

C.A.T.

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How can products be used to make people feel more comfortable when traveling?

1.1a: Identify the needs of the end user

In this first section, I will consider the main problems of travel to establish a problem I will then set forth to solve. Before a problem can be found however, it is important to institute a demographic around which to base the product. This is as the travel and tourism industry is one of the world's largest industries, on average, every day more than 8 million people fly – a number that is only expected to grow. Because of this, experiences and problems vary depending on the demographic's age, location and ways of travelling. Therefore there are many problems that can be resolved. To correctly find and address a problem, some questions must be first established.

1. Why do people travel?

2 Who travels/Who travels the most?

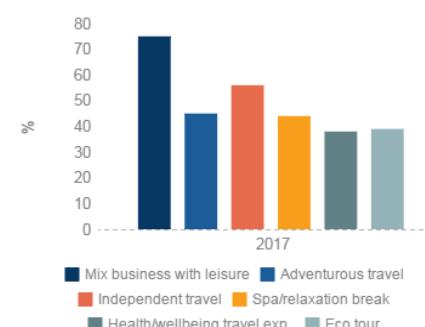
3. What is the most common way of traveling?

The purpose of these questions is to identify a client type to base my product around and subsequently, to identify a problem. The definition of comfort changes according to the demographic and the purpose of the travel. For example, while a leisurely traveller would care about the commodities of the trip, a businessman who is travelling for work would deem those things less important – instead, finding ease (and comfort) in things that guarantee an efficient trip and enable him to work while travelling. To find an answer for these questions I conducted research both online (from already gathered data) and by running a survey on my own.

From what I was able to gather online, the most frequent fliers are people between the ages 25-34, 39% of them travelled this year. They are closely followed by the age group 18-24 (cit. Source 1). We can also see that the main reasons for travel are business and to explore new cultures (cit. Source 2). This helps build a client profile around which to base a problem. However, I was not able to gather enough data as much of it is kept private by aeroplane companies for their client's privacy. Therefore, I created two surveys to identify the problems encountered while flying and who flies.

Source 2

Intended purposes of travel 2017



Source 1



Existing types of products take care of problems such as the lack of space, stiffness of traveling seats and many more already exist. They include:

- Inflatable travel pillows
- Eye masks/carriable toiletry
- Socks that help circulation when traveling
- Headphones that cancel out noises (desirable for airplane)



Interestingly, most of the products I found online were concerned mostly with aeroplane travel. A reason for this is the growing expansion of air travel, as more and more people go on planes more problems are to be encountered and the market for products targeted to aeroplanes expands. This is something that I should keep in mind when coming up with a problem as this can be both an advantage and a disadvantage. On one side, the market is very big and thriving, as there are many products out there, I can get a lot of inspiration. However, this means that there will be more competition and lessened demand.

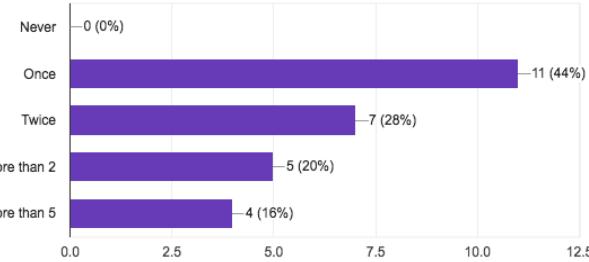
To better find the client type, and more importantly, the problem I conducted two surveys. The first survey consisted of an open-ended question regarding the nature of travelling and its problems. In this starting survey, I saw a pattern that was beginning to form, it seemed many disliked packing – to confirm it I created another survey with a bigger pool of people, this time it was a multiple-choice survey. In the first survey, I asked what the best and worst thing about travelling was, any personal stories about problems/experiences they had and what things stress you about travelling. 60% of the people answering this open-ended survey recounted that the biggest problem with travelling was the preparation to it, many stated that packing and buying things to bring is the most stressful thing and sometimes compromises the rest of the trip – making it less enjoyable and comfortable. Forgetting to purchase key things when travelling is another common theme, one person's story summarizes this idea:

" Me and my husband were going to the Maluku Islands in Indonesia for a holiday. It was only when we were already on the plane that I realized I had forgotten to buy all the basic things such as sunscreen, towels, etc. So I couldn't relax during the flight, and once we had arrived, we had no way of buying the things as we didn't speak the language and there were no shops nearby."

When traveling, the most stressful and uncomfortable part can be the things preceding it. Therefore one problem I may have to solve is this. To understand and see if this problem was common, I sent out another survey. The results confirm the theory.

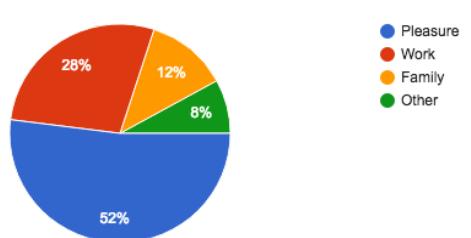
Last year, how many times have you traveled outside of your country?

25 responses



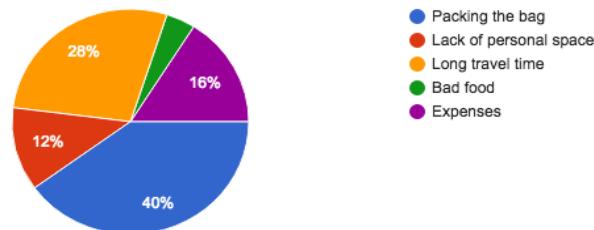
What were the majority of the flights due to?

25 responses



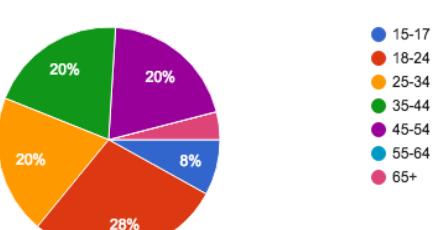
What are the biggest problems of travel?

25 responses



What is your age?

25 responses



From this survey we can gather many things:

- First is the problem, **40%** of people stated that the biggest problem and therefore what goes against their comfort is the [packing of bags](#).
- Another useful thing is that [most people travel rarely](#), and for leisure. 72% of people traveled only once or twice, and in total 52% did so for leisure. That means that their travel experience is very important. In fact, one study showed that people experiencing stress in the week preceding the vacation were 2.3 more likely to find the trip more uncomfortable and less enjoyable. Packing can increase that stress
- The last important detail is the relevance of the problem depending on the age group. In general, [younger people \(18-24\)](#) were the group that referred to packing as a problem the most, they were followed by age group 25-34.

NOTE: This is a small survey, and because of the small portion of people interviewed it has its limitations. However this data can still help understand and analyze the people I will base my design around.

General Market Research:

I decided that before I could look at solving the problem, I needed to better understand what things my demographic (18-24-year-old leisure travellers) liked as well as identifying data that could be helpful. I want to make a product that can be available to a wide market – rather than being constrained to one individual user.

What are the monetary limitations of my demographic?

The salary of my age group (18-24), changes depending on their geographical locations – with many still in college and unable to afford expensive products (the average 18-21 person in the UK makes about £1,315 a month, or £15,780 a year, only £1735 of it is spent annually on accessories or about [£146 a month](#)). So, it is crucial that my expenses remain under this restriction.

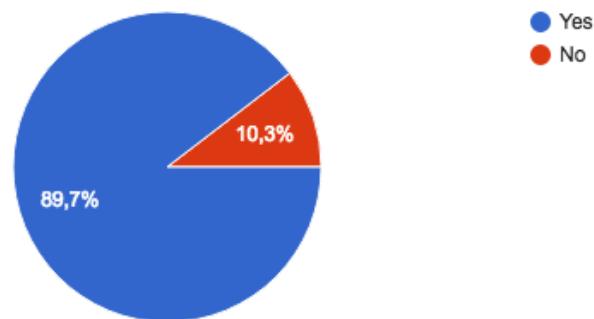
What does my demographic like?

To establish how the product should look, including its tone and style, we must first understand to what point is its form and aesthetics value compared to its function. According to another survey I took (the following slide), when buying a product [65.5% of people said that both form and function are equally as important](#), while 31% said function was the top priority. Therefore, when I design my product, I shall have to keep in mind that [form and function are both extremely important although in the end](#), the function of the product should be its selling point and therefore should be kept a priority. According to the same survey, the style and tone of the product are very important and is what makes people want to buy it, the most popular style is [modern \(27.6%\)](#) although it is closely followed by a [cute style \(24.1%\)](#). In addition, it is best to have a simple bag design rather than a more lavish/complex one (86.2% to 13.8%).

According to the data in the next slide, for people between ages 19-24, the [favorite color is blue](#) – followed by green and purple. Because the design has to be liked by my demographic, its colors need to be liked too.

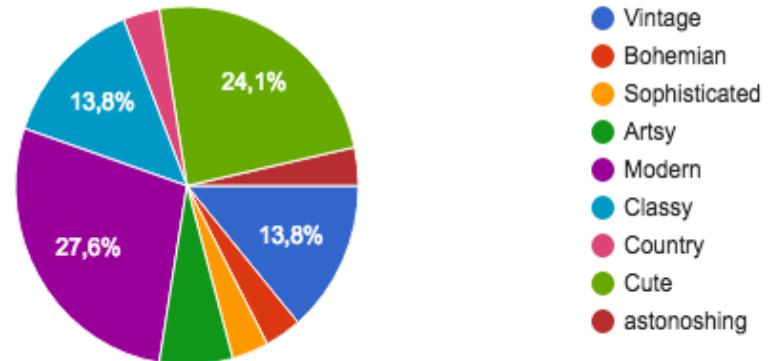
Is the style and tone of the product important?

29 risposte



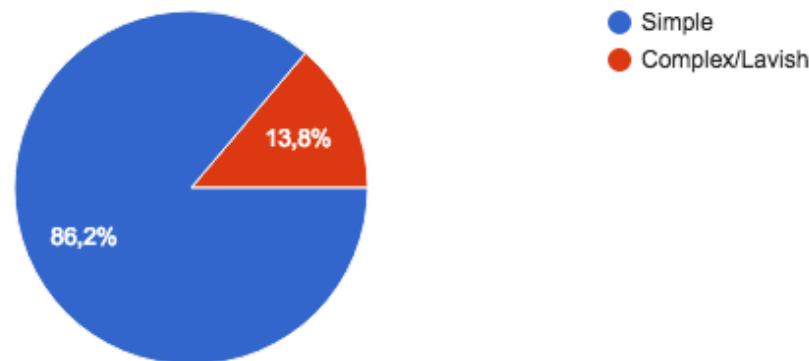
What is your favourite style when it comes to accessories?

29 risposte



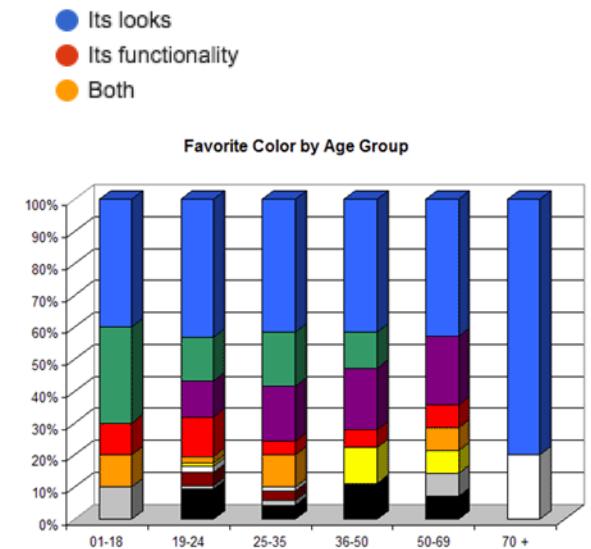
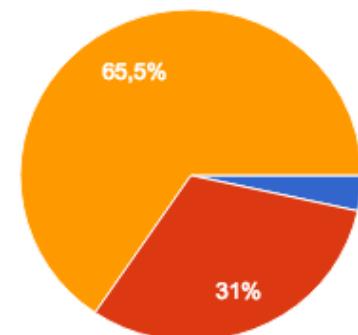
A good product should have a __ design

29 risposte



When buying a product, what is more more important?

29 risposte



Summary of Client and Needs:

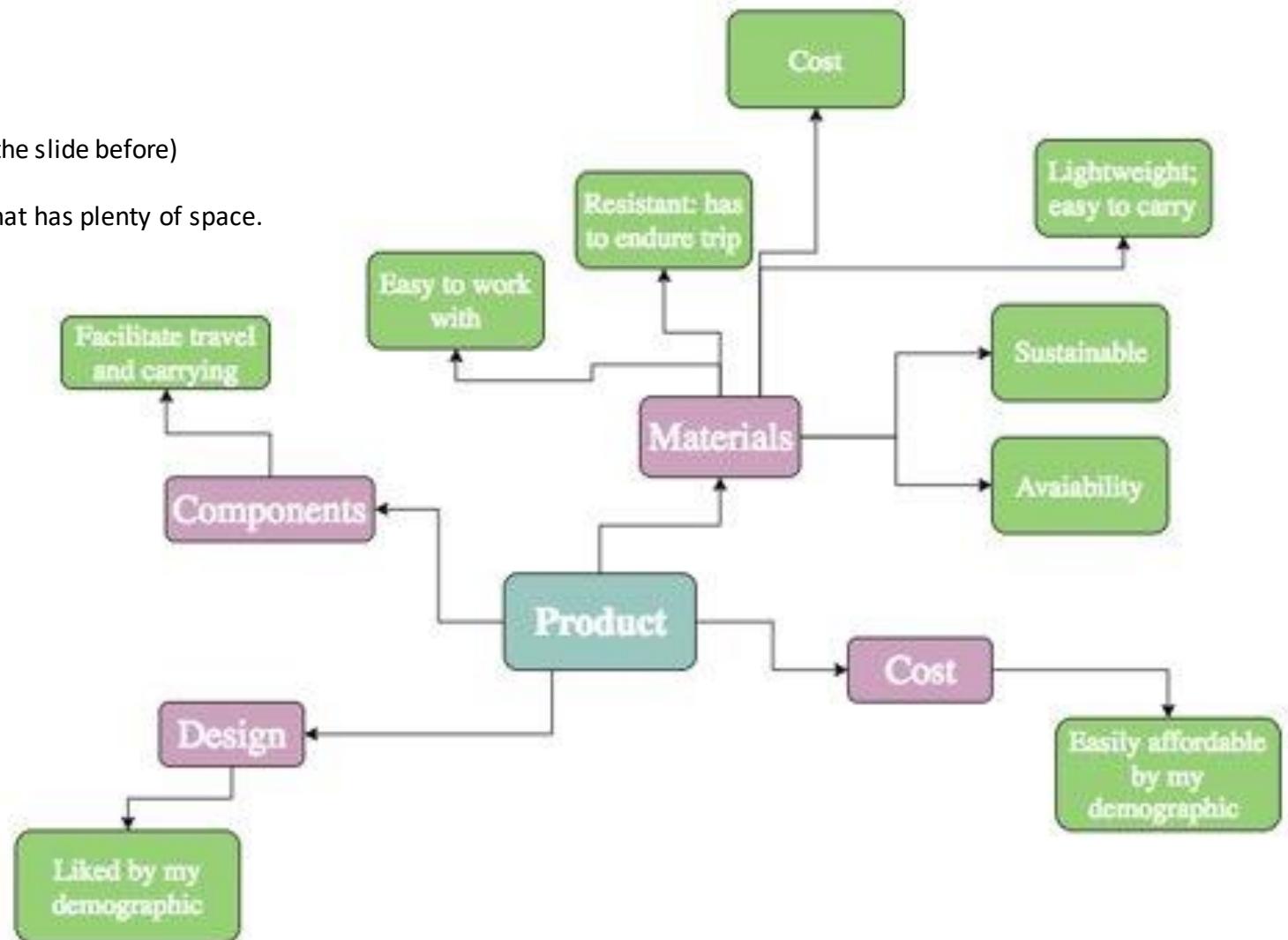
A young demographic between the ages of 18-24, who travels occasionally and for leisure (which they often do to explore new cultures). They would travel by plane. They find packing a bag quite stressful because it is time consuming and most lack the organization.

As pointed out by the research conducted on the last two pages, I need to find a way to reduce the stress of packing by making it easier and more accessible – otherwise, as pointed out by the data on the last page, it could make traveling more uncomfortable and over all less enjoyable.

They need packing to be made:

- Easier
- Faster
- More organized
- Appealing (important factor for our demographic, as established in the slide before)

All while, of course, the objects inside are safely stored in a product that has plenty of space.



Investigating Existing Products:

I wanted to find out if any such products were available on the market that helped with the packing (making it easier and faster).

I saw that many of the products available to make packing easier were the bags themselves: a well-organized bag is among the most frequently bought products for travelling on Amazon. As such, I believe that my design will probably involve making a bag. On the following pages, I consider 4 products available on the market. I interviewed an individual in regard to the product to find out what they thought about it.

This bag is known as the TRUCO Bag – Travel Utility Carry On Bag.

Existing product #1:



Form:

This is a good-looking bag, with stripes of grey and black. However, it looks a bit bulky when all pieces are assembled.

User Requirement:

This bag can be used by anyone, especially someone who needs different spaces for different occasions. It could be used by a parent or a family for both work trips and family trips. The bag can be changed to suit user's needs – they can remove the different pieces of the bag and adjust them. The bag can as such be increased/decreased in space and size.

Function and Components:

This bag is the first modular carry-on in the world, a luggage bag designed to fit any space in an airplane - either under your seat or in the luggage compartment. The bag is made of three pieces, each one easily removable to adapt to the space required. Each piece has many handles to help carrying. The bag also has one-direction wheels.

Component Measurements:

- Tote:

Height: 8.89 cm

Width: 34.29 cm

Length: 26.67 cm

- Main Piece:

Height: 41.91 cm

Width: 34.29 cm

Length: 7.62 cm

- Brief Case:

Height: 41.91 cm

Width: 34.29 cm

Length: 6.35 cm

Material:

The bag components are made of black and gray denier nylon. Nylon is the generic name for a type of synthetic polymers. Because of the structure of the polymers, that can be either aliphatic or semi-aromatic, nylon is a thermoplastic with silky textures than can be melt-processed into different fibers/shapes. The trolley case is made of an alloy of some metal, such as aluminum. The casters (the wheels of the bag) are made of solid rubber.

Sustainability:

Fortunately, it is made near where it is sold, so there aren't many environmental costs for its transportation. Nylon is a plastic and no form of it is biodegradable, so once its use has ended it will sit in a landfill for years to come. The manufacturing of nylon can also have its effects, producing it releases nitrous oxide – a greenhouse gas 300 times more powerful than carbon dioxide. Nylon also requires lots of water, for cooling its fibres, and energy – and because of the large quantities it needs it contributes to environmental degradation. However, because nylon is a thermoplastic it can be recycled and reused.

Scale of production:

This bag would be [industrially produced](#). The use of synthetic materials such as nylon for the textile means that not much manpower is required (leather, on the contrary requires a skilled worker to make it) and therefore means that products can be easily made for low costs and low work time.

Cost: £174,59

Advantages:

- Spacious.
- Adaptable to a user's needs
- Cheaper option out of the three
- The textile used – nylon – is very flexible and much less expensive than silk.
- Nylon is also quite strong
- There are a lot of handles to make carrying the entire bag and separate components easier.
- Bag can be made at a low cost – doesn't need high-skilled workers.

Disadvantages:

- Materials used aren't biodegradable
- Quite bulky and heavy
- Nylon requires a lot of energy and produces greenhouse gasses that are even worse than CO₂.

User comments: I think it's a pretty good idea! I think I'd personally buy the bag. Problem is that when it's all together it looks a bit bulky and I am not a fan of its style. I think the grey and black colours would not reflect on, like, my personality... I think it's a bit dull. I am all for helping the environment, so maybe nylon isn't so good; unless it is Econyl. I also like that it's not very expensive.

Although its design is definitely ingenious, and I could probably inspire a possible design from this, I don't think that as a whole it is a suitable product for this task. I like that it has many handles and that it can adapt to the user's needs, however its size and weight exceeds the limit sizes of bags that can be carried on an airplane. Lastly because of its bulkiness and dark colors it isn't very appealing to our demographic, as established previously it is important to equally weight the looks and the function. Its price is above the limit set by my demographic.

Existing product #2:



Form:

This is a neat and properly organized purse accessory which comes in a range of colors and sizes. The material ensues that the texture is nice, silky and smooth.

User Requirement:

This is a purse organizer which helps organize it neatly and helps not to lose personal belongings in a bag. It seems to be, according to the manufacturer's "super popular women's purse handbag organizer for speedy packing".

Function and Components:

Middle section is removable, many different size pockets: Easily fits a wallet, cellphone, small notebook or whatever items you use on a routine basis.

Because it is made of felt, it can move and is relatively elastic (so items can easily fit inside) whilst also giving structure and shape to a purse, bag, handbag, or tote.

Component Measurements:

Height: 15.24 cm

Width: 22.86 cm

Depth: 15 cm

Material:

The bag is made of luxury felt, which makes the bag organizer very thick and sturdy. Felt is the best natural insulator – meaning that the objects inside are safely stored. The middle section is removable because it is attached with Velcro.

Sustainability:

This bag is only sold on Amazon, so there will be environmental costs to the transportation as it will be shipped worldwide. Felt is a low-impact and completely biodegradable material. It comes from wood fibers – meaning that it comes from a renewable and non-finite material. I could not find any information on where the wood to make the felt came from for this material, so it could be potentially harmful if the source of the wood came from a non-FSC managed source.

Scale of production:

This bag is made through a mix of handcrafted and automated manufacturing techniques, it is made in batches of 40 which are sold individually on Amazon.

Cost: £11.34

Advantages:

- The use of felt makes the product lightweight + flexible
- The use of felt makes the product have a stable structure
- Wide range of colours and simple design make it appealable for a wide range of demographics and tastes.
- The main material used, felt, is biodegradable and comes from a renewable source
- Much like product one, it has components (middle section) that can be moved and shifted based on the user's needs
- Its cost is under the economic limit of my demographic

Disadvantages:

- Doesn't have a handle, so it can't be picked up easily
- By itself, it is very weak and can be compressed easily – it doesn't safely protect the products inside. It must be inserted into an existing product.

User comments: I really like this actually; it looks very soft and I like that there are a range of colours. It is a bit ugly, but it doesn't matter since it inside be inside the bag, I guess. It's light weight, which I really like – but I probably would not be able to fit this into the small purses I have. That means I'd have to buy another purse for this! I guess that takes away from the fact it is also quite cheap.

Personally, I think this compartment idea is excellent for easy and quick access to things (so it is a great utility organizer), however this product would be suitable only for a short outing rather than for packing a luggage bag or for a long trip – its size and capacity does not allow so. As such, a possible implementation of this idea for my prototype will have to be much larger. However, I would either have to make it into a carriable structure (which would be hard to do if it was made of felt) or have its shape easily slot into a luggage bag.

This bag is known as the Away Carryon Suitcase

Existing product #3:



Form:

This sleek and modern bag comes in a range of 11 colours. It has a simple design of regular indentures.

User Requirement:

It is a normal luggage bag, but with extra components to make its transport and handling easier – as well as saving up the space when packing, much like product 2, the simple design and colour pallet makes it appealing to a wide and generic demographic.

Function and Components:

This bag is specifically designed to be carried on board, that means that travelling via plane is quick and easy with this bag. It is sized to fit the overhead bin of most major airlines. It is made up of two compartments, one designed for clothes, the other for shoes, toiletries, and other hard objects. The outside shell bends under pressure but does not break. It has an ejectable battery that can charge any phone up to 5 times. Clean and dirty clothes are separated by a nylon bag, which saves up space. This space is further saved by an internal compression pad. Finally, it has 360° wheels to rotate in all directions

Material:

The outer shell is made of polycarbonate, which is a dimensionally stable thermoplastic – with a structure that allows for outstanding impact resistance, so strong that is used in some bullet proof vests. However, this material does significantly increase the cost of the product.



Sustainability:

The main component is polycarbon, which is a thermoplastic that can thus be recycled and repurposed because it can be re-moulded. However, like most plastics, it comes from crude oil which is a finite and polluting resource.

Scale of production:

This bag is widely available in a range of sizes in many shops and online.

Cost: £190,72

Component Measurements:

Height: 55 cm

Width: 34 cm

Depth: 22 cm

Advantages:

- Polycarbon shell makes it extremely strong and resistant, meaning that it will resist to all the different stresses and conditions it will be exposed to when traveling via plane
- Compressing pad saves up space – meaning that there's more space for more items.
- Has two basic compartments for clothes and for shoes
- Available in a range of sizes to fit the user's capability needs
- Its shell is recyclable
- 360° wheels allows it to be carried in all directions -easily

Disadvantages:

- It doesn't have many special organizing compartments – the insides are very much like any normal luggage
- Above the monthly expenditures for apparel (see previous slide)

User comments: this looks like any bag I'd get, in fact if I was looking for a bag, I'd really consider getting this one. It looks nice and I love the charging pod function. Plus the compression pad is quite cool, and I think it could come in quite handy. It just seems to sleek and fancy, though it is a bit pricey.

Overall, this product is an excellent start for designing the prototype, in addition it has many functionalities which saves up space and makes the transport of it really easy and manageable. However, it does not solve the organization issue that I am considering, there are no proper compartments, so it does not make packing easier/faster by much.

This bag is known as the Sokey Backpack organiser

Existing product #4:



Form:

The product is hidden inside the bag – so the focus is not on its appearance (which is plain and simple) but on its practicality.

User Requirement:

This organiser makes it convenient to carry in and out of any belonging. It keeps a user's backpack clean and tidy and is suitable for any kind of backpack. It organises a user's items (pens, papers, daily planner, Cliff bar, keys, coin changes, tablet, notebooks, Phone, Charge, Cable, etc. It allows the user to remove it and change bags without having to take out all the items.

Material:

Made of waterproof oxford cloth, which is durable and naturally resistant to wrinkles. It is also coated with a thin black coat which makes it waterproof. The insides are made of nylon, whose properties have been previously covered by product 1.



Front

Side

Sustainability:

As previously covered, nylon is non-biodegradable and it is difficult to recycle it. It also releases dangerous/toxic greenhouse gasses during its production stages. This type of oxford fabric is waterproof, meaning that it contains polyurethane, which has a low life span - meaning that it would have to be replaced often as it would wear down if exposed to sunlight or biological factors. In addition, it is made up of finite resources.

Scale of production:

It is made in batches of 50 which are sold individually on Amazon

Cost: £9,93

Function and Components:

It has pockets of different sizes that are ideal for a wide range of accessories from electronics accessories bottles, umbrella, to cosmetics and personal care items. A zipper bag in the middle that can be used for storing receipts.

Component Measurements:

Height: 27 cm

Width: 19.5 cm

Depth: 11 cm

Advantages:

- Waterproof – spillage proof, it can carry any type of item (shampoo bottles, drinks) without the fear of it getting damaged by it
- It makes packing easy by providing compartments for all types of small objects
- It is easily transported from vessel to vessel
- Small, so it fits snuggly into any backpack
- Very cheap

Disadvantages:

- Ugly/unappealing

User comments: Oh, this looks to be quite useful! I think this would definitely come in handy for organizing backpacks, which could work even for travelling rather than for school. It is a bit ugly, but I guess because it would be hidden it's ok. But I don't think it would be able to carry clothes or shoes – so it would need to be re-adapted, I guess.

This product shares many of the characteristics of product 2, however it is much more versatile and relevant to our problem as it fits into bags; though much like product 2, it would need to be re-adjusted to fit a greater capacity of items. However it makes packing faster and more efficient.

Potential Ideas:

1. A slidable organizer which can be inserted into a bag the user already owns.-
- Some kind of bag:
 2. A bag with different parts (like product 1) that can be removed – so extra space can be added to suit the user's needs.
 3. A bag with different compartments that can be removed, and you can buy pre-packed – so you can simply slide these slots in.

I will proceed with idea 3, this is because while idea 1 is good – it could only work for small bags, not luggage, meaning that it can't be used to pack for long travels efficiently. Idea 2 doesn't solve the packing problem; it would simply be a bag where extra space can be added. Therefore idea 2 does not help speed up packing.

Development of Idea 3 into a final solution:

Looking at the products, the best way to organize packing and make it easy/faster is to create a bag that makes so possible by including compartments and possible compression zones. After considering both the general market research and existing products:

Final Idea: to create a service where clients could order a bag designed and equipped with their needs (like mountain equipment, or beach items). The bag would be made of wood and would come in two pieces. The main skeleton, which would be much like products 1 and 3, and a 'slot', a component that would be inserted (much like design 2 and 4) which came pre-packaged with the pre-ordered items. The users would still have space to insert their own items. This idea would make packing easier, faster and less stressful because it removes the need for it entirely. The bag would ensure that upon the purchase of the item, the user would be able to travel straight away. There would be two components so that upon the first purchase, the user would simply need to buy new slots.

This is not the final design brief, in order to re-affirm my ideas, I will need to carry further research and obtain information to inform the design specifications of the prototype.

Before I begin the research, I also need to establish the limitations regarding the manufacturing of the product.

Limitations:

- Firstly the cost (previously considered during the market research)
- The product's design **should be elegant yet remain simple**, to ensure that many other ones can be created without difficulty in order for the product to be made in batches.
- The service itself would also have to be **limited to a certain area** as it would be very hard to fill the needs of the people that might live in separate continents. In addition, the cost of sending the product across the world, both monetary and environmental, might be too high. So, the product will be sold across the Emirates.
- The final big problem is the materials and what I can do and make. I **only have the materials and technologies that are available in the workshop**. The workshop's focus is around timbers, so my product will have to be **timber based**.

Firstly, I have interviewed a user to understand the priorities and requirements such a product should have.

I interview a user which fits in the categories of the demographic I am targeting to understand what are the main priorities of what the product should be. The person in question is Jamie Coe, a 24-year-old female who enjoys traveling and has been to most parts of Europe and Eastern Asia.

Interviewer: How often do you travel?

Jamie: I love travelling, usually I go on 2-3 trips every year. Last year I went to France and Belgium, this year I will go to Thailand during the summer.

Interviewer: How big of a deal is packing before a trip?

Jamie: Very important, especially if you go to remote places and need special equipment. It's always a hassle to have to go out and buy all the equipment I need – especially when I need loads of it. Two years ago, when I went to Nepal for a two weeks of hiking, I had bought so much stuff I thought I would need that in the end I just didn't have any space left in the bag for my clothes! **I'm very disorganized and can never fit all the things I need^[1]**.

Interviewer: What about buying another bag?

Jamie: Sometimes you just can't do that. Because of an airplane company's restrictions or because of where you are going, you just can't bring more than one bag. Plus, that one **bag can't exceed a certain weight or a certain size^[2]** – so often I end up leaving things out.

Interviewer: What is the worst part about packing?

Jamie: Although I travel a lot, I can still be quite lazy - so I don't love going out for ours in search of the things I need. Another horrible thing is the headache you get every time you try and fail to close your bag.

Interviewer: What type of bag do you use for your travels?

Jamie: It doesn't really matter, any bag that can carry the things I need is a good one, although I try to **avoid ones that are too bulky and hard^[3] to carry around. I prefer backpacks to suitcases though^[4]**, it makes it easier to carry them around.

Interviewer: So form follows function, right?

Jamie: Yes, although I also like things that look nice and sleek^[5].

Conclusion: I picked out some interesting things from this interview:

1. The space of the bag should be divided in compartments to promote organization.
2. The bag cannot exceed a certain size and by itself should not weigh over the limit of airlines.
3. It should be easy to carry around.
4. If possible, it should be a backpack, or have some backpack features such as straps that allow it to be carried without having to drag it around.
5. Function is more important than form, although the bag should be appealing – supported by previously gathered data.

Research into the context in which the prototype will be used

How could the context of traveling affect the product and its durability?

In this section, I will be looking at problems that a bag can encounter when travelling – especially when flying. I will then list out possible solutions to these problems.

1. When traveling, bags usually get buried under other luggage.

When travelling either by car or by plane, bags often end up under a pile of other bags. Therefore the bag's main structure has to be **strong, durable and resistant**. When under large piles, bags also tend to get scratched; when flying by plane it is even worse: the bag has to travel through various baggage handling machinery, security screeners, has to be transported to the plane, can be mishandled by staff, and has to be loaded and unloaded from the aircraft. This means that a plastic cover might not be the best option as it would get scratched more easily than, for example, textile covers.

2. When traveling, bags are exposed to an array of atmospheric conditions and may get wet.

Because of weather conditions, the bag **should be able to resist humidity, be waterproof** (or at least prevent water from getting inside the bag) and is **not likely to rot or decay**. Most dry bags use nylon coated with a water-repelling coating since my bag will be mostly made of wood it will have to be coated with **oil, sealant or with a wood-stain**.

I should also try to **avoid using four spinner wheels** like the ones shown below and instead, use two recessed rollerblade wheels. This is because when the bag is dragged from the cargo pit, it comes crashing down on those wheels sometimes causing them to break

What is the best size and weight for this product?

For carry-on bags, the maximum permitted dimensions on most airlines is **25cm (width) x 35 cm (length) x 56 cm (height)** - and that includes handles and wheels. For bags that go in the cargo, common airlines go by weight; The **weight limit is often 22 kg**. Because most weight will come from the items inside the container, the maximum weight of this product should be about **5 kg**.

Other ergonomic measurements:

- The average length of one hand is **9.45 cm** for males and slightly less for females. Therefore, if I choose to incorporate a handle in my bag it will have to **measure more than 10 cm**.
- The average back length span for males (without the two shoulders) is approximately **36 cm**, while for females it is around **25 cm**. So if I make a backpack, it should span this measure.
- Finally, the average length from shoulder to the neck is **40 cm**, so if I made a shoulder bag, the strap would need to measure 40 cm so the person can reach the bag.

These measurements will come in handy if I decide to create a backpack as my product as these measurements would constitute its length.



Research into other possible materials

On slide 10, I mentioned the limitations concerning the materials, in this page I looked at the possible materials available in the workshop and their relevance in my prototype. On slide 11, I considered some of the conditions the bag will be exposed to. Now I need to consider materials that are: strong, tough, resistant to environmental conditions and lightweight. I also considered [any sustainability issues associated with these materials](#).

Oak:

Oak is a type of hardwood that in the past was used to build houses/boars. Now it is more commonly used for high-end furniture and wine/whiskey barrels. Its main advantages is that is [very strong and durable](#), has an attractive grain when finished, and has a very [long longevity](#). However, kiln dried oak can be quite [expensive](#) and oak as a species is becoming rarer, in addition it also is quite [hard to work with](#) and corrodes iron/steel.



Beech:

Beech is a [tough](#) hardwood that [does not crack or splinter easily](#), In addition it is quite [hard](#), so it is often used in solid and laminated furniture. However it is [expensive](#) and [not very resistant to moisture](#) –so it is not suitable for exterior use.



Pine:

Pine is a softwood used for house construction of roof joints and floorboards, furniture, doors and interior woodwork. It is a good wood, being [durable](#), [easy to work with](#), reasonably strong, [lightweight](#) and [cheap/sustainable](#) as it grows quickly enough to be forested in sustainable plantations. Pine, however, can [wrap, crack and splinter more](#) than some other woods and can cause allergic reactions and/or asthma. In addition, it has a moderate to low decay resistance



Birch:

Birch a hardwood is commonly used to make veneers and plywood but also to make box crates, turned objects and other specialty wood items. Its regular, even grain makes it [easy to work with](#) though boards with wild grain can cause the grain to tear during machine operations. It is relatively well priced but is perishable and does [not do well with rot or insect attacks](#) therefore it is not for outdoor use. Because birch trees take a third as long to grow as an oak tree they are often seen as [sustainable](#).



Polystyrene HIPS - Polystyrene plastic is a flexible, resistant material that is easy to mold. It is also a pollutant that if dispersed into the environment, causes large damages to it. Polystyrene in its foam state could be used to create a model of the speaker or to safely package the final product. High Impact Polystyrene is also a type of plastic, with good impact resistance, good machinability, excellent aesthetic qualities and low costs. HIPS would be used if the method of production was vacuum forming (where the material is heated, then spread out on a surface and molded and shaped by pressure from a vacuum) or also to [make small decorations/gadgets](#).



Acrylic - a thermoplastic, meaning that it can be easily reshaped and recycled. It is rigid and has good impact strength, but is also subject to stress cracking, making this material not the best option for outside components, or even inside components. This is especially true if the method of production for such parts was via a vacuum. If a different method was used, such as drape forming (Where a molten sheet of acrylic is wrapped around a mould) then acrylic could be potentially used for the outer shell and the aesthetic components.



Nylon - Nylon is a type of plastic delivered from crude oil which is then put through intensive chemical processes that have as outcome strong, stretchable fibres which make nylon so useful as a fabric. Thanks to its strength and durability it has constituted a solid replacement to silk and other non-synthetic textiles. Unfortunately, although there are many nylon forms, none of them are biodegradable, constituting an environmental concern. The chemical processes required to make nylon also need great amounts of water (to cool the fibres, possibly becoming contaminated) and energy. Producing nylon also releases nitrous oxide, a greenhouse gas 300 times more powerful than CO₂. However, that doesn't mean it's necessarily bad –nylon is plastic, and plastic can be recycled. For example, Econyl has developed eco-friendly nylon that is made from plastics that are reused over and over, drastically reducing the energy and water required. Famous brands and designers have embraced this new nylon, such as Stella McCartney, Finisterre, Outerknown and allSisters. In the product, nylon could be used as an outside cover and layer over it.



Manufactured Boards:

Manufactured boards are boards often made from wood scraps and remainder that are sustainable as they can recycle already existing wood and don't require as much of it to make the same size of the board as a regular wooden board.



Chipboard:

Chipboard is made by having woodchips mixed with glue and pressed into flat sheets. Because waste is used as materials it's cheap. However, the surface is rough, so it needs to be plastic coated. It is not very strong or water proof. It is mainly used in self-assembly furniture and fire doors.



Plywood:

Plywood is made from gluing together veneers. It is structurally strong and resistant to cracking and twisting. It also looks like wood. However, it is quite expensive, the edges can look rough and is susceptible to water damage if the wrong grade is used. [FLEXIPLY IS AVAILABLE IN THE WORKSHOP](#) – making it an excellent material to use for bends



MDF – Medium Density Fiberboard:

MDF is made by gluing and compressing together tiny fibres of wood to provide a dense, solid board. Cheap and easy to make but by itself it is not very strong and quite weak. It also absorbs water quite easily. It is used to make cheap, flat furniture.

Style Research:

I've briefly touched on the styles that my demographic liked (cute and modern). I wanted to expand on this and understand what exactly each style calls for so that I can incorporate it into my product.

Modern Style:

What is it? - The word 'modern' is one of the most misused phrases in decoration as it is often confused with the contemporary style. Today's modern style is actually not modern at all, birthed around the 20th century by German and Scandinavian architecture and design. Because of its simple and unadorned style it is often connected to the age of machination and mass production. The modern style movement continued to grow in popularity during the first half of the century, leading to midcentury modern and postmodern.

What are its characteristics? -

- **Celebration of natural materials** – such as unpainted wood, metals, leather and natural fibers.
- **Neutral or earthly colors** – while in contemporary styling there is a range of colors, modern styles prefer more monochromatic colors.
- **Elimination of unnecessary detailing**.
- Key belief of "form follows function" - meaning its form should reflect its purpose, **emphasis on practicality**.
- **Structural elements are often left exposed(such as concrete or beams)**.
- **Lack of fussiness/fluff**.
- **Low, horizontal furnishing with clean lines**.
- Reflective surfaces - such as steel, chrome or glass.
- Natural woods/veneers

There are very famous modern designers, and by looking at their works I can better understand how my product should look like, or at least gather inspiration from them. Although most of them are interior designers and therefore design entire rooms rather than single pieces it is still crucial to look at their work. One such designer is [Jeremiah Brent](#), whose work is shown below.

His designs have soft colors and use leather and wood. An appealing mix of white and pale brown.



'Cute' Style:

What is it? - A cute design/style is one that reproduce the same characteristics that make human/animal babies adorable. Certain characteristics are universally considered cute, the answer to this can be found in our evolutionary biology, our goal as a species is to survive and pass on our genes – and that means having and caring for babies. By finding them cute, we're more likely to want to protect and take care of them. Our brains reward us when we look at cute things by rewarding us with dopamine – a chemical that makes us feel happy. However, the same characteristics that make babies cute are often found elsewhere and are what can make animals and products cute.

What are its characteristics? -

- Soft Features.
- Rounded.
- Short and stout.
- Soft colors.
- **Cartoonish figures** – usually the more stylized the cuter
- Pictures/representation of objects/animals that have:
 - Big heads compared to the rest of their body.
 - Large foreheads.
 - Large eyes.
 - Round cheeks.

for SmartPhone
わんこ型



Both pictures here are of hammers, except that the bottom one can be considered 'cute' while the one on the top ca not. That is because the bottom one is short and rounder – features found in babies and are what make things cute.



Where will this product be sold? How will the product reach the client?

The product and service will be available locally (in the U.A.E) and will only be shipped there. That is because, as previously mentioned, the service will have to be restricted to a single area because of production limitations and environmental costs of shipment. So how will it get there?

How:

Transportation:

The product would be shipped via the UPS courier (the price of a delivery of a bag for shipment from Abu Dhabi, to the farthest city from it, Ras-Al Khaimah is £29.43).

Sustainability Issues Concerning the Transportation:

The product could be placed in a [cardboard box](#), since cardboard is cheap and easy to shape to fit the required dimensions. The inside would also need to be filled with a soft material to insulate and protect the product, such as [polystyrene](#). This raises few concerns for a number of reasons. Firstly, polystyrene is a very ecologically damaging plastic that cannot be easily decomposed or recycled. One of the requirements of the design brief is to make it eco-friendly. In addition, statistically millennials are the generation who are going to be most concerned about the source and environmental footprint of their products, therefore using an environmentally harmful material such as this would cause discomfort. Furthermore, one of the design brief requirements is to minimize waste produced, and packaging is considered a waste product. The first problem can be solved by using a different recyclable material that has the same basic protecting function as polystyrene (such as wood fiber strips |). Some examples are:



- **Starch-based packing peanuts:** which are made up of grain sorghum, corn, and other crops; these are completely biodegradable and are becoming a popular packaging alternative, however that could not be ideal for people with allergies (about 1% of the population).
- **Wood fiber strips:** however it would fall into the same problem as the first option – it requires wood which has an environmental impact and is wasted once the product is unwrapped.
- **Special mushroom material:** which is biodegradable and act as another good alternative to Styrofoam.

The product will need to be placed in a small box to maximize space efficiency and to reduce the amount of packaging protection needed. A 32 cm x 43 cm x 65 cm cardboard box should be big enough to fit the product with some room to spare for protection, while also restraining space waste. The product should arrive assembled so that it can be used as soon as it arrives.



Design Brief:

After all this preliminary research, I can conclude that I will work on a bag that can be purchased and comes pre-packed with the items the client needs. The bag should have slots and compartments which can be removed and re-arranged in case the client wants to make another purchase. The client, who will be between the ages of 18-24 will want a bag that is lightweight and resistant to both stresses and atmospheric/outside conditions. The client needs a bag that is neatly packaged and sustainable. The aim of this product is to make packing easier and much faster – as no shopping or stress over unavailable space and bad space management are avoided.

The prototype will then be assessed based on these specifications. Each specification is awarded a certain value depending on its importance: must (+3), should (+2), and could (+1). By adding up the points, we can see if the prototype is successful or not.

Specification Area	Specification Point	Slide Number	Explanation
Form (A) - (Total points: 8)	A1. The product could have blue, green or purple colors A2. The size of the product must be under 25cm (width) x 35 cm (length) x 56 cm (height) A3. The product should have a modern or cute style A4. The design should be kept simple	A1. 4 A2. 11 A3. 3, 13 A3. 4	A1. As shown by my research, these are the colors my selected demographic likes the most. A2. These are the maximum measurements of a carry-on-bag allowed on by most airplane companies, making the bag carry-on means that the person can leave the airport much more quickly. So travelling is made easier. A3. According to the poll I took, these are the styles people prefer. A4. According to the poll I took, people prefer simple designs over more lavish ones.
Function (B) - (Total points: 5)	B1. The product must be mostly waterproof and immune to rot/insect attacks B2. Product should have a compartment inside that is divided into sections to promote space-saving.	B1. 11 B2. 10	B1. During the bag's travels, it might be exposed to rain and to the humid conditions of airplane hulls. In addition, depending on the location of travel the humidity of the place might be a festering place for insects and the humidity might set in rot. B2. This allows for items to be inserted with ease and will help the client re-package and re-use the bag easily.
User Requirements (C) - (Total points: 9)	C1. The product should come in pre-built. C2. The product must be no more than 5 kilos of weight C3. The product should have a handle, gripping place or straps C4. The handles should be wider than 10 cm	C2. 11 C3. 11 C4. 11	C1. If we want to make packing easier, then the product should be ready to use as soon as it gets to the client. Having to assemble the bag will slow the user down and be as stressful as having to pack a bag in the first place. C2. This is the maximum limit I have set during my research according to airplane standards. This allows for many items to be carried with the bag.
Performance Requirements (D) - (Total points: 9)	D1. The product must be stable, and stand up straight D2. The product must be lightweight- D3. The product must be resistant -	D1. 11 D2. 11 D3. 11	D1. The bag has to be stable so that it is easier to store and will not topple all over. D2. The bag has to be lightweight for it to be able to be carried with ease and also because airports have a weight limit for bags – the lighter it is, the more items can fit in it. D3. the product will be exposed to stresses and different types of forces (pulling, stretching, crushing, tearing) because it will be tossed around during the transportation and will have to be stored under piles of bags. In addition, it might fall or be exposed to rough terrain when it is being carried, the bag must resist all that.

Specification Area	Specification Point	Slide Number	
Material & Components Requirements (E) - (Total points: 16)	<p>E1. The product should have a maximum of 4-5 materials</p> <p>E2. Materials should be environmentally friendly</p> <p>E3. Materials should be available in the workshop</p> <p>E4. Product should not have a plastic cover/surface that scratches easily</p> <p>E5. Product should not have a four-wheeler</p> <p>E6. Product must be made mostly of wood</p> <p>E7. Other materials such as acrylic and nylon could be used but should be used in small quantities as they have plastic compounds which is bad for the environment.</p>	E1. 3 E4. 11 E5. 11	<p>E1. As to make as little waste as possible and to lessen costs.</p> <p>E4. The bag will be tossed and turned around, it will be under piles and overall might be mishandled. If the cover had loose plastic designs that are too soft/not properly secured they would get ruined easily.</p> <p>E5. According to my research findings, when a bag is dragged from the cargo pit, it comes crashing down and four-wheelers might sometimes break.</p> <p>E7. Though acrylic is thermoforming, it is still better to limit the use of plastic as it requires crude oil, which is a finite resource whose processing requires a lot of energy.</p>
Sustainability (F) - (Total points: 6)	<p>F1. During production, as little waste possible should be produced. Materials should be accurately calculated.</p> <p>F2. Materials used in the building should be recyclable, as well as the packaging</p> <p>F3. Packaging should not use polystyrene</p>		<p>F1. Reducing the waste reduces the cost because I'll need less material, and a higher percentage of the material I'll buy goes into the final product. In addition, the main resource I will use (wood) is precious and should be used moderately.</p> <p>F2. The product needs to have a good LCA.</p> <p>F3. Polystyrene is a very polluting plastic which does not biodegrades—I should limit its usage to limit how much of it gets out into the environment.</p>
Scale of Production and Cost (G) - (Total points: 3)	G1. Production cost must remain under 140 pounds	G1. 3	G1. My research findings showed that this is around how much my demographic spends per month on accessories.

Assessment Criteria:

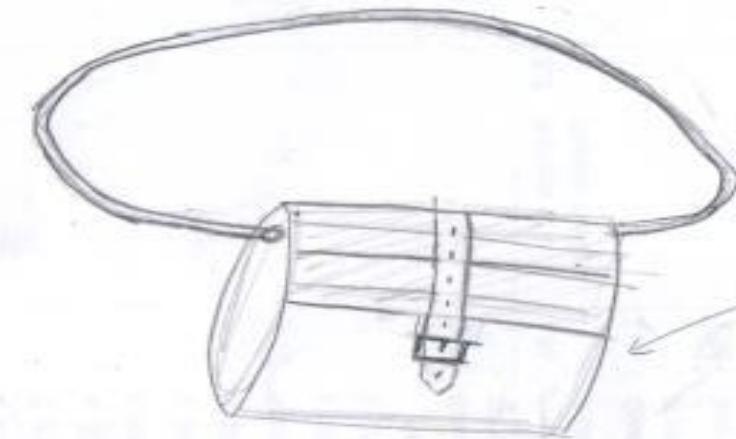
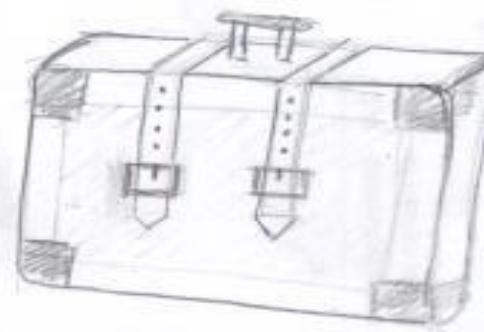
As previously considered, one way of assessing the criteria will be through the specification score. This is worth a total of 56 points. However, I will also interview 10 people and ask them to rate the product – from a purely aesthetic appeal – out of 10 and its maneuverability out of 10. The mean will then be calculated. Thus, the final rating will be out of 76, with the interview being worth 26% of the marks, and the specification worth 74%.

Design Ideas:

In the following pages, I will produce a range of design ideas, which are then narrowed down to 4 detailed designs.

Idea Development:

To get some ideas flowing, I decided to include a page of free-hand and annotated sketches and digital media to inspire a range of design ideas for the skeleton of my prototype. I then developed some of these ideas into 4 designs.



The slot would function along the same lines as the one explored in product #4



Airplane, it will probably have to be made with acrylic

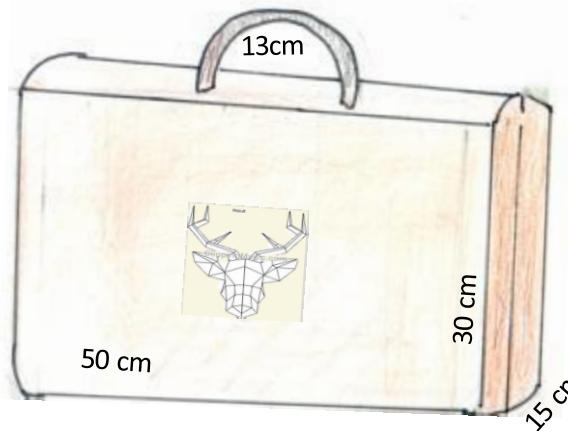


Wheels will have to be 360° rotation

Design 1:

Aesthetics:

- This product is a very simple design, which could be defined as modern or very minimalist – with few colors and materials used.
- Its size is that of most suitcases.
- One aesthetics issue is that it is very plain/boring, unappealing to the youth who are attracted to bright colors such as blue.



Cultural Considerations:

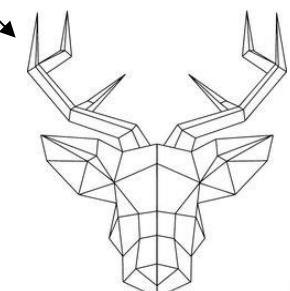
The object that will be in the middle of the front component that will serve as the turning knob will be an Oryx (shown on the drawing through cut and paste techniques). The product will be sold in the U.A.E, so any culturally insensitive symbols such as a pig or any design that might reflect negatively on Islam would not work. The Oryx is the country's national animal, as such I will include it in my prototype as a way to recall on the location of its sale.

Components:

The interesting part about this design is its locking mechanism. When the bag is unlocked, the deer will be placed on its side, to lock it simply rotate the deer anticlockwise. To work, it uses the principle that normal locks use. As you can see from the drawing below, there are two pieces to this system, piece one and two. They correspond to the pieces on the right. Piece one acts as the key and piece 2 as the lock. Now, when the bag is open, the two pieces are separate, when its closed, 1 goes inside 2, but can still be pulled out as the two aren't locked yet (as the cuts of the key are perpendicular to the lock), because the first piece is still in its position a. The deer is connected to piece 1, so when it is turned, piece 1 turns accordingly. Therefore, when the deer is turned anticlockwise, piece 1 shifts to position b, interlocking with piece 2. Because they are interlocked, the bag can't be opened because piece 1 can't be pulled upwards. To open the bag, simply turn the deer clockwise again.

Components:

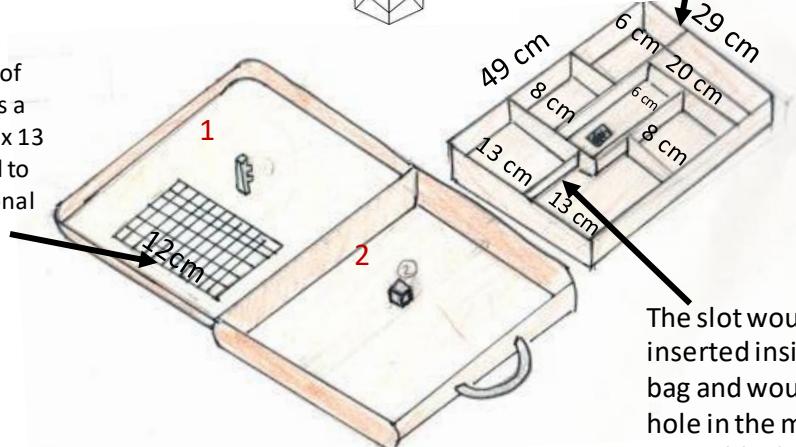
To turn the gear, there will have to be an object in the middle of the front component of the bag.



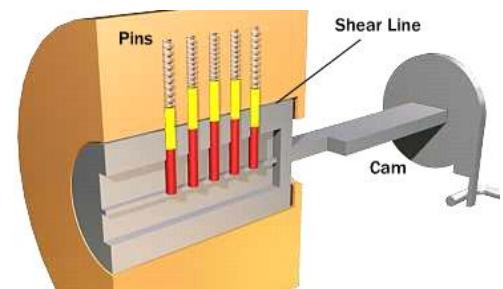
Materials:

- I would make the sides out of oak because it is very strong and durable, so it would mean that the bag would be resistant to crushing forces it will be exposed to.
- However, oak is expensive and hard to work with, plus it is quite heavy. So, to decrease the weight I would make the front and back out of chipboard or plywood.
- The design on the front that is responsible for the locking mechanism would be made from acrylic
- The slot would be made of thin layers of chipboard or MDF.
- The handle would be made from nylon

The inside of the bag has a net (25 W x 13 H cm) used to keep personal stuff in.



MDF thickness: 1 cm



Piece 1:

Piece 2

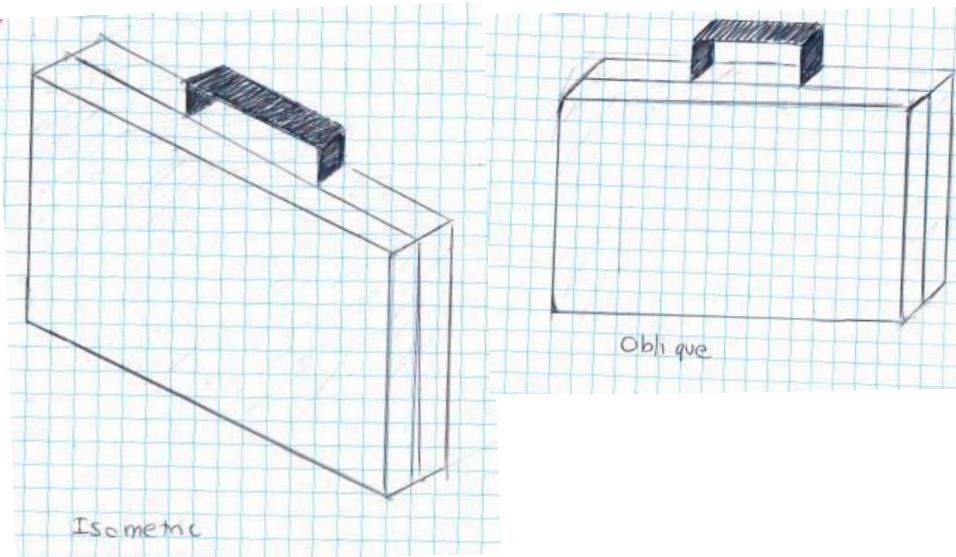
Pos a



Pos b



The slot would be inserted inside the bag and would have a hole in the middle as to not block piece 2.



Sustainability Issues:

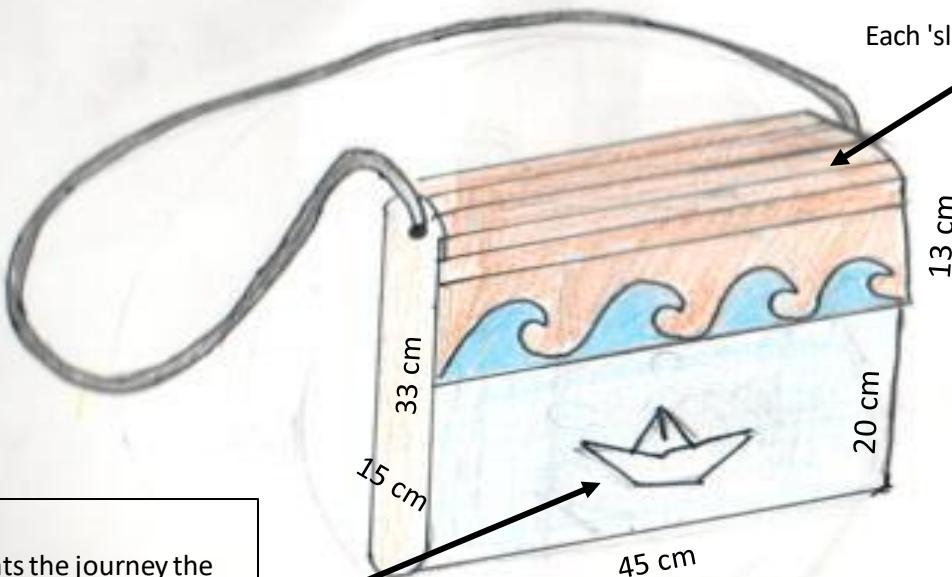
- I will use oak in this design, which is a hardwood – meaning that it does take a long time to grow back and is getting rarer. As such, mass producing a product made of oak will not be sustainable. In addition, oak is not native to Abu Dhabi – so I will have to import it from other countries, thus fossil fuels will be consumed in the transportation of the materials. Thus, though I will use some oak for the sides – the front, back, slot and the other components will be made from MDF, which has the advantage of being made from recycled fibers.

Design 2:

tavola

The straps allow the bag to be carried conveniently as a shoulder bag, rather than a backpack – meaning it is slightly more comfortable to carry.

The strap would measure 40 H x 4 L cm. This is because 40 cm is the average shoulder to waist length (previously considered).



Aesthetics:

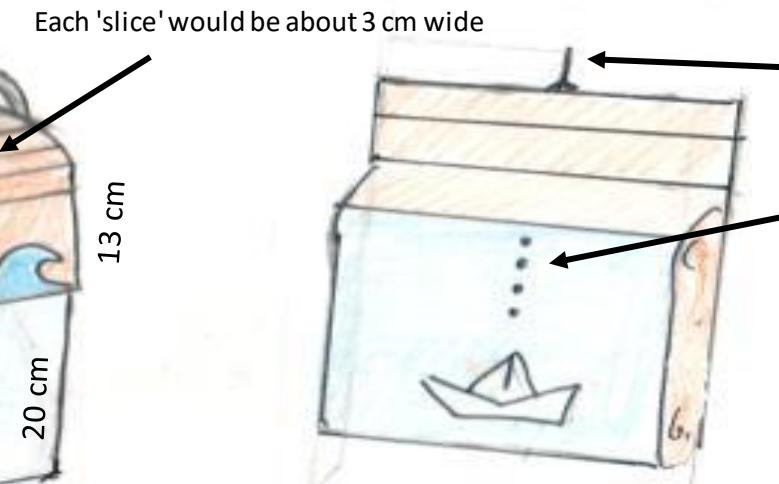
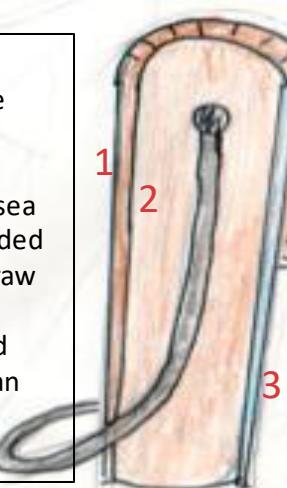
The boat represents the journey the client will face, I chose blue as a color because it is neutral and the majority of people like it.

Aesthetics:

This is designed to be a carry-on-bag, small enough to be carried on-board when flying on an airplane or when traveling. It is inspired by the Existing Product 31 previously considered. It would have a height of 33 cm, a length of 45 cm and a width of 15 cm. The width isn't a lot, but it makes it up in its height and length. In addition, because the bag can stretch if items are added in, the width might change so it is good if it remains well below 20cm. Its style is inspired by the 'cute' design – such as the boat and the cartoonish waves, but also uses the wood to give the product a simple yet elegant design.

Cultural factors:

I also chose to use the symbol of the boat to celebrate the UAE's history of sailing and sea travel, that first provided the country with the raw resources (pearls) to sustain the nation and begin the journey as an emerging economic power.



Components:

Based on how much the nylon is stretched, the bag will change its position, so it is important that it can have multiple holes to insert the hook into, much like a belt. The hook and holes must be the same size so that the first can fit and stay inside the ladder without coming off.

Materials:

The bag would be made of three different materials: nylon, oak and plywood.

- Brown nylon (2) is used in this design to connect the cover (1) with the other main components (3). I chose nylon, because as a textile it would be able to stretch easily and thus fit inside more items depending on the capacity needed. The handle will be made of black nylon.
- The other component is blue stained oak. Oak will make the front component of the bag, oak is strong and durable, the front and back of the bag are the ones that have to sustain the greatest strain/pressure, so this ensures that the items inside are protected.
- The boat will be bleached white oak carved into the blue oak.
- The foldable cover will be made from pine because it is lightweight and easy to work with, thus it will be easier to cut in chunks.



Processes and Techniques:

- First, I would use a table saw to cut two boards measuring 33 H x 45 L x 0.6 W cm. One of the boards will be out of oak, the other out of pine. These are the front and back of the bag.
- Then, I would bleach the oak plank and use a blue wood stain to give it that blue shade.
- Then, I would laser cut the shape of the boat onto the oak plank and cut out the boat onto another bleached white oak plank. I would slot the two in and glue them together using PVA glue.
- Then, I would cut several pieces of pine (3 H x 45 L x 0.5 W cm) with a band saw. Because our workshop doesn't have boards of that size, I would have to use a jigsaw to scale the board down.
- The pieces would be connected by a strip of nylon on each end, that way – the pieces can bend.
- To guarantee the nylon cuts without fraying, I would use a soldering iron to cut 2 15 x 33 cm nylon strips.
- I would use a pillar drill connected to a flat bit to cut 4 holes along the middle of the upper part of the oak plank. These are the spots an iron rod connected to the cover would go in.
- I would draw the waves onto the cover and paint the wood using a blue dye.
- After cutting a 45 cm handle, I would attach it to the bag using superglue and then placing the piece in a vacuum presser so that it is held firmly in place.

Sustainability Issues:

- Pine is a good material to use here because it grows quickly enough to be forested and cut down sustainably. Oak is a hardwood, so it takes longer to grow – consequently it is less sustainable. The good thing is that oak is sparsely used in this design.
- Nylon is nonbiodegradable, so if left outside it will pollute indefinitely. It can be recycled; however the process is energy intensive – so a lot of fossil fuels are needed to generate this energy.
- Waste will be produced when the holes are cut, this waste has to be disposed of properly and not be wasted. Otherwise, precious resources will be misspent.

Design 3:

Aesthetics:

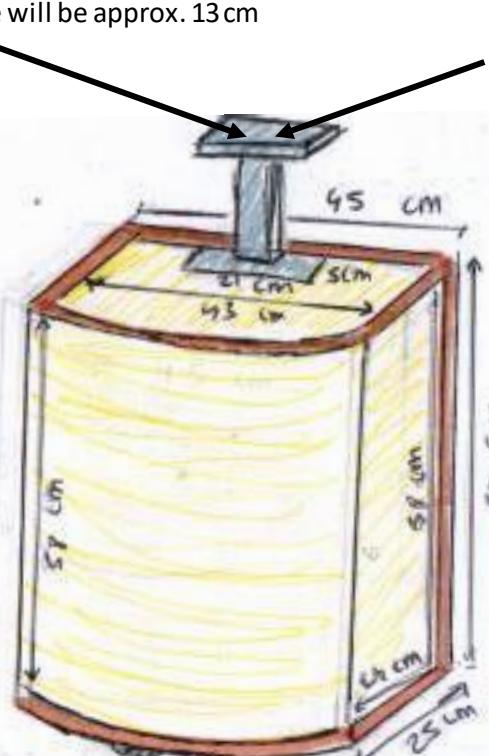
This is a trolley based entirely on wood. It would measure 45 cm in length, 60 cm in height and 25 cm in width. It reflects a modern style, with a simplistic, natural-based, and monochromatic design. This bag would be too big to carry on board and therefore would need to be stored in the cargo hold.



Components:

These latches are what keeps the bag closed and replace the need for a zip. This is inspired by this other suitcase found in stores.

Handle size will be approx. 13cm



Components:

This is a trolley case that will go inside the bag to make it easy to carry. The 360° wheels at the bottom allow the bag to be dragged across the ground.

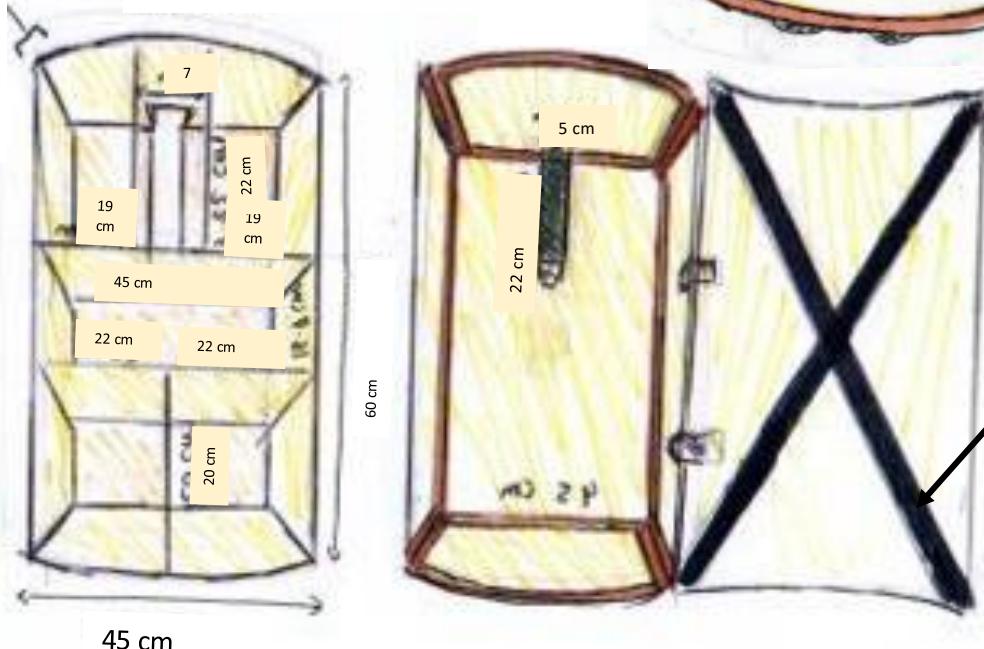
Pine veneer



MDF thickness:
3 mm or
0.3 cm

Slot

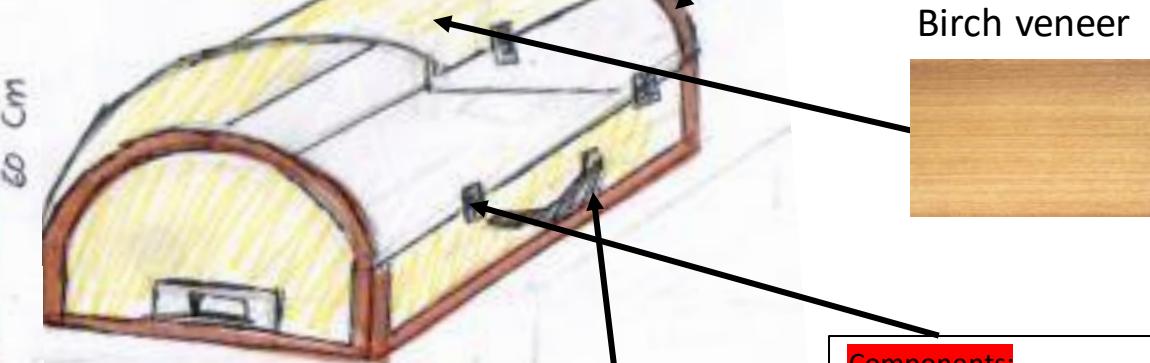
Bag



This is a pair of straps where the client can secure any additional personal items they may wish to bring.

Components :

- The bag contains curves, which means that I will need flexiplan because timber boards crack/splinter instead of bending. I will, however, veneer the flexiplan as shown above.
- The flat components of the bag will be made from birch and pine. I chose them, rather than a stained oak because they are much easier to work with. Since this is a big bag, choosing a material that takes a long time and is hard to work with will waste precious time. The flat darker edges will be made of pine, because it is stronger and more durable, and it is important that the sides resist to stress and cracking.
- The slot would be made of MDF because it is cheap and widely available.



Birch veneer



Components:
The latches here are used to remove and attach a slot to the bag and enter it

Components:

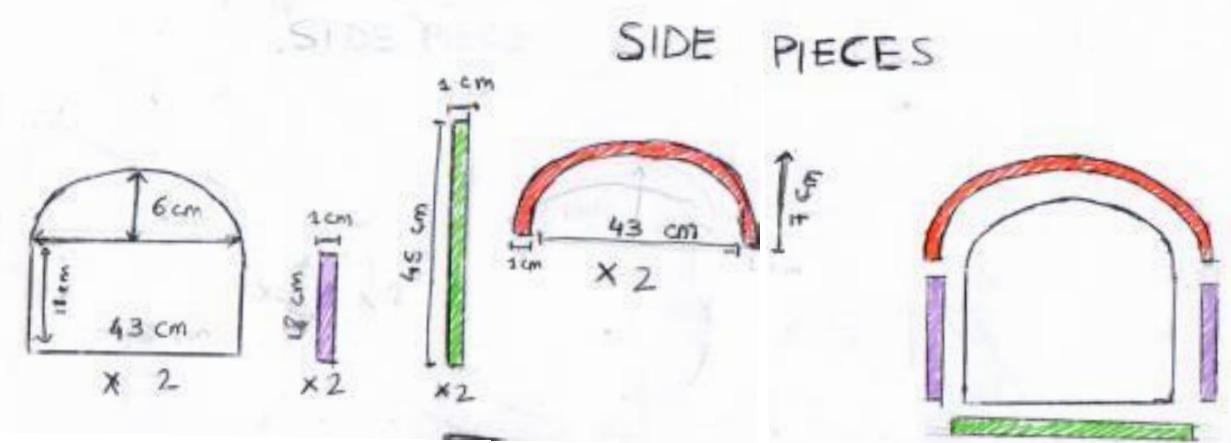
Handle to the side allows for the bag to be carried both horizontally and vertically. Which allows for extra utility

Processes and Techniques:

- Firstly I would work on the curved parts of the design. I would cut the pieces of flexiplly needed using a table saw and then I would use PVA glue to glue on the veneer layers. Two pieces of 45 H x 58 L x 0.9 W cm pieces would do.
- I would need to then create two foam mold pieces, one for the curved front (the flexiplly with the birch veneer), and one for the curved side (the one with the pine veneer).
- I would place the flexiplly on the mold and place it in a vacuum molder.
- Next, I would cut two 60 H x 1 L x 0.9 W cm, four 24 H x 1 L x 0.9 W cm and two 45 H x 1 L x 0.9 W cm pine pieces. These will make the flat frame of the bag. Much like the flexiplly, I would use a table saw.
- I would now make the oak flat pieces by using a band saw to cut two side pieces (as shown in the drawing)- which I would need to use since the side pieces are curved and two pieces of 58 H x 24 L x 0.9 W cm.
- I would stain the pine pieces to create a rich brown in contrast with the whiter oak.
- In one of the oak side pieces, I would have to cut a 5 x 21 cm hole so that the trolley handle can be inserted inside.
- I would varnish the oak planks.
- I would cut out dovetail joints for each pine side, using a combination of a chisel and gentlemen's saw followed by a coping saw to cut the wood out.
- I would then cut out biscuit joins to connect the oak panels to the pine, and then assemble the pieces together. The rounded pine-veneered flexiplly would have to be glued on.
- I would connect the large oak-veneered flexiplly to the rest of the structure using butterfly hinges.
- I would then insert the handle and screw in the latches and wheels.
- Finally, I would cut out using a table saw the MDF slot, using the measures shown in the drawing. Because the MDF is very thin, I would not be able to use biscuit joints, so I'll just have to glue them together instead.

Sustainability Issues:

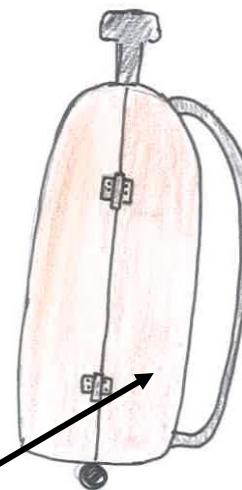
- Pine is a good material to use here because it grows quickly enough to be forested and cut down sustainably. Oak is a hardwood, so it takes longer to grow – consequently it is less sustainable. Unlike other designs, both the oak and oak veneer make up most of the design – so a lot of it will be needed.
- The wheels commercially available for purchase are made of non-recyclable rubber which is non-biodegradable. Thus, once the product has finished its life cycle, its remains will most likely end up in a landfill where they will pollute. In addition, the handle that has to be purchased will be made of a metal alloy (steel) which requires a lot of energy to melt to recycle.



Design 4:

Aesthetics:

Much like design 3, this is a wood-based trolley with a slightly smaller size of 35 cm in length, 40 cm in height and 22 cm in width. It has some elements of a modern design such as the use of natural materials, reflection on form following function and use of neutral, natural colors.



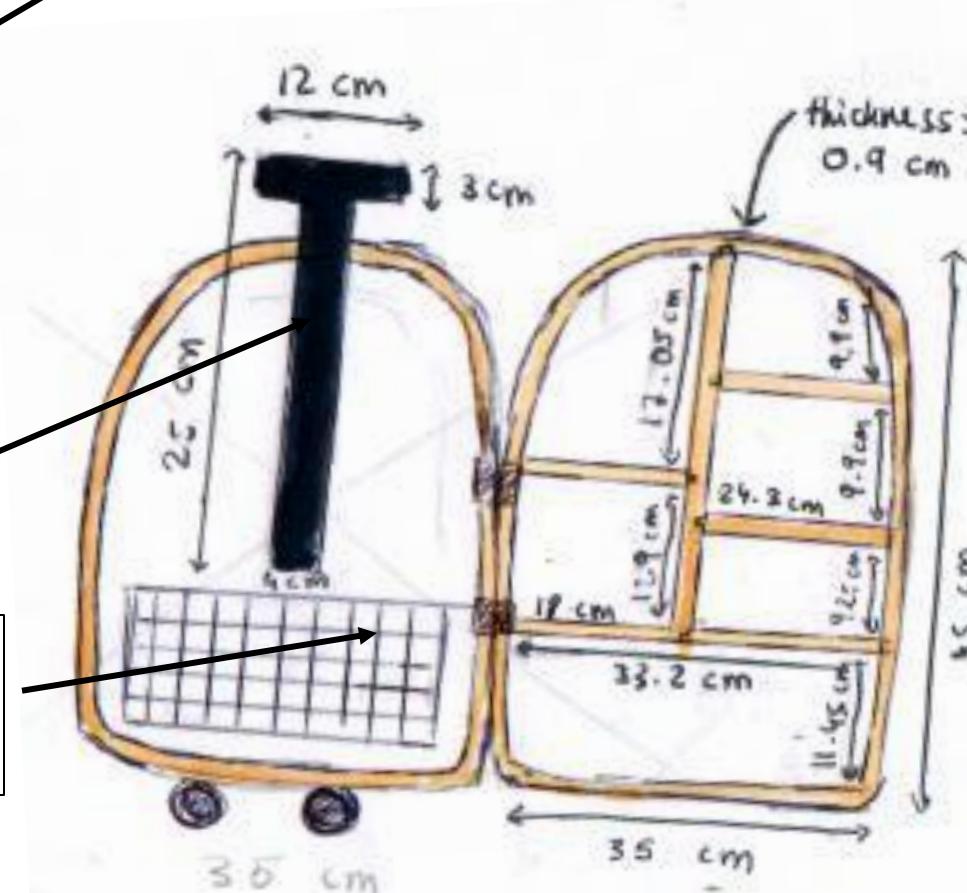
The bag has two ways to be carried, as a trolley or as a backpack – this gives it multiple uses and functionality.

Materials:

- The entirety of the bag is curved, with the exception of the inside dividers, to make the curved parts I will use flexiplly.
- The flexiplly would be veneered with an oak (marine) veneer.
- The inside of the bag, and the compartments would probably be made of cheap materials such as MDF. I won't use chipboard or plywood for the inside components because they are softer, and I need a strong material to keep the insides safe.

Components:

The handle can move out to be twice the size, not counting the handle (45 cm when extended)

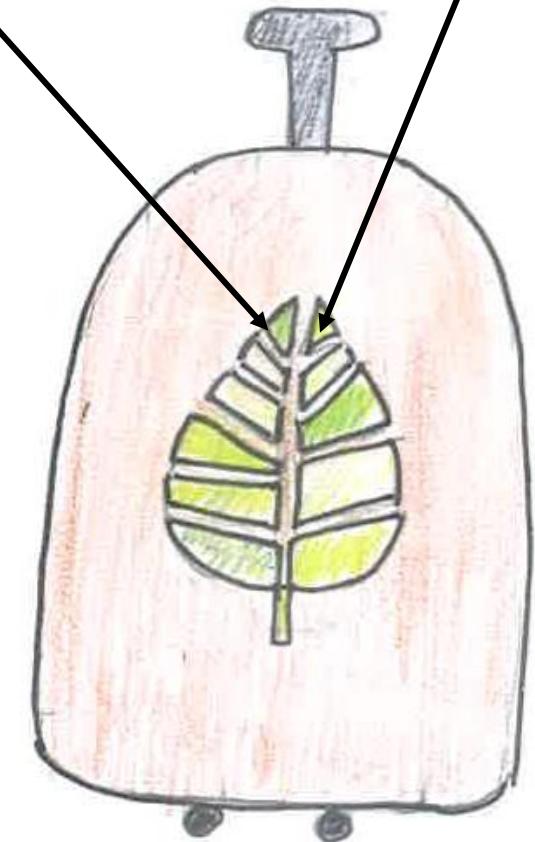


Components:

Much like design 1, this bag has a net where the client can keep items they might want to access quickly.

Cultural Factors:

The leaf portrayed in the bag resembles a palm leaf. Palms have both a symbolic and economic importance for the U.A.E. because not only are palm trees frequent symbols in the Qur'an and its dates used as a major export product. In addition, palm leaves were used to make shelters, plates and bags. This bag, is therefore a call back to the roots of the country



Processes and Techniques:

- To make, it would require two large flexiplly boards. Both boards have to be curved, by creating a foam mold and then placing the flexiplly boards over it in a vacuum molded. The marine veneer would be glued on with PVA glue during this stage to allow for maximum time saving. These boards make the front and back shells.
- Then, following the measurements of the drawing – I would cut the chipboard piece with a table saw to make the inside dividers.
- I would then cut using a gentleman saw to create dovetail joints so that each piece can fit together with each other and form a strong bond. Because the bottom where they will be placed will be slightly curved, I will need to use a combination of a bandsaw and sanding machine to slightly curve the bottom of each piece. They will be glued onto the bottom (biscuit joints can't be used as it is not flat).
- The two boards are then attached to each other by a butterfly hinge, and a latch drilled on the left side of the bag would keep it closed.
- I would cut a 4 W x 22 H cm hole at the top of the back piece to slot in the handle, which I will secure by screwing it in.
- The leaf would be made with a laser cutter on acrylic.
- The wheels would be screwed on

Sustainability Issues:

This product is almost entirely made of plywood. The manufacturing of plywood uses much more energy than wood. Thus not only does it use up key finite fossil fuel resources, but it also releases toxic and harmful greenhouse gasses. Since many bags will be created, this could have harmful effects. However because of its durability, plywood can be easily reused and have several lives. My bag has to last a long time because once it is bought, it shouldn't have to be purchased again – this means that plywood is a good material for it.

Weight Calculation:

Product 1

$$\text{oak} \rightarrow 2160 \text{ cm}^3 \rightarrow 2.16 \times 10^{-3} \text{ m}^3$$

$$\text{MDF} \rightarrow 1930 \text{ cm}^3 \rightarrow 12325 \text{ g}$$

Kg	m ³
881.015	1
x	2.16×10^{-3}

$$1.9 \text{ kg}$$

$$\text{MDF} \rightarrow 1930 \text{ cm}^3 \rightarrow 12325 \text{ g} \rightarrow 12.325 \text{ kg}$$

↳ Total = 14.225 kg

Product 2

$$\text{oak} \rightarrow 891 \text{ cm}^3 \rightarrow 8.91 \times 10^{-4} \text{ m}^3$$

Kg	m ³
881.015	1
x	8.91×10^{-4}

$$0.795 \text{ kg}$$

$$\text{pine} \rightarrow 8.91 \text{ cm}^3 \rightarrow 8.91 \times 10^{-4} \text{ m}^3$$

Kg	m ³
656.757	1
x	8.91×10^{-4}

$$0.535 \text{ kg}$$

$$\text{Nylon} \rightarrow 99 \text{ cm}^2 \rightarrow 117.81 \text{ g} \rightarrow 0.11781 \text{ kg}$$

$$\text{Nylon (Strap)} \rightarrow 160 \text{ cm}^2 \rightarrow 190 \text{ g} \rightarrow 0.19 \text{ kg}$$

$$\text{Total} \rightarrow 1.67821 \text{ kg}$$

Product 3

$$\text{pine} \rightarrow 2754.4 \text{ cm}^3 \rightarrow 2.754 \times 10^{-3} \text{ m}^3$$

Kg	m ³
656.7	1
x	2.754×10^{-3}

$$1.8 \text{ kg}$$

$$\text{oak} \rightarrow 3392.7 \text{ cm}^3 \rightarrow 3.3927 \times 10^{-3} \text{ m}^3$$

Kg	m ³
881.015	1
x	3.3927×10^{-3}

$$2.49 \text{ kg}$$

$$\text{flexiply} \rightarrow 4698 \text{ cm}^3 \rightarrow 696 \text{ g} \rightarrow 0.686 \text{ kg}$$

$$\text{MDF} \rightarrow 3082.14 \text{ cm}^3 \rightarrow 7705 \text{ g} \rightarrow 7.7 \text{ kg}$$

↳ Total → 13.18 kg

U.S Forestry Data:

→ data in pounds per cubic foot

$$\text{oak} \rightarrow 55 \text{ lb/ft}^3 \rightarrow 881.015 \text{ kg/m}^3$$

$$\text{pine} \rightarrow 41 \text{ lb/ft}^3 \rightarrow 656.757 \text{ kg/m}^3$$

$$\text{Birch} \rightarrow 35 \text{ lb/ft}^3 \rightarrow 560.676 \text{ kg/m}^3$$

Workshop Data:

$$\text{MDF: } 2.5 \text{ g/cm}^3$$

$$\text{Nylon: } 1.19 \text{ g/cm}^2$$

$$\text{Flexiply: } 0.146 \text{ g/cm}^3$$

Product 4

$$\text{Plywood} \rightarrow 3892.5 \text{ cm}^3 \rightarrow 568305 \text{ g} \rightarrow 0.568 \text{ kg}$$

$$\text{MDF} \rightarrow 1295 \text{ cm}^3 \rightarrow 3233.5 \text{ g} \rightarrow 3.25 \text{ kg}$$

↳ Total → 3.801 kg

NOTE: Handle, wheels + veneers have not been included because measurements vary depending on the supplier, however it should all fall under 5 kg

Specification Area	Specification Point	Reasoning
Form (A) - (Total points: 8)	<p>A1. The product could have blue, green or purple colours</p> <p>A2. The size of the product must be under 25cm (width) x 35 cm (length) x 56 cm (height)</p> <p>A3. The product should have a modern or cute style</p> <p>A4. The design should be kept simple</p>	<p>A3. Use of natural materials, the monochrome tone and simplicity make this product modern.</p> <p>A4. The product design and shape is simple</p>
Function (B) - (Total points: 5)	<p>B1. The product must be mostly waterproof and immune to rot/insect attacks</p> <p>B2. Product should have a compartment inside that is divided into sections to promote space-saving.</p>	B1. The varnish insulates the inside compartments, thus protecting it from water damage.
User Requirements (C) - (Total points: 9)	<p>C1. The product should come in pre-built.</p> <p>C2. The product must be no more than 5 kilos of weight</p> <p>C3. The product should have a handle, gripping place or straps</p> <p>C4. The handles should be wider than 10 cm</p>	<p>C2. Product weighs 14.2 kg</p> <p>C3. The product has both a handle</p> <p>C4. Handle is 13cm.</p>
Performance Requirements (D) - (Total points: 9)	<p>D1. The product must be stable, and stand up straight</p> <p>D2. The product must be lightweight</p> <p>D3. The product must be resistant</p>	<p>D1. The base, both vertically and horizontally is stable because of its large S.A.</p> <p>D2. Product weighs 14.2 kg, which is extremely heavy.</p> <p>D3. The sides are made of oak, meaning that the bag is resistant to crushing, the MDF available in the workshop is quite high density – thus it is in itself also quite resistant.</p>
Material & Components Requirements (E) - (Total points: 16)	<p>E1. The product should have a maximum of 4-5 materials as to make as little waste as possible and to lessen costs</p> <p>E2. Materials should be environmentally friendly</p> <p>E3. Materials should be available in the workshop</p> <p>E4. Product should not have a plastic cover/surface that scratches easily</p> <p>E5. Product should not have a four-wheeler</p> <p>E6. Product must be made mostly of wood</p> <p>E7. Other materials such as acrylic and nylon could be used but should be used in small quantities as they have plastic compounds which is bad for the environment.</p>	<p>E1. 3 materials used.</p> <p>E2. The 2 main materials are oak which can be gathered from environmentally friendly FSC regulated forests. And MDF which is a recycled resource, so it repurposes wood waste.</p> <p>E3. Product uses acrylic to make the small gadget at the front, however I will need to assess how easily acrylic is scratched.</p>
Sustainability (F) - (Total points: 6)	<p>F1. During production, as little waste possible should be produced. Materials should be accurately calculated.</p> <p>F2. Materials used in the building should be recyclable, as well as the packaging</p> <p>F3. Packaging should not use polystyrene</p>	F2. Wood can be repurposed, MDF can be made out of recyclable fibres.
Scale of Production and Cost (G) - (Total points: 3)	G1 Production cost must remain under 100 pounds	

Specification Area	Specification Point	Reasoning
Form (A) - (Total points: 8)	<p>A1. The product could have blue, green or purple colors A2. The size of the product must be under 25cm (width) x 35 cm (length) x 56 cm (height) IF it is a carry-on bag (otherwise ignore this) A3. The product should have a modern or cute style A.4 The design should be kept simple</p>	<p>A1. Product has blue colors A2. Product is a carry-on-bag small enough to be carried on board (15cm x 30 cm x 35cm x 33cm) A3. It has some elements of cute design – bright colors and cartoonish figures, but not enough to qualify as a cute style. A4. Product has a pretty simple design and shape.</p>
Function (B) - (Total points: 5)	<p>B1. The product must be mostly waterproof and immune to rot/insect attacks B2. Product should have a compartment inside that is divided into sections to promote space-saving.</p>	<p>B1. By themselves, oak and flexiplly aren't waterproof.</p>
User Requirements (C) - (Total points: 9)	<p>C1. The product should come in pre-built. C2. The product must be no more than 5 kilos of weight C3. The product should have a handle, gripping place or straps C4. The handles should be wider than 10 cm</p>	<p>C2. Product is 1.7 kg. C3. The product has a big strap to carry the bag with. C4. The strap is wide enough to be carried comfortably by an average adult with a torso length of 49 cm.</p>
Performance Requirements (D) - (Total points: 6)	<p>D1. The product must be stable, and stand up straight D2. The product must be lightweight D3. The product must be resistant</p>	<p>D1. Product is a handbag so it can't stand up straight, its base is nylon – not very solid. D2. Unlike other designs, this one uses as its main material nylon – which significantly decreases the weight of the bag. In addition its size isn't bulky and is small, so this handbag is quite comfortable to carry. D3. Oak and nylon are pretty strong, although MDF is quite weak.</p>
Material & Components Requirements (E) - (Total points: 16)	<p>E1. The product should have a maximum of 4-5 materials as to make as little waste as possible and to lessen costs E2. Materials should be environmentally friendly E3. Materials should be available in the workshop E4. Product should not have a plastic cover/surface that scratches easily E5. Product should not have a four-wheeler E6. Product must be made mostly of wood E7. Other materials such as acrylic and nylon could be used but should be used in small quantities as they have plastic compounds which is bad for the environment.</p>	<p>E2. When oak comes from FSC sources, then it is pretty eco-friendly, and some forms of nylon can be sustainable too. MDF is often made from recycled fibers. E7. Nylon is the bag's main component.</p>
Sustainability (F) - (Total points: 6)	<p>F1. During production, as little waste possible should be produced. Materials should be accurately calculated. F2. Materials used in the building should be recyclable, as well as the packaging F3. Packaging should not use polystyrene</p>	<p>F2. Wood can be reused, and some forms of nylon can be recycled.</p>
Scale of Production and Cost (G) - (Total points: 3)	<p>G1. Production cost must remain under 100 pounds</p>	

Specification Area	Specification Point	Reasoning
Form (A) - (Total points: 8)	<p>A1. The product could have blue, green or purple colors A2. The size of the product must be under 25cm (width) x 35 cm (length) x 56 cm (height) A3. The product should have a modern or cute style A4. The design should be kept simple</p>	<p>A3. Use of natural materials, monochrome colors and simplicity make this product modern. A4. The product design and shape is simple</p>
Function (B) - (Total points: 5)	<p>B1. The product must be mostly waterproof and immune to rot/insect attacks B2. Product should have a compartment inside that is divided into sections to promote space-saving.</p>	<p>B1. The materials themselves are not waterproof, however since I have decided to varnish them – I could use marine varnish to make them waterproof.</p>
User Requirements (C) - (Total points: 9)	<p>C1. The product should come in pre-built. C2. The product must be no more than 5 kilos of weight C3. The product should have a handle, gripping place or straps C4. The handles should be wider than 10 cm</p>	<p>C3. The product has both a handle and a trolley C2. Product weighs 13.18 kg C4. Handle is 13cm.</p>
Performance Requirements (D) - (Total points: 9)	<p>D1. The product must be stable, and stand up straight D2. The product must be lightweight D3. The product must be resistant</p>	<p>D1. The base, both vertically and horizontally is stable because of its large S.A. D3. Birch is a hardwood, so it is quite dense – making it quite resistant. Pine is also quite durable.</p>
Material & Components Requirements (E) - (Total points: 16)	<p>E1. The product should have a maximum of 4-5 materials as to make as little waste as possible and to lessen costs E2. Materials should be environmentally friendly E3. Materials should be available in the workshop E4. Product should not have a plastic cover/surface that scratches easily E5. Product should not have a four-wheeler E6. Product must be made mostly of wood E7. Other materials such as acrylic and nylon could be used but should be used in small quantities as they have plastic compounds which is bad for the environment.</p>	<p>E1. The three main materials are MDF, pine and birch. E4. Laminated planks could be easily scratched, veneers may be quite fragile. E5. Product has a set of two wheelers</p>
Sustainability (F) - (Total points: 6)	<p>F1. During production, as little waste possible should be produced. Materials should be accurately calculated. F2. Materials used in the building should be recyclable, as well as the packaging F3. Packaging should not use polystyrene</p>	<p>F2. Wood can be repurposed.</p>
Scale of Production and Cost (G) - (Total points: 3)	<p>G1. Production cost must remain under 100 pounds</p>	

Specification Area	Specification Point	Reasoning
Form (A) - (Total points: 8)	A1. The product could have blue, green or purple colors A2. The size of the product must be under 25cm (width) x 35 cm (length) x 56 cm (height) A3. The product should have a modern or cute style A4. The design should be kept simple	A3. Use of natural material, earthly colors, and no unnecessary detailing make this design inspired by the modern style. The combination of synthetic materials (acrylic) and natural (wood veneers) also contributes to this. A4. The product design and shape is simple
Function (B) - (Total points: 5)	B1. The product must be mostly waterproof and immune to rot/insect attacks B2. Product should have a compartment inside that is divided into sections to promote space-saving.	B1. The marine veneer makes both the inside and outside of the bag waterproof. B2. The product does have a neatly arranged interior.
User Requirements (C) - (Total points: 9)	C1. The product should come in pre-built. C2. The product must be no more than 5 kilos of weight C3. The product should have a handle, gripping place or straps C4. The handles should be wider than 10 cm	C2. The wooden components of the bag weigh 3.8 kg, so even with the addition of the wheels handle and acrylic, the bag will remain under 5 kg. C3. The product has both backpack straps and a trolley C4. The backpack straps are big enough to fit a normal person.
Performance Requirements (D) - (Total points: 9)	D1. The product must be stable, and stand up straight D2. The product must be lightweight D3. The product must be resistant	D1. The base, both vertically and horizontally is stable because of its large S.A. D2. Because the boards of larch/ash are hollowed, it can be lightweight. D3. The use of plywood alone for the exteriors makes the bag pretty weak, flexibly is elastic – and though it sets once it is glued it still has a low impact resistance.
Material & Components Requirements (E) - (Total points: 16)	E1. The product should have a maximum of 4-5 materials as to make as little waste as possible and to lessen costs E2. Materials should be environmentally friendly E3. Materials should be available in the workshop E4. Product should not have a plastic cover/surface that starches easily E5. Product should not have a four-wheeler E6. Product must be made mostly of wood E7. Other materials such as acrylic and nylon could be used but should be used in small quantities as they have plastic compounds which is bad for the environment.	E2. MDF/plywood which are recycled from wood scraps (chipboard) and overall require less wood (plywood) E4. There is a big acrylic leaf that covers the front of the bag, this could get damaged easily when travelling and could potentially come off. E5. Product has a set of two wheelers E7. Some acrylic is used but in small quantities (leaf only)
Sustainability (F) - (Total points: 6)	F1. During production, as little waste possible should be produced. Materials should be accurately calculated. F2. Materials used in the building should be recyclable, as well as the packaging F3. Packaging should not use polystyrene	F2. Plywood is made from wood, and wood can be repurposed and recycled. MDF is itself a recycled material.
Scale of Production and Cost (G) - (Total points: 3)	G1. Production cost must remain under 100 pounds	

Evaluation when design brief is considered:

The specifications and design brief are closely matched, as the first is inspired by the ladder. However, the key difference is that the design brief also specifies that the compartments must be removable – which design 2 (with its folder like organiser) and design 4 do not follow. Thus, I will now look at the final score that they each got based on the previously established criteria. If either of these designs appear to win over the others, I will have to modify this flaw in their design.

User Rating:

As part of my assessment criteria, I had to ask people about the maneuverability and appeal. Naturally, because these are still paper-based designs, I only considered the aesthetics appeal. The means (that have been rounded off) are shown below:

Design 1: 7/10

Design 2: 8/10

Design 3: 7/10

Design 4: 8/10

Summary of Design Ideas:

For each design, I tried to do a different type of bag. The first design is a handbag, the second a shoulder bag, the third a trolley and the last a mix between a backpack. This was done purposely to guarantee a range of different styles and products to accomplish the same basic idea and solve a common problem. Each has its advantages and disadvantages. What stood out about each design was:

- [Design 1](#): The best characteristic about design one was its locking mechanism, which worked much like a key to secure the bag and keep it closed. I think I will want to incorporate it in my final design.
- [Design 2](#): The second design used an interesting technique to make its cover, using a long slice of wood, cutting it up in smaller planks and attaching them together with two ropes to create a cover that was flexible and adaptable.
- [Design 3](#): The third design had an interesting mechanism for changing slots. Because the purpose of the bags is to allow the clients to purchase one every time they prepare for a trip, if they'd have to buy a new bag each time the price and space they'd take would simply be too much. Instead, there is a skeleton, which you purchase once, and slots, which you can purchase as many times as you want, that contain your items. What this design has that is interesting is the way the slot attaches. The slot and skeleton will have matching latches that attach to each other when the slot is inserted and can be detached to change slot. So you don't need to have to open your bag each time you want to change slot.
- [Design 4](#): The fourth design accomplished best the ability to be used for multiple purposes, I like that it has backpack straps AND a trolley so that it can adapt to different situations. I also quite like its simplistic design and the acrylic leaf.

Scores:

Scores are added up based on the specifications (must = 3 points, should = 2, could =1), so that I can assess which bag is the best based on a technical level. However, some points were omitted as they don't have anything to do with the product at this stage. For example, the packaging or total costs. Then I added the user scores (shown in the previous page)

Overall, the best scorer was:

[First Place](#): [Design 4](#): 52/59

Second Place: [Design 1+2](#): 46/59

[Third Place](#): [Design 3](#): 43/59

Overall, these four designs offer very different directions for this design, some are more suited for my requirements and purposes than others. I will try to create a prototype that models after the most desirable characteristics of the three, although there will probably be more influence coming from design 1 and 4, as they are in my opinion the best models. Design 3 is also good, but its size and shape would make its transport and storage quite difficult.

Modification of design ideas to fit the design brief:

I've chosen to take forward design 1 and 4, I think 4 will be most like the final prototype – however I really liked the locking mechanism design 1 has, thus I've also chosen to take this idea forward. However, there are some problems with the current prototype according to the specification. One was that I was not to use any materials that could be easily scratched - after checking with my teachers, I was able to conclude that the acrylic in our workshop doesn't scratch easily. However, there are still other problems to address:

Design 1:

1. MDF is heavy, though inexpensive.

- As we have seen from the past designs, the designs that involved a lot of hardwood were extremely heavy. However MDF is also very heavy. My contextual challenge requires a lightweight bag, because it needs to be carried easily and has to be able to pass through airport control checks. In addition, this bag's only carrying method is a strap – this will be particularly uncomfortable for passengers who have to wait in line for long periods of time before getting in an airplane and who have to carry their bag with them. If the bag was much lighter, it would then be much easier to carry. I need to find a way to decrease the weight of the bag overall whilst still using MDF.

2. Increasing the appeal

- The bag only got 7/10 for appearance rating. This is probably due to the lack of colors (blue, as mentioned in the spec) I will need to incorporate more vibrant colors into my design. The bag layout itself is unappealing, the shape offers nothing of great innovation or creativity to the eye.

Design 4:

1. Design 4 relies on plywood alone which makes the bag quite weak, it will not resist a crushing force it might be exposed to.

- I will need to use flexiply to make the curved edges of the bag – however instead of it being two big pieces, I will make any flat parts out of either a hardwood or MDF. In addition, the front and back of the bag will be flat instead of being curved so the structure itself is more stable. This means that I won't need as much plywood, and instead I will be able to use a stronger material.

2. Design 4 has no way to remove the slots, which goes against the design brief.

- I think I could do something similar to what Design 1 offers, a slot that is then inserted in. However, product 1 had the heaviest weight, and that was mostly due to the MDF used for the inside slot. So, if I make an insertable slot, it cannot be made from MDF.

Design 1:



The basic layout and measurements of the bag remain consistent with the original design, what has changed is its physical appearance. Firstly the Oryx's face is not solely for aesthetics. Though the Oryx's face remains attached to the bag, the nose rotates which moves the gear as shown previously. I've added the words "Travel" to fill the bag. I've used blue because it is according to the spec (A1) as it has been shown to be my demographic's favourite.

Another change comes in terms of the materials, the front and back will be made of plywood – this is because plywood is available at thinner widths in my workshop. Though it is not as strong as MDF, it is much lighter. To make sure the bag is still resistant, the edges are still made of MDF. In addition, the slot that inserts into the bag that would have previously been made of MDF would now be made of corrugated board – which is substantially lighter. This totals in the bag reaching 4.8 kg – below the set limit.

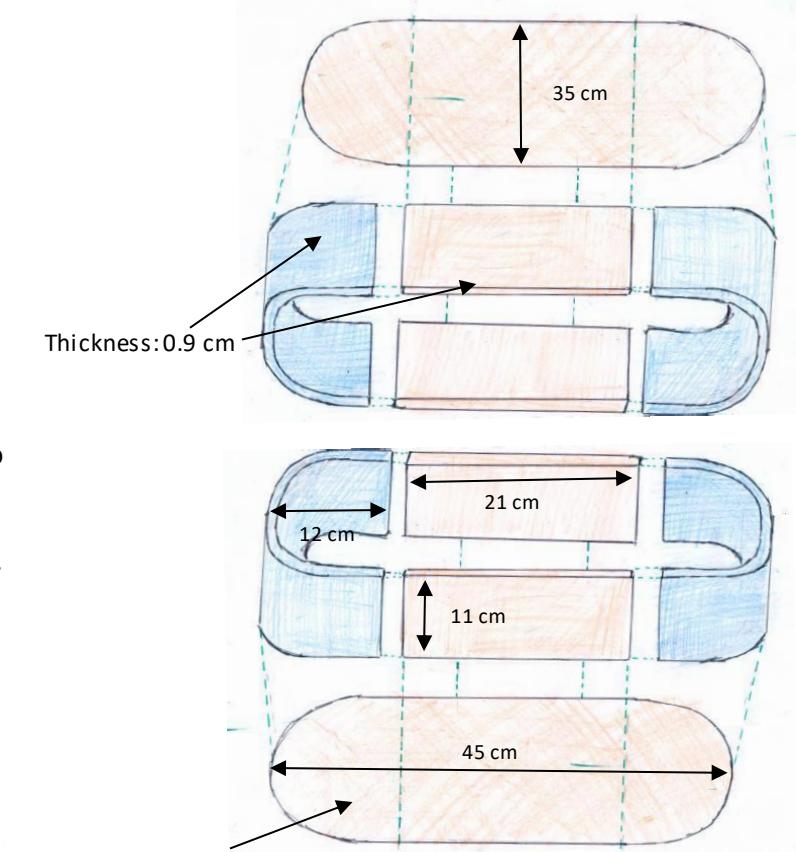
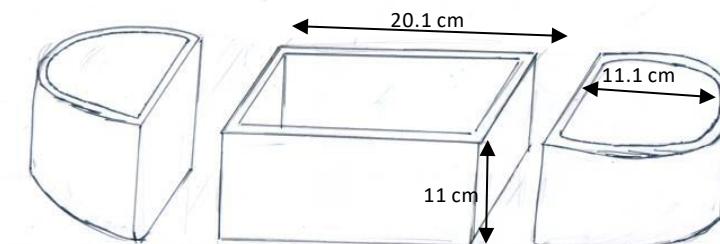
Design 4:

The basic look of the design will stay the same, since it has scored the highest in terms of appeal. However the materials and shape of the front and back will change as mentioned above. The front and back are now flat to improve stability and because they will be made from MDF. This is because MDF will act as a resistant cover for the bag – one of its failures was just that (spec D3). MDF also makes up the flat sides of the bag because this way it guarantees that under stress the sides stay up, and thus the shape of the bag is conserved.

This has however increased the weight of the bag from 3.801 kg to 4.6 kg.

This does not include the slot; thus it CANNOT be made from MDF. Instead, I will make insertable compartments out of corrugated board that fit the shape of the bag so that they can be inserted where previously the MDF compartments would have been (see original design). Corrugated cardboard is weak, but it will be protected by the strong MDF casing.

Corrugated Cardboard Compartments



Blue: plywood
Orange: MDF

Though the two design ideas have now been modified to fit the criteria, certain areas can be improved and explored further

Design 1:

Is the locking mechanism too big/bulky?

- I will need to improve on the locking mechanism and make it more compact to save more space, however that depends on the design as a whole. I think by improving the locking mechanism I can save space, which decreases the weight overall. I also need to model it to figure out if it works for the model as a whole rather than as an individual component.

Design 2:

How will the handle be made?

- I could purchase one of the ones available commercially – however these are handles that have to be inserted inside textile bags. Thus, an internal handle in my bag would take up a lot of space. A slideable handle on the outside could work. Or in alternatives, a long strap like the one in design 2.

Problems with both:

1. Is the current color scheme suitable for the prototype?

- In both selected designs, there is not much color – the wood selected is very dim and plain. In my modification of design 1, when asked again people gave the design 8/10. I need to consider whether this change in the rating could be partially due to the darker color the bag has. In order to do this, I will have to create a model of a pale bag and see how people react to its colors.

Phase 2:

I have now identified several key problems, which in these next slides I will address. Here, I have created a model of design 1 in its ideal size and measures. Here, I explore how the locking mechanism would work. In addition, in the previous slide I mentioned having a long strap instead of a handle – I have simulated it here. Finally, I also consider whether a pale color is appealing to my target demographic.



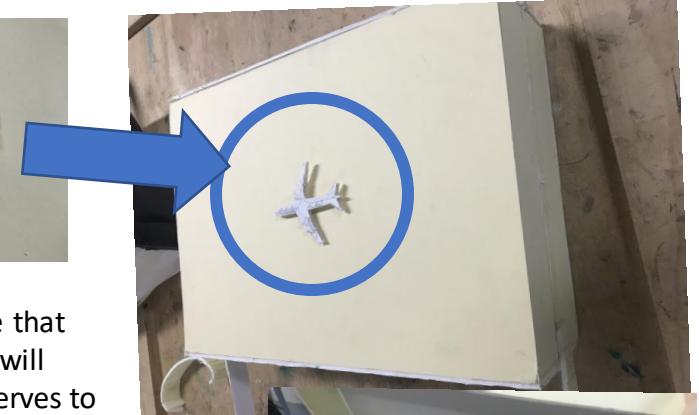
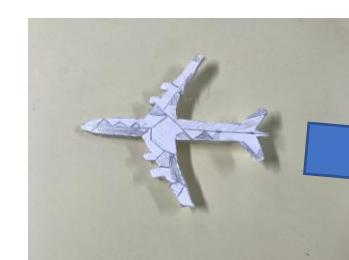
1. I first started by measuring and cutting each individual piece using a cardboard cutter. The basic suitcase is made up of 10 pieces. The sides are made from hard cardboard, while the front and back are made from a more flexible board. This gives the bag a rigid structure while maintaining a good capacity and weight. Using a hot glue gun, I glued each piece together to form a chest shaped bag.



2. I then created the locking mechanism. I placed the square box in the middle of the inside of the bag, next I cut a hole on the opposite face on the bag, one that was directly parallel to the box. The cylinder shown on the left has a small dowel connected to its frontal side (opposite of the hole), I let this dowel pass through the hole I had cut out, and then I connected it using glue to the small aeroplane figure shown below. This kept the cylinder in place and gave it the ability to be twisted. When the bag is closed, the cylinder slides under the small opening in the box, thus the two faces of the bag are locked together, and the bag can't be opened. This system worked quite well, but it is a bit bulky and does take up a lot of space.



3. I started making a handle too, I took a piece of cardboard and lightly cut small lines on both sides, each a centimetre apart. This allowed the cardboard to become a flexible handle that could be moved on both sides. The handle is longer than in the design, but this allows it to be carried as a shoulder strap.



4. I chose the aeroplane symbol because it is one that can be produced with relative ease (the product will have to be produced in large numbers); it also serves to symbolise the journeys the bag will go on.



5. I finally glued all the pieces together. I glued two small pieces of cardboard on the long side of the bag to allow it to be opened and closed with ease. I then reinforce for the outside and insides of these two pieces with some tape.





Reviews/Comments:

- the shape of the actual suitcase could be curved instead of rectangle.
→ curved instead of rectangle
→ Bigger lock as well

- The shape of the actual suitcase could be curved instead of rectangle.
- Bigger lock as well

Bit too simplistic although colours are nice. & seems a bit bulky and lock mechanism doesn't fully close the bag. → It is quite comfortable to carry.

Bit too simplistic although colours are nice. Seems a bit bulky and lock mechanism doesn't fully close the bag. It is quite comfortable to carry.

Bit too bland but the airplane design looks very nice and the handle looks good.

Bit too bland but airplane design looks very nice and the handle looks good.

'Convenient to organise specific products for travel'
'very bulky and hard to store because of material.'

- Convenient to organise specific products for travel.
- Very bulky and hard to store because of material.

bit bland, add a bit more pockets & handles.
love the idea of the plane lock, but consider the fact that it may slip to open in transit.

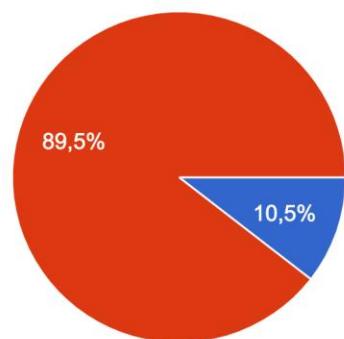
- Bit bland, add a bit more pockets and handles.
- Love the idea of the plane lock, but consider the fact that it may slip to open in transit.

Shape is a bit too simple + not appealing/bulky. I would say you should add more handles and curve it.

Shape is a bit too simple + not appealing/bulky. I would say you should add more handles and curve it.

Do you like the colour of the bag?

19 risposte



● Yes
● No

4. Is the locking mechanism too bulky?

Despite people's appreciation for the locking mechanism's idea, as one person remarked – it does not properly close the bag because it only acts in the middle – so the edges are left ajar. In addition, since it is in the middle, it makes the slot more difficult to cut.

5. How will the handle be made?

I considered two slides ago using a strap or maybe a backpack (like design 2 and 4) to carry it. However, when I was holding it, I noticed that a strap would get in the way as the bag is quite big. In addition, having to carry it would get quite trying because the bag is made of wood - so it is uncomfortable to carry as a backpack. Thus, I have to exclude the backpack and strap option - I need to work on the handle idea.

6. Is the color scheme suitable?

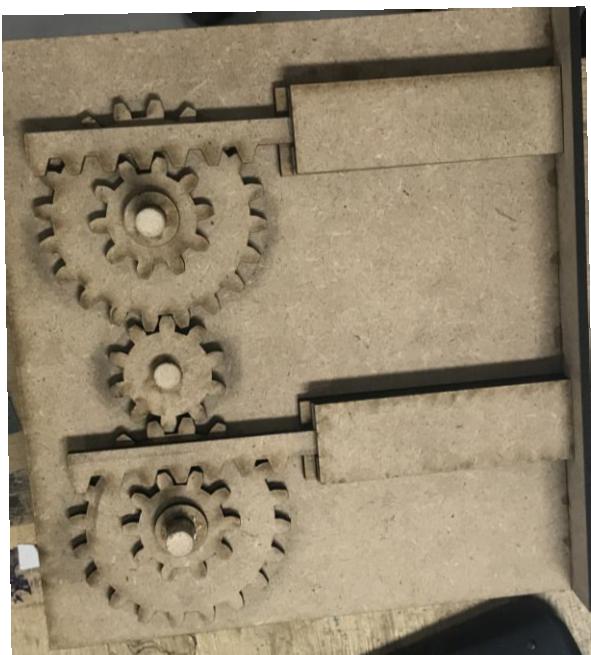
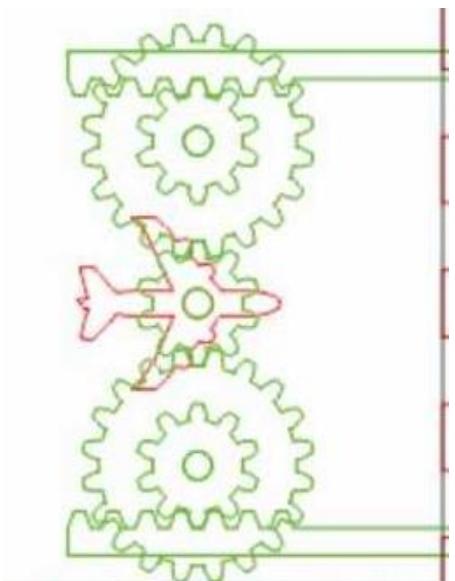
From both the feedback I received, and a survey I sent out to people between the ages of 18-24, the almost unanimous consensus was that the colors are too plain/unexciting. Thus, I should use darker wood colors for my design.

Developing the gear system

The original gear used in my prototype turned out to be unsuitable because it was too bulky and thus took away from the space of the bag. I knew that I needed to reduce the size of the locking mechanism, which I could do using gears.



For my first gear system, I decided to use a gear for the turning of the aeroplane, one to transfer the clockwise motion to a third gear perpendicular to the first two. The third gear had a hook, which would slide into a dowel – thus it would be kept still. Though certainly better than the first, this gear system only allowed for the centre to be held shut, as such with more rectangular and longer objects, the sides would be slightly ajar. [So in consideration of my design as a whole, this would be unsuitable](#)



The final gear system I developed works differently from the first and second. In total, this system works through 5 gears and two rack and pinion system, which push two shafts into two holes of the bag, thus keeping it shut. The gear in the middle is attached to the plane and translates the motion to the two compound gears, which slide over the rack causing it to move back and forth. This system worked much better than the previous ones because it ensures that the box was kept shut in multiple places closer to the sides, this ensured that the box did not open. So, it would be able to keep closed any shape, [thus in consideration of my design as a whole – this gear system is suitable](#).

Materials:

One of the limiting factors of this project so far has been the weight, which has made me discard a lot of very good materials or limit them in size due to their weight. Therefore, I decided to explore different material options and compare their weight to pre-existing materials in the workshop.

Veneered Corrugated Cardboard

In my improved designs, I used a corrugated board as an interior material to make the slots. Now I wanted to figure out whether it would be strong enough to be also used as an outside material with the addition of paperback veneer.



The corrugated cardboard I found was the one used to carry big heavy interactive whiteboards, meaning that it had a double layer to resist breakage. This means that, with the addition of paperback veneer (which I cut to size and glued on with PVA glue), the board turned out to be very strong. Though it isn't very good at resisting perforation, it has excellent shock resistance and good tensile strength.



However, the material would not be useful if I would not be able to make joins out of it. In my designs, I required biscuit joins. So I used a biscuit cutter on the board and found out that with a double board layer biscuit, joints are possible.



Improving the MDF Idea

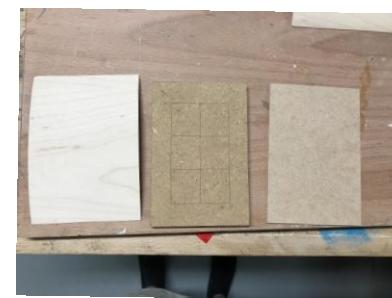
The initial plan had not succeeded, but the idea behind it would still have been very useful and applicable. So, I decided to repeat the process – however, this time I used paperback veneer (more structurally strong) and a thin sheet of MDF on one side. This way, even if there were indentures, they would not be seen on one side.

So, I cut a 1 mm MDF board using a table saw and then once again used the pillar drill to drill 25 mm holes into the main MDF piece.

Then, I placed PVA glue on all three pieces and placed them on top of each other. Next, I placed them into the bag press. At first, I thought that the idea had been unsuccessful yet again because of the indentures that were forming on the piece in the vacuum machine. However, once the piece was removed – there were no such indentures (see next page).

Modified MDF

Some building and constructions use steel as the main material. However, to decrease the weight they sometimes have hollowed interiors. MDF is material is used extremely frequently in these designs so if I can decrease its weight – I would be dramatically decreasing the total weight of some of my products.



Weight Comparisons (boards are all the same size):



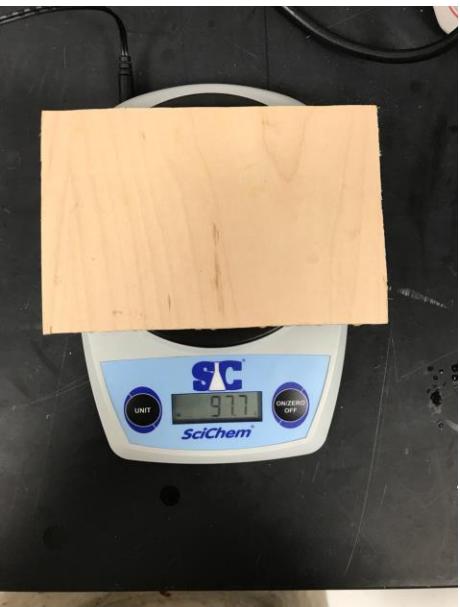
Normal MDF: 180.0 g



Birch: 130.2 g



Corrugated Card: 33.7 g



Hollowed MDF: 97.7 g



Flexiplly: 76.7 g

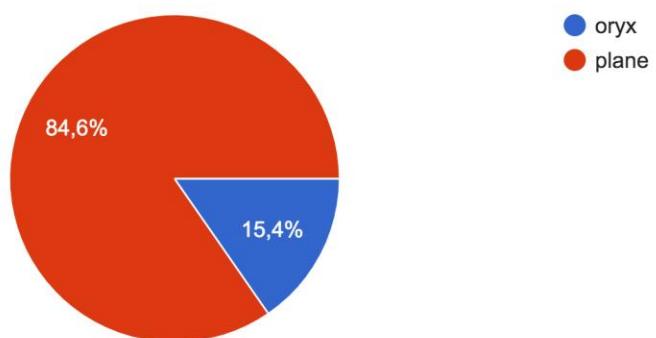
Conclusion:

Here we can see that the hollowed MDF is the third lightest, with a weight reduction of 54.3% ($180 \times 0.54 = 97.7$). This MDF is heavier than birch – so if I were to hollow birch instead, I'd get an even lighter material. However there are two problems with it: firstly as a hardwood, it warps and cracks – but according to the design brief and spec it should be able to withstand pressure. Secondly, I will be mass producing this product, and using birch will not only be expensive but also costly for the environment. Thus, I have decided that I will use as material for the final prototype hollowed MDF, flexiplly and corrugated board and some hardwood to make the smaller components that need to be strong/tough.

When doing the gear, I chose to do a plane because it was easier to cut by hand. However a lot of people really seemed to like it. So I created a poll and asked people to vote on the design they liked most. I saw that the majority of people preferred the plane design.

Do you prefer the oryx design or the plane?

13 risposte



The Importance of Planes for the U.A.E. :

Etihad is a multinational airplane company and one of the UAE's biggest and most influential business. They are an important contributor to the economy and represents tourism and travel – the third biggest industry in the Emirates. The airplane therefore represents a lucrative and key symbol for the UAE

Symbolism of the plane in context to my design:

The design brief bases around airplane travel, the size and many features of the bag have been chosen due to their way of transport (wheels, need for the bag to be resistant). In that regards, the plane symbolizes the core of travel and the mythos of the bag.

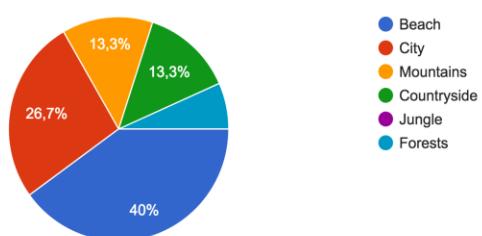


Because more people seem to like the design and because it carries a symbolic meaning, I've chosen to feature the plane rather than the oryx for my gear system.

Further Research:

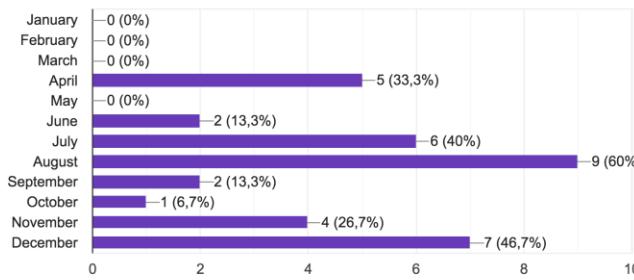
When traveling for pleasure, what is your most common destination?

15 risposte



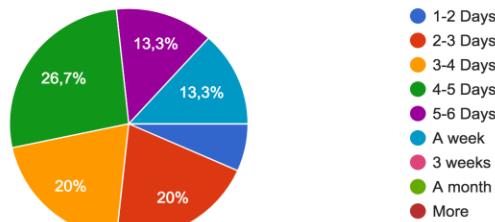
During what month(s) do you travel the most?

15 risposte



How long are your stays when travelling for pleasure?

15 risposte



Where does my demographic travel?

Though my bag will have to be used for many instances, I wanted to select a possible scenario through which I would orientate my bag around. This is especially important when considering the size and dimensions of my bag. It is apparent that most people travel to the beach during the summer season (shown by the spike in traveling during summer months like August and July). This is extremely important because for my case scenario, I want to model and furnish the bag with the essentials needed. Because beach vacations are so popular, I have decided that I will centre the contents of my bag around all the things required for traveling (my product isn't just a bag, but rather a pre-packed one).

The length of stay gives me an idea of how much things the person will need to pack, it seems from the data that the most common length stay is of about 4-5 days. As such, I will need to make sure that the things I put into the bag can accommodate this length of stay.

The actual size of the bag will not be affected by this beach scenario, because it must be applicable in all eventualities. However, I do need to understand the sizes of items to plan how to pack them and what will fit.

Items required for a beach holiday:

I need to understand the dimension of the different items I will need in this case scenario to come up with a packing solution. This could affect my design, so it is important to consider it beforehand. The "Items needed" are the ones I will provide with my bag; however the bag must have some leftover space to allow the customer to include their "personal items". The amount of items is based on the length of stay which I have previously decided will be around 4-5 days.

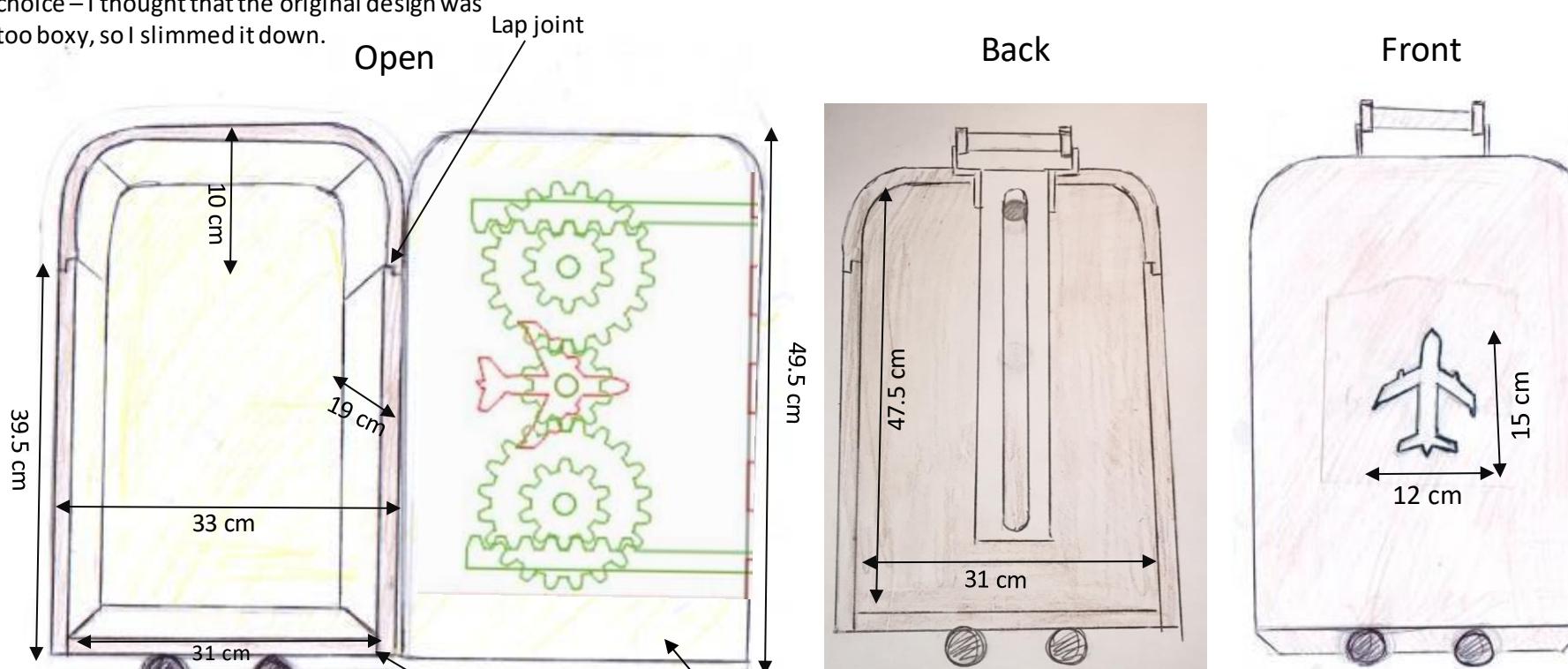
Items Needed:	Personal Items (Assumption, these will be packed by the client themselves)
Swim suit	Shirts x4
Flip flops	Pants x2
Hat	Socks x5
Beauty bag - sunscreen, soap, toothbrush, toothpaste, lipstick, mosquito repellent, aloe vera gel, brush	Under wear x6
Sunglasses	Shoes
Goggles	
Hand Towel	
Body Towel	

Final Design Idea:

Now, on slide 31 I modelled design 1 and clearly there were a lot of complaints about the product's shape. Many in fact, remarked that a more curved design would be more suitable and appealing. As such I think a curved shape like design 4 is more suitable for the product. However many found the gear system to be quite ingenious and added a touch of uniqueness to the design. Since I have developed a gear that won't take up much space, I have decided that though I will take design 4 forward I will also feature design 1's gear system.

Size:

The bag's size has slightly changed from the original design 4. The bag is now taller and less wide and deep – this was a purely aesthetical choice – I thought that the original design was too boxy, so I slimmed it down.



I found a small shop nearby my school that re-sells scrap parts. Here I found a wide assortment of wheels for a really low price. This has economic and environmental benefits because the wheels are recycled.

Jointing:

- The preferred joint is, for the contexts of this product, a biscuit join because it is very strong and can be quickly and accurately cut with a biscuit joiner. However there are exceptions.
- I will use the biscuit join to connect the different flat sides together.
- However, I will have to cut a lap join (shown in the drawings) to connect the curve to the flat sides.
- The backside slots into the frame – I will glue this in with superglue.
- The front side will be joined to the rest by a hinge.

Curved Design:

The bag is less curved than it was originally. This is because though I have found through my research that people like curves better, a straighter bag is more space-saving. So, I have kept some curves, but made the bottom flat.

Not a Backpack:

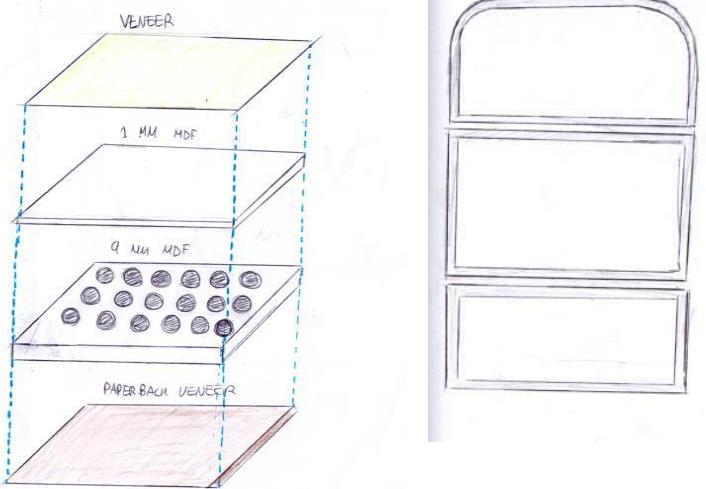
From my research and modelling of the bag I found that a big strap or backpack would be uncomfortable because wood isn't soft – hard on the shoulders. Instead, the design retains the handle (which has been modified) and the wheels.

Veneering:

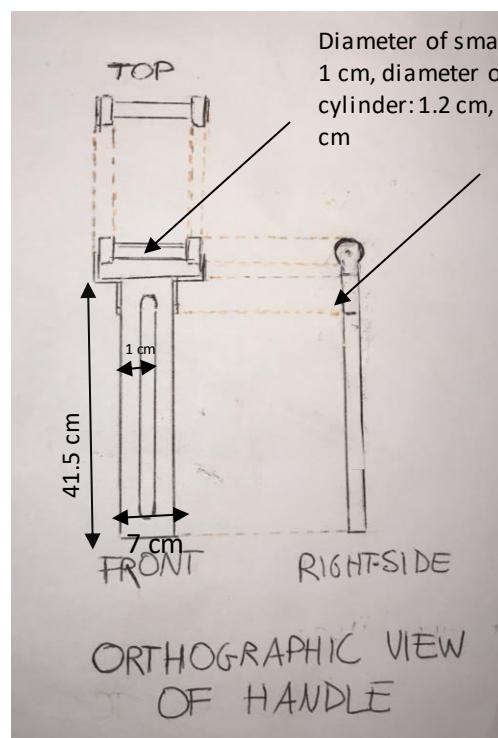
I will veneer all MDF. The outside MDF will be veneered as walnut, while the inside will be a lighter (yellowish) wood. Firstly, from my research I determined that people like a darker wood shade best. In addition, the contrast between the dark and light shade would create a nice effect.

Slot:

EXPLODED VIEW OF MDF COMPONENTS



Holes are 25 mm in diameter.



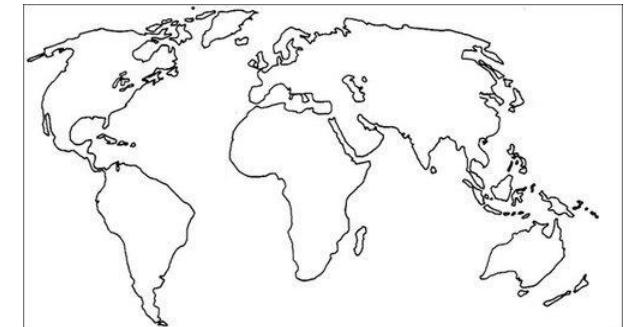
The drawing shown on the left is of the slots made out of cardboard that would fit into the bag. One (last on the bottom) will be empty to leave space for the client's items. The rest will be filled with the things the client has purchased.



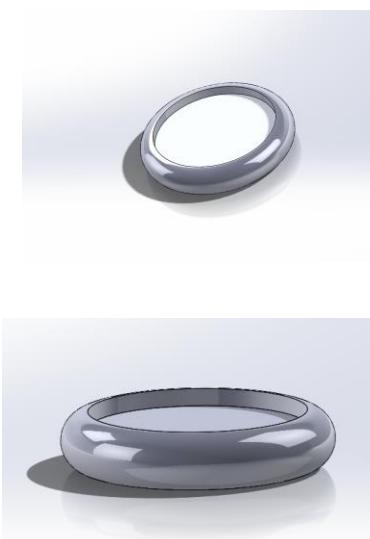
The Handle:

Shown to the left is a diagram of the handle and above a model of it. The handle now sits on the outside, so it doesn't take up any space inside. It has a screw which when tightened stops the handle from sliding up and down – so the handle is completely adjustable for any height. The handle will have a grip

In the model, a screw is fitted inside which tightens and untightens to restrict or grant the handle to slide up and down. In the model, this screw is not decorated, however I wanted to disguise the unappealing screw with a decoration. I have decided that I would design a button that covers the screw and has a world map as its inside design. I wanted the button to be in gray acrylic while the map outline to be in blue acrylic – because people like blue color according to my spec and because gray fits well with the walnut veneer. Below is the design of the map outline that I will cut with the laser cutter and slot into the button



The button has round edges so it can't be laser cut, as such I will have to 3d print it. I used the program solid works to design the product. I then saved it as a STL file so that the 3d machine would be able to process it.



Firstly I modelled the basic shape and outline of the button, I realized that the button would be too high if it was glued on top of the screw, so I made a hole inside where it could be screwed in. I then modified the hole because I realized that the shape of the screw requires is a hexagon.



Calculations:

Weight of the bag:

MDF (Not hollowed):

- Front $\rightarrow 490.05 \text{ cm}^3 \rightarrow 1.23 \text{ kg}$
- Gears $\rightarrow (\text{about}) 80 \text{ cm}^3 \rightarrow 0.2 \text{ kg}$

MDF (hollowed):

- Sides $\rightarrow 589 + 1501 \rightarrow 2090 \text{ cm}^3 \rightarrow 5.25 \text{ kg} \rightarrow (\text{reduction of } 54.3\%) \rightarrow 2.8 \text{ kg}$

Beech:

- Cylinder $\rightarrow (\pi r^2 h) \rightarrow 260 \text{ cm}^3 \rightarrow 0.00026 \text{ m}^3 \rightarrow 0.17 \text{ kg}$
- Flat handle piece $\rightarrow 290.5 - 39.5 \rightarrow 251 \text{ cm}^3 \rightarrow 2.5 \times 10^{-4} \text{ m}^3 \rightarrow 0.16 \text{ kg}$

Flexiply:

- Curve $\rightarrow 100\pi \text{ cm}^3 \rightarrow 0.05 \text{ kg}$

Wheels $\rightarrow 0.2 \text{ kg}$

Total: 4.81 kg

So the bag is under the max allowed weight

U.S Forestry Data:		
\rightarrow data in pounds per cubic feet		
oak \rightarrow	55 lb/ft ³	\rightarrow 881.015 kg/m ³
pine \rightarrow	41 lb/ft ³	\rightarrow 656.757 kg/m ³
birch \rightarrow	35 lb/ft ³	\rightarrow 560.626 kg/m ³
Beech \rightarrow	41 lb/ft ³	\rightarrow 656.757 kg/m ³
Workshop Data:		
MDP:	2.5 g/cm ³	
Nylon:	1.19 g/cm ²	
Flexiply:	0.146 g/cm ³	

Techniques and Processes:

- I will cut the various sides and MDF planks with a table saw.
- I will use a flat bit and a pillar drill to cut the holes of the MDF boards.
- I will cut a foam mold for the flexibly and glue two sides (to get to the thickness required) in a bag press to apply even pressure to it.
- I will glue on veneers with PVA glue and sand off excess with sandpaper or jack plane.
- I will use a bandsaw to cut the front and back cover.
- I will use a biscuit cutter to cut the holes for the biscuit joints, I will then have to glue in the biscuit and the pieces to each other.
 - At first I thought I would simply glue in the back cover however that would be too weak – instead I will also cut out biscuit joints.
- To cut the lap joint, I will have to mark out straight lines using a tri-square and draw a block made of straight lines which shows what I will need to cut. Using either a band saw or a tenon saw and chisel, I will chip off the wood. After I've done that for both sides, they should fit into each other.
- To cut the handle, I will need to draw onto a plank the shape of the handle. Then, I will cut the board into shape using a table saw. I need to then cut the inside parts. I have to find a forstner bit with a diameter of 1 cm and make a hole so that the router can fit in it and cut the rest. To make the holding part, I will need to get a wood block and plane its edges to make it more circular. Then I'll have to use a wood turning lathe to get it into the right shape. I will then have to cut a strip of copper and mark with a pencil where I want the bends to be. Using a sheet metal folding machine I will then bend the copper along the lines. Then, I will superglue one part to the routed plank and the other I will screw in using a power drill to the gripping place.
- I will then screw the wheels and handle in.
- I will laser cut both the acrylic, gears and cardboard boxes.
- To make the design waterproof, I will varnish the outside of the bag. This will also make it more resistant and protect it from scratches and stains. I will then stain the handle with walnut to match the veneer and to add a rich and luxurious finish.

Materials:

- The flat pieces that make up the bag frame will be made out of [hollowed MDF](#) (see exploded diagram). This is because MDF is cheap and because when it is hollowed it is much more lightweight than most natural timbers.
- The front cover will also be made of MDF and will sit on top of the bag frame. However, the MDF I will use will be quite thin – which already makes it lightweight. Adding holes would make the cover too fragile.
- The backside will be made out of [corrugated cardboard](#). Because it sits inside the frame its ugly edges are covered and are also protected from water. I will use cardboard here because I found that it is very strong and lightweight.
- The curve will be made of [flexibly](#), because it can bend into the shape required.
- The handle will be made out of [beech](#). I chose beech because though it is expensive, I will only be using it in small quantities. It is crucial however that the handle is tough and hard as it will be constantly pulled, beech is the toughest wood we have in the workshop, so I found it to be suitable.
- The curved handle and flat part of the handle are connected by a metal sheet that has been bent. Normally, I'd use an alloy of copper (brass) because it is quite strong, and the handle needs to pull behind it the weight of the bag. However, that is not available in the workshop. So, while if I were to manufacture the prototype, I'd use brass, for this prototype I will use [copper](#).
- The plane will be a laser cutout of [blue acrylic](#) – I chose blue because according to my research it is a color that is well received.
- The slots that go inside the bag will be made out of cardboard.

Overall the product does follow the specification and design brief, this products meets all the important criteria.

Specification Area	Specification Point	Reasoning
Form (A) - (Total points: 8)	A1. The product could have blue, green or purple colors A2. The size of the product must be under 25cm (width) x 35 cm (length) x 56 cm (height) A3. The product should have a modern or cute style A4. The design should be kept simple	A1. The product uses blue acrylic on the front. A3. Use of natural material, earthly colors, and no unnecessary detailing make this design inspired by the modern style. The combination of synthetic materials (acrylic) and natural (wood veneers) also contributes to this. A4. The product design and shape is simple
Function (B) - (Total points: 5)	B1. The product must be mostly waterproof and immune to rot/insect attacks B2. Product should have a compartment inside that is divided into sections to promote space-saving.	B1. The varnish and oil coat will make the product impervious to water and insect attacks. B2. The product has a series of cardboard slots that can be inserted into the bag.
User Requirements (C) - (Total points: 9)	C1. The product should come in pre-built. C2. The product must be no more than 5 kilos of weight C3. The product should have a handle, gripping place or straps C4. The handles should be wider than 10 cm	C2. The bag would have the same weight as the improved design – however it is made even lighter by the hollowed out MDF. C3. The product has an adjustable outside trolley that can be suited to any user's heights. C4. The handle is 22 cm wide.
Performance Requirements (D) - (Total points: 9)	D1. The product must be stable, and stand up straight D2. The product must be lightweight D3. The product must be resistant	D1. The base, both vertically and horizontally is stable because of its large S.A. D2. Because the boards of MDF are hollowed, it can be lightweight. D3. The different incorporation of components like oak and MDF make the bag strong and resistant on all sides. The joints at the back and sides ensures that the frame remains rigid to stresses.
Material & Components Requirements (E) - (Total points: 16)	E1. The product should have a maximum of 4-5 materials as to make as little waste as possible and to lessen costs E2. Materials should be environmentally friendly E3. Materials should be available in the workshop E4. Product should not have a plastic cover/surface that starches easily E5. Product should not have a four-wheeler E6. Product must be made mostly of wood E7. Other materials such as acrylic and nylon could be used but should be used in small quantities as they have plastic compounds which is bad for the environment.	E2. MDF is recycled from wood scraps (chipboard) and oak can be obtained from renewable and sustainable forests. E4. During my research I found that actually, our acrylic is quite resistant – so if glued on properly it should not scratch/come off. E5. Product has a two wheels. E7. Some acrylic is used but in small quantities (front only)
Sustainability (F) - (Total points: 6)	F1. During production, as little waste possible should be produced. Materials should be accurately calculated. F2. Materials used in the building should be recyclable, as well as the packaging F3. Packaging should not use polystyrene	F2. Oak can be repurposed and recycled. MDF is itself a recycled material.

Analysis of Refinements:

Overall, the bag now matches all the specifications and finally fills the requirements of the design brief. The changes that have been made affect both the functionality but also the aesthetics of the bag. The gears are now much lighter and smaller, taking up less usable space. The handle now doesn't need to go inside – where it would take up much space. Now, the handle can move up and down – to comfortably suit the customer's height. The handle of design 1 was nylon, this one is oak which gives a sturdier hold to the bag. Because the handle can be adjusted - it can be both used as a trolley case and as a normal handle.

Before, for a bag to be lightweight, I would have had to use flexiply, which is not very resistant. However, through my research, I have found that I can hollow MDF – which still retains its overall structural integrity and cheapness but now significantly decreases weight. So, this new bag is both resistant and lightweight.

Before, I didn't give much depth to the types of joints, in this design a wide range is used. I use biscuit joints which adds strength and resistance to the bonds between pieces.

The appeal has actually increased because of the sleeker change and the use of darker veneers – the mean score given to this piece was a 9/10. This is because I followed through people's feedback, many of the complaints had been regarding the bulky shape and bland colours – so I made it curved like design 4 and used a darker veneer instead. In addition, I think adding varnish and possibly staining the handle will make the wood look even more luxurious – boosting the appeal further.

Manufacture:

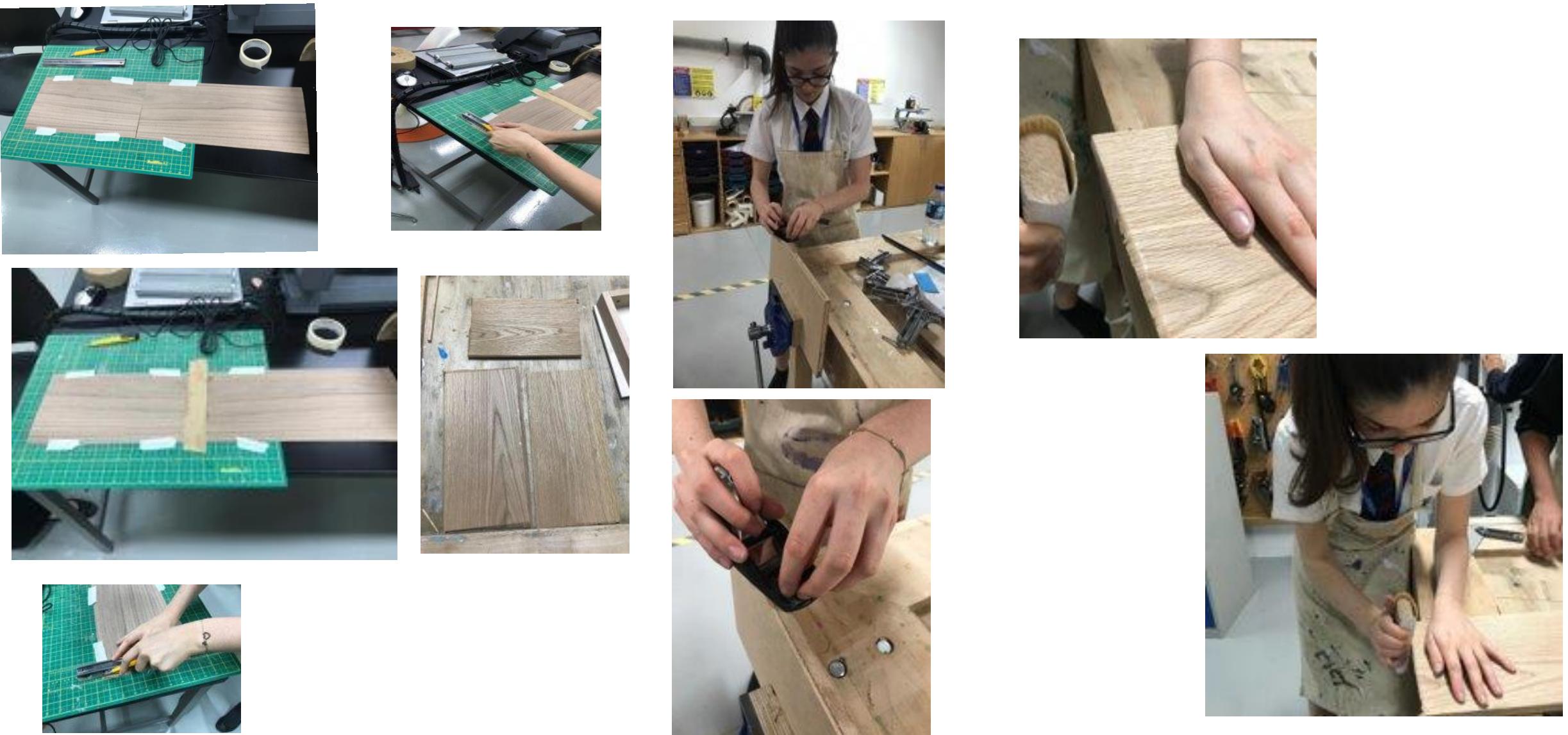
Step	Process	Tool and Machinery	Safe Working Practice
1	I needed to first make the mould for the flexiplly component. I cut out the exact shape on the laser cutter onto foam blocks. However, because a single foam block was too short, I also had to glue two moulds together. I then clamped the pieces together to make sure the glue was applied uniformly.	Laser cutter Brush set	Though PVA glue isn't very toxic, it is still good to try to limit contact with the skin to also make sure I don't contaminate any other pieces. So, to apply the glue I used use a brush and I washed my hands afterwards.
2	Next, I used a table saw to cut the planks of plywood. To do so, I placed the blade only slightly above the piece, this could have caused more tear out on the bottom and could have increased the chance of kickback, however it is a safer method than alternative (the alternative was placing it well above the piece, which meant less kickback but was also much more dangerous). To cut the length of the wood accurately, I used the fence of the table saw— which I adjusted by using the lever. To make an adjustment to the width of my cut, I then lifted the lever— which caused the fence to slide side to side. It was 1 cm longer just as a precaution. To get to around the thickness required, I had to glue together two flexiplly planks and then I used tape to keep them together. On the table saw, I also cut the pieces of MDF required for the sides.	Table saw	I needed to be really careful when operating the table saw, to safely operate it I had to: <ul style="list-style-type: none"> • Wear safety glasses, goggles or a face shield at all times. As well as a dust mask. • Avoid long sleeves, ties, dangling jewelry or any other loose fitting clothing while operating a table saw. This is because the clothes could have gotten caught in the machine. • Use a push stick because the stock that I was cutting was less than 150 cm. • Position myself so that I was NOT in line with the blade to avoid flying debris.
3	Then, I placed the plywood over the foam molds and secured it with tape, before placing it in the bag press to dry for 5 hours. The vacuum removes the air and allows the flexiplly to take its permanent shape.	Bag press	To safely use a bag press, before every use I had to make sure that the area was clear of things or people that could get crushed. Before I activated the machine under supervision, I stepped away of the table before I pushed any buttons.



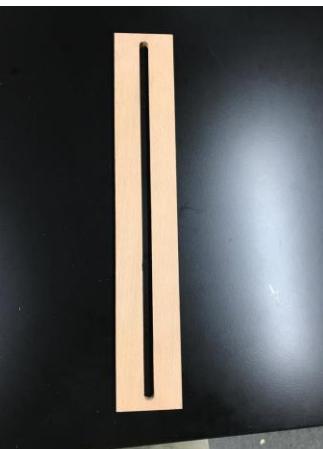
Step	Process	Tool and Machinery	Safe Working Practice
4	While the flexipliy dried, I worked on the 3 other side pieces. Just as shown when making the model materials, I first marked out the holes with a laser machine then I used a 25 mm flat bit to quickly and precisely drill the holes with a pillar drill.	Laser machine Pillar Drill	<ul style="list-style-type: none"> I fixed the board to the drill table to make sure it wouldn't move. I tied my hair backwards to make sure none got onto the prototype or got caught in the drill. I wore safety glasses to make sure no sawdust could get into my eyes.
5	Next, I began cutting the veneers for the flat pieces. For the large pieces, I simply marked out the dimensions of the sides and used that as a template to cut the veneers into sizes with a board cutter. I used a paperback veneer to make sure there would be no dents. To cut the sides I used some tape on a cutting board to mark out the width of the veneer piece I wanted to cut. So, once I had lined up the veneer paper onto the lines of the board – this fixture allowed me to cut a perfectly square edge strip in seconds.	Board cutter Cutting board Safety ruler	<ul style="list-style-type: none"> When using the cutter, it is necessary to use a safety rule as shown below in case the cutter slips. In addition I carried the operation on a cutting board to firstly ensure the pieces I was cutting were straight but secondly to ensure I didn't damage the table.
6	I then glued the veneers, 9mm and 1 mm MDF boards together and placed it all in the bag press to glue. Once they had glued, I attached the strips which I secured with tape.	Bag Press	



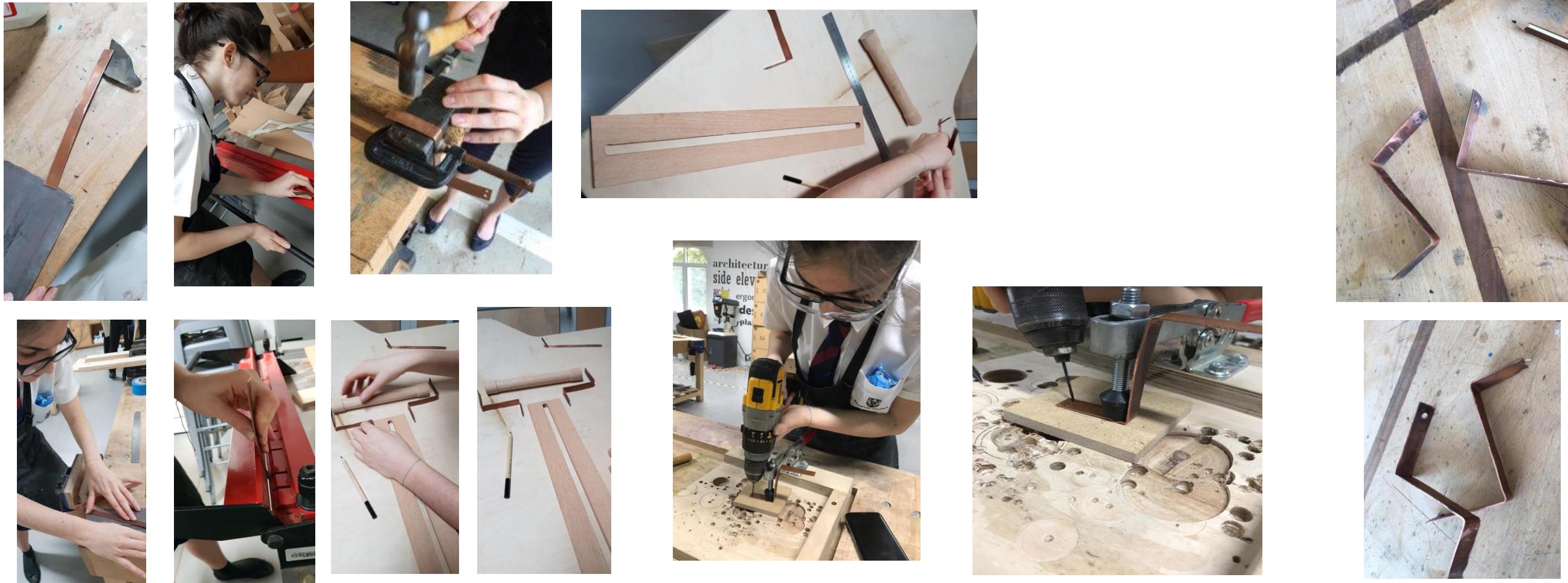
Step	Process	Tool and Machinery	Safe Working Practice
7	Next, I cut the veneer for the flexibly curvature. The curve is quite long, too long for the veneer available. So, I had to get two pieces of veneer and line them up so that their grain patterns matched. Then I connected them with a sticky tape which I would be able to sand off completely once the veneers dried. I used a board cutter to remove excess and narrow down the veneer to the appropriate shape and size.	Board cutter	I had to ensure that my hair was tied, and none was getting in the way. As the pictures show, when I was using the board cutter, I was carrying the blade along a safety ruler to prevent the blade from slipping.
8	The flat pieces had finally dried, so now I had to remove the excess veneer I purposefully included as a safety precaution. Some of the edges had little excess veneer so I used a jack plane to remove this excess – as well as any excess glue. I made sure that I was always plaining in the direction of the grain. I placed the plane at the start of the piece of wood and pushed it firmly across the entire length – without it lifting off the surface. Then, I lifted the plane back to the starting position.	Jack/smoothing plane	<ul style="list-style-type: none"> I had to make sure I was holding the plane correctly and that I was controlling it properly. When I was not using the plane, I had to leave it on its side and when I was pulling back, I had to lift the plane off the surface- otherwise the blade would blunt which could cause it to slip as it becomes harder to manage. I had to clamp the piece down to make sure it didn't move as I was dragging the plane across.
9	Some of the excess veneer was too big to be easily removed via jack plane - instead I used a very fine sandpaper (1200 p) to sand off the excess.	Very fine sandpaper	



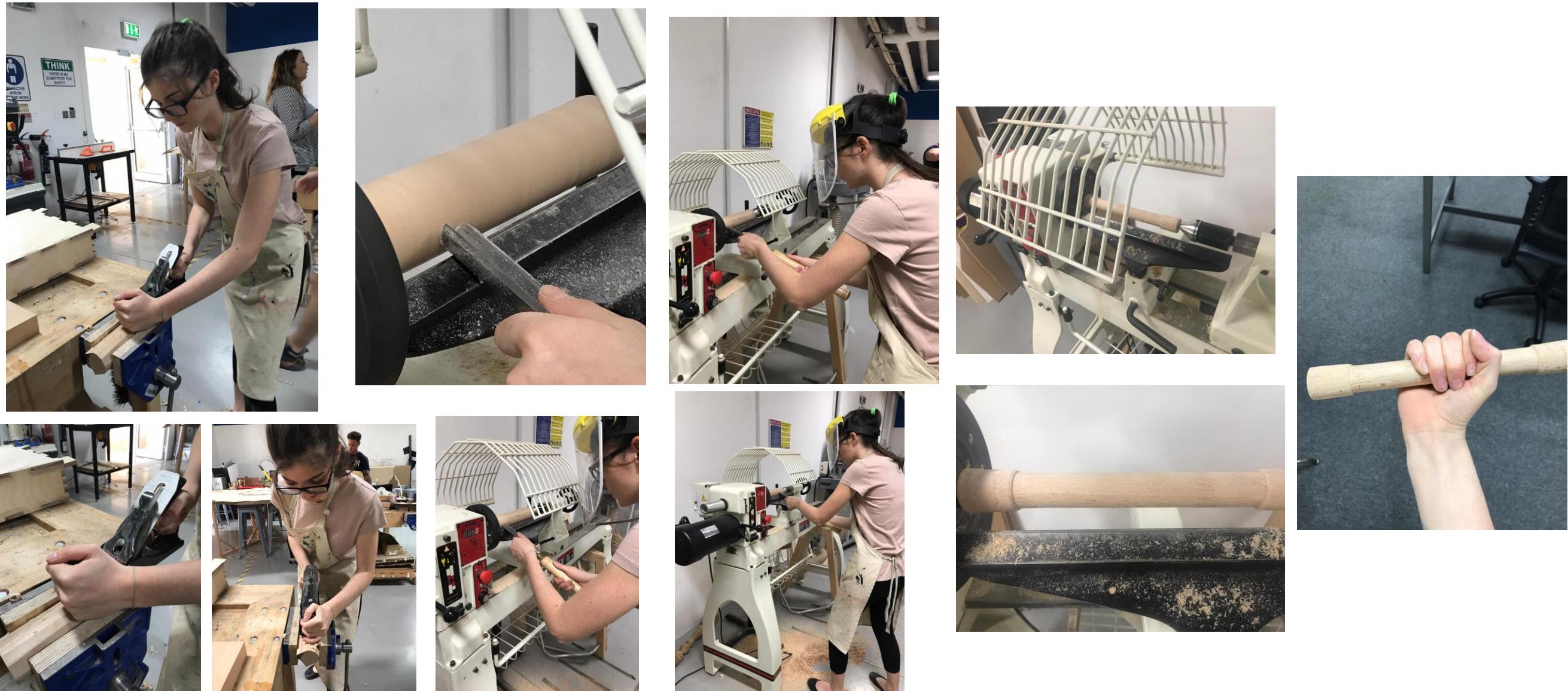
Step	Process	Tool and Machinery	Safe Working Practice
10	I now had to sand off the tape from the curve, which I did by using a very fine sandpaper (1200) and sanding along the grain. This is because the veneer I used for the curve was not paper back, so it was quite delicate. I sanded until I no longer saw traces of it.	Very fine sandpaper	<ul style="list-style-type: none"> I kept my hair tied backwards so that it wouldn't get in my way.
11	I now began to make the handle. Firstly, there were no birch planks available in that size, so I had to cut down on the available plank using a jigsaw. to get to the thickness I needed. For the jigsaw blade, I a coarser blade since I was working on hardwood. I found that using a very deep cut straight away made the blade quite unstable – so instead I cut down on the thickness by 5 mm each time, until I had the correct dimensions	Jigsaw Clamps Face mask	<ul style="list-style-type: none"> Firstly, I secured the piece to the table by clamping down two wood bars next to it and to stop it from moving vertically, I also inserted two dowels above and below it. When positioning the jigsaw, I always made sure that I was making contact with the base plate – otherwise the wood would catch the blade and make it unstable. I also made sure to wear a safety mask to not get wood dust in my face.
12	Then, I used tracing paper to draw onto the wood the shape and dimensions of the handle. Before I could use the router, I had to drill a small hole on the drill saw using a forstner bit. This then allowed me to insert the blade of the router into the hole of the piece.	Tracing paper Forstner bit Router table	<ul style="list-style-type: none"> I held on to two handles to move along the piece so that my hands would not get caught onto the blade. Because the router can hurl chips and fine dust, I made sure to wear proper eye, ear and dust protection when routing. I didn't wear loose fitting clothing or jewelry which might accidentally get stuck with the bit. I made sure that the workpiece was always fed against the rotation of the bit. Had I fed the workpiece in the direction of the bit's rotation (known as "climb cutting") I could have lost control of the router or workpiece.



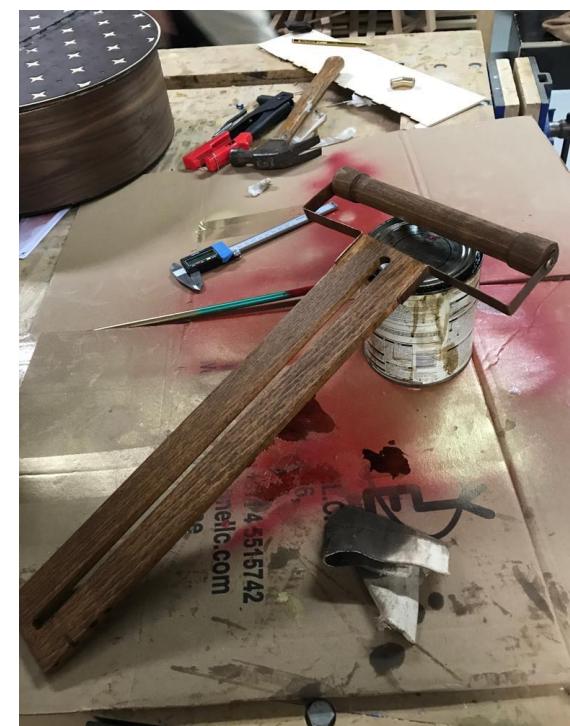
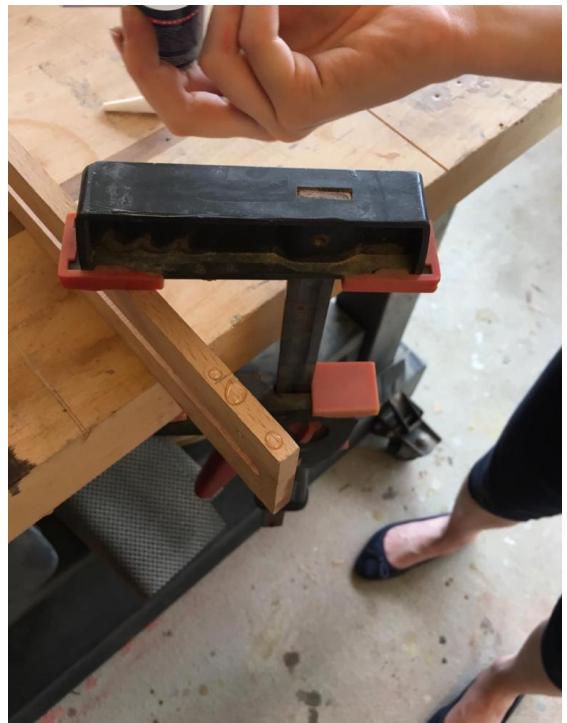
Step	Process	Tool and Machinery	Safe Working Practice
13	Now that the hand piece for the handle was done, I started working on the copper linings for it. However before I could bend them, I noticed that (as shown in the pictures) the sheets were slightly bent, so I used a mallet and hammered the sheet to flatten it down. Next, I noticed that the edges were quite sharp (which would have been dangerous for my users) so I used sandpaper (P1200) to smooth it.	Mallet Sandpaper	<ul style="list-style-type: none"> When I used the mallet, I made sure that the area I worked in was clear of debris and that I was wearing goggles in case the metal slipped. When I was sanding, I made sure to avoid touching the edges as they were very sharp and I could have cut myself.
14	To bend the copper, I firstly traced the lines with a pencil at the lengths I wanted the two folds to be, and then I lined this up on the sheet metal bending machine (specifically a cornice break). Firstly I placed the copper sheet on the machine's flat surface and then I brought down the clamping bar to hold it firmly in place. I then lifted the front gate of the machine resulting in 90° bends. Then, to guarantee that all edges were straight, I used a hammer over a metal surface to flatten them.	Sheet metal bending machine Hammer	<p>Sheet metal bending machine:</p> <ul style="list-style-type: none"> To both get an accurate bend and make sure that when it bends it doesn't accidentally hurt me, I made sure that the sheet was parallel to the bender. Before I bended the sheet, I made sure that any loose clothing or body parts were off the machine to prevent them from clogging it. <p>Hammer:</p> <ul style="list-style-type: none"> I kept fingers and body parts away from both the hammer and the metal surface. I made sure to clamp the strip to the metal surface so that it couldn't move.
15	I then marked out the holes using a pencil , then I used a twist drill connected to a handheld battery-operated drill. I made sure the copper was held in place by a clamp. I drilled one holes on each side of the copper strip that would attach itself to the gripping part (the handheld piece).	Twist drill Hand held drill	<ul style="list-style-type: none"> When drilling I made sure to wear protective goggles to cover my eyes from flying debris. I also made sure to hold the drill upright, to prevent it from slipping.



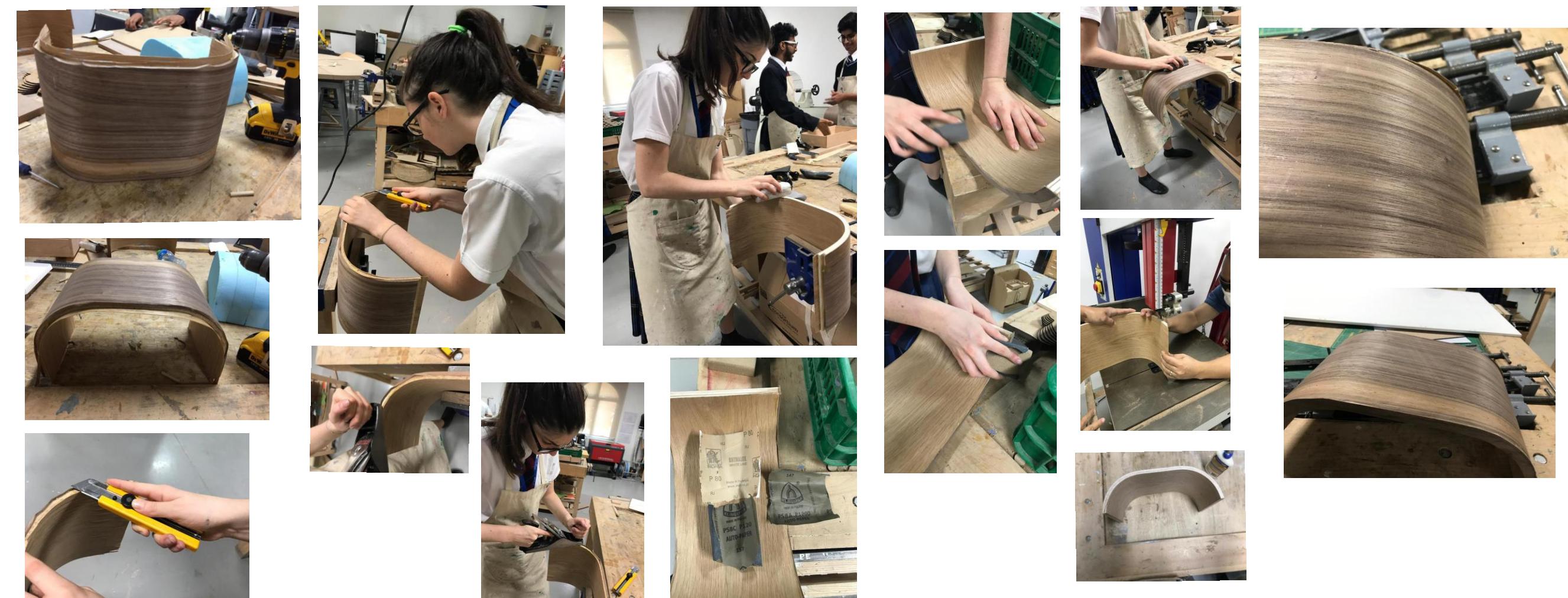
Step	Process	Tool and Machinery	Safe Working Practice
16	I then started working on the holdable component of the handle. I took a piece of rectangular wood and then slowly used a jack plane to remove the edges so that then the piece could be used on the wood turning lathe. If the edges had been there, the chisel would have caught the wood and it could have spun out of control.	Jack plane	<ul style="list-style-type: none"> I continued to follow the safety procedures that I had previously used. This piece was quite tricky to clamp down because it had to sit with its corner up for me to cut down, however it was important that I firstly established a safe clamping position so that it wouldn't slip or move.
17	Once the piece has properly cut down, I placed it on the wood turning lathe and secured it tightly. Then, I turned the machine on and used a screw chisel. Really, I had to shrink down the handle to the correct diameter and work the handle to get a smooth finish, so I chose to use the screw chisel because it is the best tool to use for smoothing the spindle.	Wood turning lathe Screw chisel	<p>Injuries with the screw chisel are quite common, and the lathe itself can be dangerous if not used correctly. So I made sure I:</p> <ul style="list-style-type: none"> Always a safety mask protection when turning wood. Because splinters or wood pieces might break apart and fly round. Made sure my chisel was clean and sharp before using. Dull tools can catch on the spinning workpiece, while razor sharp tools will cut smoothly and easily. Inspected my lathe regularly to guarantee that the fittings are secure and tight. Held the chisel properly and made sure I controlled it properly by keeping a firm grip and slightly turning it before moving it.



Step	Process	Tool and Machinery	Safe Working Practice
18	I then used superglue and an instant-dry-spray to glue the copper strips to the handle. I marked out where I wanted the copper strip to be with a pencil and clamped it to the table. I made sure to only add a few drops of superglue because it is very strong and hard to remove from both hands and wood. Once I had glued both copper strips, I let the handle sit to make sure it was properly attached.	Superglue Instant-dry-spray	<ul style="list-style-type: none"> ○ The spray might have been toxic, so I kept both hands and face away from it at all times. ○ Fortunately the room was well ventilated, because breathing the superglue fumes can be dangerous. ○ I made sure to not touch the piece until it was dry, because I did not want to get superglue onto my fingers as removing it requires acetone and a lot of time.
19	Finally I stained the beech so that it matched the walnut veneer of the bag. I applied the wood stain with a cloth, I chose to use a rag rather than a brush because it is much more efficient to wipe stain onto wood than to brush it. To make sure the stain applied evenly I made the rag wet and made sure to wipe it up and down homogenously.	Walnut wood stain	<ul style="list-style-type: none"> ○ Firstly I had to avoid getting the stain onto my clothes and hands – so I wore an apron and gloves while applying it. ○ I tied my hair backwards to keep it from getting onto the stain. ○ I washed the rag once it had been used and kept it away from machinery as the stain makes the rag highly flammable.



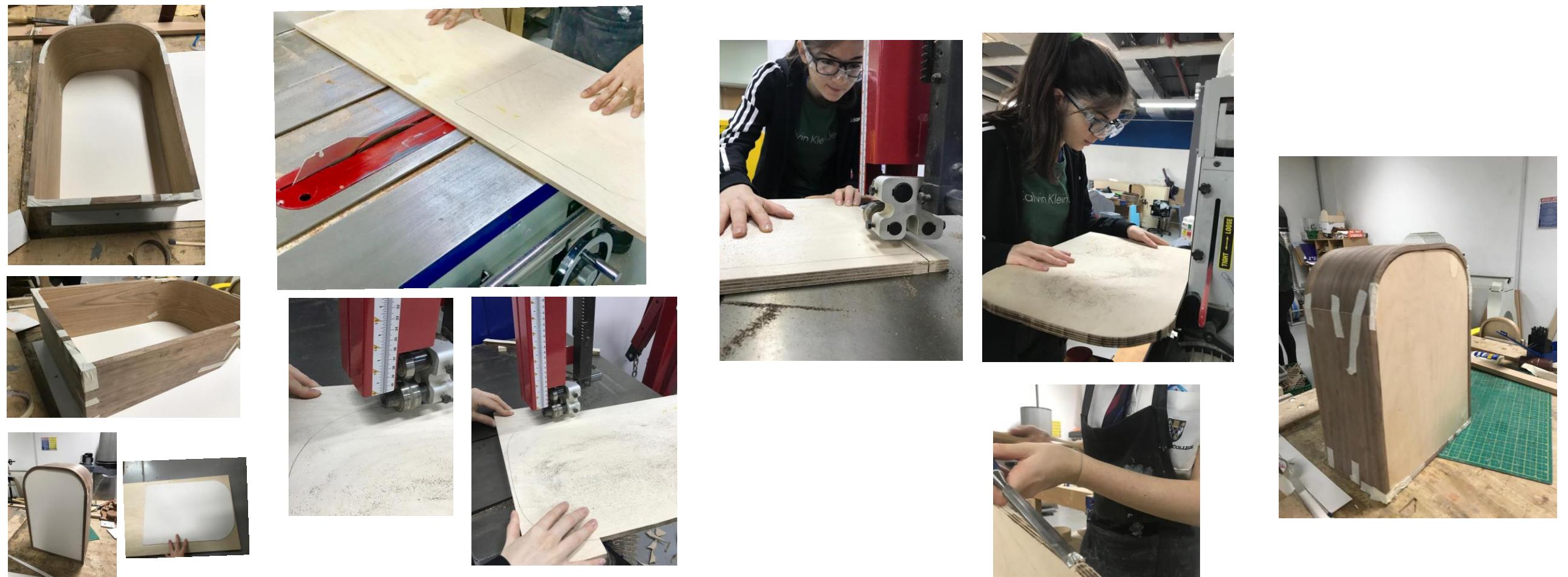
Step	Process	Tool and Machinery	Safe Working Practice
20	The veneers had now finished gluing. I had made the veneer be 2 extra cm in all directions so that I'd then be able to use a plane and cutter to result in a flush cut. Now because there was a lot of extra veneer, I removed large chunks with a board cutter. Then, to remove the remainder of the excess I used a plane. Because the shape is curved, I had to go slowly and make many straight cuts with the plane.	Jack plane board cutter	
21	The inside and outsides of curve had some glue on them, so using a different range of sandpaper grain, I sanded it off – the outside is of a more rigid veneer than the inside, so I used a slightly coarsest sandpaper for the outside. I also sanded the sides too, with a 80 p sandpaper since I had to remove glue and any remainderveneers. When I sanded, I of course always made sure to sand along the grain	80p, 1200 p, 1000p sandpaper	
22	When I made the mold for the curve, I make it 2 cm bigger. So I used a bandsaw to cut down on the size the flexiply. Because the veneers on the inside were quite fragile, I had a technician guide the piece alongside me – and looked over to make sure I was cutting it properly.	Band saw	<p>In order to safely use the bandsaw:</p> <ul style="list-style-type: none"> Wear safety goggles and a mask, because the MDF was releasing a lot of sawdust. I made sure that all guards were in place and properly adjusted. In addition, I checked that all band wheels were enclosed. Finally I adjusted the blade guard to a height of about 3 mm from the top of my curve. Made sure I kept my hands away from the blade.
23	I then cut two curved veneer pieces to cover the edges of the curve, which I thenglued on with PVA glue. This covered the unappealing grain pattern of the MDF.	PVA glue Board cutter	



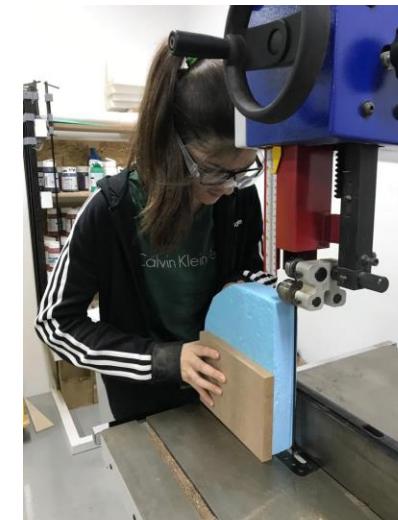
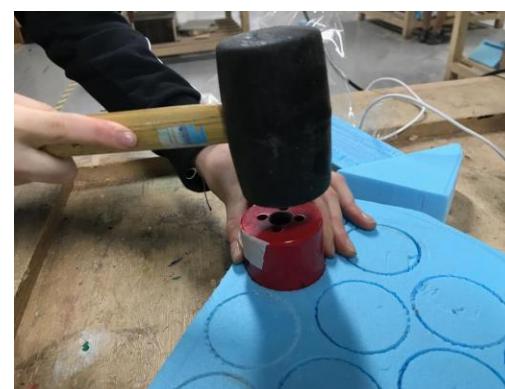
Step	Process	Tool and Machinery	Safe Working Practice
24	Now I wanted to glue two veneers onto the corrugated cardboard so that when the side pieces came together, I could cut it down to size. So firstly I applied PVA glue over the board. The veneer I had was not wide enough – so I had to glue two separate pieces and line the side grains with each other so that you would notice the two being separate. Because the curve was already made – I used it to establish the basic size of the board.	PVA glue Board cutter	
25	I placed the veneered board in the bag press to glue properly - where it stayed for approximately 5 hours.	Bag Press	
26	However, once the board came out, I could see that it was bent. As you can see from the pictures, the inside is thinner than the outside – so the board was compressed inwards. This told me that the board could not withstand the pressure of the bag press and that pressure does not apply evenly to it (so it might not be able to resist other forces, thus it is unsuitable) – so I decided that I'd simply use a thin slice of MDF.		



Step	Process	Tool and Machinery	Safe Working Practice
27	I realized that when I had cut the shape out for the corrugated cardboard I had found it difficult to mark out the shape exactly. One of the reasons for this is that the thickness of flexiply available was 4 mm off the thickness of the MDF, which mean that the MDF was slightly thicker than the flexiply. When I would make the real thing, I would then purposely buy boards of the same thickness – however for the purposes of the prototype, it would be too difficult to cut down on the plywood without generating unwanted waste (sustainability problems) and loosing precious time. To account for the step, I taped together the outside components of the bag and used a sharp pencil to mark out on paper the outline of the inside of the bag (as the board will fit inside).	Sharp Pencil Tape Paper	
28	Then, I copied the outline onto MDF and used a table saw to cut down the basic flat shape around it. I chose to use the table saw because it makes straight cuts very quickly.	Table Saw	Previously mentioned
29	Then, to make the curved cuts and remove some extra MDF from the flat sides I used a bandsaw.	Band Saw	Previously mentioned
30	To polish the edges and make them smooth, I used a sanding machine, this also helped curve the shape nicely.	Sanding machine	<ul style="list-style-type: none"> I tied my hair to prevent it from getting caught in the machine. I wore safety goggles so that no flying debris could get into my eyes. I kept my hands away from the sanding paper at all times.
31	To guarantee the MDF board fit as nicely as possible I used a chisel to clearly define the step between the curve and flat piece. I held the chisel firmly with one hand and used a mallet to remove excess.	Chisel Mallet	<ul style="list-style-type: none"> I clamped the piece to the table and made sure to hold the chisel properly, so that it went into the MDF. I looked carefully before using the mallet so I would not injure y fingers.



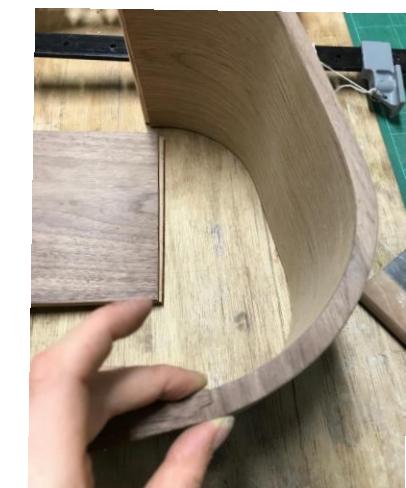
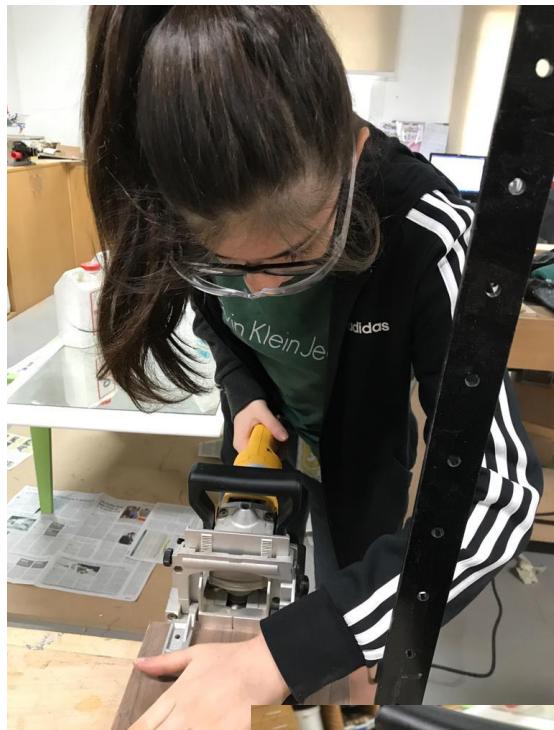
Step	Process	Tool and Machinery	Safe Working Practice
32	However, now that I was using MDF the bag would be much heavier. So, I decided I would hollow this MDF board too. The problem was that the paperback veneers were not enough to cover the entire surface. However some regular walnut veneer was available. So, I realized that to prevent the MDF from caving in I could fill the holes with foam. To make the holes I firstly cut the 25 mm shape out by using a hole saw. I placed the hole saw over the foam and then used a mallet to push the saw in – thus creating the shape onto the foam.	Hole saw Mallet	<ul style="list-style-type: none"> I kept my hands away from the front of the hole saw (where the mallet would hit) but also kept a firm hold of the hole saw so that it was kept in place.
33	The hole saw allowed me to make deep marks, so when I passed the foam through the band saw, the circular pieces popped off and were ready to be used.	Band saw	<ul style="list-style-type: none"> Since the piece was quite thin, I used a wood block to accompany my hand – so that it was kept away from the blade.
34	I then used a pillar drill to cut out 25 mm holes into the MDF with a flat bit, once I had done that, I placed the foam into the holes and glued it inside so that it would not move.	Pillar drill with flat bit	
35	I finally cut the veneers, the same way I had done for the cardboard (using two pieces of veneers and joining them together in the middle) and glued them onto the board. I then placed everything into the bag press.	Cutting knife Bag press	



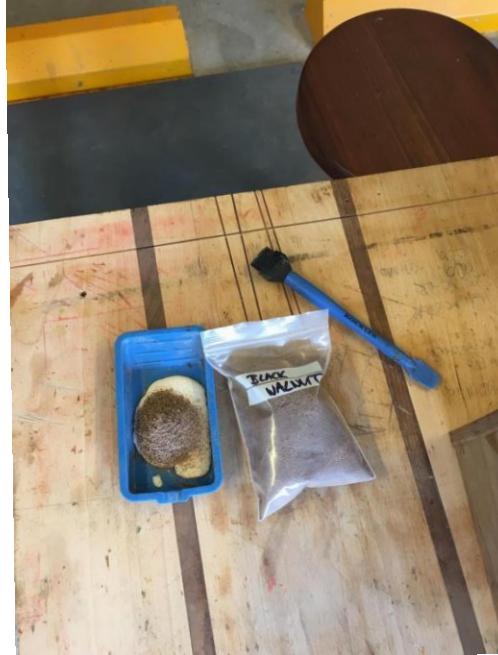
Step	Process	Tool and Machinery	Safe Working Practice
36	After the back piece finished gluing, I removed excess with a cutting knife and then used a round sanding block to remove the excess. Because this sanding block is circular and rotates anticlockwise, I always sanded on the left side because there the sandpaper went downwards. Had I done it on the right, and the veneers might have come off.	Cutting knife Round sanding block	
37	To make the edges very flush, I used 80p sandpaper to completely straighten the edges.	Sandpaper	
38	Since the MDF was covered by two veneers, there was some overlap in the middle, which I removed by using a random orbit sander	Random orbit sander	A lot of the safety regarding the orbitsander concerns the handing. So, I always ensured that: <ul style="list-style-type: none"> • I had a firm grip on the handle of the sander before I turned it on. • When the sander was on the piece, I had to always keep it flat and constantly moving. • I also made sure to not press down on it when sanding to not damage the veneers. • When I finished using the sander, I lifted it off the wood, turned it off and waited for it to stop spinning before storing it away.



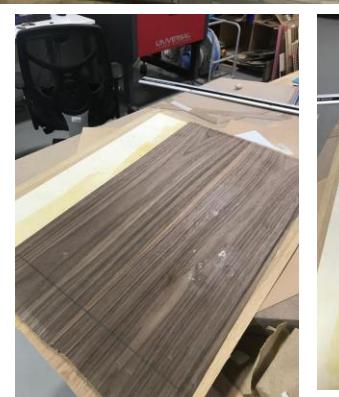
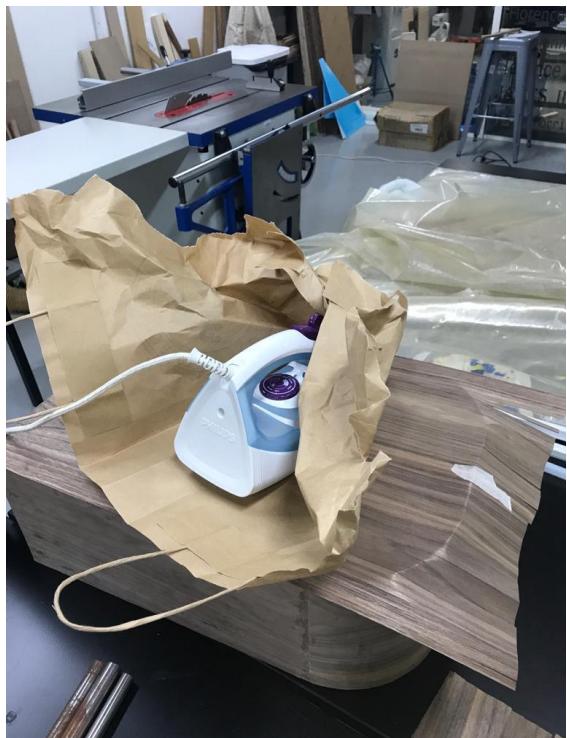
Step	Process	Tool and Machinery	Safe Working Practice
39	Now that the backpiece was made, I started working on the attachments for the frame pieces so I could put them together and attach everything. I firstly started working on the biscuit joints for the sides and the backpiece. To connect the sides to each other I cut out two holes on the interior of the long piece and side of the shorter piece so that the shorter piece would fit inside the sides. To make the cuts to connect the back to the frame I marked 4 holes along each side of the frame and repeated the process for the back piece. I marked out the places where the joints would be respectively on one side using a tri-square. Then, I took the other piece that had to be connected and I marked out the corresponding places so that it would all fit. I aligned the center notch on the plate jointer with the center mark on the boards to be jointed. I also allowed the centering stop to rest flush on top of each board I jointed. Then, I switched on the cutter and pushed it in to create the holes on both sides. I had now made the biscuit joints.	Biscuit cutter machine	To use the biscuit cutter safely I: <ul style="list-style-type: none">Secured the planks to the table attempting to make the cut, this ensured that the plank does not move and ruin the joint.I had to have a firm grip on the plate jointer and hold it with both hands before turning the switch on. Otherwise it might start off unstably.
40	Next, I made the lap joints between the curve and flat sides. I marked out the materials to cut on one side and used a band saw to cut the wood off. However, since I wanted the other side to match exactly, I now marked it in correspondence to the cuttings of the first and then used a tenon saw to cut the wood block out. This allowed, for me, more precision and accuracy.	Band Saw Tenon saw	
41	Now that all joints were cut, I added glue to each joint and fixed them all together. To hold the frame still while the pieces dried, I clamped it all together.	PVA glue Clamps	



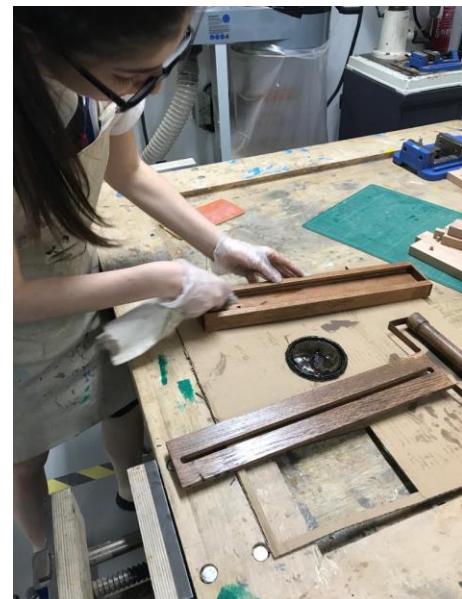
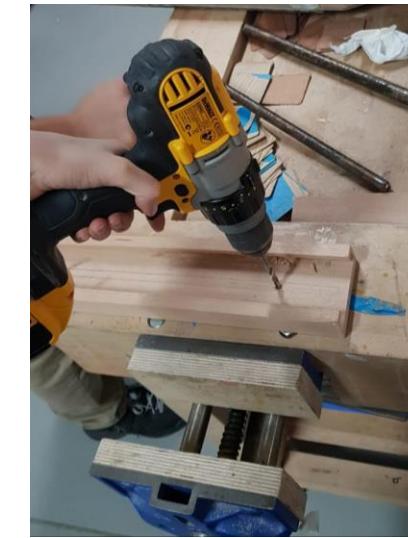
Step	Process	Tool and Machinery	Safe Working Practice
42	Now that I had both the frame and backpiece done and had cut the biscuit joints for each, I glued them together. I just added PVA glue onto all the edges of the backpiece and then I used my finger to run across it, guaranteeing that the glue was applied homogenously. I then inserted the biscuits. After I had inserted it into the frame, I used a rubber mallet to make sure it was fitted inside properly. I used a rubber mallet to not damage the surface.	PVA glue Rubber mallet	
43	I then clamped the frame and the backpiece so that they could glue properly without moving.	Clamps	
44	After the pieces had finished gluing, I saw that there was a small gap along the back frame because of the step. So, I got some walnut sawdust and mixed it with glue to create a wood filler I could use to close the gaps. I applied it evenly, pressing into the gap, before then dragging the brush perpendicularly to remove excess (which would have been trick to sand off). Once the wood filler had dried - I removed the excess with sandpaper	Walnut wood filler. Sandpaper	<ul style="list-style-type: none"> I made sure that my hair was tied back so it wouldn't get dirty with glue or wood filler. I made sure to keep the table clean, otherwise other parts of the bag might get dirty.
45	Personally, I didn't like the frame around the back – plus there were still remnants of the wood filler. The cover would sit in the front, covering the sides, so I thought that it would make more sense to re-veneer the back to also cover the side. If I'd also put the MDF across the sides beforehand, it would have added weight to the bag. So, I placed PVA glue and cut out a layer of veneer for the top		



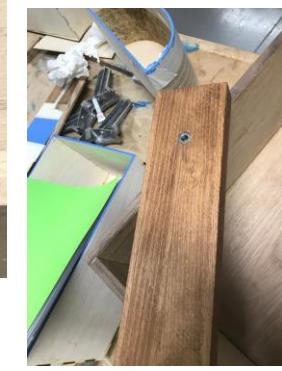
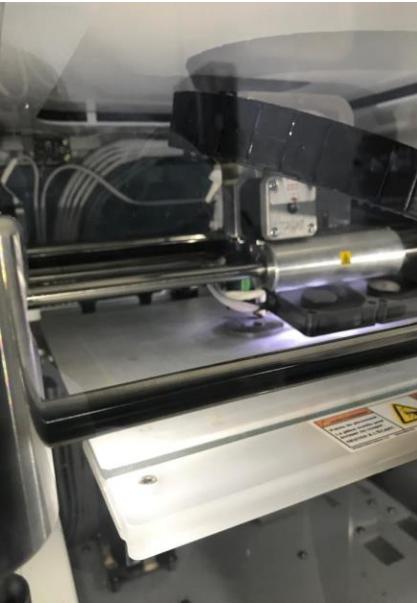
Step	Process	Tool and Machinery	Safe Working Practice
46	I couldn't place the bag in the bag press again as I feared the great pressure might indent the sides and parts. So, I used heat to press down on the glue uniformly so that the veneer dried evenly to the back. I covered an iron with a paper bag to prevent the great heat from possibly damaging the veneers and also to prevent any glue from getting onto the iron.	Heat pressing	<ul style="list-style-type: none"> I made sure to never touch the hot surface of the iron. When the iron was on, I also made sure not to leave it in the same area for too long. Once I had finished using it, I switched it off and moved it to the side so people wouldn't accidentally touch it.
47	I then cut the extra veneer off and gently sanded the edges to remove any excess.	Cutting knife Sand paper	
48	Since the back and sides were finished, I began working on the front lid. Firstly I glued on a 3 mm MDF board a slide of veneer for both the front and back. I placed the parts of the bag that had already been glued on (back and sides) to draw an outline for the front with a sharp pencil. I finally cut this outline using a band saw.	PVA glue Bandsaw	
49	To make sure the edges of the front were flush with the rest of the surface, I used tape to place it firmly on top of the rest of the bag. I then sanded off any little extra mdf until it fit perfectly on top.	Sandpaper	



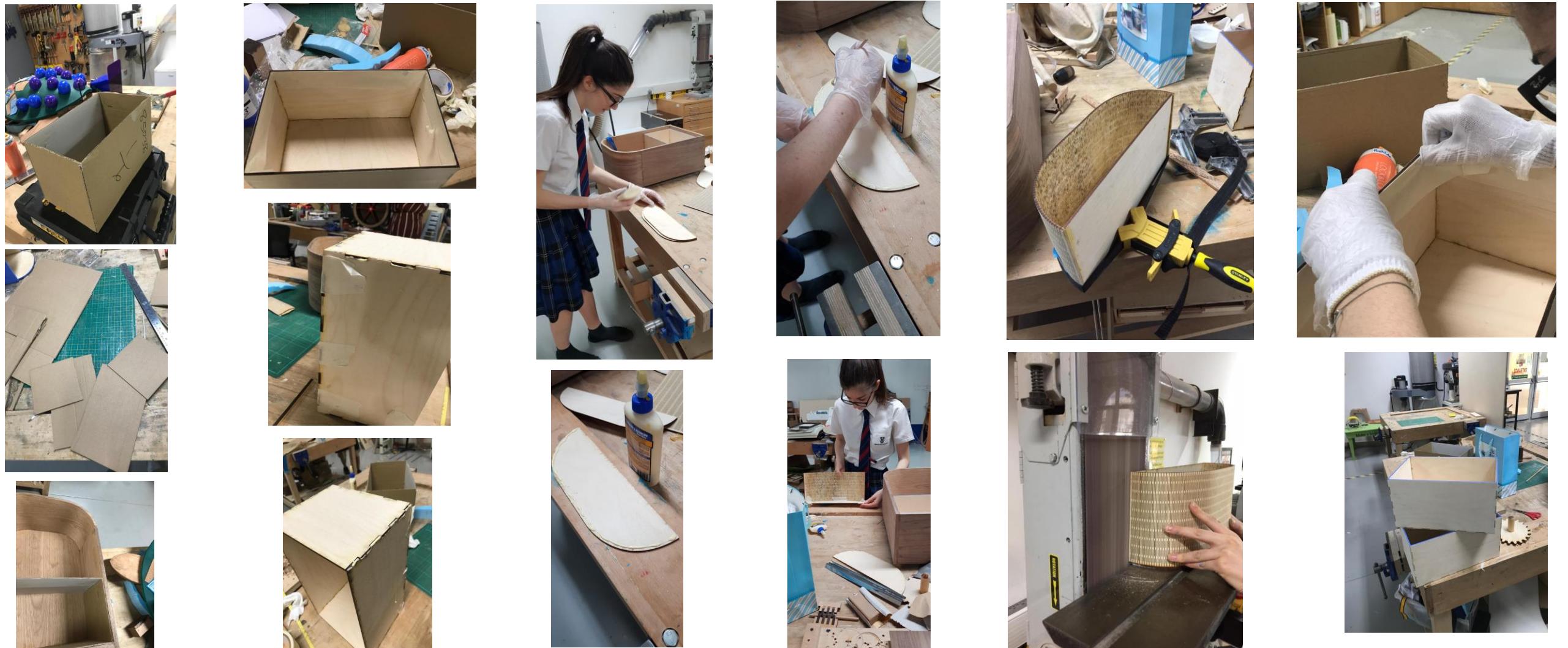
Step	Process	Tool and Machinery	Safe Working Practice
50	Now, for the actual bag all that was left was the gear system – whose components were then being laser cut. Therefore I began working on setting up the handle. In my original design, I didn't consider how the handle would be kept stable, however I realised it needed a guard container around it to prevent it from wobbling around while the user is carrying it. So, I cut out a beech plank and glued two beech planks to its side. I chose beech because it is strong and widely available in the workshop.		
51	I placed the handle inside it and noticed that the copper joint with the beech didn't fully fit in, so using a chisel I had to cut off some of the inside part so that the handle would be able to slide in. Then, whilst the handle was still inside, I marked out the handles hollowed insides and traced it onto the guard. This was because it would help me figure out where to place the screw in which would be used to keep the handle from sliding. I chose a hole near the top so that as much of the handle was used which meant it could be placed higher. However if the handle stopped at the very edge of the guard rail – I noticed it would wobble about. So, I reached a compromise, placing a dot about 4 cm before the edge.	Chisel	
52	Once the dot was marked, I used a 4 mm drill bit attached to a hand drill to cut a hole into the guard	Drill bit	
53	Now that the basic parts of the guard rail were done, I stained it using a walnut stain to fit in with the exterior veneer.	Walnut stain	



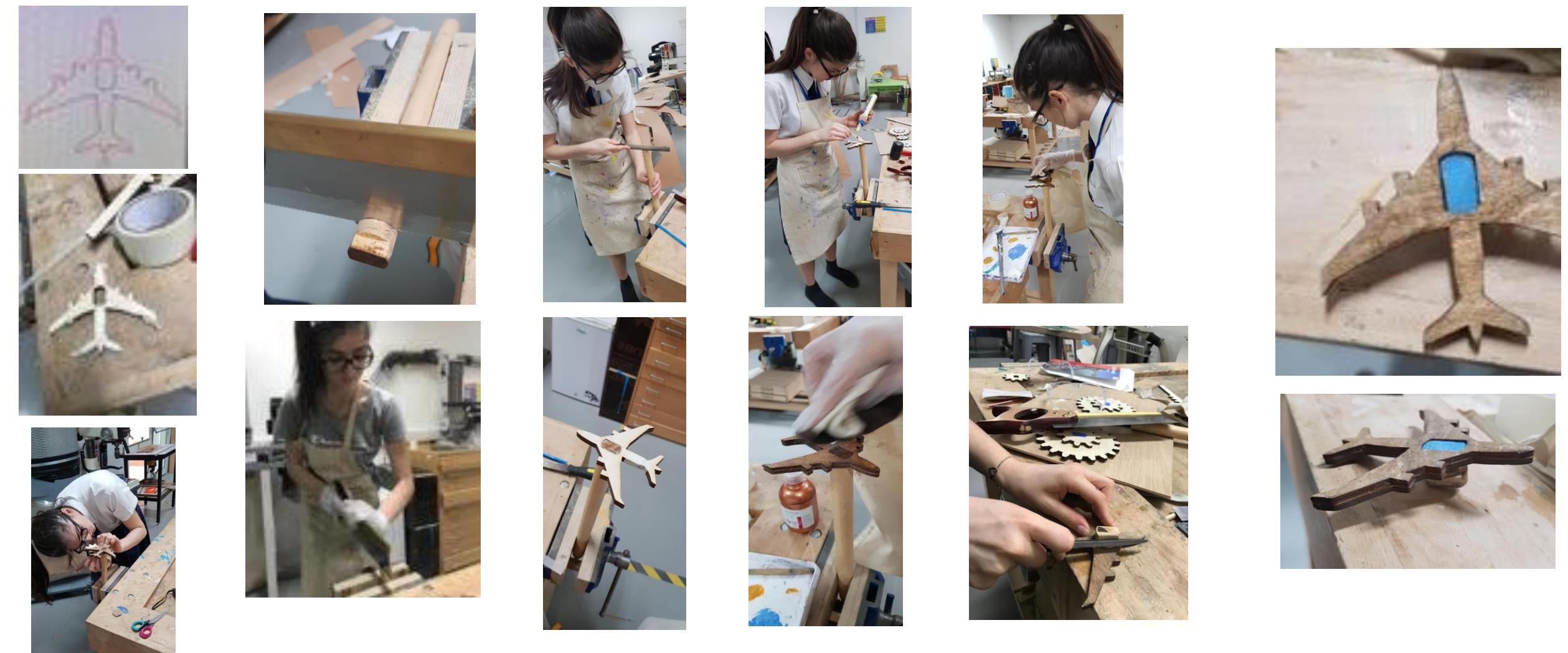
Step	Process	Tool and Machinery	Safe Working Practice
54	Next, I loaded the STL file onto the 3d printer and have it print out a 3d plastic model of the container where the map (which was laser cut acrylic) would be placed in. The model is made out of thermoplastic filaments – this means it can be recycled and reshaped. Our 3d printer used a thread-like plastic filament (the feedstock), this was then liquified via heating and jetted through a nozzle. I used a two-part epoxy resin to connect the pieces together. I chose this as it is a viscous substance (meaning it can thus be applied easily) which hardens considerably –keeping the pieces together. The resin offers resistance to heat and chemical applications, so it retains a strong hold under pressure. However, epoxy is not very water resistant – fortunately the epoxy was to join the map, which would cover and thus shield it. I also fit in the screw as per design.	3d printing Laser cutting Epoxy resin	<ul style="list-style-type: none"> The heated thermoplastic in the 3d printer can sometimes be hazardous if there's a prolonged exposure to fumes from the materials. Fortunately, our workshop is adequately ventilated and there's a fire extinguisher always on hand. Epoxy is non-volatile – so it is not very dangerous, especially since I only used it in a small quantity. However, to be certain that none would get on my hands, I used some latex gloves. This means I wouldn't be able to accidentally ingest it or get it on some other unrelated parts.
55	Once the stain had dried (some hours later), I cut out a hexagon shape on the outside of the whole so that a screw that would hold the world map piece would fit flush to the surface. I used a chisel to make sure the edges were perfectly in line with the shape of the hexagon. Next, I screwed in the necessary screws to connect the map.	Chisel	
56	Next, I started gluing the handle onto the back of the bag. To do so, I used a ruler to find the middle of the back and of the handle. I then lined up the two so that the handle would be centred. I traced the shape of the handle onto the bag using a fine pencil, removed the handle, applied PVA glue (with a brush) and then placed the handle back on. To make sure the gluing was uniform, and the handle was properly pressed to the surface, I added a weight on top of the handle while it was drying.		



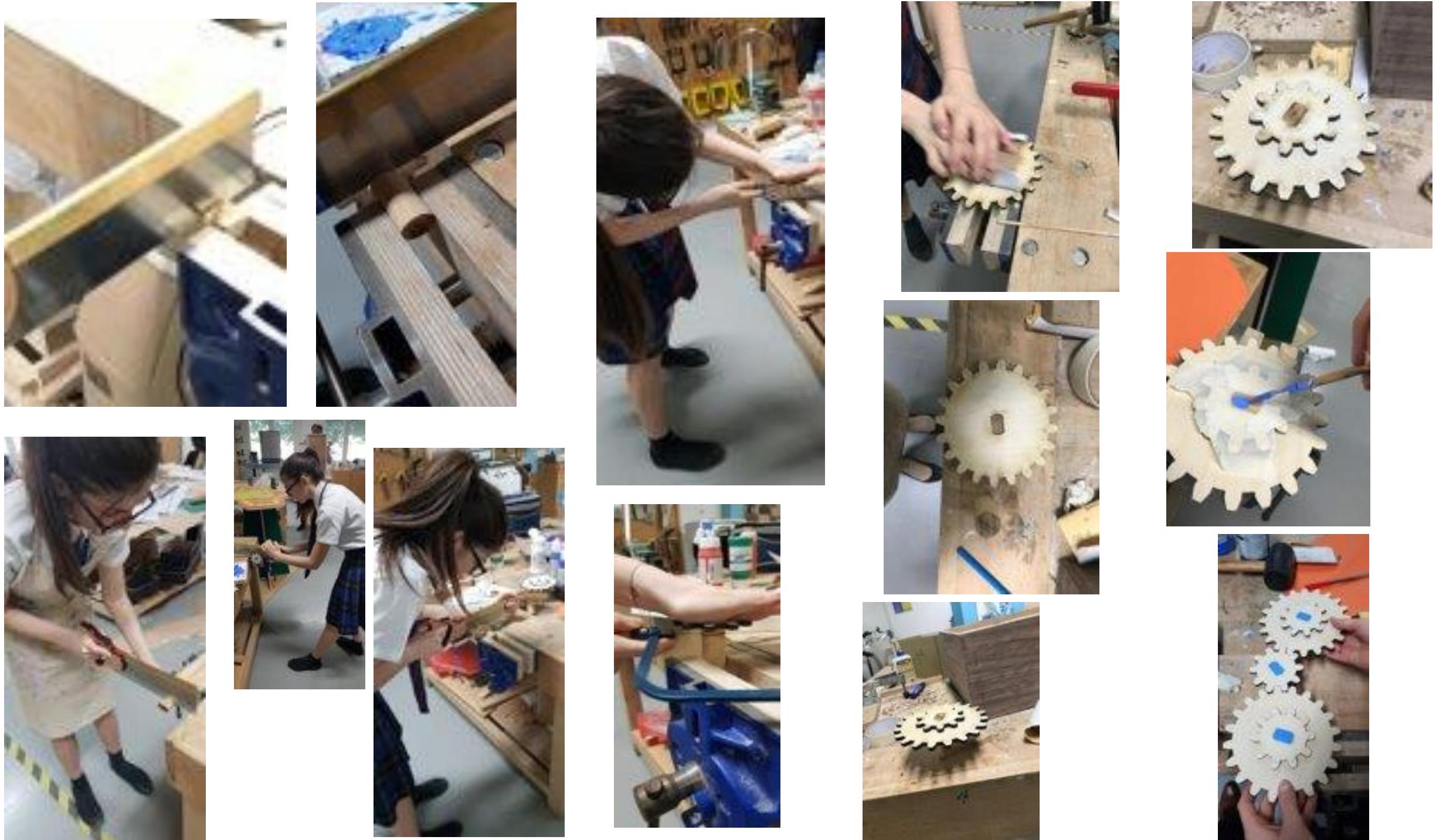
Step	Process	Tool and Machinery	Safe Working Practice
57	Next, I decided to work on the inside compartments. In my design, I had planned on making the slots out of cardboard. However after cutting and putting together a cardboard slot into the dimensions given by my design, I realized that it looked very cheap and that it easily broke down and got scratched. My inside compartments would be protected by the bag – however since you can only glue cardboard pieces together (and butt joints are very weak) there would be the risk that the cardboard broke or disconnected during the trip – which would make re-packing difficult. So, I decided to use laser-ply instead. This is because laser-ply was the lightest out of the timbers we considered and will not be scratched or break apart easily. In addition, the laser-ply will be able to be cut so that it can curve. In addition, it looks much nicer. Nonetheless, I didn't want the cardboard box I had made to go to waste – thus I used it to make sure the dimensions I had given it were accurate and fit inside the bag. I then laser cut the laser-ply parts, they'd have biscuit joints connecting all 5 sides so that the bag would be able to long strongly together. I used tape to keep all the pieces still while the glue was drying.		
58	I then made the curved slot, I used flexible laser ply to make the bend, which was connected to the sides and bottom via butt joint as any other joint is hard to make on a curved surface. The other flat parts were joined to each other via finger joint. The bottom was made of two parts which glued on top of each other. The first part was large and acted as the base upon which the side pieces would be glued on, the second part was shorted by the thickness of the side pieces, so it slotted inside the box. This meant that it was more secure and stable, the box would not collapse inwards. I used clamps to keep the box in place while the glue was drying. I then used a sanding machine to sand off the front flatside slightly so that the box would fit inside the bag.	Sanding machine	
59	According to my specification, blue is a needed colour. I decided to paint the blue frames of the boxes which would be seen when the bag is firstly opened. However I did not want to accidentally paint or colour the rest of the box, so I used tape around the box edges to make sure that any paint spills would stain the tape and not the box. Then, I mixed together some blue and white to create a vibrant but rich colour. I used a small paintbrush to apply this colour and then left the boxes to dry.	Painting	<ul style="list-style-type: none"> The paint I used was non-toxic, however it is still good to keep it off the skin as much as possible and not consume it. So, I wore gloves and an apron to make sure no paint would get onto my clothes and/or skin. Because the paint was non-toxic and the room was adequately ventilated, I didn't have to wear a spray respirator. I made sure to keep away from possible electric outlets as paint is flammable.



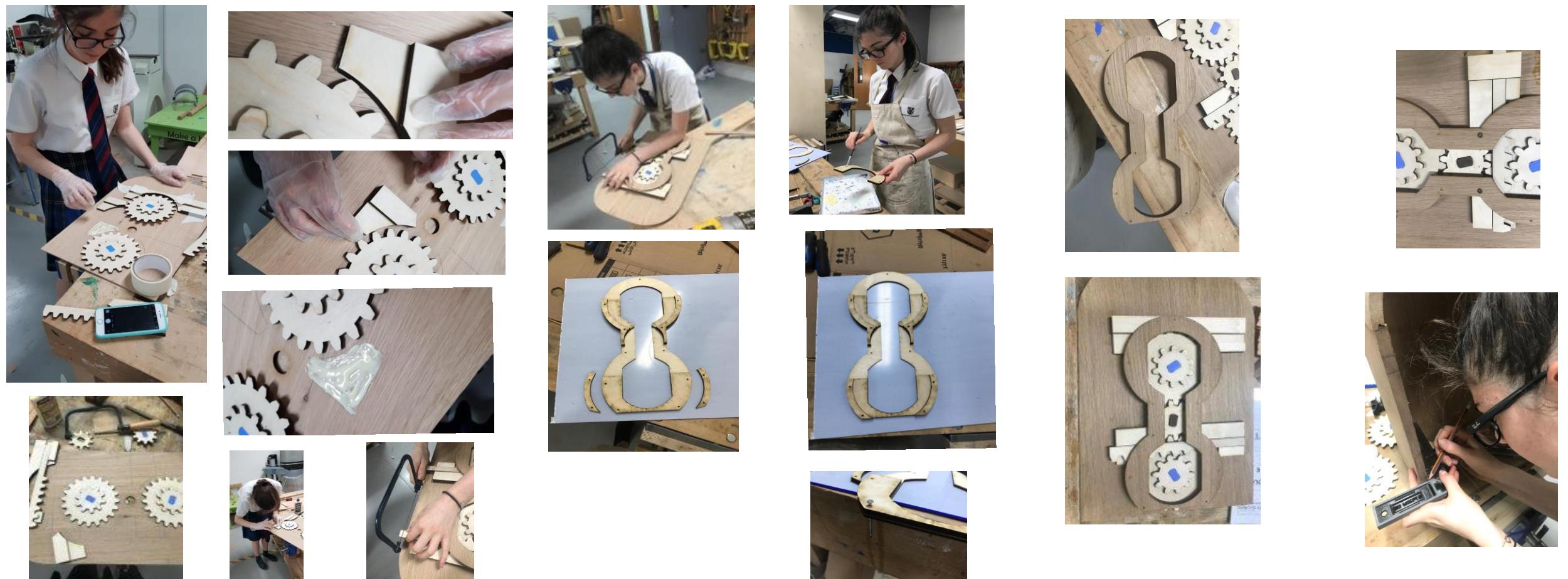
Step	Process	Tool and Machinery	Safe Working Practice
60	I then started developing the gears. I began by laser cutting the different pieces from the CAD I had created of the gear system. I firstly started working on the central piece – which would be the airplane which was connected to an idle gear on the back of the front cover. All the gear pieces including this one have a quadrilateral hole where a dowel fits in – this makes the connection between the two stronger. However, the dowel needs to spin, so its spinning part has to be a circle. So, I had to cut the quadrilateral shape onto a dowel with a height equal to the thickness of the gear it would insert itself in. So, the part just below the gear would still be cylindrical and would thus be able to spin. So, I got a 9 mm dowel and marked a line based on where the thickness of the plane ended if I placed the airplane at the start of the dowel. Then, I placed the airplane shape on top of the dowel, and I marked out its quadrilateral shape onto it. Then, I used a gentleman saw to cut down from the lines I had just drawn to the lines that determined the airplane's thickness. I used a gentleman saw because I wanted a flush and accurate cut so that it would fit in perfectly with the airplane.	Laser cutter Gentleman saw	
61	To make sure the edges were smooth throughout, I filed them.	File	
62	Then, I glued the plane to the dowel using PVA glue and a brush. Once this had dried, I used a walnut stain to give the plane a nice stain that fit in with the bag.	Staining	
63	The middle gear is the hardest gear as it has a quadrilateral shape on each side (one to connect the dowel to the airplane, the other to the idle gear). So, I needed to cut out a joint on each side. I measured the thickness of the front and then drew a line on the dowel, on the line I placed the idle gear to record its thickness. I repeated the process illustrated in step 60. I didn't glue in the idle gear yet because I obviously needed to place it on the front cover first.		
64	Finally, I decided the front cover would have a touch of blue - I received positive feedback on the blue I used for the boxes. So I painted the middle piece of the airplane blue.	Painting	



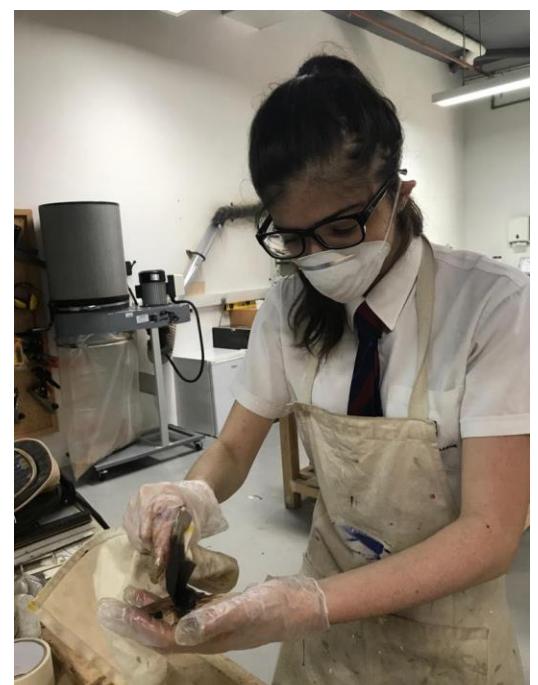
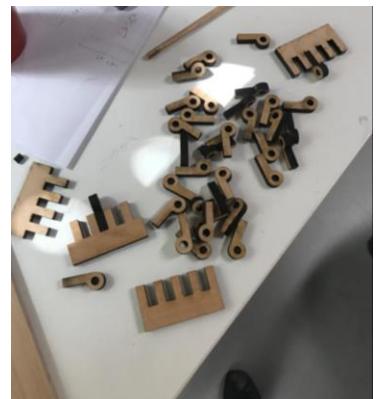
Step	Process	Tool and Machinery	Safe Working Practice
65	The rest of the gears were cut in the same manner as shown previously. With the exception that since they were a double gear system, the quadrilateral shape cut onto the dowel was deeper. In addition, before I glued the gear pieces and dowels together, I had to sand the gears off as the laser cutting had left some burn marks. The gears were quite bit, so I used a coping saw to cut out some of the dowels because it made it easier to change directions of the blade and cut 90° to the dowel	Sanding Coping saw	<ul style="list-style-type: none"> The coping saw's blade gets quite hot, so I had to avoid touching it after its use. I also checked that the coping saw was in good conditions before using it – I checked that it didn't have splinters or a loose blade.
66	Then, I decided I'd also pain the center of the gears blue in accordance to the specifications. I used the same method I had used to paint the boxes, I put tape around the gears and then applied the white and blue mix with a paintbrush. Once the paint had dried, I removed the tape.	Painting	



Step	Process	Tool and Machinery	Safe Working Practice
67	Now that the gears themselves were done, I started attaching them onto the front cover. I firstly had to drill 3 holes using a hole saw connected to a pillar drill - these corresponded to the 3 gears.	Hole saw Pillar drill	
68	I then started to draw the position of the various gears and nonmoving parts onto the back of the front cover, and then glued on the nonmoving pieces and placed the gears inside the holes to make sure they fit, and that no extra part of the dowel came out. The sliders of the gear were of different lengths, so before placing them I had to cut the longest down using a coping saw. The gears were now set up.	Coping saw	
69	I didn't want the gears to get stuck with any of the contents of the bag – so I created a protection laser ply cover I would place onto the gears which I cut using a laser cutter. This cover was made of 8 pieces, which had to be glued on properly so that their respective holes aligned. Once I had applied glue onto the pieces and placed them in their designated location, I placed a screw in each hole to make sure that they were matching and that the screw could pass through. After so, I glued on laser cut veneers that had small holes for the screws.	Veneering	
70	I then placed the protection laser over the gears and attached it to the MDF board via screws that were placed in the holes in the middle.		
71	Finally, I had to mark out and cut the holes for where the bars would go in that would keep the lid closed. used a tri-square to mark out straight lines perpendicular to the flat side surface where the holes would be. Then, using a chisel I removed the wood from those holes and sanded them flush.	Tri-square Chisel	



Step	Process	Tool and Machinery	Safe Working Practice
71	I now began working on the hinges, according to my design they were to be butterfly hinges. I chose these hinges because they would also serve as a décor for my bag. I firstly laser cut all the parts. The hinge is made up of two pieces, which are connected together via a dowel. The pieces themselves are p-shapes and a finger joint where each of these shapes slots in. I firstly started by sanding off the p-shapes to remove the laser machine burn marks. I then added glue to each p-shape and attaching it to the finger joint. Then, I used a mallet to make sure there was no gap between the two.	Mallet	
72	To get the dowel to its exact length, I sanded it off by having it spin in a hand drill while I held sandpaper around it. Then, I inserted the dowel to fit in between the two pieces and marked the excess dowel, which I then cut out with a coping saw.	Sanding Coping saw	<ul style="list-style-type: none"> When sanding, I wore heat proof gloves to avoid my hands from getting burned by the friction.
73	Finally, I stained the hinge with a walnut stain	Staining.	



Step	Process	Tool and Machinery	Safe Working Practice
74	I now entered the final stages of manufacture and so I began varnishing my pieces. I could choose from two varnishes which I tested out on some veneer to see what type of gloss would result. I preferred the one on the left because of two reasons. Firstly, it was glossier and gave a sleeker result and secondly because the other one was water based – so it would dissolve with water (acrylic). According to my spec, the design has to be waterproof, so the varnish I chose will serve as an insulator too. I applied varnish to a cloth which I then used to coat the wood pieces (including the airplane and hinges). I used long, even strokes, and worked along the wood grain. After each coat, I would wait 24 hours for a complete dry. I applied 2 coats and small finishes.	Varnishing	<ul style="list-style-type: none"> I wore a face mask to prevent from breathing any fumes and from getting any varnish in my mouth I wore gloves to keep the varnish away from my hands I wore an apron to avoid getting varnish on my body or clothes.
75	I then varnished the insides where the gears were located. I didn't varnish the gears because I didn't want to compromise their torquing action, but I varnished the veneers surrounding them. To do so, I used a big brush and a small brush to varnish the smaller and less accessible spots.		

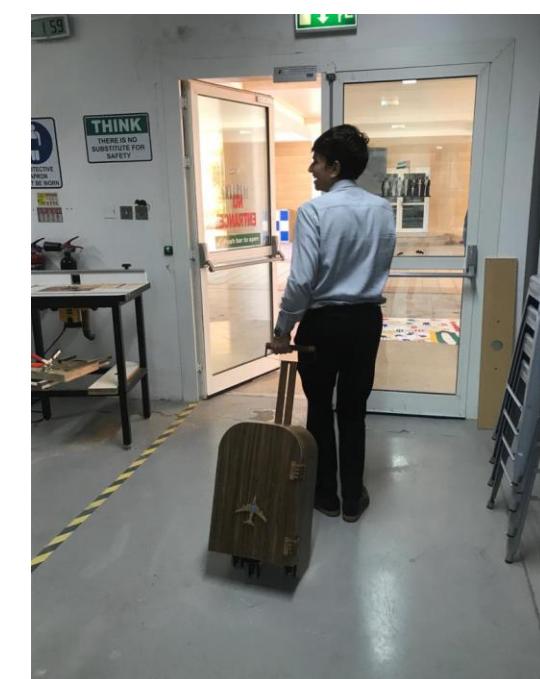
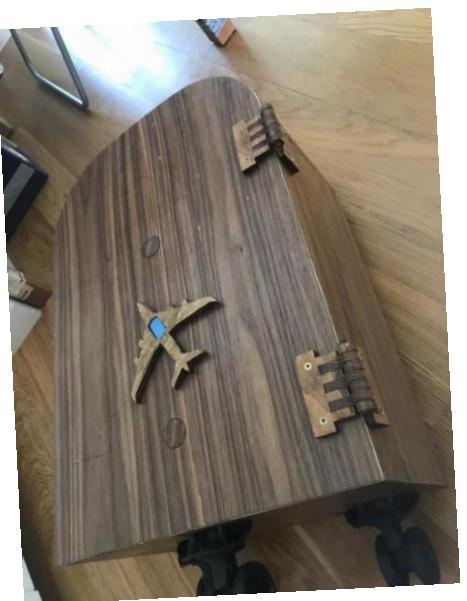
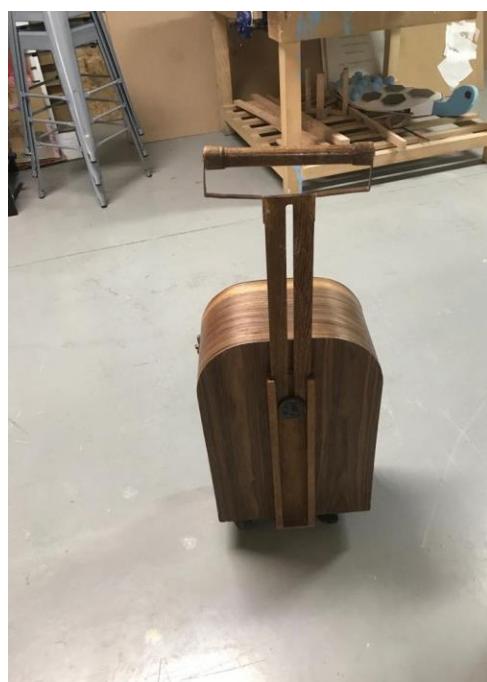
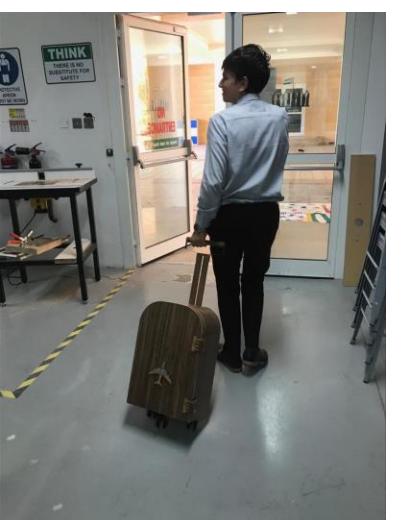
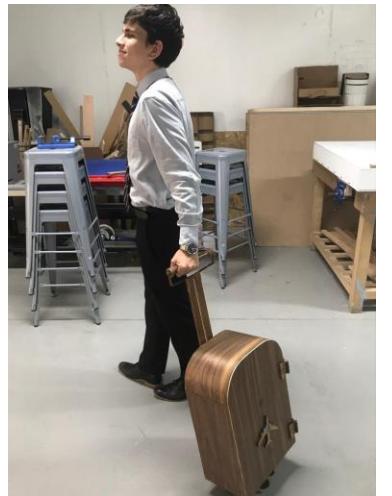


Step	Process	Tool and Machinery	Safe Working Practice
76	Next, I screwed int the wheels I had purchased. The wheels attached to the bottom of the bag via screwes, the screwes were then secured to the bag because on the other side of the MDF plank I placed a metal grid that came with the wheels that kept the screws still. I used a hand drill to drill the holes and then I screwed the wheels and screws in place.	Power drill	
77	Then I attached the hinges. I firstly glued them on and then added screws to keep them permanently in place.		
78	Finally, as shown in the pictures, to have the gears rotate I had to drill three holes onto the front cover. To cover the wood, I cut out 2 veneer circles which I glued on in line with the rest of the veneer grain when the gear was closed – the position it will most often be in. I then applied tape to keep the circles down while they glued.		



Photos of Final Design:

I also asked an 18-year-old college student to try out the bag



Testing the product:

The product was actually quite easy to carry via handle, and the airplane could be moved around to open the bag easily and without much difficulty. However it was stiff enough so that it would not accidentally come undone. The boxes were easy to slide into the bag, however because they had no handle it was a bit difficult to get them out. To fix it, I would attach a handle or a strip of textile I'd be able to hold on to push the boxes out. The bag is quite sturdy and strong, the gear system is protected so that it does not get stuck on items or clothes.

Quality and Accuracy of Product:

- The use of laser cut for the gears makes them very accurate and thus they work very well.
- The varnishing is done well on the inside and for the gears, but a further coat could have been applied to the back as there is a small unevenness.
- The bag can move via wheels in all directions – it can spin and turn.
- The materials used were all high quality

Life Cycle Assessment:

The life cycle assessment (LCA) is “a technique to assess environmental impacts associated with all the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling”. In the age where the consumers (especially those of a younger demographic) become more conscious of their own carbon footprint and products' impacts, a sustainable LCA is crucial.

One problem with the material sourcing is that the UAE lacks many of the woods and timbers I use, therefore I will have to ship the materials from Europe or India here. However, some materials I have used are recycled – such as wheels for instance. In addition, I mostly used MDF rather than hardwoods – meaning that my materials are recycled and do not add pressure to the dwindling European forests. Furthermore, the product is quite durable, therefore it will not need to be replaced. Once the client has purchased the bag, they will only need to buy slots. Finally, though the bag is strong the joints I have used are not impossible to separate – thus the bag can be disassembled and recycled once it has ended its use. Moreover, I have used acrylic – which is a thermoforming polymer – thus it can be reshaped if heat is applied to it, meaning it can be remodeled and re-used for different purposes. Finally, the product will be only shipped in the U.A.E., so it will not have need to travel far – thus reducing the carbon emitted by the transporting lorry.

User feedback:

I have asked a group of 21 college students to review the bag. They then took a poll and some also submitted feedback.

What they liked:

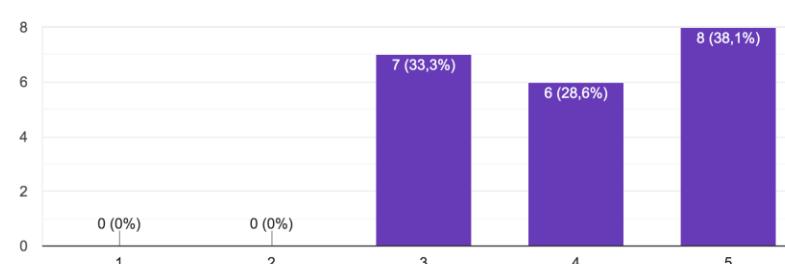
- Colour - "it was very simple, yet sleek – the glossy finish was quite elegant too".
- Gears - "it seems very inventive and creative"
- "The shape is quite cool too"
- I love the small decors too, like the airplane and world map. It adds a touch of personality"

What needs to improve:

- The handle was a bit weak – due to the copper, the handle was not very rigid, so it bends easily.
- The front cover has its MDF sides exposed (not veneered) this could result in moisture getting in.
- They were afraid that the gear might still get stuck on loose clothing if the bag was tossed around.
- Their laptop/books would be hard to insert in.

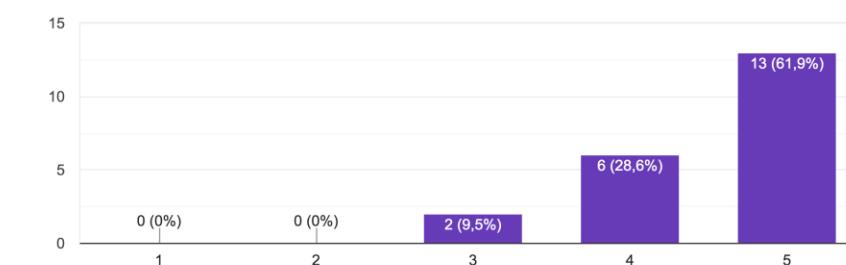
How comfortable is it to carry the bag via the handle and wheels?

21 risposte



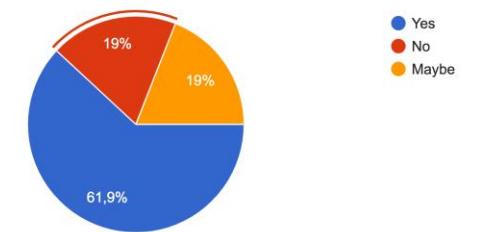
How satisfied are you with the appearance of the bag?

21 risposte



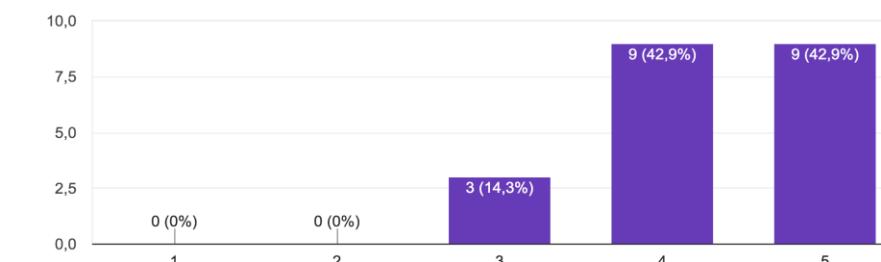
Would you buy the bag at a cost of around £100?

21 risposte



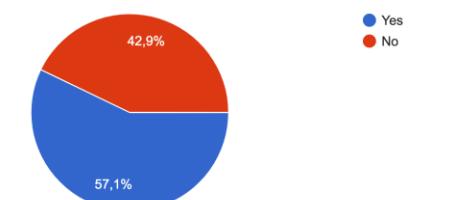
How easy is it to use the gear to open and close the bag?

21 risposte



Do you think there is enough space for your personal items?

21 risposte



From this poll I can see that the appearance and gear of the products are fine, and the incentive to buy the product is there. However, I would have to modify either the wheels or the handle to make them more comfortable.

Testing and Evaluation:

Specification:

A1. The product could have blue, green or purple colors

The product does contain blue colours on its front, insides (boxes) as well as the products that come with it (towels are blue)

A2. The size of the product must be under 25cm (width) x 35 cm (length) x 56 cm (height)

The size of the product is 20 x 35 x 49 cm

A3. The product should have a modern or cute style

Its sleek design and use of natural colours and materials falls under the 'modern' classification

A4. The design should be kept simple

The design itself is very minimal, with only two decorations – front airplane and the back map. The slots are bi-coloured and the colour palette is simplistic (walnut, blue, bare mdf, light veneer).

B1. The product must be mostly waterproof and immune to rot/insect attack

I decided that in order to test this out I would add water on one side of the bag and leave the other dry. After 3 hours, I removed the water and saw no changes to the bag. It had not seeped through and the veneers had stayed in place – they had not expanded.

B2. Product should have a compartment inside that is divided into sections to promote space-saving.

The bag has three slots, one is for the user's personal items, one for general utility items the user purchases and the third is for specialised gear for the location (beach).

C2. The product must be no more than 5 kilos of weight

The product weighs 5.2 kg



D3. The product must be resistant

My product will be often exposed to crushing forces from bags, therefore, to test if it was resistant, I placed two bags on top of it filled with books. My prototype resisted this force and came out undented and unaffected.

E1. The product should have a maximum of 4-5 materials as to make as little waste as possible and to lessen costs

- Oak
- Beech
- Copper
- Laser ply
- MDF

F3. Packaging should not use polystyrene

I have found a local company in the U.A.E. that sells corrugated boxes like the one shown in the picture that would just fit my bag. I will not be using any packaging material such as polystyrene or bubble wrap because the bag is resistant and durable enough to be safely transported.

G1. Production cost must remain under 100 pounds

- MDF – less than 2 m² of board used - £ 25
- Beech – less than 1m² of board used - £ 10
- Wheels - £ 4
- Laser ply – less than 2 m² of board used - £ 25
- Oak – less than 1 m³ of board used - £ 30
- Copper - £ 5

Total: £ 99

Specification Area	Specification Point
Form (A) - (Total points: 8)	A1. The product could have blue, green or purple colors A2. The size of the product must be under 25cm (width) x 35 cm (length) x 56 cm (height) A3. The product should have a modern or cute style A.4 The design should be kept simple
Function (B) - (Total points: 5)	B1. The product must be mostly waterproof and immune to rot/insect attacks B2. Product should have a compartment inside that is divided into sections to promote space-saving.
User Requirements (C) - (Total points: 9)	C1. The product should come in pre-built. C2. The product must be no more than 5 kilos of weight C3. The product should have a handle, gripping place or straps C4. The handles should be wider than 10 cm
Performance Requirements (D) - (Total points: 9)	D1. The product must be stable, and stand up straight D2. The product must be lightweight D3. The product must be resistant
Material & Components Requirements (E) - (Total points: 16)	E1. The product should have a maximum of 4-5 materials as to make as little waste as possible and to lessen costs E2. Materials should be environmentally friendly E3. Materials should be available in the workshop E4. Product should not have a plastic cover/surface that starches easily E5. Product should not have a four-wheeler E6. Product must be made mostly of wood E7. Other materials such as acrylic and nylon could be used but should be used in small quantities as they have plastic compounds which is bad for the environment.
Sustainability (F) - (Total points: 6)	F1. During production, as little waste possible should be produced. Materials should be accurately calculated. F2. Materials used in the building should be recyclable, as well as the packaging F3. Packaging should not use polystyrene
Scale of Production and Cost (G) - (Total points: 3)	G1. Production cost must remain under 100 pounds

Conclusion:

This prototype has overall been successful. The uniqueness of the appearance, materials and gears as well as its use makes it very attractive for my demographic. However, if I wanted to start manufacturing the product, I would need to modify the wheels and the handle to make them more comfortable. If I were to do it again, I would also increase the size of the client's personal slot by decreasing the size of the special items slot – when I was packing I saw that there was a lot of empty space in that one. I would also need to better insulate my bag to prevent dust or water from getting in.