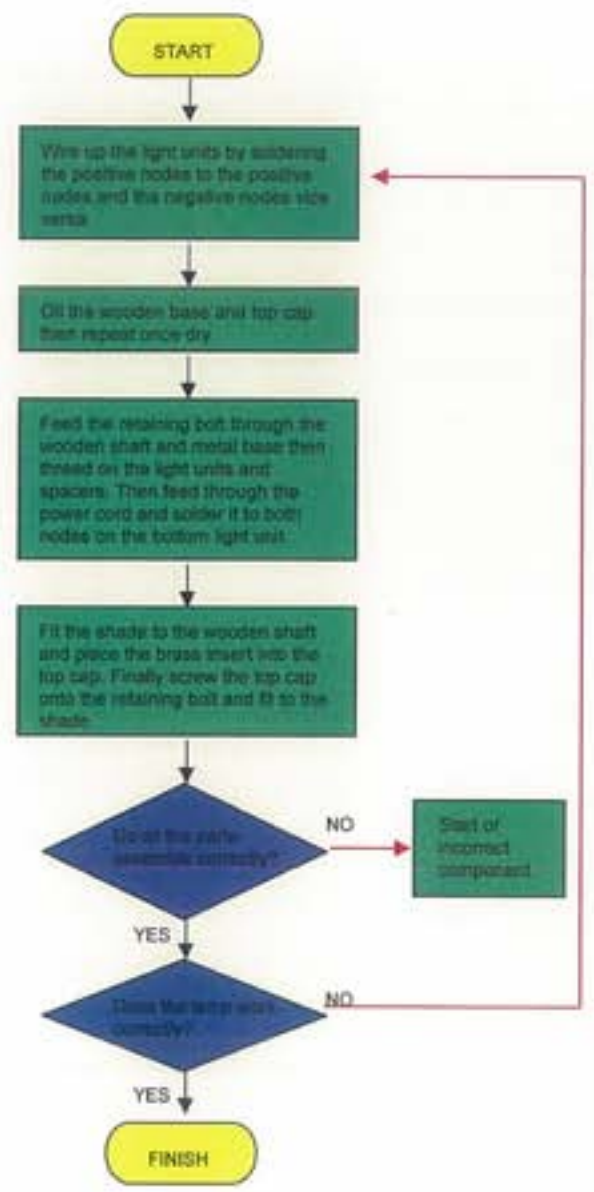
Spacer Production



Brass Insert Production



Assembly



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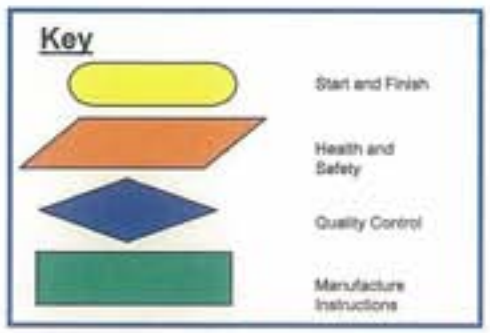


Risk Assessment

Wooden Shaft Turning

Hazard/Harm Potential		Severity X Frequency = Risk
1)	Drilling centres	2 X 1 = 2
2)	Wood thrown off lathe	2 X 2 = 4
3)	Tool catches on work	2 X 1 = 2
4)	Work splintering	2 X 2 = 4
5)	Trapped body part in lathe	3 X 1 = 3
6)	Inhalation of dust	4 X 3 = 12

Risk Potential Score: 15 X 10 = 150

Factors Which Increase Risk

1) Speed of lathe
2) Blunt tools
3) No safety equipment
4) Improper instruction
5) Inadequate supervision

Controls Needed to Reduce Potential Risk

1) Wear safety equipment during use
2) Be properly instructed on operating procedures
3) Be well supervised
4) Tools well serviced
5) Speed of lathe properly set
6) Dust extractor turned on during use
7) Immediate area clear of obstruction

Revised Potential Risk: The risk of this process is significantly lowered if the user counters the dust inhalation with an extractor and a facemask. With this risk reduced the overall potential score is lowered significantly.

General Comments

The wood lathe is a relatively safe machine to work on, with most of the potential risks arising from improper instruction. If the user is walked through the operation procedure then risks like having the tool catch on the lathe (which is mainly due to bad technique) is greatly reduced. So the emphasis for health and safety on the wood lathe is to have a proper introduction to the machine and to be supervised during use.

KEY (Risks)

1 = Minor cuts/bruises/burns
2 = Major cuts/bruises/burns
3 = Loss or breaking of limb/s
4 = Singular death
5 = Multiple death

KEY (Frequency)

1 = Virtually Never
2 = Rare
3 = Occasionally
4 = Likely
5 = Certain

Open Sand Casting

Hazard/Harm Potential		Severity X Frequency = Risk
1)	Burns from furnace	2 X 1 = 2
2)	Burns from spillages of molten metal	2 X 1 = 2
3)	Scalding from vaporised water from spillage	2 X 2 = 4
4)	Burns from hot mould	2 X 1 = 2
5)	Inhalation of toxic fumes from furnace or mould	4 X 1 = 4

Risk Potential Score: 12 X 6 = 60

Factors Which Increase Risk

1) No safety equipment
2) Failure to pre-heat ladle
3) Moisture on floor/ mould
4) Crowed area/ obstructions

Controls Needed to Reduce Potential Risk

1) Wear safety equipment during use
2) Be properly instructed on procedure
3) Be well supervised
4) Pre-heat ladle
5) Carry out procedure on sand to minimise moisture
6) Wait until mould is fully cooled before opening
7) Have a gas extractor on during the process

Revised Potential Risk: If the process is carried out over a sand pit and there is a gas extractor on then the two major risks are reduced and the overall risk potential drops.

General Comments

The main danger with casting are burns. Most of these risks to the user can be effectively countered by wearing safety equipment and being properly instructed on the procedure. However there are also significant risks to others in the immediate area due to the heat of the materials in use. Surface moisture, like that on any normal floor, will vaporise instantly should it come into contact with the molten metal. This poses a safety threat and to avoid this the process should be carried out over a sand bed. Also the user should be very careful to avoid spillages.

Aluminum Base Turning

Hazard/Harm Potential		Severity X Frequency = Risk
1)	Drilling centres	2 X 1 = 2
2)	Work thrown out of lathe	2 X 1 = 2
3)	Trapped body part in lathe	3 X 1 = 3
4)	Tool / Bit breaks and is thrown off lathe	2 X 1 = 2

Risk Potential Score: 9 X 4 = 36

Factors Which Increase Risk

1) No safety equipment
2) Lathe speed set too high
3) Tool incorrectly positioned or damaged
4) Improper Instruction
5) Work not securely fastened in Lathe
6) Inadequate supervision

Controls Needed to Reduce Potential Risk

1) Wear safety equipment
2) Lathe speed set at correct speed
3) Be well supervised
4) Tools well maintained and set at correct orientation
5) Be properly instructed on the lathe operation
6) Check work is secured tightly in the chuck jaws

Revised Potential Risk: Aluminium base is a relatively safe process as long as the operator knows thoroughly how to safely work the lathe. If they are well instructed then risks like having the speed set too high and not having the work securely fastened are negated.

General Comments

The lathe is quite a complicated machine and the main risks in this process arise from improper operation. If the user is properly walked through the lathe operation then the risk is fairly minimal. Also as long as safety equipment is worn then the risks of injury from objects flying off the Lathe are also greatly reduced.

MIG welding (Retaining Bolt)

Hazard/Harm Potential		Severity X Frequency = Risk
1)	Burns from blowtorch	2 X 1 = 2
2)	Burns from hot work	2 X 2 = 4
3)	Burns from sparks	1 X 1 = 1
4)	Damage to eyes from torch light	3 X 5 = 15
5)	Electrocution from torch end	2 X 1 = 2
6)	Electrocution from the machine	4 X 1 = 1
7)	Compressed gas exploding	5 X 1 = 1

Risk Potential Score: 19 X 12 = 228

Factors Which Increase Risk

1) No safety equipment (especially welding mask and gloves)
2) Improper instruction
3) Inadequate supervision
4) Gas cylinder badly maintained / not frequently checked

Controls Needed to Reduce Potential Risk

1) Wear safety equipment (especially welding mask and goggles)
2) Have a proper introduction to the tool
3) Be well supervised
4) Carry out regular quality/ safety checks on the compressed gas cylinder
5) Curtain pulled across to block light from welding area

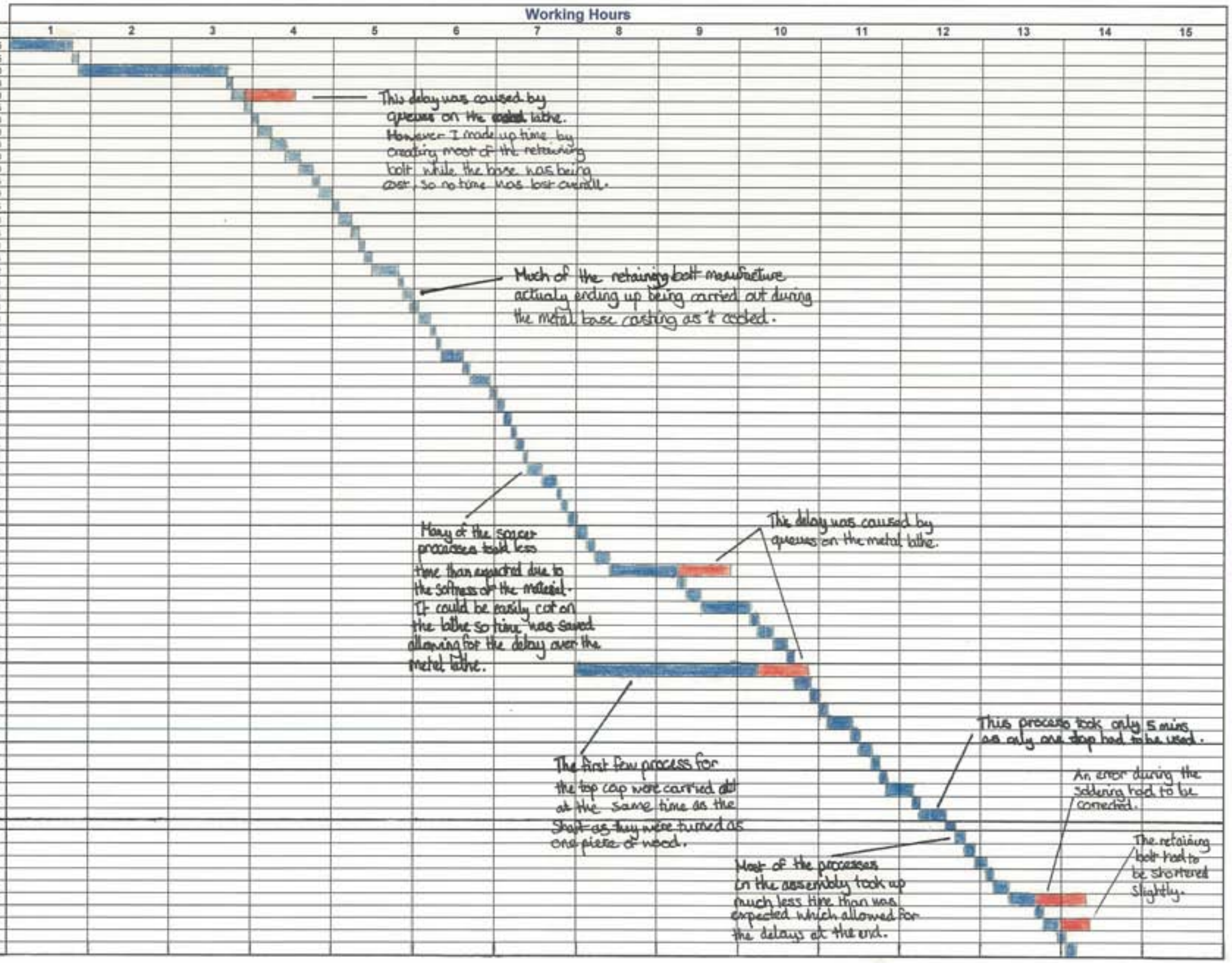
Revised Potential Risk: The MIG welding tool is probably the most dangerous tool in the work shop, especially the compressed gas cylinder. However if the proper safety precautions are taken to maintain the tool and also during use, then it is much safer. The light from the torch in use can cause considerable damage to eyes, but this can be completely countered by wearing the welding mask and pulling the curtain across. The gas cylinder also can be made safe as long as regular checks are made for faults or damage. With this we can guarantee that the cylinder will be much less of a threat.

General Comments

The MIG welding tool can be extremely dangerous if the proper safety precautions are not taken. The compressed gas cylinder especially is very dangerous and could cause multiple deaths if it should malfunction. The light from the torch is also very damaging to human eyes especially if directly looked at. However both of these risks can be negated effectively by following the correct safety precautions.

Gantt Chart

Part	Process	Time(Mins)
Base	Produce Pattern.	45
	Q.C Are measurements within tolerances?	5
	Cast In Aluminium.	40(1hr)10
	Q.C Check casting for defects.	3
	Machine the base.	10
	Machine the outside profile.	5
	Q.C Check against tolerances.	3
	Machine bolt recesses.	10
	Drill hole for bolt.	10
	Drill wire feed hole.	10
	Drill horizontal wire feed hole.	10
	Q.C Dimensional tolerances.	5
	Polish to a suitable finish.	10
	Q.C Visual quality check.	5
Retaining Bolt	Cut bolt from Mild Steel rod.	10
	Face off the rod.	5
	Q.C Are measurements within tolerances?	3
	Chamfer the edges.	5
	Create thread on one end of the bolt.	20
	Q.C Is the thread straight?	3
	Face off the rod.	5
	Centre drill a separate thicker Mild Steel rod.	3
	Drill through the Mild Steel rod to suitable depth.	10
	Pat off top bracket from rod.	5
	Q.C Are measurements within tolerances?	3
	Weld top bracket to the unthreaded end of bolt.	15
	Q.C Is the top bracket welded securely and flat?	5
	Angle grind the top bracket to a flat finish.	15
	Cut screwdriver recess on top bracket.	5
	Q.C Visual quality check.	5
Spacers	Cut plastic rod to length.	5
	Q.C Is there enough material for spacers?	3
	Face off the rod.	5
	Centre drill the rod.	3
	Drill through the rod.	10
	Cut rod at appropriate lengths.	10
	Q.C Are measurements within tolerances?	3
	Face off the various spacers.	5
	Q.C Visual quality check.	5
Shaft	Cut billet to octagonal shape.	10
	Mark up ends.	5
	Drill and cut centres.	10
	Turn billet on lathe.	45
	Q.C Are measurements within tolerances?	5
	Mark up recesses on turned shaft.	10
	Turn recesses on shaft.	30
	Q.C Are measurements within tolerances?	5
	Sand the shaft.	10
	Part off Top Cap.	10
	Q.C Visual quality check.	5
Top Cap	First 9 processes of Shaft (At same time)	2hr 10
	Part off Top Cap.	10
	Drill recess in Top Cap.	5
Light Unit	Laser cut MDF bases.	3
	Set lights into bases.	15
	Q.C Wire up lights and check they work.	5
Shade	Cut plastic tubing to length.	10
	Q.C Are measurements within tolerances?	5
Brass Insert	Face off brass rod.	5 40
	Centre drill and drill through brass rod.	10(10)
	Knurl and part off rod.	5
	Create a thread through the insert.	15
	Q.C Is insert made to correct degree of tolerance?	5
Assembly	Fit Wire protector to wires.	5
	Feed wires + protector through base.	5
	Feed wires + protector through shaft.	5
	Feed retaining bolt through base and shaft.	3
	Fit light units to retaining bolt.	10
	Connect wires to light unit.	15
	Fit shade to shaft.	3
	Fit top cap to shade and screw onto retaining bolt.	10
	Tighten retaining bolt under base.	5
	Q.C Visual Quality Check.	5



Key

- Estimated time for process
- Delay

Manufacturing Diary

23rd September

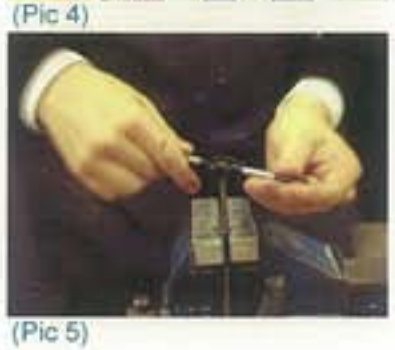
- Took rectangular billet and cut down to rough dimensions of 205x100x104mm.
- Marked up billet ends using compass to a rough circle. (Pic 1)
- Roughly cut billet corners to a few mm from the edge of the marked circle to make turning easier. (Pics 2,3)
- Cut mild steel rod to length of 287mm and 6mm diameter.
- Filed rod end to a slight chamfer and turned the screw thread at one end with a 6mm split die. (Pics 4,5,6)


(Pic 1)


(Pic 2)


(Pic 3)


(Pic 4)


(Pic 5)


(Pic 6)

24rd September

- Took 15mm diameter mild steel rod and mounted on lathe. Then faced off, centre drilled and bored a 6.4mm diameter hole to a suitable depth for the retaining bolt. (Pics 7,8,9)


(Pic 7)


(Pic 8)


(Pic 9)

24th September (Cont.)

- Gave end of retaining bolt a slight chamfer and then parted off the bo at 5mm. (Pics 10,11)


(Pic 10)

29th September

- Took retaining bolt and welded onto the bare end of the mild steel rod using an oxy-acetylene torch. (Pics 12,13,14)
- Used an angle grinder to flatten the top surface of the retaining bolt once the weld was cooled. (Pics 15,16)
- Made a slight cut for locating a screw driver with a hacksaw once the retaining bolt was flattened.


(Pic 11)


(Pic 12)


(Pic 13)


(Pic 14)


(Pic 15)


(Pic 16)

03rd October

- Started construction of aluminum base mould using turned wooden billet. Took green sand and filtered it through sieve to make it fine. (Pic 17)
- Placed two wooden billets into open ended wooden box. (Pic 18)


(Pic 17)

04th October

- Packed sand into box using hands and wooden hammer to compress the sand around the billets. (Pics 19,20)
- Once compact the box was turned over and screws were put into billets to allow them to be removed. Also made a small channel to allow the molten metal to be poured in. (Pic 21)
- Heated aluminum rods in the furnace until molten and poured the metal into the mould. Then left to cool and set. (Pics 22,23)

06th October

- Removed the cooled aluminum base from the mould. (Pics 24,25)
- Began to turn aluminum base by facing off and roughly turning the edges along a parallel axis. (Pics 26,27,28,29)
- The turning on the lathe was automated which meant that the base had a smoother finish.


(Pic 18)


(Pic 19)


(Pic 20)


(Pic 21)


(Pic 22)


(Pic 23)


(Pic 24)


(Pic 25)


(Pic 26)


(Pic 27)


(Pic 28)


(Pic 29)

anufacturing Diary

07th October

• Mounted wooden billet on wood lathe to turn down to cylinder.

• Turned the wood down to the correct diameter with a scraper and measured the width using a set of external callipers. (Pics 30,31)

• Once the wood was the correct diameter it was removed from the lathe and the divisions were marked up.

09th October

• Re-mounted the wood onto the lathe and used a cutting tool to remove material at the marked points down to the correct diameter.

• Various degrees of sand paper were then used to create a smooth finish on the wood. (Pics 32,33)

• The Top Cap was parted off from the body using a band saw.

• The ends of the body and top cap were sanded down on a belt sander to a smooth finish.

10th October

• Cut plastic rod to slightly over length for spacers using a hack saw. (Pic 34)

• Mounted plastic on metal lathe, then faced off and centre drilled the rod. (Pic 35)

• Bored a 6.5mm hole through the rod. (Pic 36)

•Parted off the rod at the correct length for the spacers.


(Pic 30)


(Pic 31)


(Pic 32)


(Pic 33)


(Pic 34)


(Pic 35)


(Pic 36)

11th October

• Used a CAD system to design the two light units and then assigned a laser cutter to cut the shapes from acrylic. (Pics 37,38)

• Removed the shapes from the laser cutter and separated them from the remaining acrylic.

20th October

• Continued aluminum base production. (Pic 39)

• Mounted on lathe and turned the circumference of the various levels to provide a zero. (Pic 40)

• Turned the edge down to a slight angle.

21st October

• Bored into the metal base to make the indent on the lathe. (Pic 41, 42, 43, 44)

• Bored hole through the centre of the base on pillar drill. (Pic 45, 46, 47)

• Bored the off centre hole for wires on pillar drill.

• Bored the side hole for wires on pillar drill. (Pic 47)


(Pic 37)


(Pic 38)


(Pic 39)


(Pic 40)


(Pic 42)


(Pic 41)


(Pic 42)


(Pic 43)


(Pic 45)


(Pic 46)


(Pic 47)

24th October

• Bored out the wooden base on lathe and drilled through the base on a pillar drill for the wires and retaining bolt. (Pic 49, 50)

26th October

• Stuck LED's to light units and cut shade from clear plastic cylinder. (Pic 51, 52)

• Sanded shade down using wet and dry paper with water. (Pic 53)


(Pic 48)


(Pic 49)


(Pic 50)


(Pic 52)


(Pic 51)


(Pic 53)

anufacturing Diary

30th October

- Put a layer of Danish oil on the top cap and shaft. (Pic 54, 55)
- Started wiring by soldering the wires between the two light units. (Pic 56)

02nd November

- Finished wiring by feeding the power chord through the shaft and soldering it to the corresponding nodes on the light units.
- Shortened the retaining bolt slightly to provide a better fit between the top cap and the shade.

03rd November

- Finished assembly and fixed top cap into position.

PROJECT COMPLETION

(Pic 54)


(Pic 55)


(Pic 56)

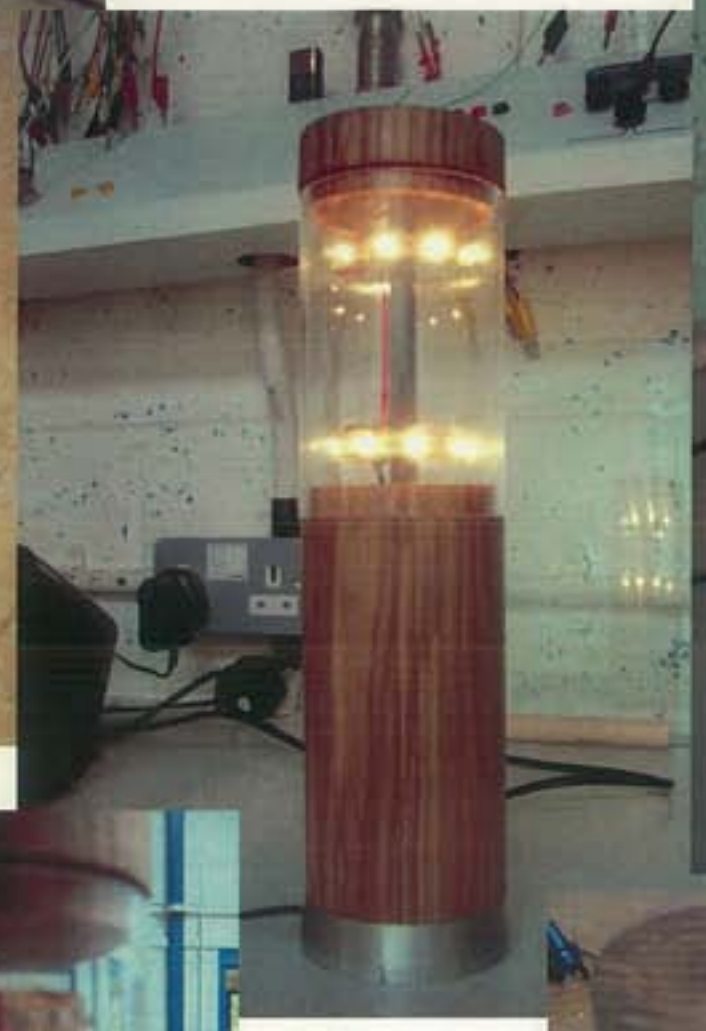
Industrial Points (Alternative Methods)

In this project there are several methods of manufacture that we've used that would likely be carried out differently in industry. Its likely that the welding would be carried out by specially engineered machines. This obviously is not a viable option in the work shop. The turning of the wooden shaft and metal base would also likely be carried out by automated machines which could provide accurate components in large quantities. Again this is not possible in the work shop however turning the components on a lathe is accurate enough for the project. The manufacture of the unturned metal base in industry would probably be die cast. This would be to lower costs by reusing the same mould. This is not a viable in the work shop as this is simply a one off product and so having a specific mould would be not be cost effective. So open sand casting was chosen for this process.

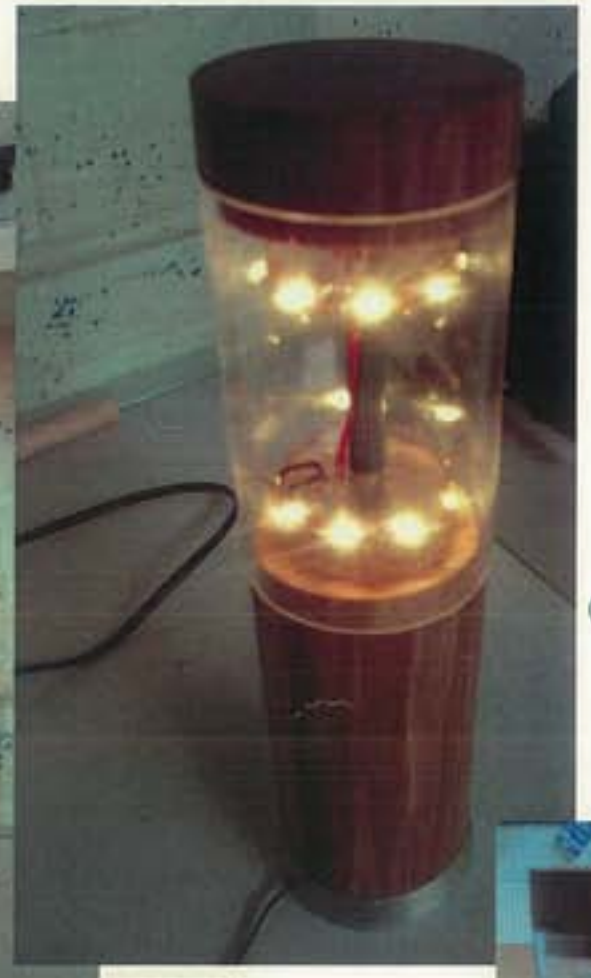
Notes On Health and Safety

Throughout this project there are several procedures that are potentially quite dangerous. The four major ones of which are covered in the Risk Assessment section. However the other minor processes like soldering the wires to the light units and creating the brass insert on the metal lathe contain potential risks within them. To minimise these risks it was essential to make sure that safety equipment was worn at all times in the workshop and that with each machine or tool we used, we were briefed on the safety points and its correct operation. Also it was necessary that we had adequate supervision when in the workshop to avoid any hazards. With these precautions and walkthroughs on the operation of machines it greatly reduced the risks posed by the smaller less obvious processes.


(Pic 57)


(Pic 58)


(Pic 59)

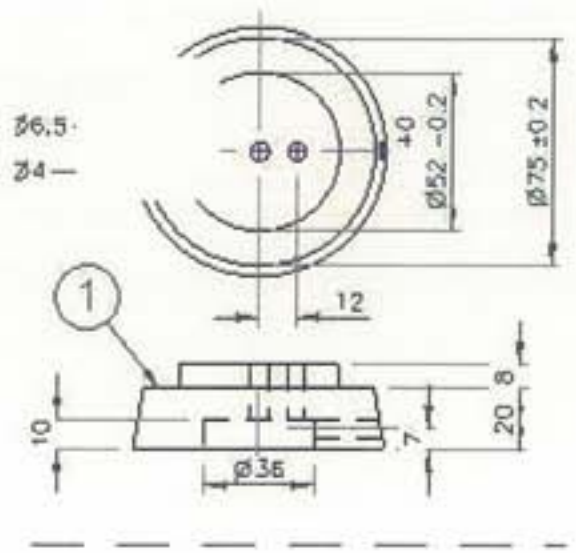

The Completed Lamp Project – Shown on and off. (Pics 57, 58, 59, 60, 61, 62)

(Pic 61)


(Pic 60)

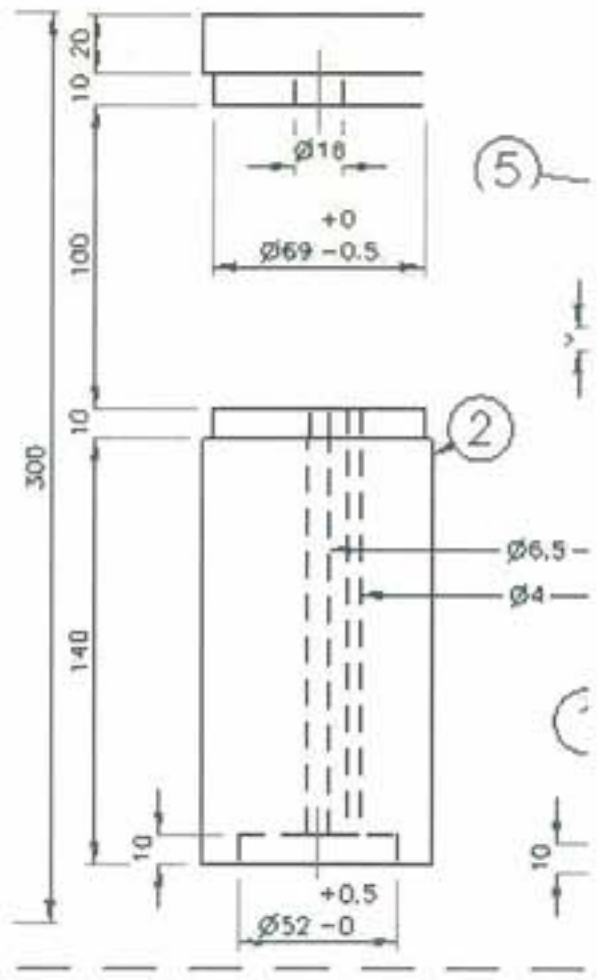

(Pic 62)

Quality Control Checks



Stage	Quality Control Checks	Outcome
Sand-Casting: Mould	Conduct visual checks: Check mould is smooth and no sand has fallen out of place as this will cause defects in the casting.	All sand is pushed into the mould and compacted down before being smoothed over. Check there are no rough edges.
Sand casting: Base	Check that the casting is properly formed and there are no defects. Check for burs or flash.	Remove any burs or flash with a file and prepare base for turning.
Turning Base on Lathe	Check base has the correct dimensions and that it is turned to a smooth finish with no defects.	The base has an aesthetically appealing, smooth finish and it is the correct size to fit into the wooden bottom.
Drilling	Check the right sized drill bit is being used and that the hole is vertical and in the correct position on the base.	The holes are the correct size and are located in the right place for the product to be assembled quickly and easily.

Final Outcome	Measurements	+ or -
Internal Dia. 52.00mm	52.0	0.2
External Dia. 75.00mm	75.1	0.2
Total height of Base	28.0	0.0
Height of step	20.0	0.0
Height of instep in base	8.0	0.0

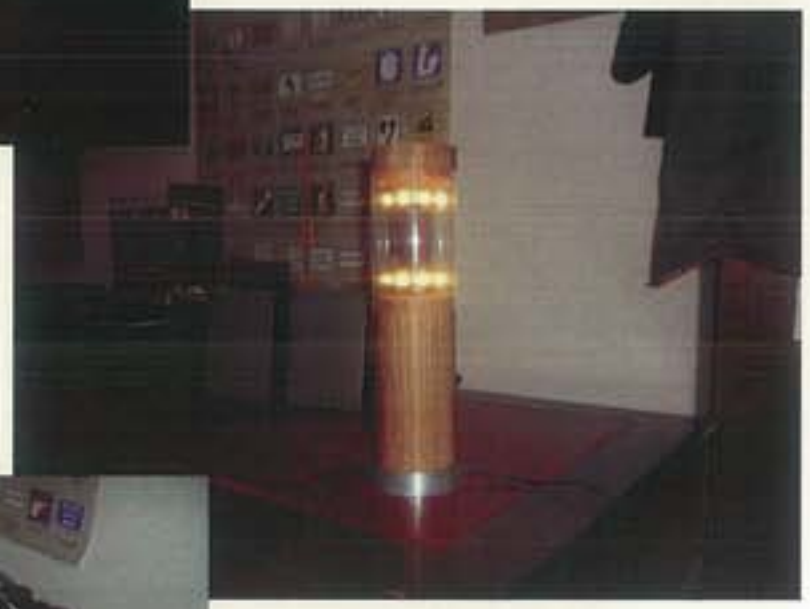


Stage	Quality Control Checks	Outcome
Selection and preparation of Blank	Check blank is the right size and that there are no major faults in the structure. E.g. cracks or warping.	The blank will be the right size and the wood will be of good quality with no major faults.
Turning Top and Bottom on Lathe	Check that it is turned to the correct diameter with a smooth finish and that there are no defects. Also check that the body has been parted off smoothly in the correct place.	The body will have a smooth finish and will be the correct size and shape and there will be no defects.
Finishing	Check that the body is sanded to a smooth finish and that the varnish is applied evenly all over the product.	The body will have a smooth well varnished finish.
Drilling	Check that the holes are of the right diameter and that they are in the correct position on the lamp and that they are vertical.	The holes will be the correct size and will be in the correct position to allow the lamp to be assembled quickly and easily.

Final Outcome	Measurements	+ or -
Height of top	30.0	0.0
Diameter of top	75.1	0.5
Height of base	150.0	0.0
Diameter of base	75.0	0.5
Drilling	6.5/4.0	0.0

Product In Use

The lamp is shown here in a bedroom environment. It is easy to see how it could be used as a night or reading light on a bedside table. It could also be used to light a desk or work environment.



In the two pictures above the lamp is shown as a centrepiece on a dining room table. The lamps design and ability to illuminate the immediate area mean it is a aesthetically pleasing centrepiece that would go well on most dining room tables.

This final pair of pictures shows how the lamp could simply pose as an ornamental piece on a dresser or sideboard of any kind. The varnished wood design enables it to fit in well with any other antiques pieces.

Testing Against Specifications

Specification Point	Test/s	Outcome
• Purpose - **• Function** 1) It must provide adequate light to be able to move safely about the room with a single light unit in use. 2) It should provide sufficient luminosity to be able to read while in bed. 3) In should be easy to turn off and on. In line with the low power ethos of the hotel it should have a low power rating. Maintenance should be kept to a minimum. 4) It must be stable to avoid toppling if knocked accidentally. **•Form** - **•Safety** - **•Cost** - **•Manufacture** - **•Market** The client is a hotel chain opening a modern hotel. 1) The lamp unit must be easy to operate 2) It should provide enough light to read a book while lazing in bed. 3) It should have a small footprint and allow other items to be placed on the bedside area.	**• Purpose** - **• Function** 1) The unit was placed in a bedroom and switched on and all other light sources were turned off or obscured. Random objects were placed on the floor to act as obstacles. An individual then entered the room and walked around the room for a minute making sure to visit each corner of the room, avoiding the obstacles by the light of the lamp only. This test measures the lamps ability to successfully light a room on its own with no other external sources of light, to the point where it is safe to walk around the room using only the lamplight. B 2) The unit was placed on a bedside table and switched on while all other light sources were switched off or obscured. An individual then sat in a bed close to the lamp and read two pages of a small print book. This test allows us to measure the lamps ability to provide enough light to read by. 3) The unit was placed on a bedside table and six different individuals were asked to switch the unit on and off. They were then asked to comment on the ease of switching it on and off. This test measures how easy the unit is to operate and allows us to see if there are any design or manufacturing flaws that make it difficult to switch on or off. 4) The lamp was placed on a flat surface and steadied. It was then pushed with gradually increasing force until it toppled. A judgement was then made as to whether this required force could be applied accidentally should someone knock it. This allow us to measure how the steady the lamp was and allowed us to see how great a force was needed to topple it. **• Form** - **• Safety** - **• Cost** - **• Manufacture** - **• Market** 1) See **Function** test no# 3. 2) See **Function** test no# 2. 3) The lamp was placed on an average sized bedside table in the middle. Various other relevant objects (a book, a pair of glasses, an alarm clock, a wallet, a set of keys, cough sweets and a pack of tissues) were placed on the table one at a time. It was then seen whether the lamp took up too much space for these other objects to sit easily on the table. This test allows us to see if the lamp has a small enough footprint to allow other common bedside objects to be easily placed on an average sized bedside table with it.	**• Purpose** - **• Function** 1)  The individual walked around the room safely for a minute ,without tripping over or breaking any of the obstacles on the floor, with only the lamp lighting the room. 2)  The individual read two pages of a small print book from the light of the lamp, easily without having to strain, from the bed with the lamp on a bedside table approximately half a metre away. 3)  The six individuals all switched on and off the light without any problems or complaints. 4)  The lamp required only a relatively small force to topple it and so could probably be easily knocked over should someone hit it accidentally. However the lamps materials make it very sturdy and tough so it is unlikely to break unless dropped from a high height. **• Form** - **• Safety** - **• Cost** - **• Manufacture** - **• Market** 3)  The lamp was placed on an average sized bedside table and all the objects were placed on the table with it. They all easily fitted and none fell off the table.

Qualative Feedback

Opinions

• Generally people seemed to think that the lamp was a good success and that it achieved most of its specification points. They felt that it was an all round pleasing product that had no major faults and they would be willing to pay the set price to have one in their home. To test what people though of the product I asked twenty different people what they though of the product overall and if there were any specific points they would like to highlight. Below are some of the good and bad opinion points that arose during the questions about the product.

Positive Points	Negative Points
• People seemed to think he Product is very aesthetically pleasing and that it can fit in well in many different home environments.	• Some people found that while the lamp was easy to operate, it could have benefited from an on or off switch on the actual unit or on the cable, so they didn't have to go to the plug every time they wished to switch the unit on or off.
• People were pleased with how bright the lamp was and its ability to illuminate the a room.	• Some people though that the lamp while being perfectly steady on its own was fairly easy to knock over and so could get accidentally broken as a result.
• People liked the way it took up less space than a traditional bedside lamp and seemed to think it would be helpful to have extra space on a bedside table to place other objects.	• One person remarked that while the lamp illuminated the room well, the fact that it had no shade and the LED lights were very bright meant that looking directly at the lamp or near it hurt your eyes. This may apply especially to older users.
• People found that operating the lamp was very easy and quick.	

Overall Conclusion/ Evaluation

Overall Opinions

• Overall people thought that the lamp was a very good design and had the potential to be a successful product but for a few minor flaws. They felt the lamp succeeded in achieving most of the goals set out for its manufacture in the specifications. They also felt that it managed to present a style that could be used in many different environments. So after questioning the main points to consider where:

- **Stability**: The lamps small base made it easy to accidentally knock over.
- **Operation**: People felt that the lack of an on/ off switch on the actual product made it awkward to have to go to the plug every time to operate it.
- **Eyes**: One unexpected point was that the lamp could hurt your eyes as there was no shade an it was very bright.

• To address these issues the following design changes have been suggested:

- A slight increase in the width of the base to make it more sturdy.

OR - A slight decrease in the height of the unit to make it more sturdy.

- The inclusion of an on/off switch on the side of the product.
- The clear plastic shade surrounding the LED's could be darkened slightly to reduce the glare of the lights. This would only detract slightly from the products ability to illuminate a room but would eliminate the problem of the lamp hurting peoples eyes.

• These suggested changes could easily be implemented into the manufacturing processes of the lamp without any major changes. The metal base could be turned the same way with slightly wider dimensions and the power cord could still be a bought in component but it could be one with a switch. Finally for the shade a slightly darker or more opaque plastic could be used to reduce the glare. Alternatively some sort of semi- transparent spray or paint could be applied to the clear shade already used during the products assembly to solve the same problem.

Overall Conclusion

• I think overall this product is a very effective and aesthetically pleasing product. The testing showed that there were no major issues with the design and only minor changes would have to be made to the manufacturing processes to solve theses problems. Also disregarding the minor issues raised in the questioning the product actually is a very successful one meeting nearly all the specification points and I think that it has great potential to be a successful product should it go into production.