EDEXCEL

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

EXEMPLAR MATERIAL 3

Title: Garden Lounger

UNIT: 6RM04

edexcel
advancing learning, changing lives

A2 Product Design

A Garden Chair

edexcel
advancing learning, changing lives

Criterion A

Research and Analysis

Design Brief

The client:
My chosen client is going to be my neighbour as she is easy to communicate with and is very good at giving me advice and constructive criticism therefore the design I make will be desirable for her. She has been wanting a new garden lounger for a while because some of hers are old and starting to rot therefore are not very smart or aesthetic which she does not like. She has asked me to design and make her a new but different styled lounger. There are a couple of spaces in her garden where she would like this to go therefore my design needs to suit the garden as a whole to allow her the freedom of moving it around if she wants to. Because our neighbour is also a good friend I will be able to talk to her a lot about the design and get a lot of feedback from her which will be helpful to me.

The Brief:
My client has asked for an innovative garden lounger that will be both aesthetically pleasing and suit the area in which it will go. I aim to design and make a lounger that will fit her garden and suit her needs for a comfortable chair that will be able to be moved. I still need to clarify with my client whether she wants it to be a one off design or one that can be batch produced as this will affect the design.

This image above shows the seating that she would like to be able to replace with something more inviting and sculptural. The other images show the garden as a whole so I can show the style of her garden. As you can see from the photos it is a lawn garden with no patio or hard standing so I need to keep this in mind when thinking about the feet or base of the chair.

The area:
There are a couple of areas in the garden where the lounger could be moved to therefore it needs to be in keeping with the whole garden. There are a lot of mature shrubs and trees of different colours and different seasons. Because of this I have to think of designs that will not gather leaves or other things dropped from trees as this will inevitably make the lounger look old and uninviting so I need to find a way to keep the seating area clean. It also needs to fit in with the aesthetics of a tree using natural lines and shapes and I must keep in mind the changing seasons as the garden looks very different in the winter compared with how it looks in the spring due to the blossom and flowers of the different plants.

What I need to research:

Anthropometrics
I need to look at the dimensions of the human and the positions of sitting.

Materials
I need to find appropriate materials that will be strong. Find ways I can either make materials waterproof or use waterproof materials.

Aesthetic specifications from the client
What she likes and dislikes

Performance specifications from the client
Does she want any added accessories e.g.. Drinks holder.

Existing solutions:

Why is it relevant ?

Anthropometrics are relevant to my design as I need know the human dimensions in order to get the right shapes and sizes. I need to know the average dimensions of limbs and shapes of sitting positions in order to design a comfortable and suitable lounger.

Materials need to be investigated to find ones that combine strength with workability and aesthetic quality. This is relevant as I need to ensure I am using the most efficient and appropriate materials possible.

Aesthetic Specifications from the client are key to my designing as I need to make sure what I am going to make will be something she will want in her garden

Performance specifications are also important as I need to know if she would like the lounger to be able to recline or incorporate a drinks holder etc

Existing solutions will feed into my designs as it will help me to see what people like and dislike and what aspects are best received.

How will I retrieve the information:

Anthropometrics
I can find out a lot from books or the internet on this topic and also special sheets that allow you to compare the differences between male and female dimensions which will be very useful to me as the lounger will be used by all members of the family however I will design something aimed at the adult market so only adult dimensions will be relevant. I also need to look at dimensions of existing products.

Materials
Again research carried out using books and websites looking into expense, properties and ease of use of different materials will aid my designing.

Aesthetic specifications and performance specifications
These will both be found out during various interviews or discussions with the client in the form of questionnaires where I will ask her about specific details.

Existing solutions
These can be found on the market or at home or at other friends houses for example and I will be able to find out what are the best things about the product and what are the worst if any which will feed into my design.

Questionnaire

Part of my research will be carried out in the form of a questionnaire or an interview with my client. This will include many questions about aesthetics, performance and the aim of the design. One of the main things I need to find out is whether she will want to have the option of making more of the product to create a collection or whether she wants it to be a one off statement design as this will have a huge effect on the type of design. I have put together a questionnaire below.

Materials:

For the frame of the seating unit, if it is made of wood, what colour or type of wood would you prefer?
A: I would prefer something along the lines of teak as this weathers nicely. Obviously cost and availability is a consideration so if there is a suitable alternative I would be willing to consider it. The important point is that I am wanting the shape to be organic and blend in with its surroundings.
If I have to make it out of metal for structural reasons then what finished effect would you like the metal to have or would you like it coloured?
A:I would like the metal to look rustic so a distressed look would be preferable. I do not want a shiny finish.
Would you like any use of different materials for detail or for contrast?
A: I would like the stand to be made of a different material to the seat.

Aesthetics, shape and design:

Do you like the idea of a more round shaped seat or wide seat that enables you to sit in different positions or do you want a lounger that you can only lie straight on?
A:I like the idea of a large bulbous shape so that you can curl up in it.

Do you like upholstered seats?
A: I might like a soft squidgy cushion in the bowl of the seat.

Do you like angular, geometric shapes or natural shapes?
A: Natural shapes.

Do you have a limit for the size of the lounger?
A: No but it must be able to live outside all year.

Do you want to be able to lie down in it or are you happy for it to just be a seating lounger?
A: I would like it to be a seat with more of a round shape instead of a long thin lounger so that one can curl up in it.

Do you like the idea of it being suspended or do you want it to be grounded?
A: I like the idea of it being suspended though a grounded seat would be equally as nice.

Performance:

Do you want the lounger to incorporate a drinks holder or other such accessories which may include an iPod stand?
A: A drinks holder sounds quite fun and an iPod stand might be useful however I don't want these to become obvious features. If they could be integrated into the shape of the seat then I would like that.

Would you like it to be on wheels or are you happy for it to be lifted and moved?
A: I am happy for it to be lifted and moved.

If cushions are used would you like them to be detachable?
A: Yes, essential.

How many people would you like it to seat?
A: One but it must be roomy and comfortable.

Having given the questionnaire to my client I am able to evaluate her answers and use them to help write the specification for my product.

Anthropometrics

For the research into anthropometrics I looked into the angles used on the chaise longue by le Corbusier. This is because he created a very comfortable position that fits anybody and I wanted to replicate this in my design if my design requires it.

I did this by attaching wood to the metal of the chair in order to create triangles. From this I could measure the lengths of the wood and using algebra I can then work out the angles where the wood meets and that way I can form a picture of the angles involved with making the position of the chair.

Lengths of sides in mm:
A: 885
B: 480
C: 538
D: 410
E: 802
F: 175
G: 102
H: 93

The angles I am interested in are BC, BD and AF. These come to:
BD: 128.4° - 128°
BC: 120.7° - 121°
FA: 127.3° - 127°
I have rounded up the angles so that they are easier to replicate if I was to use them. From this information I can now make the shape of my seat to match that of the chaise longue above therefore making it comfotable for the sitting position.

Other dimensions I may need to take into account in my design:

	Average Male (mm)	Average Female (mm)
Upper leg length (below knee)	574.8	555.2
Upper leg length (above knee)	673	656.4
Lower leg length	552.1	509.7
Shoulder breadth	543.9	514
Hip breadth	443.3	479.6
Sitting height	980	911.8
Elbow span	1018.5	929
Sitting height to shoulder	661.1	622.4

Existing Products

I need to look at existing solutions in order to compare and contrast the way their design has achieved aesthetic simplicity and comfort. I need to find ways in which I can use ideas and maybe improve on some existing products to create a new design.

This product uses smooth, curved lines to create simplicity yet in doing so also looks inviting and relaxing. The large mattress like cushion adds to the comfort of the design. Another point is the colour scheme, the dark brown against the cream/white of the cushion makes the product more modern as do the metal legs. This would fit in quite a smart garden.

The round shape of this encourages people to relax, the cushions also add to the inviting feel.

This garden swing chair has a base of 1.5m in diameter and so is large enough for two people.

This is the chaise longue design by le Corbusier. I looked at this product because it is known to be the most comfortable chair and comfort is a major part of my product. I looked at the way this chair was designed and what factors make it so comfortable for everyone, this included calculating the angles involved.

All these designs help me by telling m what people like, what people want and what is attractive to clients. It also helps me to work out how best to make my seat comfortable and as my client wants it. Having got one of the chair hammocks (above right) at home I know that, although it looks fun and comfortable, it is in fact cramped as once you sit in it, it collapses on you just as a hammock does. This has made me think of making a solid shaped chair similar to the two moon shaped ones on the left. The chaise longue, although incredibly comfortable and cleverly designed, does not offer the freedom that the ones on the left do as it only allows you to sit in one position. This I think is not desirable in my product and so I must take that into account when incorporating the chaise longue's angles into some of my designs.

edexcel
advancing learning, changing lives

Criterion B

Product Specification

Specification

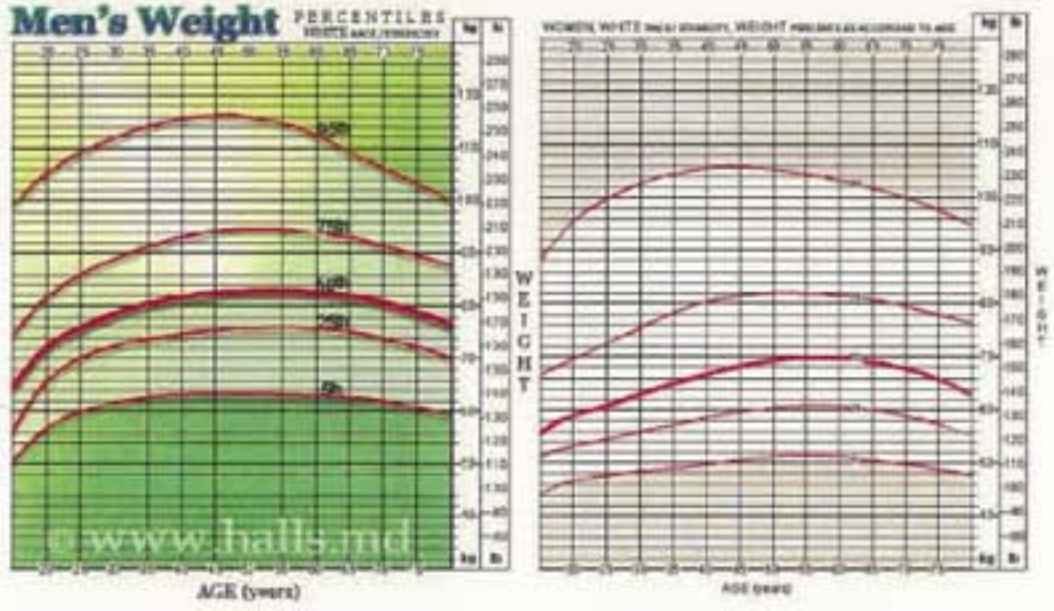
Having conducted my research, from its evidence I can put together specification points that my product has to stick to. The questionnaire I put to my client gave me a lot of good feedback as the questions were relevant and my client gave a good range of detailed answers giving me enough information to work from. Other research such as the calculating of angles in the chaise longue and also looking into existing solutions have helped me to conclude a specification for this product.

Purpose:
To provide a comfortable garden seat that will blend in with the surrounding area and allow the person to relax and admire the garden.

Form:
Designed to blend in with the garden using natural or rustic materials with rough finishes and designed around natural shapes. Seen as a garden sculpture as well as a seating unit.

Function:
To provide a roomy seat for one person to sit, in any position and ideally be able to 'curl' up in.

User Requirements:
Must be "roomy and comfortable", does not need any additional accessories but if it fits with the design then they would add to it.



Safety and Quality:
The maximum weight of a man in the 50th percentile (shown above left) is about 85kg. Therefore, for safety, my seat needs to hold an additional 50% of that weight to allow for the force when a person sits down or if a child jumps into it. This comes to 128kg. In terms of finishing I need to make sure I leave nothing sharp in the seating area so all screws must be flush with the wood etc. in terms of quality the finish must be high so the wood must be waxed or coated so as to prevent weathering of any sort.

Sustainability:
As much as possible, without compromising on strength or aesthetics, woods from sustainable sources should be used. In the manufacture of the product, recyclable materials should be used to lower the amount of waste from manufacturing.

Performance Requirements:
Must be able to hold one person's weight be it a man or a woman. The cushions must be detachable as the seat must be able to live out all year.

Material Requirements:
The materials used need to be strong and durable as they are to be left outside all year. This also means any adhesives used in the assemble must be weather and water proof as well as the woods themselves. Colours must be dark/rustic so no new looking, light coloured wood preferably unless the budget restricts it.

Scale of Production:
It is a one off production because it is designed specifically for a client and is designed to suit their needs.

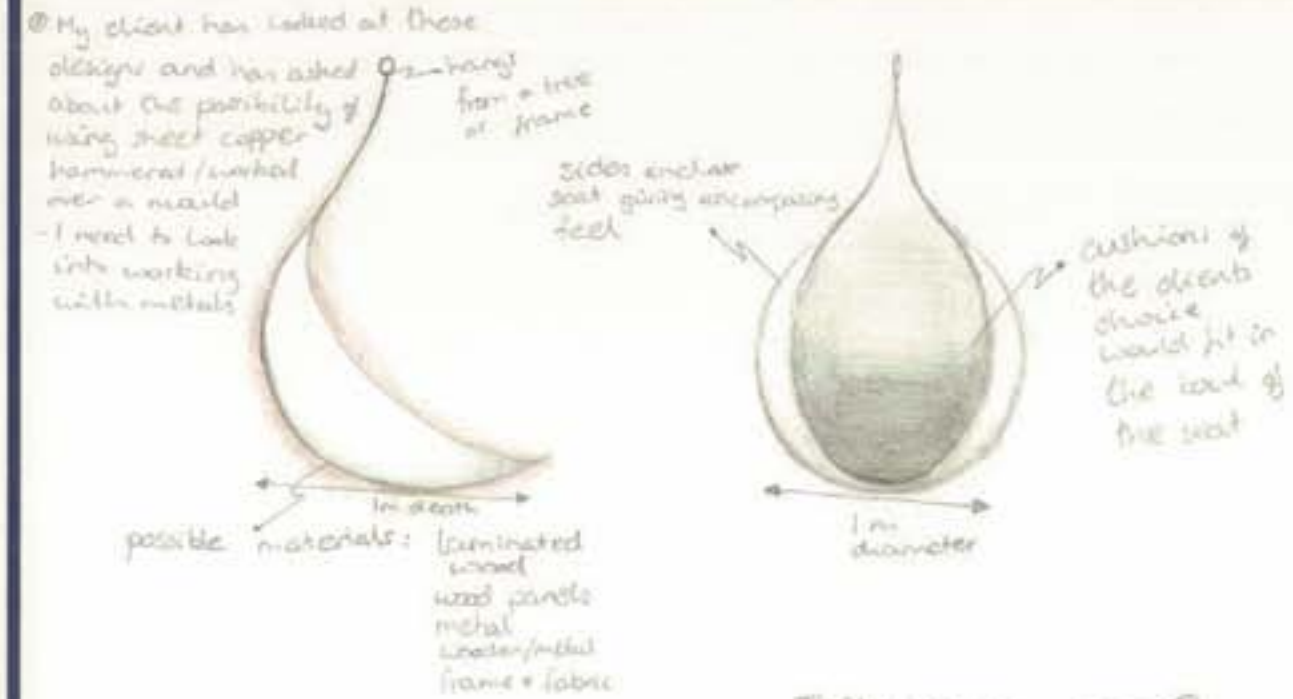
Costs:
I have talked to my client about the budget and we have agreed on a budget of around £250 because the materials for the lamination will be more expensive when bought as a one off than when bought for batch production.

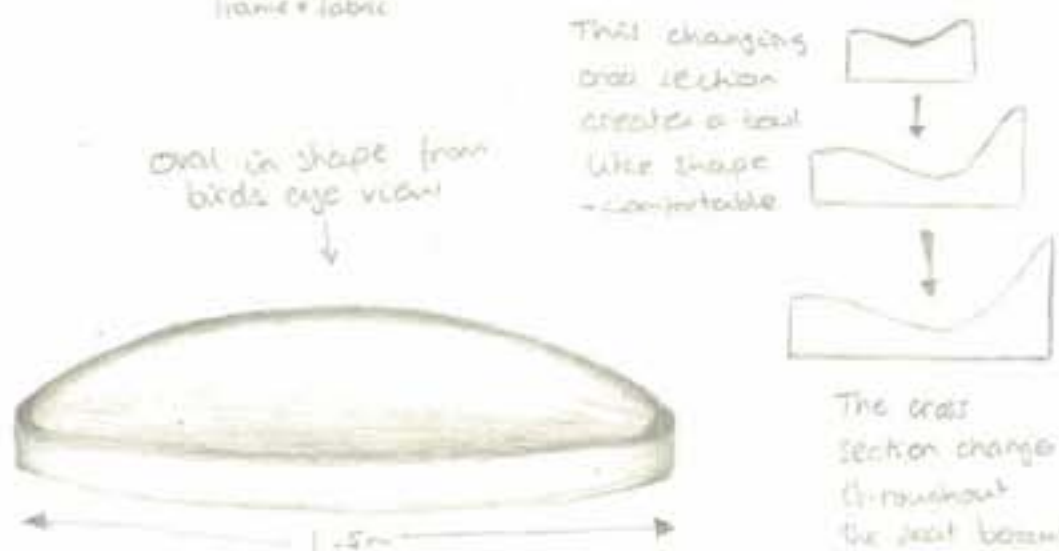
edexcel
advancing learning, changing lives

Criterion C

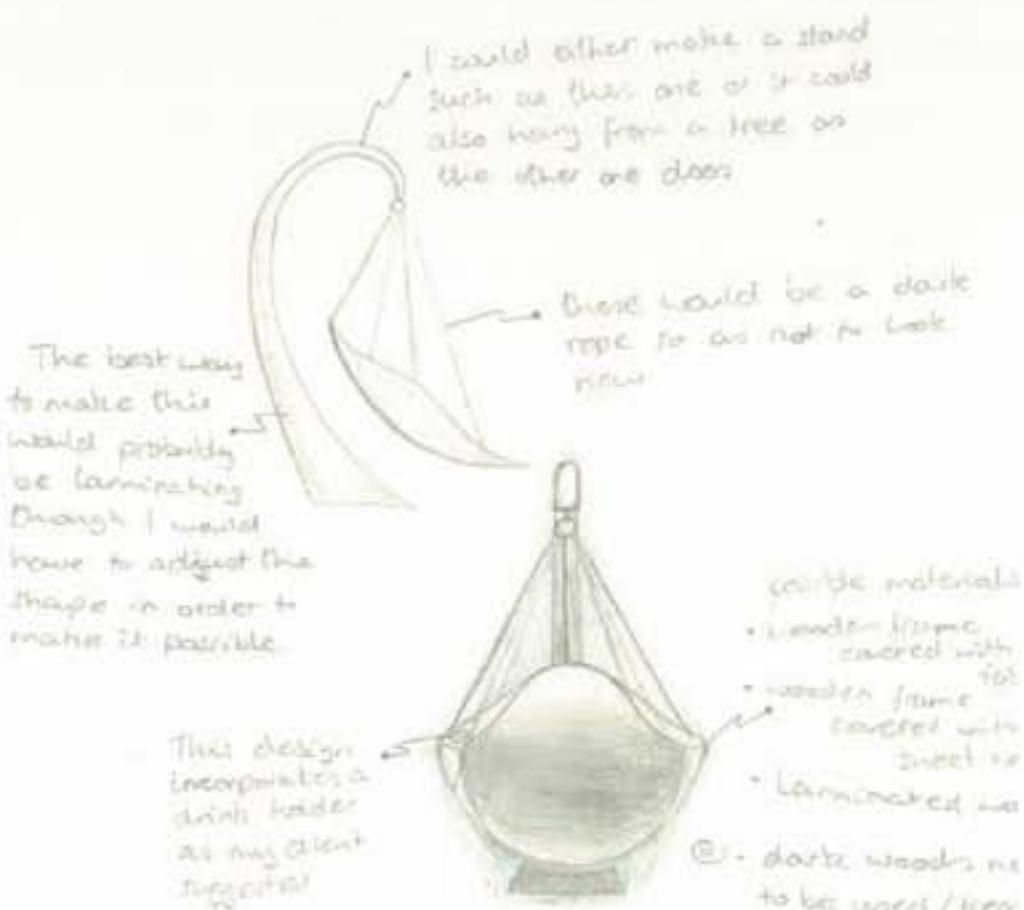
Design and Development

Design Ideas





Angles taken from my research into the chair longue by Le Corbusier



As you can see so far on my designing I have kept my ideas on curves, this is because my client specified that she would like to be able to curl up in the seat therefore the curved shape fit perfectly to anybody.

All my designs will include soft cushions filling the seat to add to the comfort.

Design Ideas

This would be made by laminating either natural wood or plywoods.

5 of this shaped laminated wood or metal, joined in the middle of the seat

angle from the chosen hangers by le Corbusier

turned on the wood lathe

@there is a possibility of creating a copper look by using a copper foil. This would give the same effect as using foiled copper as my client was wanting but would be cheaper and stronger

Front view

egg shaped hanging chair

All the wood would be moulded over the same mould so as to create a symetrical shape and then cut to the correct shape

wide planks of wood / laminated wood

Birds eye view

roller

made flat pack, pin or roll tube as in other designs

full of cushions for added comfort

roller supports to prevent rocking

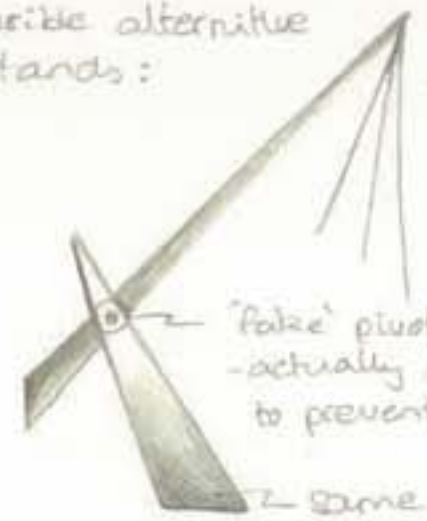
The shape of this seat means it allows for curling up and comfort and it is also made of natural curves so will blend in with the garden trees. The use of a stand makes it more of a sculpture as well as being free standing as my client wanted. This design does incorporate a drinks holder and another pocket for objects such as an iPod or phone. This would be made out of laminates therefore being a nice smooth surface to sit on and the bowl shape allows it to be filled with cushions therefore adding to comfort. The problem with this would be making the stand strong enough to support the seat and the additional 125kg I have allowed for an average male to sit in it. The strength will also come from the cable attaching the seat to the stand. The woods used will be treated with wax coatings making them weather proof therefore allowing me freedom to use whichever wood is best without being restricted to water resistant materials. I think with the making of a stand as well as the seat, the cost and scale of this product will exceed my limits and therefore will not be possible to complete.

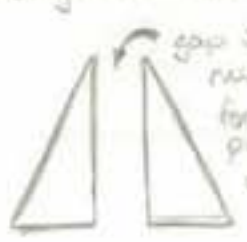
This seat is also designed around natural shapes and so will blend in with the garden. It hangs from a tree instead of a ready made stand making it better for me to concentrate on the seat rather than having to design a stand as well which will take longer. The bowl shape again will be used to hold cushions that will be detachable so it can stay out all year and not get ruined. The problem with this design which I would have to address is the balance and the pressure on the curves; this makes it weaker than the other design and I will have to focus on making a strong spine or set of spines to accompany this. This design is the one I am more likely to do as it is my clients favourite an the one, I think, that offers the most potential in development and manufacturing. I think it will suite my clients garden and with the appearance of a falling leaf, will add an aesthetic side to it once hung under a tree.

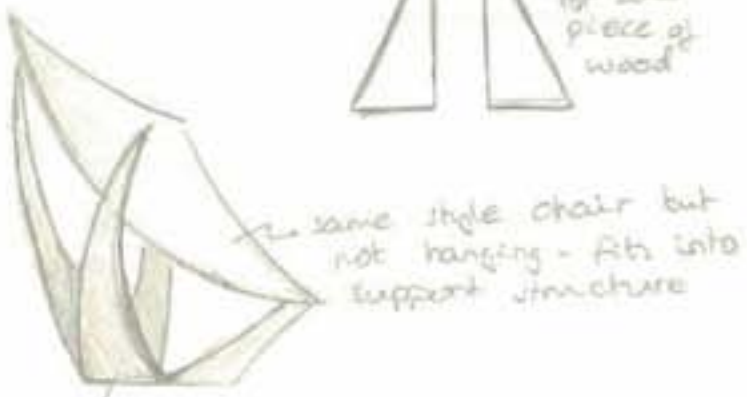
This is possibly the simplest design as it is resting on the ground and does not involve any forces being exerted on any pressure points as it will all be absorbed by the ground. It is a simple lamination process however the size of it is almost too large, It is more of a lounger than a seat so it should hold the whole body including legs not just the torso. This will be restricted by the size of machines and space available so may not be suitable for this project. Again the comfort will be provided by feathered cushions that are detachable so the lounger will be able to stay out all year. It will be a more dominant feature in my clients garden and I think it will be too large for her. Although I like this design and think it offers more in the way of lying down and curling up I think it is essentially more of a sun lounger and therefore more suited to an area perhaps by a pool or in a hot country, neither of which are like my clients garden.

Design 1

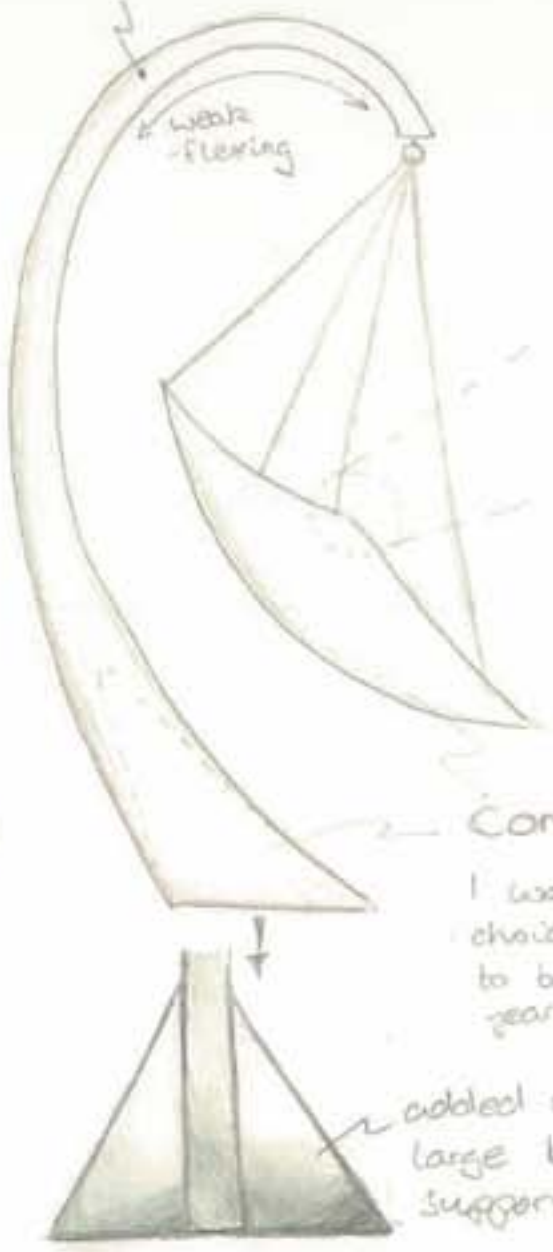
possible alternitive stands:



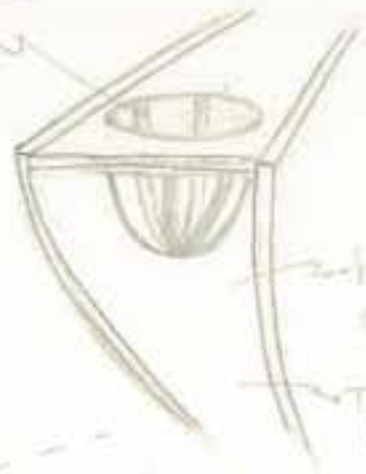




possible manufacturing solution to create curve are steam bending or laminating
- problem in strength due to curve



fabric strap/pouch to hold a standard round glass/can - thing - mine allow for a little flexibility in the size



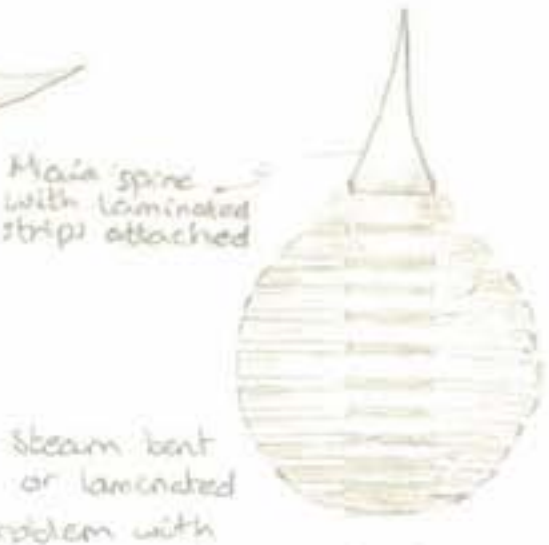
these pieces of wood can possibly be joined by using biscuits in a biscuit joint

Design 2

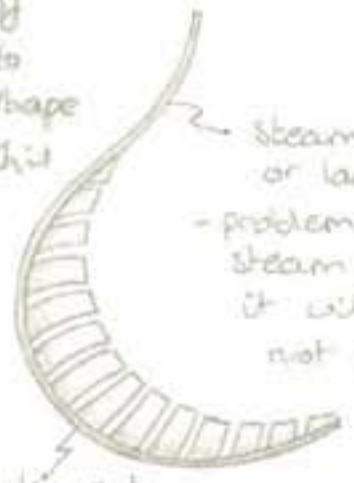
Leaf shaped hanging chair

My client was wanting this design made in copper but copper is very expensive so wood is a more desirable material to use

This shape can not be made as a whole piece so I have to find ways to split it up to make it possible to manufacture



Making it out of individual strips of wood allow me to keep the curved shape of the seat as this can be achieved by laminating



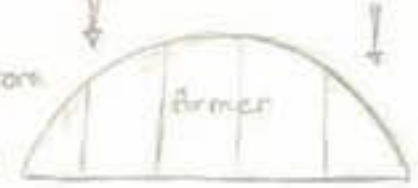
- Steam bent or laminated - problem with steam bending is that it will tend to 'relax' and not hold its shape unless held in place by other pieces

This would have to be laminated to a thickness that would be strong enough

Laminating

A minimum of three strips of wood can be used. The best wood used for laminating would be ash because of its flexibility. The diagrams below show the laminating process using a former and a vacuum bag

former made from blocks of blue foam cut into shape



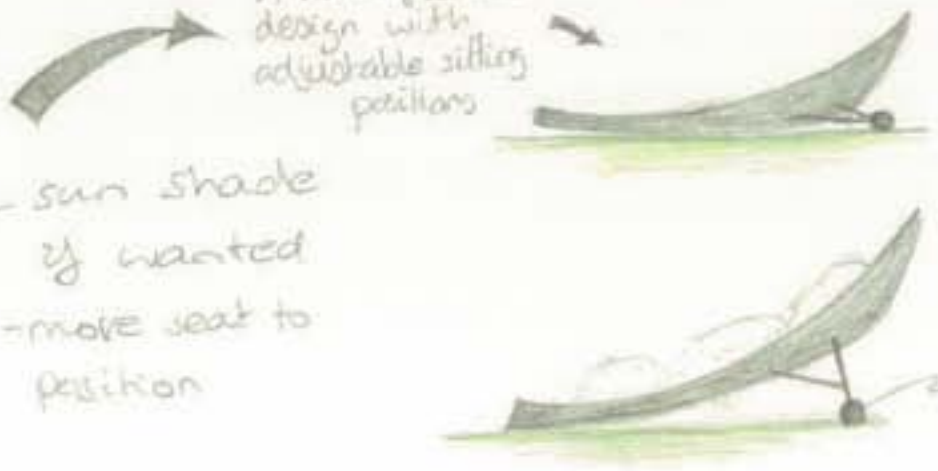
The laminates are placed over the former in a vacuum bag and then bent into shape by the pressure of the vacuum. Alternatively the laminates could be placed between or over a mould and clamped together using sash clamps.

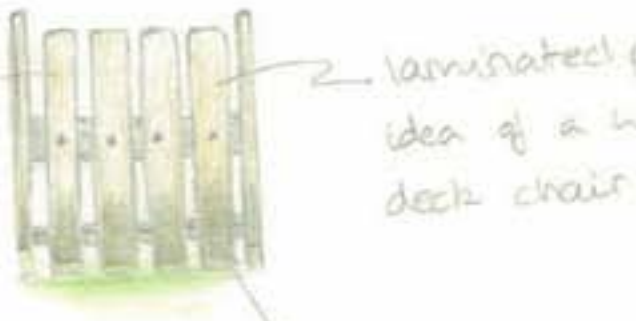
once formed the strips need to be either cut to shape or size or just have the edges squared off using a planer or hand saw.

Having taken these designs to my client a discussed options with each one as to how I could develop and improve each one she has shown a big interest in this particular design as she likes the artistic nature of the 'falling leaf' design. So this is the one that I will further develop and take to manufacture.

Design Ideas

Design 3





If the smaller thinner planks were used in these designs then I would make them by laminating strips of balsa using the same technique as shown before

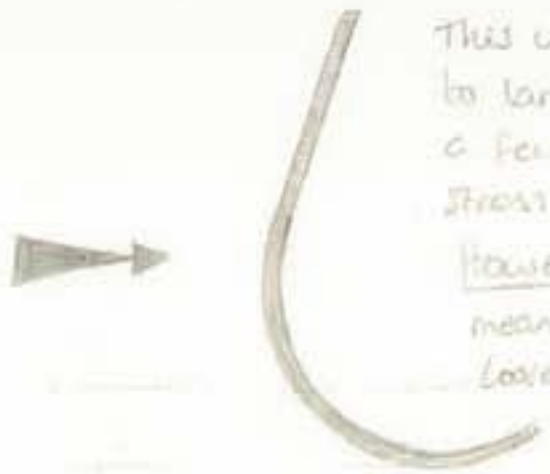
If the larger sheets were used then there would be sheets of ply laminated and then veneered to give the nice effect of hard wood grain. This means I have to be particular about treating the wood to make it weather proof and use weatherproof glue.

My client has said she prefers the idea of a seat rather than a sunbed so I have chosen not to develop this further.

Design 2

Due to the curves of the spine I need to think of sensible ways of achieving the shape but with strength

Another option is to simplify the curves:



This would be easier to laminate as there a fewer curves so less stress on the wood

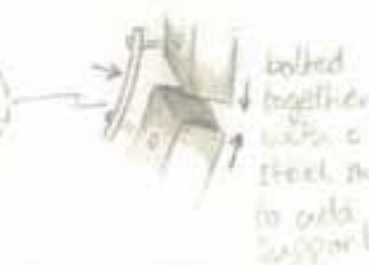
However the shape means it automatically loses its natural balance when hung

→ because of this, and also my client finds the double curve more aesthetically pleasing, I have to focus on ways to laminate that design this involves finding a wood that is flexible enough not to split.

Individual slats cut to exact shape on the router and then joined together

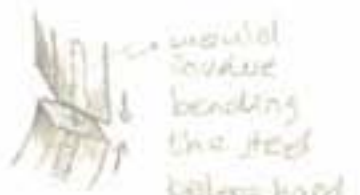
→ problem: joints will add risk of weakness as pressure will be put on both

→ laminating is strongest option

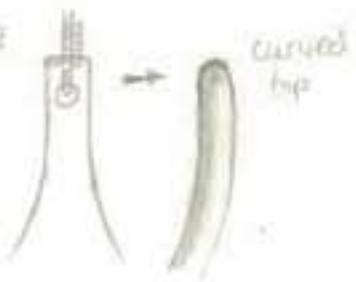


Alternatively:

Steel rod screwed into both sections

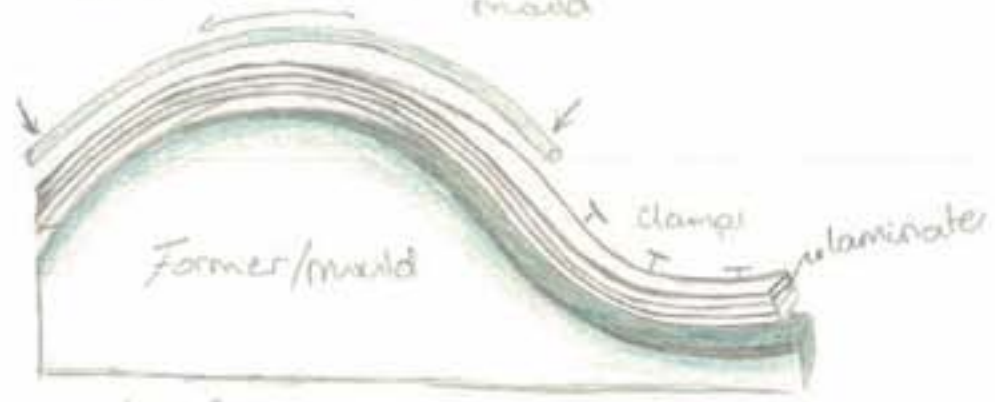


Top



option

or



Too big for vacuum bag
- use of clamps instead

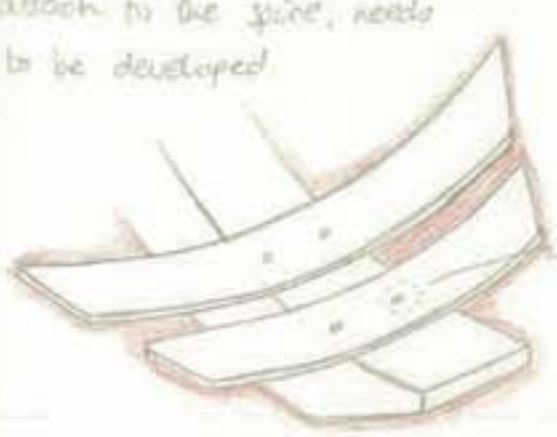
Having decided to develop and model my second design idea I had to get the shape and size drawn up at a 1:1 scale so I could work into the design and find solutions to certain problems.

I started with drawing the shape out to scale on MDF which I did by relating it to the size of a normal chair and I used the average height of a male sitting up straight, which is 980mm, to give me an idea of how large the seating area needs to be. Because the purpose of my seat is to be able to curl up and not to sit up straight, I was able to take this into account and make the height slightly smaller. This was to prevent the seating unit becoming too large.
One of the first things I had to take into account about the shape of the profile was the bottom and whether it is easy to get in or if it is too curved at the base preventing people getting in easily. I drew several different forms before deciding on the dark line you can see on the MDF board.

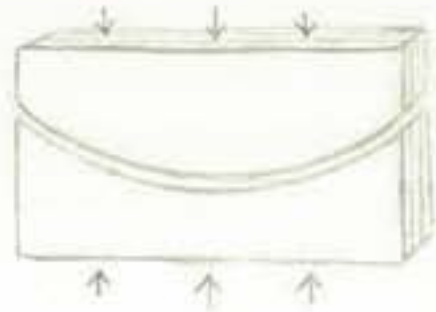
(above) The next thing I had to take into account is how it would hang and whether it would be in balance when it was hanging, therefore I made allowances for extra hanging holes at the top of the model, hence the large top. The red line represents the ideal shape and the black lines show the space allowed for any adjustments in shape or size that may need to be made once tested.

Having decided on the shape I then cut out the two spines, I used two in the model for strength issues as I needed to see if using two spines was going to have to be the option I take on my final design. I found that the hanging hole which gave the best balance was actually the one that was on the red line which meant I didn't have to alter any balance issues and the shape could stay the same. I took the testing further and asked someone to sit in the chair for me and this caused one of the spines to break which was good for me to see as it meant I really had to focus on how to alter the design in order to make it stronger, this also means I have to think of appropriate materials as obviously MDF is a much weaker wood than any natural timber.

With the help of my modeling I have seen that the struts and their shape and how they attach to the spine, needs to be developed



Slats laminated as shown in initial development. All laminated to the same curve.



easier than vacuum bag. Use of clamps and MDF board, with the curve cut on the router

Attached directly onto main spine
- knowing curves problem - spine has a flat edge and slats are curved. Joint wont be strong and not stable to sit on

too thin at edges - make it too weak and screws wont fit in

attached by three screws - middle + two edges

Solutions

much stronger as thicker - more aesthetically pleasing

each one attached to spine as shown bellow

aesthetics and comfort are slightly ruined by this design

needs a wider base of support to sit on.

to make it more stable:

fits over the spine and attached with two screws

- gives a wider and more secure base of support

different size brackets for the different length planks - all the same curve - cut on router using C-10 CAM

To help in the development of my product I visited a local steam bending specialist who could give me advice on laminating. I took a full size drawing of my product out to show him and we talked about how we would form the shape. A number of possible answers came up which was interesting and one of the problems which we were trying to solve was the weight, we went out with the proposal of laminating strips of oak which we were quickly told would be very heavy and would take a long time to get the strength/thickness needed. From this point we started talking about ways to lighten it yet still keep it weather proof, as other lighter woods are, more often than not, not waterproof. This brought up the possibility of using a product called the west system which is a lacquer that would add stiffness and make it completely waterproof.

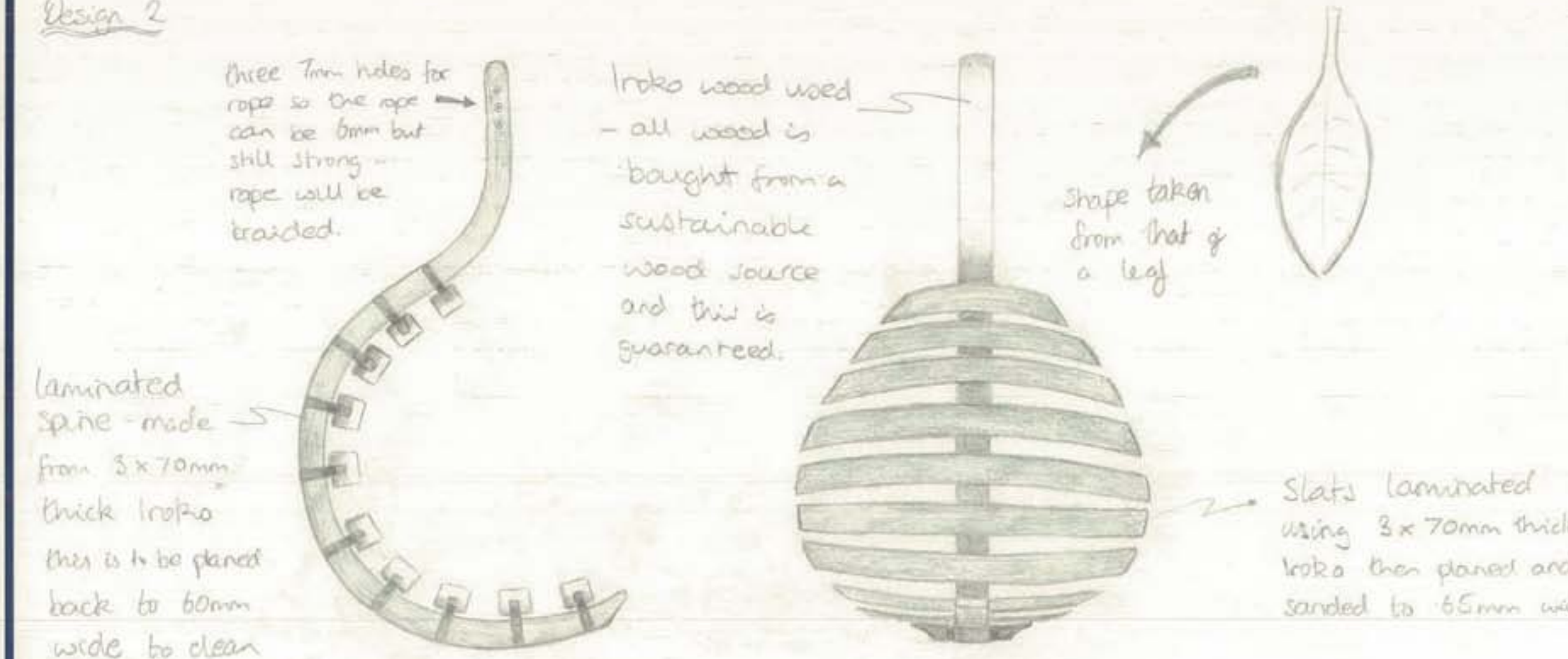
Having decided that this was a solution to any weather proofing problems we could then talk about using different woods and different structures for the actual spine.

One structure which we talked about a lot is the I beam structure using two central pieces sandwiched between two laminates. This gives the strength needed and means the centre can either be hollow or contain a light soft wood or foam. Because the strength now is in the structure not reliant on the type of wood, I can use a much lighter wood than oak such as ply wood with an oak veneer. This system also means that I can cut the inner pieces by hand to the shape I want and then use them to clamp the laminates of ply onto. This has left me with a lot more options to think about and I need to decide which one will be the most successful.

From this trip I also collected lots of off cuts of laminates of different thicknesses and woods so I was able to test these out on my mould. From this testing I have found that a laminate of Iroko of about 3 mm thick will bend easily around my mould as you can see from the pictures on the right. This has helped my decision as it means my worries about the curves of the mould are unfounded and it has shown me that the original idea of laminating will actually be successful. Despite the advice for other methods and the unknown quantities involved in the laminating I decided that using laminates would be the best way to create the design I wanted and I decided to push forward with the decision to laminate.

Final Design

Design 2



edexcel
advancing learning, changing lives

Criterion D

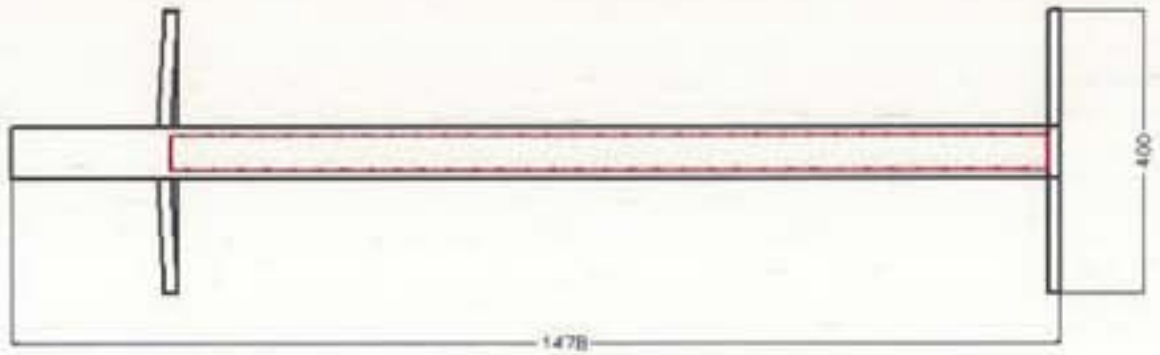
Planning Manufacture

Process	Tools and Equipment	Time	Safety Issues	Personal Protection Equipment	Tests/Checks/Quality Control
1. Construction of mould					
1a. Graphite design into Gibbs	CAD/CAM: Graphite for the design Gibbs for programming the machine codes	1 hour			Run the machining route on Gibbs to check that all edges are cut through and on the correct sides
1b. Cutting mould	CAM: Gibbs programme on the Router, MDF.	4 hours	Fine MDF dust generated but machining will take place in a sealed cabinet	Extractor must be on and doors sealed.	Correct dimensions, dowel holes will match up and mould pieces will fit together.
1c. Constructing mould	PVA, 14mm dowels, hammer and G clamps	30 minutes each layer (4 layers)	Glue being used	Apron will be worn to protect clothes	Check all air gaps are squeezed out in clamping. All dowels are able to be pushed out so are not glued in.
1d. Finishing mould	Sheet plastic, tape, knife, cling film	5 minutes	Use of knife	Cut away from your hands	Smooth surface for laminating side
2. Laminating					
2a. Cut lengths of wood	Iroko, band saw, measuring equipment	5 minutes for each layer (4 pieces)	Band saw needs safety assessment before use	Apron, protective glasses, ear defenders (optional), push sticks for cutting close to the blade.	Dry clamping to check wood is right length and to mark out the centre line to make sure wood is in the correct place when clamped again.
2b. Mixing glue and gluing wood	Aerolite 306, Acid catalyst, spreader + brush.	10 minutes each layer	Acid is corrosive and glue powder can irritate skin	Apron, gloves, protective glasses	Check alignment of laminates and use engineers clamp to keep it.
2c. Clamping laminates	Sash clamps, foam blocks, G clamps	20 minutes each layer	Glue and acid on the wood, large forces being applied to wood to bend	Apron, gloves, two people to prevent wood from springing out of position uncontrollably.	Visual checks for air gaps in-between laminates for each section of clamping, clamps need to be adjusted and loosened before air gaps can be dispersed.
2d. Unclamping and finishing laminates	Chisel, measuring equipment, electric and hand planers, scraper.	3 hours	Sharp dried glue, planers, chiselling, all these could cut you if not careful. Fine dust created by planning	Apron, protective glasses, breathing mask, extractor held by one other person. Chisel and plane away from body.	Visual check for any gaps once planed and check the right dimensions all the way through. Check all glue is removed with the scraper/planer.

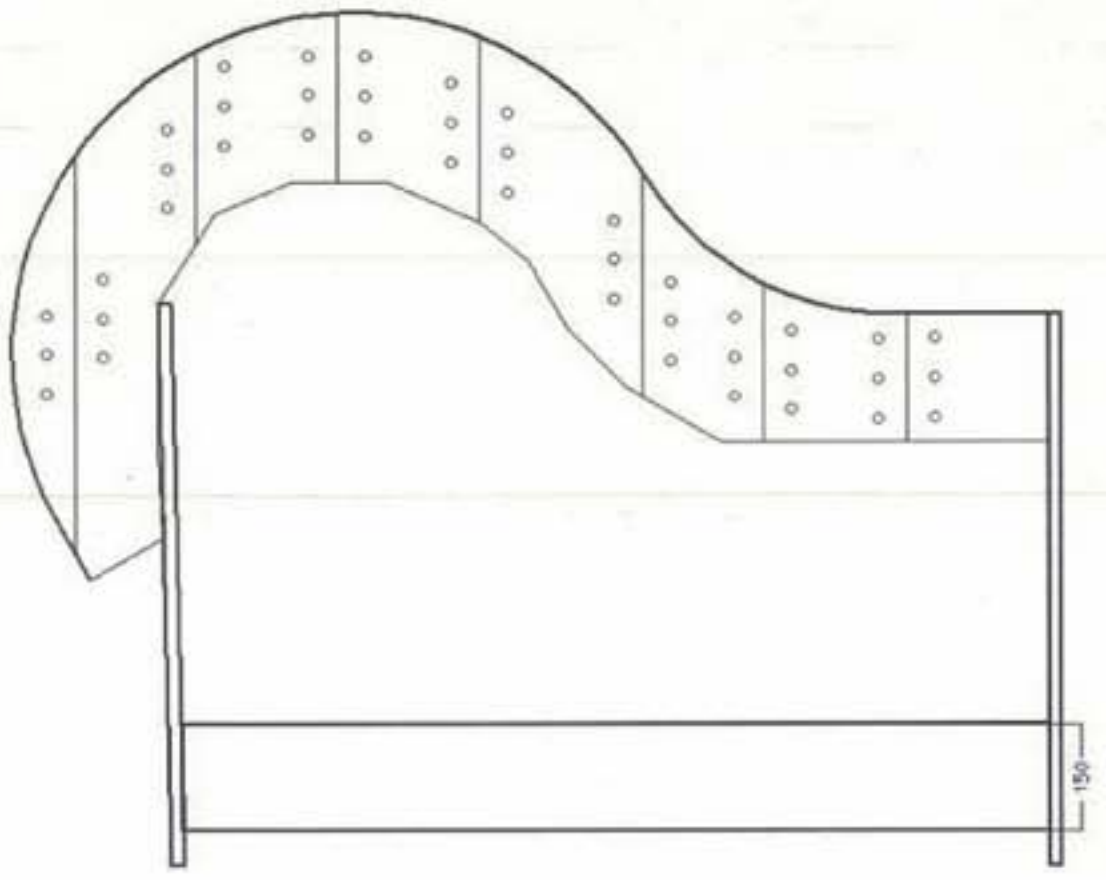
Process	Tools and Equipment	Time	Safety Issues	Personal Protection Equipment	Tests/Checks/Quality Control
3. constructing seating supports					
3a. Designing supports	CAD graphite, measuring equipment, MDF models, band saw.	1 hour	Band saw needs safety check before use	Apron, protective glasses, ear defenders (optional)	Test models fit on spine, visually check aesthetics of models and redesign if necessary.
3b. Programming supports	CAD/CAM, Gibbs and graphite.	15 minutes			Check machining route on computer and all lines are cut fully.
3c. Cutting supports	CAM: Gibbs using the router	30 minutes each one	Fine Iroko dust generated but machining will take place in a sealed cabinet	Extractor must be on and doors sealed.	Check for clean edges, correct curve and right dimensions over spine.
3d. Finishing	Band saw, sand paper, electronic vernier	15 minutes each	Fine Iroko dust generated, Band saw needs safety assessment before use	Breathing mask worn if too much dust, eye protection and apron for protective clothing.	Check for correct dimensions over spine in correct position as each will be different.
3e. Marking and drilling holes	Measuring equipment, pillar drill, clamps, 4.5mm drill bit, counter sinking drill bit	1 hour all together	Fine Iroko dust generated, splitting wood, drilling	Eye protection, apron and breathing mask if needed, keep hands clear of drill bits	Check for correct size counter sinking, if it is big enough for screw, check it has been drill the whole way through
3f. Pilot holes in spine	Pencil, battery drill, 2.5 drill bit, steel screws, screw driver	1 hour all together	Drilling, possible splinters and fine Iroko dust	Eye protection and apron and if needed a breathing mask	Check holes line up and screws are in straight to cut thread for softer brass screws.

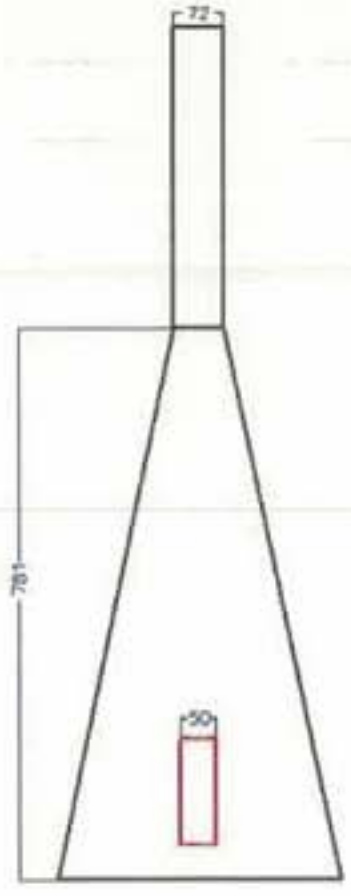
Laminating for seating planks will be as before but using a different mould and clamping block. It will use the same process of gluing with the acid.

Attaching the planks will be similar to attaching the seating supports but will be done before the supports are attached to the spine and using size 6 brass screws so the clearance and pilot holes will be different sizes. Counter sinking and drilling will all be the same.



These are the CAD drawings for the structure of my mould for the spine.
The mould had to take great forces so had to be very strong. I made sure of this by layering the MDF sections and using dowels shown by the blue circles on the mould. The base needed to be a good support so I made it wide at the bottom and added a panel in the middle to give it extra support, all the diameters and positions are shown by these technical drawings.



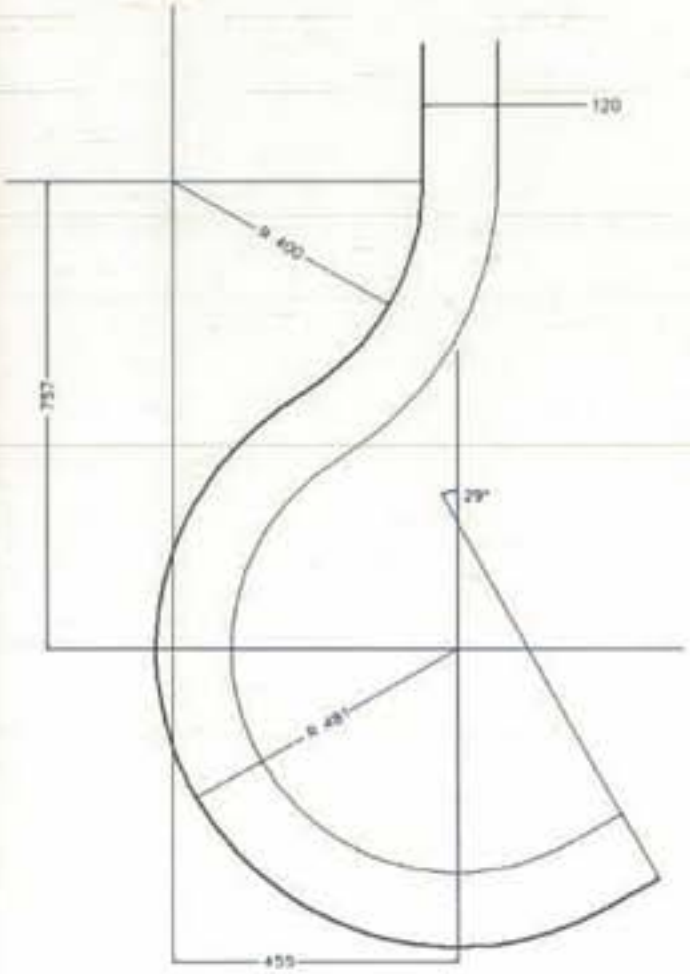


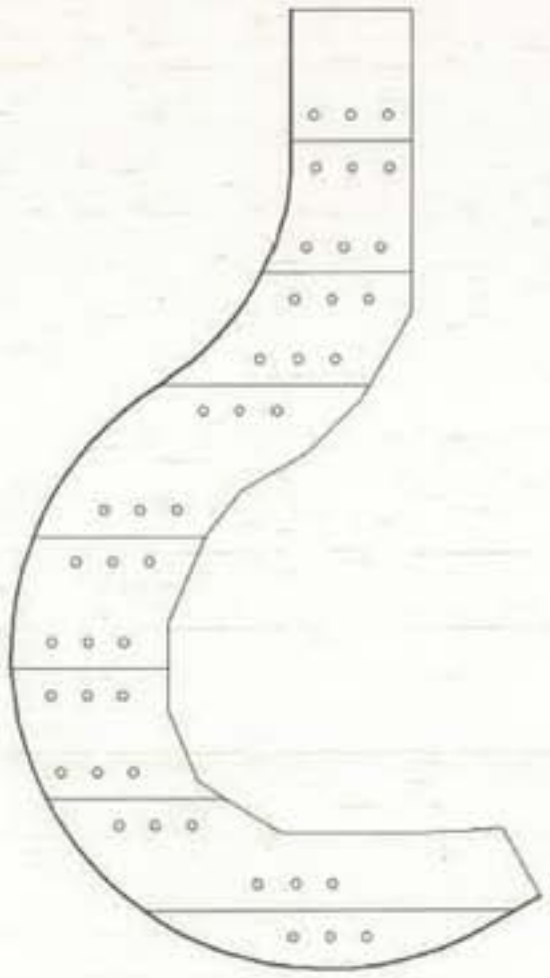
edexcel
advancing learning, changing lives

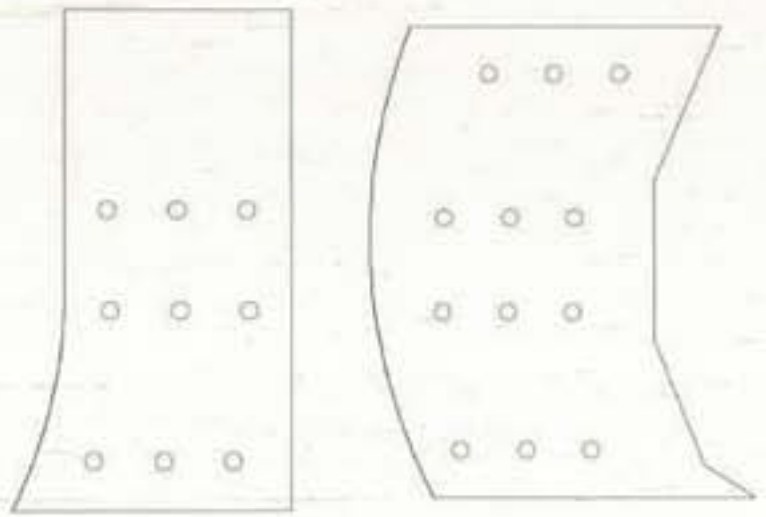
Criterion E

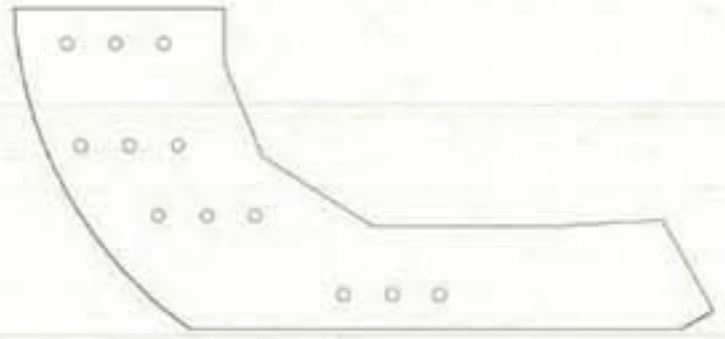
Manufacture

Having drawn the design out by hand I then had to translate this onto graphite. This I did by drawing out the dimensions in a grid and then plotting them on graphite. I was lucky with the curves as they are both circles with a tangent joining them which meant the translation from paper to computer was simpler than I initially thought.
The drawing below shows the dark line as the actual shape of the seat and the thin line shows the starts of the mould.







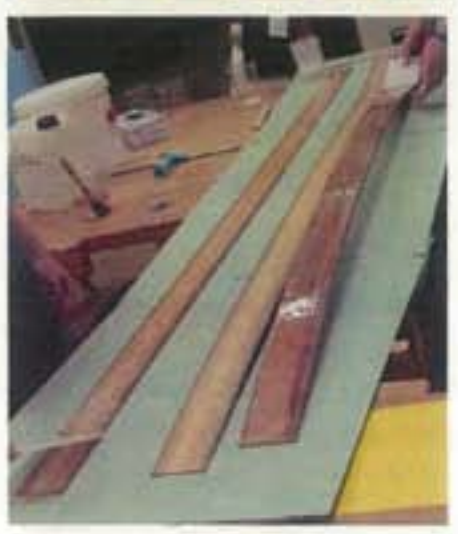


I then had to re draw this out with a layered mould pattern. This was done by cutting the shape into 9 sections and then splitting these onto separate pages. This allowed me to export them all individually to Gibbs and then programme them for the router. The dowel holes show where the layers will be joined together with wooden dowel.

These are some examples of the different sections I made. They fitted together similarly to brick-work in order to dive strength and structural support for the tensions involved in laminating. The straight edges on the inside of the curve are for attaching the clamps to in order to prevent them from sliding during clamping.

Clamping:
To start with we dry clamped three strips of wood in order to organise the clamping sequence and trial the most efficient and best way of starting the clamping. Instead of using a steal rod to pull the wood against the mould I made foam moulds to clamp against the wood and spread even pressure which works well. The wood is clamped together using a machine clamp to prevent it from slipping out of alignment and is held on to the mould by two G-clamps to begin with so I can line the marks on the wood up with the marks on the mould to get the correct position. Then the first block which goes on is the top one as it is the easiest to bend the wood to and then the other blocks are clamped on as appropriate. What I had to look out for was any air gaps forming when clamps were tightened and this I could judge by the glue being squeezed out of the sides. As the layers progressed, more and more clamps were needed as the forces increased due to the changes in the dimensions of the curves, as you can see in the second top photo in the middle compared to the opposite on the left.

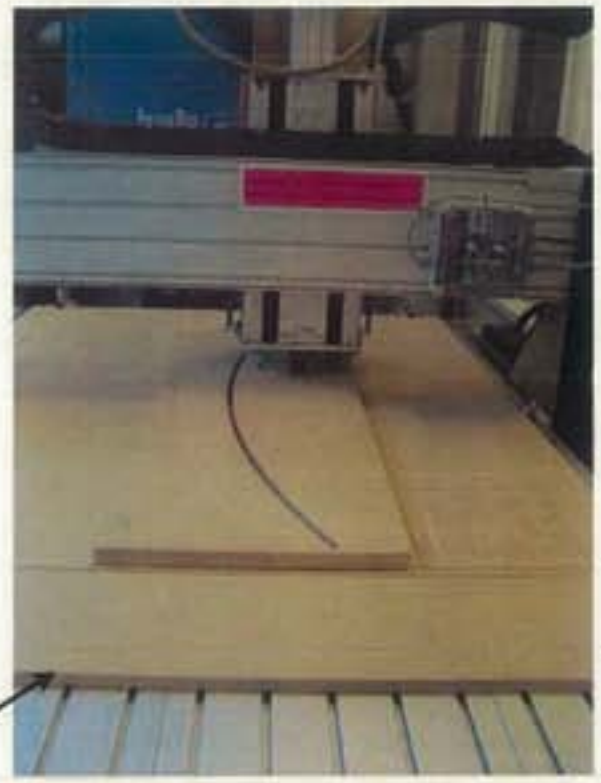
Gluing:
The type of glue I used is called aerolite 306 with an acid catalyst (acetic acid). This is for a number of reasons, the glue doesn't start setting until it is in contact with the acid therefore making assembly easier and allowing more care to be taken. It has good gap filling properties so any small air gaps that are undetected will be filled and should not cause a problem and it is also waterproof therefore will not disintegrate in outdoor weather conditions. It is mixed in a ratio of 4:1 glue powder to water till it is a runny consistency and then spread on every other side. The acid is applied first on the other sides, which will have been marked out before application. When put together an acid side will be against a glue side therefore activating the setting reaction. The wood is then clamped together with the machine clamp and put through the clamping process explained before.



These photos show the manufacturing of the brass rope holders. They had to be worked to the correct diameter and the hole in the middle was drilled using a centre drill and then a 7mm drill bit.

This photo on the right show the router cutting the MDF boards used for the mould for the slats. This is the same method used for the large spine mould and for the seating supports. I used the router in order to achieve consistent perfect curves and identical pieces as each mould was pieced together in layers so the layers needed to be identical in order for it to work.

Glass doors shut and sealed for safety.



This photo shows the facing off stage of the brass work.

Using a similar method I also made the large grass hoop but the hole had to be widened using a boring bar as a drill bit was not large enough. I also had the part off the hoop before I could adjust the width of it.

These two photos, left and above, show the unfinished spine with model slats and seating supports in place. Using the models allowed me to adjust dimensions such as length and width (done by adding card onto the slats) and also gave me an idea as to what the finished product was going to look like. I was able to adjust the distances between the slats using this model and also the length I wanted each slat to be to create the right shape.

edexcel
advancing learning, changing lives

Criterion F

Testing and Evaluating

Testing and Evaluating

Testing

Initial Testing:

These pictures show the initial stages of testing. Once the product was finished I used climbing rope as a temporary support and hung it to check the balance was correct and the chair hung in the correct position.

Having seen this was all balanced and correct I could then go onto to look at other areas which needed testing. The first was whether it would hold a person's weight which it did as you can see I am sitting in it.

Having sat in it I could then judge it's comfort and what if anything needed to be done to make it more comfortable.

I had already planned to upholster it but I had to decide what would be the best way of doing this and so that all came about from this initial testing. I decided to make a large fitted cushion from feather cushions which meant it was thick and comfortable as well as adding support to the person's back.

Another thing I had to think about was the rope and how I was going to braid it or tie it onto the brass hoop and then the tree

This is a photo of my client enjoying her chair in the evening, I took it to her for more evaluation once the cushion had been pinned together, as we made it together to fit the chair perfectly, and it was helpful to see how much difference the cushion made to the sitting position and comfort. This I have collated in my evaluation.

Client Evaluation





I took the project over to my clients garden and hung it up for evaluating and testing. I asked what she thought of the different aspects of the design and where she thought improvements could be made, she gave some useful constructive criticism and some good comments which I have collated below.

Materials and overall product:

The wood and finish blends in beautifully with the environment which fits the initial requirements
Initially I thought that a free standing suspended chair was what I wanted but I am very happy with the way it hangs from a tree.
A criticism would be that the fixtures are not very adequate for the ease of moving the chair around

Aesthetics shape and design:
The shape is wonderful and is a clever twist on my original thoughts. The skeleton leaf idea is aesthetically perfect for the situation-hanging from a tree branch. My only criticism would be that the curve is too deep or the vertical diameter is not big enough as it forces one's head to be pushed forward
The duvet cushion is blissfully comfortable and makes the curve of the seat more shallow so one's head doesn't get pushed forward as much
I am pleased with the fact that it is suspended and the aesthetic qualities make it seem like a spiraling autumn leaf when the wind catches it
I am not disappointed that a drinks holder or ipod stand etc haven't been incorporated as I feel they would have hindered the aesthetic design of the end product.
Improvements:
Perhaps a hook and eye system for the hanging mechanism would be a good idea
The slats forming the boy of the chair are quite delicate and would benefit from being thicker, there is a danger that they will not hold if someone sits on it off centre.
Needs to be stronger in general so we don't have the worry that it will break if the boys sit in it because it was meant for the whole family.

Evaluation

My evaluation : to be referenced to specification on page 6

I'm happy with the end result of my project. It achieves what it was meant to in being a comfortable garden chair that blends in aesthetically with the surrounding garden. My client was able to relax in it and enjoy her garden which is what she wanted in the evenings.

I think however it limits the sitting position one can sit in due to the curve of the spine, the top pushes your head forward if you sit too far back in the chair which means you have to sit towards the edge to be comfortable. This effect was worse when there was no cushion but with the thickness of the cushion adding support to your back it makes it more comfortable and reduces the amount of curve in your back. This cushion is detachable which means it can be kept clean while the chair can stay out all year round. It has already been out in the rain and has shown it is fully weather proof which is good as it would be an inconvenience to take down when the weather is bad.

This leads me onto another point I could improve were I to make it again. The way it is attached to the tree via knots and rope is quite tricky to do up and undo so a mechanism such as a hook could be more useful.

I like the decision to put three holes through the top instead of one, it meant I was able to use nice 6mm rope instead of one large bit of garden rope and still get the strength because there were three pieces not just one.

One thing I am a little weary of with this seat is the fact it is quite delicate for a garden chair. The seating supports could be made wider in order to be more stable when sat on and as my client said she hasn't allowed the boys to sit on it incase it couldn't take the weight which is not ideal so if I was to do it again I would try to find ways to make it stronger which could be just making the spine thicker or there are other possibilities drawn out on the next page.

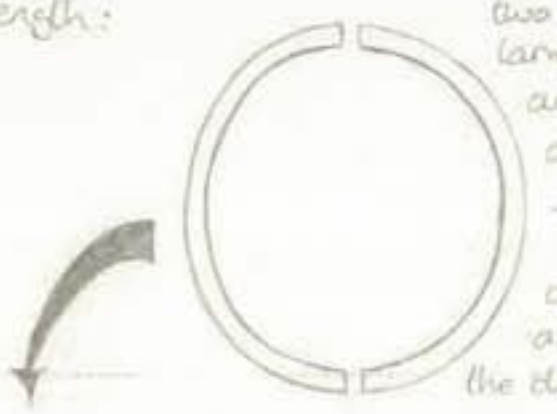
I have managed to buy all the wood from the same seller and he has a guarantee that it is all from sustainable sources so although I did use purely hard wood, Iroko, it was from a sustainable source so is environmentally friendly.

When oiled the Iroko stained really nicely into a honey colour which I think suites my clients garden and fits the description she gave me of using rustic woods and colours.

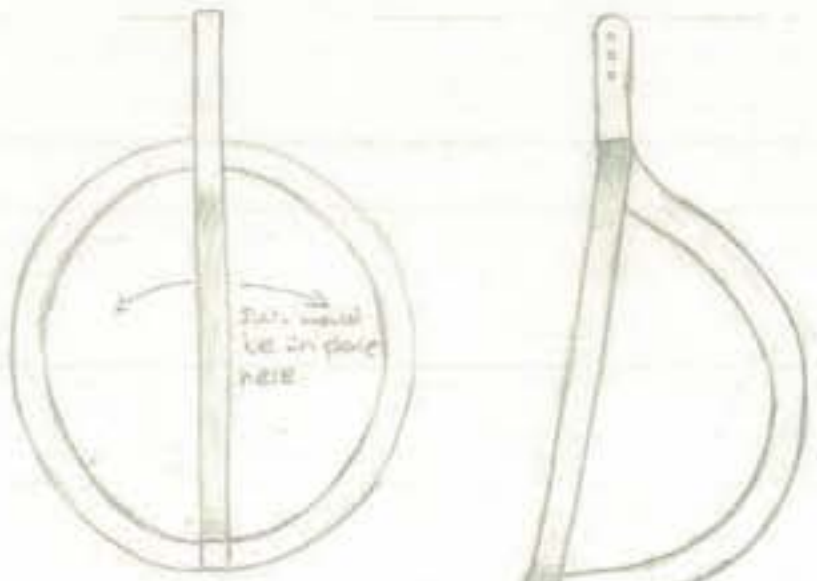
Cost wise it came in under the budget we set of £250 with the wood costing less than £200 which is good.

further development

For strength:



two additional laminated pine curves bolted onto the seat - because these are just pine curves they are a lot stronger than the thinner curved pine



Although this additional support would add lots in the way of strength - which is an area that needs to be improved - it takes away too much aesthetically for it to be successful

Stability:

much wider supports - 40mm - originally they are only 20mm - this makes them very unstable when sat on so a wider support would be better in that respect - it will mean you don't have to be so careful when sitting down.

This will make the slats less wobbly as sometimes when sat on in the wrong position they move.

- this however will use a lot more wood and although all the Iroko is from a sustainable source, it is a slightly unnecessary use of hard wood.

hanging device:

These two ideas could be combined so the hook could hook onto the twisting mechanism

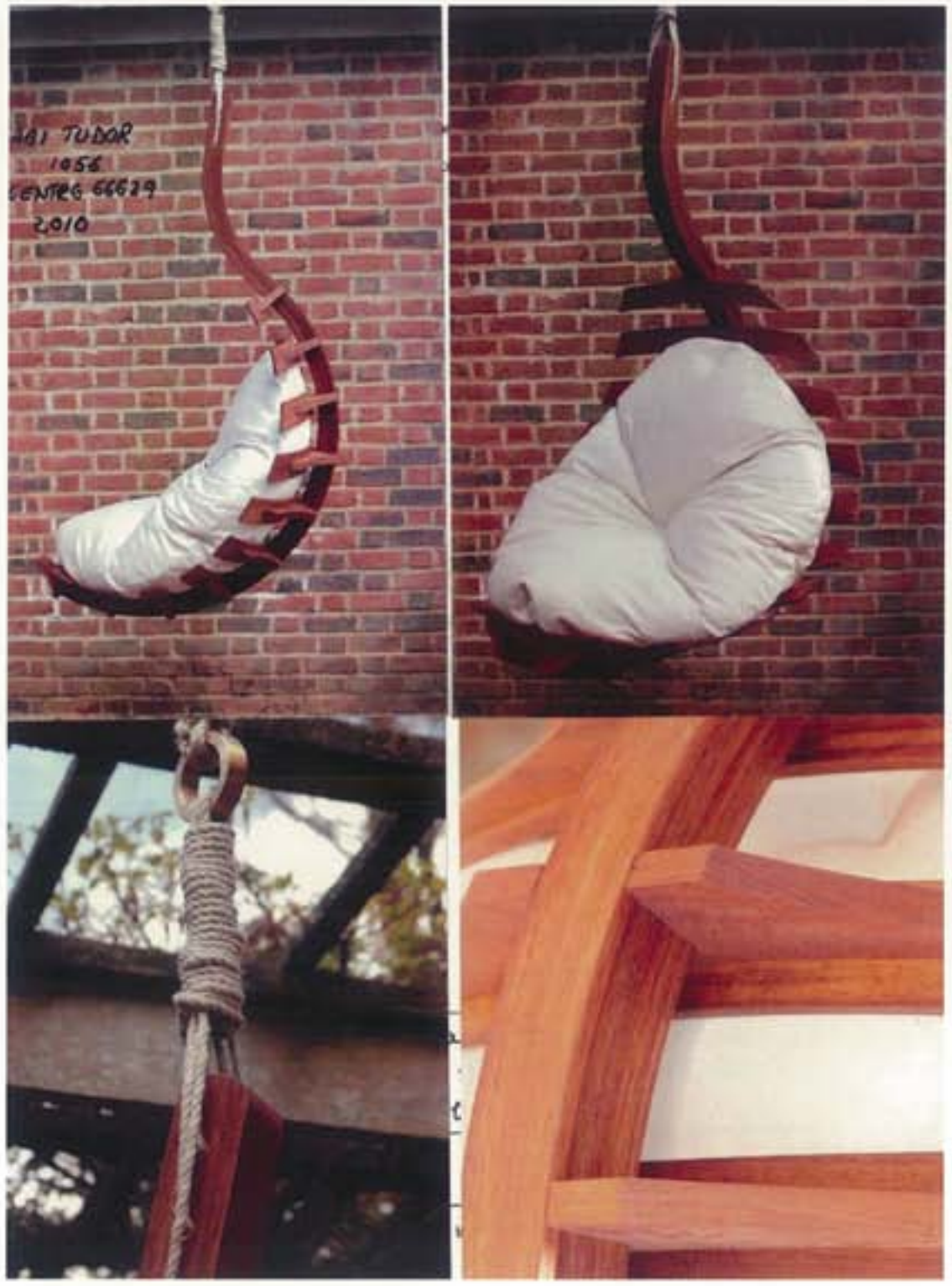
This allows 360° rotation with ease instead of twisting the rope.

My chair tend to hang facing the tree due the way the rope went through the brass hoop which is not ideal so this twisting device will allow the chair to be faced in any direction

a hook and eye system for ease of use - means you can take it down easily.

(not to scale)

trying to untie the knots keeping the chair up is quite hard so a hook and eye system would be easier if the chair needed moving.


AQA TUDOR
1056
CENTRE 66629
2010