Raised Garden Planting Bed

Michael Robinson

Candidate Number: 6139

Centre Number: 62451

Investigations of my Context:

Context: Outdoor plant storage

Explanation of intentions:

- My intention is to create a product which has a purpose of storing plants/flowers and is able to grow these fully within the bed or begin the growing process of the plants/flowers within the bed to then eventually transfer them into the ground for further and full growth.
- My grandad is a gardener and needs a product which enables/allows him to plant and grow flowers/plants but is also suited for an elderly person at the same time.
- I believe I can contribute and create a design solution suited for my stakeholder's problem/requirements.

Stakeholders:

- Julie Robinson (Middle aged keen gardener)
- Ivy Timms (Elderly gardener)
- Lucy Kirby (Young person who is interested in gardening)

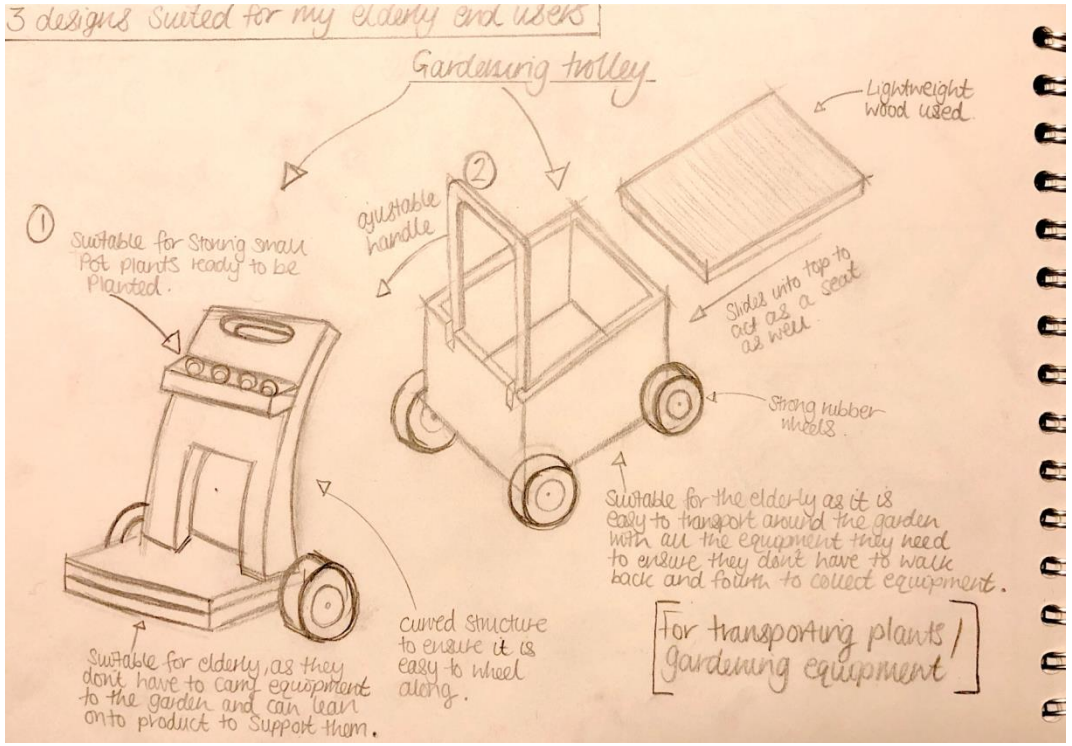
As you can see I have got a wide range of stakeholders of different ages in place to use and incorporate throughout this project and the designing, testing and manufacturing process.

Some problems with existing plant storage products:

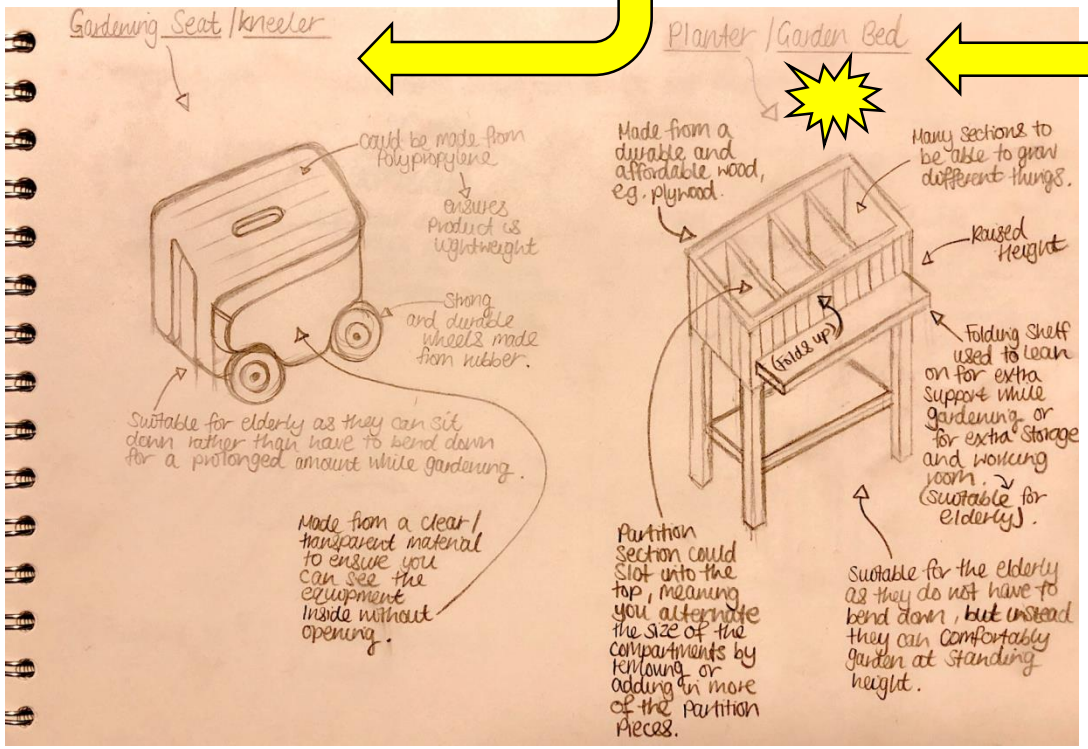
- Many are not suited for specific users, for example; the elderly, or disabled users.
- Some may be more difficult to function due to the complexity of the designs.
- Some products may favour appearance/aesthetics over practicality and stability.
- Some products may not be made of quality materials and not have suitable protective finishes, which means they won't be as durable.
- Some products may not provide the requirements/particular specification which you want from the product.
- Some products are too expensive and not affordable for the average consumer who earns an average wage income.
- Some products may be too heavy to easily transport.

Design Ideas responding to the needs of the elderly:

1) Trolley which can transport heavier items – e.g. plants or equipment:



2) Seat/kneeler to give extra support when gardening:



3) Planter/garden bed which can store plants and gardening equipment:

I have decided to choose a raised garden bed as my chosen design to create as my product.

Raised garden plant/flower growing bed/table

Next Steps:

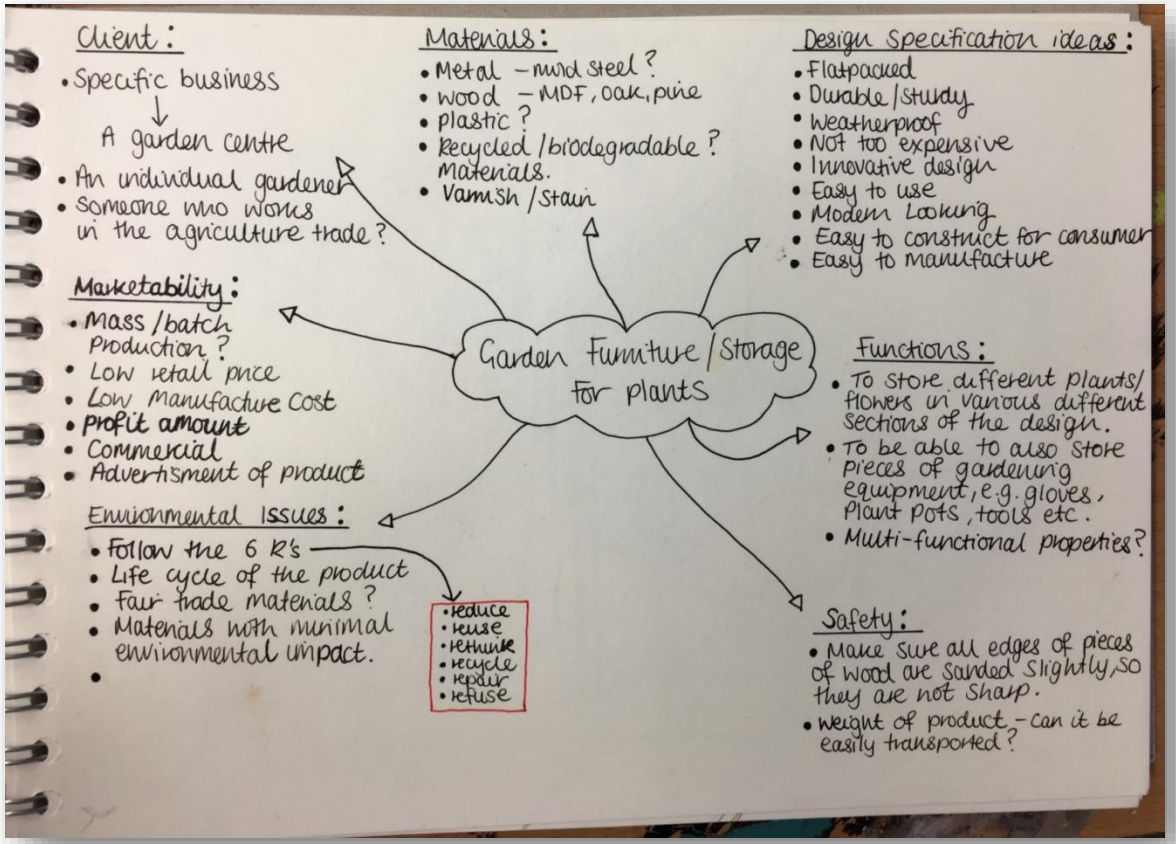
- To create design ideas which relate and meet the needs of my stakeholder.
- To draw initial conclusions on what I am going to create, by writing a brief and introduce my stakeholder and to explain specifications.

Context: Outdoor plant storage

Design Brief:
I am going to design and make an innovative, unique and creative outdoor storage solution suited for use by an elderly person and will be used for mainly growing multiple plants/flowers in the garden. My product should allow my end user/stakeholder to obtain a suitable storage option which allows the growing and storage of their plants/flowers in a neat and tidy configuration allowing them to identify everything easily, while still ensuring an aesthetically pleasing piece of furniture that looks cool, funky, stands out and meets all of the specifications, requirements and needs of my client.

My End User

Next Steps: To begin getting inspiration and ideas/primary and secondary research based on existed products, the idea of using an interlocking system, materials, finishes, processes, flat packed products/packaging etc.



End User Specifications:

End User/Target Market Intro:
My Stakeholder Bill Timms is a keen gardener and bee keeper and would like me to produce a storage solution suitable for many different plants which has an easy system for planting, emptying, cleaning and renewing. This plant storage solution should be accessible while standing up, so it should be based on the idea of a raised garden bed.
It should be suitable for outdoor use/storage.

Summary of stakeholder specifications:
- Can store equipment within the design as well as plants.
- Should be vey durable/long lasting.
- Should grow/store multiple plants/flowers.
- Should be easy to construct.

Non-technical Specification: (Conclusion of talking to my client, and we have come to the decision of these specifications also):
- As my stakeholder is elderly, I need to ensure that the raised garden bed is a suitable height to ensure that my stakeholder doesn't have to bend over a lot to access the plants within the product, linking to meeting the needs of the elderly.
- The final product shouldn't be too heavy in weight, as it needs to be suitable for transportation by an elderly person, for example to be able carry it from the car to its destination for constructing, but also to move it around in the garden.

Primary Users:
- The elderly in particular
- Professional Gardeners
- Anyone with a strong passion/interest in the growing of plants/flowers.

Lower platform used for equipment, plant pots etc to save user reaching to the floor.
structure to be treated as required to preserve for a long lifespan.
ensure design caters for multiple planting of different species.
To be easy & functional and practical and long lasting.
Simple to construct and be stable.
Use marine plywood. (economical)

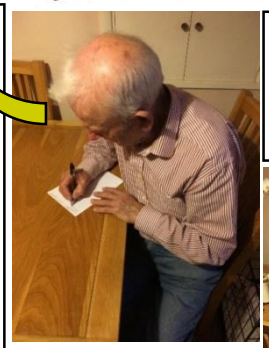
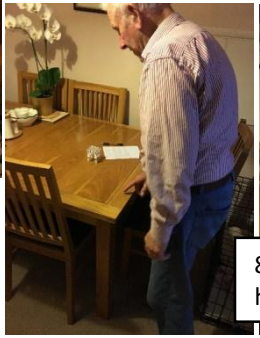
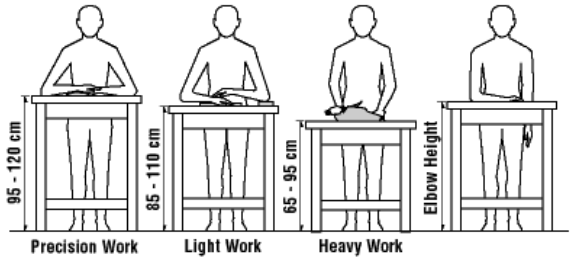


Photo of end user/stakeholder showing a comfortable standing/working height (calculating suitable ergonomic measurements):



Measurement of table height can be used, as my end user said that this would be a suitable height for the raised garden to be at.



Secondary Online Research/Inspiration on garden plant storage:

I really like the interesting and varied appearances within the different products I have researched to give me inspiration for designing my product.

Malayas 6 Tier Wooden Pedestal Plant Stand Plant Flower Display Flowerpot Storage Rack for Indoor Outdoor Garden

£29.99 from 2 shops

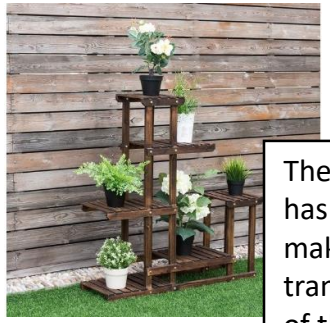
Material:Natural pine wood - Color: Stained medium brown - Size: L*W*H 95cm*26cm*71cm(37.4*10.24*27.95in)Weight: 2kg - Package ...

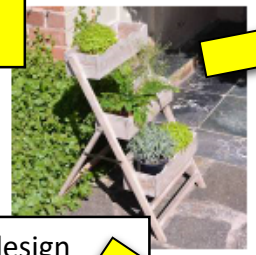
Other style options: Bronze (£30)

£80.00
Hayes Garden World

£54.99
Garden Street

Many of the products use slated wood to allow for water drainage from the plants.





Triple Tier Wooden Plant Pod Stand

£75.00 from notonthehighstreet.com

Rustic triple tier wooden **plant** pot stand Our new rustic triple tier

As an idea you could even use the basis of this design and create circle shaped indentations on each shelf using the router tool for the pots to be placed in, although this may limit the efficiency usage of the space in the product.

Norfolk Leisure Florenity Verdi Folding Pot Shelf

£62.00 from 5+ shops

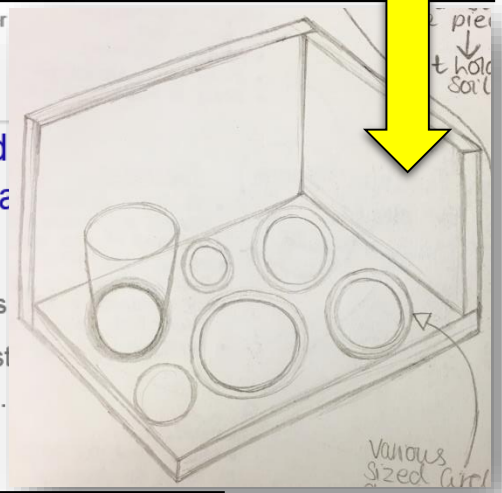
Displaying **plants** can be a tricky task however this Florenity Verdi Folding Pot Shelf takes away the uncertainty and gives you ...

The design has a handle making the transportation of the product much easier.

Homes on Trend Planter with Meta Box

£15.95 from 2 shops

This is a fabulous rust addition to any home. from a ...



I think the idea of having the shelves for the plants at staggered levels is effective, however I think that this wouldn't meet the needs of an elderly person because for example; they would have a reduced access to the plants lower down, making it harder for them to get to them. Also the plants lower down which are placed further towards the underneath of the previous shelf is less likely to have the same amount of growth, due to a reduced amount of sunlight as it is placed so it is covered by the previous shelf above.

Next Steps: To gain further secondary research into specific garden bed existing products and relevant research into garden beds.

Multi-Tiered Plant Stand Relaxdays Colour: Honey E

£46.99 from 5+ shops

★★★★☆ 7 product reviews

These lovely flower stairs provide endless space for you to display

Other options: Honey Brown - 82 cm H X 83 cm W X 28 cm D (£34

I like how many of the products can store multiple plants within the one product rather than just having the product dedicated to one sort of plant as it is a more efficient and suitable way to use the space provided by the product.

Secondary Online Research/Inspiration on specific raised garden beds and growing tables:

HOMEBASE
Always your home. Always low prices.

Forest Caledonian Tiered Wooden Raised Bed

£95

Romak Raised Planter Box - 102 x 26.5 x 80cm

£34.96

VegTrug - Small 1m Raised Bed

£129.99

VegTrug Natural Wooden - Medium

£180

Natural Wood Wall Hugger - Medium

£170

Greenhouse VegTrug - Medium (Planter Not

£45

Primrose.co.uk

Herb Planter 78cm x 58cm (H80cm)

£69.99

In Stock

Caledonian Tiered Raised Bed - 90cm² (H60cm)

£109.99

5 reviews

In Stock

Next Working Day Delivery

Quick facts

Raised beds are good for:

- Improving drainage
- Increasing soil temperature
- Improving access
- Growing plants in a different soil type

Next Steps:
Investigate further into the ways regarding the construction techniques of my product.

Relevant research on raised garden beds:

- Is a fixture of gardens and allotments, which reduce environmental footprint.
- Can plant many things from small trees, shrubs, vegetables, soft fruits, flowers and herbs.
- Allows for more planting, as the increased depth means that you have a better quality, aerated soil for growing your plants in.
- You have fewer weeds growing, as each plant is physically separated from the surrounding areas.
- Is an improved drainage system, especially when using difficult clay soil and waterlogged areas of the garden, however during warmer weather the plants need extra watering to maintain hydration, which results in constant growth/quality.
- It is a great way to separate particular plants from others in your garden, e.g. protecting from pests, children or from being mown.
- Garden beds are not as compacted and have a better structure for seedlings.
- It is important to ensure the soil depth is correct, meaning extra space can be provided to cater for root vegetables, e.g. carrots, turnips and potatoes, which also allows for looser soil which ensures plants can grow better/more effectively.
- They are usually made from either metal, plastic or wood. The wooden ones are usually made up of garden sleepers/railway sleepers that are pressurised and then treated ensuring their durability. For example galvanised steel can be used, which is very protective and resistant to corrosion. Plastic raised beds are also an alternative option which offer a very strong, durable and affordable design.
- They can be designed into a range of different shapes, for example; squares, rectangles, pentagons, hexagons.
- They can also be made with legs attached to ensure that they cater for individuals who are less mobile than others.

Relevant research on raised garden beds:

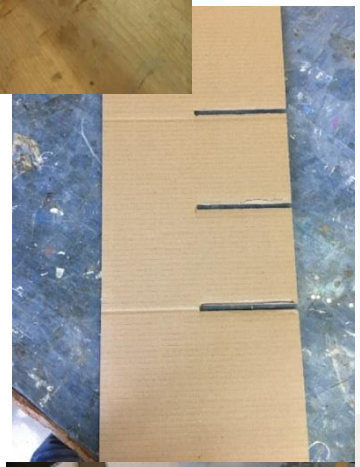
- When picking an area to grow your plants, it is recommended that you find out your soil type to be able maximise the usage of your garden bed, for example they are very beneficial if the soil in your garden is much heavier and poor.
- When using a raised garden bed, it allows you to ensure a nutrient-rich area with the latter to grow your plants in.
- However, if your soil already drains quickly, the bed will drain very quickly also, this means that gravel or stones will have to be placed at the bottom of each compartment within the garden bed.
- It is recommended that you place your garden bed in an area which allows it to receive enough sunlight, this is crucial to warm to soil during the colder weather. To do this properly, the garden bed should be placed facing the north direction for example.
- If the garden bed is to be placed onto concrete, a plastic lining should be placed in the bottom of the bed to prevent leakage/drainage from the plants.
- Adding organic matter into the beds is also highly effective, as well as mixing your garden soil with compost to make sure that the soil contains all the needed and useful micronutrients along with earthworms for example.
- You must ensure that you water around the inside edges of the garden bed to ensure that the soil near the edges doesn't dry out, as the heat from the sun creates an environment which dries the soil out, creating the perfect habitat for red ants which can disturb the plants and their growth.
- Raised garden beds should be moved inside during the colder months of the year, because an elevated soil temperature may fall below that in the ground effecting the plants state, however this will not effect beds close to the ground, only ones above, e.g. garden beds with legs.
- It is recommended that crop rotation is practised in the raised garden bed, for example rotating the crops you grow in a four year cycle, in order to achieve the best possible yield.
- Asparagus is a traditionally grown crop, which is suited well to the well drained soil/conditions that a raised garden bed provides.

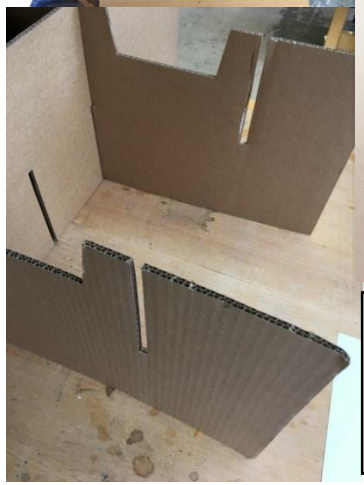
Primary/First Hand Research/Inspiration:

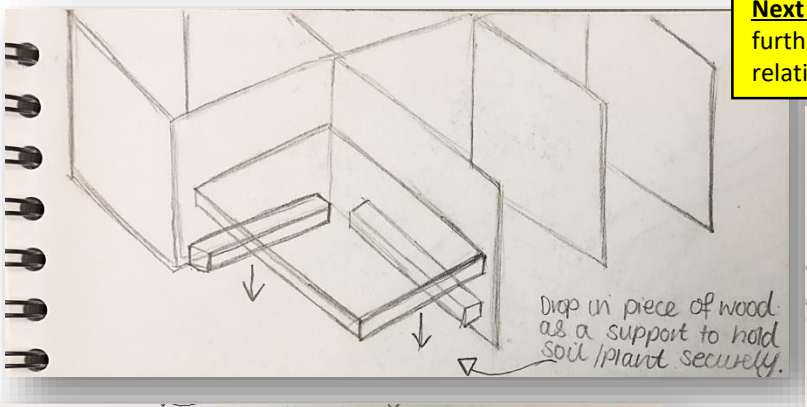
When progressing with the idea of this interlocking system I also need to think about how I could create bottom pieces which can either slot in the bottom of each compartment underneath to be able for it to hold the soil for the plants but have holes in it to ensure water can escape, this means that when replanting in the product you can remove the slotted in bottom supports to release the current soil/plants in the product and clean it out if necessary and replant some. An alternative idea would be to have drop in pieces with supports so that you can insert them and they would hold the soil, however then it would be fairly difficult to find a solution of removing them as they wouldn't be able to be pulled out from the bottom (underneath), all the soil would have to be removed so then you could remove the piece of wood.

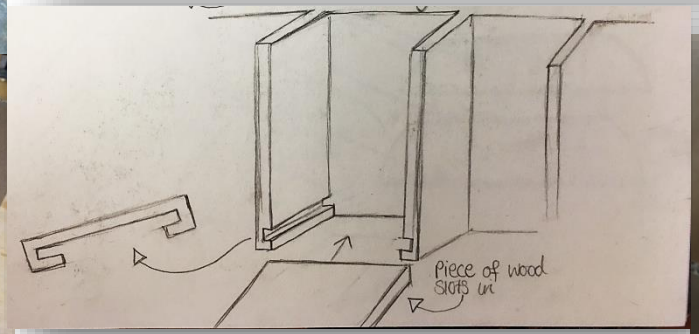
Next Steps: Carry out some secondary research to investigate further into flat packed furniture and any existing products relating the idea of an interlocking system.

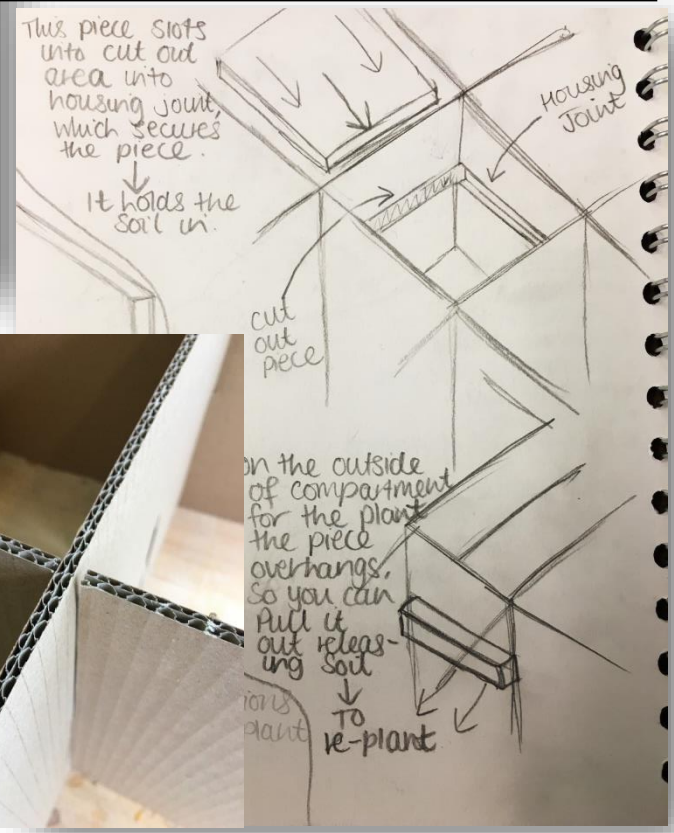
Firstly, once I knew that I wanted to make a storage system to store plants in the garden, I began to think about the certain way the design of the storage element of the product would be constructed. So I found this interlocking cardboard model structure from Costco, and looked how I could incorporate this idea into my product. I really liked the functionality and practicality of this interlocking idea, as it is easier to manufacture, construct, and cheaper to produce as you don't have to use expensive woods I could just use plywood and it would still remain a sturdy structure due to the design configuration. I like the idea of using interlocking pieces to make up my design, because I can easily design the pieces on CAD (2D Design) and laser cut models to work out the design and the progression towards the final end product. From this point I am going to start to design CAD models of the top interlocking storage element before experimenting with creating the legs of the product and the side storage element etc.

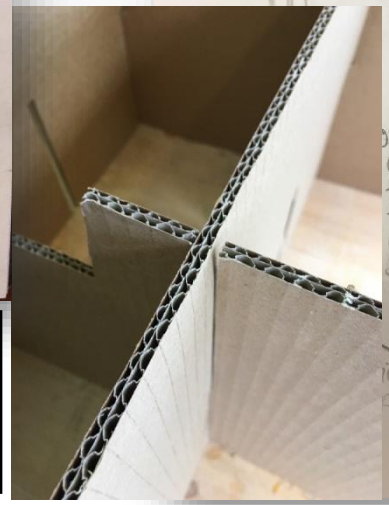












Conclusion of this research:
My product will have many different compartments within the design which consists of an interlocking system enabling the product to be flat-packed and allowing many different sorts of plants/flowers to be grown.

Secondary Online Research: Flat-packed Furniture:

https://www.somerlap.co.uk/blog/flat-packed-gar... Pre-assembled or flat packe...

Flat packed garden furniture

Flat packed garden furniture is great for those on a tight budget as well as DIY enthusiasts:

- Assembling a product yourself will normally save costs.
- Great for gardens or homes with limited access. The product is boxed up and much smaller, so can fit through tighter gaps.
- Easy to store until you need it, for example if you're buying furniture in autumn or winter.
- Fun to build if you love DIY!

All Somerlap flat packed garden furniture is securely packaged and comes complete with quality fixings and easy-to-follow instructions.

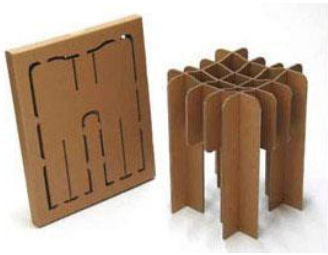
Both pre-assembled and flat packed garden furniture have their pros and cons. Here's how to decide which is right for you…

Pre-assembled garden furniture

No time or inclination to assemble? Pre-assembled garden furniture is for you:

- No set up time, good for busy homeowners.
- Ready to use straight away, ideal if you have a BBQ or garden party coming up!
- No tools or DIY skills required.
- Perfect for those with limited mobility who would struggle with set up.

Existing product research - Packaging of flat packed/Interlocking furniture:



What is Flat Pack Furniture Made From?

The materials used for the making of flat packs is either solid wood, medium-density fibreboard, or chipboard. MDF is the product of the residuals of softwood and hardwood mixed with wax and combined to form a panel and is stronger than chipboard. Chipboard is made from wood chippings, sawdust, wood shavings or particles, and are bound together into a board.

The chipboard material is cheaper, but it is also quite stable. The only disadvantage of it is that it is more susceptible to water damage. Solid wood can crack due to time or environment conditions, which is something that cannot happen to chipboard.

MDF prices can vary as well, but if it is of a high quality, then it is much stronger than chipboard. It is easy to shape and work with, unlike solid wood. It is often used in furniture such as desks, and cabinets.

Next Steps: Gain some more primary first hand research which looks at existing garden beds.

Disadvantages to Flat Pack Furniture:

- Simple and limited designs
- You have to read complicated instructions to be able to build the furniture
- Disassembly and reassembly of the same piece of furniture many times can decrease the products durability/may cause damage
- Low durability – as its made from man-made MDF
- Limited style/originality despite modern aspect
- You may have to pay extra money for someone else to assemble it for you if you cannot.

Advantages to Flat Pack Furniture:

- Affordable – due to mass production
- Easily Transported/shipped/disassembled and put together
- Less expensive
- Can be customised
- Compact
- Variety of colours
- Eco-friendly and sustainable – uses more solid wood
- Uses machines meaning companies don't have to pay individuals for their labour to make it.

Primary/First Hand Research:

Next Steps: Visit existing companies/places which sells garden beds and take photographs to be able to gain knowledge and ideas for when designing my own product.

From looking at the product closely, I can see that there must have been a layering of wood on top of each sides of the garden bed covering up the top so you cant see the layers of material. Or it could have just covered the corners to improve the products appearance.

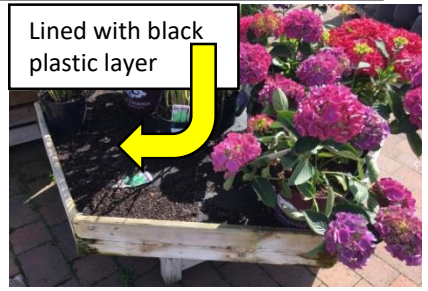
When looking around the gardens of my secondary school to find inspiration/ideas for plant storage solutions, I came across this old plant bed which I thought would be good to look at and see the sorts of materials used and the durability of these materials, the structure/construction of the product, the overall appearance/aesthetics, any defects the product has produced over time, any wood joining techniques and the finish/weathering protection on the wood e.g. varnish, wax, paint, veneer, chemical treatments etc. This is to see what techniques are most effective to give me more ideas on what techniques are reliable and durable, however I do need to consider that I want my product to be interlocking and flat packed meaning I am limited with other techniques I can incorporate/add, materials I can use, wood joints especially (as my design I will produce should be interlocking to enable it to be flat packed, be easily transported and light this means that it would be difficult to try and then incorporate other wood joints, as this would unnecessarily increase the complexity/cost of the design making it harder to produce/design/construct the product quickly and efficiently)etc.

For this garden bed design, by analysing the product and looking at all of its features, I think they would have used a wooden frame as the main structure of the plant bed, then used waterproof glue to attach exterior plywood on to the outside, and I could also see a layer of plastic on the inside to protect the wood and hold the soil within the bed. I think the idea of this product is purely based on the design of layering, making the product stronger and more durable when more layers are added, this is why it has lasted a fairly long time. When talking to staff who have been at the school for a fairly long time I found out that the garden beds were installed about 5 years ago, however from looking at them it seems as though their appearance has been slightly altered due to weathering of the product, as the wood has lost its colour and any sort of protective solution/coating of the wood e.g. varnish that would have been applied when they were made/installed.

First Hand/Primary Research – Garden centre visit:

They have plant storage which caters for plants which are much taller than a lot of the plants, where they would be placed underneath it and tied to the piece of wood above to ensure the straight growth of the plant. Also, they have storage solutions where plants can be placed at the bottom of the piece and then there are compartments sectioned above so you can store double the mount of plants and a range of different sized plants.

From my images I can see that they have a range of storage outdoor solutions to store their plants in, they have things which have sectioned compartments similar to my idea where you can store a different plant in each section, they also have storage where it isn't sectioned, it is just one whole piece and you can fit as many plants in their as possible and it has a lining of black plastic inside to protect the wood from being affected by the plants moisture.



When looking around Haddenham Garden Centre, I was interested in the various ways that the plants were stored throughout the inside and mostly outdoor facilities in the centre and the ways in which the plant storage solutions were constructed, the materials used and the finishes to the wood.

They have bottom connected pieces to provide extra support and height to the storage design.

Next Steps: To come up with a range of initial design ideas for my product, and get my clients opinions/feedback on them.

William Hands Furniture Visit:

each bespoke product is hand made.

Industrial scale machinery used.

Various batch produced wooden parts

process of attachement of various sheets of material together.

Different wood types used

If my product was to be produced commercially, this is the sort of workshop environment it would be constructed/produced, the machinery used, as it would keep costs down when bath producing, and would ensure my product is manufactured accurately.

Each product is suited for a various environment, e.g. an office for different companies.

consistent Product

Each Individual Product is time consuming.

batch/Mass production

each piece is identical and precise.

The design looks sleek and modern.

Showing us all the different woods they use and why they choose to use them.

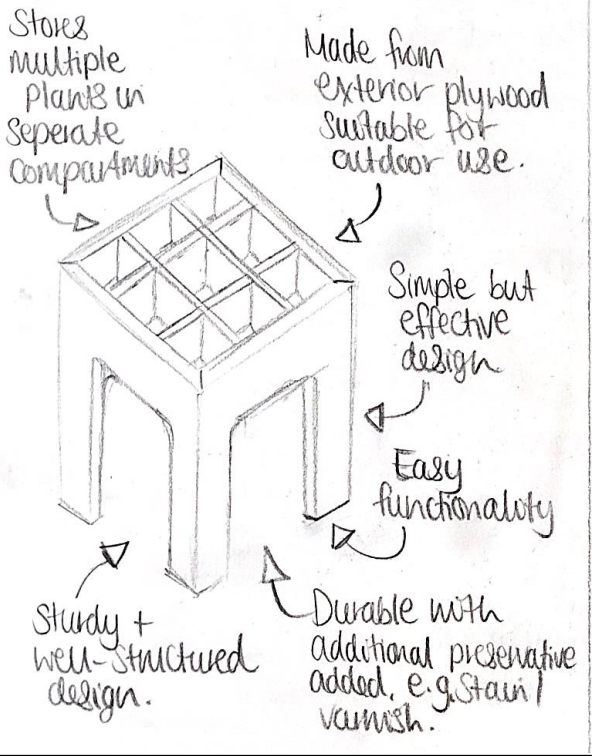
Next Steps: To create different variations or alternative designs of my design idea to consider all my options and maximise my generation of ideas.

First Hand/Primary Research:

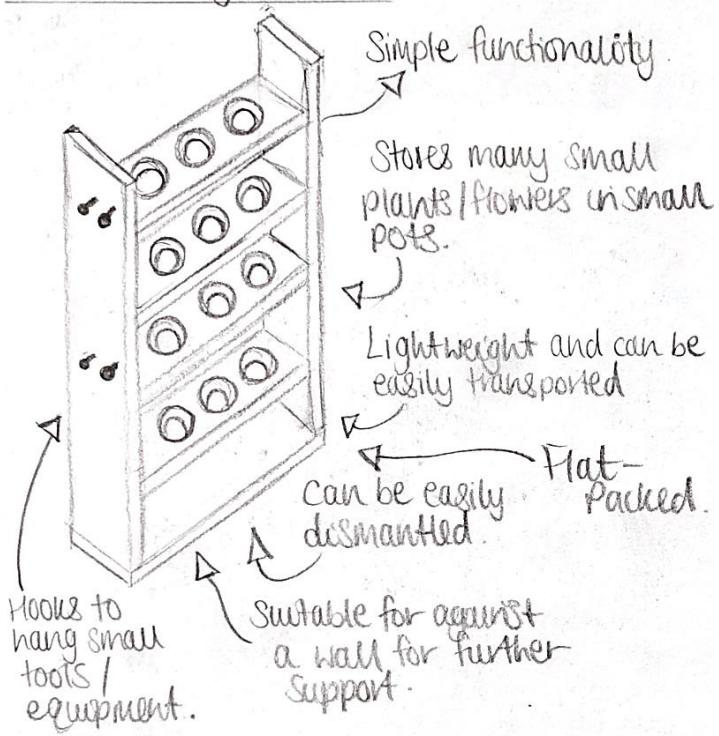
Initial Ideas (Plant Storage):

For my initial ideas, I have come up with a range of ideas relating to my main theme of garden/plant storage while also considering my target market of the elderly to ensure the product is easy for them to use and function in everyday use. I have produced a range of ideas spanning from storage units with shelving to store plants, a folding flower/plant stand to a potting station for gardeners and even a mini greenhouse to store particular small plants which need certain conditions to grow, maybe they are more tropical plants etc. I have also come up with the idea for a raised garden planting bed to store/plant multiple plants/flowers within one product.

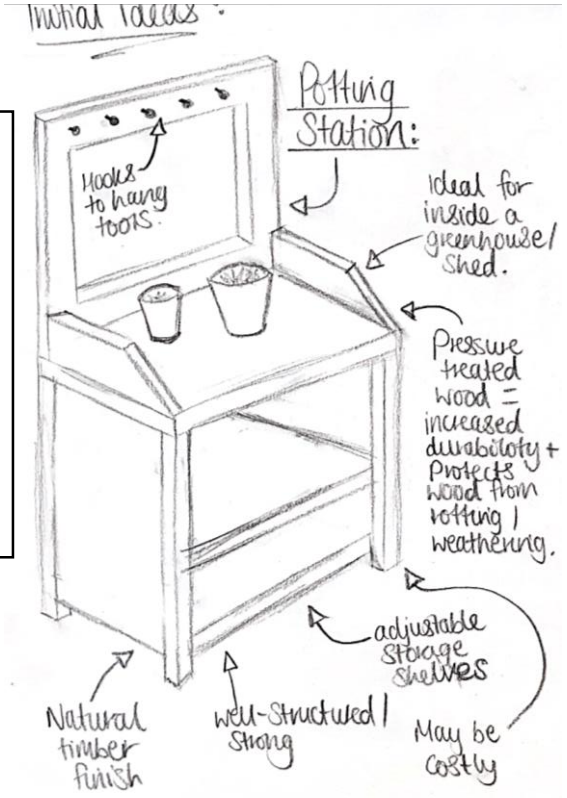
Raised Garden bed/planter:



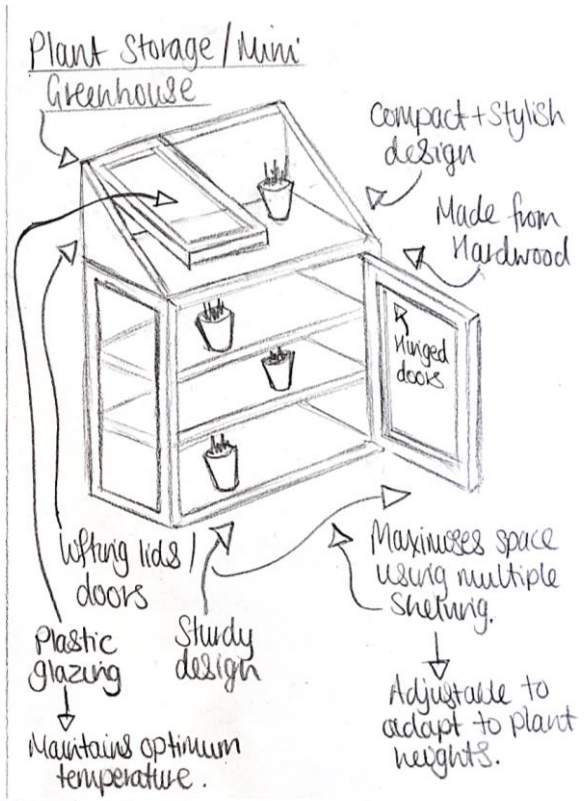
Plant Storage Unit:



Initial Ideas:

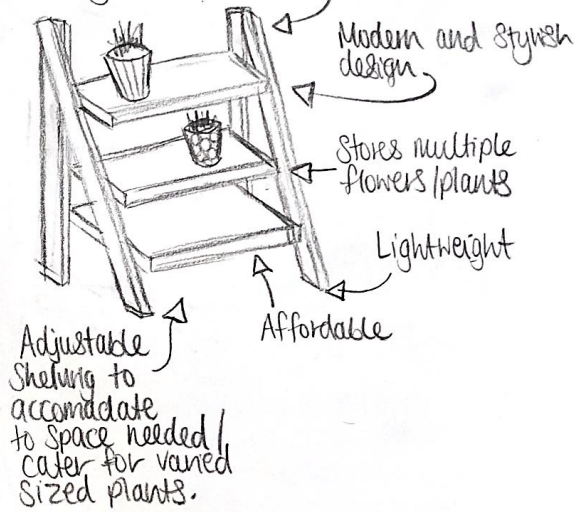


Plant Storage/Mini Greenhouse



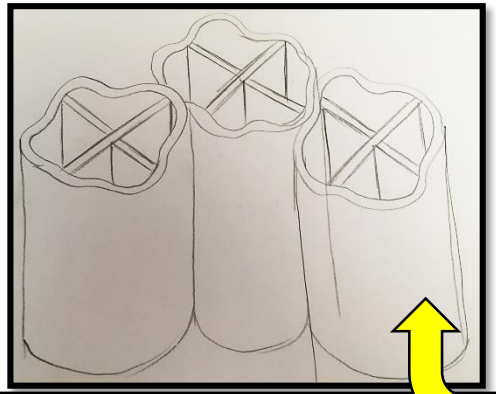
Regarding the cost of the product, I have to also take into consideration that different people will have different budgets and ranges in which they are able to afford/spend on this product. I must also ensure that the product is made from a suitable material in which is suitable for the conditions in which it will be held (outdoors) – also whether this means a protective finishing will need to be applied to ensure its durability. So I need to choose a design from this range which can meet all these specifications/requirements.

Folding Flower Stand:



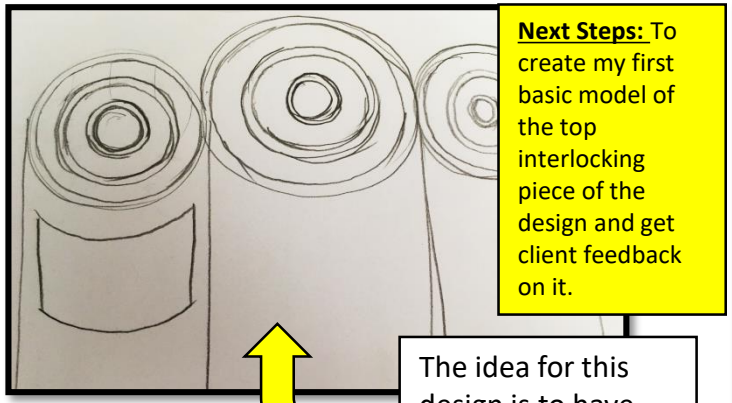
At the moment, my favourite idea in which I would like to develop further would be the raised garden bed/planter. This is because I would be able to incorporate the idea of making the product interlocking and flat packed which links back to my research. I think that using these elements within the product would make it more appealable to consumers, because the product would be more unique and practical regarding transportation, assembly and use in general.

Design variations of my chosen idea (Raised garden bed/planter):



This is a modern looking design, which has compartments suitable for planting four different types of plants, they could be produced individually or as a set of three garden beds.

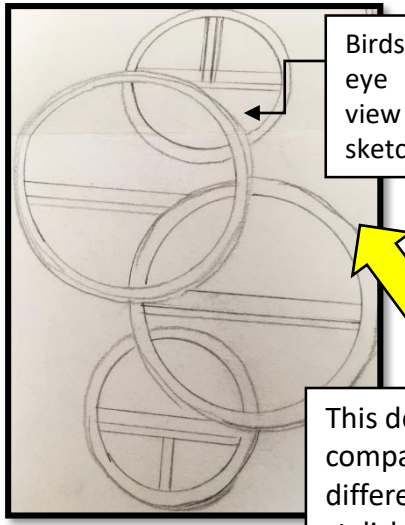
Client Feedback:
'The design is too deep in proportion to the width of the garden bed.
It has a good interesting shape.
It meets its function as you could tip it upside down to empty the soil out when cleaning and replanting.
However how it is supposed to hold the soil in and be transported without soil falling out the bottom – I suppose you could put a bottom piece of wood which can be slotted in and pulled out when needed.'



Next Steps: To create my first basic model of the top interlocking piece of the design and get client feedback on it.

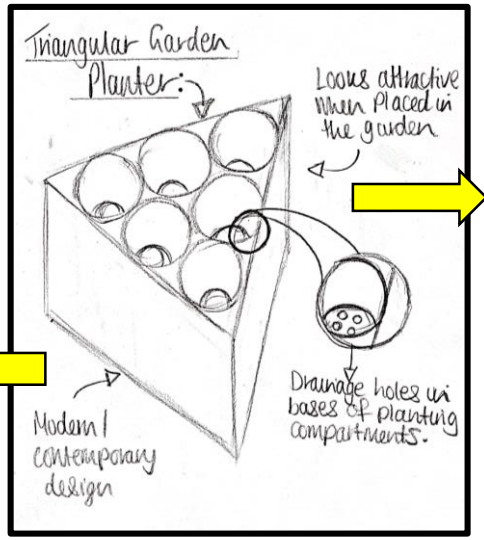
Client Feedback:
'Depending on size (width of each ring) there wouldn't be enough room to plant different species of plant or empty specific ones.
To empty the soil out, as its so long you could use a slot-in piece of wood in the middle leaving room to place a bucket underneath to collect the soil .'

The idea for this design is to have one solid structured garden bed with three different compartments to plant different things in, so then it gives a aesthetically pleasing appearance as every ring is a different colour/species.



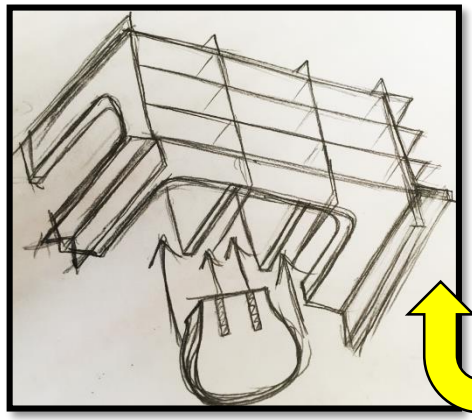
Client Feedback:
'The idea is too complex. Not really that practical as there isn't much room for each plant despite being an interesting looking design. Although it isn't that practical it would look good when displayed.'

This design idea features many compartments catering for many different things to be planted, using a stylish structure/shape to display these in.



This is a modern and contemporary design idea which is a unique take on the more traditional raised garden bed/planter. The design features multiple circular planting holes, which are deep enough to hold the minimum capacity of soil and allows for drainage of the plants also with small holes drilled into the bottom of each compartment. The design looks cool and funky, however the design may be quite heavy and more difficult to transport.

Client Feedback: ' I like how this idea is very unique, as I have never seen anything similar to this and its triangular shape before. I think that it is more of a visually pleasing product rather than being 100 % practical, however it would definitely be suitable for using in the garden to plant specific plants and flowers in. Overall, I think it s a new and exciting design which could be developed further to suit for more particular needs/specific customers but would make a good addition to the garden storage options in my garden'.

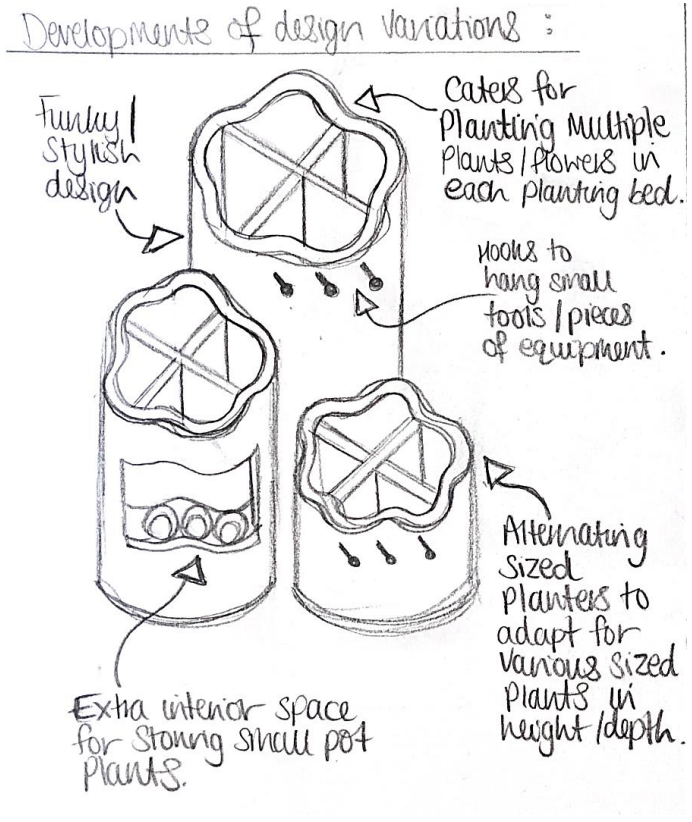


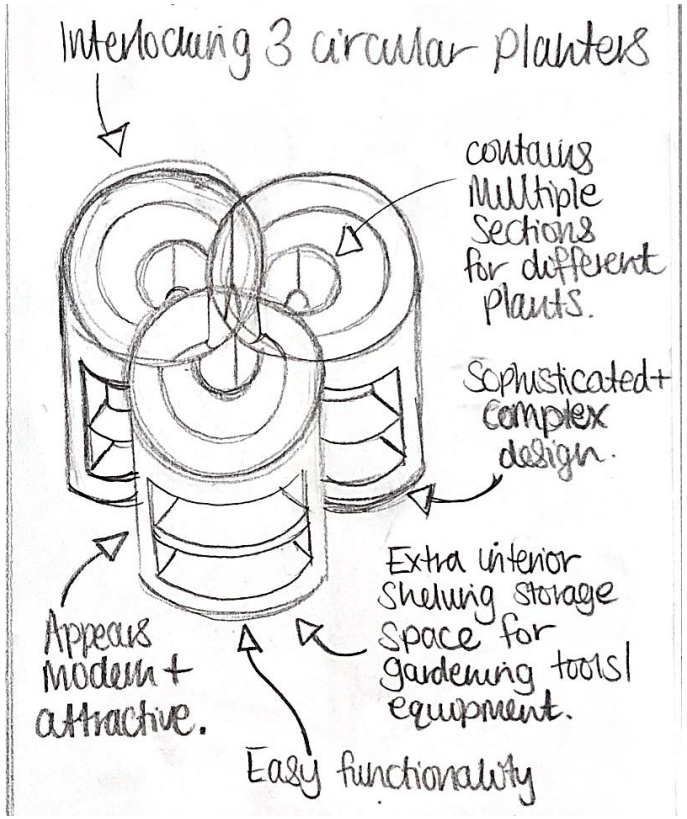
Client Feedback:
'Good seat idea which is suitable as I could sit down while gardening.
I think that it should be constructed so that the pieces which are slotted into the side are flush rather than sticking out.'

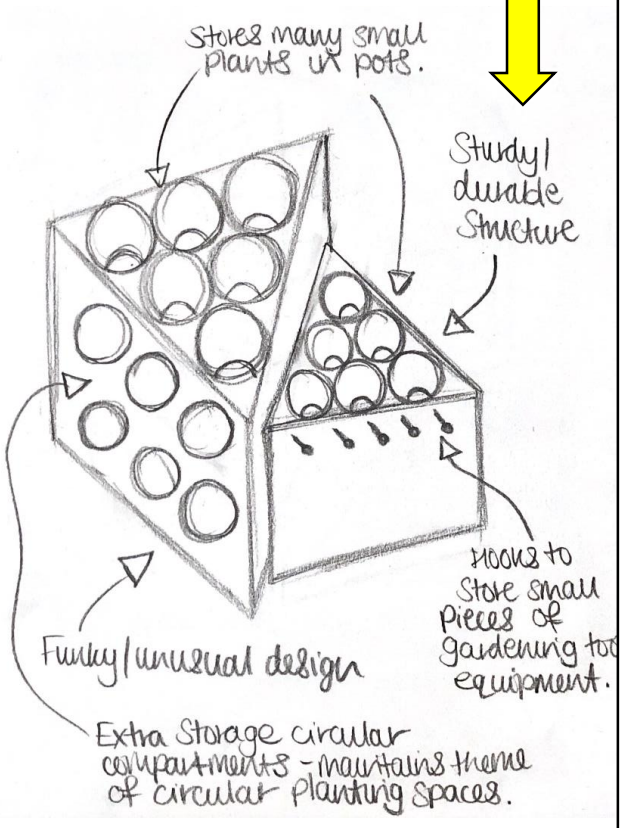
This design uses the idea of an interlocking system which can be flat packed and features a slot in seat to allow the client to sit down while planting.

Next Steps: To get in contact with my stakeholder, so that they can pick their favourite design which meets all of their needs and wants, so I can begin experimenting with the chosen design using CAD software and initial sketching.

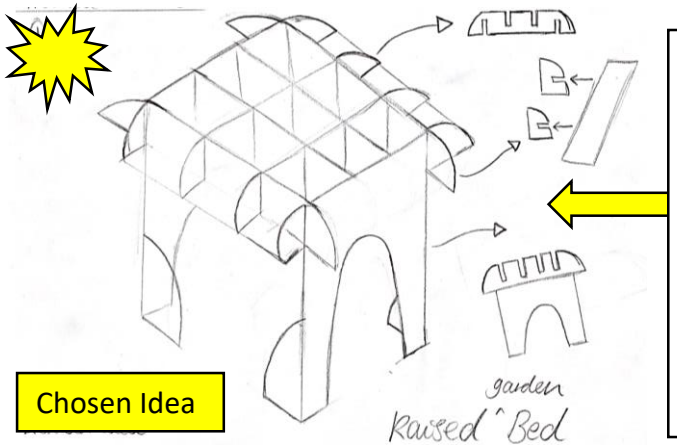
Sub-ideas/Developments of design variation ideas:







When developing my design variations I have ensured that I sustain an imaginative and unique style when adding additional elements to my designs which would appeal further to my target market and overall consumers. I have applied additional features, for example; metal hooks to store small pieces of equipment/tools, internal shelving which is build into the product to store anything to do with gardening in general which can fit into the spaces, and within this extra interior shelving I have incorporated extra space for storing small plants in pots which I think would look very attractive once in place, while also increasing the products functionality and maximises the space available within the product well.



For my chosen design idea, it is a more modern/stylish take on an interlocking and flat packed idea. It had shelving on the outer sides to allow for more storage, it has supports on the legs to ensure it stands freely and securely without falling over. It also allows easy access to empty each plant and its soil once needed to replant.

Client Feedback:

'Not suitable for planting vegetables or big flower species as there isn't enough space, it is only really suitable for small flower species.

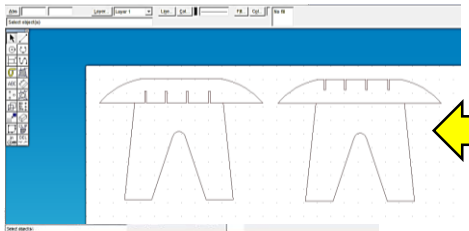
I think it would be better if the end pieces were square not curved.

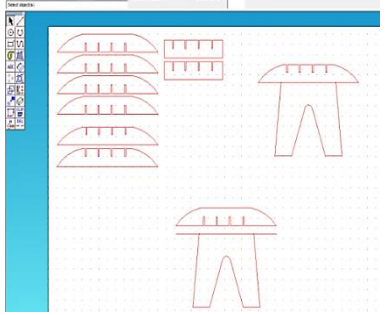
Maybe not make it flat packed as you can't have normal joints because the sticking out parts look out of place and a bit unnecessary.

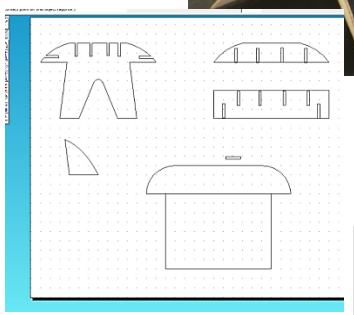
I'm not sure how you would ensure that the slotted bits stay together securely.'

First rough experiment with design idea using CAD:

Firstly, I tried to experiment with creating a CAD design of an idea of what my product could look like just to give me a bit of an idea of what direction I was to progress in.
I began trying to create the side pieces, experimenting with the shapes I would use to make the appearance look more funky/stylish, I tried making the other pieces which would slot into the other pieces. After having a little experiment with shapes/ideas found that It would probably be more sensible to start designing the storage interlocking element of the product first rather than add a lot of complexity by trying to design the whole thing at once, which is more likely to not go right as I cannot put my focus on individual elements of the design to ensure that each part is the best/most suitable it can be.

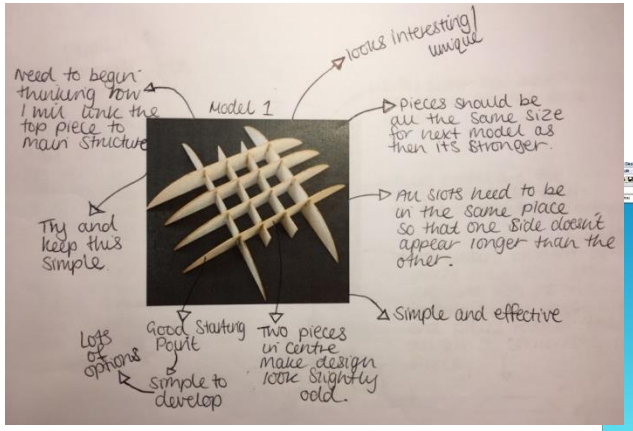


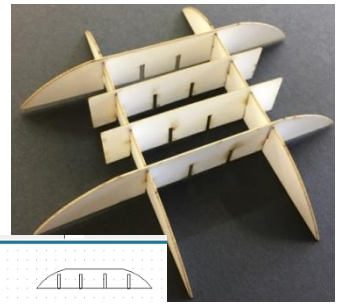


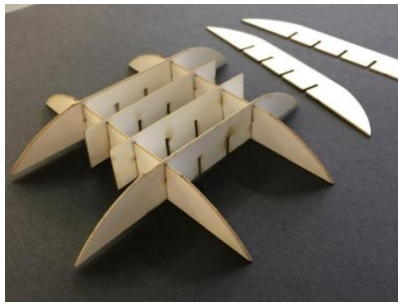


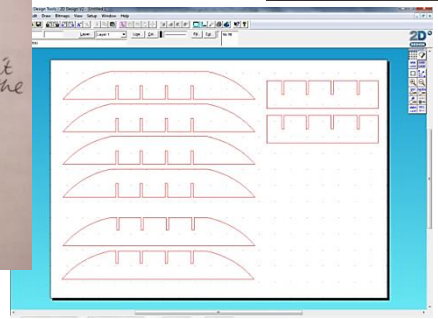
My stakeholder looking at my chosen idea design variations:

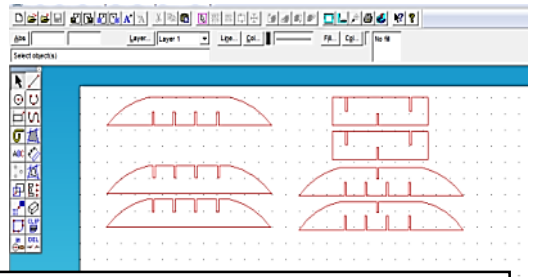
Model 1 – Developing design of interlocking top piece:

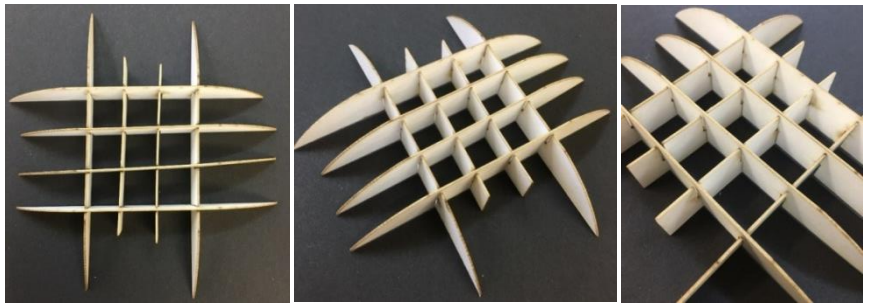












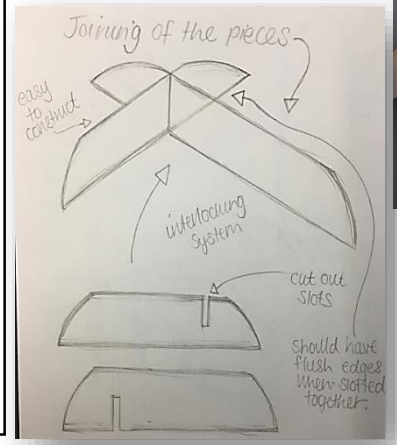
This CAD design shows the design of each individual piece of the interlocking storage element of the product. I also added in the parallel slots to start to get an idea of how it would slot together etc.

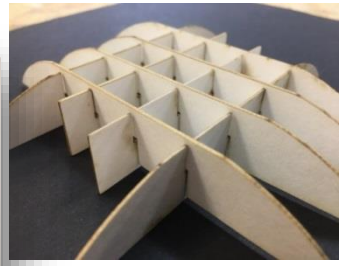
I then reduced the scale of this CAD design down to A5 to ensure I didn't waste any materials when laser cutting the model out. (I used thick card when laser cutting and I also had to cut through the material multiple times to ensure it went through).

After cutting out the design and constructing it I found that I could experiment with this model further my adding more slots into the pieces so that I could construct the model in a different configuration just to see if it was a more successful way than the first one.

From this model, I can see that the idea for the design of the interlocking system my design I based on is fairly effective as it looks aesthetically good and interesting, meaning it would be more appealable to my client/consumer.

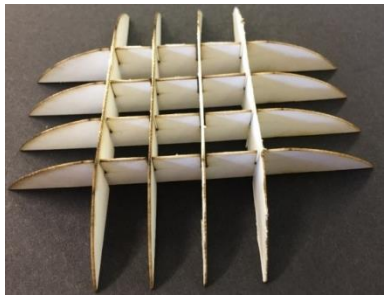
I think that this was a successful CAD experiment, as it has given me more of an idea about how the structure of the top interlocking section of my product would be constructed. However next I need to create another CAD model which has a more practical idea for the interlocking system, for example one that has all larger pieces rather than the two smaller interlocking pieces also, because they are less stable and sturdy. I also need to begin to develop a CAD model which has interlocking pieces to slot into the sides of the model as shelves which I wanted to include in my design, to get a further idea of how I would construct this element of the design.

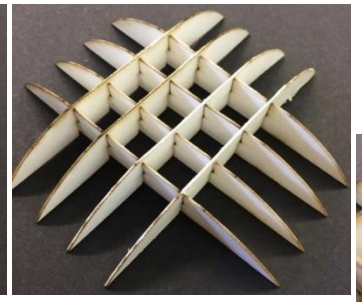


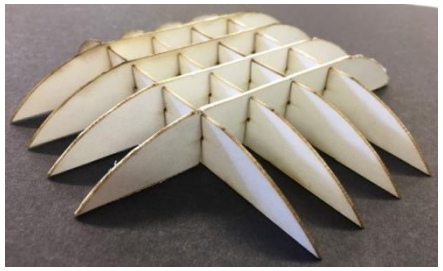


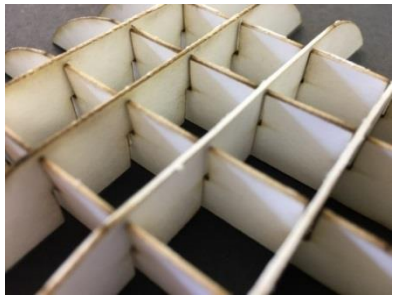
Next Steps: To create another model so that all pieces are identical to see if the outcome is more successful.

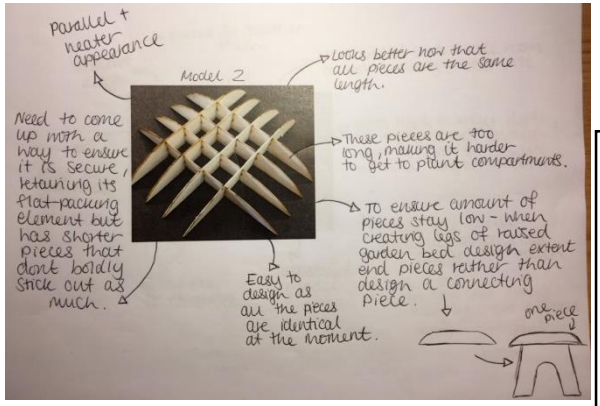
Model 2 – Developing design of interlocking top piece:

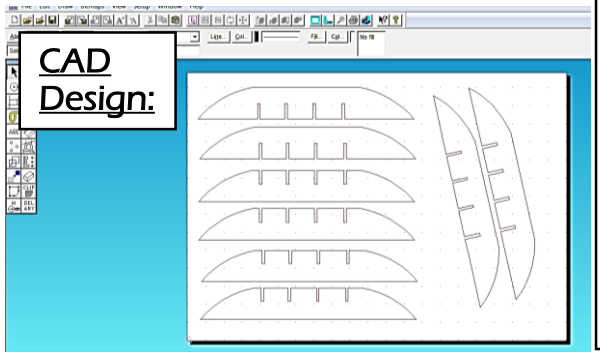












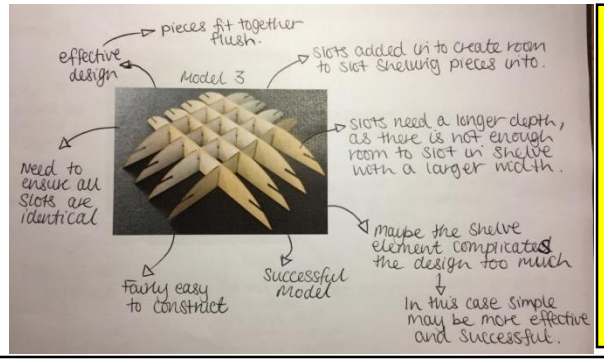
CAD Design:

For this model, I have developed my previous model variation by making every pieces the same exact size and shape to have the design look more flowing and fluid as I thought for the previous model the two shorter pieces in the middle of the top piece looked slightly odd. I think that this variation looks much better because each side is more parallel and sleek, also it allows me to easily add in shelving to each side of the model, whereas if the pieces that stick out on each side were differently shaped/length it would be harder to create a shelving piece for each side that fits perfectly.

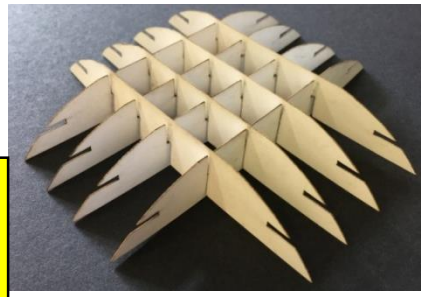
When doing these designs, I began to develop the design of the interlocking top piece so that it just consisted of 8 pieces all the same shape/size to make the design simpler to construct and develop the remaining elements within it.

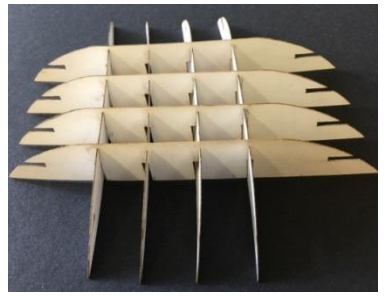
Changes made to model:
Pieces made all the same shape and size to create a visually better design.

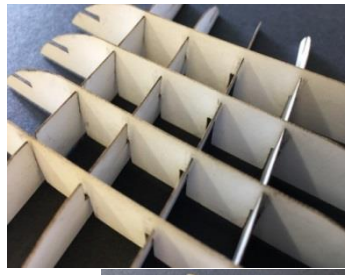
Model 3 – Developing design of interlocking top piece:

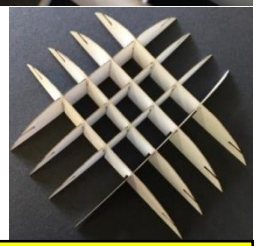


Changes made to model:
- Added slots to cater for a shelf on each exterior side to be inserted to maximise the storage element to the design.

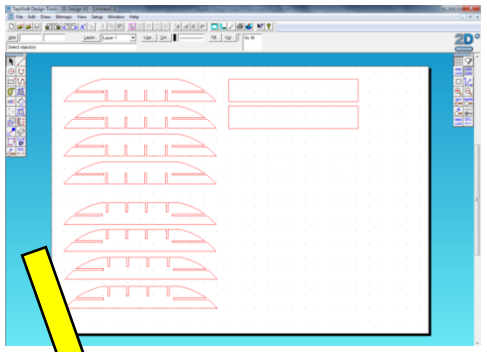


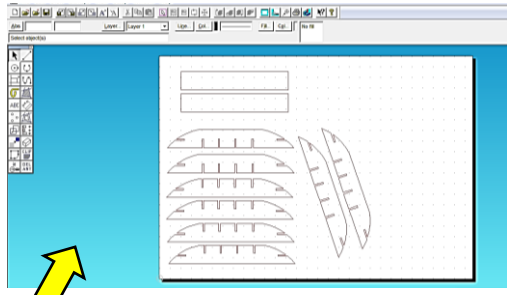


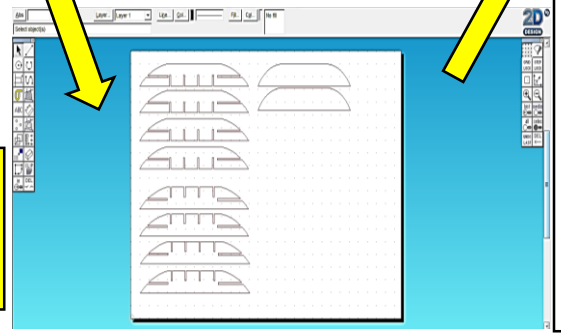




For this model, I continued to develop my design for the top interlocking element of my product by adding in slots to be able to insert shelving into each side of the model. However I found that for it to look right I need to make the shape of the shelves the same shape as the other pieces and I need to make the slots much wider in length to be able to fit the shelves in so they are not sticking out.



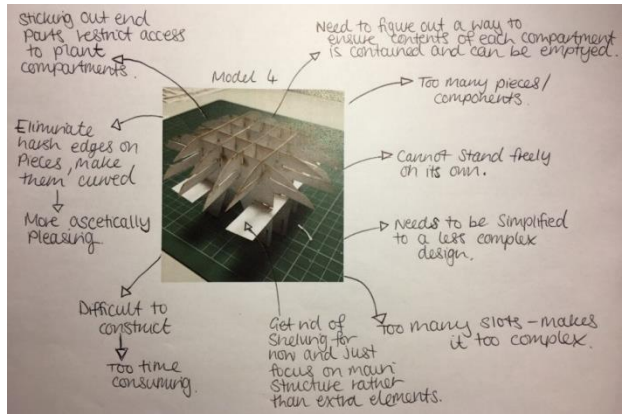


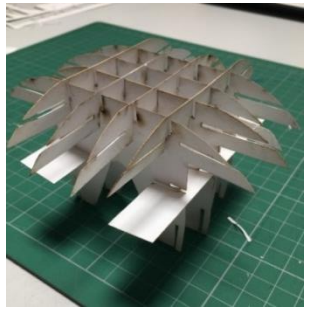


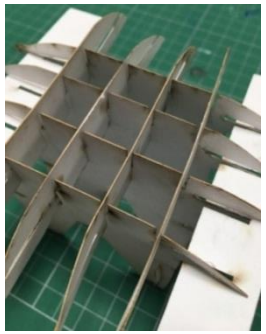
I developed the design so that there were cut out slots to be able to insert shelving on each side of the top interlocking system element of my product.
I have also designed the shelve size so that the depth and length will suit the design of the top piece, however this element will have to be further developed as I go along.

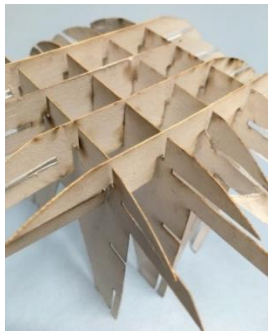
Next Steps: To create another model but try and experiment with making the whole design rather than just the top piece just to see what it could look like and where I would need to go from that point to develop the deign into a functioning product.

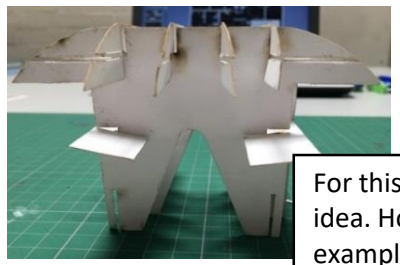
Model 4 – Developing design of interlocking top piece:



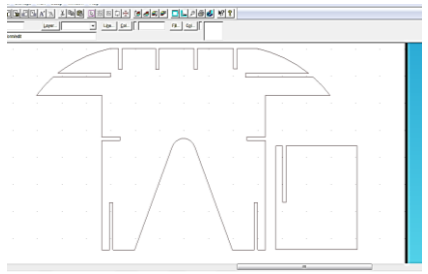


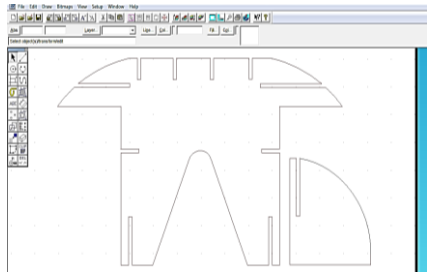


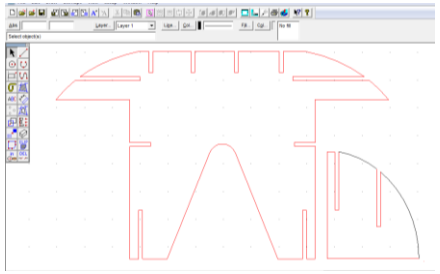


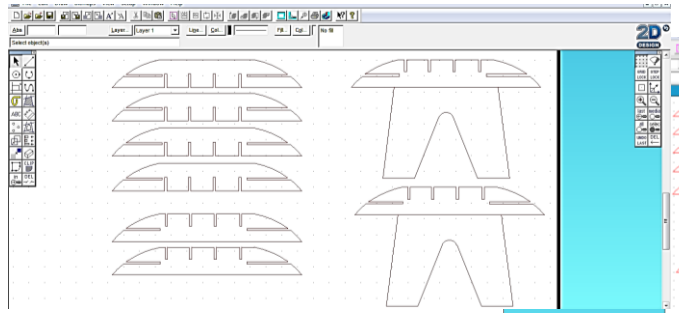


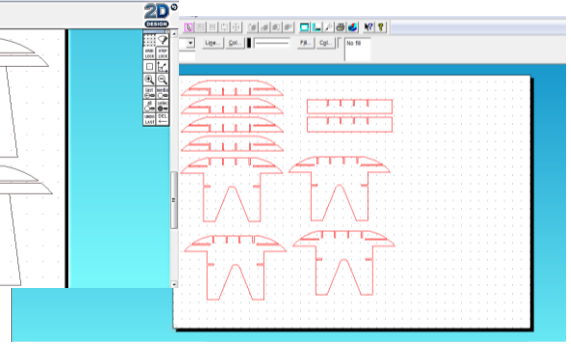
Progression of CAD Design:

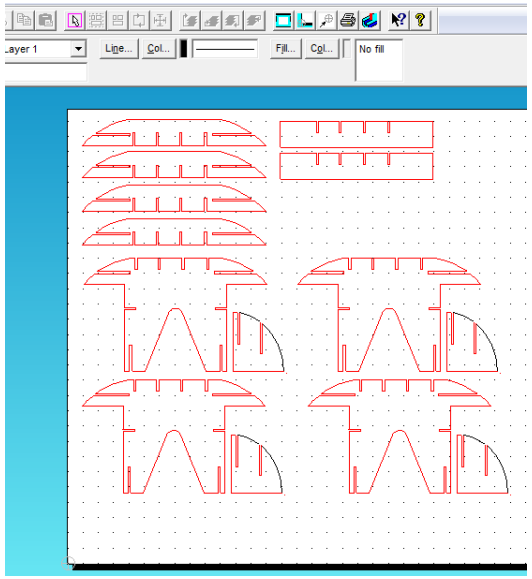












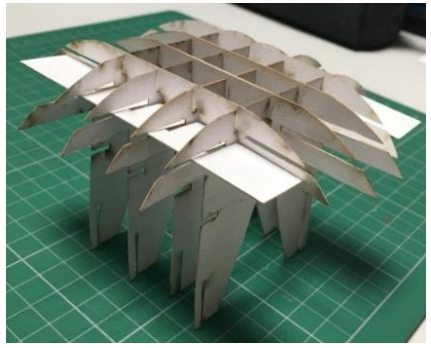
For this model, I attempted to construct the whole basic design rather than just the top piece idea. However, in doing this I found many improvements that need to be corrected, for example I need to develop the design to ensure it actually can stand freely and is strong and secure, I need to simplify it so that there isn't so many pieces, which is making the design and its construction very complex, I need to develop the shape of the pieces, e.g. curve the edges and get rid of the harsh edges, I need to go back and just focus on the main structure rather than trying to think about extra elements like the shelving on the outer sides, leg supports etc.

Stakeholder feedback:

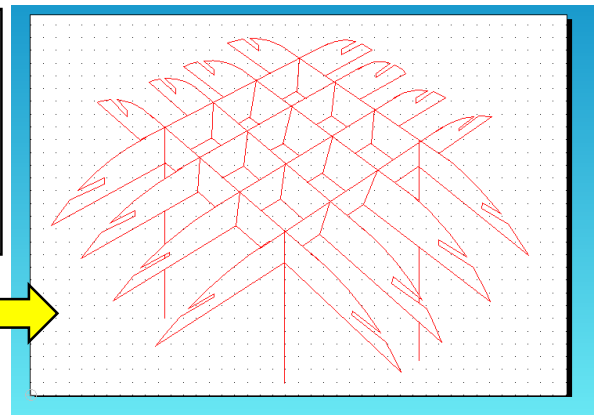
'I think you could get rid of the side sticking out parts as its not good use of space although it may increase the strength of it.
The design is too complicated and I think that it needs to be simplified, and if that means changing the idea of flat packing it and the interlocking system idea you may have to change it.'

Changes made to model:

- First attempt of modelling entire design idea rather than just the top interlocking element.
- Slots added to legs to be able to insert support piece to give it a sturdier structure.



Full idea of what top interlocking piece could look like:



Next Steps:

- To begin to gain primary first hand research into the different materials I could use to make my product out of and which one is most suitable.
- To create a fifth model which is more simplified, refined and focus on a main structure/design rather than trying to incorporate many elements at once, which makes it too complex to develop and construct.

Secondary Source Materials Research:

Manufactured Boards:
- Manufactured boards are made from processed timber, and come in various forms.
- They are mostly made into sheets, which are then used to create products.
- Most boards are supplied in standard sizes, and in a range of standard thicknesses.
- The various manufactured boards vary in cost, and are suitable for different applications.

Manufactured Boards Research:

Type of Manufactured Board:	Properties:	Uses:	Limitations/disadvantages:
Plywood	• Very strong		
MDF	• Relatively cheap • Quality material		
Block board		• Furniture Manufacture, e.g. fitted kitchens/bedrooms.	• Not suitable for exterior use
Chipboard	• Not as strong as plywood/ block board • Not expensive		• Only really suitable for interior use
Flexible Plywood			
Sterling wood			
Hardboard	• Cheap • Not as strong as other materials		• It absorbs water, meaning it is not suitable for exterior use.

Hardwoods tend to have a tighter grain, and take a long time to grow. They come mostly from deciduous trees.
Softwoods have a looser grain structure, and take less time to grow than hardwoods. They come from coniferous trees.

Wood Joining:
- Adhesives
- Traditional joining methods (wood joints)
- Screws and nails
- Nuts and bolts
- Knock Down Fittings

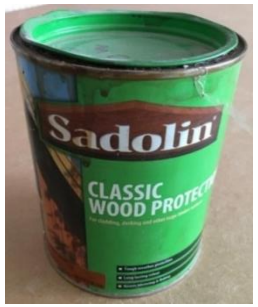
Softwoods Research:

Type of Softwood:	Properties:	Uses:	Limitation /Disadvantage:
Scots Pine	• Low stiffness/resistance • Medium bending strength • Harder on side grain and tougher.	• Furniture • Joinery/Turnery • Vehicle bodies • Construction • Carcassing • Railway sleepers	• Non-durable • Susceptible to insect attack.
Spruce	• Straight grained • Light in weight • Medium density • Moderate strength	• Decorative plywood and veneer. • Domestic flooring • Factory flooring • General carpentry.	
Douglas Fir	• Relatively knot free • Straight grained • Moderately durable	• Veneer • Plywood • Structural/construction.	
Red Cedar	• Light in weight • Straight grain • Quite durable • Moderately inexpensive	• Cladding buildings. • Boatbuilding, boxes, crates, and musical instruments.	• Not very strong

Hardwoods Research:

Type of Hard wood:	Properties:	Uses:	Limitation/Disadvantage:
Oak	• Hard • Very Strong • Tough • Open grained	• Expensive furniture • Interior woodwork	• Expensive to buy due to short supply. • Corrodes metal fittings
Teak	• Straight grain • Naturally durable • Moderately hard • Low stiffness • Contains oils which means it is resistant to decay.	• Ship/boatbuilding • Veneer • Furniture • Exterior construction • Carving	
Beech	• Close grained • Tough • Hard • Strong • Warped easily	• Toys • Furniture • Flooring	
Ash	• Light • Creamy-brown colour • Open grained • Tough • Flexible	• Sports equipment • Wooden ladders • Tool handles	
Mahogany	• Straight grain • Versatile • Rich, dark coloured wood • Fairly strong • Durable • Some interlocking grain	• Good quality furniture	

Wood Finishes primary Research (My Photos)



Protection of timbers:

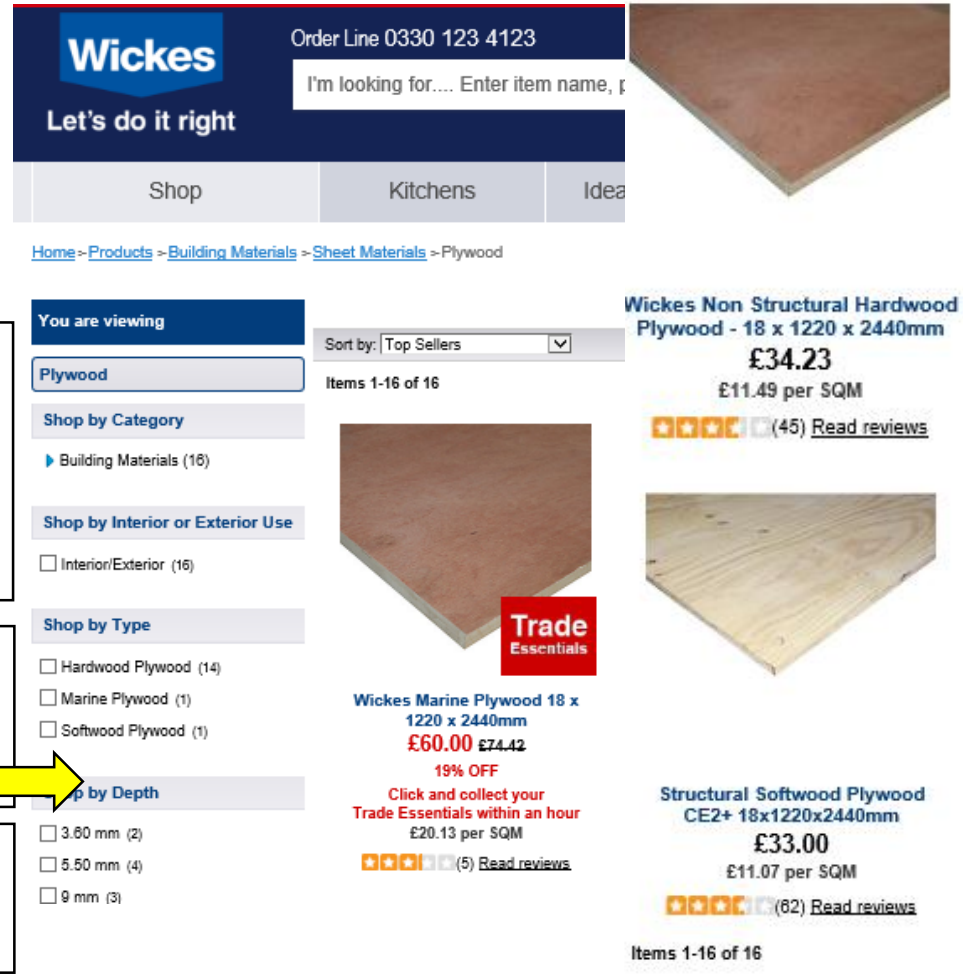
- Chemical treatments such as tanalising
- Varnishes and stains
- Waxes, polishes and oils
- Paints
- Veneers

I found many different wood finishes I could use for my project, however I next need to research which one is best, most effective, lasts the longest and if it is suitable to be used on the particular type of wood that I choose to use. I also need to ensure that the intended finishing product doesn't harm the plant within the raised garden bed/planter.

This is the price list for all the materials which are supplied by the school, which will come in very useful for me once I know how much plywood I need for my product when it is made.

Plywood is too expensive purchased from normal suppliers, best to buy from school supplier as its cheaper is easily sourced as I don't have to travel to purchase materials.

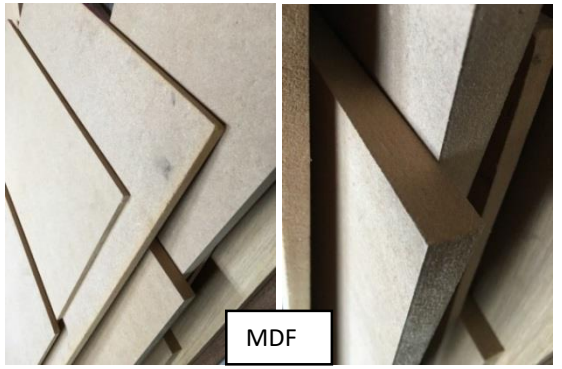
Prices of Materials – Secondary Research:



Materials and Finishes for wood – Primary Research:

Various types of Plywood (Different Thicknesses)

Chipboard/Sterling Board



MDF

I will need to use marine or exterior plywood when constructing the final product.

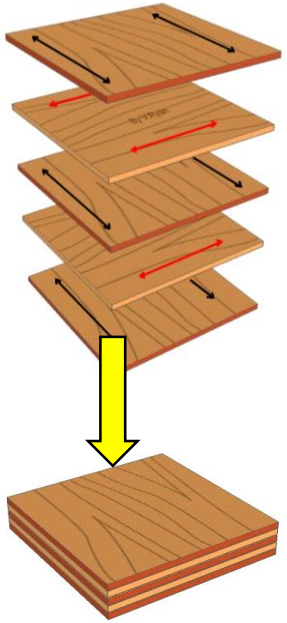
Veneered MDF

Flexiply

Plywood Research:

Standard exterior plywood is bonded using an exterior phenol glue. Previously termed as "WBP" (Weather and Boil Proof). Plywood bonded with this glue will not delaminate, even after 72 hours in boiling water.

- Marine Plywood works well in humid or wet conditions and anywhere it will receive prolonged exposure to moisture, meaning it is perfect for using for my product as it will be set outdoors for its use.
- It is also very durable as it resists bending, warping or delaminating which can often result from too much moisture exposure.
- It is more expensive than regular plywood.



I think that as I am going to put soil into the compartments within the design, I may need to use some sort of plastic lining to protect the wood from being effected by the moisture produced by the plants when they are watered, also there needs to be some sort of drainage system in the bottom of each compartments e.g. holes in the bottom to allow drainage etc.

School Material price list:

Plywood

Thickness	Birch Ply	Marine
6mm thick	£26.00	£23.00
9mm thick	£32.50	
12mm thick	£40.50	£42.00
15mm thick	£45.00	
18mm thick	£56.00	£68.10
24mm thick	£76.00	

Machining Requirements of Plywood: When machining plywood, a CNC Router (probably industrial sized) is used to cut out the pieces for a product.

Conclusions made from materials research:

- From my research on materials I have concluded that the most suitable timber to use would be marine plywood.
- 15mm width may be the most suitable to use.
- I will use a stained finish on the plywood for the best result/protection as my product will be for the outdoors.

Next Steps: To gain further knowledge into finishes for wood, and prices and characteristics/key facts on plywood in particular.

Research on plywood:

Durability:
Plywood board is a versatile engineered wood product which is made up of thin layers of wood, usually about two to three pieces are used and are then cut with a flat or rotary method. Each individual wooden layer (ply or veneer) is composed up of a range of materials and is glued together using a bonding agent, e.g. resin and then pressure is applied. The particular adhesive/glue used depends what the material is going to be used for, e.g. interior or exterior surfaces, as this will then depend on if the plywood is softwood or hardwood. The method used where each layer of plywood is placed upon another layer with the grain of the wood aligned perpendicular to each other, ensures that it makes the material stronger than steel, warp resistant, and less prone to cracking, swelling, and shrinking.

Versatility:
Plywood comes in many sizes to cater for many different project needs. It is available in sheets which measure a range of different thicknesses. Large and flat plywood panels which are used in construction stop any wasted material. Smaller pieces are also used in things like furniture making, decorative items, ramps, wall panelling, shelving and ceilings.

Plywood Veneers:
Hardwood plywood is available from many sources, for example; mahogany, oak, ash, teak, maple, cherry, and birch. Softwood plywood are also available in a wide range, for example; redwood, cedar, spruce, pine and Douglas fir which is said to be the most commonly used material. Plywood can also be made by using both hardwood and softwood.

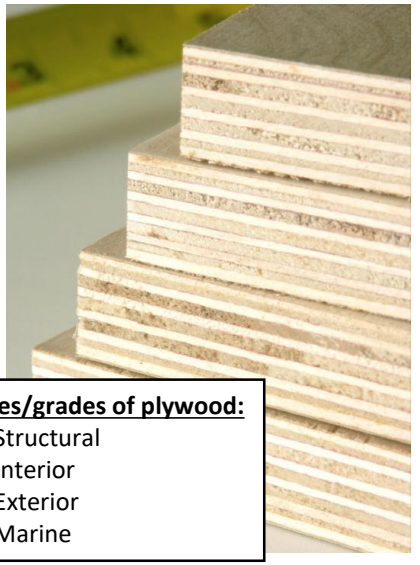
Other Advantages:
Plywood is a popular material because of its natural patterns and markings in the wood. Plywood can be stained, creating a finished look to interior and exterior surfaces which enhances the visual effect of the wood grain. It can also be treated with chemicals to help prevent the wood from rotting and act as a fire retardant. Plywood is created from renewable sources, making it very environmentally friendly.

Other disadvantages:
The price of plywood, depending on its availability locally to you, hardwood plywood can be expensive if compared to the standard particle board for example. One reason this is more expensive is because of the manufacturing process, as it uses more material per sheet and produces a heavier and sturdier piece of material.

Sustainability of plywood:
Plywood may not be the best choice because of its natural defects. These include pin knots, colour streaks, burls, and discoloration, it can also be prone to water damage if not protected properly.

Safety Issues:
Plywood which has been treated still pose dangers to us for example, the danger of inhalation of wood dust and fumes from chemical adhesives. To reduce this hazard take safety precautions like always cut treated plywood outdoors, and wear safety glasses and a mask for protection.

Marine Plywood:
It is used when constructing docks and boats, and usually costs more than standard plywood would because of its more durable face and core, meaning that it must have to resist humid and wet conditions. Also the marine plywood veneers are made up of tropical hardwoods and attached with water and boil-proof glue/adhesive (moisture/water resistant and therefore suitable for exterior use).



Types/grades of plywood:
- Structural
- Interior
- Exterior
- Marine

Advantages:
The layers within the plywood are glued together at alternating right angles. This gives it strength and durability. This cross-graining reduced the amount that the wood splits when nailing at the edges, and it makes it more resistant to warping, cracking, and twisting. Plywood has a consistent strength across the entire length of the wood piece. As well as its strength, it is less expensive than other alternative similar looking boards made of full wood species, which means that it is an ideal construction planking material.

Disadvantages:
Due to its layering properties, it makes the wood porous and susceptible to water damage if exposed to leaks over time. It can also become heavy when wet and should be covered if left outside to reduce the risk of absorption.

- Plywood is usually sold in sheets measuring 2440mm × 1220mm or 1525mm square.
- Typical thicknesses are 4mm, 6mm, 9mm and 12mm and 15mm.

Conclusions made from materials research:
From my research on materials I have concluded that the most suitable material to use for my product is marine plywood.

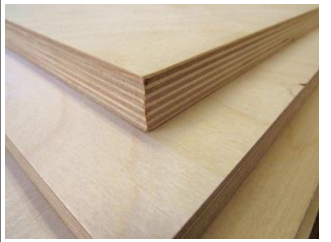
Technical details

Thickness:	3-40mm - thicker by arrangement
Standard sizes:	Dependent upon product, typically 2440x1220mm, 2500x1220mm, 2550x1250mm with some also 3050x1220mm/1525mm
Special sizes:	Other sizes available, subject to agreement up to maximum 3700x1800mm / 3120x2030mm
Tolerances:	Typically as per EN 315 (others by arrangement)
Finish types:	'Dead Matt' (<5% sheen) Matt (5-10% sheen) Satin (20-40% sheen) Gloss (50-70% sheen) High Gloss (>70%-90% sheen - typically achieved by burnishing)
Coating processes:	Roller/brush applied Sprayed Curtain coated
Other options:	Face of panel can often be coated with paper prior to painting to achieve a more uniform surface finish
Performance:	EN 636-1 - Interior usage & minimal exposure to moisture EN 636-2 - Covered exterior usage, e.g. soffits & behind cladding EN 636-3 - Fully exposed exterior usage, e.g. exterior hoardings

Next Steps: To create another model next which shows the application of my development points, which shows an overall improvement of my design.

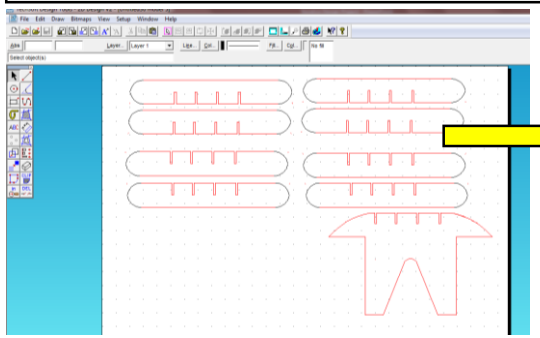
Weathering of Marine Plywood:

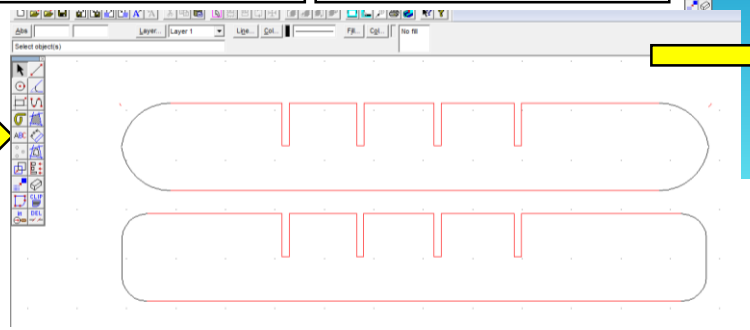
- Important actors of exterior exposure are; rain (particularly wind-driven), fluctuations in relative humidity, sunlight and fungal organisms which under conditions favourable to their growth can give rise to mould growth and decay.
- Rain can be rapidly absorbed by unprotected end grain of timber. Plywood contains much end grain around the edges which must be protected. If it is not, water enters periodically, giving rise to stresses which eventually causes the splitting of the timber and delamination around the edges of weatherproof adhesive bonds. In short term, it often gives rise to staining behind a finish which can lead to mould growth, decay and blistering of paint. Normally, water will penetrate more rapidly than it is lost, particularly when it enters where improperly applied edge sealant is. Under these conditions, water can be trapped for long periods behind fairly impermeable finishes which puts a demand on the natural durability or preservative treatment of the plywood.
- Sunlight and rain will result in rapid loss of colour from unprotected plywood. Prolonged exposure will lead to splitting, surface roughness and loss of fibre. So, a protective finish is crucial unless a bleached, weathered appearance is acceptable.
- Ply-woods are made with glue bonds which range from those suitable for interior uses only to those which will withstand full exposure for long periods. There are two categories of bond suitable for exterior; a fully exterior grade and a somewhat less resistant exterior grade suitable for less demanding exterior exposure or shorter service life.
- Marine grade plywood to BS 4079: 1966 ‘Plywood made for marine use and treated against attack by fungi, insects or marine borers’ is inherently durable because strictly controlled preservative treatment of the veneers is specified. Marine grade plywood to BS 1088: 1966 ‘Marine plywood manufactured from selected untreated tropical hardwoods’ is similarly durable because (with the exception of that made from gaboon which must be specially marked) veneers are restricted to those of adequate durability and the amount of sapwood permitted is restricted.
- Most plywoods have one or both faces sanded. Rough surfaced plywood (unsanded) is not suitable for coating with paint or textured finishes, but can be finished with an exterior wood stain. Certain textured, striated, sculptured, plank effect, etc, plywoods are available as proprietory items. Similarly, speciality plywoods are available with a resin or resin impregnanted paper overlay. High density overlays of this type have weather resistance without further treatment. A medium density overlay of paper impregnated with phenolic resin which is bonded to the original plywood surface under heat and pressure is designed to improve the paintability of the plywood surface. Paint performance on plywood used externally is often unsatisfactory particularly where full exposure to weather is involved. The medium density overlaid plywood (painting grade overlaid) is not intended to be self-finished although it does have considerable weather resistance. A further advantage of many overlaid board types is that factory sealing of edges is standard. Cut edges obviously require re-sealing before installation.
- Exterior wood stains provide an alternative method of finishing. These penetrate the wood surface to a greater or lesser extent and act by creating a water repellant surface which sheds rain. Moisture content fluctuations will occur because these finishes do not form thick plastic skins over the surface, but neither do they trap moisture or invite failure by blistering. Surface checking will occur eventually with exterior wood stains, but this does not cause flaking and loss of adhesion as it does with paint.
- Maintenance procedures for paint are the stripping of weathered paint films from overlaid plywood, requiring care if damage to the overlay by heat or chemical stripper is to be avoided. Maintenance of lightly textured paints, a maintenance coat of conventional gloss or emulsion paint may suffice, but more extensive deterioration of the finish may require removal of the original coating and renewal. Exterior wood stains require redecoration every 3-4 years in exposed locations if their visual aspect is to be maintained, which is inexpensive and easy, so long as access is straightforward. The weathered surface is cleaned of superficial dirt and two coats of stain applied. It is the characteristic of these finishes, weathering by erosion rather than cracking and flaking, which makes renovation easy. For fully exposed plywood, and frequently in more sheltered exterior exposure, protection of plywood by a finish is necessary for long service life.

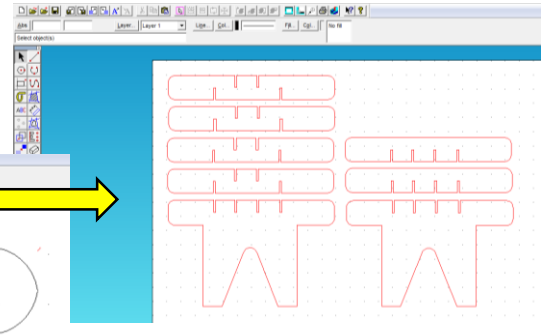


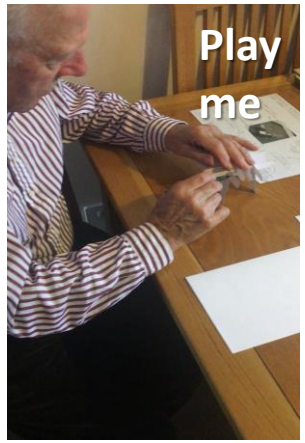
Model 5 – Refining and Simplifying the design of my previous model:

Progression of CAD Design:



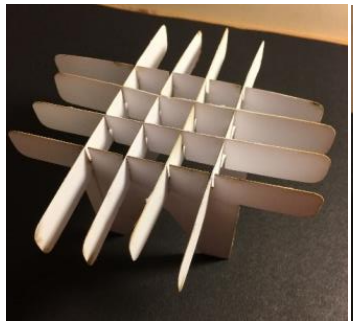


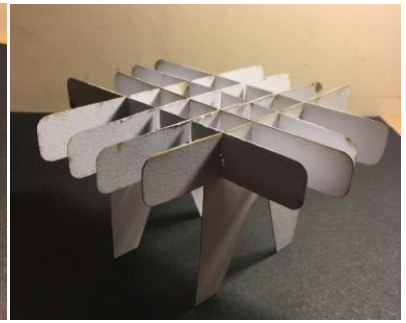


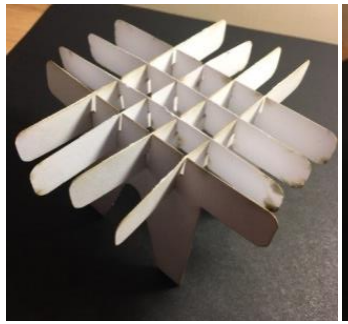


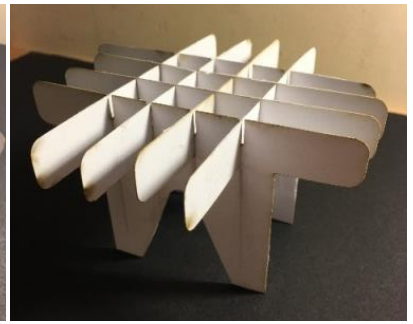
Changes made to model:

- Shape of pieces altered
- Design has been simplified
- Extra slots have been removed to refine design idea.

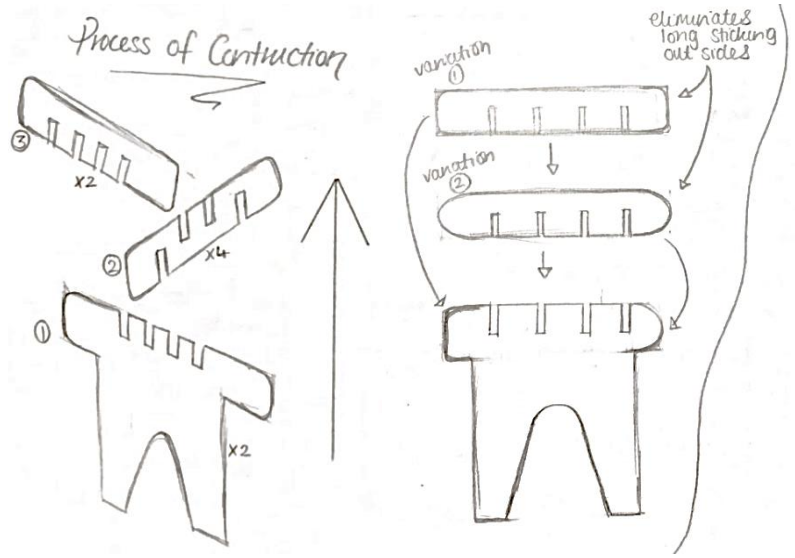




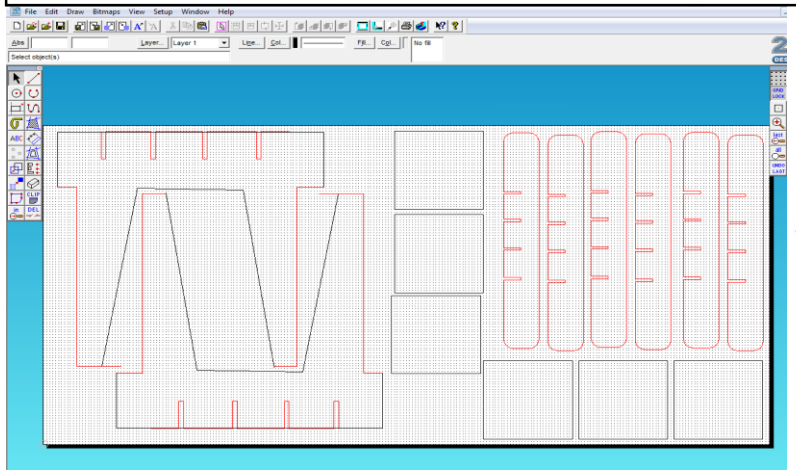


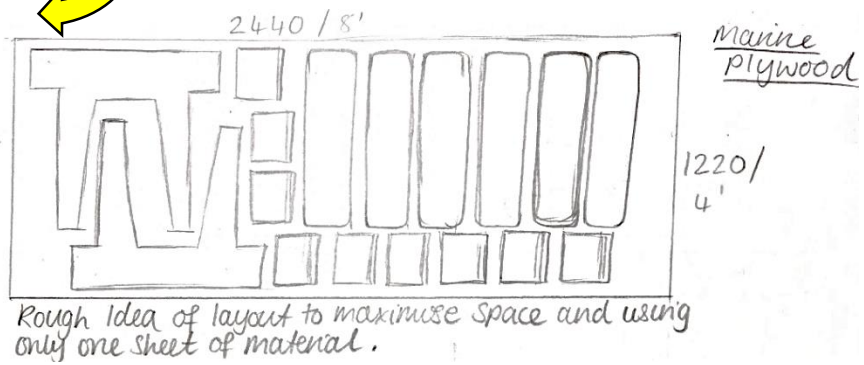


Developing the shape of pieces:



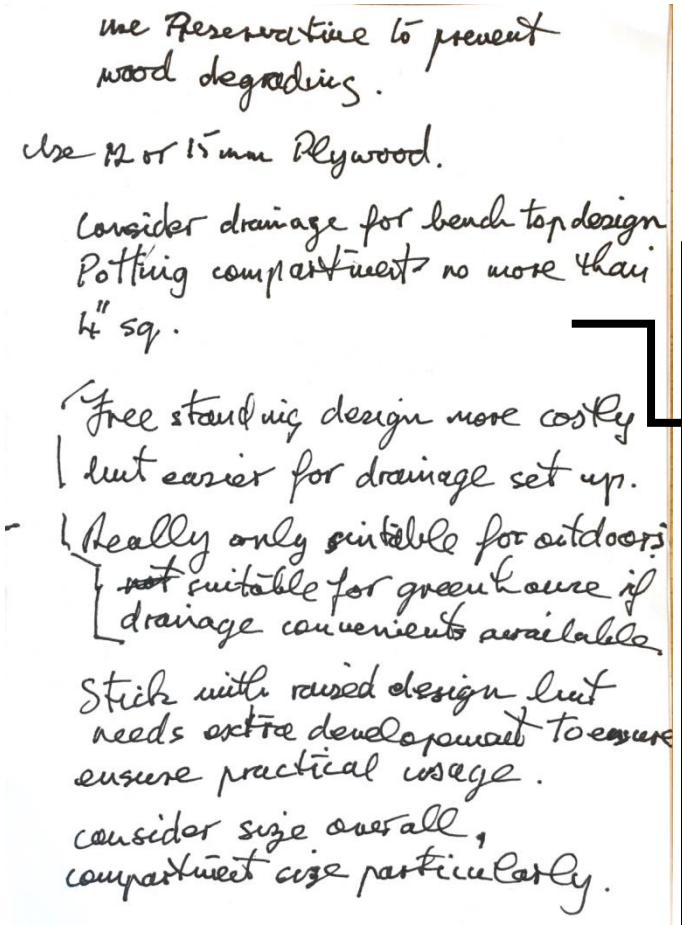
Starting to think about how to fit all the pieces on one piece of material using CAD to show this:

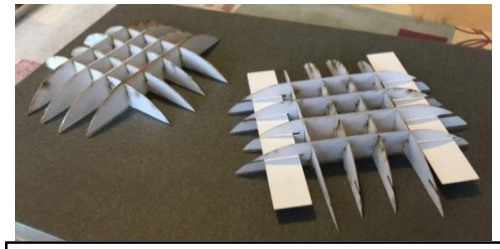


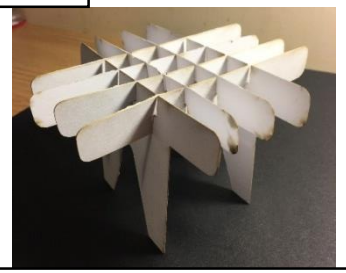


Next Steps: To create another model next which shows the application of my stakeholder feedback and development points, which overall shows improvement of my design.

Models 2, 3 and 5 – Overall Stakeholder Feedback:



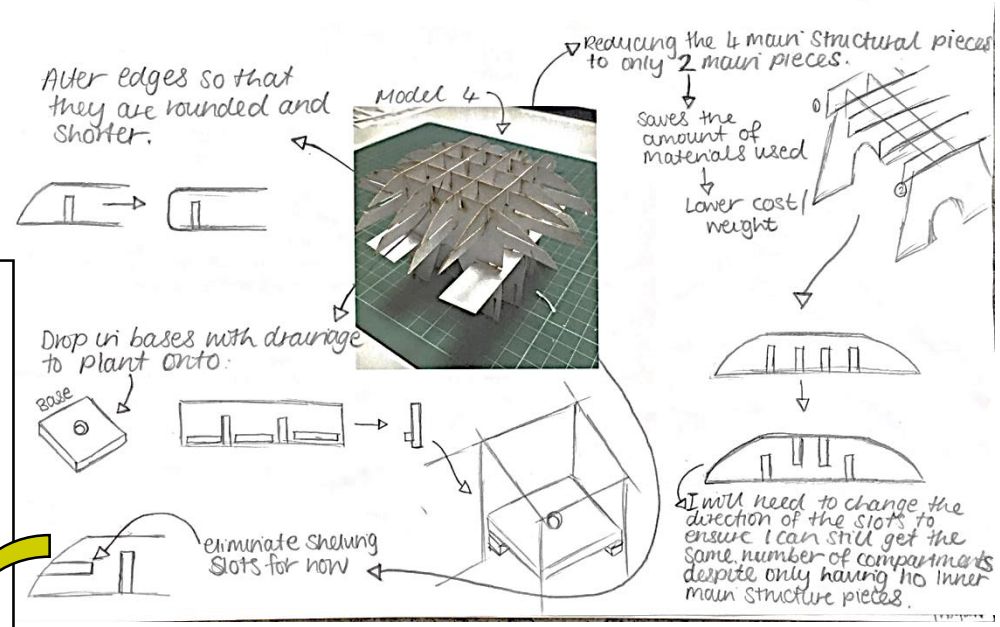


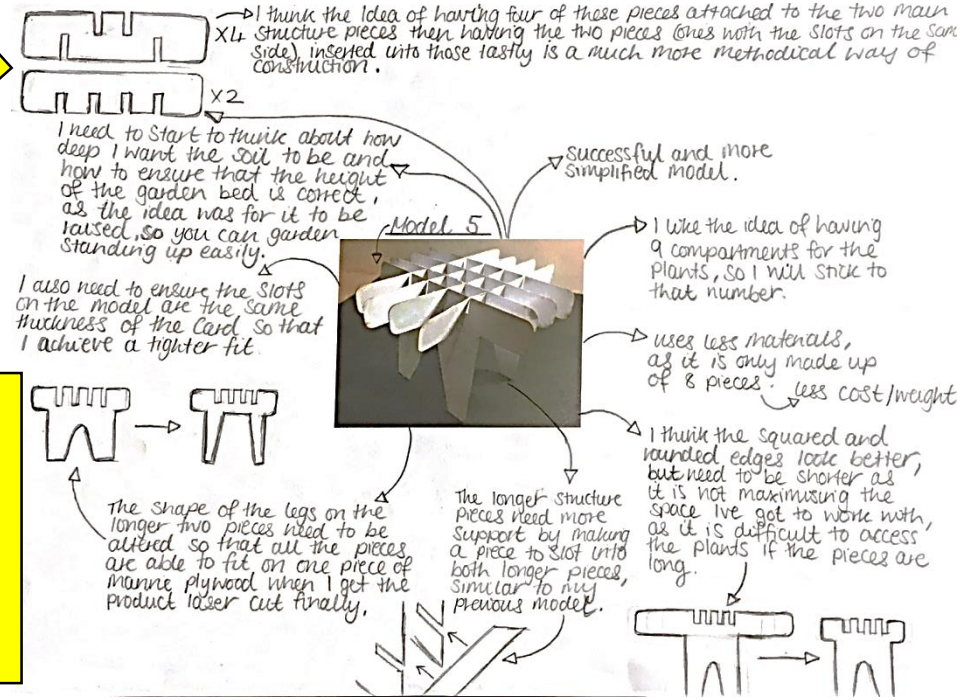


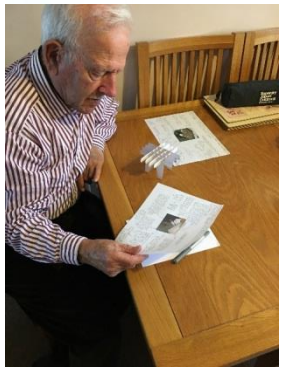
My response to the stakeholder feedback:

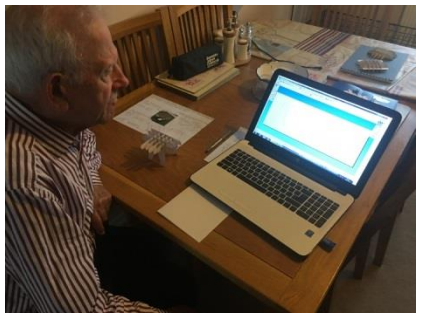
- I am currently researching various preservatives to prevent the wood rom degrading.
- I will either use 12 or 15mm plywood, I just need to look at the prices on the school materials price list to see how much the cost varies. Depending if I can fit all the elements to the deign onto an 8 foot by 4 foot sheet of plywood will depend on the size of each potting compartment for the plants.
- The full freestanding model design will be easier to allow drainage from the plants rather than having the design without legs just for a benchtop, as then I would have to design something to collect the water underneath, whereas with the freestanding design with legs allows the water to drain into the ground when outside.
- The product is only suitable for outdoors, as in a greenhouse there is no where to allow drainage of the plants.
- I am going to stick with the raised design, and I am still currently developing the design by making many models to ensure it is practical for use.
- I will ensure that the product is a suitable height for standing up and being able to plant into the compartments, I will also ensure each potting compartment is big enough to plant in and has suitable drainage system, which I will create a model next to show.

Developments of this model to be carried out when making the next model. / Simplifying + Refining design.



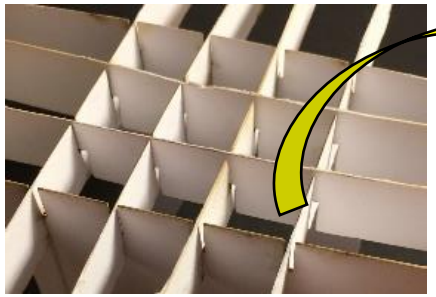


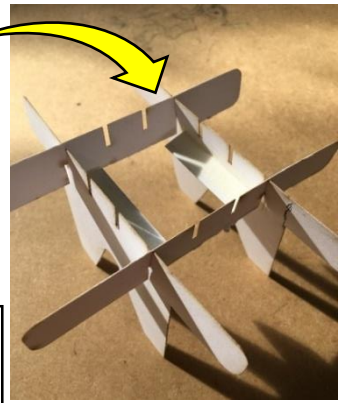




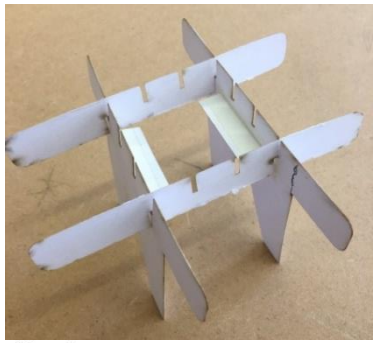
Next Steps: To create another model next which shows the application of my stakeholder feedback and development points, which overall shows improvement of my design.

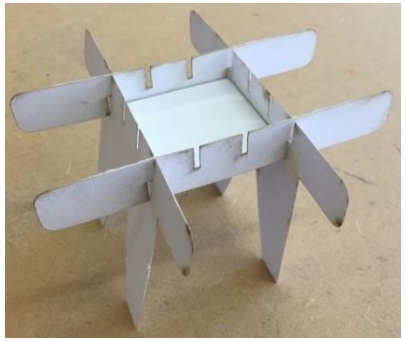
Sub-Model – To show the drop in base with support underneath and the drainage element :

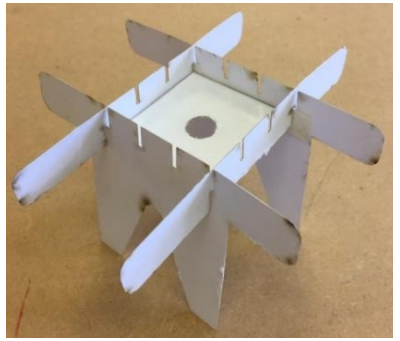




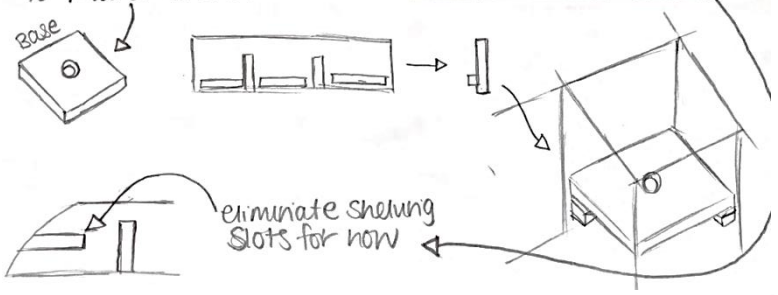
This model shown in the second photo is meant to represent one of the individual plant compartments out of the nine total compartments within the whole design.

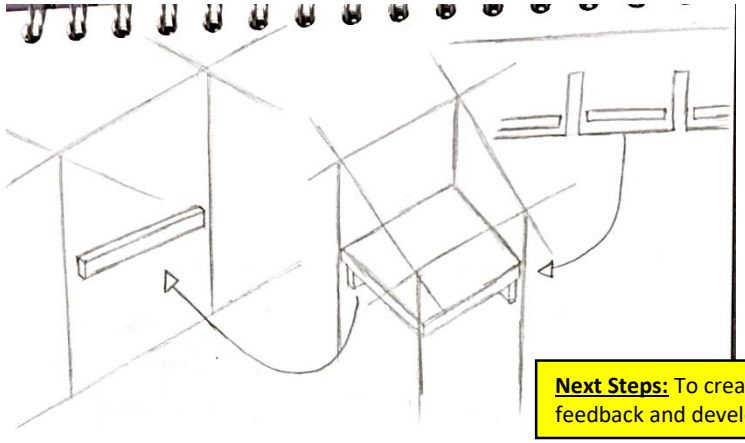






Drop in bases with drainage to plant onto:





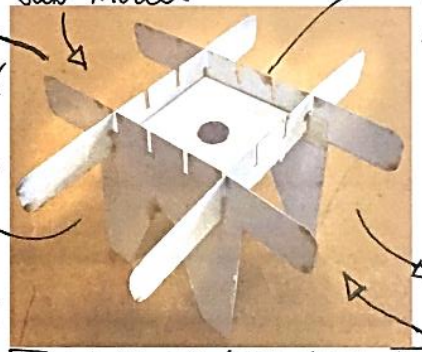
Maximises space available

Simple, methodical idea

Fairly easy to construct as supports will be attached to structural pieces and bases, so both can be flat-packed.

(One of the nine compartments)

sub-model



Model shows how drop-in base works / drainage system etc.

I need to research if the idea is a suitable drainage technique?

Design is easy to produce as all pieces can be laser cut.

Bases can be easily removed to re-plant.

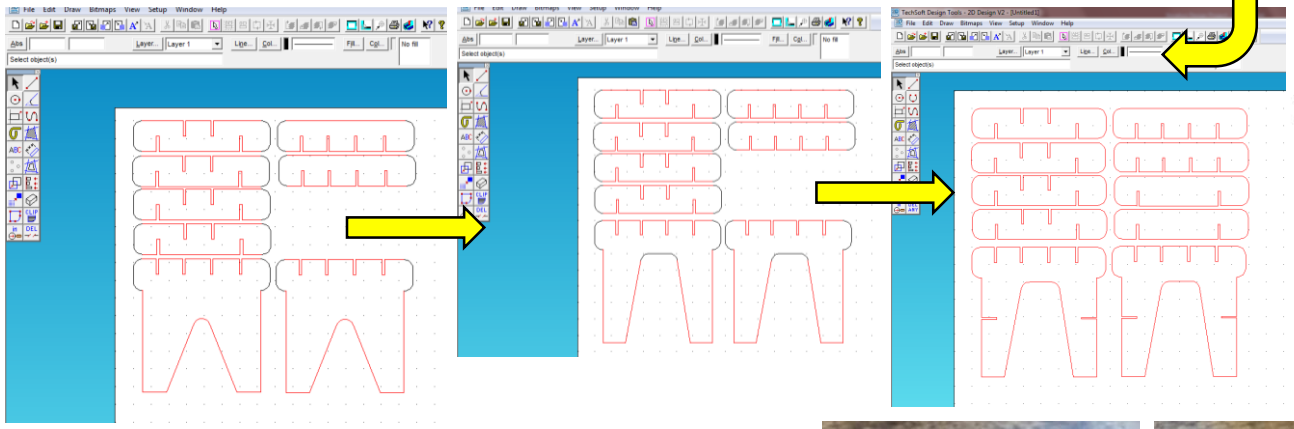
Notes → Things to Consider next:

- Think about how deep I want the garden bed to be (depth of soil).
- Drainage options for soil.
- Models – slots need to be same thickness as material to ensure a tight fit = sturdy structure.
- Look (research) for place / company who can laser-cut on a large scale – my finial product.
- Research garden bed linings – do I need them, or is whole in drop-in piece of wood enough?
- Decide overall height of product – ensure when standing you can access potting compartments easily.
- Decide if a hinged seat attached to larger outer piece is an option / extra – realistic?
  ↓
  As my client is elderly, they may need to sit down when planting as it isn't a really quick process.

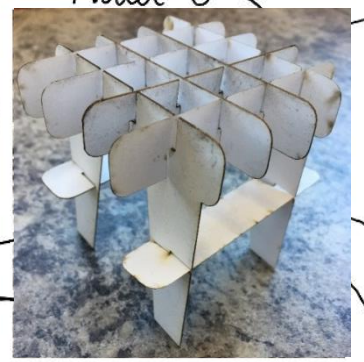
Next Steps: To create another model next which shows the application of my stakeholder feedback and development points, which overall shows improvement of my design.

Model 6 –Developing refined design further using feedback :

Progression of CAD Design:



Model 6



Make slot widths smaller so that I can achieve a tighter fit making the model overall more sturdy.

The overall design is sturdier with the added piece slot into the legs.

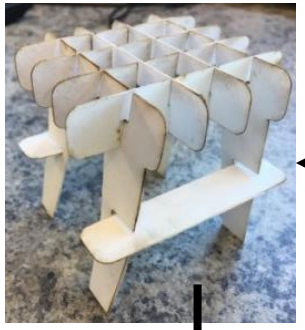
Make potting compartments larger by moving slot positions so they are wider apart.

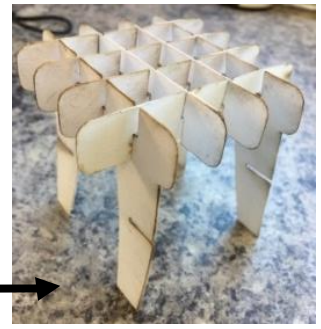
If not making potting compartments larger, make pieces even shorter.

The overall design looks much better, I think making the pieces smaller was really effective.

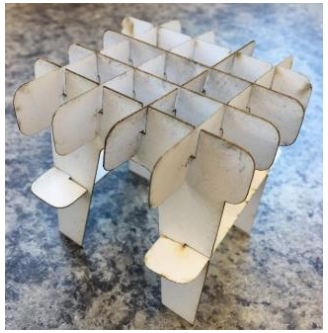
Make the structure piece attached to legs lower or redesign to maximise functionality of product.

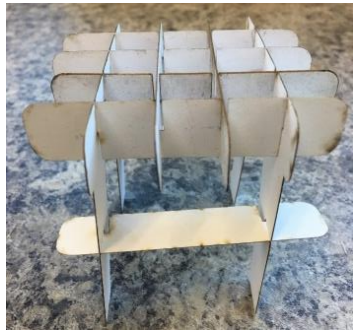
This model included the just placed in supporting piece which doesn't have slots on it so it doesn't make the model that much sturdier.

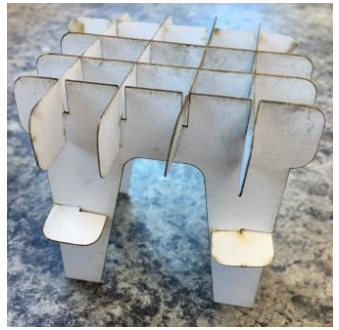


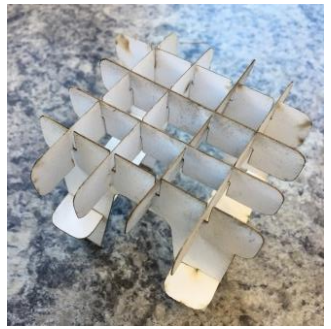


This model includes the piece which has slots on it, to connect the legs together to ensure the overall model was sturdier.









Next Steps: To create another model next which shows the application of my stakeholder feedback and development points, which overall shows improvement of my design.

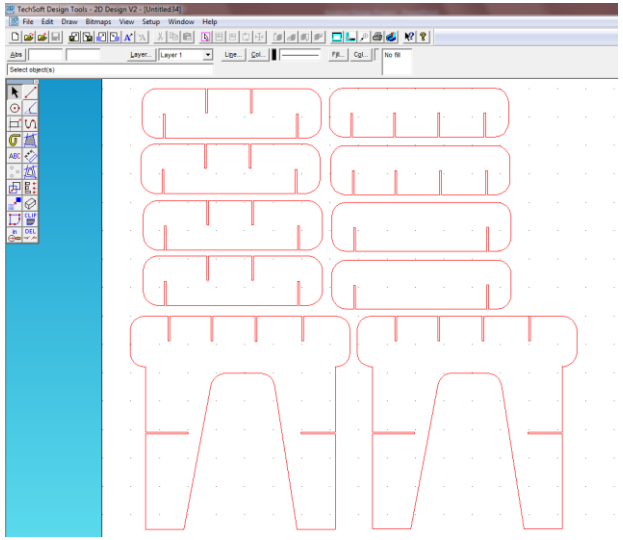
Changes made to model:

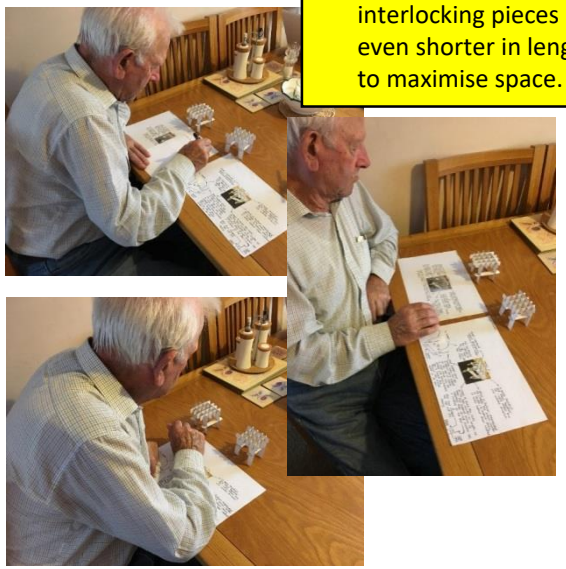
- Shape of legs altered
- Extra support piece added to attach legs.
- Length of pieces reduced to use minimum amount of materials.

When Laser cutting Models I used:

- Card 350 microns
- Higher Power level (100) and slower speed level (20) to ensure it cuts all the way through the material first time. – uses more energy/electricity/cost
- Ensure design is highlighted red to cut.
- 5.00 space gap to ensure it doesn't miss out any of the design.

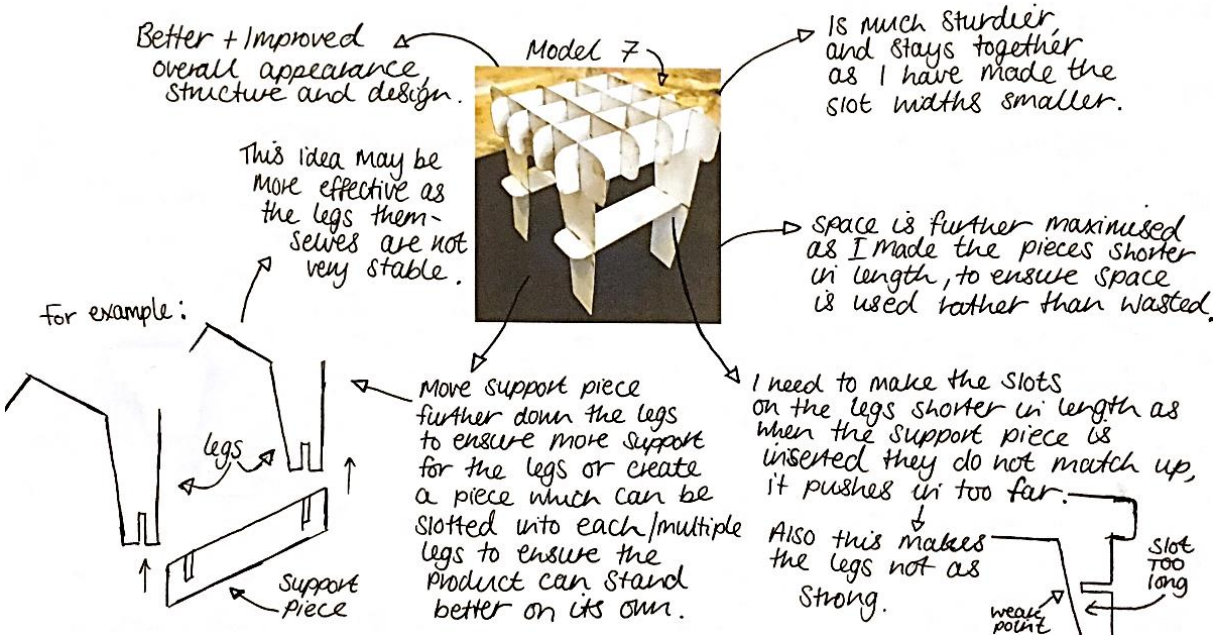
Model 7 –Developing refined design further using feedback/my opinion :





Changes made to model:

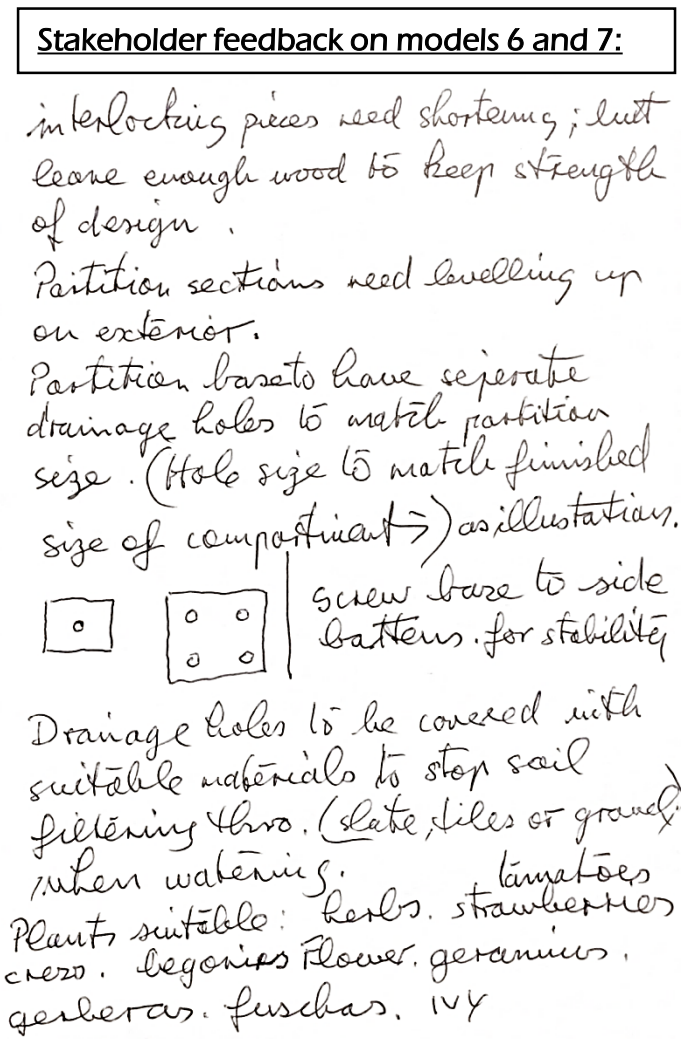
- Made slot widths smaller to achieve a tighter fit.
- I had made interlocking pieces even shorter in length to maximise space.



Response to stakeholder feedback for Model 7:

- I will ensure that each piece is further shortened to maximise space available to a further extent, however I will leave enough room to maintain the strength of the joining of the pieces within the design.
- First I will shorten the two larger pieces with legs to make sure that each length of each piece line up together in parallel when constructed.
- Depending on the size and scale of my design, I will make the drainage holes in the compartment bases corresponding to the size.
- When attaching compartment bases to the support pieces I will screw them together to ensure it is secure. (support piece will be screwed to main piece then base will screw into support piece).
- I will have to cover the bases (once installed and constructed to the whole design) with either gravel or broken tiles for example, to ensure that the soil doesn't filter through the drainage holes and clump and block the holes preventing the drainage from happening. Covering the bases with these suitable materials will allow for only access water to drain through the material and through he drainage hole for example when watering the plant an increase amount of water will be able to drain through.
- As only particular plants can grow within this environment and space, I am limited to choices to plant. However I will take the suggested species and do a bit more research to come to a decision on what plants will be most suitable to plant.

Stakeholder feedback on models 6 and 7:



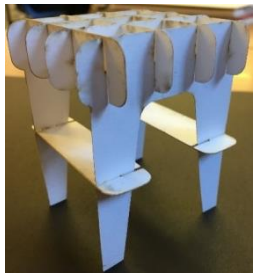
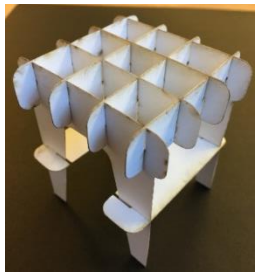
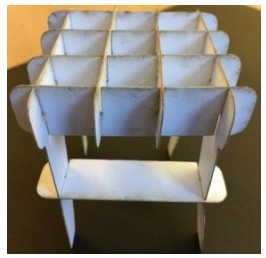
Next Steps: To apply development points to the next model I make to eventually come to a final design.

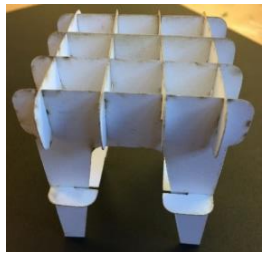
Model 8 –Developing refined design further using feedback/my opinion :

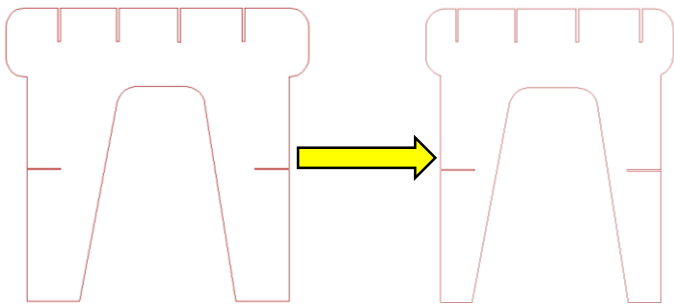
Stakeholder feedback:

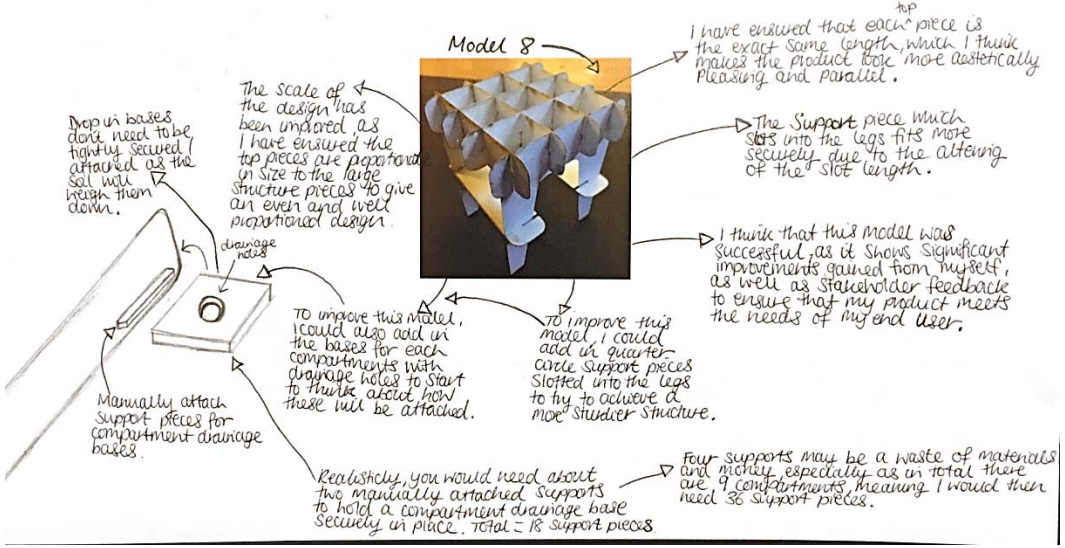
For closing bottoms of seperate box's use a single piece of timber.
(This will be more economical of time + expence.
2 Battens need to be fixed to main structural supports and floor could be inserted from side + fixed to battens as required.
To further stabilize structure a board could be put across lower leg supports.
Make legs shorter + add a ¼ circle piece that slots into legs to add support + strength.
Height of box's to be such that user is comfortable when working. ie, elderly.

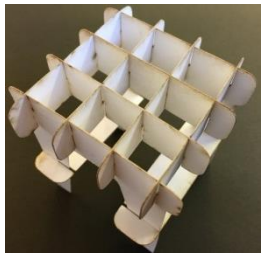






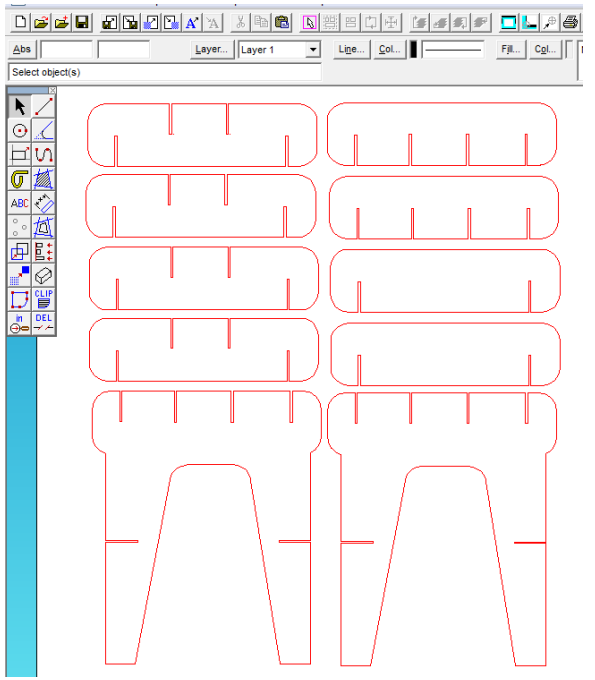


Changes made to this model:

- Made slots on the legs shorter in length to ensure that when support pieces are slotted in that they are level/parallel with the edge of the main structure piece.
- Levelled up partition sections on the exterior to ensure they are parallel (all the same length).
- Reduced the size of two main structure pieces so that they are proportioned with the remaining pieces/elements.

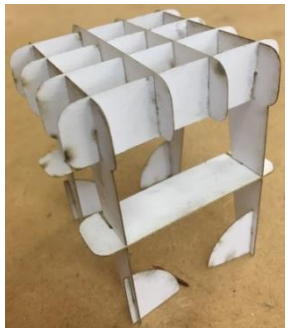
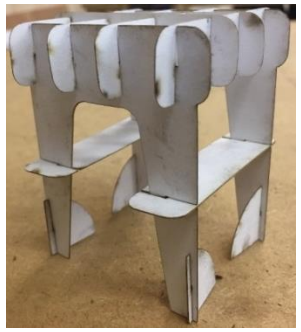
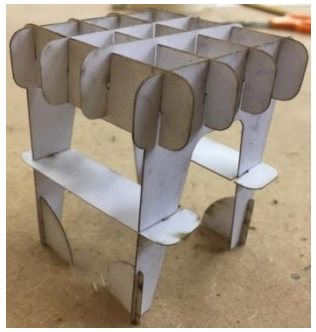
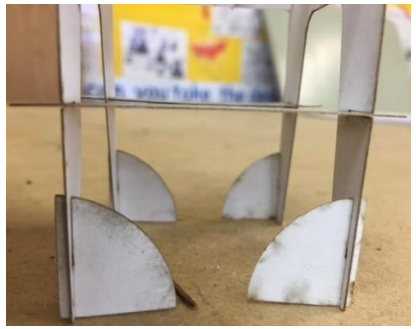
The proportions between each piece/element of this model has been improved, as in my previous model (7) my stakeholder pointed out that some of the pieces had been altered to be shortened, however the larger two main structure pieces had not been, they were still wider and longer. However, I will need to review and analyse this model to ensure if this is a successful development or if it works better to maintain the size of the two larger main structure pieces shown to the left of this text on this page .

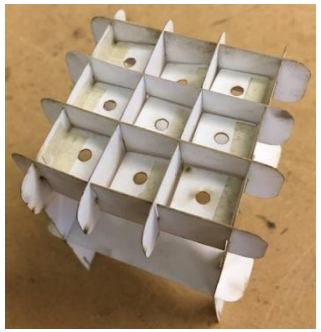


Next Steps: To create another model next which shows the application of my stakeholder feedback and development points, which overall shows improvement of my design.

Model 9 –Developing refined design further using feedback/my opinion :

I think this is an effective development model, however I believe that there are too many pieces and elements that the idea becomes to complex, and sometimes a more simplistic design can result in a more effective product in my opinion.

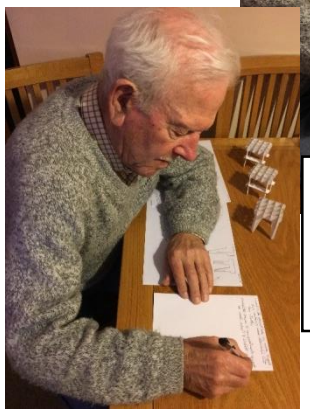







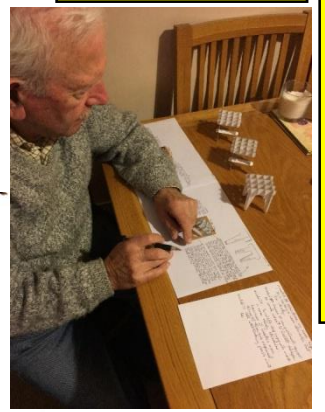
Next Steps: To create another model next which shows the application of my stakeholder feedback and development points, which overall shows improvement of my design.

Changes made to this model:

- Experiment by moving support piece attached to legs further down to see if it makes design sturdier ?
- Make the legs shorter in length.
- Slotted in bases added to ensure that the plants do not fall through.
- Add in quarter circle support pieces attached to the legs to ensure a more sturdier structure.
- Measure table to calculate comfortable height for user to correspond with height of design.
- Add In drainage holes to the design of the base elements added into the model.

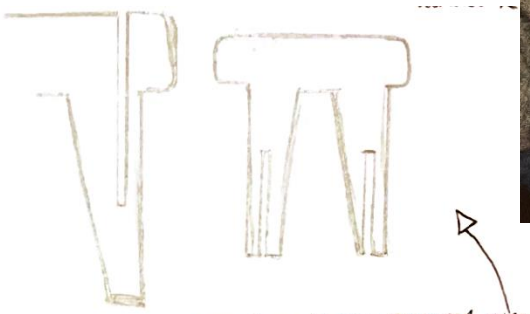


My End User giving me Stakeholder feedback on my developed design :



Response to stakeholder feedback for Model 8:

- I intend to use 2 batons to attach onto the sides of the compartments to then be able to drop the bases onto so they are fairly secure.
- I have experimented by adding in the quarter circle leg supports to try and make the structure sturdier.
- As I have measured the height of the comfortable standing height of my stakeholder user, I will use this measurement in the application of my technical specification of my designed product.
- I will also consider all the other ideas which my end user has given me to try and increase the sturdiness of my product, however same may not be realistically do-able and same may mean that the design becomes even more complex, meaning that I may just stick to a more simplistic approach and try and develop those elements alternatively.



drainage

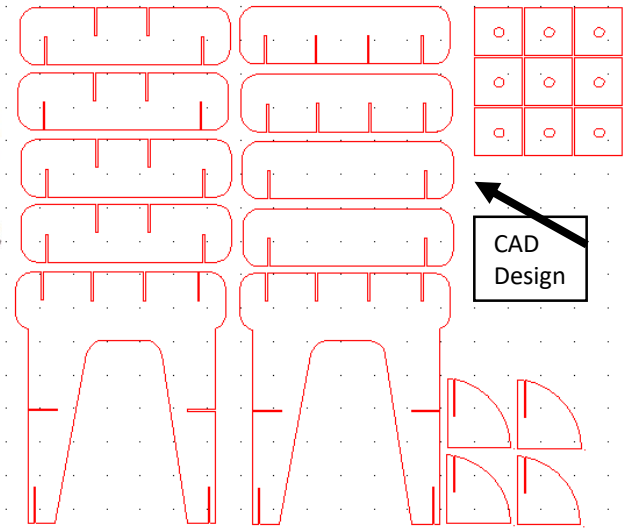
I added in the bases elements, which I think were successful, as the construction process I've thought out is straight forwards and realistic for making on a larger scale.

Model 9

For my next model, I need to apply an alternative support method in place of the quarter circle supports to create a more effective and sturdy support for the weight of the above put on the legs.

Alternatively, I could create one support piece for each side of the design to eliminate the idea of having many individual pieces combined to create a strong structure. However, this would require more material, resulting in a product which is more expensive and heaver in weight, meaning not as feasible for the elderly, however it may be a more effective idea to produce support for the structure.

I have added in quarter circle support pieces which the legs slot into to try and achieve a more balanced and sturdy structure. However, after analysing this model, I think that they weren't very effective, because it doesn't provide a secure base. They either needs to be one individual base which the four legs push into or two long supports much like the leg supports above which slot into the bottom some way.



CAD Design

Model 10 –Developing refined design further using feedback/my opinion :

After analysing my previous model I have come to the conclusion/idea that I may need to create some sort of base or alternative designed support to give a better structure to the lower areas of my intended design. However this may not be necessary because I need to consider that I'm only using card to create my developmental models, where the card is only about 350/450 microns in depth , and as the real prototype would be constructed using marine plywood it would be much sturdier and give me a more realistic vision.
However considering further complications, as my product is designed to be outside in the garden, if we have bad weather e.g. wind, then hopefully the weight of the soil, gravel and the wooden bed itself would ensure that it wouldn't tip over. However this might mean that I need an extra piece/element within the lower element of my design to ensure the weather isn't a factor in the products stability (stable) and that it is stable within itself as an individual product and doesn't require extra support or precautions to be taken or applied to the product, e.g. after a customer purchases the product.

Next Steps: To create another model which shows the application of the stakeholder feedback I have gained fro my previous model feedback and takes into consideration my ideas and opinions from my annotation sheet from my previous models. Also, to draw conclusions based on elements regarding my design.

Models 8, 9 and 10 – Overall Stakeholder Feedback:

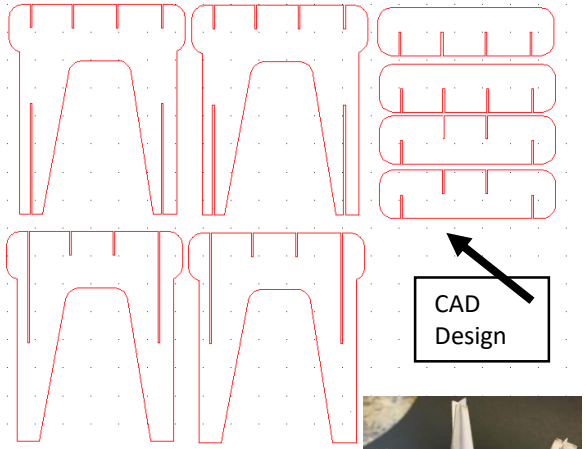
Model 10, its structure is more rigid, " 8 & 9 contains more elements but less sturdy.
Model 9 bases to compartments appear to work. adapt to latest design.
Model 9. ¼ circle leg supports made a more sturdy structure: however it creates more elements than are required.
Model 10. All interlocking parts must be closely constructed to ensure rigidity of structure.
. make 4 drainage holes within compartments. ensures drainage without compost falling thro.

I also think that this alternative system idea, is much more methodical and ideal, because as my end user is elderly, it will be easier to construct when purchased, it consists of fewer pieces, it is easier to transport because there are less pieces, meaning less weight, also it is less expensive because there are fewer pieces and hopefully when made (Industrially out sourced laser cut) I will be able to fit all of the pieces within one specifically sized piece of marine plywood to reduce costs even further.

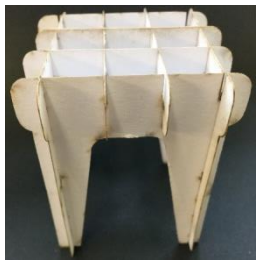
Here I got my end user to make comparisons and talk about what elements within my three latest developed design models was successful and should be carried out and applied to the next model, eventually coming to a final decision for the design of my raised garden bed.

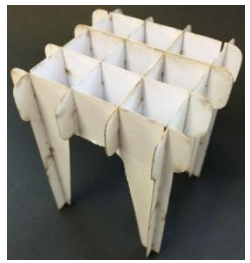
Changes made to this model:

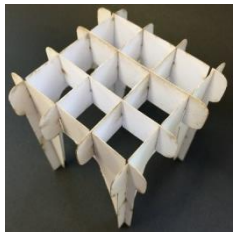
- I have developed my design to create an alternative system which provides a sturdier structure within the bottom half of the design, which has reduced the amount of extra support elements needs to be slotted into the legs , to be able to provide more strength and support to the overall structure of the garden bed, as the weight of the gravel, soil and plants need to be well supported to create a durable and sturdy end product.

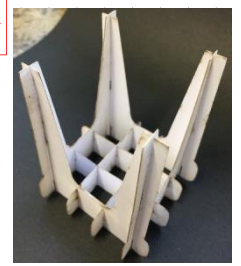


CAD Design









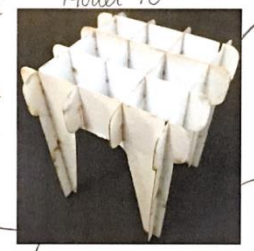
I need to ensure that from where the longer slots begin within the main structural pieces, that they are the correct length, because when they are slotted together I need to ensure that the bottom of the legs and the top of the legs finish in parallel when finished constructing the Raised garden bed.

Michael K

Accuracy is key in this case to create a product which is durable, and I need to ensure that no error is made, because if the interlocking system isn't configured correctly then the product will not meet its specified functions and particular requirements regarding my end user and myself as the designer.

I need to ensure next, that the width of the slots are the same as the width of the material with a few added mm, to ensure that when slotting the interlocked pieces together that I create a tight fit which ensures the rigidity of the structure.

Model 10



I think that this alternative construction idea works much more effectively as there are less pieces needed and the way the pieces are slotted in together in a criss-cross motion creates a stronger join, which creates an overall more sturdy and rigid structure.

Next, I will apply the drop in drainage bases for the compartments to the next developed / improved version of this design.

When adding in the compartment bases, as my end user pointed out, it will be more effective to have 4 smaller drainage holes within each individual base, rather than 1 to ensure that the soil doesn't all fall through when planting.

I really like the appearance of this developed model, as it looks simplistic but highly effective regarding its structure.

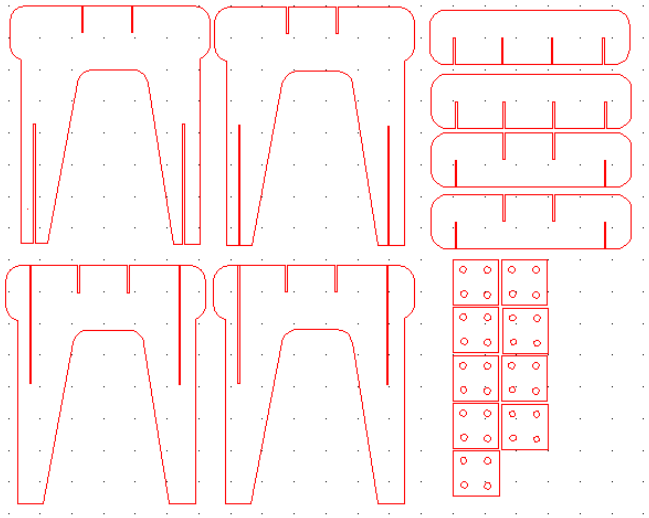
TO improve this model, I should eliminate the far left and right slots from two of the main structure pieces, because when it is slotted together there is no function for those particular slots, meaning that they are no longer needed due to the continuous developments and changes throughout the design process of my product.

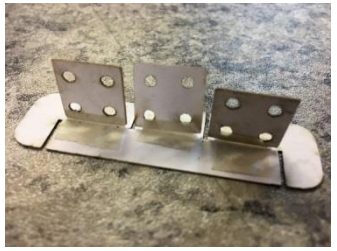
Model 11 –Developing refined design further using feedback/my opinion :

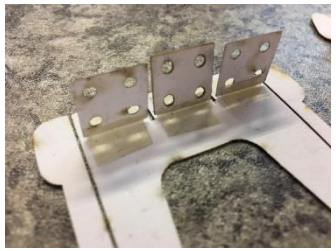
I think that at this point I am finished developing my design at this point to meet the needs of my end user and my own specifications and requirements.

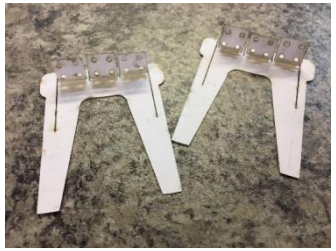
Response to Models 8, 9 and 10 – Overall Stakeholder Feedback:

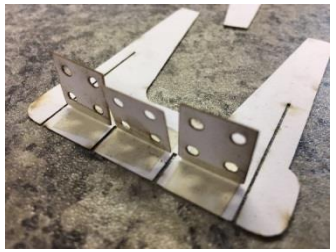
- I am going to use less elements to ensure the structure is more rigid like my end user has suggested.
- I will be using the idea of the drop in bases for each plant compartments, as I think this was an effective design solution for bases to hold the plants rather than built in fully attached bases.
- I will not be using the quarter circle leg supports which I had experimented with in a previous model, as this then amounts overall to too many pieces which don't necessarily make the design stronger, they just add cost and add more to the amount of materials and pieces needed.
- I will ensure that all the interlocking parts to my design are closely and securely constructed so that they fir together tightly, which will ensure a sturdy product.
- I will be using four drainage holes within each compartment base instead of one or two to ensure a more even drainage and so that the soil doesn't fall through.
- I will ensure that the size of the slot widths are the same as the material width with a couple of 0.1cm added to ensure that it can be easily slotted together and taken apart is necessary.

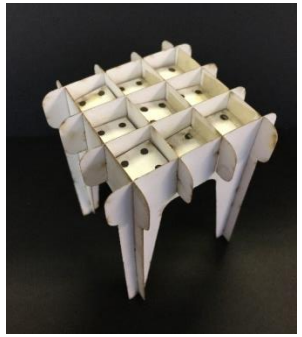


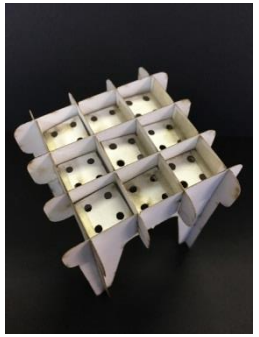


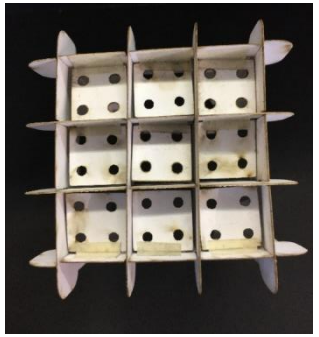


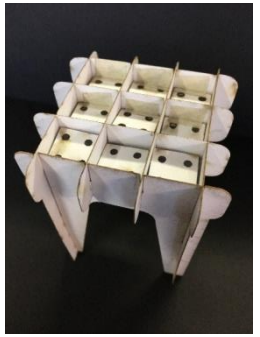








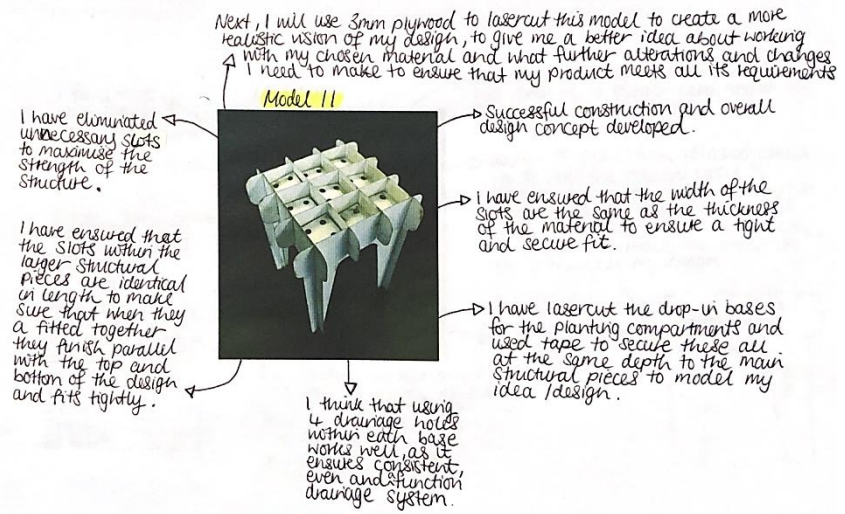




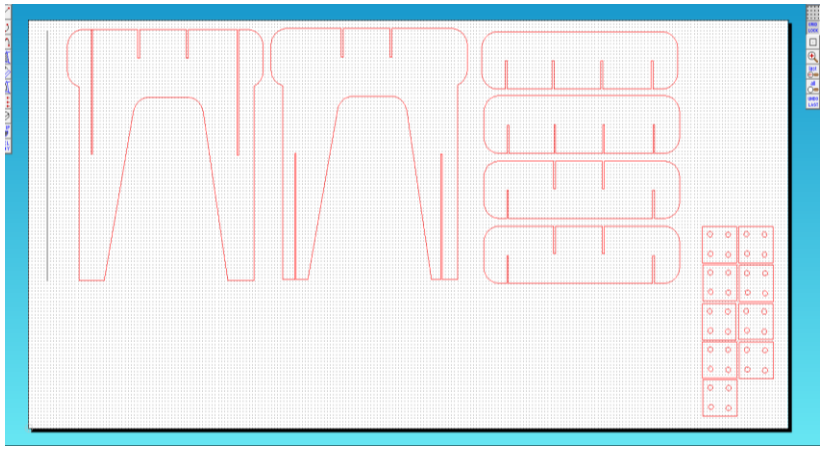
Next Steps: To create another model which shows the application of the stakeholder feedback I have gained from my previous model feedback and takes into consideration my ideas and opinions from my annotation sheet from my previous models. Also, to draw conclusions based on elements regarding my design.

Changes made to this model:

- I have made the width of the slots within each piece smaller to provide an even tighter and sturdier fit.
- I have eliminated the far left and right slots from two of the main structure pieces, because they are no longer needed.
- I have also ensured that from where the longer slots begin within the main structural pieces, that they are the correct length, because when they are slotted together I need to ensure that the bottom of the legs and the top of the legs finish in parallel when slotted together during construction of the raised garden bed. Accuracy is key in the case to create a product with a good durability, and I need to ensure no error is made, because if the interlocking system isn't configured correctly then the product overall will not meet its functions and requirements regarding my end user and myself.



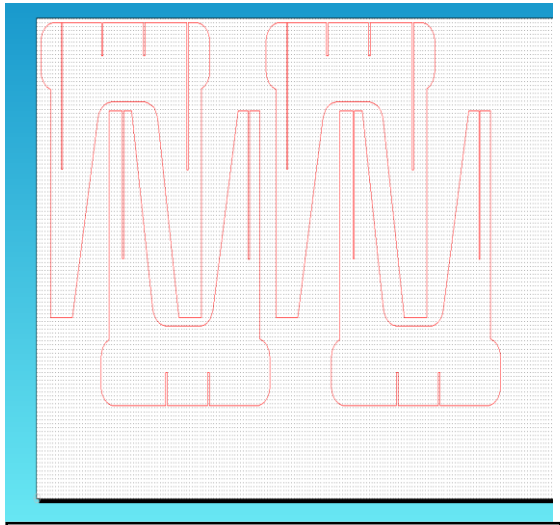
Scaling up the Final Design :



On 2D Design, using my CAD design of the pieces which make up my raised garden bed, I have copied them onto a blank page which measures the same as the piece of material I intent to try and fit all of the pieces on to cut out when manufacturing. I have done this to help me proportionally scale up my pieces, which at this present time are designed to a small scale, as I have only been developing the design by creating small card models, as I do not want to waste any materials.

Next Steps:

- I will get in contact with C.G.Joinery to enquire about the cost of manufacturing a complete large scale laser cut prototype of my raised garden bed design.
- However, at the moment I am predicting that this will be very expensive, meaning that I would just make a plywood laser cut smaller prototype instead to represent the realistic product.
- To create experiment piece showing different widths to find out which one fits best.
- To talk to end user about the latest decisions I have come to and to check if they are all ok or if there's anything that they want me to change or add.
- To find out how much the materials will cost and then order the amount of 15mm marine plywood needed – from the school materials cost list which I have included in a previous slide, it is £42.00 for a piece of 15mm marine plywood.



After a bit of experimenting, I found that the best way to lay out the main structural pieces to maximise the space I have decided on using, is to almost interlock the pieces as close together as possible. As this efficiently uses the space while leaving enough room for the remaining pieces to be fitted onto it.

Notes:

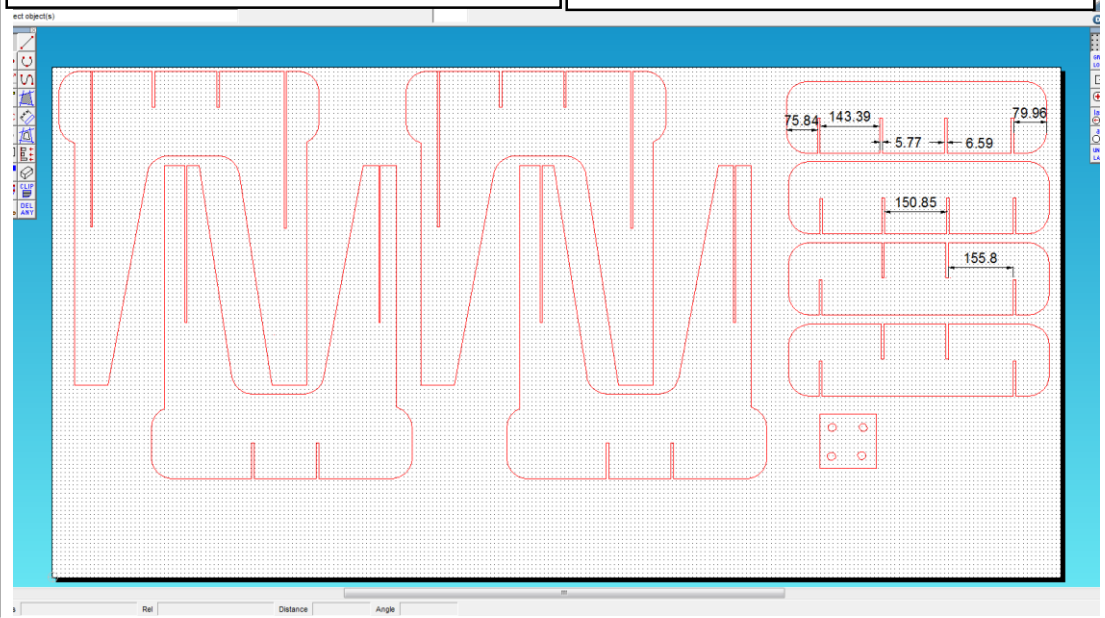
- I have decided to use 15mm Marine Plywood.
- I will need to work out how much of a gap to add to the width of the wood to be able to work out the slot overall width. I will do this by carrying out a small quick investigation experimenting using different slot widths and which ones fit best, and would be most suitable to use when manufacturing my product. For example I will keep adding on a small amount (mm) each addition to achieve the most accurate fit.
- I have attempted to scale up the pieces to the realistic size of the piece of plywood.
- My aim is to try and fit all of the pieces onto one piece of ply measuring 2440mm/8' in length by 1220mm/4' in width.
- The height of the side main structural pieces are 750mm

I have come to the decision that I probably will not be using any sort of protection on the plywood, as it is 'marine' plywood which means that waterproof glue is used to glue together the layers. However, the two exterior sides of the piece of wood are still exposed meaning as my product is supposed to be suited for the outside, I may have to apply something to them or imply that it is only suitable for specific areas within the garden/outside to reduce its exposure to the aspects which will weather the wood and decrease its durability and stability.

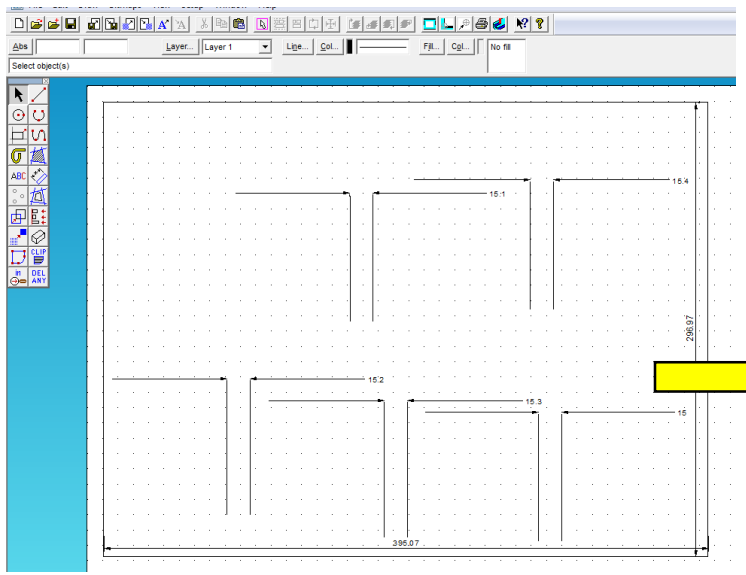
Notes 2:

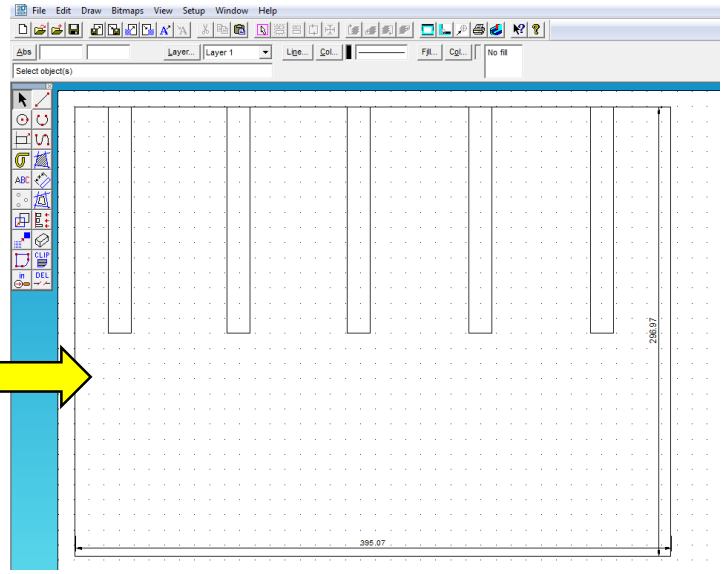
- The varnish applied to the wood will result in adding to the width of the piece of wood, this I will need to consider when investigating a suitable width to use.
- As my product is made for outdoor use, I need to take into consideration that the moisture from the air will effect the wood, creating a tighter fitting construction. This is because the wood will absorb and soak up any moisture, however this does make the material more rigid.
- I want to achieve a 'push-in fit' for when constructing my product, as it cannot be too loose or tight as this will effect all aspects of my product, e.g. its stability, functionality, safety etc.

From this screenshot, you can see that from when I was designing the pieces, my level of accuracy has been slightly off. For example on the pieces containing four individual slots, the distance between each one should be identical and proportionate, however there is a slight difference between them, This means that I will have to go back and correct this piece. Then I will use this corrected piece to fix the remaining pieces, as I used the first piece I mentioned and added to it/developed to create the more complex main structural pieces.



Width of slot experimental piece idea:





- Firstly, using the dimensions tool on 2D Design, I have drawn out the size of the piece of scrap marine plywood which I will be using for this experiment, which I had to do on a A2 scale.
- Next, I have measured out the different possible widths for the slots to test.

- Next, I have lined up the varied slot widths evenly but approximately and will then use the other half of the piece of material to cut up into pieces which measure 15mm in width to be able to slot into each one and then compare to see which one results in the best fit.

I will next need to use the large router machine to cut out the different varied slot widths, however I will have to get someone else who knows and can operate the machinery to cut this out for me.

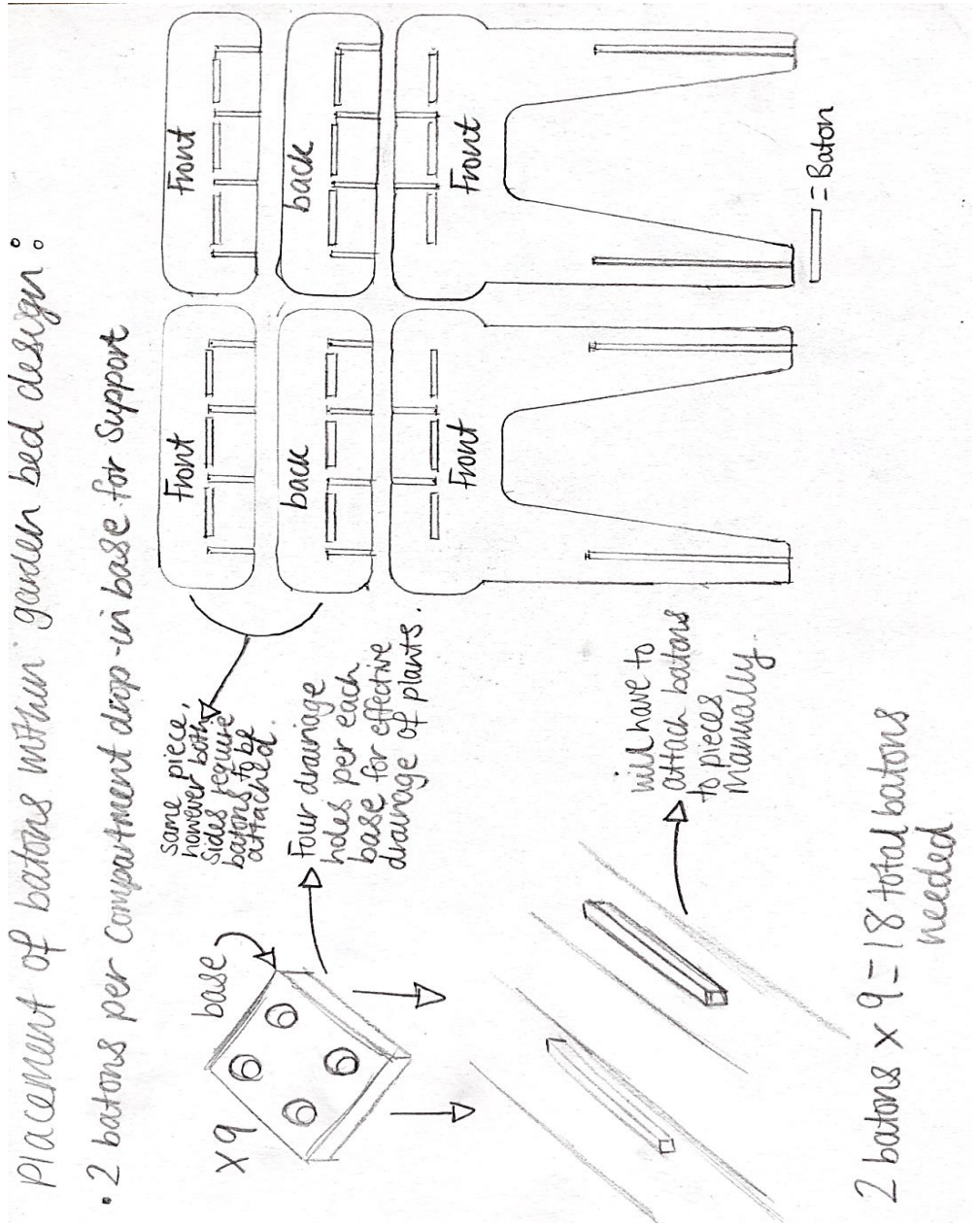
Next Steps:

- Once I have my result from my experiment telling me which width of the slot is the most suitable, I will then apply this gained knowledge to my CAD design by ensuring that all the slots on every piece is the exactly the same size to ensure a tight push-in durable fit.

Conclusion:

- To design the slot widths as 15mm on my CAD design, to allow for the CNC routering company who are machineing the pieces, to leave the correct amount of space needed to be able to slot the pieces together correctly.

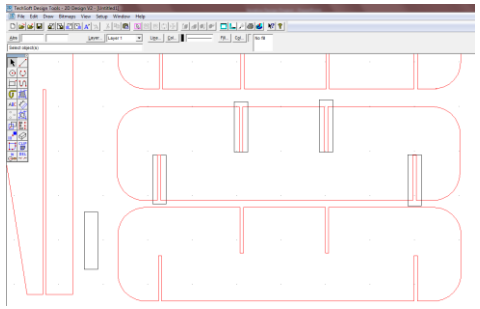
Plan of baton/support pieces placement within garden bed design:

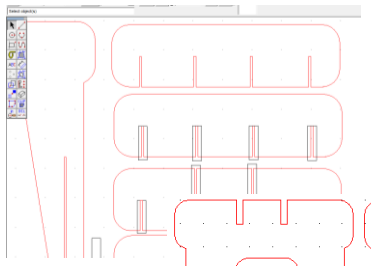


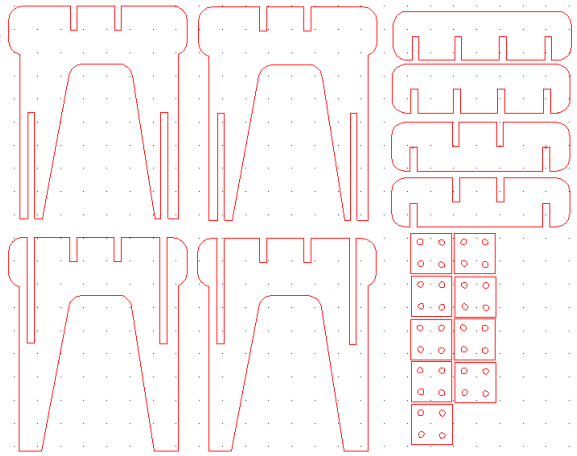
Model 12 – Using 3mm Plywood:

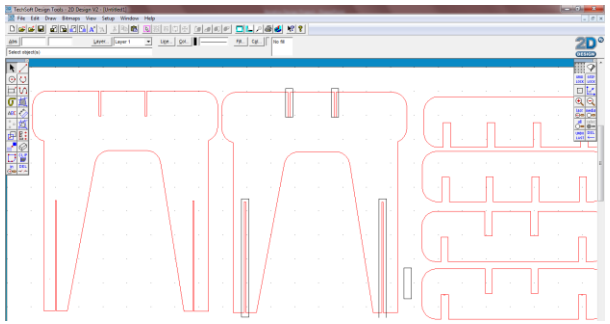
Next Steps:

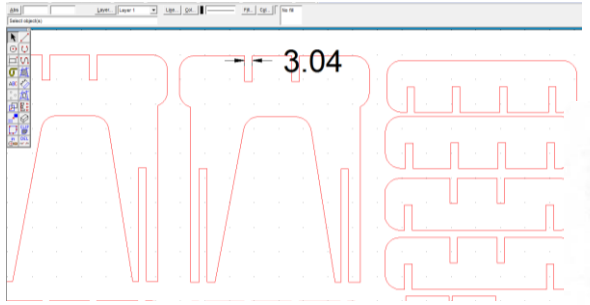
- Make last developments and corrections to model to ensure maximum quality, accuracy and functionality of the product.
- Contact the 'C&G Joinery' to enquire about possible making my final product.

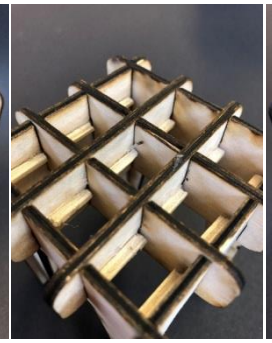


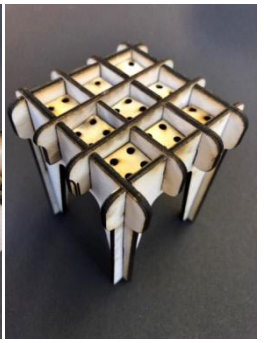


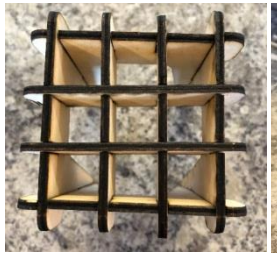


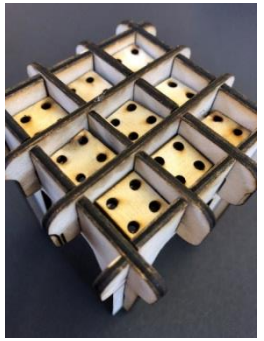






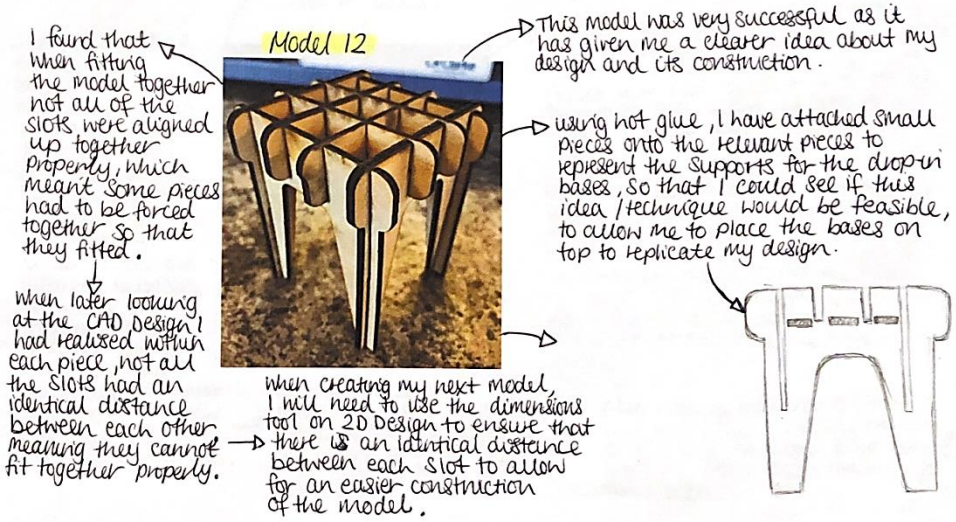






Models 11 and 12 Stakeholder Feedback:

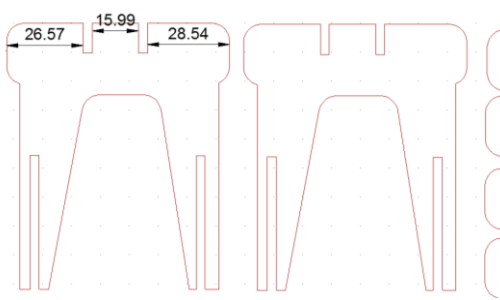
Modifications ok. Floors need to be 10cm deep.
apply a suitable height for easy use by adults.
Partitions to be evenly spaced.

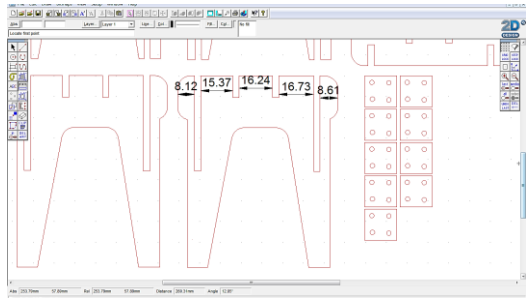


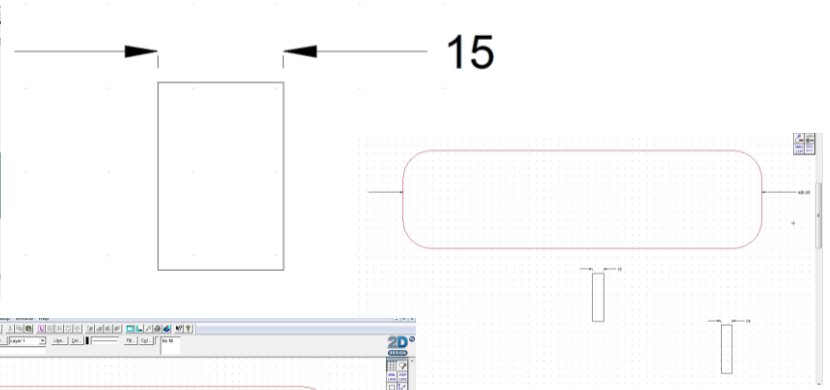
Developments/Next Steps:

- Need to work out depth of compartments.
- Need to work out width of slot.
- Need to even out length between each slot within each piece.
- Need to work out accurate size of bases regarding length and width.
- Need to work out the full size of the product and then a 1/5th scale option to make a smaller prototype.
- Get a quote for how much it will cost to laser cut a full size product locally.

Final Design Development:



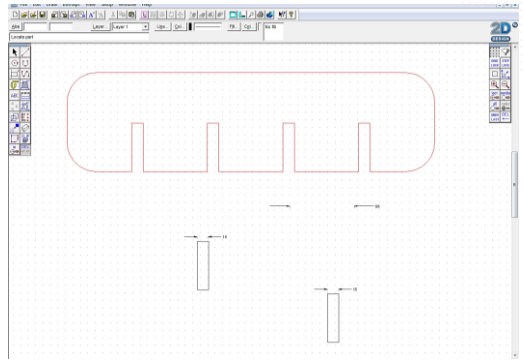


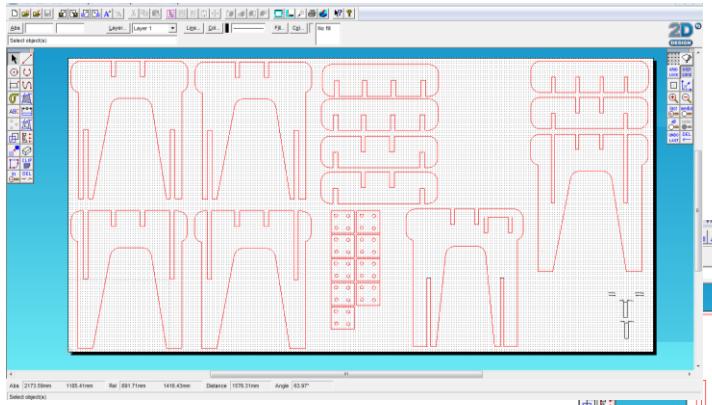


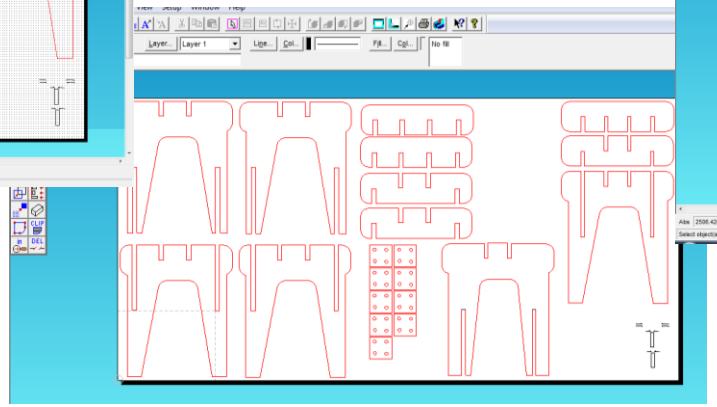
My next step is to make sure that all of the dimensions of the spaces between each slot on each piece is identical to ensure that the product slots together more easily with less force and effort needed, linking well to meeting the needs of my consumers particularly (The elderly). As currently my latest model using 3mm plywood is slightly difficult to construct as some of the slots are different lengths apart from each other meaning that when you go to slot the pieces together, the slots are at slightly different positions, meaning that you have to use some slight force to line up the slots to construct the model properly.

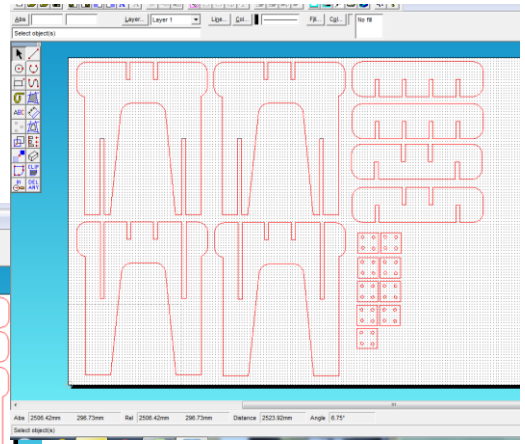
The company should be able to source the 15mm plywood for me so that they can cut my design out for me, so that I then don't have to supply them with the materials,. I just have to collect the product and pay.

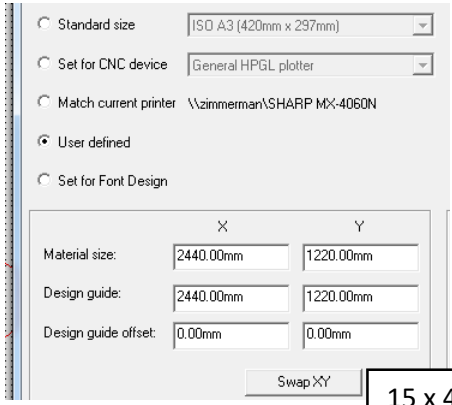
I also need to ensure that the drop in bases for each compartment are correctly proportioned/sized to suit the scale and size of the raised garden bed, as with my latest model the larger versions of the bases did not drop in, so I had to make them smaller to be able to drop in, while still leaving some room to be removed, as support for them is provided from the support pieces which are attached to the actual pieces which make up the garden bed when slotted together.











15 x 4 = 60
490 – 60 = 430
430 divided by 5 = 86

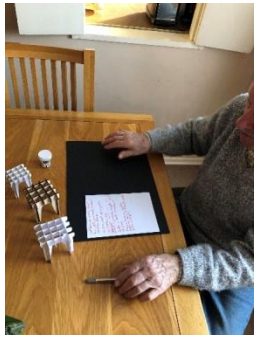
Each slot is 86 apart
Each slot measures 15mm

Model 13 - Developing refined design further using feedback/my opinion :

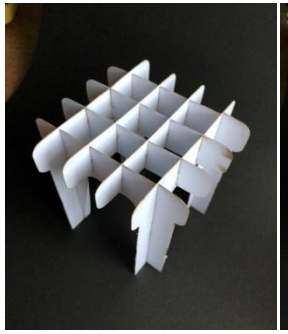
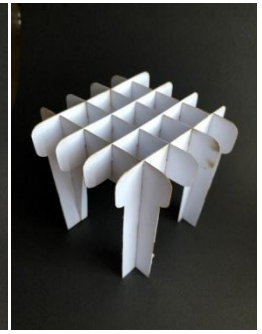
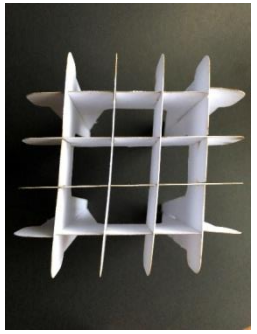
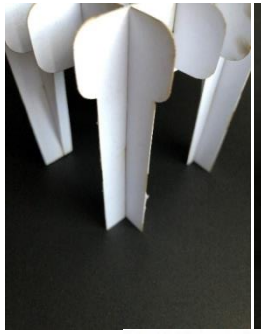
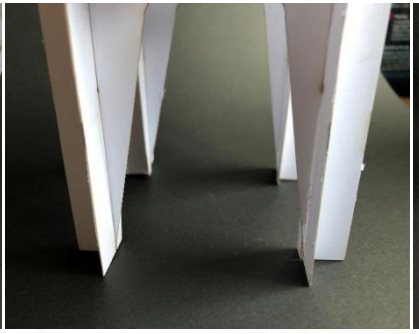
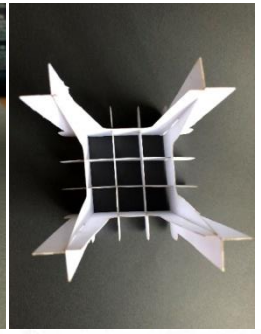
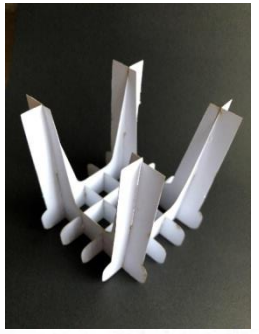
To apply the previous model shape/structure I will have to increase the distance between the outer slots and the inner slots to allow for a smaller width to the legs as the model using a slimmer leg and shorter pieces in length were more aesthetically pleasing and used a reduced amount of materials.





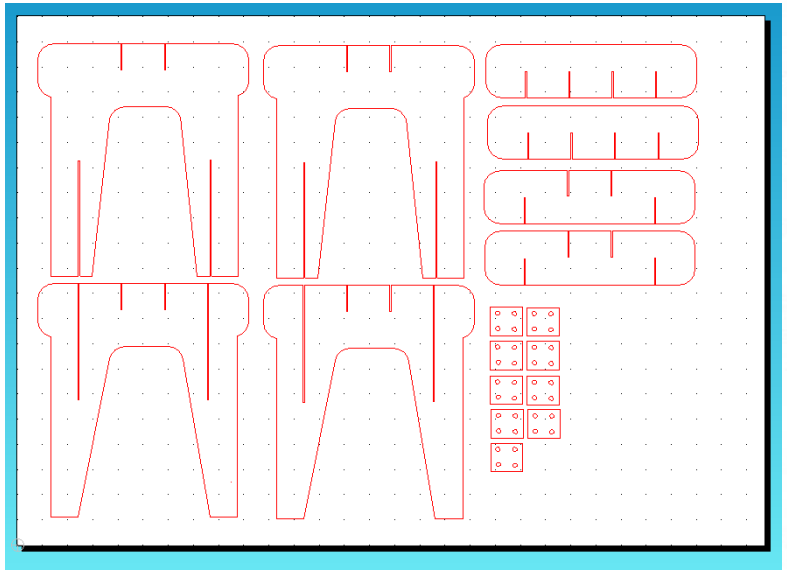
Notes:
- Soil Depth
- Height of garden bed
- Work out size of base support pieces
- Work out size of drop-in bases

Models 13 Stakeholder Feedback:

Partitions now evenly spaced.
Leg width increased to allow partition change.
'increase width of apposite interlocking legs.
However:
Model 12 partition lengths work better as Model 13 pieces are too long.
Reduce distance between partition pieces to allow for smaller pieces in length.

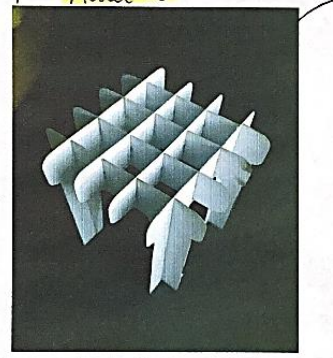
Have ensured the application to my design of the height to suit my stakeholder - 80cm



Next, I will reduce the leg width back to how it was within model 11 and 12, however to do this, while still maintaining an even distance between each slot, I will have to either reduce the distance between each slot or increase the distance between the outer two slots and the inner two slots to allow the width to be reduced of the legs.

Next, I will also need to apply the height suitable for my stakeholder to my design, as well as applying a suitable soil depth which will allow me to sort out the positioning of the supports for the drop-in bases.

Model 13



For this model, I have ensured that there is an equal distance between each slot, which has worked successfully as the pieces now slot together alot easier then they did before, as you do not have to force any pieces together.

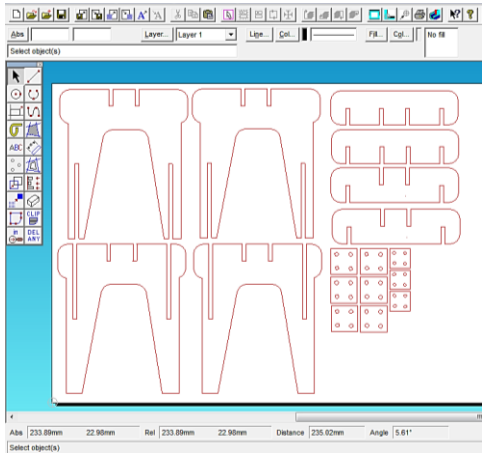
↓

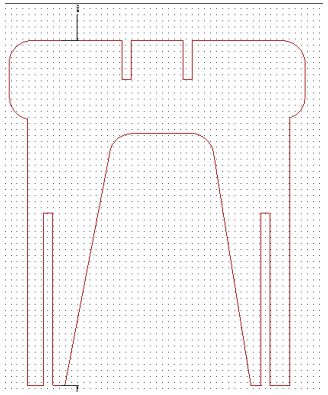
However, in doing this I had to increase the width of the legs to allow for the developed positioning of the slots to be applied. This meant that the length of the protruding pieces around the edge are longer, despite previously aiming to reduce these, as agreed with my stakeholder to maximise the material / space.

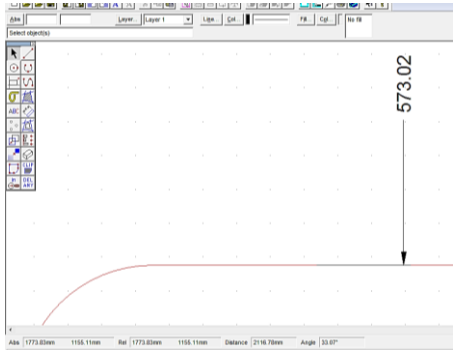
This will also then mean that the protruding pieces of the top edges of the design are shorter, to maximise the space within my design.

After making these developments, I will then need to modify the size of the drop-in bases to correspond with the other pieces making up the design.

Final Design Development:

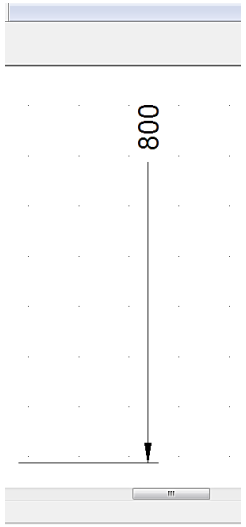


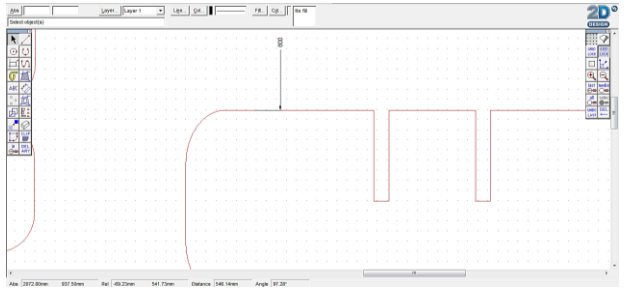




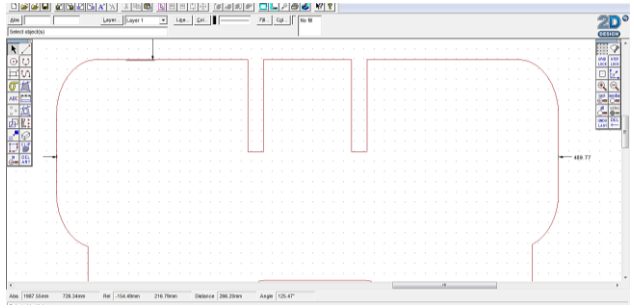
Current height = 573.02mm
= 57.302cm

= Needs to be 80cm

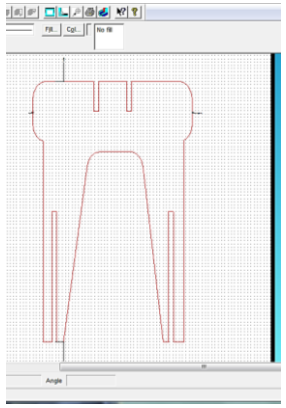


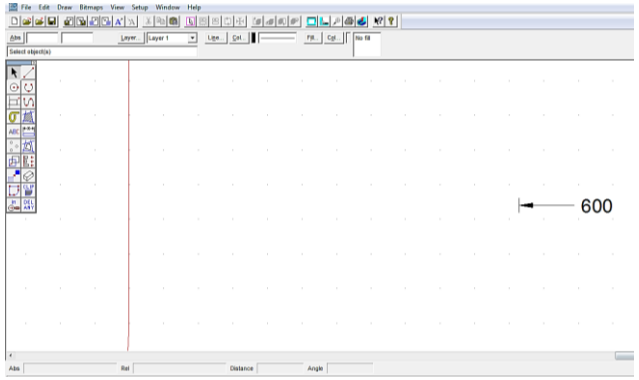


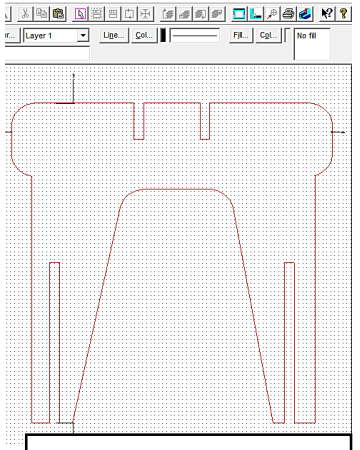
Height of 80cm applied shown here in CAD Screenshot



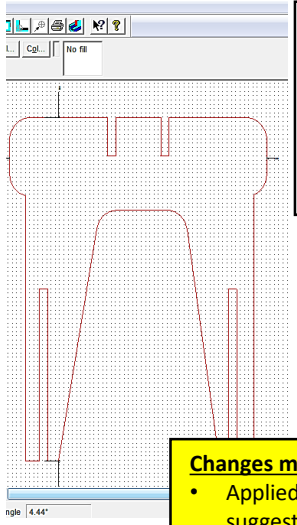
Working out whether I would need to increase also as I have increased the height to ensure it is proportionate



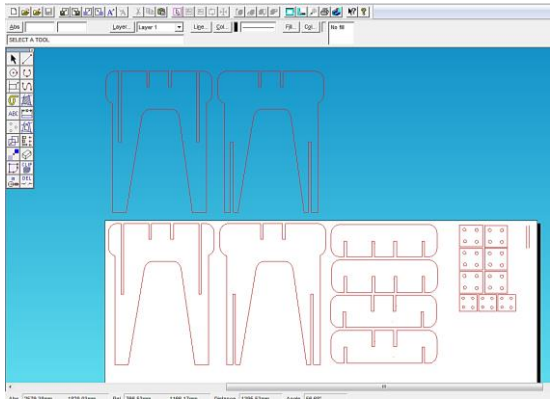


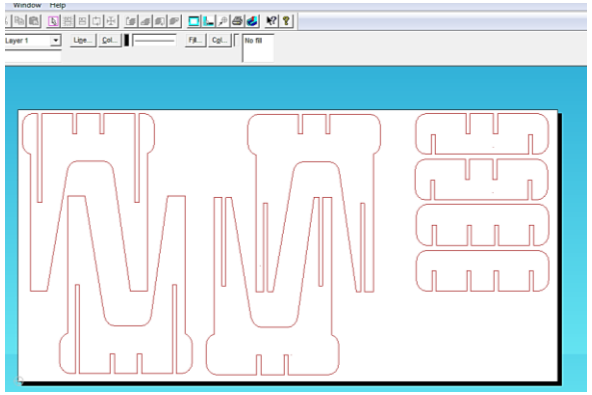


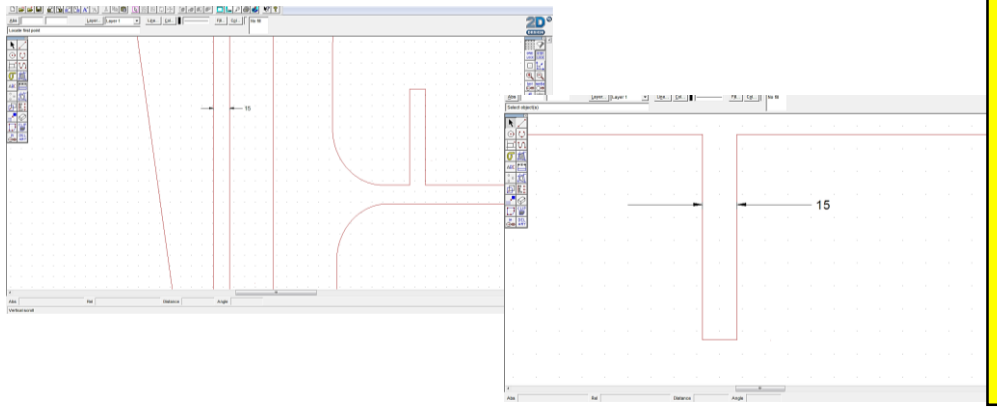
It is now 80cm in height by 80cm in width



It is now 80cm in height by 60cm in width to ensure a proportionate design.



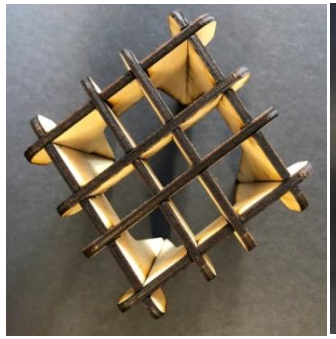


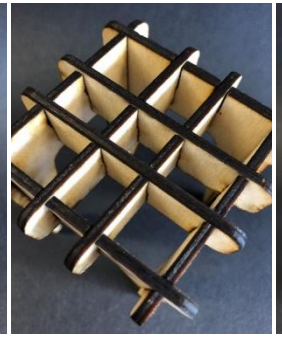


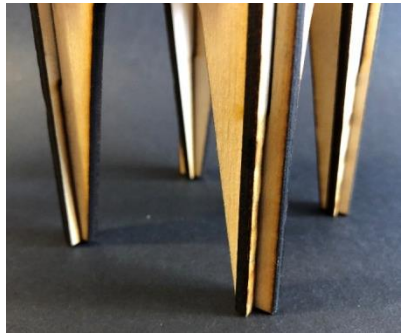
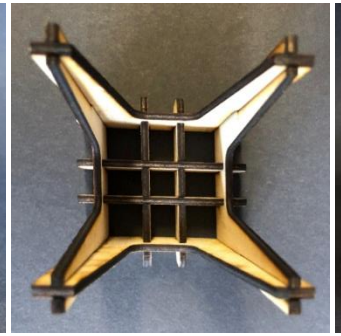
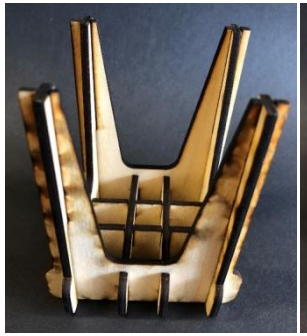
Changes made to final design:

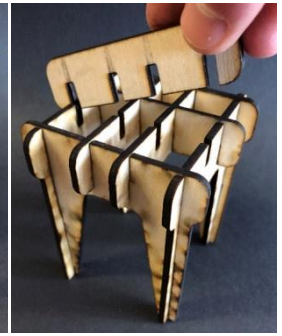
- Applied 80cm height suggestion from stakeholder
- Made the width of the slots 15mm (with added 0.1cm for fitting ?).
- Enlarged design to actual size including bases.
- Created a larger distance between the inner two and outer two slots to be able to reduce the width of the legs to the smaller size they were when I made model 12.
- Attempted to arrange pieces onto the material piece which measures 2440mm x 1220mm.

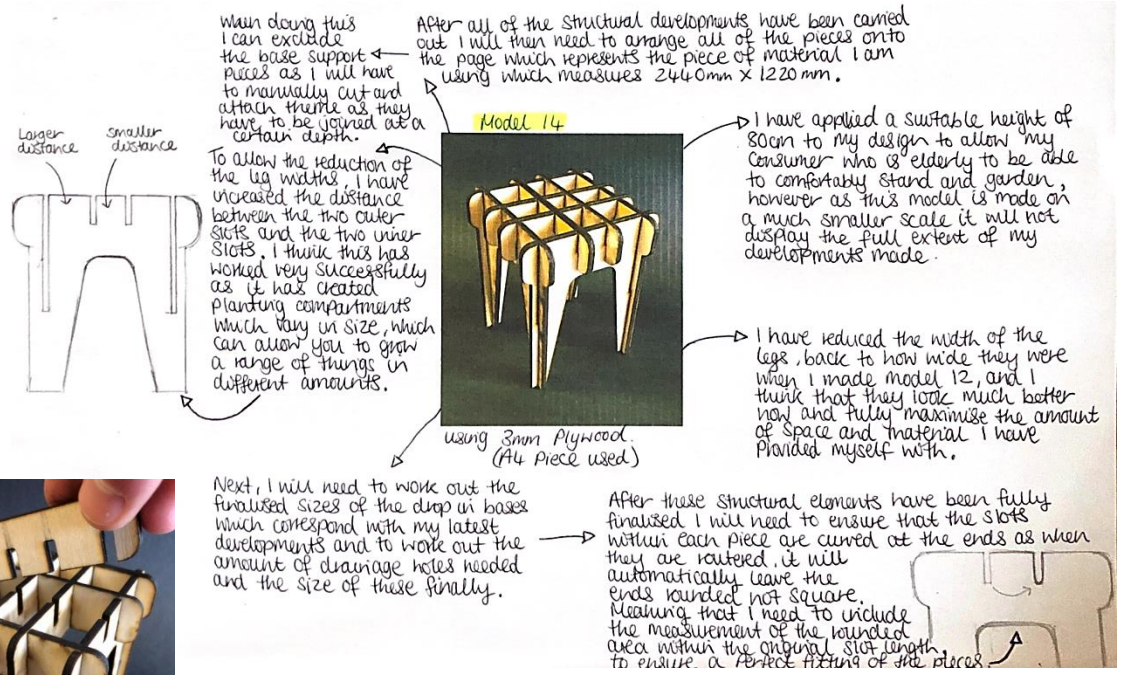
Model 14 – Developing Final Design Main Structure Element - Using 3mm Plywood to model the final design:

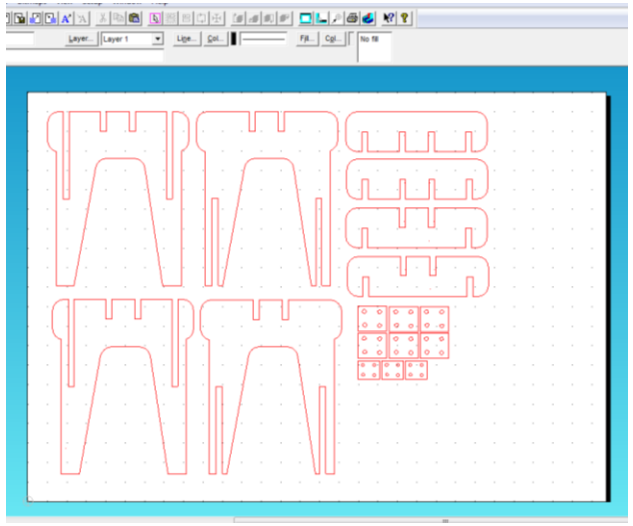


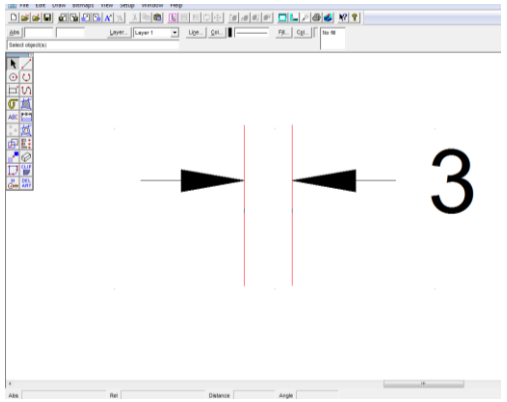


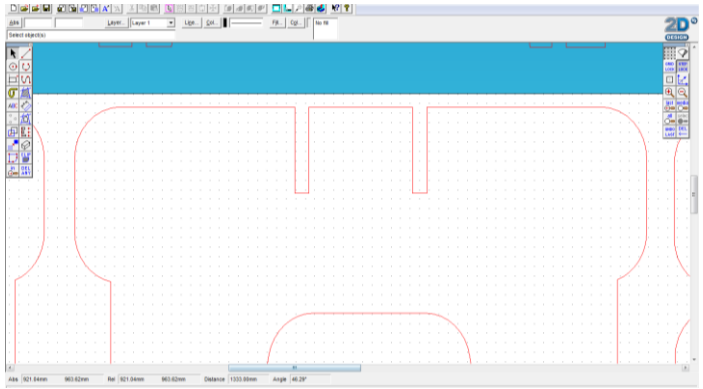














Next Steps:

- To ensure that the slots are curved at the ends as when they are routered finally they will automatically round it, meaning that I need to include the measurement of the rounded area within the original slot length to make sure that it still fits together properly despite being rounded instead of square.
- To work out the finalised size of the drop in bases and the amount of holes needed in each one and how big these need to be.

Changes made to this model:

- Applied 80cm height suggestion from stakeholder
- Made the width of the slots 3mm (with added 0.1cm for fitting ?).
- Created a larger distance between the inner two and outer two slots to be able to reduce the width of the legs to the smaller size they were when I made model 12.

Model 14 – Developing Final Size of Compartment Planting Bases:

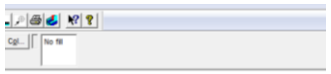
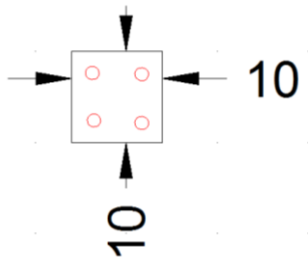
There are 9 planting compartment bases in total, however some of them vary in size and shape due to my recent developments, this means I have had to create the individually sized bases to ensure that they fit perfectly, as one sized base would not fit all of the compartments. There are now three different sized bases, which multiple of each are needed except one size – photograph them to explain the compartment base size/amount/scale etc.

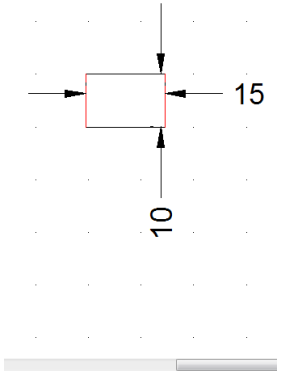
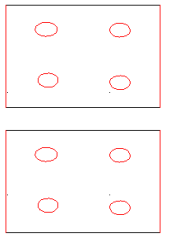
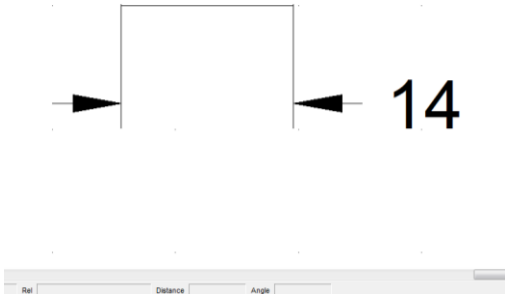
Photos of model 14 with added compartment bases and added base support pieces.

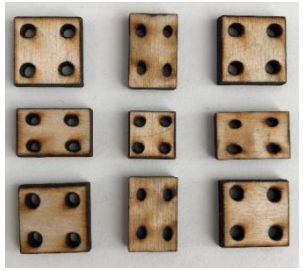


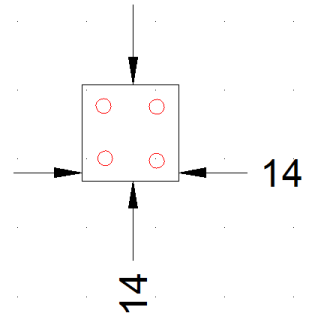




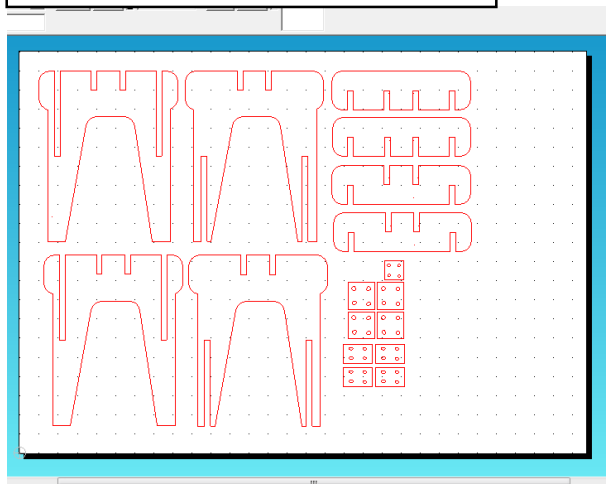
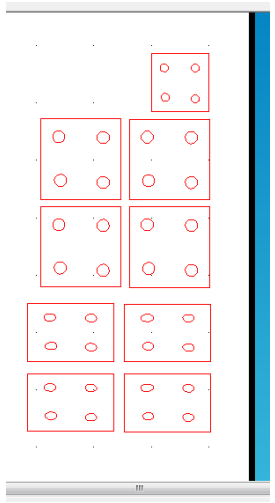




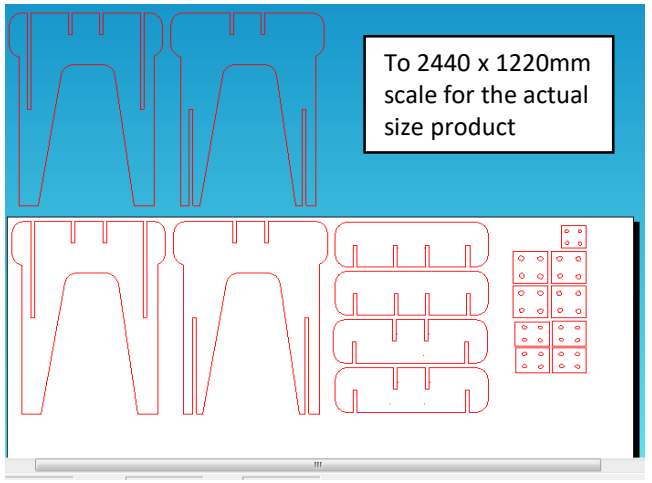









CAD Design to A4 scale for 3mm Plywood model made above:

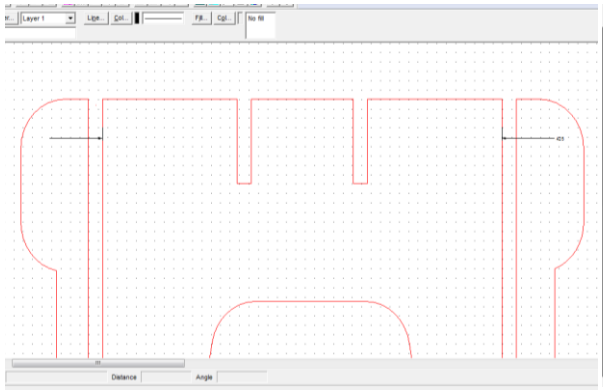


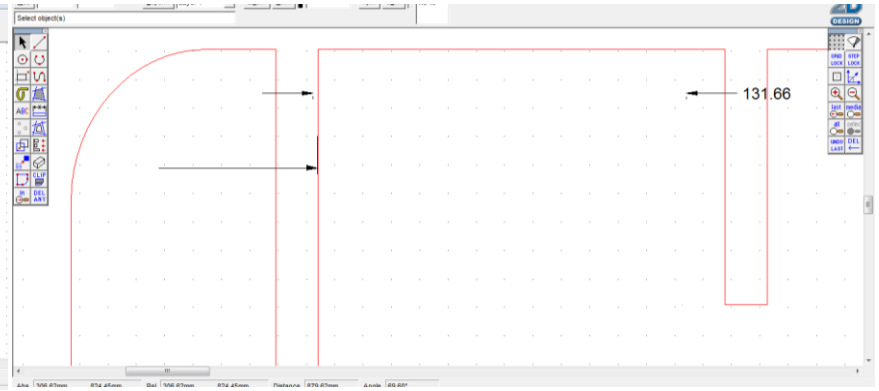
To 2440 x 1220mm scale for the actual size product

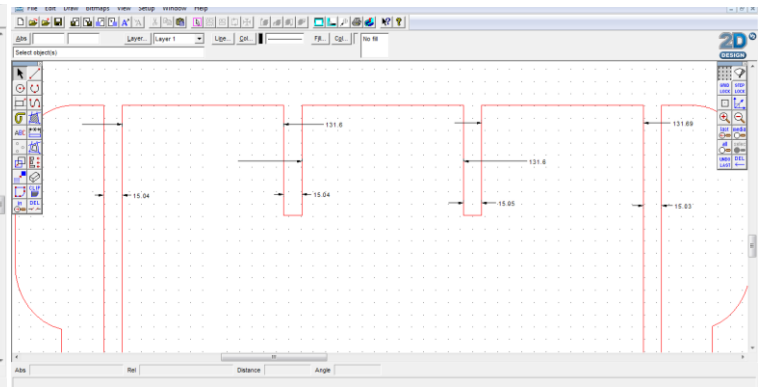
I have used the A4 design and scaled it up to fit the actual full size scale. To do this I have had to make some minor adjustments to the size of the planting bases to ensure that they fit to the pieces properly, because this full scale size is much wider and shorter in height than an A4 scale. This means that I cannot just enlarge the A4 scale pieces and expect them to fit as it is on a totally different scale altogether regarding height and width. However if I was enlarging from A4 to A1/0 for example I would be able to do that.

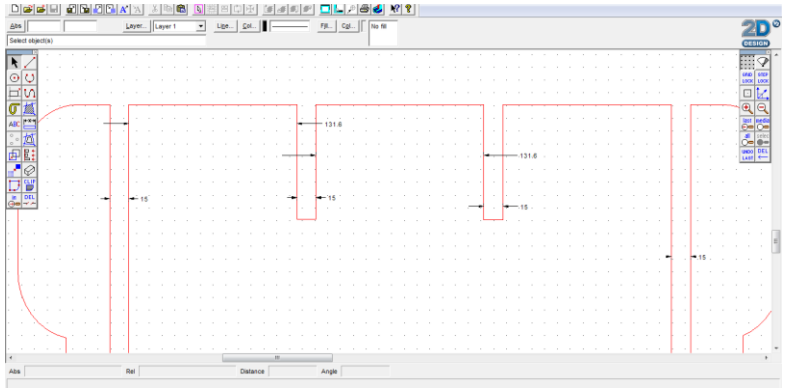
Final Design Developments:

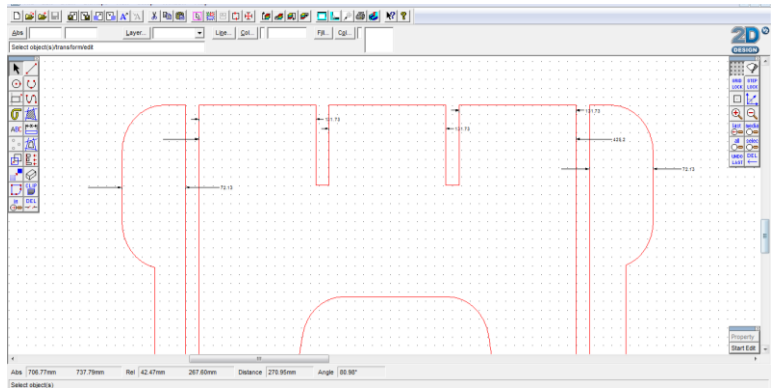
425 – (15 x 2) divided by 3 = 131.66



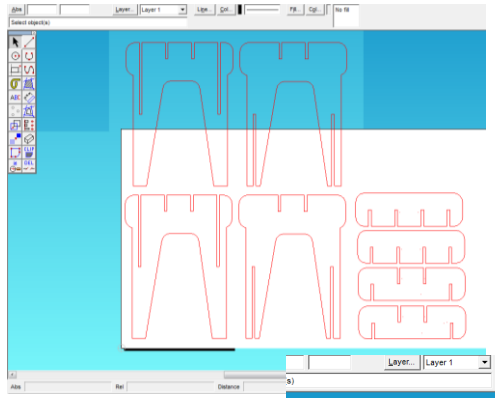


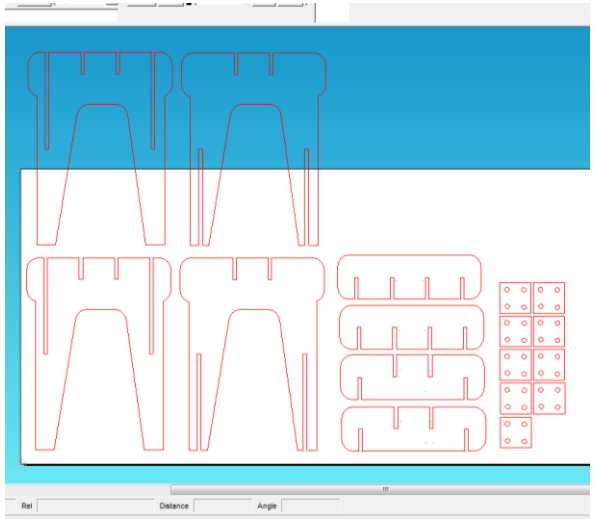


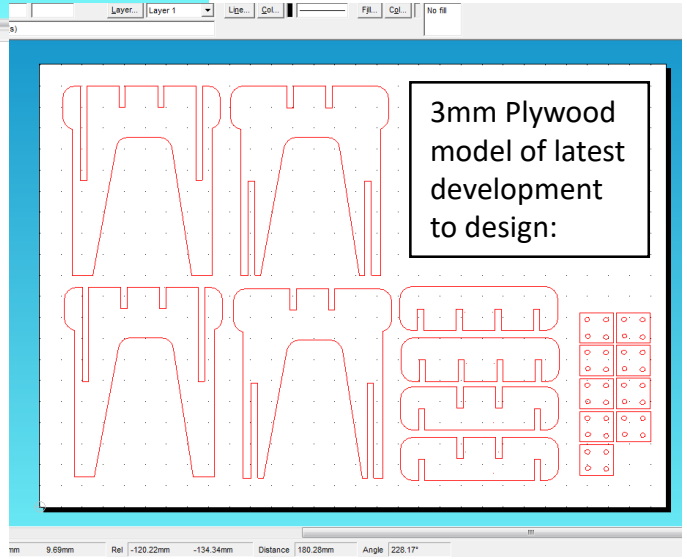




425.2 – (15 x 2) divided by 3 = 131.73



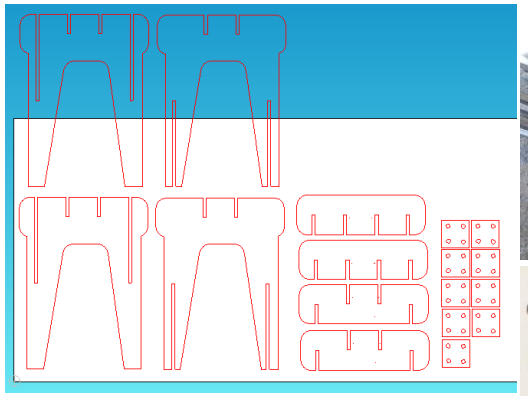


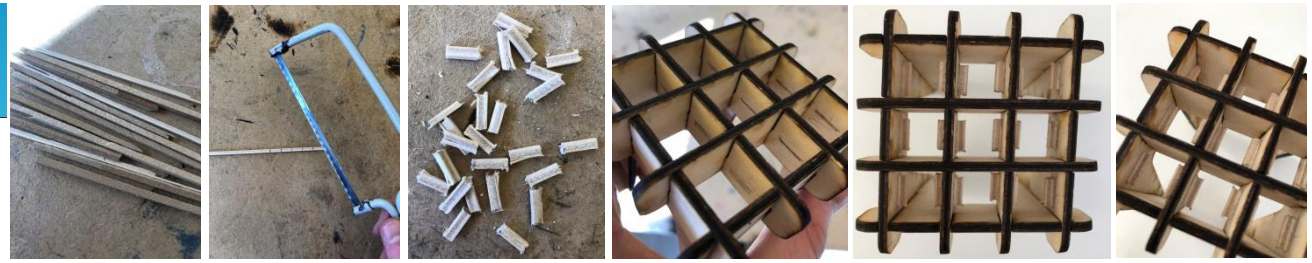


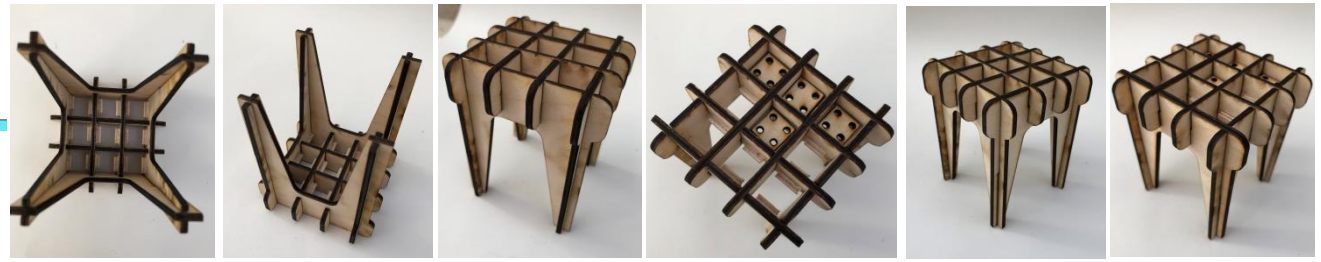
3mm Plywood model of latest development to design:

Model 15 – Developed Final design:

Size of marine plywood piece of material which I am using 2440 x 1220mm.







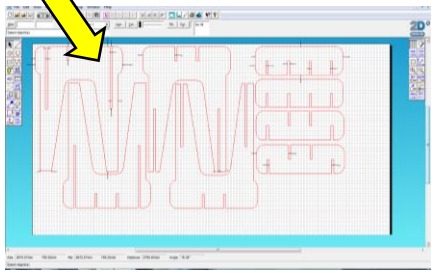
Next Steps:

- To work out the amount of space which I need to leave between the bases and the sides of the planting compartments.
- Work out the size of the drainage holes within the drainage bases and the amount of holes needed within each individual base.
- I now know that I will not need to curve the slots within each piece as their router machine will automatically do this when they cut out my design.
- Finally I then need to arrange all of the pieces so that they all fit onto the required sized piece of material (Marine plywood).

Models 14 and 15 Stakeholder Feedback:

- Bottoms need to be lower or deeper
- Bases need to be all of same size.
- Proto type very stable
- Adhesive could be used in assembly to provide more stability.
- Looks very aesthetically good.
- Staining with preservative for durability preferred to paint. (Paint goes 'flaky' quickly.
- Suggest bases screwed in preference to ~~screws~~ glue.
- Bases to be as tight as possible to prevent structure moving
- Only 1 drainage hole required. (gravel or pebbles or crocs used to allow drainage without soil falling thro).

I have left enough space so that there will be enough spare material left over for the company machining that we will be able to cut the bases using this material and not have to purchase any additional material.

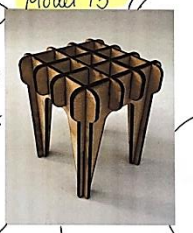


When making and attaching the support pieces for the compartment bases, I need to ensure that I attach them at a low enough and suitable depth, agreed with my stakeholder which is deep enough to allow the plant growth.

I have had a quote from C.G. Joinery which said that it will cost around £114.20 + vat to supply the material, programme and machine the design.

I have decided that I will be sending my chosen manufacturer only the main structural pieces to be cut out of the sheet of marine plywood measuring 2440 x 1220mm. Then using the offcuts I will make and fit the support rails and planting bases myself to ensure an accurate fit.

Model 15



My next step is to ensure that when I have recieved the machined pieces, that I accurately take measurements to then be able to make the support pieces to the correct length and the bases to the right size, as I want them to drop-in easily but still have space for adjustment and removal, but they shouldn't be so loose that they fall through or slide about a lot.

I increased the distance between the two outer slots and the two inner slots to be able to create 9 planting compartments which are all an identical size.

The height of the legs correspond with my stakeholders needs, as we agreed that for the actual product 80cm would be a suitable standing height for him to be able to comfortably stand while planting while not having to bend down or reach far for anything.

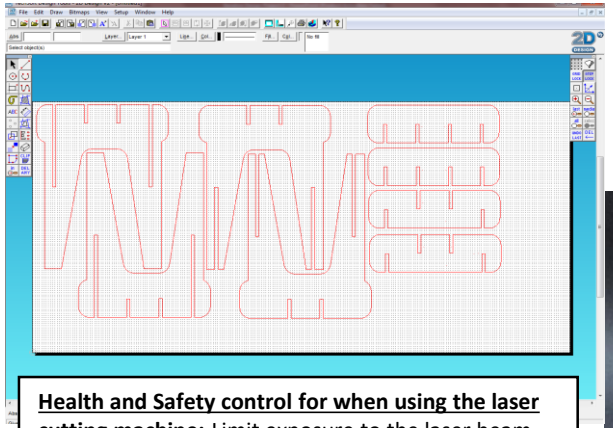
My stakeholder and I have decided that only one drainage hole per compartment base is necessary as then only a small amount of gravel is needed to cover a smaller surface area to maintain significant drainage but reduce to risk of too much soil falling through. (If I used 4 drainage holes per base, it would be more difficult to prevent soil falling through).

I have decided to use stain on the marine plywood to provide to necessary protection and durability for my product as it will be placed in an outside environment.

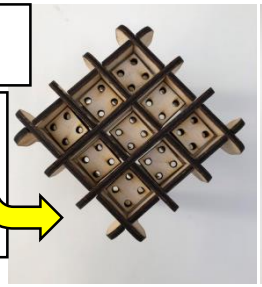
After fully developing my design, it is now much more stable and strong, it functions easily and is simple to construct and de-construct.

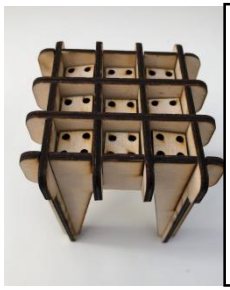
As more gravel would be required, meaning more weight and pressure is put on the bases, reducing their durability and overall strength.

Final Design Solution – small scale model:

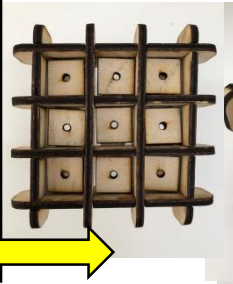


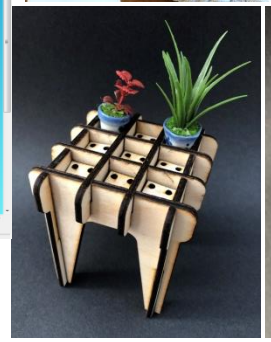
Models made from 3mm plywood

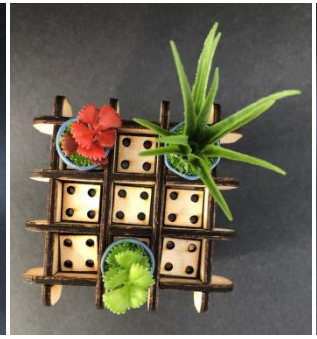


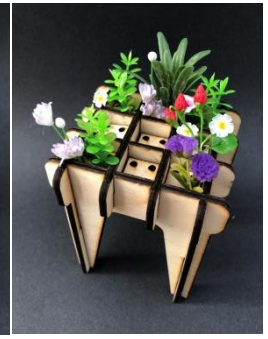


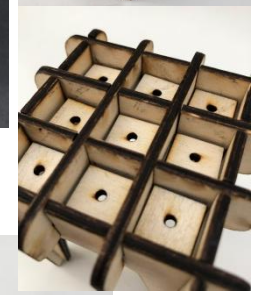
Model with drainage bases containing only one drainage hole per base



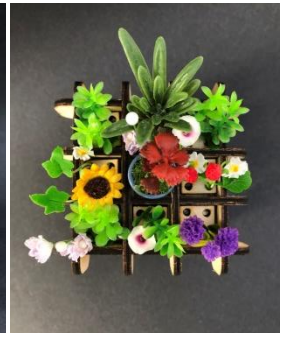


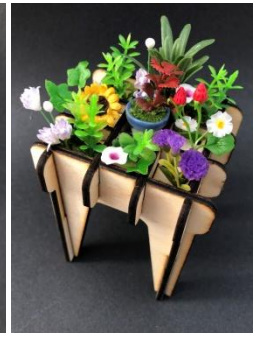




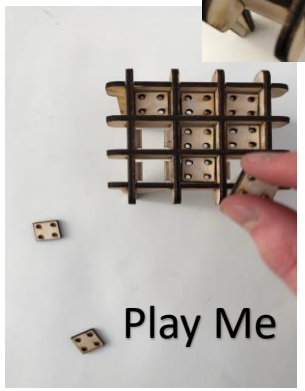


Health and Safety control for when using the laser cutting machine: Limit exposure to the laser beam, take all recommended precautions, e.g. don't stare into the laser/bright light can cause eye damage etc.



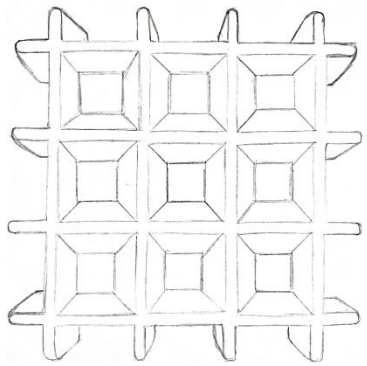


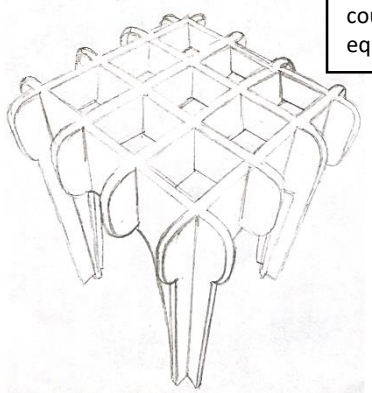
Linking back to the my original end user specifications, they requested a lower platform for storing other small gardening tools/equipment, e.g. plant pots to save the user from reaching to the floor a lot. However, my end user and I have decided this will not be necessary, as it will result in an additional cost and it may take away from its unique appearance which is preferred at the moment. Also, we have concluded that any spare compartments which haven't had plants/flowers planted in them can be used to hold extra small pieces of equipment easily. We also concluded that small hooks could be added onto the edge pieces protruding out around the sides which could be used to hang small tools and pieces of equipment on e.g. a small shovel/spade.



Final Design Stakeholder Feedback:

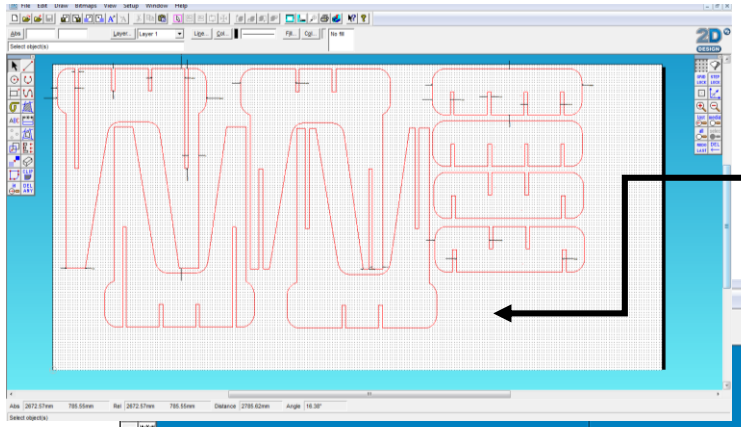
Bedding begonias. French marigold. trailing petunias
bedding geraniums. trailing lobelia.
violas. ivy.
(all the above could stay in to maturity)
if planted out of pots, bottom of compartments need small gravel lining before compost.
if planting in pots gravel not required.
Pot rims to be level with top of compartments.

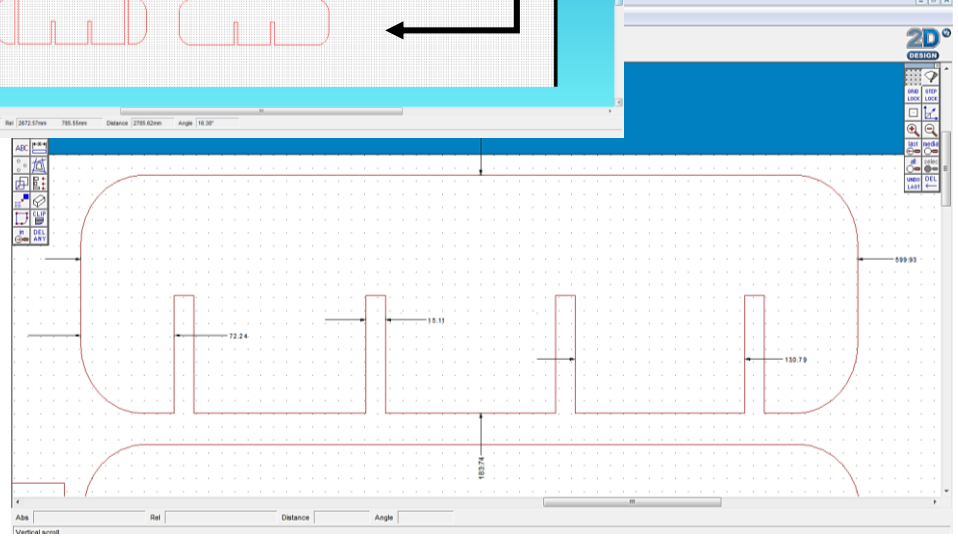


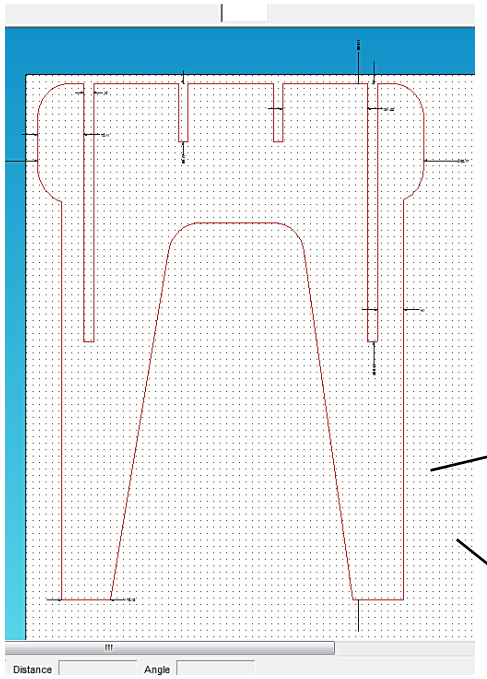


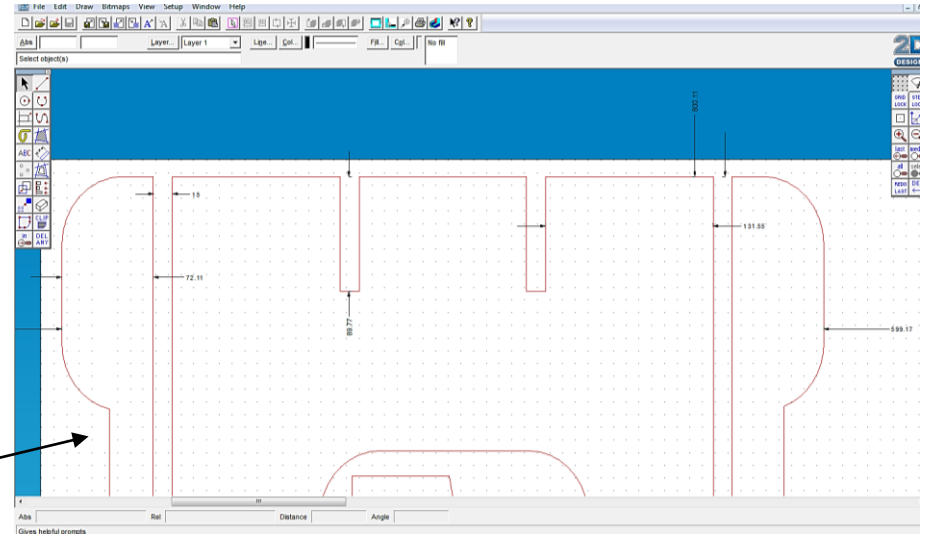
Final design –Technical Specification:

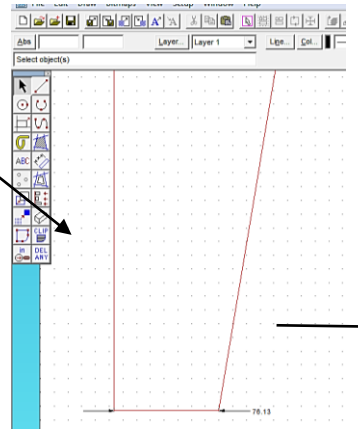
This exact CAD design file was then converted into a DXF file and sent directly by email to C&G Joinery to be manufactured by machine (CNC Router).

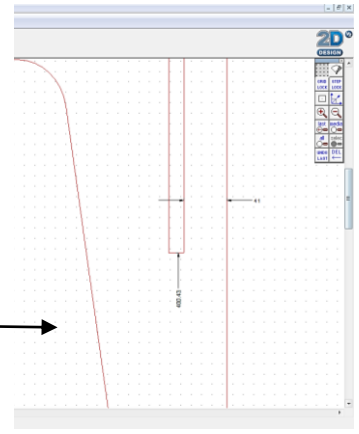


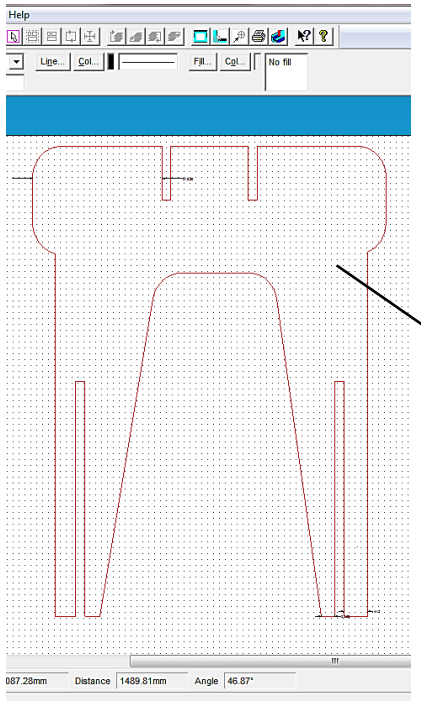


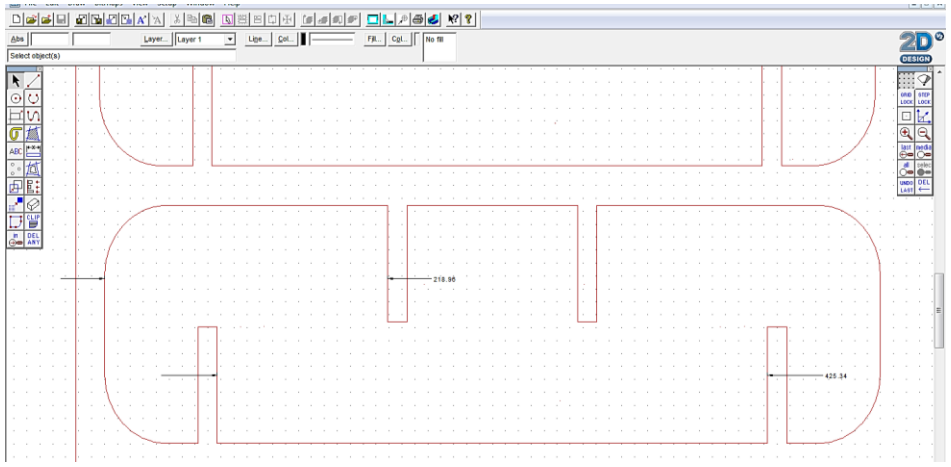


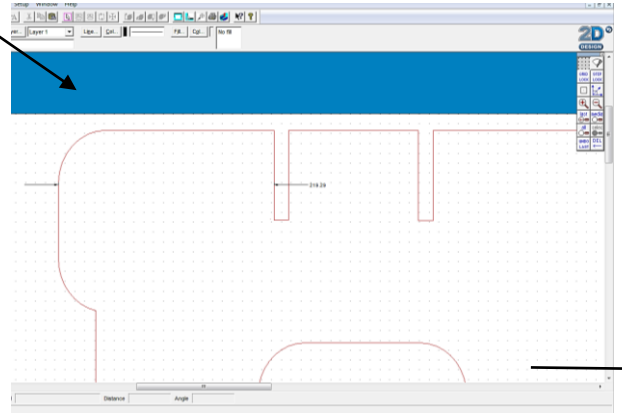


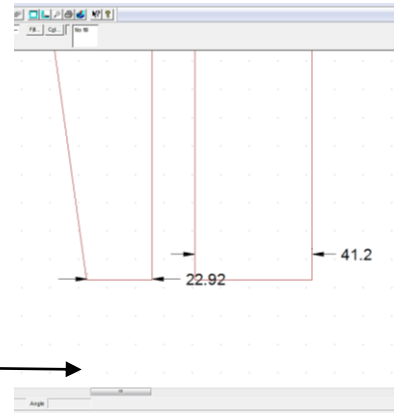




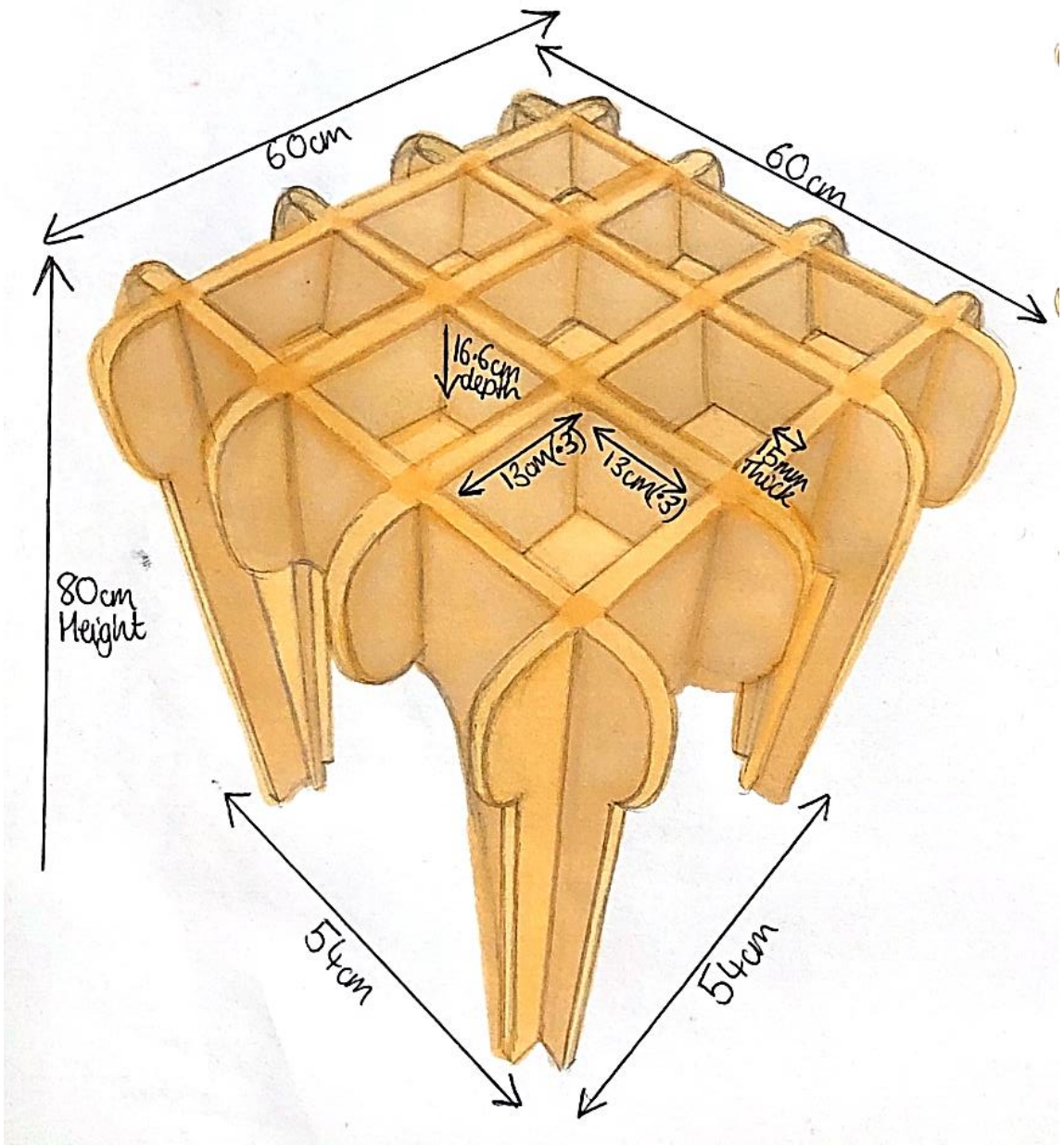


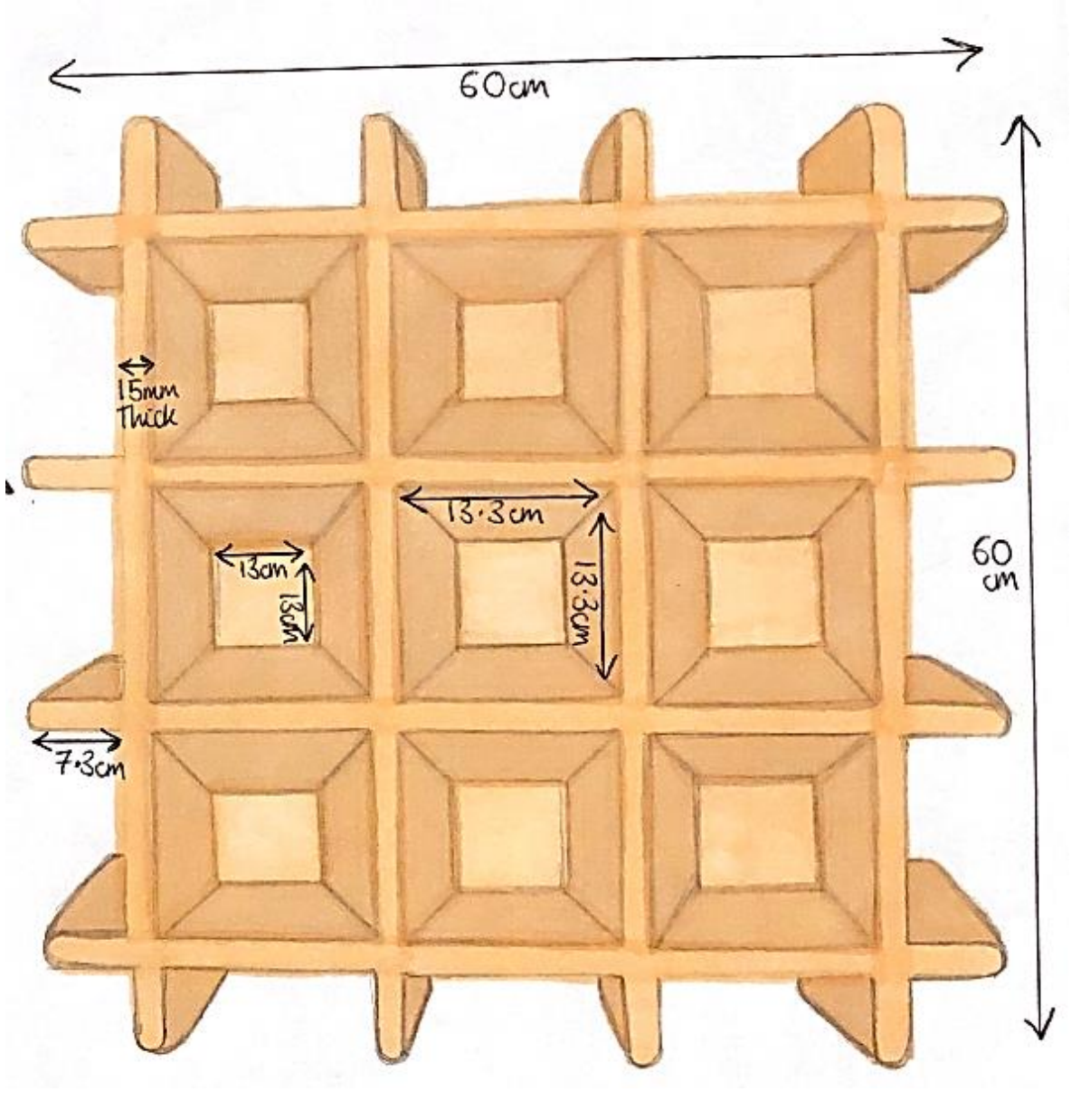




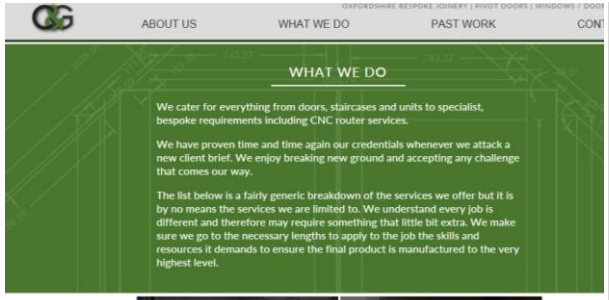


Final design –Technical Specification Continued:

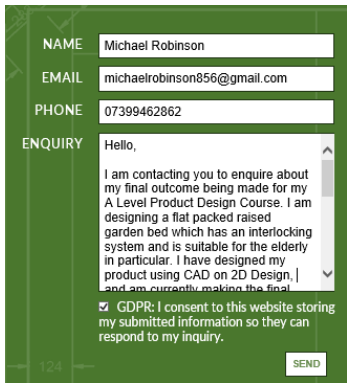


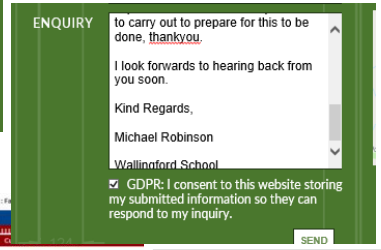


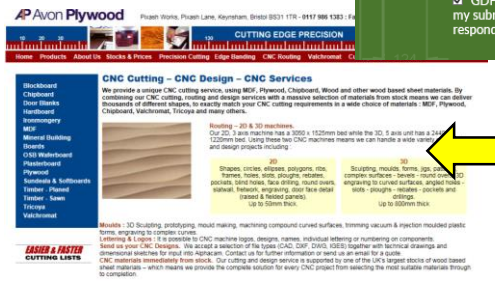
Contacting the company regarding the making of my final product in full size:



I think that I will use CGJoinery to enquire about making my product, as they are more local to me, as they are based in Wantage, whereas the other company are based in Bristol, meaning the added cost of transportation of the product as well as the final product itself, wouldn't be worth it.







Other researched machining company to consider when manufacturing my product.

I will only need to get the company (C.G.Joinery) to cut out the main structural pieces, so I have only put the larger structural pieces onto the CAD Design to be cut out. This reduces the overall machining cost, as the company has to cut less, however the price of the material will obviously stay the same. Then using the offcuts which I will ask to keep, I will cut out the bases and supports using a machining technique/tool we can use at school.

Michael Robinson <michaelrobinson856@gmail.com> Fri, Mar 15, 4:35 PM (8 days ago)
to patrick@cgjoinery.co.uk

On Fri, 15 Mar 2019 at 4:32 pm, Michael Robinson <michaelrobinson856@gmail.com> wrote:

> Hello,
>
> I am contacting you to enquire about my final outcome being made for my A Level Product Design Course. I have designed a flat packed raised garden bed which has an interlocking system. I have designed my product using CAD on 2D Design and I would like to use a sheet of 15mm marine plywood which measures 2440mm (width) by 1220mm (height) to get some of the pieces cut out. If possible, I would also like to keep the off cuts so I can make some smaller additional pieces for my product at school.
> I will be able to send you the CAD design on monday (18th of March) as I can only access the 2D Design software at school. Please could you then give me a quote for purchasing the material and cutting out the pieces. Thankyou.

Hello,

Following on from my previous email, attached is my CAD design for my flat packed raised garden bed product, the layout size should be 2440 x 1220mm. Please could I have a quote for purchasing this particular sized piece of material and to cut out the pieces too. Thankyou.

Kind Regards,

Patrick Howe Mar 22, 2019, 3:48 PM (1 day ago)
to me

Hi Michael,

It would be £114.20+vat for us to supply the material, programme and machine the sheet.

Kind Regards

Patrick Howe
C&G Joinery
13 w&g Estate
Challow
Wantage
Ox12 9tf
Tel. 01235 763233

Michael Robinson <michaelrobinson856@gmail.com> Mar 22, 2019, 4:06 PM (1 day ago)
to Patrick

Hello,

Thankyou for the quote, that's fine I would like to go ahead please. Please can I have an estimated date of when this can be done and when I can collect the pieces, preferably ASAP please, thankyou.

My CAD design that I sent them, which had to be converted to a DXF file.

Photo of the machined plywood pieces as they came back from C&G Joinery:

Cutting List:

Material	Quantity	Length (mm)	Width (mm)	Thickness (mm)	Unit Cost	VAT Cost	Total Cost	Total Material
Marine Plywood	1	2440mm	1220mm	15mm	£114.20	£22.84	£137.04	One sheet

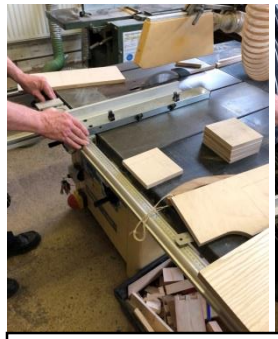
Planning for making the final prototype:

Task	Material	Sizes	Quantity	Equipment, tools and processes	Health and Safety – (Hazards and solution/precaution – RISK ASSESSMENT)	Quality Control
Manufacture of main structural pieces carried out by C.G.Joinery furniture company	15mm Marine Plywood	2440 x 1220 mm	1	CNC Industrial Router Machine	Take extra care when handling the machined pieces and offcuts, because they are freshly cut they can easily cause splinters/cuts if your not careful, so wear protective gloves as a precaution to prevent this from happening. Also, when using any equipment ensure that you wear an apron and safety goggles for protection and precaution.	Carried out using a CNC router machine to ensure accuracy and precision to ensure all elements fit together perfectly when assembled.
Using the offcuts left (minimizing waste produced), cut out planting compartment bases	15mm Marine Plywood	Various	9	Circular Saw or Routing machine		Use a set square when measuring and marking out the bases to cut which will ensure precise 90 degree angles to the square shaped bases.
Manufacture support pieces for planting bases.	15mm Marine Plywood if there is enough remaining offcuts to use/ or MDF.	One size: Length = 12.2cm x Width = 2.1cm	(2 support pieces per base) 2 x 9 = 18	Circular Saw	Ensure a qualified person able to use the circular saw carries out this particular task. Also ensure to always wear goggles to protect the eyes from any pieces which flick up from the cutter.	Make sure the saw is set in the same position/measurement when cutting all support pieces to ensure a consistent width which will support each base when assembled.
Attach support pieces for bases at correct depth to the main structural pieces.	15mm Marine Plywood Screws/nails ?	Depth at which they were attached = 16.6cm	18	Drill 25mm Panel Pins Wood Adhesive/Exterior PVA glue	Take extra care when using sharp and dangerous tools, e.g. panel pins and a hammer. Also when using the wood adhesive to attach the support pieces to the main pieces be careful as it contains a chemical solution which can trigger allergic reactions, so avoid skin and eye contact, but if it does come into contact wash immediately and thoroughly.	Use a spirit level to ensure they are exactly straight/parallel to allow the base to be placed in flat and securely.
Construct the raised garden bed together fully by interlocking/slotting the pieces together, using a mallet to knock pieces tightly into place.	15mm Marine Plywood	Final size of constructed product: Height = 80cm, Top of garden bed = 60 x 60 cm, bottom of garden bed = 54 x 54 cm	1	Mallet	Take extra care when using potentially hazardous tools, e.g. a mallet – peer supervision may be necessary. Again, ensure to wear goggles which protect the eyes from small chips of wood getting into the eyes or any dust floating about.	Don't just knock the pieces together using a mallet – make sure you place a piece of scrap wood onto the area in which you are joining and then only make contact between the mallet and that piece of scrap wood to prevent you marking your final pieces of wood as you want them to maintain their good condition so they will last in the long term regarding their durability/strength.
Fit the drop-in compartment planting bases to ensure a tight fit to support the plants.		Size of each base = 13 x 13 cm	9 bases in total	N/A	Be careful not to trap your fingers when dropping in the compartment bases as they fit fairly tightly – position in one ide then drop in position on the other side the flatten out.	Try to put the best looking side of the wooden bases to the top to ensure the best aesthetic appearance for the photos taken of the product.
Stain/varnish all parts to prevent weathering of product when it is in use outside.	Stain/varnish	N/A	Amount used = ½ layers(ml)	Paint Brush/piece of material/fabric to achieve an even distribution and finish.	Wear Gloves when doing this and also avoid any contact with face/eyes/hands as it stains and can be harmful.	Ensure an even distribution of product within each stroke to create a smooth and even colour/protection result on the material.

Report/diary of making:



Marking out the planting bases onto the scrap pieces of marine plywood which were left over from the machining of the main parts of the raised garden bed designed using CAD. When marking out the bases, I ensured that I designed them to a specific size so that there is a small gap around the entire circumference of the base to allow for the removal of them when cleaning the garden bed out or re-planting for example. Each compartment measures exactly 13.3cm x 13.3cm, so I have made the bases 12.5cm x 12.5cm, which allows for a gap of 4mm around the perimeter of each base when within the garden bed compartment.

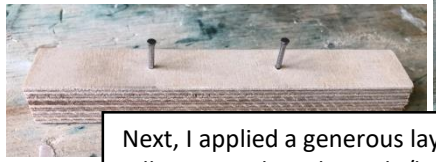




Using the circular saw, I asked a qualified user to machine the compartment bases and the support pieces out of the spare scrap wood left over from machining my other pieces.

Then using a machined template made from MDF, which allowed me to position the support pieces in the exact position flush and parallel to the bottom of the piece and allow me to hold it in place more securely when attaching to achieve a more precise result.



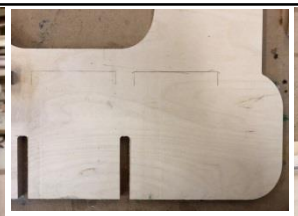

To attach the support pieces, I firstly gently hammered in two evenly spaced apart marks for where the 25mm panel pins were to go, I then knocked them in three quarters of the way down, but not allowing them to protruding through the bottom of the support piece.

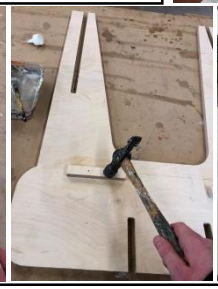
Next, I applied a generous layer of the exterior PVA glue/wood adhesive to the other side/bottom of the support pieces and then pushed it down into the marked area/space onto the wood piece moving it gently side to side as I was attaching it to ensure a strong and bonded attachment.










Using a slightly damp sponge/cloth/dry paintbrush I then wiped away the access glue gently so I could clearly see if it the support pieces was in place – flush against the bottom edge – using the template to help me ensure this accuracy. I held it firmly in place for a minute or two to ensure it was stable enough so that I could then hammer the pins fully into the support pieces and through into the wood to fully attach them together.

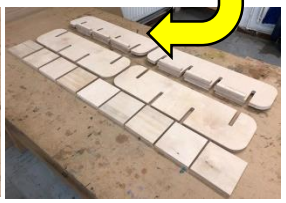
I then repeated this process by attaching support pieces onto all of the necessary pieces of wood. Finally I wiped away any remaining dripping glue from the edges to ensure a neat a professional appearance/finish and then I let all of the pieces fully air dry until I tried testing if the bases fit into the compartment spaces to rest onto the support pieces.

The finished pieces ready to be constructed by interlocking/slotting them together.

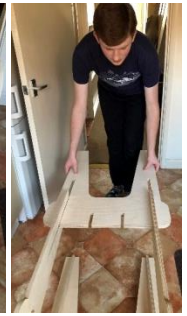
To attach the support pieces I purchased and used 25mm panel pins and some wood adhesive/exterior PVA glue.











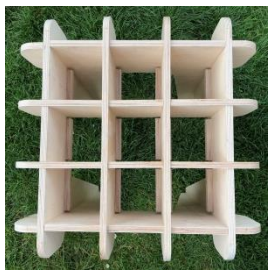


Next, I began to construct the raised garden bed together by slotting each piece together one at a time, using a small mallet or hammer to knock pieces tightly in place together as some were slightly more difficult to slot together than others.




My end user and I went to the local garden centre to purchase the plants/flowers to plant into the raised garden bed. Then we planted them into singular pots ready to place in the compartments.

When the raised garden bed was fully constructed, I then moved my focus onto marking out where the drainage holes were going to go within each compartment planting base. My stakeholder/end user and I decided that one drainage hole directly in the centre of each base would be what's necessary, however when testing to see if the bases fitted into the compartments now the product is constructed together, I found that here was enough room around the edge of the base piece and the compartment for any water to drain through which means that there is enough drainage options/opportunities available for complete functionality.



After finishing fully constructing and interlocking all of the pieces together, I then fitted the drop-in planting bases into their individual compartments ready and in preparation for planting.







I have currently applied no finish in particular to the raised garden bed, this is because if I were to produce these on a large scale for many customers, I would be able to customise the sort of finish required for each individual consumer, to ensure that I meet their needs of the product to suit their preferences.

Final Product: Raised Garden Bed











Planning the feasibility study of design solution :

What?	Who?	Where?	Why?	How?	Completed ?
Functionality Tests – standing/sitting height, volume of plants held etc. (Testing relating to the requirements)	The designer will undergo the majority of these tests and will have assistance from the end user.	Home	To conclude to whether the product meets all of is requirements and functions correctly suited for my end user.	Set up small tests to measure each aspect of its functionality – A good quality camera is required for photos and record and present results.	YES
Photos of final prototype in context.	End users and peers to give comments	School/Home	To test how the final product functions, appears etc.	Use a selection of photos and clips as required.	YES
End User Interview/Feedback	Gardener	Home	To conclude potential for manufacture/commercial use and to conclude if the product meets the specification.		YES
Questionnaire/Survey User Feedback	Users and peers to offer opinions and comments.	School and home	To conclude any further improvements which could be made in the future and to test whether the product meets its requirements.	Digital/Written questions.	YES

Feasibility Study – Have the requirements been met?

Stakeholder and Technical Requirements:	Have the requirements been met?	Requirement Met?
The product should cater for growing multiple plants/flowers.	The product contains 9 different planting compartments which allows the user to plant 9 different plants/flowers within the entire product.	YES
The product should be suited for an elderly person by being able to be easily accessed while standing so that they wont have to bend over constantly to access the plants within the garden bed. It should be around 80cm in height to accommodate for my end users standing height to bend down to reach he plants easily.	After my end user had analysed my product and tested it out, he is able to stand next to the product and work on the planting compartments easily without having to bend over a large amount, he is also able to remain seated while sitting next to the product and still be able to use it so that means that the product has successfully met the specification required.	YES
The product should be durable and long lasting.	After fully constructing the product together and then analysing it, I have come to the conclusion that it is extremely sturdy as all of the pieces fit together to achieve a tight and secure fit. He product is of a certain weight that it will stand alone on a flat surface easily, e.g. grass. Also, as I have used a particular thickness of plywood, which is 15mm in this case, this factor also adds extra strength and security to the entire construction.	YES
The product should be easy to function and practical.	My end user has expressed how easy the product will be to function for him as a gardener as he can just stand while watering and planting within the product, which means it will be a lot more practical for him as he is of a more elderly age, he wont have to keep bending down in multiple different areas apart constantly within his allotment grounds and do his gardening.	YES
The product should be preferably made from marine plywood and my end user wants to use a more economical material.	The product was made from the marine plywood requested as it contains a waterproof glue which is highly suitable for my product, as it is to be placed outdoors, however it was a little more on the expensive side due to these extra functionalities of the materials, e.g. being waterproof.	YES
The product should be suitable for use/storage outdoors.	My product is perfectly suited for the outdoors because of the waterproof type of marine plywood I have used and that I will be covering the entire product with a couple of layers of protective solution – e.g. stain or varnish to prevent any weathering which may occur and be a result of being outdoors for a majority of the yea round in use for planting.	YES
The final product shouldn't be too heavy in weight, as it needs to be suitable for transportation by an elderly person, for example to be able carry it from the car to its destination for constructing, but also to move it around in the garden.	The product can be easily carried by two people, as it is fairly small, but is of a certain weight as plywood tends to be a lot heavier due to the amount of components it is made of up (layers) and the fact that I have used a relatively thick type of plywood at 15mm.	YES
The product should have a purpose of storing plants/flowers and is able to grow these fully within the bed or begin the growing process of the plants/flowers within the bed to then eventually be able to transfer them into the ground for further and full growth.	The drop-in planting compartment bases allow for easy planting, emptying and cleaning of the raised garden bed, as plants/flowers can be easily planted into the bed by adding a layer of gravel into the bottom of the planting compartments first to allow for effective drainage, then a layer of soil and compost then the plant. They can also be removed from the garden bed then later transferred and deposited into the ground if required for further full growth depending on the plant species or they can remain in the garden bed if suitable for full growth.	YES
The plant storage solution should have an easy system for planting , emptying, cleaning and renewing.		

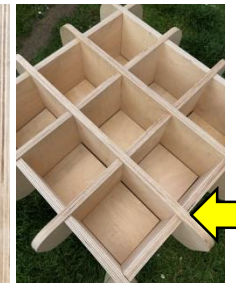
Feasibility Study:

The raised garden bed is a suitable height to ensure that my end user didn't have to bend over at all to be able to access the planting compartment to put in all of the plants/flowers. My end user felt that the product was set at the perfect height which allowed him to easily access all of the plants much easier then having bending down to the ground constantly to attend to his allotment plants which resulted in a lot of pain, rather than the enjoyment of gardening/planting.

The raised garden bed is also suitable accessed while sitting down in a chair, as after a while they may get tired, so this allows them to have a rest until they feel they can stand and continue, however they are still able to garden and do some tasks while sitting in the chair, so that is an added alternative. This means that my product would also be suitable for anyone in a wheelchair as then they can garden while remaining in their wheelchair with no need to stand to access the product.

Testing relating to requirements :

As you can see from the image, the raised garden bed allows for an effective but subtle drainage system. The small gap around the circumference/perimeter of each planting base which is fitted into its individual compartment, allows any water to drain out from around the sides and fall onto the ground and be absorbed. This should not effect the stability or durability of the wood itself as a protectant, e.g. a stain/varnish of the customers choice would be applied before purchasing which would prevent any warping of the wood or weathering from the water for example.

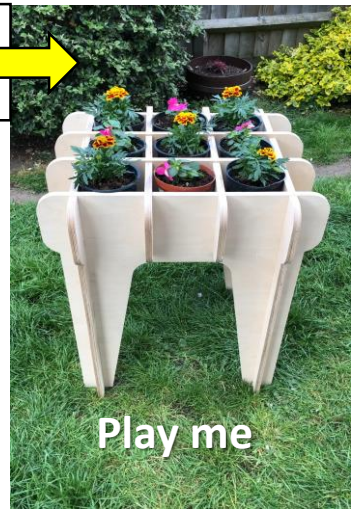


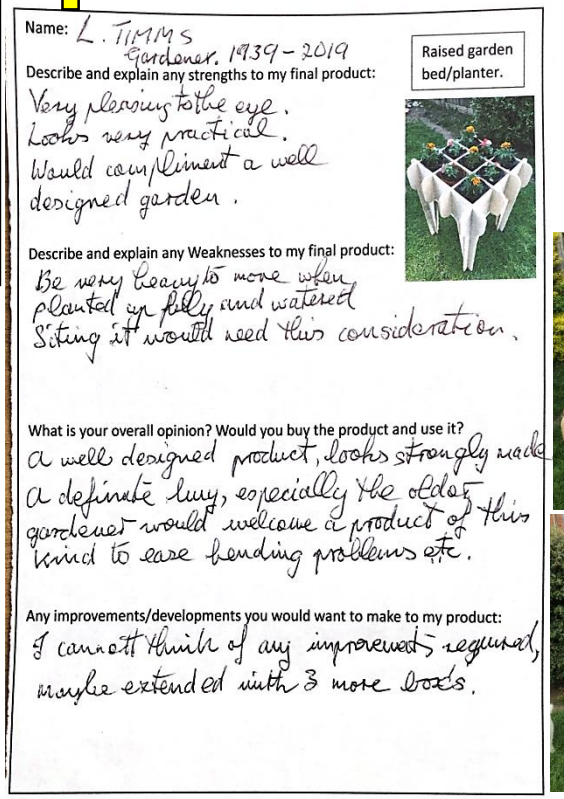
The raised garden bed has an easy system for planting. emptying, cleaning and renewing. This images above show the practicality and functionality of the drop-in base system allowing the user to easily plant and renew/clean with minimal effort. This is perfectly suited for someone who is more elderly, as small tasks can pose as a great task at an older age, however this system ensures it stays as small and as manageable as possible which can be easily carried out and straight forwardly attempted by anyone.

End/primary user testing/analysis and feedback:

Response to end user feedback: I also agree that if I extended the design by adding around three more planting compartments this would allow for an even wider variety and larger amount of plants to be grown. I could even add enough planting compartments to achieve a rectangle shaped design – similar to those existing products which I have researched, as it seems to be a popular shape and design required by consumers.

Video/tour of the finished product:





Name: L. Timms
Gardener. 1939 – 2019

Raised garden bed/planter.

Describe and explain any strengths to my final product:
Very pleasing to the eye.
Looks very practical.
Would compliment a well designed garden.

Describe and explain any Weaknesses to my final product:
Be very heavy to move when planted up fully and watered
Sitting it would need this consideration.

What is your overall opinion? Would you buy the product and use it?
A well designed product, looks strongly made
A definite buy, especially the older gardener would welcome a product of this kind to ease bending problems etc.

Any improvements/developments you would want to make to my product:
I cannot think of any improvements required, maybe extended with 3 more boxes.

Feasibility Study – comparison to existing products:

A

Height = 80
Width = 100
Depth = 76cm

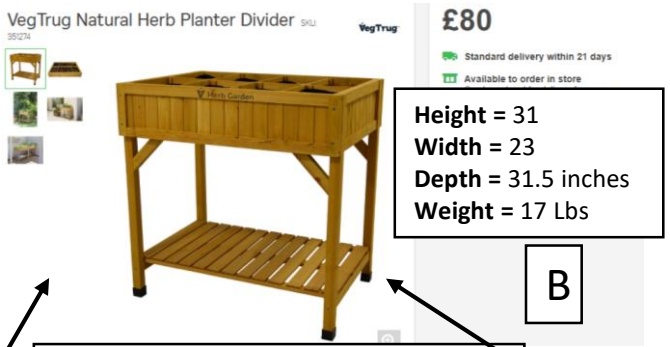
'Treat yearly with a water-based, food safe preservative'. 'Can be easily netted or covered, finished with a high quality powder coat so it will last for years'.

The majority of the garden beds I have analysed here look as if they have durable structure, which is important as the product must withstand the conditions of being outside for an extended period of time while still having a perfect functionality.

Many of the products I have looked at here have expressed within there descriptions that their product will prevent the need to bend and kneel down a lot and suitable for wheelchair users and the elderly – so this idea seems to be a common requirement from consumers, which means my product will be widely appealable on the market to consumers.

My product: Raised garden bed/planter. Cost £140.69 to manufacture.

Many of the existing products and my product both cater for multiple plants to be stored, which seems to be a popular requirement of consumers. In my opinion this is because the garden bed appears more attractive containing many different shapes and colours then say a singular garden bed containing one type/species of plant flower, for example in Example C shown on this page – it doesn't look as appealing and attractive as Example A or B and my product personally.



Height = 31
Width = 23
Depth = 31.5 inches
Weight = 17 Lbs

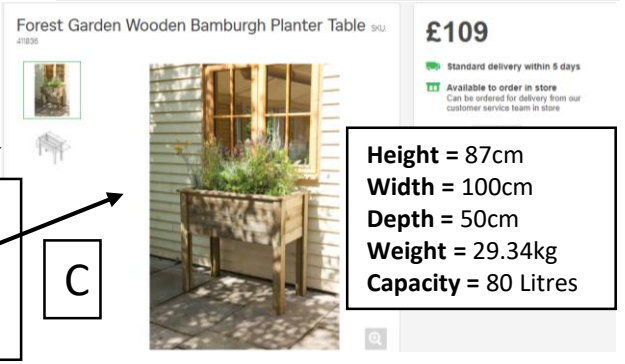
B

It is treated with 'Food Safe Stain' for the purpose of growing herbs and plants.

All of the products I have looked at here have had some sort of protective layering added, e.g. stain/varnish to protect the wood from wreathing and use, which is crucial to ensure that the product is long lasting.

I think that overall visually that the shape and design of my product looks the most interesting as its shape is unique and square rather than rectangle like most of the others I have looked at.

The existing products often contains extra additional shelving pieces attached to the interior towards the bottom used to store any equipment or planting equipment required, for example in Example B shown on this page. My product does not feature this added feature, however I believe that if I were to add this feature, it may result in many positive functionalities, however it may produce an increase in the cost of the product as more material would be required. It would also increase the weight of the product, which may mean that two elderly may no longer be able to easily transport the product from the shop to their home as easily for example.



Height = 87cm
Width = 100cm
Depth = 50cm
Weight = 29.34kg
Capacity = 80 Litres

Made from 'High quality Pressure Treated timber, which can withstand rot and fungal decay for 15 years'.

C

Test/specification	A	B	C	Mine
Caters for multiple different plants/flowers to be planted within the product.	YES	YES	YES	YES
Plants can be easily accessed while standing and sitting down by an elderly person	YES	YES	YES	YES
Has a sturdy and durable structure	YES	YES	YES	YES
Has some sort of protective layering/product applied – e.g. stain/varnish etc.	YES	YES	YES	YES
Practical and easily functional design	YES	YES	YES	YES
Affordable Costing ?	NO	YES	YES	NO

The pictures show my product put up against some of the existing products which I looked into at the beginning of the project during the researching stage. When comparing my design to these existing raised planting beds I have come to some conclusions:

- My design has the same height as product A which claims on it website (Homebase) that it *'has an easy working height. No more bending or kneeling and ideal for the elderly and wheelchair users'.* This means that my product would be proven to offer the same services in which were specified within my end users requirements.
- As my product was fairly costly to produce, this means to make any sort of profit I would have to slightly increase the price to achieve an estimated sale value. However I would think that if my product was to be manufactured on a larger scale, that the cost would be reduced because the manufacturing would be varied as they would be making many at a time which would end up being cheaper rather than just making one individual piece.

Evaluation:

Now I have approached the end of the iterative designing process, I have concluded that no designed product will ever be fully developed so it is perfect, as improvements and modifications can be constantly and repeatedly made to meet the needs of a specific end user and to keep up to date/use the latest technologies/designs, despite whether they be successful or unsuccessful/have no effect.

Strengths:

- The product meets the needs and requirements of my end user effectively.
- The garden bed looks very attractive when filled with colourful plants/flowers and would be very appealing to consumers if on show at a local garden centre.
- Using 15mm marine plywood provided a product which was of a high quality regarding the finish and overall appearance. It is extremely sturdy constructed together and will remain durable in the long term.
- The raised garden bed is very stable and secure when placed outdoors in the garden, which is crucial because if a consumer who purchases the product has children it will be less likely to pose as a danger if they are around it because it is safe and securely placed onto flat ground held down by its cumulative weight.
- The support pieces were attached in the most accurate and effective position as the top of the plant pots are perfectly aligned with the top of the garden bed, which means you have easy access to all the plants.
- Due to the size of the overall garden bed, standing from any angle/side you have a good access to every compartment for gardening.

Weaknesses:

- On two of the identical larger main structural pieces, the two longer cut out slots which are near the edges of either side of the piece, meant that when you slot all of the pieces together, the end pieces protruding out the outer edge are not fully aligned and parallel with the continuous edge of the garden bed However this is a very minor adjustment that I could change if I were to make the product again, as it is only regarding the products aesthetics not its functionality.
- The protruding pieces around the perimeter of the top of the garden bed could be maximised regarding their functionality further. For example; horizontal slots could be cut into them so that they are all in parallel, meaning you could slot in some sort of shelving piece which would then offer a working space to do some small gardening jobs on, e.g. mixing the compost and soil together to go into the plastic pots ready to then fit the plants in.

Modifications/Developments:

- If I were to make the product again, I would think about using an alternative wood which was slightly lighter in weight so that one individual would be able to carry it/transport it alone.
- To improve the product further, I could increase the overall size of the garden bed to create a larger raised garden bed, creating more room while still maintain the specified height suited for my client. This would mean that the current number of compartments (9) would become larger to allow for slightly larger species of plant/flowers to be planted. I could alternatively just increase the length of the raised garden bed to create a rectangle sized bed, so you could plant many more plants and have a more of a tradition appearance.
- I could add in an additional element which would consist of a sort of shelf piece attached to the four legs below the bases/support pieces which would again slot in/interlock as the same as the rest of the pieces. This would accommodate for any tools or small sized pieces of equipment which you could store outside so you would have easy and instant access to them when you are gardening, for example; extra plastic planting pots, gardening gloves, a small hand shovel or plastic bowls for mixing the soil and compost in preparation for planting etc.
- If I wanted perfect aesthetics to my product, it would be possible to use an electric planer to smooth down the top edges of the pieces so that everything is flush and flat. However this isn't necessary as you could argue that the way the pieces are slightly risen and not flush and flat does give the design that bit of definition and edge of character, due to the rounded corners which I like – again this is an aesthetics issue so isn't necessary as it doesn't effect the functionality of the product at all but is just an alternative option thinking from all perspectives.

Critical evaluation of design solution - marketing the product:

Product :	Price:	Promotion:	Place:	USP – Unique Selling Point/proposition
My product is a raised garden bed/planter suitable for the elderly, and is manufactured to a suitable standing height to significantly reduce the amount of bending down they will have to do when gardening and planting. The product is based upon an interlocking system which allows the user to easily construct the garden bed together by just slotting all of the pieces together, this makes its simple and practical for anyone of any age to be able to construct is on their own. As all of the pieces slot together, this means that the product can be sold as a flat packed product, which makes it a lot more convenient regarding transportation from the manufacturer when you purchase the product and fitting it in your car etc. The product also consists of a system where within each planting compartment (9 planting compartments in total) there are two support pieces attached at a certain depth (suitable for the amount of soil capacity required) which hold in place the drop-in bases when you fit them in by just placing it on top resting on the two pieces for support within each compartment. These are designed to hold the soil and plants in place, diving each different plant type you plant within each different compartment within the entire planting bed.	I would aim to sell my product for around £155-160, as this would produce a profit per individual sale, but take into consideration that the product cost around £141 to make. However relating to mass/batch production there may be cheaper alternative methods and processes used which mean that I would be able to reduce the manufacturing costs and then the sale costs of my product overall. This would be better because after researching many existing garden beds/planters, I have found that the average cost ranges from around £80 - £130. So despite that my product offers many added alternative elements, for example it can be flat-packed, it interlocks together and it consist of a drop-in planting base system which allows for easier planting and renewal/cleaning of planting areas etc. I would still want the cost of my product to be within this range and be compatible with people budgets and appealability or else people probably wouldn't want to purchase it as it would be slightly more expensive, when they could get one for less of the cost.	I would look to sell my product to distributors which sell their product on to local garden centres, where they could have one constructed together on display to intrigue consumers to investigate this new and innovative product and then have flat packed and boxed up ones on display to show that they can be easily transported home when purchased etc. I would also look to approach larger chain companies/businesses, for example; Ikea, Argos, Homebase etc, this would be good as each company has hundreds of stores nationwide and this would make sure that the vast majority of the population and consumers who often visit these stores regularly, can access my product widely to purchase it. I could also exhibit my product at national garden shows, on a stand to attract an increased amount of interest and popularity in the product from genuine consumers who are interested in this area/type of products. For an extended amount of advertisement I could also create a short online ad/TV commercial or any sort of poster/notices to spread the idea of my product to consumers and to get my product out there on the market. Also, these days a significant amount of consumers use online shopping services from companies rather then visiting their in store branches regularly, so using the internet as an advertisement strategy would also work very successfully.	As mentioned, before I would investigate marketing my product at gardening/gardening equipment based shows around the country to access nationwide consumers. At these shows I would be able to offer a discounted price to the product due to it being new and just exposed to the market to see if people would be interested in the product itself and if its worth continuing with the designing and manufacturing of the product. Also, to boost the introduction and presence of the new brand, I could look at trying to get a sponsorship with specific gardening shows, e.g.' Gardeners' World' on TV for instance.	The factors which differentiates my product from its competitors are that; 1. The product has a unique interlocking system, allowing you to easily construct the product quickly by slotting the pieces together. 2. The product is suited specifically for the elderly regarding the fact that it is made to a specific standing height (80cm) to reduce the amount they will have to bend down to garden, they can also be seated and still access the garden bed from each side depending on the chair height. 3. The way the pieces are interlocked together adds an additional amount of stability to the structure as the weight is evenly distributed between the four contact points within each leg and the ground, rather than having one singular leg piece which may ruin your grass and sink in easily or become wobbly when the ground is not flat/even. Whereas with my design an uneven ground shouldn't effect how stable the garden bed will be as much as it would other designs.

Testing and Evaluation – User/stakeholder/peer feedback:

Name: Joy Timms

Raised garden bed/planter.

Describe and explain any strengths to my final product:

I like the design and appearance.

Describe and explain any Weaknesses to my final product:

Could be wider to take more plants, it could be any size you require

What is your overall opinion? Would you buy the product and use it?

I thought it was very unusual, if I saw this in a garden Centre I would buy this, very pretty and useful very well designed.

Any improvements/developments you would want to make to my product:

Wouldn't change a thing its really lovely very unusual.

Name: Julie
Keen gardener

Raised garden bed/planter.

Describe and explain any strengths to my final product:

It looks accurately made because all the compartments are symetrical. I like the fact you can plant many different things within the same product.

Describe and explain any Weaknesses to my final product:

Planter compartments may be slightly too small.

What is your overall opinion? Would you buy the product and use it?

It is an excellent product and innovative. I would definitely buy the product and use it in my garden.

Any improvements/developments you would want to make to my product:

Maintaining the height of the product but enlarging the size of the compartments to allow you to grow a larger quantity of plants.

Name: Lucy Kirby

Raised garden bed/planter.

Describe and explain any strengths to my final product:

- Nicely structured
- Aesthetically pleasing
- Suitable height
- Neatly proportioned
- Nice symmetry

Describe and explain any Weaknesses to my final product:

- could have colour/design, like paint, carving.

What is your overall opinion? Would you buy the product and use it?

- I love the innovative design and would definitely ~~have~~ buy it and use it.

Any improvements/developments you would want to make to my product:

- Variation of compartment sizes
- Different sizes for different purposes, e.g. rectangle for the window sil.

Raised Garden Bed.

I looked at this Project and I thought there was a lot of thinking went into this design because it looks so professional, very attractive.

The flowers made it look very pretty indeed, if this was on show in garden Centre, I am sure it would sell well.

Response to stakeholder feedback:

From the feedback I have received, I agree with the fact that while maintaining the personally suited height of the raised garden bed, I could enlarge the sizes of the compartments so they are slightly bigger to be able to grow a larger quantity of plants, as currently the compartments are fairly small and would only be suitable for growing plants and flowers, but not vegetables or herbs. So hopefully this improvement will allow for this to change. However to do this I would also have to increase the depth of the planting compartments to allow for the longer roots to fully grow and develop to ensure the best conditions which are required to achieve the best results to the crops. Another suggested development that I would consider is using varied sizes of planting compartment sizes to allow for varying amount of specific plants/flowers to be planted within the garden bed – which I think is a really good idea considering not all consumers are going to want to plant 9 different separate plants all of the same quantity for example. I also really like the suggestion of manufacturing varying sizes of the overall garden bed which may be a possibility, as I could use the one raised garden bed design and then be able to offer a couple of different options which are a variation in shape, this would hopefully intrigue consumers more due to the fact that there are many options being available rather than just one set product.

Critical Evaluation of design solution:

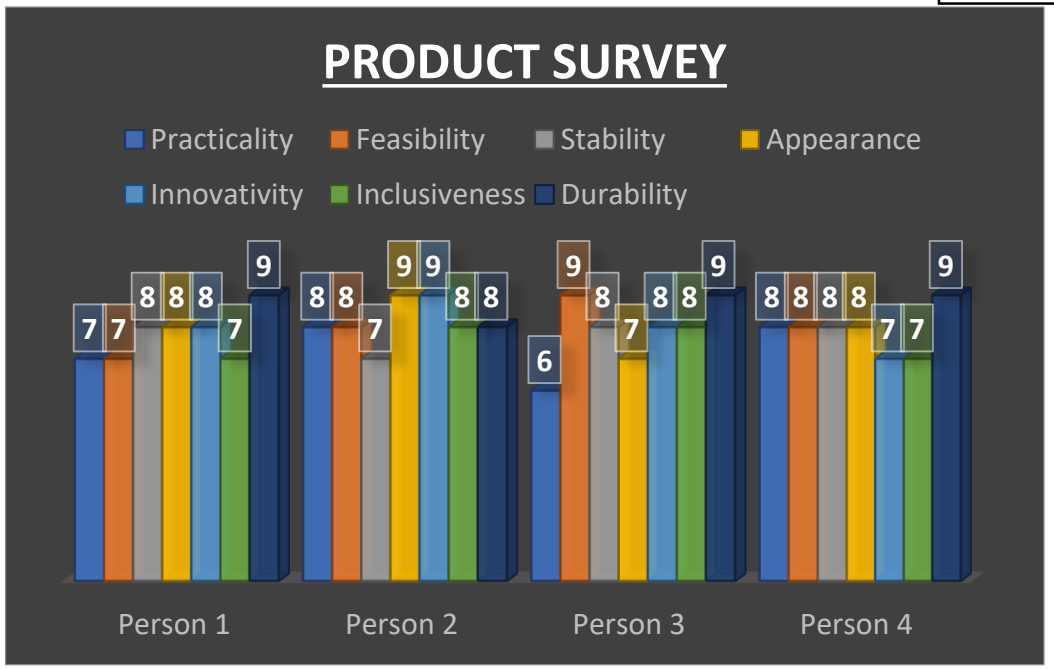
Suggested improvement from feedback:

- To increase the length and depth of the planter to allow you to grow a larger variety and quantity of plants, which will allow you to not only grow plants and flowers, but vegetables and herbs too because there is more room for longer roots to grow and develop easily.
- To vary the compartment sizes to allows different amount of various species/types of flowers and plants to be planted in the bed, e.g. if you want to plant more of a certain plant than another.
- To make the garden bed different sizes, e.g. a rectangle shaped raised garden bed which is the correct size to display directly outside your kitchen window for example.

1 = Bad 10 = Good

Conclusions from the feasibility study and testing:

- I can conclude that my product meets all of my stakeholder (non-technical) and technical requirements in which were proposed at the beginning of the iterative design project.
- When carrying out testing relating to my requirements, I found that the raised garden bed meets the specifications and requirements of my end user very well and the product has enabled my client to gain an increased amount of practicality and support from the product to help him with gardening daily, which means my product was suitably designed and manufactured.
- From all of my end user/stakeholder feedback, I have found that the product was; an aesthetically pleasing product which looks durable and practical to function and use daily within the garden. It is extremely innovative and unique and is suitable for gardeners due to the fact you can plant a variety of different things, and is specifically well suited for the elderly due to the particular set height of the product.
- When comparing my product against other existing products which I had researched at the beginning of the project, I found that they all met the variety of specifications set which I compared them against, except for the aspect regarding their cost, as I thought that due to the high cost of manufacturing my product, that I would have to have a fairly high sale price to make even a small profit. However after researching further I have found that when industrially producing my product, e.g. batch production, there would be processes used which would be quicker and much more efficient, which should result in a reduced manufacturing cost, which means I wouldn't have to sell it for as much money, but still be able to make a relatively good profit. However also when researching found that some raised garden/planting beds can cost up to £180/200 depending on features and quality, so my product may not seem as expensive as I think once I am comparing it to a wider range of more higher end products.



Cost of materials/production:

Component :	Cost:	Quantity/Amount:	Potential Batch Production Cost per unit or cumulative:
Supplied and Machined 15mm Marine Plywood Pieces from C&G Joinery.	£137.04	Original sheet measuring 2440 x 1220mm.	
Exterior PVA Glue/Wood Adhesive	£2.90	125ml	
25mm 1” Panel Pins	£0.75	50g	
Stain/varnish			
TOTAL:	£140.69		

Review and Reflection:

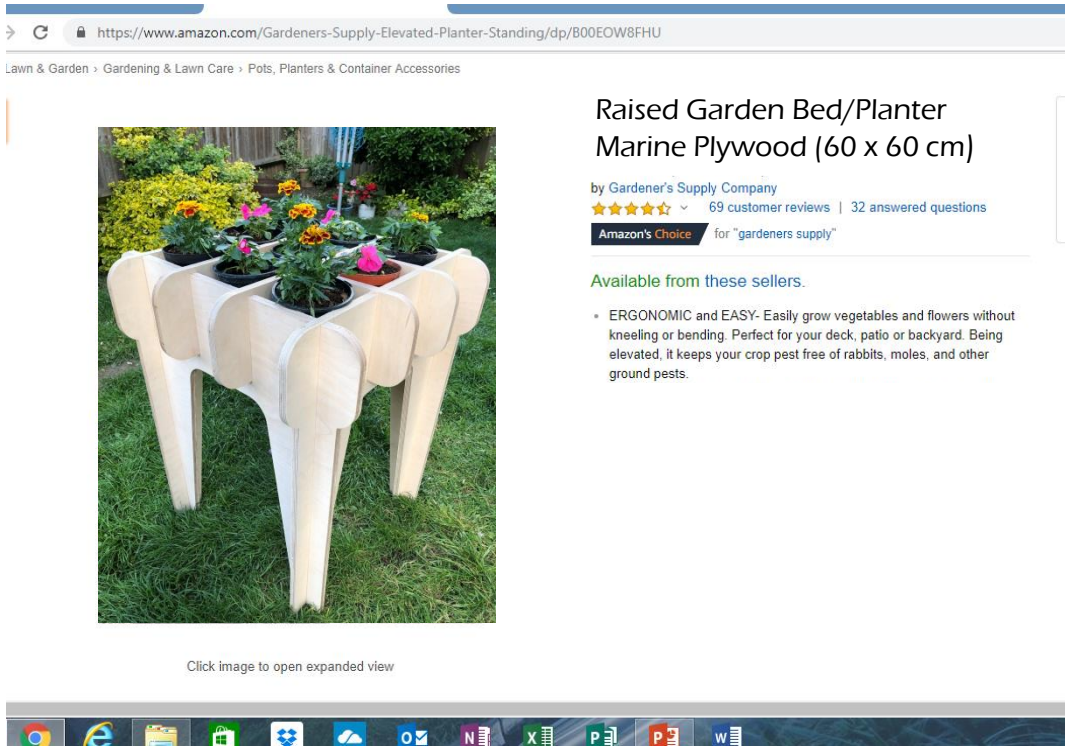
Design and making process: The designing and manufacturing process in my opinion was fairly lengthily and complex at certain times, however this is the case almost all of the time when designing any new product which is innovative and unique, because it is your own design, so nobody can tell you where it will go and sometimes you don't even know what path the designing project will take you on. However this allowed my design to naturally progress and evolve in the intended direction and in the end I managed to achieve an exceptional result in which I am very pleased with along with my client/end user as they can now use my product within their daily life to improve the functionality of their job as being a gardener. During the development process, this allowed me to explore what worked successfully and what didn't, so I could then develop and change these elements to improve the overall design. However due to there being some minor limitations due to the fact the school's CAD/CAM equipment cannot achieve the results in which an industrial/commercial large scale machine could do, I managed to cope with this and find alternative routes to achieve a suitable and as effective result.

What I have learnt throughout the project: During the designing process, I have learnt a vast amount regarding the ways in which to design, for example I have learnt that I should always be open to new exploration and experimentation of ideas and keep all ideas open to ensure I don't limit my self regarding the innovatively of the product, as often these experiments quickly become a successful element of the product in which to incorporate. I have also learnt that suiting a product for a particular end user is a critical part of the designing process to cater for the needs and requirements of the consumer, as incorporating this specifications can vastly improve the products functionality and practicality for its user.

The likely success of the product in the market place: The product will be able to be sold to any retailer or an end user specifically. The products success will largely depend on the amount of promotion and marketing in which is carried out to promote this new product to its consumers. Also the brand will have to be built up to be known as a reputable and responsible company which then will appeal to customers well. The brand/company should aim to have very good customer service. Aldo, once the brand has established many connections with larger chain companies/brands, e.g. Ikea and Argos and independent retailers, e.g. garden centres across the UK the product should sell, as long as they are satisfied with the product itself and it appeals well to customers who visit these retailers.

Industrial and Commercial design improvements:
For my product to be successfully manufactured and sold within the industry, I may have to change a few things and modify some elements. For example;; to maximise the quantity of materials that I would need to use, I would have to ensure that all of the pieces of one product fits on to one sheet of marine plywood which measures 2440mm x 1220mm. Also industry scale/standard CNC Routers are likely to produce a higher quality finish, in less time and will overall be more efficient and an effective process to manufacture the product which would reduce the cost slightly. I would also have to consider transport costs for materials/product, labour costs, and any influence regarding moral, social and cultural issues. My product would either be batch produced in order to suit the demand of consumers, to ensure minimal waste is produced, and what waste there is can be reused/recycled in some way, whereas mass production may create more waste depending on the amount of product/stock required.

Marketing the product – Possible Webpage Design:



I would use Amazon UK as one of the base's of my products webpage because it is one of the biggest online retailers and would be a highly suitable company to approach to suitable and effectively market my product online. Also, prior to purchasing consumers can leave reviews on the products page, which would hopefully help with the promotion aspect to the product.

The product would be easily flat packed if it were to be properly manufactured in larger quantities – batch production is suitable as all you have to do is construct by interlocking and slot all of the pieces together and drop in the planting bases.

The description on the webpage: *'The unique plywood planting bed can be used to store multiple quantities of your favourite plants, by using an interlocking and drop-in base system which allows for functionality and practicality at the same time by creating an easy system for planting , emptying, cleaning and renewing your plants while also ensuring a simple and effective drainage solution is in place. The raised garden bed is conveniently flat packed to ensure it can be easily transported to you directly and can be finished with any choice of protective finish which suits your requirements'.*

Future design developments from suggested improvements feedback:

Suggested improvements from feedback:

1. To increase the length and depth of the planter to allow you to grow a larger variety and quantity of plants, which will allow you to not only grow plants and flowers, but vegetables and herbs too because there is more room for longer roots to grow and develop easily and room for a larger capacity of soil.
2. To vary the compartment sizes to allow different amounts of various species/types of flowers and plants to be planted in the bed, e.g. if you want to plant more of a certain plant than another.
3. To make the garden bed different sizes, e.g. a rectangle shaped raised garden bed which is the correct size to display directly outside your kitchen window for example which may appeal to the consumer more, rather than a more traditional square shaped garden bed/planter.