

ELVIS LEE - 2482

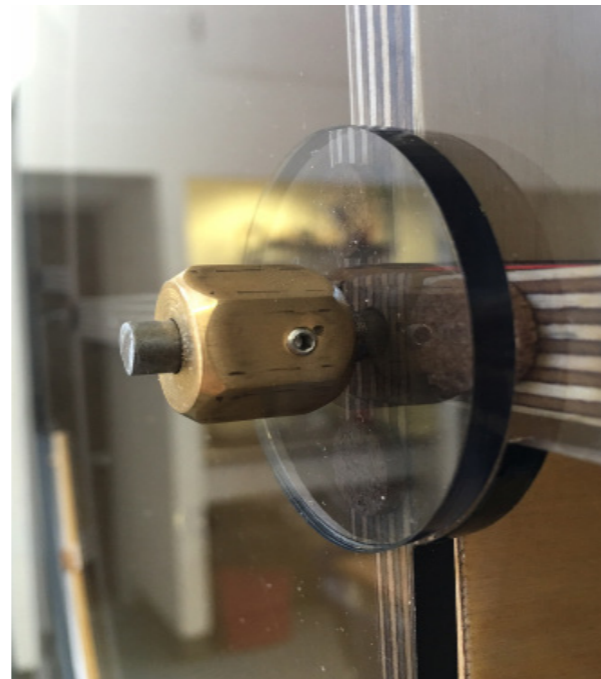
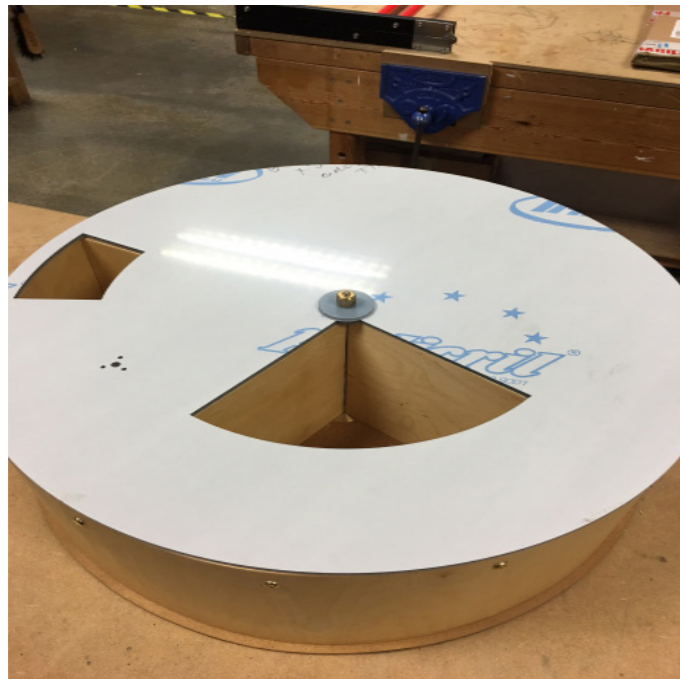
A2 - Commercial Design

Camera Cabinet

UPPINGHAM SCHOOL - 25176

Table of Contents

1	Problem Identification	19	Components and Industry
2	Interview and Market Research	20	Specification check & Final Design
3	Factor Analysis	21	Cutting List
4	Ergonomics Analysis	22	Production Plan
5	Materials Research	23	Production Plan
6	Product Specification	24	Gantt Chart
7	Sketch Idea 1	25	Manufacturing
8	Sketch Idea 2	26	Manufacturing
9	Sketch Idea 3	27	Manufacturing
10	Sketch Idea 4	28	Manufacturing
11	Client Feedback	29	Manufacturing
12	Product Review	30	Manufacturing
13	Specification Check	31	Manufacturing
14	Development	32	Specification Test
15	Development	33	Production plan Test
16	Modelling	34	Client Feedback
17	Modelling	35	Client Feedback & Finished Product
17A	Solidworks - 3D Orthographic drawings	36	Product Use Evidence
17B	Components and Orthographic Drawing	37	Life Cycle Assessment
18	Finishes and Processes	38	Modifications
		39	Bibliography



This sheet explains the general problems that the first or second client has. It identifies the areas which could be problematic to how you use to product.

Explanation of the Problem:

In the Leonardo Centre (Art and Design department) in my school, more specifically the Art department, there has been and there is still, a storage device for **Cameras** which can be borrowed by pupils for their projects and there is no method of recording who has **borrowed** which camera. There are also 3 larger sized and more expensive cameras which mean that **safe and secure storage** would be much more important to keep these expensive cameras safe. In the existing storage device, there is also no method of charging the camera batteries from the back end of the device. This means that the cables would have to be longer and curve around the existing storage device to charge the cables. This would also mean that perhaps some extension cables would have to be used.

Another problem would be the fact that it is much easier to accidentally **drop and damage** some of the cameras. This is because the storage space for these cameras may not be sufficient and if the cameras are not put back perfectly, they may have a chance of falling down and getting damaged, while also being a **safety hazard**. This would cost the department a lot of money and also wasted time to buy new cameras. Furthermore, the cameras will need a secure storage space which means a lock and a cover for the front.



The picture on the left shows the existing way of storing the products in the Common room or Staff room in the Leonardo Centre which is the Art and DT department of the school. Here, people can borrow a selection of 12 small Yellow cameras and 3 Larger scale Nikon Cameras. You can clearly see that there is **not enough storage space** for the cameras. Especially for the larger scale cameras, the biggest concern is that the most expensive cameras in the department get damaged beyond repair and require replacing which would cost a lot of money. You can also clearly see that the smaller yellow cameras on the top are bulging out of their containment. This is because the **case is larger than the width of the space that is given**. This is also another hazard.

The Existing Product and Problems.



Here is a picture that I have taken of the existing storage method of the larger Nikon cameras. As you can see, there is no space and the Nikon cameras are bulging out of their containment.



This picture clearly shows that the case of the camera **does not even fit inside the gap** that has been previously provided to fit the cameras in. This is a problem as the camera will easily fall out and be damaged.



You can also see here that the cameras that have been stored are very messy and the ones that have been borrowed have no evidence or knowledge of **who has borrowed the camera**. This means that it is much easier to lose the cameras.



Here is another problem with the existing product. There are 3 rows of cameras which mean 3 rows of signing out tabs. The tabs are quite low down and are difficult to write on for an average student. This means that the writing can be illegible and we will not know who has signed the camera out and therefore can't chase them up



Here you can see somebody using the product. The person is trying to put one of the cameras back into the slots that the existing product provides however the slot is not very large and it is evidently quite **difficult to put back** securely. There are also many loose cameras which are unstable and if the person accidentally puts the camera against another, it could cause the cameras to **fall down** and become damaged. Therefore a new and improved method must be thought of.

Research into existing product:



This is another example of a method of storing the cameras. This is an actual camera cabinet which has been made just for the purpose of **safely storing the cameras in a secure place** which can be locked up by the hinge and lock on the door and also the cabinet is quite heavy and that means that the cabinet **will not be able to topple** and damage the cameras. The storage inside has been separated into **3 sections so that the lenses or cameras can be in separate sections** and fit in quite well. I would also assume that there is some foam in the inside of the sections to add further protection.

www.amazon.com

Here you can see a device which would seem like a drawer which has lots of foam that will safely secure the cameras. The **foam also protects the cameras from sudden shock** which can happen if the drawer is opened too quickly or the entire drawer falls out because of pulling the drawer out entirely. The foam spaces are also tailored and made so that the cameras and their parts (lenses) **fit exactly in that space** which gives it the most **shock resistance and absorption**.



www.pentaxforums.com



lifehacker.com

This is a more travel heavy storage system. You can clearly see that the cameras have been put in **suitcases** which means that the people using this storage method would be travelling much more than others. You can see inside the suitcases that there is quite a lot of protection and **thick soft layers** in between each camera/lens. This would mean that the cameras will not be damaged when rolling the suitcase on bumpy roads.

Research: Interviewing and Market research

Primary Client

My first client is Nell, the Art technician of the Leonardo Department. She is in charge of organising the art projects of all the students and also therefore in charge of the cameras. She has identified that the camera storage at the moment is not the best and could be better improved. There is a very major lack of space and holes which the cables for charging could be put through the back. Because Nell is one of the people in charge of the cameras and she would be very beneficial to the progression of my project. Nell has been very helpful in the Art Department and she has gotten involved quite extensively with all the projects that the Art students have done in the past few years.



Date:

Signature:

Secondary Client



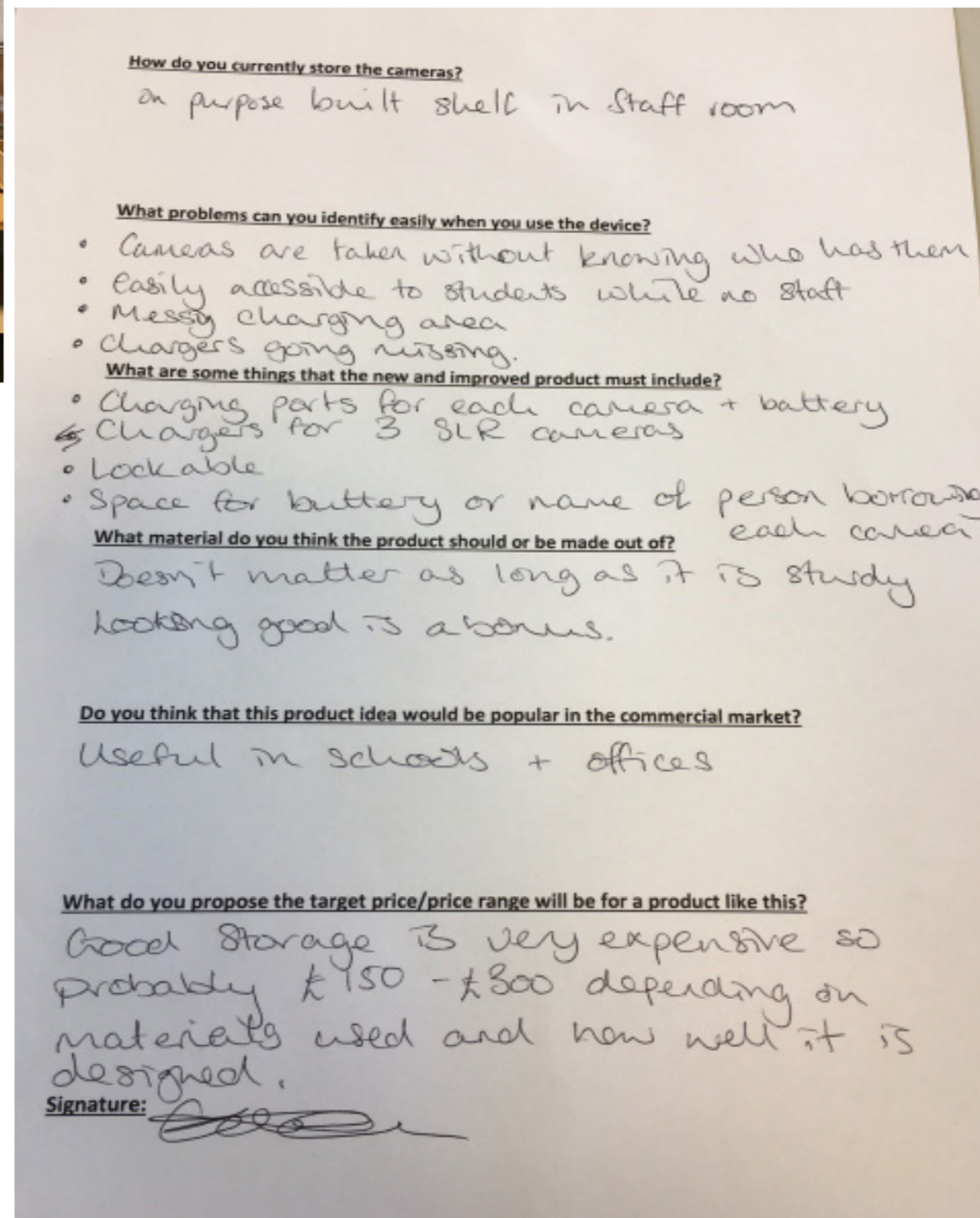
Miss Hallam is a very important Art Teacher at Uppingham School and she has students in her classes who have borrowed cameras from time to time. She therefore would have lots of experience with the cameras and can easily identify some major and minor problems with the storage device. As an Art teacher, she may also have some other ideas for the design of the product that could make it better or any different ideas for the appearance and aesthetics of the product. She teaches a wide range of classes within the school from 4th Form to Upper 6th.

Date:

Signature:

The Interview

For the First interview, I will be asking Nell some questions about the product that has been in use up until now and also **what problems there have been** from using the product. I will also ask her **what she wants in a new product** and questions that will help me develop more of an idea as to how my project will come together at the end. This will also help me in identifying what she wants the most and what she considers to be the **most important factors** in creating and designing a product like this. The purpose of this interview is also to get a general idea of **how large** the product is supposed to be, whether the product will be **hung on the wall like the existing product** or if it would be **freestanding** and perhaps have wheels which means that it may be much more transportable.



Summary of Interview

In Summary, I have found out and also reinforced my ideas on what the main ideas are for the product that needs to be made and also what the key things that the product must include. I have also learned that some of the product's musts, such as it **must be able to be charged from behind** so that once the cameras are in, you can keep them on charge until they are full or until the next person who wants a camera takes it. Another thing that is very key in the product that I have to make is that it **must be secure** and hence, the product must be lockable and so the cameras will be safely secured, therefore none will go missing and no students can just come into the department and take a camera without any member of staff present. Another very key point that must be thought about during the designing of the product is that there **must be a space for the 'buttery card'** this is the card that everybody uses to get into departments such as the Science school or the Leonardo Centre in Uppingham. This would therefore mean that everybody would have a buttery card and must bring it to the Leonardo centre to open the door. The use of the Buttery cards is also to make sure that the person who has borrow the camera can be identified and if it has gone missing, we can find out who it is and then charge the person for the price of the lost/damaged camera. I have also questioned the fact of whether the product should be hung on the wall or be freestanding. My clients have said that the product should be **hung on the wall** and be fixed to the wall, so that it will be easy to find and use. This will also mean that the weight of the product must be carefully considered and material types must be considered too.

Target Market

The target market for the camera cabinet will probably be people who would be using cameras quite often and would require a way of storing the cameras in a **workplace or at their homes**. This would mean either the person is quite interested in cameras and photography or they have work which includes lots of photography.



www.toysforhobbies.com



www.oishi-ele.co.jp-

The two pictures on top are the two most common designs for storage of Cameras. the picture on the left has wheels which means that the camera cabinet can be moved around quite easily. The cabinet on the right has no wheels but has plastic friction pads which would stop it from moving/toppling.

Factor Analysis - The factor analysis is a method used to show the importance of various aspects of the project and to show the key factors relating to the design product. To show how important individual factors are, I have put them into a table that uses a scale (1-10) 1 being the least important factor and 10 being the most important.

	1	2	3	4	5	6	7	8	9	10
Cost										
Materials										
Weight										
Aesthetics										
Ergonomics										
Colour										
Reliability										
Durability										
Portability										
Safety										

Breakdown of Factor Analysis

Cost - Level of Importance 6

Cost is a relatively important issue because **we do not want to create a product that is too expensive** but at the same time, it would be quite hard to get the cost of the product to be that high because of limited space and a fixed amount of cameras that need to be stored. This would also mean that the product cost on the market if it were to be sold to the public, would also not be too high so that people would not even think about buying the product.

Materials - Level of Importance 4

The material I will choose must make it so that the product is **lightweight and easy to manoeuvre and use**. The type of material is not too important because the main function of the product will not be very different if the type of material is changed from something like Mild Steel to wood. There is a chance that the product may be hung from a wall, and in that case, the material must be even more lightweight than if it was freestanding, **eg. no mild steel**.

Weight - Level of Importance 8

The weight of the product is crucial for the product to function to its required standard. If the product is being hung on the wall, the **weight can not be too great** so that it will have too much pressure on the material and break. If it was a freestanding product, the weight is also important that its it not too heavy so it cant be moved around but also heavy enough so it won't topple over easily.

Aesthetics - Level of Importance 4

The main idea of this product is that it should work well by storing the products. This means that the aesthetics are not the most important factor of the product. The aesthetics **should still be considered** as the product will be seen by lots of people and so it should still look relatively good.

Ergonomics - Level of Importance 9

The Ergonomics of this product is the most important factor. This is because the product **needs to be easy to use** and be ergonomic so that people can easily put their hand in and grab a camera. The **locking mechanism should also be easy to use** and the cameras should fit in their slot very easily and smoothly. The camera's dimensions should therefore be considered quite a lot in the design of the product as there are 20 small cameras and 3 larger cameras. I will also have to **consider height of people** so that I can measure how high to hang the product from the wall. I will also think about how the **user will interact** with the slots and whether it will be easy to use for a range of hand sizes.

Colour - Level of Importance 4

The colour of the product is very closely tied to the aesthetics of the product which is why I have given it the same score of 4. Colour is not the most important factor of the product because it will not affect the use of the product and it also won't affect how ergonomic the product is. I still think that colour is something that should be thought about because there will be lots of people using the product and so if it looks quite good, then it will be more satisfying to use.

Reliability - Level of Importance 8

The reliability of the product is quite important. This is especially the case in the **locking mechanism**. If the locking mechanism is not reliable, then the product would have a much higher chance of losing the cameras. The rest of the product should also be reliable because it should end up being a product that is good to use and the product use should be self-explanatory. The product should also be working all the time which means that people can borrow cameras at any time. The product must still be in good condition and still be functional for people to use over longer periods of times such as 3-4 years. This must mean that the product must be finished off well and the pieces or parts should be joined together firmly and safely.

Durability - Level of Importance 8

The product should be quite **durable and resistant to wear**. Technically, there should not be any factor that should make the product wear down relatively easily. The type of material chosen should also be of good quality so that the product will not break down as easily over time. Even though the product will not be needed to withstand shock or hits since the cameras would be placed gently and with care, the product durability should still be taken into consideration. Because the product must be reliable, it must therefore also be durable so that it will last longer and become reliable. This means the materials that I will use must also be of good quality and finished well to last longer.

Portability - Level of Importance 2

The portability of the product is probably less important factor of all of them. This is because the product will most probably be hung on a wall. This is because the product **should not be moved that much so that the students will know where to find the cameras** every time somebody would need to borrow one. This also means that if the product is a freestanding product, then it should be securely fastened on the ground either being heavy or with friction.

Safety - Level of Importance 8

Safety is always an Important issue that must be thought about. The most important thing about safety for this product is the camera not falling down and hurting anyone and also the cabinet that has to be made must not scratch or hurt any people trying to borrow a camera.

Conclusion:

In conclusion, I think that the main factors of this project are Ergonomics and Durability followed closely by Weight, Reliability and also Safety. This is because the product must last a long time as well as be easy to use and the cameras must be easily stored away. The weight must be considered so that if the product is hung from a wall **which the clients have stated will probably be the case**, the product will not easily fall down and also damage most of the cameras. The Weight will also contribute to the amount of strain on the product and the materials. This would decrease the life span of the product and in turn decrease durability and become less reliable. The Reliability of the product is also important because of the security system that has to lock them up, as well as being available to anyone who wants to borrow a camera at any time. It must also be long lasting which has been mentioned in the last point because the clients are willing to spend a large sum of money on the product and if the product does not last very long, the product will not only have bad durability, but also unreliable. Lastly, safety is also important so that people don't get hurt in the process of taking cameras.

Secondary Client

Miss Hallam is my Second Client and she is an Art Teacher at the Leonardo Centre of Uppingham which is the Art and DT centre. Because she has many pupils who do art and may need to borrow cameras to take pictures of evidence or art pieces for their coursework at times, she will be using the cameras and accessing the current camera storage device quite frequently. This will therefore mean that she will have first hand knowledge of what the problems are with the current way of storing the cameras. The Cameras are stored in the common room area, and that is where the current device / cabinet is kept.

How do you currently store the cameras?
 We have a dedicated locked cupboard in the Photo area where the equipment is stored. The cameras are in separate trays along with other photographic accessories. We also have clear sets of cameras in the Staffroom on shelves which can be signed out.

What problems can you identify easily when you use the device?
 The cupboard is full with the equipment and the trays are not deep enough to stop the cameras from getting stuck or jammed. You have to open each drawer to see the contents. Nothing is labelled that clearly. Sometimes the outer doors do not open while changing the trays.

What are some things that the new and improved product must include?

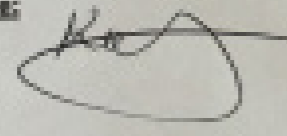
- Clear labelling
- Easy access
- Supportive padding to protect the equipment
- better ways to take charging of batteries?

What material do you think the product should or could be made out of?

- protective and safe outer material. (Metal / Plastic)
- wood could be used but something that is dust free
- Any materials that are light or easy to slide in and out

Do you think that this product idea would be popular in the commercial market?
 Yes if successful as having cameras and equip can take up space so any school, studio or shop may be able to use it as storage and/or display purposes.

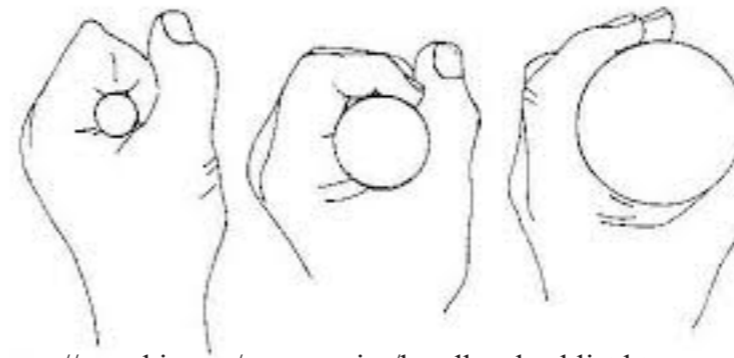
What do you propose that the target price/range will be for a product like this?
 we are entirely sure but probably around £500? depends on how big the storage is and how much it holds.

Signature: 
 K. Hallam

Ergonomics Research

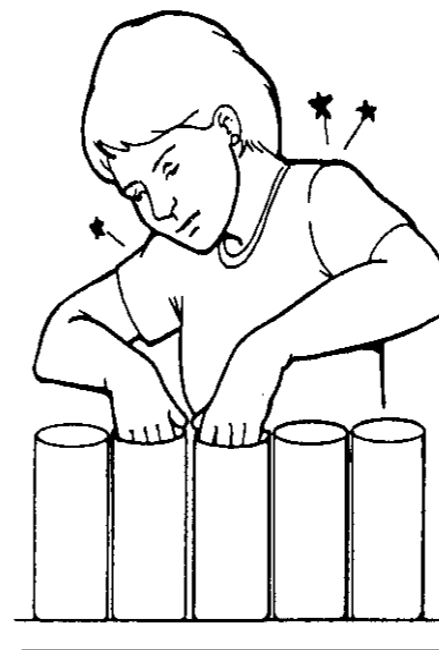
As you can see from the sheet before, Ergonomics is quite an important factor. This is because the product must be easy to use and the hand **must fit very well** so that it can retrieve the camera quite easily and also so that it can put the camera and slip in back in with ease. The camera case should also be considered as well so that the case should also slip into the slot quite easily. This means that I should also **consider the width of the case** and also the width of the hand and fingers when thinking about how wide each slot for the cameras must be. The person's hand length must also be considered because I will also have to think about what depth to put the slot. This will also effect the depth that the camera will be sunken down and so therefore there must be a compromise for the height of each slot.

The majority of the ergonomics that need to be measured will be in the hand sizes which means that the length of the hand, the width of the hand, the **thickness of the average hand and fingers** will need to be considered in the ergonomical side of the product.



https://mpatkin.org/ergonomics/handle_checklist.htm

The picture on the left shows **grip and also thickness of the hand** at different points in the grip. The camera size will probably be in between the middle and far right circle, even though it is an awkward shape. If width of the camera would be in between those 2 circles, that means that getting the camera with the case out will probably be much thicker and probably be as thick as the 3rd circle.



www.danmacleod.com

Largest User		%ile	
British Male 18-64		98th	
Smallest User		%ile	
British Female 18-64		2nd	
Settings...	Adjustments	1208	1587
Help	Footwear	1x20	1x40
Export	Jacket	1x0	1x0
enter optional item		-0	+0
Hide/Close		TOTALS	
Units mm		1228	1627

Notes: Measurements TO %iles...
 Measured vertically from the floor to the bony tip of the shoulder (acromion). The person stands erect with the arms hanging loosely at the side.

On Peoplesize 2008, I have researched about the height of the normal human being and also at which shoulder height most people are at. At shoulder height, people are most comfortable in putting away items such as cameras into slots. From this information I have found out that from the **2nd to 98th percentile of people have a shoulder height of 1228mm to 1627mm**. I will need this to measure how high to hang the product on the wall.

The picture on the left shows the way that someone would pick something out of a tube with their hand. This clearly shows that the hand must be dipped inside in order to pull something out. This picture also shows the person struggling to pull something out. This is because the diameter of the hole is too small and therefore he cannot put his hand entirely through.

On the right, I have researched on peoplesize2008 about typical hand spans and widths and the average 2%-98% of males and females in the UK have a hand span between 97mm and 154mm. This would mean that up to 140mm of that needs to be the slot width so that someone can pull the camera out of the slot. I have also chosen a value that is **larger as it can also accomodate smaller hand sizes**. This dimension will be reflected on when I am designing the slot with of each individual camera storage component part.

Measurements FROM percentiles

Square edge grip, Thumb - Index Finger

Largest User		%ile	
British Male 18-64		98th	
Smallest User		%ile	
British Female 18-64		2nd	
Settings...	Adjustments	91	154
Help	Gloves	-2x0	-2x0
Export	enter optional item	-0	+0
mm		TOTALS	
		91	154

TO %iles...
 on the square edges of index finger can grip.

Peoplesize 2008 (school software)

Materials Research

Acrylic

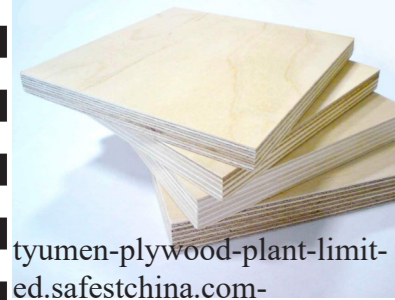
Acrylic is a plastic which means that it is **self finishing**. This would mean therefore that it will look good and smooth even without any external work. Acrylic can also come in transparent sheets which would be another way to see whether the cameras are still in the storage slot. Acrylic is also a hard material but can be brittle as well because of its molecular structure. Another advantage of acrylic is that it can come in many **colours** which better the aesthetics. Acrylic is also a relatively softer material which means that it will be easier to work with in conjunction with other types of materials such as wood/metals. It is also not a very heavy material.



www.smsamas.com-

Birch Plywood

Birch plywood is a very strong material because it is made out of opposite patterns of birch wood which are glued together which make the grain pattern overlap, and hence giving it good strength. Birch plywood can also come in different thicknesses which means that I could use sizes such as 6, 9 or 12 mm which they go up in increments of 3mm. This means that I could use a **different thickness** for different areas of the product. Birch plywood is also not a natural wood and is man-made type of wood. This means that the wood will not warp or bend easily. Birch plywood can also be finished off quite easily and will look good. It is also not a very heavy material to use.



tyumen-plywood-plant-limited.safestchina.com-

Aluminium

Aluminium is an extremely **lightweight** material especially for a metal. This is an advantage because I could use Aluminium for larger scale parts such as the back board of the product and it would not be too heavy. Aluminium is also a very **strong** material as well as durable. One problem is that it can be scratched very easily and therefore I don't think that this material should be used in places that are quite visible and will be used a lot as this would encourage the storage space with aluminium parts to wear down more. Aluminium is also a very common metal which means that it will not be too expensive to use and therefore if I use this material, I could keep the costs relatively low in comparison to other materials.



en.wikipedia.org-

MDF (medium density fibre board)

MDF is a man made board which has been composed of multiple wood scraps pressured and pressed into a single board. This means that the wood has **no grain pattern**. MDF is a very low cost material for woods and this means that I could use quite a lot of this in my product. However, MDF does not look particularly good and also it will absorb quite a lot of water if it comes into contact. Therefore I would have to consider whether or not the product will come into contact with water. MDF is also a very **easy material to work with** because there is no grain pattern and cutting and drilling in the material is quite easy. MDF will also not warp or bend or cup because it is a man made wood which means that I will not have to worry about it changing shape as much as other natural timbers.



www.collisdiy.co.uk-

Conclusion of Materials Research:

In Conclusion, the materials that could be used would be woods such as Birch plywood for more visible parts of the body of the product and perhaps some MDF in places less visible. This is because Birch plywood is a relatively **lightweight** material and because it is man made, it will not warp, causing it to be more durable and therefore more reliable. Birch Plywood and MDF can also be recycled and reused and therefore it will be good to use as a sustainable material. Acrylic may also be used because it is also relatively **lightweight as well** as being aesthetically pleasing. Acrylic is also a sustainable material which means it can be reused, or recycled and therefore will save the world from using more resources. As for metals such as Aluminium, though the material is lightweight, I do not think that aluminium is a suitable material to use. This is because Aluminium would be a hard material to join together along with woods and acrylic. The bond with resins and other ways of joining different materials can be less strong and if the product is hung up on a wall, I do not think that the choice of using Metals such as Aluminium in conjunction with Woods such as Birch Plywood and acrylics, is wise. **Stock standard component parts** will also be used in conjunction with the product for parts such as the hinges on the door that must be locked, the lock for the actual security system, as well as many screws. Aluminium can be recycled and melted down and recasted but the energy that it takes to do that process is much more than the energy used in the process of recycling woods and plastics such as Birch plywood or even Hardboard.

Sustainability:

The Earth's resources are limited and **FINITE** which means that everything that we make and product at a global scale will be using and potentially wasting materials in most cases. Raw material need to be changed to usable materials such as plastics. This means that the process requires energy and the burning of fossil fuels and creating more pollution. Sustainability is a large issue because the world pollution levels have gone up a tremendous amount in the past few years and I will analyse this by researching the 4 R's.

Reduce

The point of Reducing what you use is so that the product's **raw material usage goes down**. This in turn will mean that the amount of production and the amount of product will go down and as people get used to this, you will slowly be saving money as well as time. For example, you could reduce the size of packaging for some product which means that the product's packaging is much smaller and would waste less materials. This would mean less goes to **landfills** and therefore less energy for mining and extracting raw materials is used, leading to less pollution.

Re-use

During the design stage, I will consider carefully what **types of components** I can use which can be re-used. This for example would be things such as stock standard component parts such as springs, or screws or hinges. Re-using the elements of the product will mean that the cost of the next product will be much lower because some of the parts are already there. The advantage of reusing is that it reduces the amount of raw materials that we need to mine/extract. Materials that have been reused will be hard to use in my project because **we are not accessible to the buying of the materials**.

Recycle

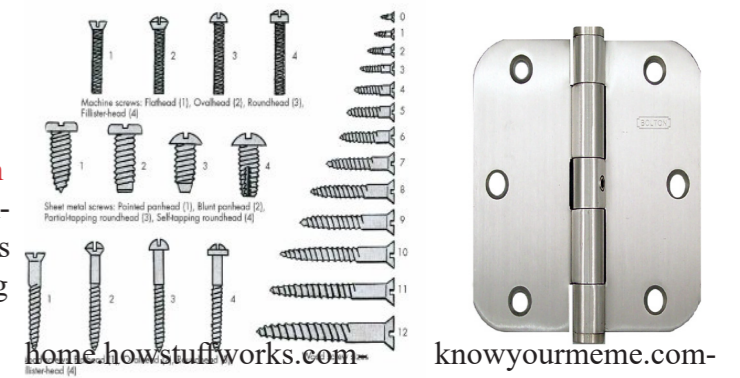
Recycling can reduce the size of our landfills. To recycle a material is to reuse the material that has been already used. For example, any metals that I end up using in my product can be **melted down and then recasted** into another product. Any plastics can also be melted down if they are thermoplastics which also can be extruded again or injection moulded. Woods can also be recycled by chopping it up and turning it into MDF. As a result, This would mean that again, much less raw materials need to be mined (metals) and taken from Nature, hence less pollution. Therefore I will try to use sustainable materials in my project and use materials that can be recycled.

Recover

We produce a lot of **rubbish** in our lives. This means that all of this would go to landfills and be stored up and will take a very long time to biodegrade, especially metals and plastics. We could recover lots of unused metals by hovering an electromagnet on the top and therefore extracting many useful metals from landfills which we can reuse. Plastics can also be recovered from the oceans as well as landfills which would help sea life and also reduce oil usage. Recovered plastics and metals from these places can then be melted down and recasted or remoulded into more products and therefore reduce cost as well as the amount of pollution caused by extracting or mining materials.

Stock Standard Component Parts:

Stock standard component parts are a very useful way of efficiently solving problems when you have minimal space. For example, Hinges can be used to create a door or cover for the product I am making and this will **solve my problem** of locking and securing the cameras once I also have a locking system on the door connected to the main frame. Screws will also be used and they will also be very useful in joining several pieces of materials such as woods together while also being a nonpermanent joint



home-howstuffworks.com-

knowyourmeme.com-

The Brief: - The brief is a statement of intent for my product

My research on the Materials, Sustainability and also the Interview that I have done has shown me what I need to do to solve the problem of the storage of cameras. Therefore **I will product and manufacture a custom made, easily accessible, secure, and efficient Camera storage device or Camera Cabinet.**

The product will be either hung on the wall, or a freestanding product which will have slots for 12 cameras as well as slots for battery cards and also 3 larger scale SLR Nikon cameras. This should all come with a method of charging and keeping the wires away from sight. The product should be made of materials that will not hurt anyone as well as being relatively lightweight and with consideration to the ergonomics of the user.

Product Specification:

Purpose

1. It must provide an easily accessible, safe, and efficient solution for the storage, and borrowing of cameras. This would also mean creating a way of locking the cameras up and making sure that people will have to take responsibility for borrowing a camera.

Form

2. It must allow the cameras to be easily slotted into the individual slots provided by the storage device.

This would also mean it should not hurt the user whilst storing or borrowing the cameras.

3. It must be able to store the cameras with enough space as well as fitting charging cable and the 3 larger individual SLR Nikon Cameras **as requested by my clients.**

Function

4. It must provide an individual slot for each individual camera as well as 3 larger slots for the SLR Nikon cameras.

5. It must be able to provide a path for cables in order to charge the individual cameras when they are back into their slots.

6. It must provide 15 slots for Battery cards so that the person borrowing the camera can be identified. 12 for smaller cameras and 3 for the SLR Nikon cameras **as mentioned by my client Nell during the interview.**

User Requirements

7. It must be easily accessible so that the user can take the cameras out and borrow them with some efficiency and ease.

8. It must have a slot large enough so that the ergonomics of the hand will be considered and will not hurt the user when they are retrieving the camera.

9. It must have a cover which can be closed and locked when the cameras will not be used anymore for safe storage.

Performance Requirements

10. It must be able to hold up the weight of all the cameras if the product is to be hanging on the wall.

11. It must have a way to charge all the cameras once they are put back into their individual slots **as requested from my client Nell**

12. It must have spaces for battery cards so that the borrower can be identified **as requested from my client Nell as well.**

Materials and Components

13. It must not be too heavy so that the product has too much weight and strain on the materials because it will be hanging on the wall **as my client has said as general points during an interview.**

14. It must use and consider using more sustainable materials such as woods like **birch plywood** so that there is minimal environmental impact and materials that can be recycled or reused should be considered even more. **Acrylic** could also be used because it can be reused as well as recycled. **Metals** can also be fine as they can be melted and recycled quite easily. Using **Brass and Mild Steel** are good options for Metals.

15. It must have well finished materials especially if it was to be a wood such as birch plywood so that the product will be more durable. If plastics are used, I will probably use acrylic as it can be recycled by melting in an oven and then remaking into a different shape/product.

Size and Weight

16. The product must not be too large so that it cannot be hung on a wall if being hung on a wall is the method I have chosen. Wall size limits me to **70cm** wide and **90 cm** long.

17. The product must not be too heavy to put strain and stress on the materials which could damage them over time. If the product exceeds **20kg** then it may reduce the life span of the product.

Safety

18. The product must be safe to use and should not hurt the user when taking cameras out.

19. The product should be finished off well with no sharp edges or wooden edges that have not been sanded down so that splinters do not become a problem for the client and people/students that will be using it.

Quality

20. It must be made to the highest possible quality so that the client will be satisfied with the product.

21. It must have high quality materials which are supplied by trusted and good suppliers to enable the product to be made out of good materials which therefore means higher general quality.

Scale of Production

22. It must be able to be manufactured with energy efficient processes.

23. Even though the product will be one off, batch production should still be considered.

Cost

24. The budget of this product according to my 2 interviews with both clients would be about **£350** **because my clients have had a range of £150 to £500** which I think **£350** would be quite a good middle point for the cost of the product. This figure will be excluding all labour costs and energy costs which would include machines.

Sustainability

25. It must be fully functional for another **10** years after I have created it. This is to ensure that the quality of the product will be high and this will also ensure customer satisfaction and also because the amount of money they are willing to spend is quite high.

26. It must consider the uses and applications of more sustainable materials such as birch-plywood and acrylic which could be reused or recycled should be considered even more so that there is as little impact on the environment as possible. This will mean that I should try to find materials that can be reused and recycled such as most woods and most plastics. Recycling metals is also possible but the process takes much more energy and therefore is still not as good for the environment. As mentioned, the **4 R's should be thought about** and considered carefully when choosing materials and thinking about the end of life circumstances.

Summary of the Problem:

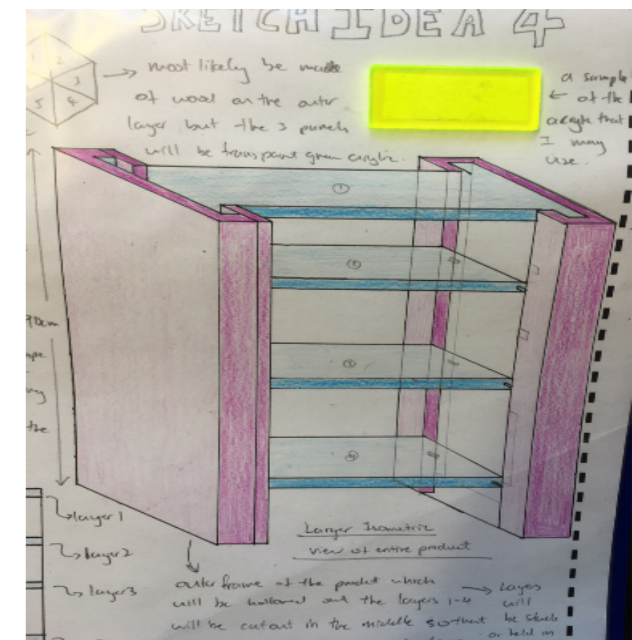
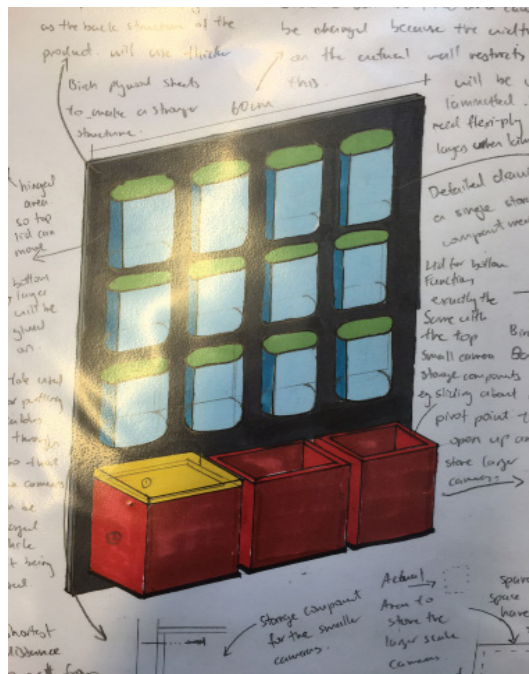
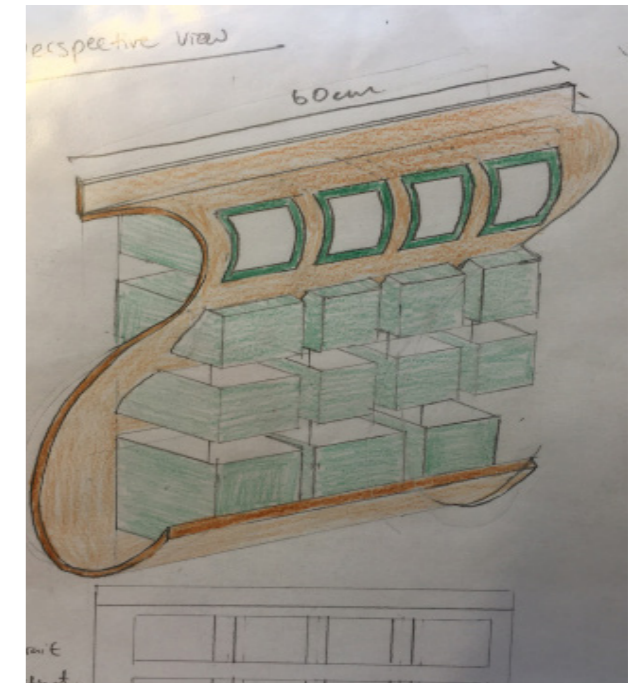
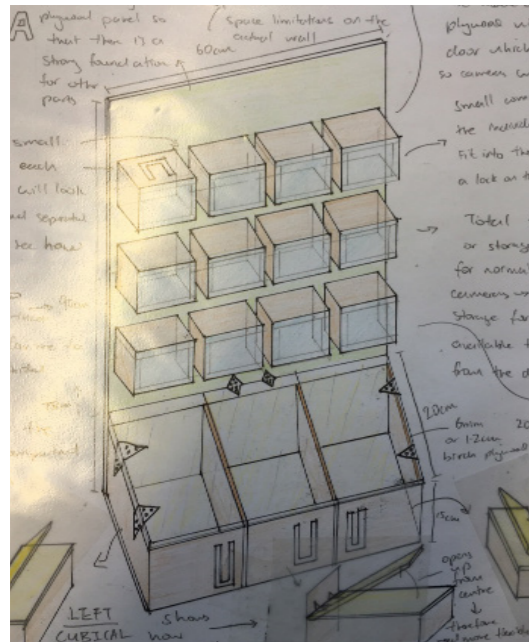
The main problems can be identified from pictures taken of the existing product:

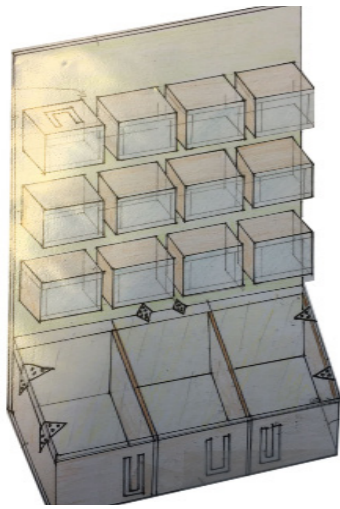
- Not enough space both Width and Length as well as height for the Camera along with its case to be stored safely without potential damage by falling down.
- No method of keeping track of who has borrowed which camera and that will create a potential for losing and misplacing cameras which will cost the department money as well as time to buy a brand new camera.
- No method of charging the cameras when they are in the storage device. This means that when somebody needs to borrow the camera, they may not have a camera which has battery, and that would lead to more and more cameras being low charge.
- No safe way of storing the Larger SLR Nikon cameras which are bulging out of the storage area that they have been provided.

As you can see, There are the main problems of the product and this is also the reasons why the storage of cameras will need another product to replace the existing product. The product should meet the specifications.



This project will be completed, tested and evaluated by the 25th of April 2017





Product Explanation

Idea 1 is a easily manufactured product which meets the specification and is easy to make. It is a **simple design** which looks a lot like the product that is existing but with the correct dimensions as well as security for each of the cameras. I have also begun thinking about how the battery cards would fit into this design which will identify who has borrow which camera from each slot. This has raised some problems, but with further development, it could very well be a possibility. The design consists of a flat back structure with 12 smaller containers that will fit each smaller camera as well as 3 larger containment areas for the larger Nikon cameras. There will be a lockable acrylic door with a hinge attached to each of the containers for security.

Product ①

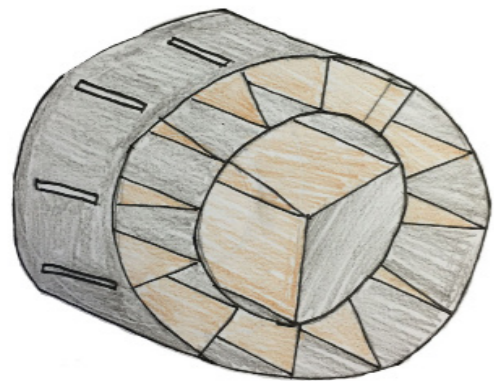
This is a great design due to the consideration of identifying who has borrowed what camera with the available card slot.

1. Also really like the transparent front of the boxes and believe this needs to be part of the design to clearly see at a glance what storage we have.

Summary of points:

1. It looks sturdy and secure
2. Easy to access but possibly too bulky?
3. What about batteries or charger storage?

Product Explanation



This idea is based around the design of the **lens of a camera**. This will give the product an easy approach from people who would not know where the cameras would be stored. I have also included a circular design because it is efficient in creating storage space with little amount of materials in total. There will be 12 panels dividing up storage space connecting the outer ring to the inner ring and there will be 3 larger dividing panels connecting the centre of the circle and the inner ring, creating space for the larger cameras to be stored comfortably. There will also be 1 or potentially 2 rotating acrylic circular sheets which will have a pivot point in the middle to rotate. There will also be a gap in it so cameras can be taken out.

Product ③

This is the most aesthetically pleasing design to the eye as it represents the camera design itself. I am pleased it has an effective use of materials and is neat and compact. The rotation element enhances the design to be more functional for the user and the perspex lenses are colourful and eye-catching.



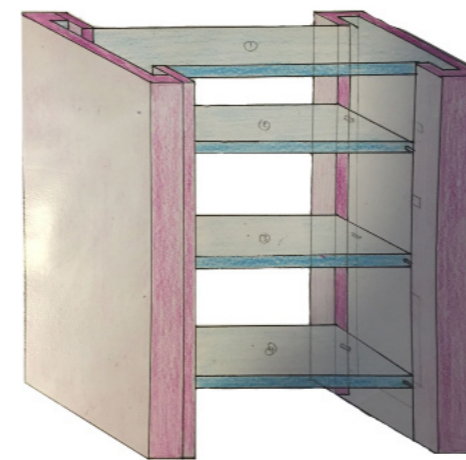
Product Explanation

Idea 2 takes a different view of how the product could be made, I have thought about it being hanged from the top ledge and the **laminated structure** would have slots in which the camera storage cabinets individually would fit into the hole. Again, there will be 12 smaller boxes and 3 larger for the large cameras. There is a difficulty in creating the product because the holes for each box on the larger curved wood lamination would have to be very accurate so that the product looks good as well as the boxes being parallel. A key problem that this product holds is that it would be quite heavy which means that further development would be needed if this product would be chosen to be the one I would make further on.

Product ②

This is a very futuristic design and I think aesthetically is looks striking. I don't seem to me to be as practical to use and movement or access to the boxes may not be as effective as idea ①.

Product Explanation



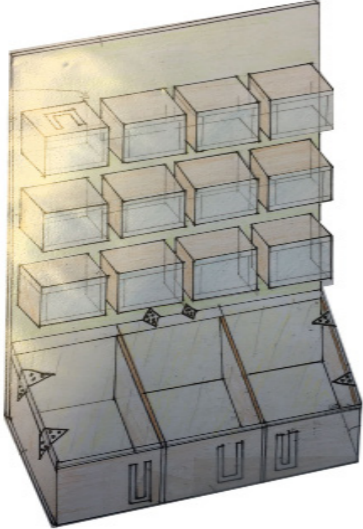

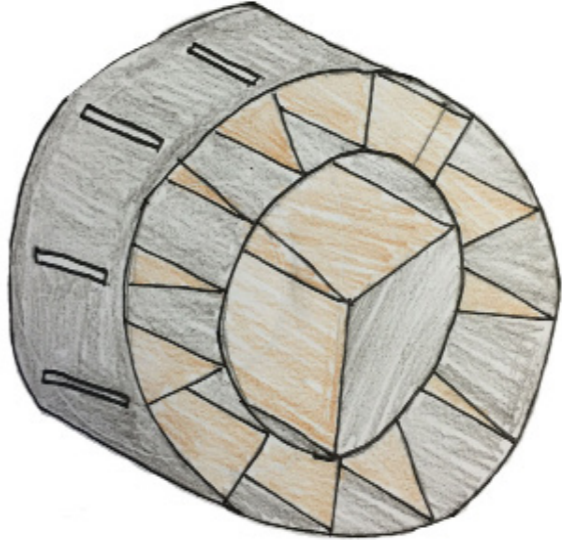
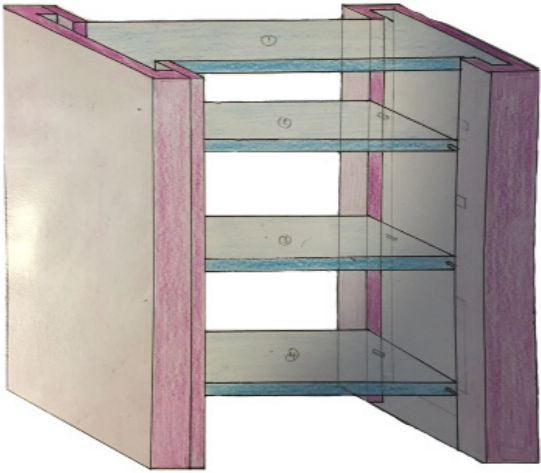
Idea 4 is based around **security** and how weight could be a contributing factor. Layer 1 would be the top layer with no cameras stored on top but the other 3 layers would have 6, 6, and 3 larger cameras stored one each of the layers 2, 3, and 4 respectively. The outer frame consists of a slot which the layers would fit in and would be able to slide in and out of the product. To secure the product and store the cameras away, the layer must be able to sit on a ledge which would be a dowel and the cameras will be put inside. To lock the product, the layers will simply have to sit on top of the other layers with the top layer being locked and not moveable. This would mean that the other layers could not be accessed.

Product ④

Again, similar to design ② this might be too over complicated a design to justify the access needed. I like the look and movement aspects but it is not as compact or easy to approach as the others. The small pots to store the cameras are great but the outer design to access them I don't think works.

Products Analysis -

Throughout my design ideas I have produced detailed sketches of 4 separate designs showing the major component parts that make up these sketch ideas, I have also included different ideas and shapes that would make my design different from the average camera storage device and I have tried to also satisfy the original requirements of the product.

<p>Proposed Prototype</p>				
<p>Advantages</p>	<ul style="list-style-type: none"> • Simple product that is easy to understand and use • Flat back or structure which will make it attach to the wall quite easily • Storage is secure and large enough for cameras to fit. • Relatively easy to manufacture • Has an Idea for slots for the battery cards. This will be good for identification 	<ul style="list-style-type: none"> • A different and possibly more aesthetically pleasing product • Allows quick and easy access to the cameras through the front • There is lots of space for each camera including the 3 larger Nikon cameras. • Main structure of the back will be quite straightforward to make in one or more lamination steps. 	<ul style="list-style-type: none"> • Product is easy to understand and use • Safe and secure method of storing the cameras • It looks more aesthetically pleasing • Charging could be an easy solution if the middle section can be rotated full circle. • Plenty of storage space for each camera that needs storage. Including the 3 large cameras which are Nikon. 	<ul style="list-style-type: none"> • Has a natural way for security with layers falling down onto the bottom layer. • Two sides will provide a strong structure for the layers to move up and down. • Layers can be rearranged by order of use and frequency of use.
<p>Disadvantages</p>	<ul style="list-style-type: none"> • Very similar to the existing product and there is not much different in shape. • Storing the smaller cameras could be annoying as you would need to open and close the hinged door. • Middle hinge may not lift very far up. • Small boxes may be difficult to retrieve the cameras 	<ul style="list-style-type: none"> • Will not attach to the wall as strongly as the first product because there is less contact area which we could attach. • Very difficult to manufacture especially holes for the chambers in the structure. 	<ul style="list-style-type: none"> • The product must be made extremely accurately because the angles for the circular panels and slots must fit exactly. • Relatively more difficult to manufacture • Acrylic sheet can be easily scratched and cause the front of the product to look less satisfying. 	<ul style="list-style-type: none"> • Another difficult product to make • Difficult to attach to the wall firmly. • Layers may become quite heavy to lift up and get cameras out. • More difficult way of taking/storing cameras.
<p>Client 1 feedback</p>				
<p>Materials</p>	<p>The main material that I would be using would be Birch Plywood and also possibly MDF for the back structure. Acrylic may also be used for the hinged doors so that users may be able to see which cameras have been borrowed and which are still there. I will also use Stock Standard component parts.</p>	<p>Mainly Birch Plywood as the back frame would be laminated Birch plywood along with Flexi-ply. The chambers could be a mix between Birch Plywood and also Acrylic for the same reason or seeing which cameras are still there to be borrowed. There will be little amount of stock components</p>	<p>Mainly Birch Plywood as well as some acrylic. Potentially 2 circular sheets of Acrylic with a rotating slot where the camera can be taken out. The Birch plywood would need to be laminated in 3 parts for the outer circle and in 2 parts for the smaller circle. Wooden panel dividers will also be birch plywood.</p>	<p>Again, the mix of materials in this product would be Acrylic and Birch plywood of different thicknesses. The acrylic would be for the containers for the cameras on each layer and the Birch plywood would be for the frame and also each layer for it's strength.</p>
<p>Sustainability</p>	<p>Basically all of the materials used here would be recyclable which means that this product would be quite environmentally friendly to product. MDF and Birch plywood would be shredded down to make more MDF and Acrylic can be melted and reformed.</p>	<p>The main structure being made as Birch plywood and Flexi-ply would be recycled by shredding and making it into MDF. other pieces of Birch plywood could be re-used and the acrylic doors could be reformed by using heating methods.</p>	<p>Because the materials used will be Wood and Acrylic, Basically all of the product can be recycled, reused or chip the wood to make MDF. Acrylic can also be melted down and recasted for other products. Flexi-ply for lamination can also be made into MDF.</p>	<p>The pieces of wood from the layers could be recycled or reused if others would need it. The outer frame could be reused as well and the acrylic can easily be reused but as they are relatively small pieces, they could be melted and recasted/reformed.</p>

Overview of Sketch Ideas - This page will be used to analyse the four selected sketch ideas in further detail against my specification. Using my client feedback I will decide later on with the help if this overview to develop one of these ideas to become the product that I will eventually come to manufacture.

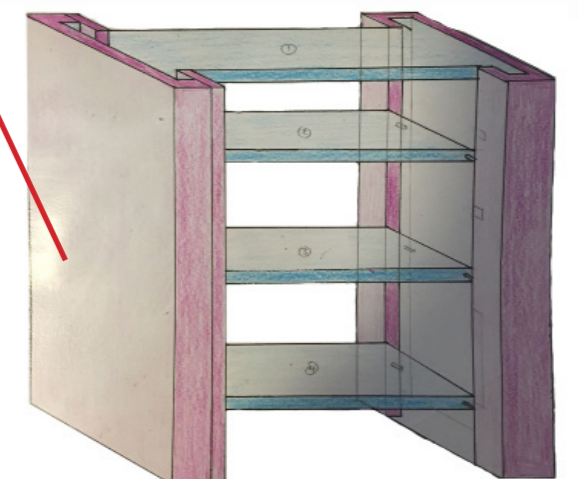
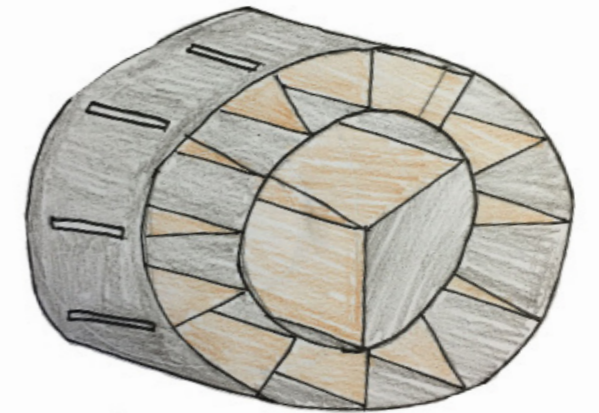
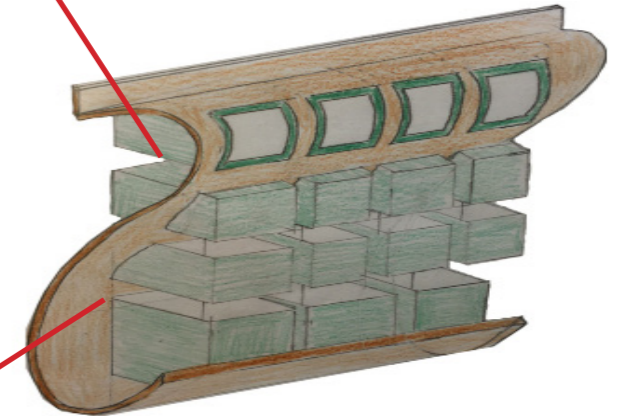
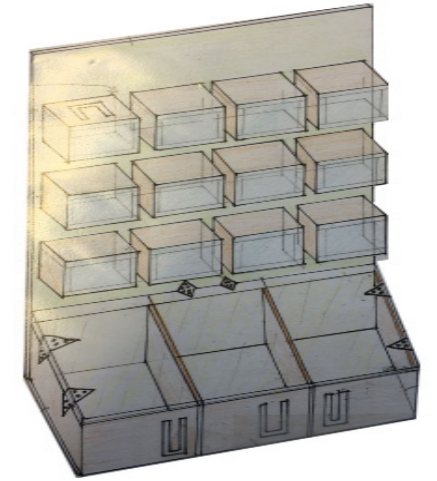
Product Specification:

1. It must provide an easily accessible, safe, and efficient solution for the storage, and borrowing of cameras.
2. It must allow the cameras to be easily slotted into the individual slots provided by the storage device.
3. It must be able to store the cameras as well as fitting charging cable and the 3 SLR Nikon Cameras
4. It must provide an individual slot for each individual camera as well as 3 larger slots for SLR Nikon cameras.
5. It must be able to provide a path for cables to charge the individual cameras when they are in their slots.
6. It must provide 15 slots for Battery cards so that the person borrowing the camera can be identified.
7. It must be easily accessible so that the user can take the cameras out and borrow them with efficiency and ease.
8. It must have a slot large enough so that the ergonomics of the hand will be considered
9. It must have a cover which can be closed and locked when the cameras will not be used anymore for safe storage.
10. It must be able to hold up the weight of all the cameras if the product is to be hanging on the wall.
11. It must have a way to charge all the cameras once they are put back into their individual slots
12. It must have spaces for buttry cards so that the borrower can be identified
13. It must not be too heavy so that the product has strain on the materials because it will hang on the wall
14. It must consider using more sustainable materials such as birch plywood therefore less environmental impact
15. It must have well finished materials especially if it was to be a wood such as birch plywood
16. The product must not be too large so that it cannot be hung on a wall
17. The product must not be too heavy to put strain and stress on the materials which could damage them over time.
18. The product must be safe to use and should not hurt the user when taking cameras out.
19. The product should be finished off well with no sharp edges or wooden edges that have not been sanded down
20. It must be made to the highest possible quality so that the client will be satisfied with the product.
21. It must have high quality materials which are supplied by trusted and good suppliers
22. It must be able to be manufactured with energy efficient processes.
23. Even though the product will be one off, batch production should still be considered.
24. The budget of this product according to my 2 interviews with both clients would be about £350
25. It must be fully functional for another 10 years after I have created it.
26. It must consider the uses and applications of more sustainable materials such as birch-plywood and acrylic

Evaluation of Initial Ideas against each Specification Point

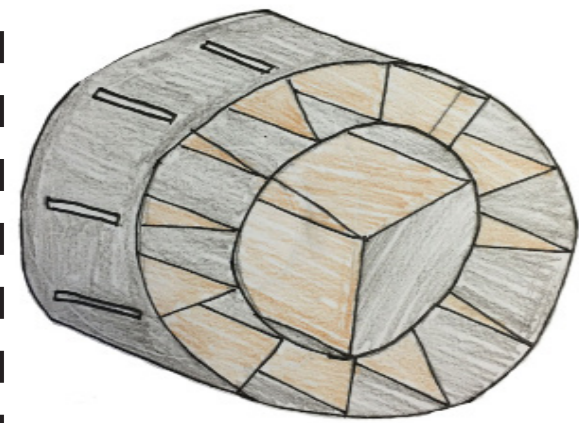
1. I think that product 1, 2 and 3 do a good job in meeting this specification point but the 4th ideas will be an outlier. This is because the layers would have to be moved into their positions on the dowel every time the product will be used and the layers need to be fixed before the product can be used and any cameras can be taken out.
2. All of the products allow the cameras to be stored away in a specialised slot. but for storage idea 4, it could be slightly more difficult in trying to lift up the layers and then putting the cameras away. The layers would also have to be lifted and set down on some dowels every time before the product can be used.
3. I have considered charging for ideas 3 and 4, but for ideas 1 and 2, charging could be more difficult because the wires may not be long enough to stretch up to the very top box.
4. All ideas have individual slots for each camera including the larger slots for Nikon.
5. Charging has been considered for ideas 3 and 4 but for ideas 1 and 2, it would need some consideration and development.
6. Battery card storage for identification has been considered for ideas 1, 3 and 4 but for the 2nd idea, it would need some development before the product would be made.

7. The products are all easily accessible and it easily retrievable from their slots, but for Idea 1 and 2, this could be a possible problem which would require further development.
8. This will be further considered during the development sheets because hand ergonomics will need to be considered and slots will need to be larger.
9. This has been considered besides idea 2 where further development is needed. Security is a very key factor in meeting the product's needs. Most products have this already but for idea 2 will require further development.
10. Weight is a problem for ideas 2 and 4 because there will little contact with the wall where the pressure can be relieved.
11. Charging has been considered for idea 3 and 4 but not 1 and 2 which require further development.
12. Battery card slots have been implemented in idea 1, 3 and 4 but not yet for the 2nd. It will mainly be an indented slot with a circular hole to take the card back out.
13. Product 2 is the only heavier product because there is only the top 10cm where it comes into contact with the wall, this would mean either the product weight is decreased or the design would need more development.
14. Birch Plywood, Acrylic and stock standard component parts can be reused or recycled.
15. Acrylic is a self finishing material and Birch plywood would need to be sanded, oiled and waxed.
16. Dimensions should all be considered as there is limited space on the wall. Width must be less than or equal to 60cm and 90cm in height.
17. The only idea where the weight could break the wood, would be idea 2, this means further development would be required.
18. All the products must be finished off well and make sure that there are no sharp corners or splinters that could hurt the user. This will be the case for the inside of the boxes or storage compartments.
19. In general, the product must not have splinters coming out of wood as well as sharp corners or edges which could potentially hurt the user if they are using the product.
20. The product will be made from top quality materials as well as accurate measurements and dimensions will be followed intensely.
21. The school has bought high quality materials for us to use in our products.
22. I will try to use the machines for 'must' processes and try to combine processes when possible.
23. Batch production would be considered in the development stage even though the product is a one off product. CNC machines and CAM machines would need to be used in Batch production.
24. The cost of the product would need to be discussed with the clients because the materials that i will be using must not be too expensive so that the overall product would make a profit if it was going to be made by batch production in the future.
25. The product must be of high quality so that the materials will be long lasting. Maintenance must also be a key factor in trying to make the product longer lasting and potentially last 10 years after it has been made.
26. I have tried to use more sustainable materials and environmentally friendly materials which can be recycled, reused, created or remoulded into new products or other product component parts.

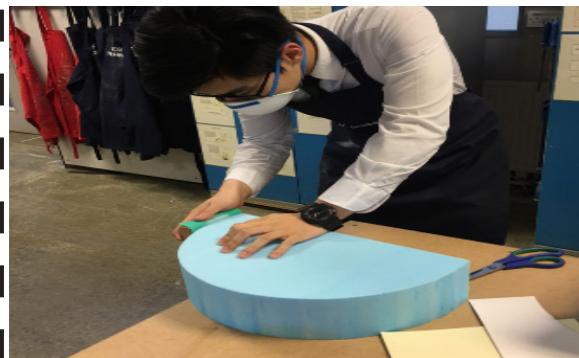


CHOSEN IDEA (IDEA 3)

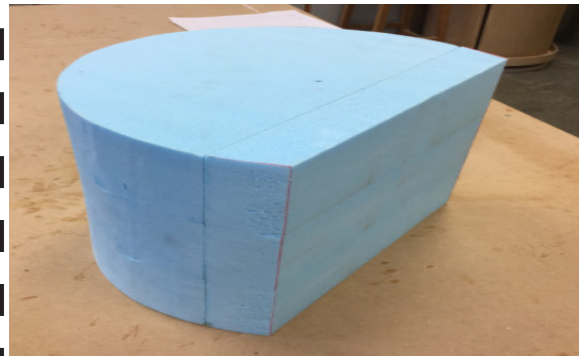
< Design Idea 3 is the design I will be creating and developing at this stage. I have started by wanting to investigate how the large scale cameras will be stored in their containers. I will also want to model how the panels on the inside of the product will come together to become a pivot point of the acrylic sheet as well. I will then further model how the outer ring will be small enough for charging cables and still have enough space for each small camera. These models will help me figure out exact dimensions as well as decide if the product need be larger or smaller than intended.



Model 1: Modelling the outer ring and storage for the smaller cameras. I want to see whether the size of the product will also be too large and if there is enough space in total for the cameras to be stored well.



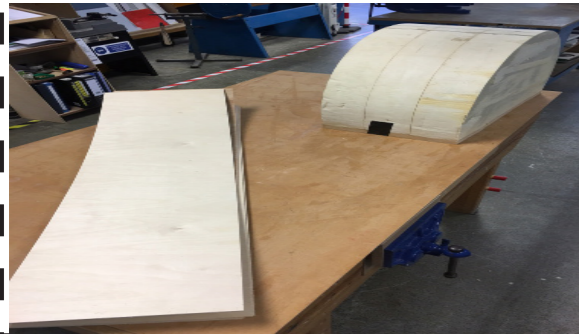
Stage 1 shows me with the mould of the larger 30cm radius circle. I will be laminating the inner circle in 2 parts and the joining them together later on. Here I have cut out the semi circle of the blue Styrofoam and will attach 3 of these formers together to create a final former that is large enough so that I can laminate it with width 20cm total with 5cm either side to spare. Here I am sanding the former so that the radius is exactly 30cm which would mean that the eventual formed lamination will be perfectly round and will fit together well with the other parts eventually.



This is the finished mould for the lamination for the inner ring of my product. This is 30cm in radius and I am planning on testing the actual size model by using the right thickness of 18mm. I have taken the blue styrofoam and cut out the same piece 3 times and also put a base on the bottom. Then I cut the semi-circle using a band-saw and sanded it down to make it smooth and ready for lamination. As for the base part, I have added extra lengths so that I have extras during lamination which I can cut down if necessary later on. I will be doing 2 of these moulds for the entire ring.



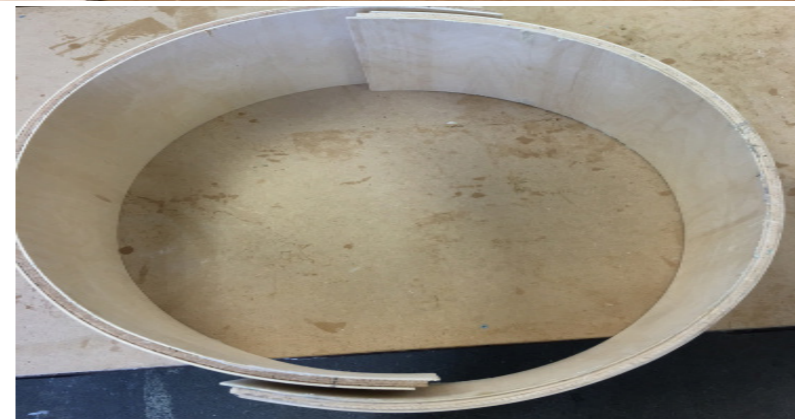
I have started a second former because the first one was just slightly too small and therefore I will use it for the smaller inner ring former. I have firstly measured the radius as you can see here from the initial point which is the origin point. This point will extend and create a diameter line if there was line joining the side of the circle to the origin to the other side. I have also chosen a thicker former, which will account for the 3 pieces that I had to use the last former that I made. This former will also allow me to have a larger circumference so that I can cut some off in the future if I need to.



This picture shows the initial step of lamination. I have laminated a total of two of these halves which will give me a full circle. I have chosen sheets of Birch plywood of thickness 1.5 mm and also flexi plywood which will give me more of the thickness that I need for the outer ring. I have then glued each individual sheet with PVA and taped the middle, before putting it onto the mould / former and taping it again against the former. After that I have put the entire thing into a bag press where the lamination process begins.



Here you can see the process of the lamination. I have asked for some help from the technician because the bending of the wood will be hard to hold and also tape by one person. Here you can see that I have prepared the brush, the PVA glue and also the tape. Firstly I have to identify which sides of the birch plywood I will need and be visible, then I will glue the opposite side and glue the other layers on top. After this I will bend the entire thing over the former which is 30cm radius and I have cut out some extra bits of wood just in case I will need some spare to cut off later.

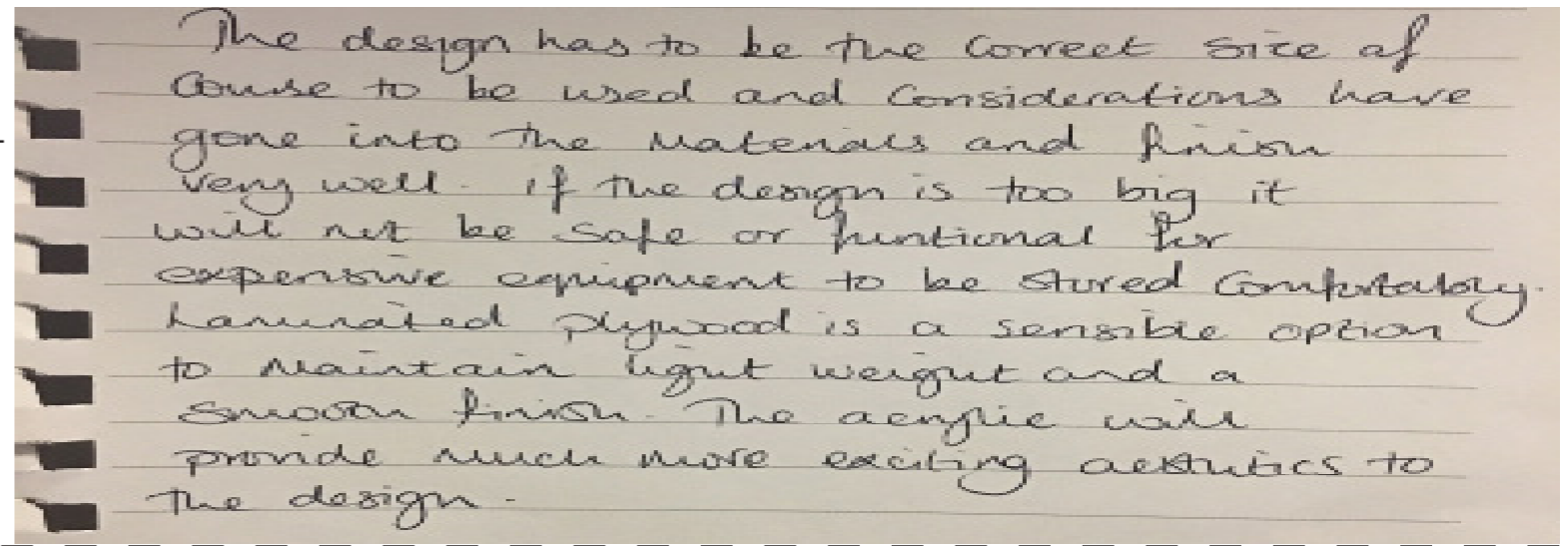


This picture shows a bird eye view of the two laminates that I have completed, I have taken this birds eye view photo so that I can see that or estimate how accurate the circle is when it will be joined up later on. Here the picture is relatively squashed but by eye I have found that the product is actually quite circular and will be quite good as the main structure of the product as it will be reliable to attach other pieces onto it.



I have also checked the alignment of the two laminates. Here you can see from a side angle, the line markings that I have made on the side of the wood. This shows the length of the wood that I actually need to make the 60cm diameter circle. After aligning the two circles on both sides, I can get a better idea of how well the two ends will be joined up and how well the circle will be in the end. I have also decided that I will stick both laminates on a back panel made from MDF which will increase stability as the laminates will have something more to hold onto.

Client Feedback:



Modelling of the 2nd idea: Panels on the inside attached to the inner ring and the acrylic rotating sheet. For large camera Storage. (Model will be done to full size to understand space for large cameras.)



I started off by marking the wood and preparing it to be cut. My initial idea for the dimensions of the wood were 200x200mm with an area which the four pieces can join together to create a hole for a metal rod to fit through, connecting the storage part to the actual acrylic sheet which is used for security of the cameras. I have noticed that there are copies for the 1st and 4th part and also the 2nd and 3rd part. This meant that I could just do one of each part and trace a copy out to get the best and most accurate dimension possible.



Here I am cutting the wood on the bandsaw. I have left out extra space for the width of the bandsaw blade which is around 2 mm. I started off by cutting the larger pieces out first, so that I would have smaller and more detailed cuts later which the bandsaw can cope with because the piece I am using in the picture was too large to work with and hard to get around. After cutting each individual pieces out, I could use the fence as a guide so that each piece was identical. For safety I have used safety goggles an apron and also kept my fingers away from the red zone, near the blade.



Here I am showing the pieces that I have cut out initially. You can see clearly that there are 2 pieces that are the same and each piece has the same gross dimensions. I then realised my problem which was that I could not have a drill bit to drill the holes on the little panel of wood sticking out of each part. This is why I have decided to create 4 smaller wooden panels to stick onto each piece of wood individual, having been drilled before stuck on, we can ensure that the hole is exactly in the middle of the wood and that the steel rod of 6mm that I have chosen will fit well and provide a solid pivot point for the product.



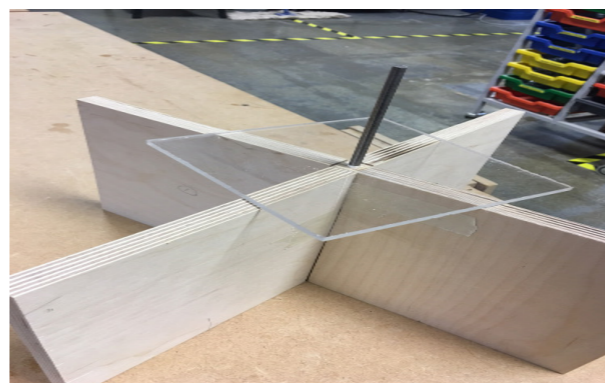
At this stage, I have decided to create smaller panels for each individual inner ring dividers because it will be easier to drill out the hole for. This also means that I would have to modify the wood dimensions. I have therefore changed it to 192 mm x 200 mm. This will mean that I will stick each individual panel onto the wood after having drilled them, creating a hole large enough so that the steel rod can go through and be strong enough to support the larger acrylic sheet. In the picture on the left, I am using the belt sander to remove the edges that I have done previously and also made sure that each of the 4 inner ring dividers are of the same size.



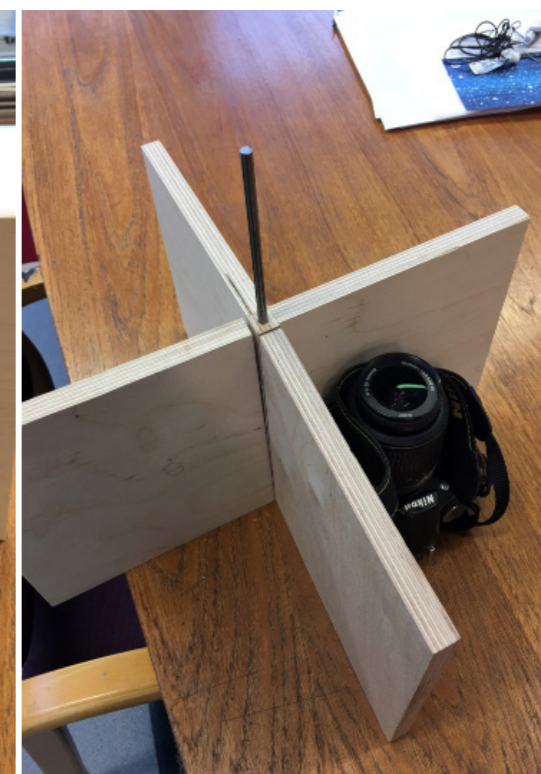
Here i have attached a smaller piece of wood onto one of the sides of each of the 4 panels. This will act as the main point in which I put a rod through to support the acrylic sheet that will rotate about the middle rod. The weight of the acrylic sheet will also be entirely supported by this rod and so the size of the hole and the tightness of the holes drilled in the smaller pieces of wood in the picture shown, must be quite accurate, linking all 4 pieces of wood and joining them together to create the middle structure. This will separate the area into 4 spaces which will be the storage areas for the 3 larger cameras.



Here you can see that I have assembled 3 of the 4 pieces with the middle 6mm diameter steel rod. This will act as the centre point of my product, and the 4 sections that have been outlined will be for the large cameras. As you can see, I have just glued on the smaller bits of wood onto the sides of the panels and have drilled holes into each piece before attaching them. The size of the hole is 6.5mm because this will make it fit better but not be too loose. the size of the steel rod is 6mm which means the rod should fit well.



Here you can see the completed model that I have made. The 4 panels have been joined together and fit relatively well with some small gaps in the middle due to incorrect cuttings or dimension markings. I have also got a piece of acrylic which is transparent and also 5mm thick which will be the actual thickness of the acrylic that I will be using in my actual product. I have cut out a smaller piece of the acrylic out as the actual acrylic sheet will be a massive circle of radius 30-31 centimetres including the thickness of the outer ring. The next stage of the modelling is the testing of the model with the real life cameras seeing if they can be stored with sufficient space.



Here I have started to test the product with the real life sized cameras (large Nikon cameras). Here you can see on of the cameras in one of the storage component parts. As you can see, the product can easily fit into the space provided with quite a lot of height still available, and potentially even include an area in which charging stations can be installed as a bonus. Here I have removed the acrylic sheet just to make the camera more visible and clearer. but in the second picture I have put the sheet back in for height.

Conclusion from Modelling:

From my conclusion, I have realised that the size of the storage space for my larger cameras, (X3) will be securely stored because the dimensions in the x,y,z or (length width height) are all sufficient and will allow the cameras to be stored well. My other model of the large circular outer ring has also proven to me that the product will have sufficient space and will not be too large that it will not fit on the wall where it needs to be after I have made the product. Both these models have provided useful information that will allow me to confirm that the size of my product as it is now is fine and maybe even better than expected. The storage for the large cameras is comfortably good and also provides enough space to maybe install charging stations inside each part as well.

Finishes for Birch Plywood (Woods) - This page shows my research into wood finishes for the main structure of my product. This research will hopefully help me decide which finish will be the most beneficial for my project

Danish Oil

The photo on the right shows the difference between a piece of wood which has been oiled by Danish oil and the other section shows it where it has not been touched. As you can see, the wood that has been oiled looks much better and brings out more of the colour of the wood. As well as aesthetics, the Danish oil will also greatly improve the durability of the wood as the oil seeps into the inside of the wood and strengthens it much more than the wood would normally be. Further finishes can also be added on top of danish oil and the oil can also be applied multiple times.



Varnish

Varnish is a similar finish to oil but it brings out the colour of the wood even more and gives it a better looking shine to the wood. This is why it can be sometimes considered the best looking or best aesthetically pleasing finish to use. Varnish binds to the surface of the wood as well as strengthening the inside of the wood, preventing cracks and also limiting processes such as warping or twisting, allowing the wood and the product to be more durable. One key advantage to varnish is that it will help the wood remove moisture and prevent the moisture entering the wood, reducing mold.



Waxing

Waxing is a very useful finish that can be applied to a wood. This is because it can be applied after processes such as the two finishes above which are oil and varnish. Wax is also a very strong finisher because it fills the holes of the wood after the oil has been applied and smoothens out the surface of the wood, making it less prone to friction damage as well as protecting the wood from water to a certain degree. Wax can also further protect the wood from damage and increase durability. A very important advantage of wax is that it can be applied regularly as the wax will slowly wear off, giving it a new layer or protection every time.



Paint

Paint is also an alternative finish that can be applied to woods. Paint mainly serves as a binding liquid which will mildly strengthen the wood but will protect it from wear on the surface quite well. A visible advantage to paint is that you can choose any colour you want and apply it to the wood, you can also put more coats of if you wish as well as reapply coats of paint once some wear off and break away.

Wood Lamination Process

In the picture to the right, you can see a vacuum machine, a bag press and also a suction pump. Things inside the bag include the former, the wood that you are trying to form and also a piece of cloth for permeability and breath-ability for the vacuum to suck air out efficiently and completely. These are the main components to Wood Lamination.



The Process:

Wood lamination involves a few basic steps:
 1. Create a mold for the wood and prepare the equipment in the list above
 2. Prepare the wood and glue each layer onto each other whilst also taping the middle and then bending it over the former.
 3. Then tape the bent wood over the former onto the former tightly.
 4. Put into the bag press and place cloth over the piece of wood so it can vacuum out easily.
 5. Vacuum out the air and wait 12 hours to set
 This wood lamination process is the best way to create curved pieces of wood without it being warped, twisted or deformed in any other way. This is because the process lets the wood set in a certain way. The only safety precaution that needs to be thought about is the fact that if the wood is thick, bending it could make it snap or rebound quite quickly. So I had to make sure that the wood was secured tightly and taped well. Another thing to be careful about, is the fact that I should not use too much glue because it will stick to the bag, making it harder to remove afterwards. The picture on the left shows most of the things that are required besides the PVA wood glue and tape.



Uppingham School Wood lamination

Conclusion:

After researching different finishes, I have found out that the best combination of finishes to use for my product and the way to give it the most durability, is using Danish Oil and Wax. Firstly the Danish oil will be good in creating an initial layer in the wood as well as seeping into the wood, making it stronger and more resistant to water already. The Wax will also further improve the strength and durability of the wood. This is because it will not only make it more water resistant, but stronger in resisting warping, twisting and other natural defects. Wax will also make it smoother after the oiling which will prevent the wood surface from hooking onto anything and potentially doing some damage. Wood lamination is also one of the key parts of my design and my product. I have used 4 total laminates and curves to form 2 circles. I have also chose to do more wood laminations because it is a process where the wood will not warp and be stable. Wood laminations which are in circles also create a lot of tension and therefore strength within the wood and hence in the structure of the wood.

Stock Standard Component Parts - This shows my research in to the stocker standard component parts that I am using in my product.

Cost: As Stock standard Items are produced on a mass scale, the companies that mass produce the products benefit from economies of sale in the purchasing of materials. The cost will be much lower that expected due to the high volume of product that they are making and producing, **reducing cost per unit item**. This will make it more efficient economically to buy a mass made product rather than make your own which will take much more time and machines that cost a lot of money.

Sustainability: It is much more sustainable to use Stock standard component parts because they have been made **without wasting much energy**. The machines will create a lot of them at a time which will better use moulds if they are used. Resources will also be maximised without much waste, hence the cost will also be lessened.

Environmental: Industrial manufactures will have also calculated how to use material the most efficiently, this means that the materials will be used to their limits, allowing **less materials to be wasted**. This will reduce the amount mining required to collect the resources, hence reducing the damage done to the earth.

Efficiency: It will take valuable time to product the items which means that I will save time which would otherwise be used manufacturing the parts. This **time can be spent ensuring quality control** which is vital to my design. Stock standard component parts reduce the amount of effort i will need to put into creating the part instead of buying it. Having this part already made will also allow me to just install it without having to think of ways to incorporate it into the design. Hence allowing me to focus more on the actual design and main structure of the product.

Below are the Stock Standard Component Parts that I will have to purchase or get and use on my product.



Protruding Lock mechanism

I have this lock already because of the fact that it is spare in the DT department in school. The lock works by **extending a rod** when the key is pushed through which can be steadied by twisting the key. This lock will act as my stopper for the acrylic sheet, allowing me to **stop the rotation of the sheet** and make it stay fixed at a point where there is no camera to take from the product. As I am creating 13 slots for 12 cameras (small) and 4 slots for 3 Larger cameras, the acrylic sheet will have it's opening stopping at the **13th small camera slot and the 4th Large camera slot**. This lock is very simple to use and to place it on the acrylic sheet, I will need to countersink parts of it to fit the screws, the body of the lock and also take into account the rod length.

Screws

Screws are one of the most fundamental standard component parts. This is because the thread of the screw is extremely useful and to make the actual thing would be absolutely more **time consuming and inefficient**. I will be using screws to fix a lot of the panels to the outer structure or 'rings' that I have laminated in the bag press. These screws will provide a good joining power and strength along with some glue to withstand the tension within the structure and also weights of the cameras which should not be too much of a problem. I will be using different lengths and widths of screws at different points so I will have to **drill different size pilot holes** in different parts.



Industrial Process of Wood Lamination

Wood lamination is also a process that is used in industry. This method is very efficient for a number of reasons, one being that the mould can be used multiple times for a single product. Even if the process of waiting and allowing the bag press to have an effect on the wood is slightly long, the fact that all the moulds can be used **unlimitedly** and also more moulds can be made to meet demands, makes it **efficient**. The process can also be automated by clever software.



<http://www.ebay.co.uk/itm/171958072878>

The picture on the left shows a lamination machine that is used in the process of **Wood lamination in industry**. The bag press is constructed by the two sheets on the top and bottom of the cover. This comes down and air is sucked out to make the vacuum. This machine is quite large which means that more than one product can be made at the same time. If they are put into the machine at the same time, they can also be **timed simultaneously**. This makes the process of making multiple of these product much easier. The cover is much taller than the base of the cover and this is to allow the mould to be able to protrude higher up if the wood design needs the product to be slightly taller than expected. The plastic used in the bag press will also be slightly more elastic to make the wooden design fit more comfortably.



The picture on the right shows the part that I will need to laminate. This is the larger ring and I will have to do 2 copies of this and also 2 laminates of the smaller ring. The larg ring will have a radius of 30cm and along with the thickness of the wood I will be using to laminate with, the total radius of the product should be about 30.8cm. The smaller circle has a radius of 20cm and with the thickness will end up about 21.2 cm radius in total. I have made 2 moulds, one for each size of the laminate.

Computer Aided Manufacture and Just in Time (JIT)

CAM or Computer Aided Manufacture is when a design that has been made on the computer on certain software can be converted to become the actual product. This is the case because the computer will automatically send the design to certain machines which will make certain parts. When each part has been made, the parts are conveyed to a machine such as the assembly machine which will combine each part and create the full product. This will save a lot of **labour time as well as costs** for the company. A machine can be used many times and the only downside of this will be maintenance as well as high initial setup costs. **Machines can also adapt to different designs** especially when the design of the product is changed because of different market demands or a change in a company's products because of certain problems. This will allow the company to have a good edge on their opponents due to fast adaptation. Wood lamination is a very good process especially for companies who use the system **Just in Time**. Just in time applies the knowledge that every order is done when it is taken. This means that materials are assembled and made into the product once an order for a client has been placed. This is better suited for Wood lamination because Just in Time process will start once the order is taken and the woods will not have to be wasted if there is no order placed. The Lamination process can be started whilst all the other parts are made and sent off together as one.

Final Design - This page is a summary of my development Section.

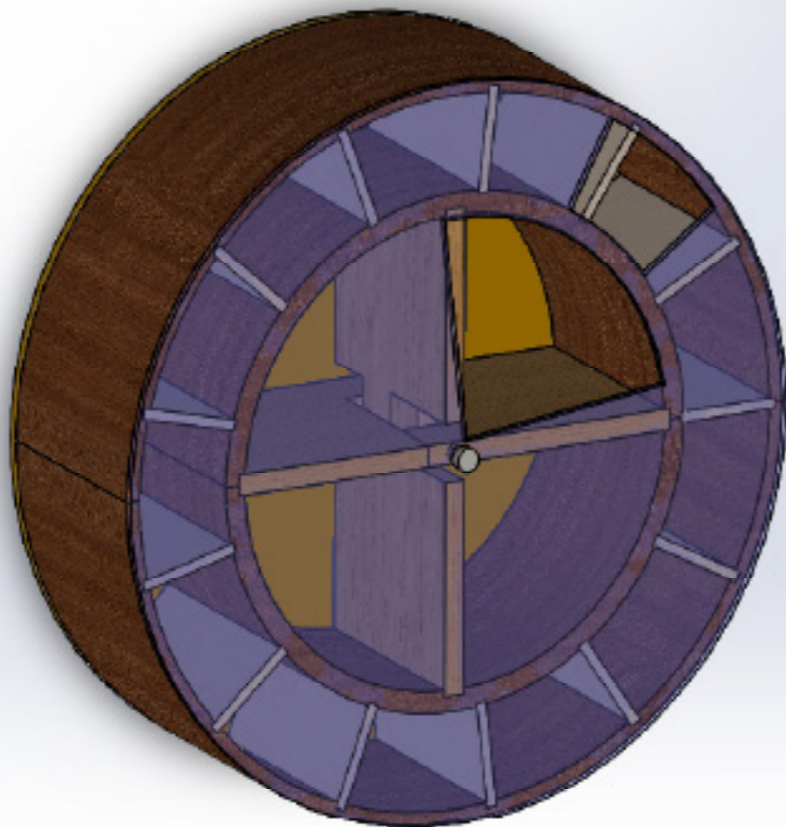
Client Feedback

Processes

Most Component parts will be joined together by screws or glued onto a flat backboard platform which will be the main structure of the product. The main rings or laminates will be glued onto the orange backboard in the picture below.

The purple acrylic sheet will need to rotate about the middle axis which is the metal rod. This will need to be thick enough to withstand weight of the sheet. This acrylic sheet's dimensions are 30cm radius which means that it will be pretty big.

Each individual panel that will be attached to the outer ring connecting with the inner ring will be attached by the screws. The only thing stopping all the parts from coming off the steel rod is the slightly thicker end of the rod which will allow the parts to stay in place. at the back, the rod will need to be fixed onto the backboard so that all the parts will have a main structure to rely on and not fall apart.

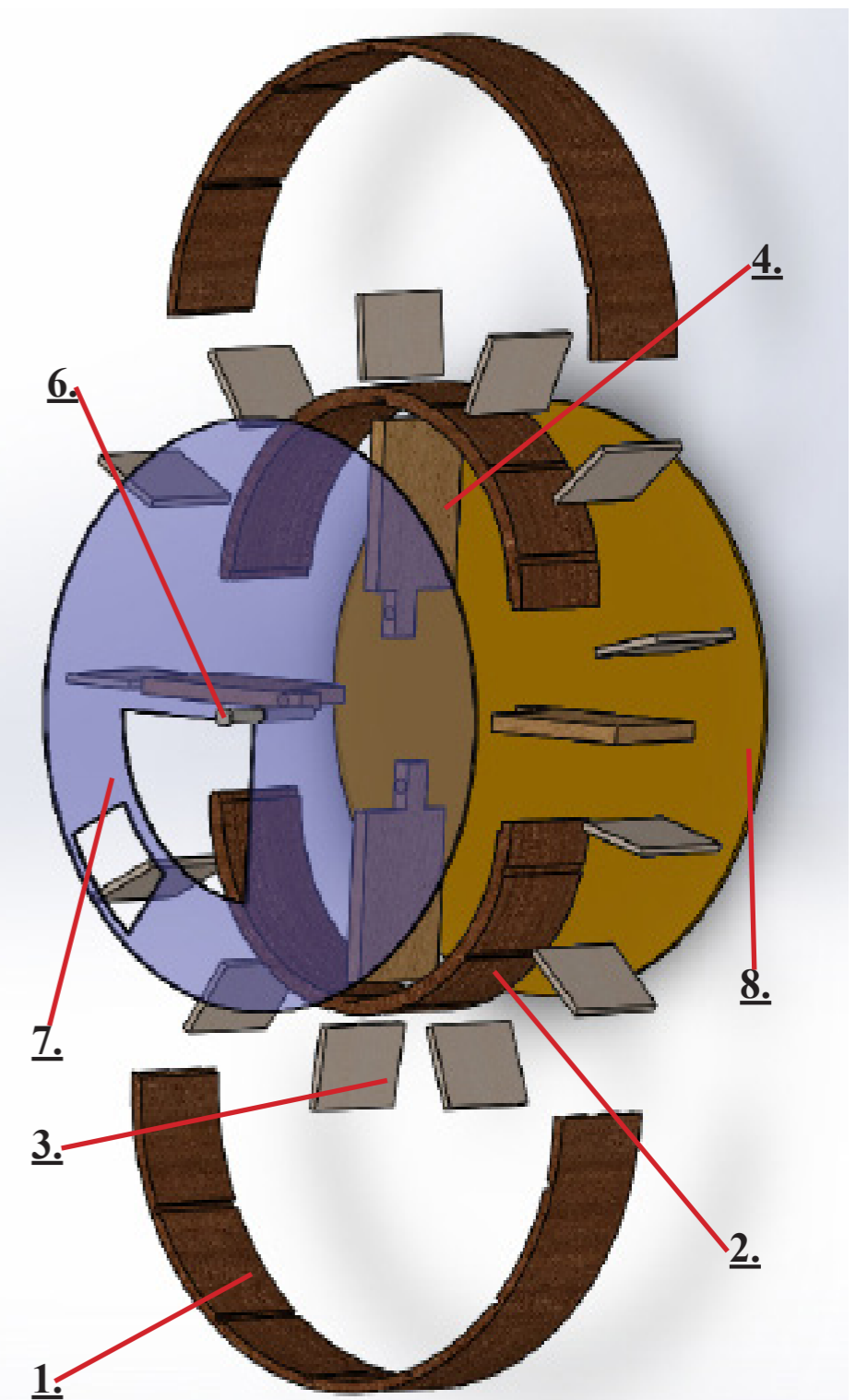


Product Specification:

1. It must provide an easily accessible, safe, and efficient solution for the storage, and borrowing of cameras.
2. It must allow the cameras to be easily slotted into the individual slots provided by the storage device.
3. It must be able to store the cameras as well as fitting charging cable and the 3 SLR Nikon Cameras
4. It must provide an individual slot for each individual camera as well as 3 larger slots for SLR Nikon cameras.
5. It must be able to provide a path for cables to charge the individual cameras when they are in their slots.
6. It must provide 15 slots for Buttery cards so that the person borrowing the camera can be identified.
7. It must be easily accessible so that the user can take the cameras out and borrow them with efficiency and ease.
8. It must have a slot large enough so that the ergonomics of the hand will be considered
9. It must have a cover which can be closed and locked when the cameras will not be used anymore for safe storage.
10. It must be able to hold up the weight of all the cameras if the product is to be hanging on the wall.
11. It must have a way to charge all the cameras once they are put back into their individual slots
12. It must have spaces for buttery cards so that the borrower can be identified
13. It must not be too heavy so that the product has strain on the materials because it will hang on the wall
14. It must consider using more sustainable materials such as birch plywood therefore less environmental impact
15. It must have well finished materials especially if it was to be a wood such as birch plywood
16. The product must not be too large so that it cannot be hung on a wall
17. The product must not be too heavy to put strain and stress on the materials which could damage them over time.
18. The product must be safe to use and should not hurt the user when taking cameras out.
19. The product should be finished off well with no sharp edges or wooden edges that have not been sanded down
20. It must be made to the highest possible quality so that the client will be satisfied with the product.
21. It must have high quality materials which are supplied by trusted and good suppliers
22. It must be able to be manufactured with energy efficient processes.
23. Even though the product will be one off, batch production should still be considered.
24. The budget of this product according to my 2 interviews with both clients would be about £350
25. It must be fully functional for another 10 years after I have created it.
26. It must consider the uses and applications of more sustainable materials such as birch-plywood and acrylic

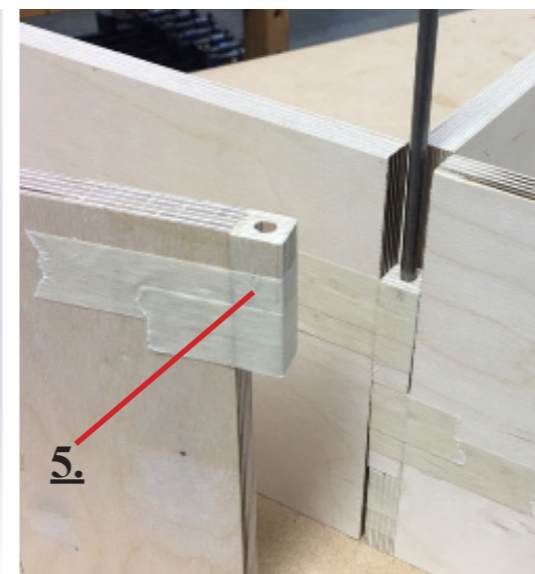
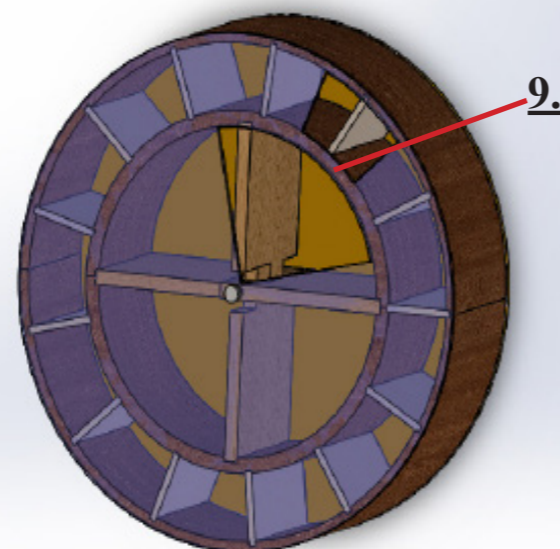
This is the Cutting List - where I will be listing out all of the materials that I will be using and also dimensions of them. This will also be according to the final design and development.

PART	COMPONENT	MATERIAL	NUMBER OF	LENGTH (mm)	WIDTH (mm)	HEIGHT (mm)	FINISH
1.	Outer Ring Semi-circles	Birch-plywood & Flexi-plywood	2				Danish Oil + Wax
1.1.	1.5mm thin Birch plywood sheets	Birch Plywood	2	1885	200	1.5	Danish Oil + Wax
1.2.	6mm Flexi plywood sheets	Flexi-plywood	1	1885	200	6	Danish Oil + Wax
2.	Inner Ring Semi-circles	Birch-plywood & Flexi-plywood	2				Danish Oil + Wax
2.1.	1.5mm thin Birch plywood sheets	Birch Plywood	3	1260	200	1.5	Danish Oil + Wax
2.2.	6mm Flexi plywood sheets	Flexi-plywood	2	1260	200	6	Danish Oil + Wax
3.	Outer Ring dividers	Birch Plywood	13	83.5	200	5	Danish Oil + Wax
4.	Inner Ring Dividers	Birch Plywood	4	191	200	15	Danish Oil + Wax
5.	Small Panels for Inner Ring Dividers	Birch Plywood	4	15	50	15	Danish Oil + Wax
6.	Steel Rod	Mild Steel	1	Radius - 6	210	-	
7.	Acrylic Sheet - Front	Acrylic (transparent)	1	Radius - 312	6	-	Self Finishing
8.	MDF sheet - Back	Medium fibre density board (MDF)	1	Radius - 312	6	-	Oil and Waxing
9.	Sliding Patio Door Lock	Stock standard part	1	-	-	-	-



The Cutting list that I have produced is not composed of many materials. The main part of the product will be made of Birch-Plywood and there is only one main part which is the sheet at the front of the project, the acrylic sheet. MDF will also be used for the backboard of the product and some mild steel will be used as well as stock standard component parts.

The Picture on the right shows the entire project as one with the acrylic sheet at the front being rotatable and will fit into each slot of the cameras well, allowing access to the cameras. The Lock will be placed in between the openings of the acrylic sheets, this will stop the sheet from rotating and become lockable.



This Production Plan shows the processes and steps which i will follow and how long it will take. Safety for me and others are important so I have listed all the nessary precautions.

STAGE	PART & MATERIAL	PROCESS	EQUIPMENT	TIME (MINUTES)	QUALITY CONTROL	PERSONAL SAFETY	SAFETY OF OTHERS
Outer Circle (1a)	Styrofoam building blocks and sheets	Cutting out and making a former out of the styrofoam	Bandsaw, Sanding paper and block	90	Check that the measurements are correct and accurate When cutting on bandsaw, cut on the waste side of the line	Wear apron and goggles Fingers away from the Blade	Make sure people stay clear of machine
(1b)	(2X) 1.5mm thin Birch plywood sheets 6mm Flexi plywood sheets	Cutting out the wooden strips with extra lengths	Bandsaw	20	When cutting on bandsaw, cut on the waste side of the line	Wear apron and goggles Fingers away from the Blade	Make sure people stay clear of machine
(1c)		Gluing each layer together	PVA wood Glue and Painbrush	15	Make sure that the glue is not spilling out and don't put too little glue, but a good amount	Do not get lots of glue on the fingers	--
(1d)		Taping all the layers together and bending over the former	Masking Tape	5	Tape the middle of the layers tightly, keeping them together	--	--
(1e)		Put into Bag press and vacuum out the air - Lamination	Bag press, Lamination kit	900	Make sure that the bag press is not underneath the wood, making the product inaccurate	--	--
(1f)		Mark and drill holes for the screws to attach to outer panels	Pencil, Bradawl, Pillar Drill	30	Check that the hole is centred in the block Mark and Bradawl correctly	Wear apron and goggles	Make sure people stay clear of machine
Inner Circle (2a)	Styrofoam building blocks and sheets	Cutting out and making a former out of the styrofoam	Bandsaw, Sanding paper and block	90	Check that the measurements are correct and accurate When cutting on bandsaw, cut on the waste side of the line	Wear apron and goggles	Make sure people stay clear of machine
(2b)	(3X) 1.5mm thin Birch plywood sheets (2X) 6mm Flexi plywood sheets	Cutting out the wooden strips with extra lengths	Bandsaw	20	When cutting on bandsaw, cut on the waste side of the line	Wear apron and goggles Fingers away from the Blade	Make sure people stay clear of machine
(2c)		Gluing each layer together	PVA wood Glue and Painbrush	15	Make sure that the glue is not spilling out and don't put too little glue, but a good amount	Do not get lots of glue on the fingers	--
(2d)		Taping all the layers together and bending over the former	Masking Tape	5	Tape the middle of the layers tightly, keeping them together	--	--
(2e)		Put into Bag press and vacuum out the air - Lamination	Bag press, Lamination kit	900	Make sure that the bag press is not underneath the wood, making the product inaccurate	--	--
(2f)		Mark and drill holes for the screws to attach to inner ring	Pencil, Bradawl, Pillar Drill	30	Check that the hole is centred in the block Mark and Bradawl correctly	Wear apron and goggles	Make sure people stay clear of machine
Inner ring Panels (3a)	(4X) Birch-Plywood panels	Cut out each individual panel after marking them out on a larger sheet	Pencil, Ruler, Bandsaw	60	When cutting on bandsaw, cut on the waste side of the line	Wear apron and goggles Fingers away from the Blade	Make sure people stay clear of machine
(3b)		Mark and drill holes for the screws to attach to outer ring	Pencil, Bradawl, Pillar Drill	30	Bradawl a large enough hole but not too big No fingers in the red zone of the drill	Wear apron and goggles	Make sure people stay clear of machine
Small Blocks for Inner Ring Dividers (4a)	(4X) Birch Plywood blocks	Smaller blocks need to be cut out after being marked out	Pencil, Ruler, Bandsaw	15	Make measurements correctly and accurately When cutting on bandsaw, cut on the waste side of the line	Wear apron and goggles Fingers away from the Blade	Make sure people stay clear of machine
(4b)		Blocks are bradawled and then drilled on the pillar drill all the way through from the top	Bradawl, Pillar drill (6.5mm drill bit)	25	Bradawl well and make sure that the drilled hole is in the centre of the wood	Wear apron and goggles	Make sure people stay clear of machine
(4c)		Blocks are then glued onto the panels and taped up, then left to dry	PVA glue and Masking tape	15	Tape tightly and make sure the glue is not spilling out	--	--

This Production Plan shows the processes and steps which i will follow and how long it will take. Safety for me and others are important so I have listed all the nessary precautions.

STAGE	PART & MATERIAL	PROCESS	EQUIPMENT	TIME (MINUTES)	QUALITY CONTROL	PERSONAL SAFETY	SAFETY OF OTHERS
Outer Ring dividers (5a)	(13X) Panels of Birch plywood	Marked out on a sheet of birch plywood	Pencil, Ruler	25	Make sure the markings are accurate and account for the thickness of materials when nessary	Wear apron and goggles	--
(5b)		Cut out on the bandsaw	Bandsaw	40	Cut on the waste side of the line and go slowly for accuracy	Wear apron and goggles	Make sure people stay clear of machine
(5c)		Mark and drill holes for the screws to attach to outer ring	Pencil, Bradawl, Pillar Drill	45	Mark and Bradawl correctly and drill in the centre of the wood and on the mark	Wear apron and goggles	Make sure people stay clear of machine
Steel Rod (6a)	6mm steel rod	Parralell turn the rod to get different thicknesses (Turning between centres)	Centre Lathe	60	make sure that the dimensions are checked correctly and the metal's diameter is correct with a micrometer or other tools	Wear apron and goggles	Make sure people stay clear of machine
Acrylic Sheet - Front (7a)	Acrylic sheet (radius 312mm)	Mark out the openings for slots of the cameras	Marker, Ruler	30	Mark out correctly and accurately	--	--
(7b)		Drill a small hole and cut out the opening slots	Hand Drill, Coping Saw	60	Drill the hole slowly so the acrylic doesn't crack Use the Coping saw carefully and slowly again		
(7c)		Drill a hole in the middle of the sheet	Hand Drill, 6mm Drill bit	15	Drill the hole slowly so the acrylic doesn't crack	Wear apron and goggles	Make sure people stay clear of machine
(7d)		Drill hole in-between openings for cameras slots for the lock	Hand Drill	10	Drill the hole slowly so the acrylic doesn't crack	Wear apron and goggles	Make sure people stay clear of machine
MDF sheet - Back (8a)	MDF sheet (radius 312mm)	Cut out the sheet after marking out	Tenon Saw, or other saws, Pencil ,Ruler	25	Mark out accurately Cut from a line for the Tenon saw and keep checking if I am on track	Wear apron and goggles	When using the Saw, check there aren't people around you who will bump into you
Sliding Patio Door Lock (9a)	Stock Standard component Part Lock	Attach the lock to the Acrylic sheet and screw it in	Screwdriver	5	Make sure the pilot hole drilled is far down enough and don't force the screw down	--	--
Sanding (10a)	All wooden parts	Sanding them down and making them smooth	Sand Paper/Machine	120	Take time with the sanding paper and machine, don't take too much material off	Wear apron and goggles if using the machine	Make sure people stay clear of machine
Finishes (11a)	All component parts that are wood	Apply an Oil layer	Danish Oil	45	Apply a thin layer and don't use too much oil Apply it to every corner and area	Gloves, Apron	Don't get oil on others
(11b)	All component parts that are wood	Wax layer and wiping down afterwards	Wax, Iron Wool, Cloth	45	Apply evenly everywhere and wipe down with the cloth gently	Gloves, Apron	Don't get wax on others
Gluing and assembly (12a)	MDF backboard Outer Rings	Glue the Outer rings to the MDF backboard	PVA glue	20	Spread the glue evenly and around the parts well	Wear apron and goggles	don't get glue everywhere
(12b)	(13X) Outer ring panels	Attach all the outer panels to the outer ring	Screws and Screwdriver	30	Make sure the pilot hole drilled is far down enough and don't force the screw down	--	--
(12c)	Inner Rings	Attach inner rings to the outer ring panels	Screws and screwdriver	30	Make sure the pilot hole drilled is far down enough and don't force the screw down	--	--
(12d)	Steel Rod and Acrylic sheet	Attach the Steel rod and Acrylic sheet onto the product	-	5		--	--
TOTAL				2875			

GANTT CHART - This Gantt Chart will illustrate a schedule of production that I will follow to manufacture my working prototype, It includes deadlines and Quality control points as well as other details.

Stage No.	Task	Week 1					Week 2					Week 3					Week 4					Week 5					Week 6				
		Days					Days					Days					Days					Days					Days				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1	A	Make Styrofoam former	█	█																											
	B	Cut wooden strips			█																										
	C	Glue Layers			█																										
	D	Tape and form Layers				█																									
	E	Bag press and Laminate				█	█	█																							
	F	Mark and drill holes									█	█																			
2	A	Make Styrofoam former																													
	B	Cut wooden strips																													
	C	Glue Layers																													
	D	Tape and form Layers																													
	E	Bag press and Laminate																													
	F	Mark and drill holes																													
3	A	Mark and cut panels																													
	B	Mark and drill holes																													
4	A	Cut small blocks																													
	B	Bradawl and Drill holes																													
	C	Glued and taped to panel																													
5	A	Mark out on sheet																													
	B	Cut out on Bandsaw																													
	C	Mark and drill holes																													
6	A	Turn on Centre Lathe																													
7	A	Mark out Openings																													
	B	Drill and cut out opening																													
	C	Drill hole in centre																													
	D	Drill Hole for Lock																													
8	A	Mark and cut out (back)																													
9	A	Attach lock to acrylic																													
10	A	Sand components down																													
11	A	Apply Danish oil																													
	B	Wax and wipe down																													
12	A	Glue outer rings stable																													
	B	Attach outer panels																													
	C	Attach inner rings																													
	D	Attach Acrylic and rod																													

Key

Work Time - 1 hour per box █

Quality Control - 1 hour/box █

Spare time - 1 hour per box █

Deadline

Colour:

Ensure that the edges and dimensions are very accurate

Finish Outer Rings completely by: 1 Feb 2017

Ensure that the edges and dimensions are very accurate

Use spare time to check the rings for accuracy

Finish Outer Rings completely by: 9 Feb 2017

Make sure Panel dimensions are checked and accurate

Finish Inner Panels by: 12 Feb 2017

Finish Inner and outer panels by: 15 Feb 2017

Use a micrometer to check the dimensions are right

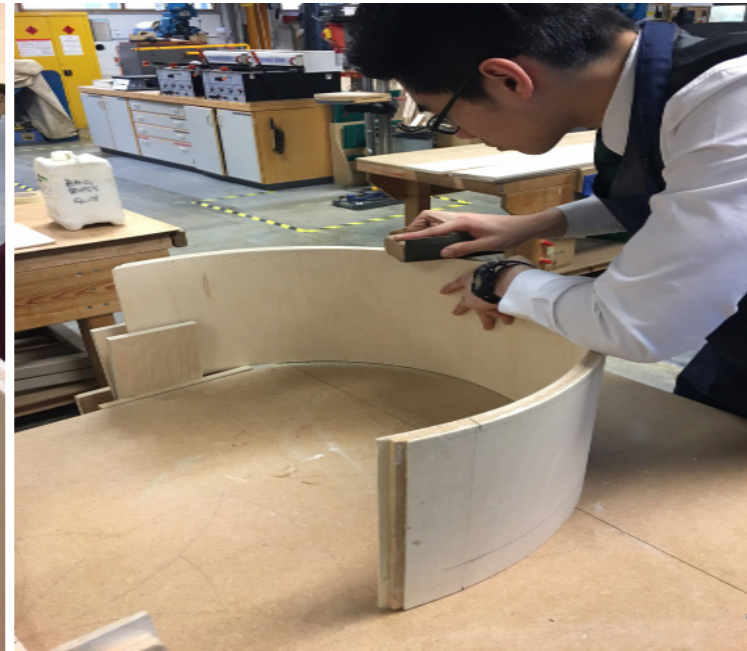
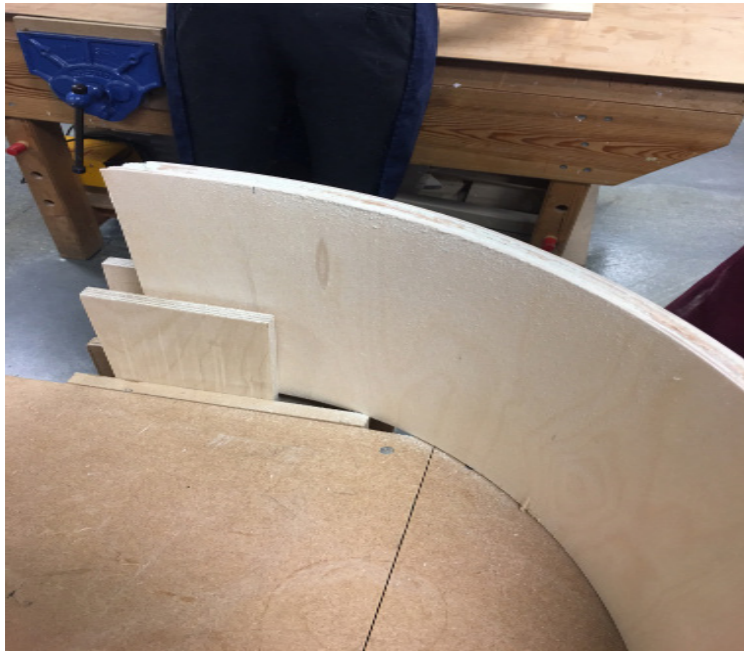
Finish All Acrylic sheet processes by: 27 Mar 2017

Make sure that the oil is completely dry before Waxing

Be ready to assemble by: 1 Mar 2017

Check all component parts are finished completely

Project Completed by 8 Mar 2017

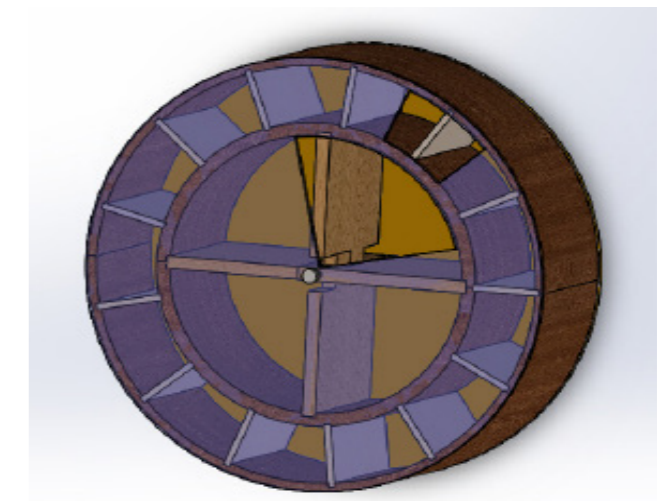


Here I am starting to work on the Outer rings of my product. I have taken the first half of the ring and sanded one side of it down so that it is smooth and I can measure 20cm from one flat end. This will ensure that the entire ring will be exactly 20cm all the way around. I have tried to clamp the semi-ring in the vice which you can see, I have taken two wooden panels to clamp it into the vice to elevate it for sanding.

Here you can see me sanding the edge of the semi-ring. The most coarse piece of sand paper that I could find is the 40P sandpaper. This was especially useful for getting rid of the glue after the lamination. After that I have used some 60P to make it smoother. I have also checked that it was flat against the table by putting the edge face down. This will check that the face is flat and level.

Here I have gotten some help to bend a piece of thin MDF around the inside of my product. This will allow me to mark out the 20cm line correctly. This line will help me cut out the product better on the bandsaw which I may not be able to do because of the size of the product being larger than the bandsaw, which I might need help from a technician. I have ensured to use a sharp pencil and push into the side of the MDF board.

Here I have asked for help from a trained teacher to help me cut the large outer ring of the product. I have taken 2 photos, one to show that the ring is larger than the bandsaw and that the curve will be relatively difficult to cut out because we will have to keep the blade perpendicular to the wood at all times. The second photo shows this, the perpendicular blade to the wood will lessen the effect of splinters on the other side



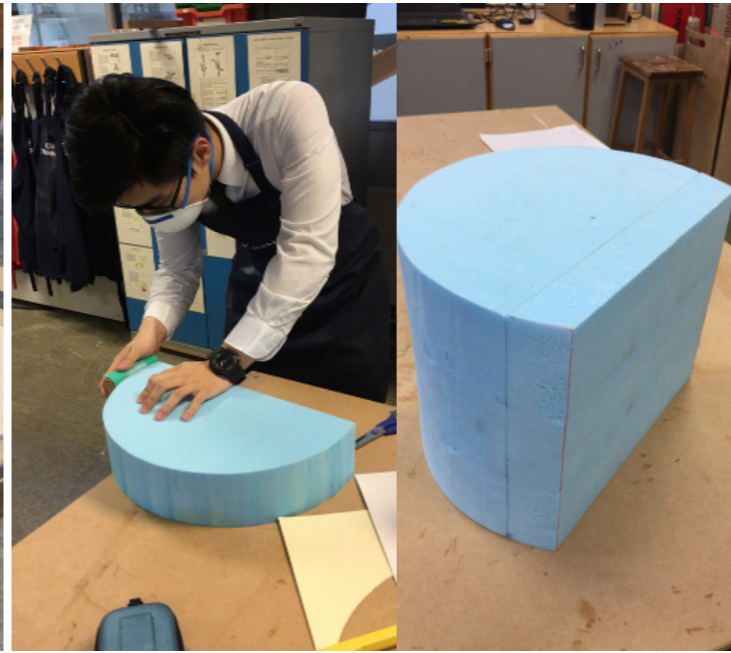
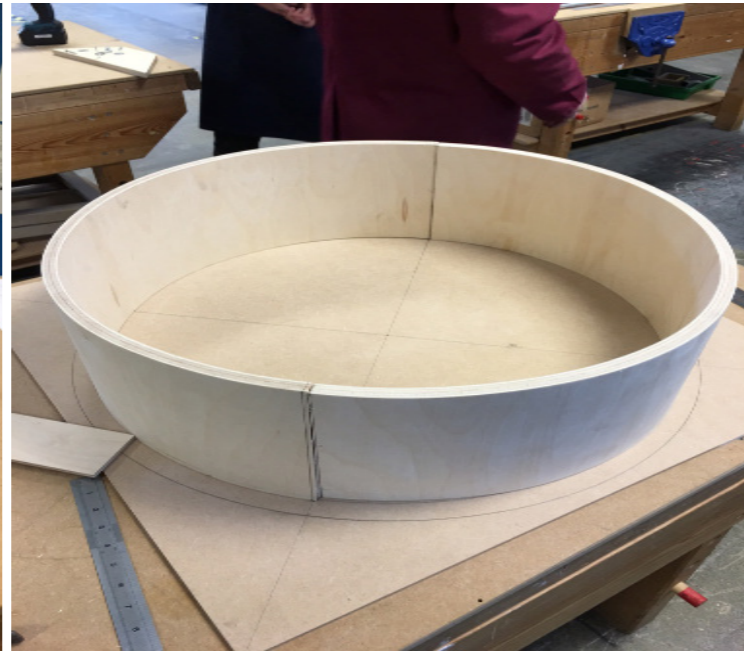
In this photo, I have marked out one side of the outer ring as the datum side and have sanded it down so that it is flat. Here in the photo you can see that I have put that side against the table to further confirm that it is flat. I have even pushed down on sides of the outer ring and because there is no rocking in the part on the table, I can confirm that the side is flat.

Here I have taken both pieces of the outer ring and put one above the other. This is to see if both sides are matching. Because the top piece has a datum edge which is completely flat and has been confirmed, I will be able to identify a better side for sanding and creating the 2nd datum side for my second outer ring part. This will mean both pieces will join together well and be flat on the same surface.

Here I am cutting the second outer ring part. This will allow me to have the correct dimensions for the width of the product being 20cm excluding the width of the MDF board at the back and the Acrylic sheet in the front. This will also allow me to have cut the oversize part down using a much easier method than I would have thought of previously. Safety precautions include an apron and goggles that will protect my eyes.

The Picture above shows the product which has been finished on CAD software

- KEY:
- Red: Tools and Materials
 - BLUE: Processes
 - Green: Safety
 - Orange: Quality Control

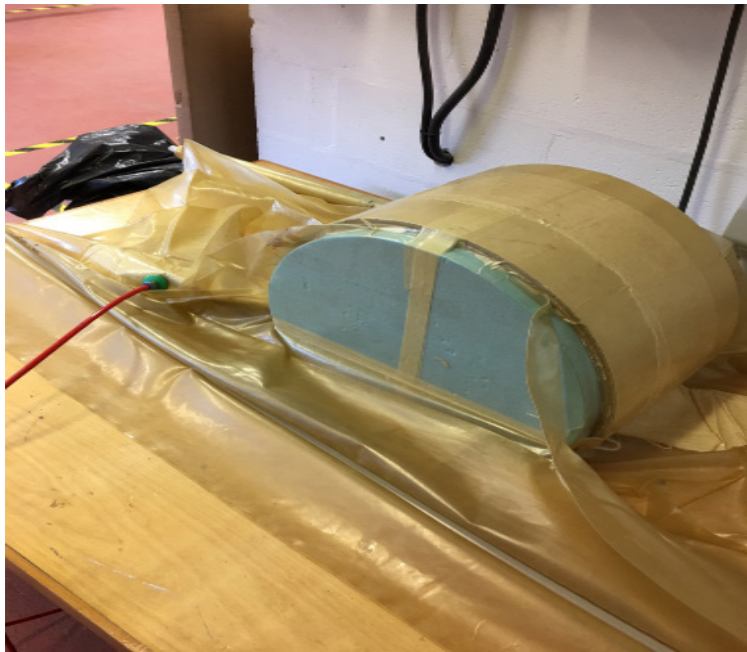


Here I am using a **hand made compass** which will allow me to **mark out circles of certain diameters** that I would like. This device has been thought of by my teacher and he has showed me the way by using pins and a strip of wood to mark out the circle. By doing this, I can now set-up my outer rings which have been cut to width but not length yet and see whether or not they fit well and **I can do my markings based on the circle template.**

Here is the follow up picture to the picture before, showing the two outer rings being put onto the sheet of MDF which I have marked out the radius of **310mm**. **This has been slightly smaller than the outer rings that I have made so I have adjusted it slightly** and marked out lines in which cutting the Laminate would be suitable to later join the two pieces to create the outer frame of my entire project.

Here I am making my Lamination former for my inner ring **mainly by cutting and also some sanding down**. As you can see, the former is smaller and of a radius of 20cm. I have stacked 3 of these together on top of each other to create the width of 30cm for my 20cm that I need. I have also allowed for extra length on the bottom **so that I can cut it to actual size later on**. I have also worn a **safety mask** whilst sanding to limit inhaling.

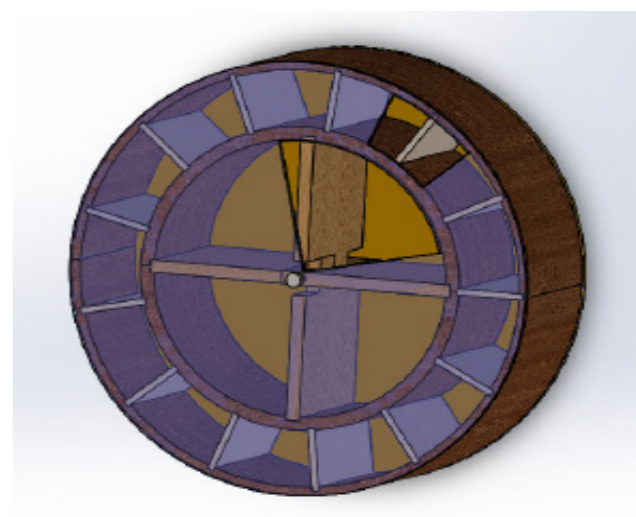
Here I am using some **PVA wood glue** on top of some layers of birch plywood veneers as well as flexi-plywoods to create a lamination sheet of width 16.5mm. This will be bent over my blue former and I will tape it up well so that the product will be a nice circle after lamination. **I have tried to make sure that each layer of glue is not too excessive as well as being evenly spread across the entire sheet so there are no glue patches.**



This picture is mainly showing the lamination process of my inner ring former being done. **I have ensured that the sides of the plastic bag does not slip under the wood which would mean that the bag could potentially break and split**. I have also put a piece of cloth which will allow the air to be continually drawn out to create a more stable vacuum and a stronger vacuum. I will leave this to set overnight and up to 24 hours.

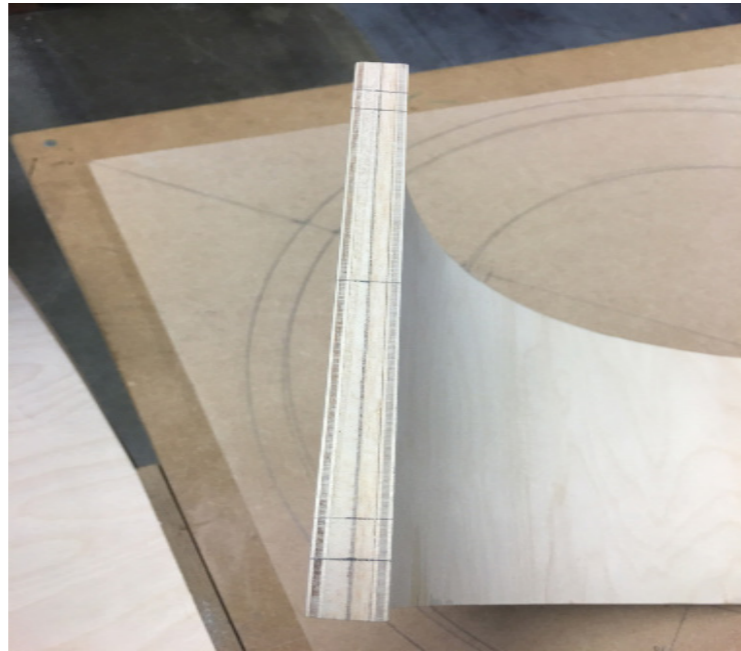
Here I have taken the lamination out of the mould and because there is quite a lot of excess glue, I have taken a **chisel as well as a mallet** to try to remove lots of the excess glue easily and **gently** so that I will not have to sand the glue down later on as it is more difficult than sanding the wood. **I have made sure that my fingers are not below the chisel** when i did this as well as tried not to accidentally chisel the wood away.

Here I am using a thin piece of **MDF** to line out the points around the curve which are 20cm from the datum line. I have also **clamped each end to the curve** which means that it is stable and I can safely mark out the inside part which will allow me to cut it on the bandsaw much easier. I have tried to find a piece of MDF which is **not too thick so that it will snap** and i wouldn't be able to bend it around the curve



The Picture above shows the product which has been finished completely

KEY:
Red: Tools and Materials
BLUE: Processes
Green: Safety
Orange: Quality Control

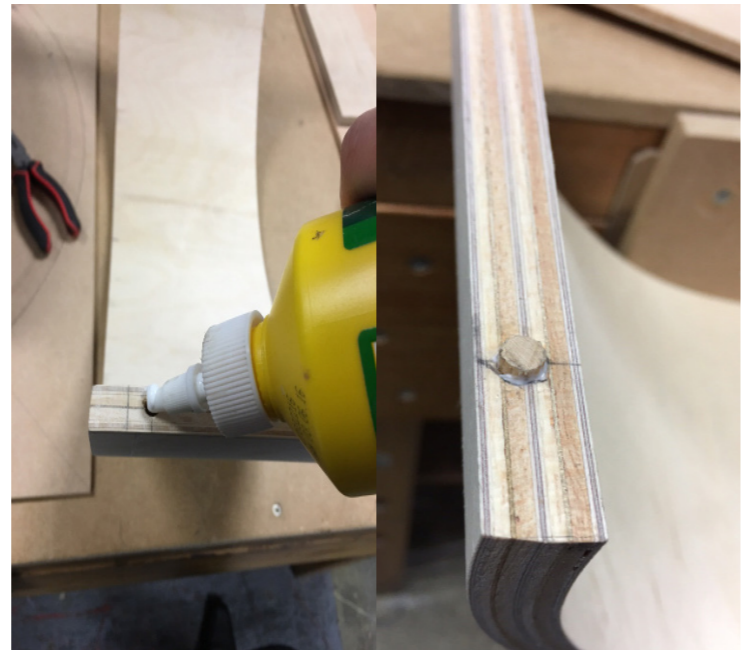
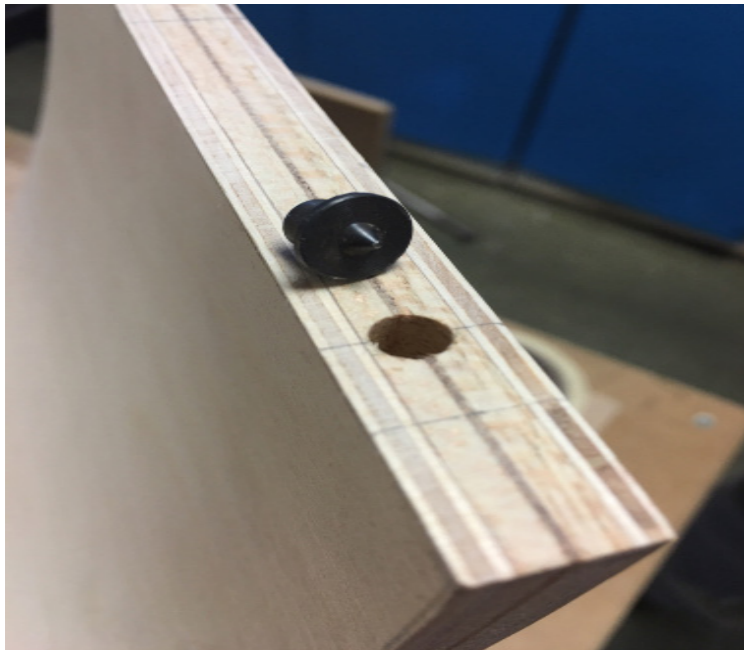


Here I am using the **machine sander** which is a hand held version to sand down one of the edges. I have found that this machine is hard to operate because it shakes a lot and also I must not make the machine accidentally tilted so that it will **sand the edges**. This would cause lots of splinters. **I have worn safety goggles for this and also put a bag in the exhaust pipe place to collect the sawdust.**

Here I have marked out different measurements and I will be **bradawling** 2 small holes in the middle of the wood **25mm and 175mm from the datum edge** that I have used to base all my markings. This bradawling will allow me to drill **accurate holes** in the centre of the wood. The bradawling has been relatively hard because the centre line in my lamination is much harder than the sides of it, making the bradawl move sideways.

Here I am using a **spirit level** to make sure that the lamination has been clamped into the vice at a good angle. This will also allow me to drill the holes for the dowels at a 90 degree angle. I am wanting to **join the two sides of the semi circles with dowels** on the end as well as screws from the backside of the MDF backboard so that the rings are secure and stable.

Here you can see me drilling the holes into the wood at the position where I have previously bradawled it. If you look closely, I have put some **tape on the drill bit** for the 6mm drill bit because it will give me a **good indication of where to stop**, allowing me to have a protruding dowel that I can use to join the 2 semi-circles. I have made sure that the **drill is vertical and perfectly straight before I drilled by the help of a teacher.**



After drilling the hole, I have used 6mm **dowel locator** pins to line up the other semi-circle. This will allow me to accurately line up and join the two semi-circles which will in turn allow me to have a fuller circle and a better looking and **smoother joint**. Because I have drilled the hole for 6mm dowels, I can only use the 6mm dowel locator pins which will fit well and give me a pin point **accurate point** on the second semi-circle.

I have made a small mistake in the second photo as I have accidentally drilled the hole slightly to the side. This means that the joint will be less effective and also not flush. Therefore, **I have put a dowel into this slot, glued it and then sanded it down to prepare for a second drilling.** This will be better for me as the hole will be more central.

Next I have glued all the dowels into the slots that I have drilled previously and flipped them upside down so that the dowel is **getting pushed into the slot by the weight of the lamination**. I have done this for all 4 pieces so that the gluing process will be strong and I will be able to join these pieces together well at a later stage for further making.

The Picture above shows the product which has been finished completely

KEY:
Red: Tools and Materials
BLUE: Processes
Green: Safety
Orange: Quality Control



Here I have shown the progress I have made to my client and she have given me some **feedback and her opinions** which were generally good. This has allowed me to confidently continue with me production. At this stage I have completed **joining the dowels** into the sides of the rings which will allow me to join them together at some degree of strength for eventual flat-pack joining in the future.



Here I am using a **ruler** to line up the middle of the MDF backboard to the edge of my circle where my outer ring will be located. I have then **marked out holes at every 25 degrees from a diagonal edge**. These markings will then be **bradawled** in the centre where it will be lined up and joined to the Outer ring part using **1 inch No. 6 screws**. I have ensured that the angle has been accurately measured by a **360 degree protractor**.



In this next picture, I am **drilling holes** into the backboard MDF because this will allow me to join the backboard with the outer ring. These screws will go into the Edge of the outer ring which will be the outer structure of the product mainly completed. I have drilled a **Clearance hole** using the **4mm drill bit for the No. 6 screws**. I have also **drilled into a board beneath** to stop the MDF at the back splitting and tried to drill completely **straight**.



After drilling the holes into the Backboard, I have **countersunk each hole** so that the no. 6 screws will fit in well. Here in the photo I have also started to line up some of the holes to the holes drilled into the outer ring which were **pilot holes of 2.5mm**. I have screwed two screws in at either end so that all the other holes in the MDF line up with the Backboard, allowing me to bradawl and **drill more accurate holes** through the MDF.



Here I have completed the drilling of the Outer ring as well as the Inner ring which has taken me slightly longer as attaching the inner ring whilst having the outer ring attached was slightly harder to do. In the photo, I have used an **orange belt to tighten the Outer ring** so that both **semi-circles join together flush to each other**. I have also put a piece of flexi-ply where the metal part of the belt is to make sure it **doesn't scratch my outer surface**.



In photo 1, I am using a ruler to identify the **diameter across the circle** and I have also used a **tri-square** to help me **line up the centre point on the circle** and the certain points on the **inner circle's edge** as well as the outer circle's edge. This is because I am starting to separate the space between both rings into 13 slots for the smaller cameras. Photo 2 - **drilling the holes into each separating panel** so that I can join the panel and the MDF backboard. Again using no.6 screws.

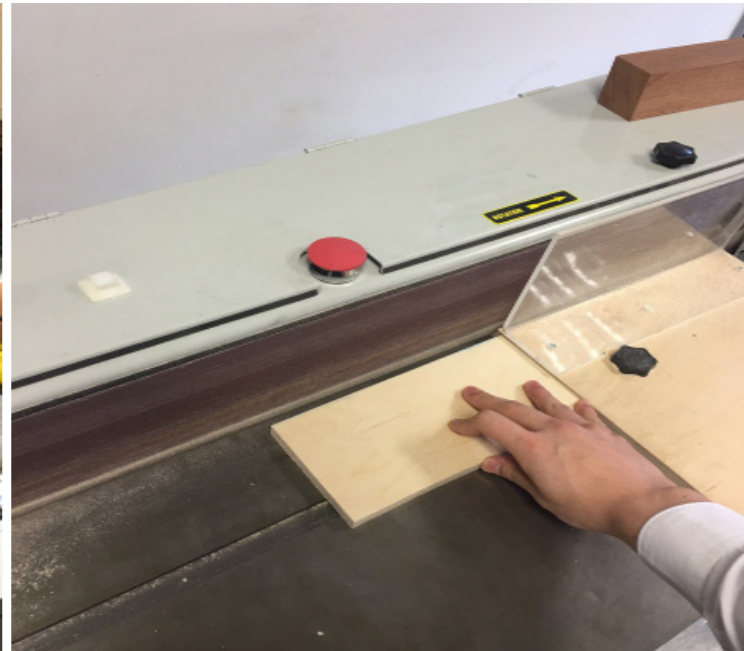


I have **joined up 3 pieces** of the separating panels in between the rings. As you can see, I have tried to make them as close as perfect to line up against both rings well. I have also asked the technician to cut out 13 identical panels which I will **sand down individually to fit each allotted slot**. This will require me to mark each panel and assign it to its own slot.



The Picture above shows the product which has been finished completely

KEY:
Red: Tools and Materials
BLUE: Processes
Green: Safety
Orange: Quality Control

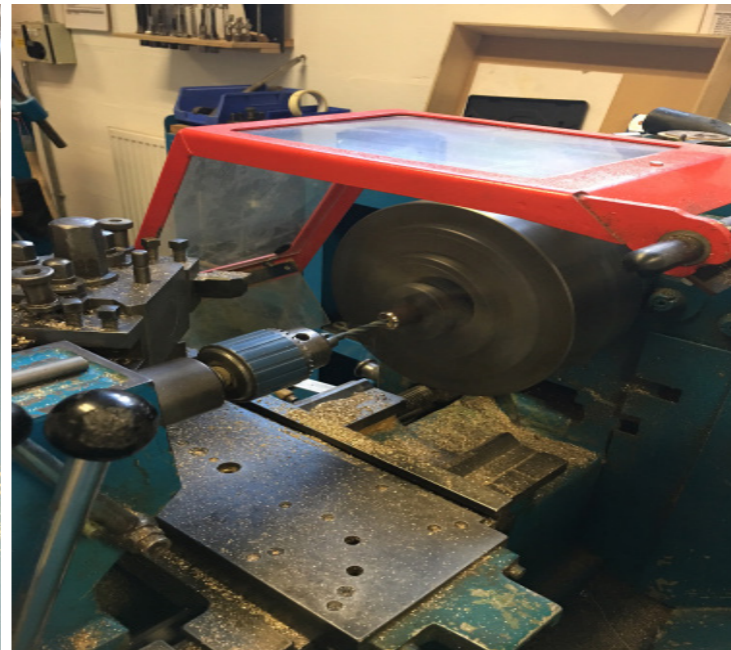
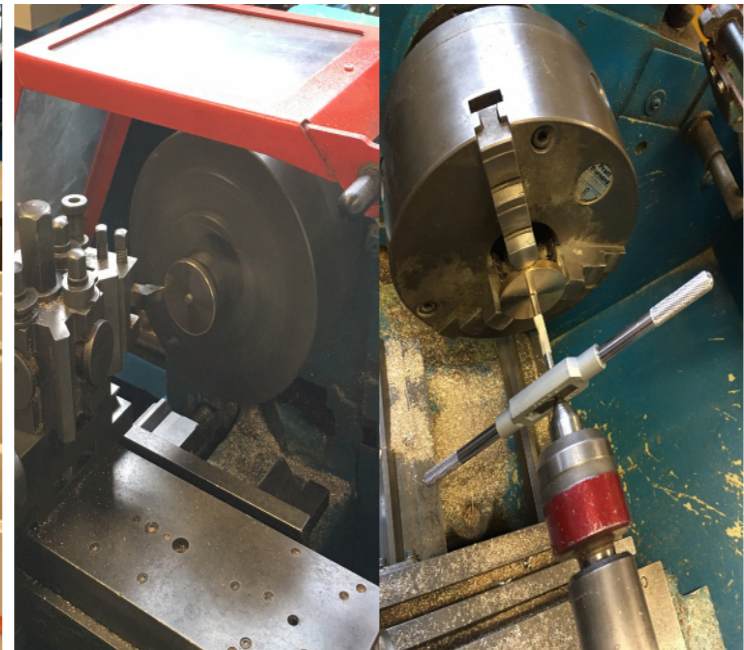


I have then gone back to the basic camera and checked the dimensions of the camera when it is being charged. This has been done because being charged whilst being in the product is one of the key things that my product has to be able to do. This has also proven to be very useful because I had initially thought about making 15 slots but after finding out that there isn't enough space for 15, I have had to change it back to 13.

Here I am sanding each individual piece down to fit the slots which vary in size depending on where it is - due to the rings not being 100% perfectly circular. I have sanded down small margins at a time to ensure that I have not taken too much off at once. I have also worn an Apron as well as safety goggles to protect myself. I have also made sure that the extraction has been switched on so that not too much wood dust is collected around me.

I have completed all the outer ring to inner ring separating panels. I have also taken the model that I have made which is the inner ring divider panels and put it into the middle. Because the model was to actual size, the model fit very well and the rod could go through quite well. As you can also see, the orange belt has come back. I have used it to keep everything tight while attaching the 13 separating panels so that they are slightly looser.

After seeing that the model that I had made fit well, I have decided that the next step was to join the model to the MDF backboard. I have decided to use the same screws so again, I have drilled 4mm clearance holes for the Model to be joined. I will also have to put the rod through all the pieces and join them individually because that will ensure that they will definitely fit inside later on.



I have decided that the outer panels need to be secured to the outer ring. In the first picture I am using a engineers square to mark a line that has been taken from the centre of the circle and I have marked 25 mm down. There I have bradawled the mark there and drilled 2 holes, one clearance hole through the ring (4mm) and a pilot hole (2.5mm) through the panel. This will make the circle tight and there will be smaller gaps between semi-circles

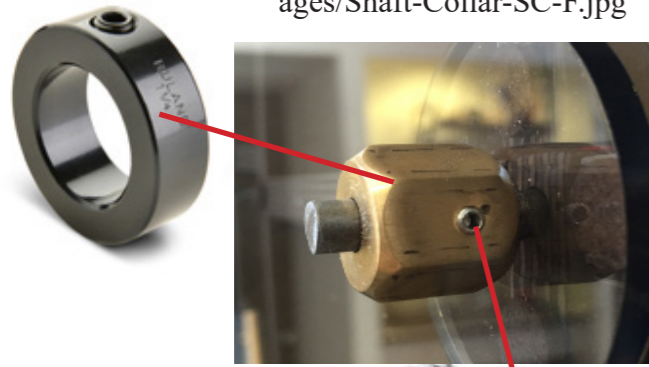
Here I am making progress on my Steel rod which will be the axel of rotation for my entire product. I have decided to put a 50mm diameter brass 6mm thick circle which will be tapped from the inside allowing me to screw it onto the rod. Here I am showing a picture of facing of the material on the centre lathe to clean it up as well as doing an accurate tapping in the middle, utilizing the drill bit slot to slowly push the tap in perpendicularly

Here I am doing the other part of my steel rod. I am creating what is called a 6mm collar grub which is a bit that will go through the top of my rod and will allow me to secure the acrylic sheet onto the rest of the product without it falling off easily. The brass part will have a hole through the side as well for a 4mm grub screw to tighten the part to the rod nicely.

The Picture above shows the product which has been finished completely

- KEY:
- Red: Tools and Materials
 - BLUE: Processes
 - Green: Safety
 - Orange: Quality Control

<http://www.ruland.com/images/Shaft-Collar-SC-F.jpg>

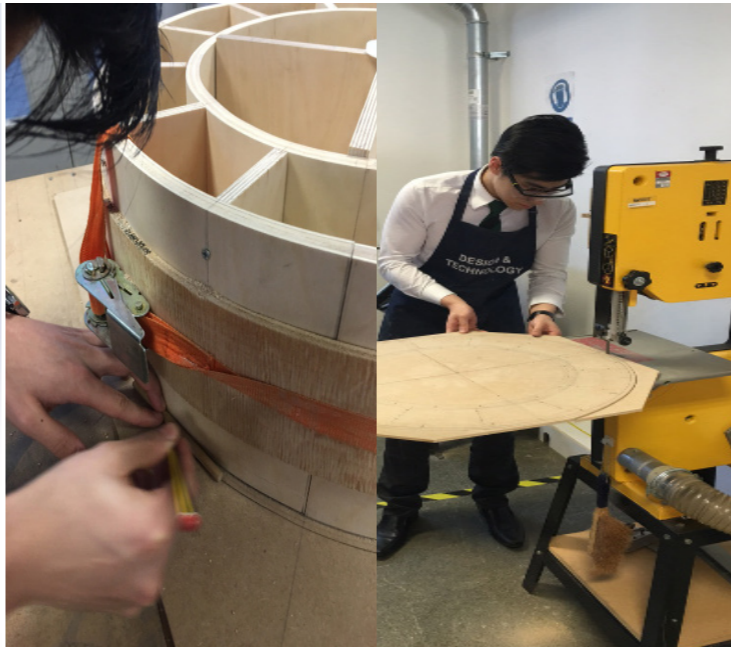


<http://thumbs2.ebaystatic.com/d1225/m/mmVjWxnLlvAXSKs-LuVS4nw.jpg>

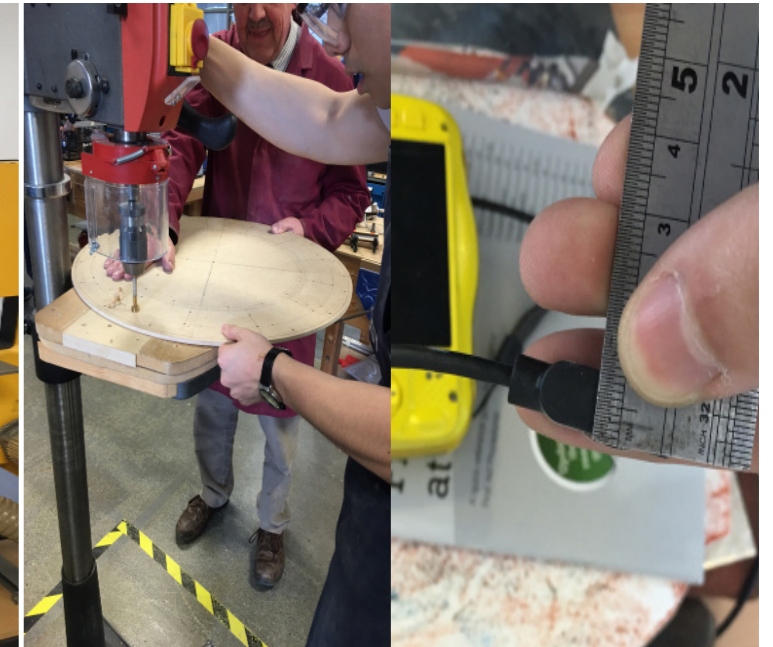


In the last 2 stages, I have been developing my steel rod. These are the parts that I will be making to suit my rod which will allow me to secure my acrylic sheet to the rest of my product quite well. The top photo is a Collar grub which I will be using with a 6mm hole in the middle. There will also be another hole on the side where the grub screws (4mm) example in the 2nd photo, will fit through, allowing a tight fit onto the rod from the side.

These two pictures are made from solidworks designs that I have done to illustrate the way the I intend to change my steel rod design. This is the back part of the rod with a tapered base which is screwed onto the rod. This will allow for it to have a tight fit and make the Base it flush with the MDF surface. The Base will be made of brass as is the Collar grub or the Grub Screw nut that goes on the top of the steel rod.



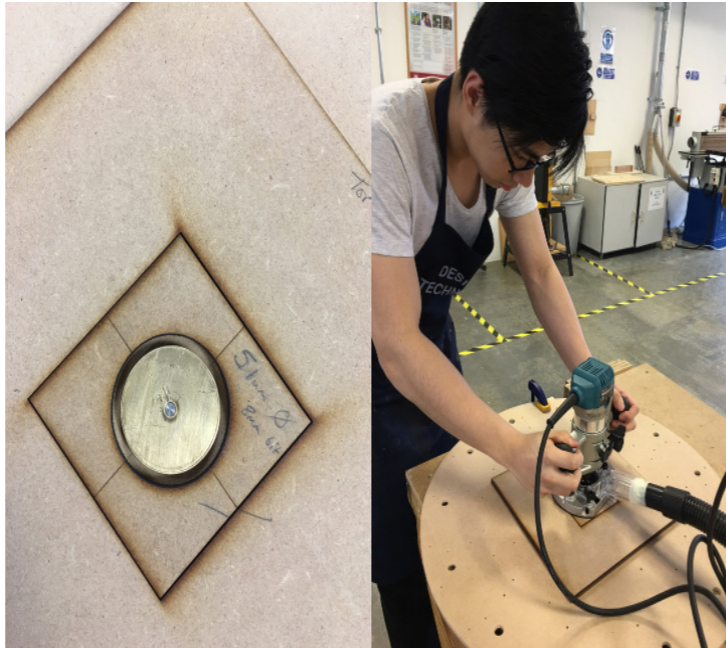
After the steel rod's development, I have started to finish the backboard of my product, the MDF part. In the first photo I am using a dowel and a pencil to mark out equal distance from the outer ring which will be the line that I will cut to. This means that the circle will be slightly larger than the outer ring which will make the screws on the outer ring stronger and withstand more. In photo 2 I am cutting the circle on the bandsaw. Safety - goggles.



Here I have measured some cables that will go in the backside of the product so that the small cameras can be charged whilst being stored in the product. I have decided to use 15mm forstner and therefore I have marked out holes near the outer edge of the product and drilled these holes on the Pillar drill. This will allow charging to be better and also easier as the cable will easily fit through.



Because I have finished the MDF panel for my backboard, I will have to finish it using some danish oil as well as some woodwax later on. In this step, My teacher is helping me sand this part down quickly by using a larger belt sander which is faced downwards. Unfortunately I am not allowed to use this machine as I am not well trained enough, so he has had to do this for me to increase the speed of my production.



As I have finished making the steel rod parts, I have decided to submerge the brass end bit into the wood, which means that I will need to cut a 50mm hole on the backside of my MDF board. Because of this, I am using a router and I have had to make a jig which a technician helped me with, guiding me to cut this out as the jig will need to account for the bit I am using. In the 2nd photo, I am routing and I have ensured that wood dust is being extracted so that it doesn't affect me.



As I have finished most of the wooden component parts, I have started to oil the component parts, In this time, I have oiled 2 inner panels as well as 6 outer panels which I have sanded down completely and oiled individually. I will also have to repeat this process for the outer and inner rings as well as the other boards in the product. I have made sure to wear gloves and wipe down any excess glue using a white cloth.



The Picture above shows the product which has been finished completely

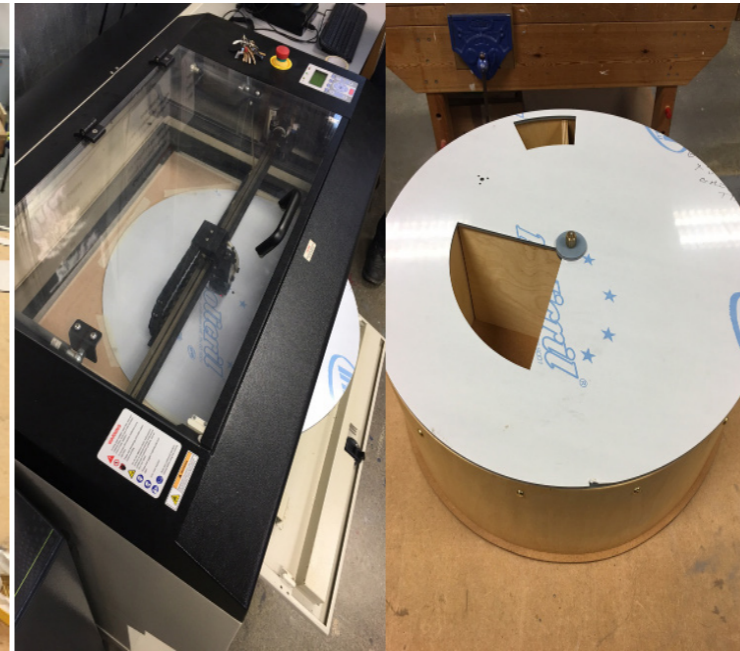
KEY:
Red: Tools and Materials
BLUE: Processes
Green: Safety
Orange: Quality Control



After the oiling stage, I have continued to wax all the component parts using some steel wool to rub the wax in and then rubbing it off by using a piece of white cloth. Using more wax than needed is not much of a problem here as the wax can be spread quite evenly. For safety against the smell of the wax and how hard it is to get off clothing, I have worn some gloves as well as an apron to protect myself and my clothing



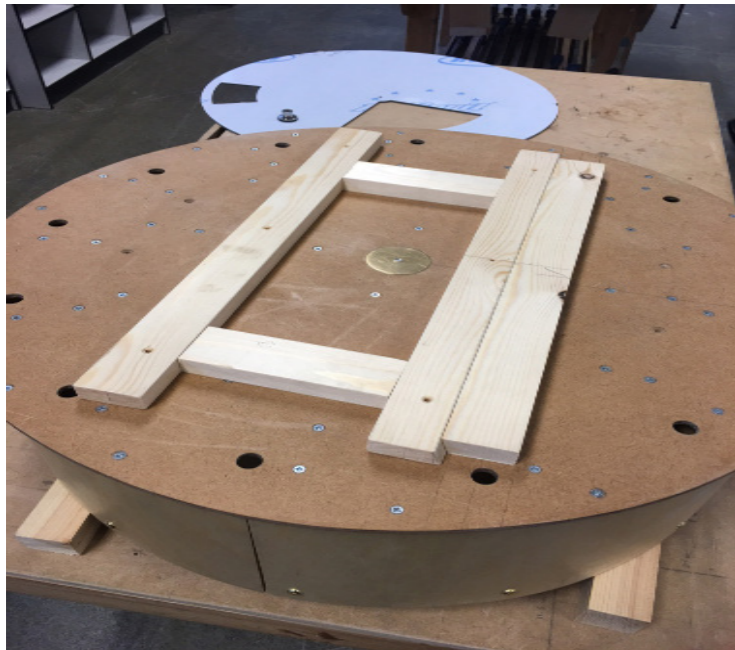
Here I am assembling the entire product together after having finished each individual component part. Here in the photo I am attaching the inner ring dividing panels to the MDF backboard which is the main part to hold all the pieces together. This will allow me to get a final sense on how the product is and what quality it is at. I also used the correct screwdriver as I would not like the screws to be blunt after a screwing them in.



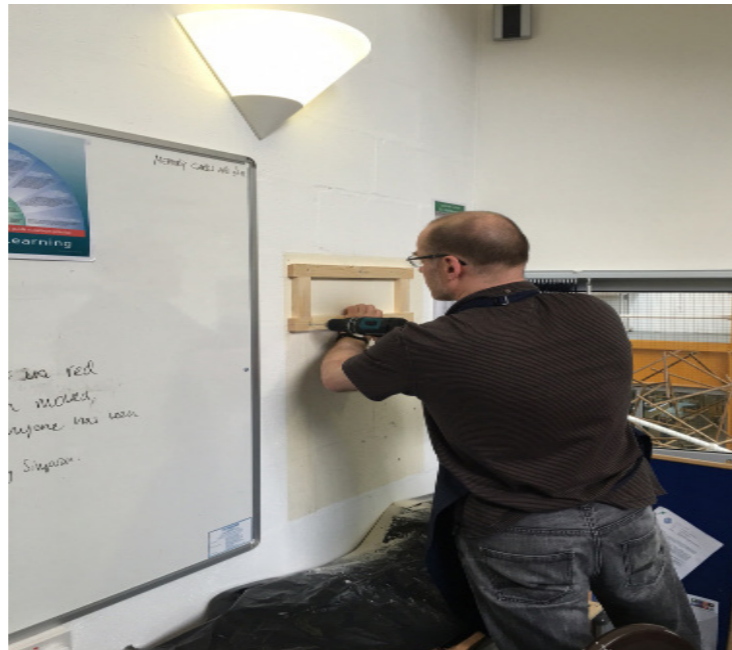
Here I am preparing the last functioning component part of my product - the Acrylic sheet. This circular sheet has been ordered in and I have to cut some holes in the sheet using the laser cutter so that there are holes in there allowing me to access the cameras. In the first picture, I have put the acrylic sheet in the laser cutter and the second picture is the result of the cutting, it includes the holes for the lock and the lock's screws.



After cutting the acrylic sheet out, I will need to countersink the screw holes for the lock to sit flush on the surface of my product. Hence, one of my technicians have brought in his own countersink machine which has a depth stop as well as a base which would mean that the countersunk hole would be exactly perpendicular to the acrylic sheet. I have used this for 3 holes which are the screw holes for the lock.



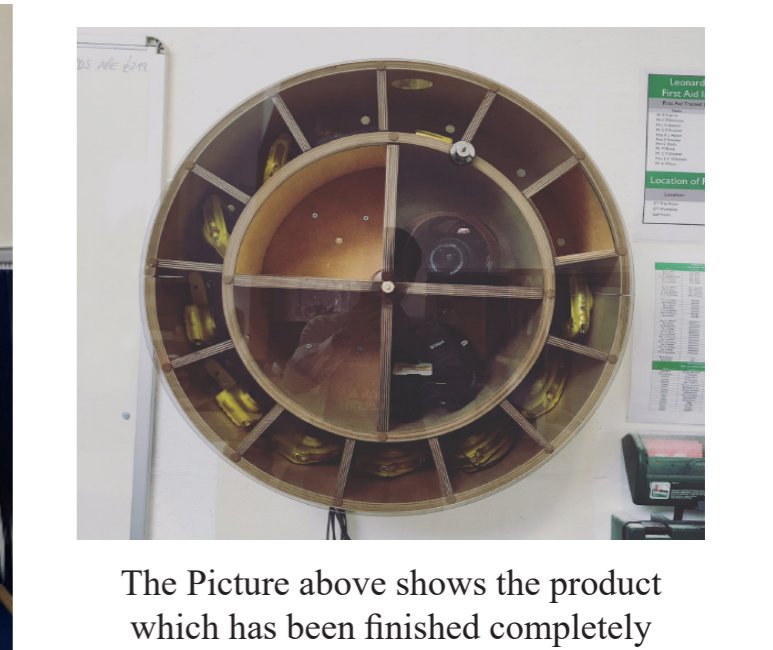
Here I have made some batons for the product to be hung on the wall. If you can look closer, the top baton has a slight incline on both the pieces so that when I put it on the wall it will sit nicely and not come off easily from the weight of the product in a horizontal direction. These batons will also help the product to be securely fastened onto the wall meaning the product will not easily come off unless the screws are taken off.



Here one of my technicians is screwing some batons onto the wall using some special drill bits. He has also used some spirit levels to make sure that the batons are level, which in turn will allow my product to sit upright and straight. We have put some bin liner on the bottom where all the dust will collect from drilling into the wall to make sure that the dust can be removed later on easily. The two smaller batons in the middle are spacers to make sure the bottom baton is straight



After the batons have been put up, I have put the product up without the acrylic sheet to see how it looks without it. As you can see, the product looks quite good and has filled up the majority of the space width-wise. This means that the space has been efficiently used and therefore the camera slots are large enough and as large as they can be. After this, I have removed the protection sheet on the acrylic and put it on to finish the product.



The Picture above shows the product which has been finished completely

KEY:
 Red: Tools and Materials
 BLUE: Processes
 Green: Safety
 Orange: Quality Control

Testing Against the Specification

Purpose

1. It must provide an easily accessible, safe, and efficient solution for the storage, and borrowing of cameras. This would also mean creating a way of locking the cameras up and making sure that people will have to take responsibility for borrowing a camera.

Form

2. It must allow the cameras to be easily slotted into the individual slots provided by the storage device. This would also mean it should not hurt the user whilst storing or borrowing the cameras.

3. It must be able to store the cameras with enough space as well as fitting charging cable and the 3 larger individual SLR Nikon Cameras as requested by my clients.

Function

4. It must provide an individual slot for each individual camera as well as 3 larger slots for the SLR Nikon cameras.

5. It must be able to provide a path for cables in order to charge the individual cameras when they are back into their slots.

6. It must provide 15 slots for Buttery cards so that the person borrowing the camera can be identified. 12 for smaller cameras and 3 for the SLR Nikon cameras as mentioned by my client Nel during the interview.

User Requirements

7. It must be easily accessible so that the user can take the cameras out and borrow them with some efficiency and ease.

8. It must have a slot large enough so that the ergonomics of the hand will be considered and will not hurt the user when they are retrieving the camera.

9. It must have a cover which can be closed and locked when the cameras will not be used anymore for safe storage.

Performance Requirements

10. It must be able to hold up the weight of all the cameras if the product is to be hanging on the wall.

11. It must have a way to charge all the cameras once they are put back into their individual slots as requested from my client Nel

12. It must have spaces for buttery cards so that the borrower can be identified as requested from my client Nel as well.

Materials and Components

13. It must not be too heavy so that the product has too much weight and strain on the materials because it will be hanging on the wall as my client has said as general points during an interview.

14. It must use and consider using more sustainable materials such as woods like birch plywood so that there is minimal environmental impact and materials that can be recycled or reused should be considered even more. Acrylic could also be used because it can be reused as well as recycled. Metals can also be fine as they can be melted and recycled quite easily. Using Brass and Mild Steel are good options for Metals.

15. It must have well finished materials especially if it was to be a wood such as birch plywood so that the product will be more durable. If plastics are used, I will probably use acrylic as it can be recycled by melting in an oven and then remaking into a different shape.

Size and Weight

16. The product must not be too large so that it cannot be hung on a wall if being hung on a wall is the method I have chosen. Wall size limits me to 70cm wide and 90 cm long.

17. The product must not be too heavy to put strain and stress on the materials which could damage them over time. If the product exceeds 20kg then it may reduce the life span of the product.

Safety

18. The product must be safe to use and should not hurt the user when taking cameras out.

19. The product should be finished off well with no sharp edges or wooden edges that have not been sanded down so that splinters do not become a problem for the client and people/students that will be using it.

Quality

20. It must be made to the highest possible quality so that the client will be satisfied with the product.

21. It must have high quality materials which are supplied by trusted and good suppliers to enable the product to be made out of good materials which therefore means higher general quality.

Scale of Production

22. It must be able to be manufactured with energy efficient processes.

23. Even though the product will be one off, batch production should still be considered.

Cost

24. The budget of this product according to my 2 interviews with both clients would be about £350 because my clients have had a range of £150 to £500 which I think £350 would be quite a good middle point for the cost of the product. This figure will be excluding all labour costs and energy costs which would include machines.

Sustainability

25. It must be fully functional for another 10 years after I have created it. This is to ensure that the quality of the product will be high and this will also ensure customer satisfaction and also because the amount of money they are willing to spend is quite high.

26. It must consider the uses and applications of more sustainable materials such as birch-plywood and acrylic which could be reused or recycled should be considered even more so that there is as little impact on the environment as possible. This will mean that I should try to find materials that can be reused and recycled such as most woods and most plastics. Recycling metals is also possible but the process takes much more energy and therefore is still not as good for the environment. As mentioned, the 4 R's should be thought about and considered carefully when choosing materials and thinking about the end of life circumstances.

Red Text = Failure to meet the Specification point

1. My product does provide an easily accessible safe storing option for the cameras. But, making sure that the people take responsibility would be a slight difficulty as I have not created a buttery card slot for identifying the borrower.

2. The product does allow the cameras to be easily slotted in as well as being safe to use, and not hurting the user whilst they are storing the cameras due to well finished component parts with no sharp edges.

3. The product does provide enough storage space for each camera as well as charging cable for the smaller cameras. The 3 larger SLR Nikon cameras also have their own position in the product.

4. The product does provide an individual slot for each camera as well as slots for the larger cameras.

5. The cables do have a path that has been provided so that the smaller cameras can be charged whilst being in their storage unit. Larger cameras do not have a charging station as they are not charged by cables but by removing the battery itself.

6. The product DOES NOT provide slots for buttery cards so that the person can be identified. This has not been considered and is entirely a fault. However, there have been modifications in the sheets afterwards to provide an easy fix to this problem.

7. The product is easily accessible and is efficient when transferring the cameras from different positions.

8. The product allows large enough slots for each camera as well as proving hand space and ergonomics of the hand have been considered and they will not get hurt as there is plenty of space to retrieve the cameras from their slots.

9. The product does have an Acrylic sheet which acts as a cover to keep the cameras safely stored away as it also has a lock.

10. The product is capable of holding the weight of all the cameras as well as it's own weight thanks to some strong batons and the batons on the back of the product.

11. The method of charging is through cables running at the back of the product and into each individual slots. After the product has been finished, I have asked Nel about this point and she has agreed that it has been done to a good standard.

12. Buttery cards have not been installed but there is a modification that can be added on at a later date if required.

13. The product is not too heavy which means the stress on the materials and the screws as well as the batons are not as great.

14. The product does consider more sustainable materials as I have used mainly woods in my product. Birch plywood and Flexi-plywood have been used which can be recycled easily. Other materials include Brass and Mild steel which can also be reused in the future. The acrylic that I have used is still in a large sheet so it can be reused in the future.

15. All my wooden component parts have been oiled down and waxed and therefore finished properly meaning it is safe to use. The acrylic that I have used is also self finishing which is very helpful.

16. The product's dimensions match the provided space which is very useful as it is just large enough to fill the gap. The position of the product is also at a medium level to the eye so that many students can also access it easily. The actual size is 32.5cm diameter and is a circular shape

17. The product's weight is not too heavy to exceed 20kg to put much strain and stress in the materials.

18. The product is very safe to use as all component esp. Wood have been finished well and are smooth with no sharp edges.

19. The wood has been oiled and waxed and have been checked for any sharp edges and splinters coming out of the wood. Such things have been removed during the sanding process.

20. The product's quality has been checked at many times within the production stages as I have done some quality control checks regularly. This has helped me maintain a high quality within my production and kept my processes accurate so that the end product is of a high quality.

21. The product has been made from good quality materials ordered by the school and I believe that the supplier of these materials are quite trustworthy as we have been ordering from them for quite a while now.

22. The product has been manufactured with efficient processes, and steps that could be done quicker whilst keeping the accuracy have been done. Otherwise, processes which control the quality of the product such as sanding down, have been done fully so that the product is still kept to a very high standard.

23. The product's batch production and industry potential has been considered and many of the machines and processes can be repeated and copied into the actual processes that one would use in industry to create this product there.

24. The budget of my product would have been about £200-215 and the most expensive component being the acrylic sheet cost £30. This has been within my range and I am quite pleased with the overall cost of the product. The cost has been lowered or kept to a lower standard because many of the component parts were not ordered in but made by me, Such parts include the steel rod and it's brass component parts which could have been bought (Grub screw nut) but because I have made them on the centre lathe, the overall cost was slightly lower. However, the product's price is still high because it is a one off product, so if it were to be made in industry in batch production, the product's material cost would be lower still.

25. The product will be fully functional to up to 10 years in my opinion. This is because the product has been finished off well to a high standard. Faults in the material can be fixed over time when they are spotted and the acrylic sheet that has been laser cut can be recut again using the same template. This means parts are replaceable.

26. The material's impact to the environment has been carefully considered (and 4 R's) and that I why I have tried not to use any materials that I would not need - such as incorporating my model into my actual product by making the models full size.

Testing Against the Production Plan

STAGE	PART & MATERIAL	PROCESS	EQUIPMENT	TIME (MINUTES)	QUALITY CONTROL	PERSONAL SAFETY	SAFETY OF OTHERS
MDF sheet - Back (8a)	MDF sheet (radius 312mm)	Cut out the sheet after marking out	Tenon Saw, or other saws, Pencil, Ruler	25	Mark out accurately Cut from a line for the Tenon saw and keep checking if I am on track	Wear apron and goggles	When using the Saw, check there aren't people around you who will bump into you
Gluing and assembly (12a)	MDF backboard Outer Rings	Glue the Outer rings to the MDF backboard	PVA glue	20	Spread the glue evenly and around the parts well	Wear apron and goggles	don't get glue everywhere

Alteration to Stage 12a

During the Manufacture of my prototype, I have changed one stage slightly and therefore didn't follow the production plan exactly. Stage 12a is where initially I wrote that I would be doing the gluing of the Outer ring to the MDF backboard, but because I would like this product to be **assembled and have the option to be a flat-pack**, I have not glued anything in the entire process. Not gluing the product together also allowed me to assemble the product easier in parts because I could work on the MDF backboard easier on its own as well as the other parts that would be attached to both the MDF backboard as well as the Outer rings simultaneously.

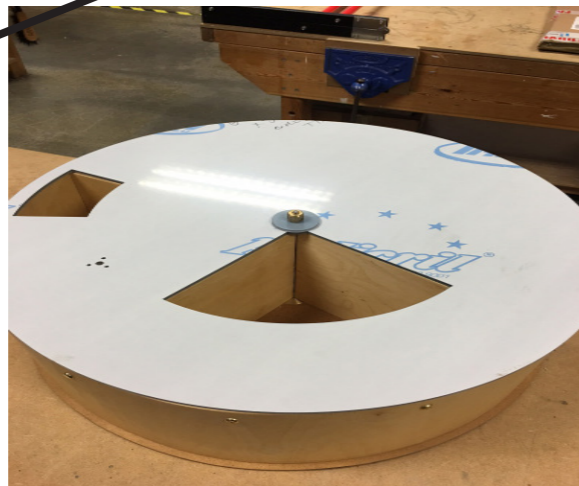
Having a **flat-pack option** is also very good for industrial production in the future if my product was to be taken there because it gives the clients the option of assembling it at home or buying the product already assembled. This means that the flexibility will increase customer's choice in the product that they are buying and may even increase the **customer satisfaction**.

If Glue were to be used, it would make the product more stable as well as make it more durable because of the added strength of the glue, but my decision for a non-glue flat-pack design, I think is quite justified.

Alteration to design : Acrylic Sheet

The initial design of the Acrylic sheet had one flaw in it. It was the fact that the strength of the acrylic between the two holes in the sheet, would be much weaker and therefore reduce the **life span** of the acrylic sheet, therefore I have made a revised version of this and with the help of a technician, we have cut the final design out on the laser cutter.

From the pictures below, you can see that the modified design has the two holes for the larger and smaller camera compartments to be **separated much more**, this **increases the strength** within the acrylic as there are no thinner bits that may be prone to snapping in the future. This therefore allows the product to be more durable. The first picture shows the cutting of the **acrylic sheet on the laser cutter using a MDF template**.



Edit to 8a

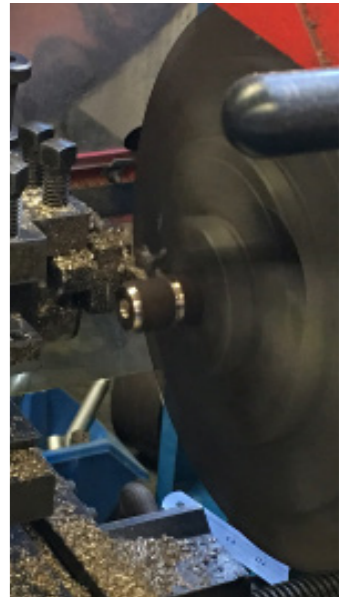
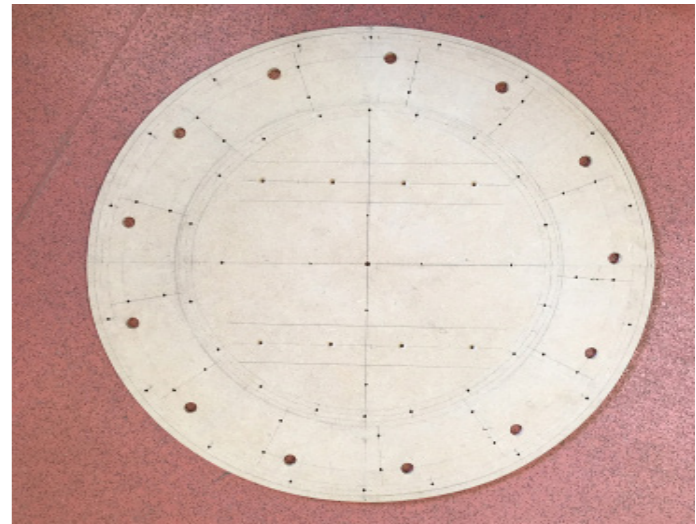
A small change to the MDF's history throughout the process, is that I have been working on the MDF backboard quite a lot during other processes because it is very good for joining 2 or more difference components together to see if the holes were drilled correctly or other factors **influencing the overall fit of the product**. Therefore a small change to part 8a would be the fact that MDF backboard was being worked on throughout the project, aiding compatibility between parts.

As you can see from the picture on the right hand side, This shows all the marking out and holes that I have drilled on the Backboard as I have continued through my processes to make sure that all my pieces are joining together as I wanted them to initially. Drilling and marking out these holes as we go is very useful because it **allows me to check my accuracy as well as work in general to make sure that I have made no mistakes or that the margin of error is much less and is also acceptable**.

Alteration to design: Steel Rod

Initially, I have not thought as much about how the parts would be held together horizontally. Therefore I have had to think of a way to stop the Acrylic sheet from detaching itself from the product, and I wanted to join this with the back MDF backboard. Therefore I have added a brass pad to the back MDF backboard by simply **tapping and dieing the brass pad and the steel rod** respectively, to create a strong horizontal base. Then I have created a hollow Brass part with a grub hole + screw in it so that it can be tightened onto the steel rod at distance. This allows me to secure the Acrylic sheet as well as find an easy way to make it detachable.

The first picture on the right shows the base of the product. This hole has been **routed** out so that my brass bit on the back end of my steel rod will fit well. The reason the hole doesn't seem to fit is because this was a **test run to see if the hole was too large and it was, so we adjusted it down and made it tighter later on**. The second photo shows the **Grub screw nut** being produced and cut off the end of a **hexagonal rod**.



Conclusion

The production plan has been **very useful** in the stages of production and manufacture of my product because as you can see, there hasn't been much modification to the production plan but there have been slight modifications across the component parts that will help the product develop into a **more stable and durable design**. These modifications have been very useful and have come from ideas when making the product as well as criticism and discussion amongst the clients and the technicians and teachers.

Within the original production plan, The **times that I have planned out were pretty accurate** which was quite surprising to me. The only factor that I could really not account for is the difference in component parts and this is because I could not predict the new design for the product's component parts. This means that I could not account for the time needed to create the modified products such as the **Brass disk and the Brass Grub screw nut for the Steel rod alone**. These two processes required me to do some **turning on the centre lathe**. The new design for the Acrylic sheet also required some attention to detail such as the **angle of separation** between the two holes and the position of the hole of the lock as well as the position of the screws that will attach the lock to the acrylic sheet which have all been cut out by the **laser cutter for extra accuracy**.

Client Feedback

What are your first impressions of the finished prototype?

The design fits perfectly into the environment and is displayed at the right height to access. It looks very eye-catching and bold and resembles modern and contemporary features. I really like that the cameras sit well in their compartments and the visibility is clear - movement of the design face is flawless - well done!

Do you feel this product would be an improvement on your current product and why?

Yes! The cameras are visible and it is very easy to see at a glance that we have available. The security is much better to ensure they are locked away and it's very nice to use and handle.

Does the prototype tackle all the requirements that it needs to?

Absolutely, as above really easy access, visibility and security. It looks aesthetically pleasing and the design is fit for purpose!

Are there any modifications you would like to see made?

possibly the colour could be more vibrant and exciting and maybe a more prominent handle for easy grip?

External Testing

My Completed product (Camera Storage device) has been brought up to the intended area that it should be put up in. This camera storage device is used quite often, maybe even **daily** as the pupils of the school will always need the cameras to do parts of their Art projects. As a result, The product will be used very often and will need to provide simple access to the students. The product has been screwed onto some batons which have been attached to the wall. The top baton also has a slant in it to allow it clip onto the Top baton on the wall which also has the same slant. Both my clients have given some critical feedback which will **help me improve my device** as well as give me a better idea of what to notice for next time I plan a project.

Aims of Testing

- Does the device work
- Ease of Camera storage and retrieval
- Ease of charging the cameras
- Locking Mechanism works
- Quality Check
- Rotation of Acrylic

Conclusion from External Testing

- The cameras do fit well and can be stored as well as retrieved quite easily as there is **enough hand room** for your hand to fit inside and still move. This is thanks to the ergonomics research that I have done regarding the hand width and more.
- The product does provide a practical, easily accessible and fun way of cameras storage compared to the old product which was much more bland. The spinning Acrylic sheet provides an **extra fun and interactive method** of camera retrieval.
- The cameras **can be locked away safely** including the larger cameras due to the well fitted acrylic sheet
- Dimensions of the product are quite accurate to the size that was available filling up quite a lot of the space which meant the product has **maximised its size** as a circular product
- Attaching the device to the Batons does not take long and you do not have to hold the product up for long as you can rest it on the slanted top batons. The weight of the product is also **not too heavy** allowing the product to be hung nicely on the wall. The added weight of the cameras when in the product will still not have much effect on the product as the baton's strength is good and the backboard is holding the entire project together.
- 'The acrylic spins really smoothly' was a comment made by a teacher regarding the lockable acrylic sheet. I have ensured to put **cork pads** beneath the acrylic so it not only doesn't scratch the acrylic, but the acrylic will also run smoother.
- Another comment: 'What an upgrade' from a 3rd member of the Art/DT department showed that the product has been made to a good quality and that the design is quite aesthetic overall.

Client's Suggested Improvements

- One key thing that My clients have suggested is the fact that **there should be slots for the battery cards** to be placed. This is a large problem as it was part of the specification and has not been dealt with at all. Even though I have suggested a modification later on, This still does mean that there are no methods to identify the person who borrowed the cameras and therefore does not fulfil all the specification points.
- Miss Hallam also suggested that the **handle could be improved** as the handle at the moment is not that prominent and a better handle would provide for an 'easy grip'. This means that my handle at the moment is not as easy to use as I wish because maybe the **grip is not sufficient** for the acrylic sheet to be spun well.
- One last improvement that could be made is that the **cables could have an area where they are grouped up** and acts as one large bundle of cables. This would mean that the cables would look less messy and this would improve the overall aesthetics of the product, meaning the entire area would also look more clean and tidy. The cables are also not long enough to plug into the USB slots where the cables would be plugged in, this means that new cables would need to be ordered but this cost is not too high and is acceptable. **More cables would also have to be installed** because there are currently more camera slots than there are cables, meaning more cables will need to be bought anyway.



In the picture on the left, my secondary client Miss Hallam is inspecting the product as well as using it to see the functionality of the product. Overall, she is very pleased with the product and thinks it is a large improvement to the last one.



In the picture on the right, You can see my product being up in the intended area and the main features are also shown as the front is transparent.

Client Feedback 2

My Primary Client, Nel was present on the day that I have put the product up and she has now seen the new product in the staff room and has given some comments. Throughout the manufacture of the product, I have shown Nel my design and prototype during the production a few times, which has helped me in getting better ideas as well as giving her a better idea of how the product is going and if there are any things that she would like added. In general, she has been impressed with the product during the manufacture up until the end product.

One key thing that she has mentioned is that there are no battery card slots which is a main problem as the product was intended to have this in the beginning. Therefore this is a point where I can definitely improve on.

Below is the questionnaire I gave to Nel after she had studied the finished prototype and has given some feedback regarding the product.

From the questionnaire, I think that she likes the design aesthetically but mainly focuses on the lack of the battery card slot as it was one of the main points that I was required to address. Hopefully with the modification that I will propose later on, this can be solved and incorporated if need be.

What are your first impressions of the finished prototype?

Really love the design and look of the camera storage. It makes the area look so much smarter and clears a table and space from clutter.

Do you feel this product would be an improvement on your current product and why?

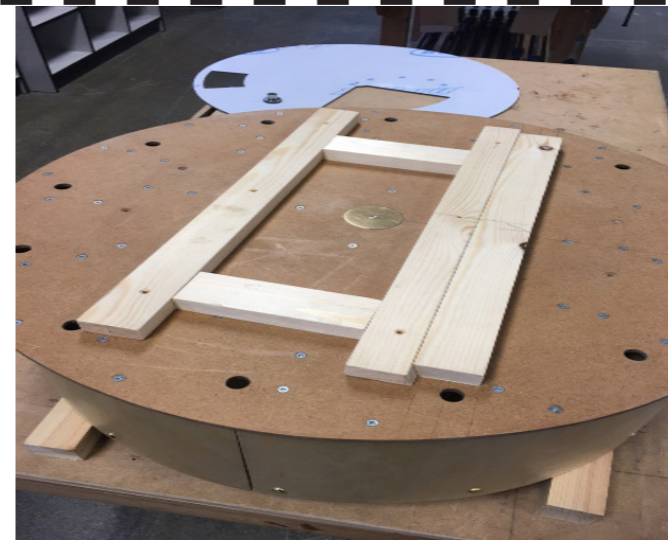
Yes, massive improvement. It can be locked. It looks better and it clears away all the clutter.

Does the prototype tackle all the requirements that it needs to?

Yes. My only concern is where to put battery cards or names of who has borrowed each camera.

Are there any modifications you would like to see made?

A slot for writing names of who has borrowed each camera.



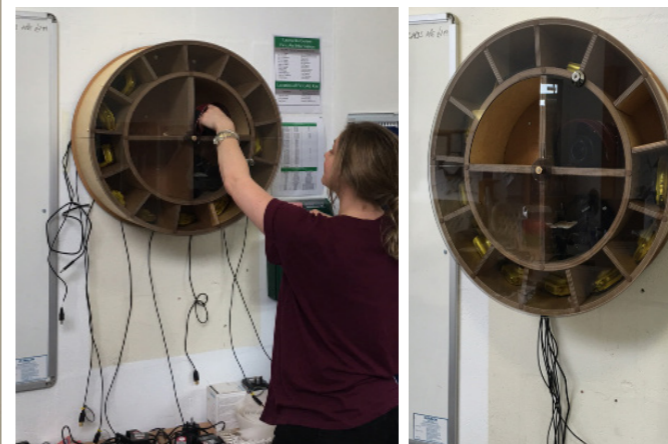
Above:

This photo shows the **layout of the batons** in the back of my product. There are 2 main batons that are attached to my product and there is a third baton which is placed on the wall below my top baton which allows my top baton to rest on top of the existing baton on the wall, **making it easier to load my product and put it on the wall**. We have also had to drill new holes into the concrete to allow these batons to be fitted well.



Above:

Here you can see my primary client Nel using the lock on the acrylic sheet as the handle to spin the sheet itself, **accessing different cameras by spinning it to different positions**. One problem that I have identified with the acrylic sheet is that the weight is not evenly distributed meaning that if it is not locked in place, it will want to spin naturally to a place of equilibrium. This also means that when trying to access certain cameras, the sheet may spin slightly, making it harder to get the camera out of the slot. This is why I have added a few Cork pads on the inside of the acrylic sheet, these **cork pads will stop the acrylic from scratching as well as increase the friction, stopping it from spinning itself**. (Picture 2)



Left:

Here in the photo to the far left, you can see that all the cables are not very organised and that they are just dangling from each individual slot. This is firstly **not as aesthetically pleasing** and also it is quite messy as it is literally all over the place. Therefore in the second picture, **Nel has grouped up these cables and made it into one strand of cables**. This could be a possible problem as the cables are different lengths, meaning that they may not reach the charging point altogether. After discussion with Nel, she has suggested to **buy some new longer cable** which will mean that this problem would be solved.



Left

This picture shows the position of the product in the staff room. The product stands out and fits the allotted space that has been provided well.

Right:

Here I have also had some other pupils test the product in which the main feedback is 'The sheet **spins really smoothly**', concluding that the **cork pads behind the acrylic sheet** have been put to good use.



Evidence of product in use

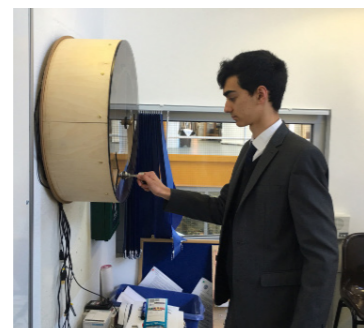


1. This photo on the left shows a front on view of the product put into place already. From this, you can see that the product is **just wide enough to fill the space that has been provided from the Green Safety equipment and signs as well as the white board on the left**. Within the product itself, I have also put some cameras into the device as well as attach all the cables we could find and thread them through from behind. The product was then locked up and it was clearly seen that the cameras that have been stored away could not be accessed easily. As the design is intended, 12 cameras can be placed and combined, the 13th slot along with the 4th slot of the larger cameras are left empty. This allows for the product to be locked in that position where no cameras can be taken, hence a **secure storage system**. Here you can see that in action, this allows the locking mechanism to work well. This tested the Lock functionality, the ability for the product to hold these cameras, and if it the product was a good size. All of these tests have been **passed**.

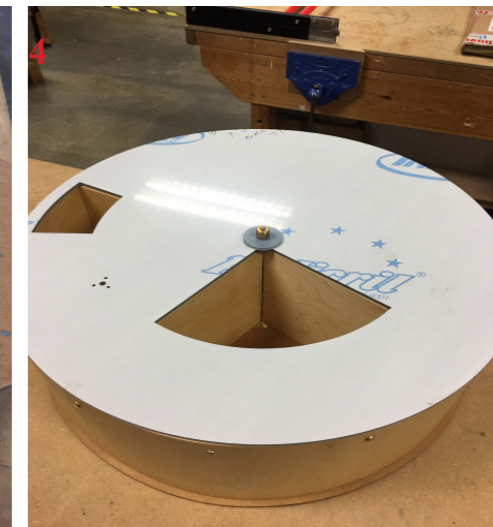
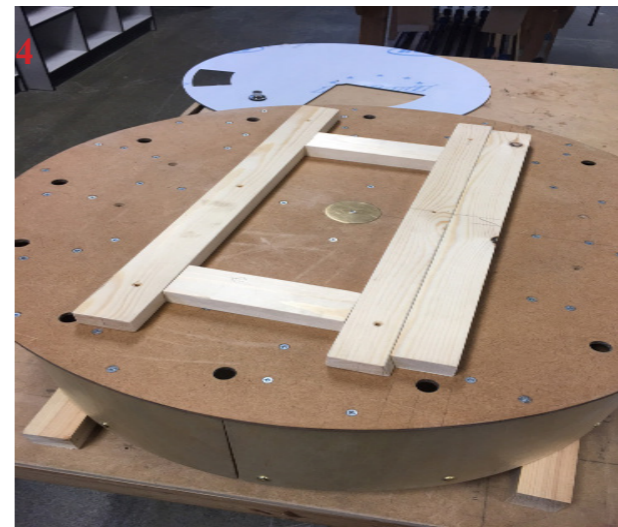
2. By placing the product's weight on the top baton where there is a **slight incline**, most of the horizontal forces are negligible and the Camera storage device is easily secured onto the wall. The wall batons are very strong as the screws into the wall are much longer than any on my product, so the main problem would be if the batons withstand the weight. **The test to see whether the weight of the product is an issue has been passed as the product still functions completely fine since the weight is not overwhelming.**



3. This photo shows some different people using the product. I **mainly want to test the weight of the acrylic sheet which generates the spin**, making it potentially harder to retrieve or store the product. This is because the sheet will rotate onto your hand whilst it is still inside, taking the camera, which makes it more uncomfortable. After consideration, I must give this testing point a **fail** as the acrylic sheet **does in fact have enough friction due to the cork pads and doesn't spin on its own much**. Even though the spin is not too serious, it still affects how the product is used and the functionality of it. (Pictures of teachers/ client and pupils)



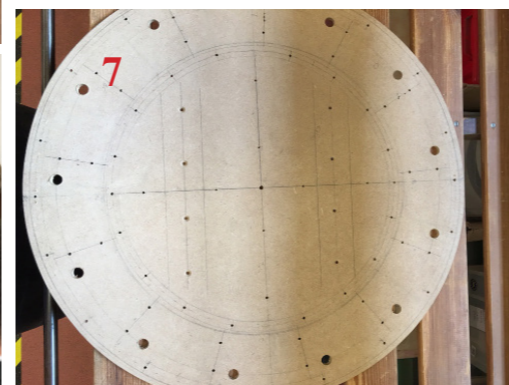
4. This photo shows the product before it has been put on the wall. It clearly shows that the **product can be removed very easily by removing a few screws** and this allows the device to be **easily worked on if it needs any repairs or has suffered any external damage** that needs to be fixed. This test involves the ability to work on the product after it has been completed and I give it a **pass**.



5. Aesthetically, I think that the product is very good, and I have received comments regarding how this product looks **more professional than the one before**. This means that more people are likely to come and look at the product, which also means that using the product will also be more satisfying and fun as the product does involve movement of the acrylic sheet to retrieve the cameras. Therefore Aesthetics - **Pass**



6. This picture shows the product without the acrylic sheet put on it. Here you can see that the circular shape has been done to a good quality and the **spaces for each camera are quite equal**. This means that all the cameras can be put into every slot without problem. Spacing for each slot test - **Pass**



7. When putting the cables through the back of the product, I have drilled a hole on the backside of the Backboard which means that even with a **thicker wire in the future, it can be changed easily by just putting the new wires through the hole** when you take the product off the wall. This charging is very simple as it has been shown to the people who have attempted this, the cable can be pulled slightly longer through the product and there is sufficient space to plug the cable into the camera and then slot the camera back. I have also attempted to charge the cameras within the product and found it relatively simple and easy to do. So with longer cables in the future - test for charging cameras is **passed**



8. For the acrylic sheet, **the holes that I have cut out using the laser cutter have been slightly small**. This test is to see whether the **holes were too small in which the ergonomics of the hand and the usability of the smaller camera slots has been affected**. Here in the photo to the left, one of the pupils is testing this by putting his hand **perpendicular** to the way it normally should be when retrieving a camera. As you can see, the hand does not fit in width wise and therefore I must give this point a **fail**. Improvements could be easily made by making the hole **slightly wider** which will solve this problem very directly.

Life Cycle Assessment - This technique assesses the environmental impacts of a product from the extraction and processing of raw materials to the use and final disposal of the product

Raw materials:

My product is mainly made out of **Birch Plywood** which make up the main outer and inner frames, the batons, and the separating panels within each of those frames. Other materials used included **Flexi-plywood**, **Mild steel** for the rod, **Brass** for the back lock and the front grub nut, **MDF** for the Backboard, **Acrylic** for the cover sheet and plenty of **stock standard component parts** such as the screws.

Birch plywood is a man made plywood but is normally not used again in its finished state or even the panels will not be used as there are holes in them, but they can be shredded down and turned into MDF which can be used for many other applications. The **MDF will often be compressed into large sheets** which will then be sold back to places such as my school. Other woods that I might have used such as **Flexi-plywood** would also undergo this procedure and be turned into useful **MDF** or even different densities such as **HDF**. Mild steel has a melting point of **1510 degrees Celsius** if it is pure mild steel. Mild steel is a very common material that is used in a lot of engineering as well as in many other applications. This can be melted down in large batches of unused mild steel and recasted into other things such as more rods of different sizes. The limited amount of Brass can also be melted down and reused as it has a melting point of **940 degrees Celsius** which is even lower than mild steel which means that recycling this metal will be even better and even easier to recycle. **Acrylic is also easy to recycle as there is still a relatively large sheet unused within my cover and therefore other shapes can be cut out**, if not it can be melted down and remoulded.

If my product was to go into commercial production I would try to ensure that the Material that I have used came from **good quality manufacturers** as well as the origin of the materials coming from good backgrounds. It would also be ideal if the product's materials were coming from a recycled source, which would be much more sustainable to the environment as there will be less virgin materials being extracted which means less energy is dedicated into mining these resources. To possibly reduce the amount of resources that the product I could possibly reduce the thickness of my separating panels or even use thinner flexi-plywood to do my lamination, but that would come at the risk of overall product strength.

Manufacture (Processes Used):

For my product, the main processes I have used are **Wood lamination** for the rings, **Centre lathe** for the brass parts, and **laser cutting** for the front acrylic sheet. I have tried to use the most efficient and minimal waste producing processes that would also give me a **high quality end product**. This will imitate the production method in industry and therefore mean that this process will be as efficient as it can be.

Even though in industry, the processes used may be slightly different to school machines, I think that processes such as my **Wood lamination for my rings will still be needed**, but they would probably be done in batches if my product was to be batch produced. However, one change would be the linking up of machines and CNC machinery which would allow the production of my product to be **less labour intensive** as it would be just created by machines. For example, **CNC machinery** could drill out all the holes in the backboard and assemble each other wooden piece at a time, funnelling all the parts into one, but being all controlled by machines. Laser cutting is an industrial process already but when it is for batch production and controlled by a program, it can **run efficiently for 24 hours a day**.

Distribution:

The Camera storage device that I have manufactured is a **one off prototype** made for a specific client using job production. This product has been delivered upstairs and into the intended area by hand as the distance wasn't too great. This also proves that the product can be moved short distances by hand quite easily.

If my working prototype was to be mass produced, this delivery system would not work as the distance may vary across the entire of the UK. **The standard parcel sizes in UK is 'Medium Parcels (not exceeding Length 61cm x Width 46cm x Depth 46cm)'** which means that the next size being large, would be more expensive to distribute.

Therefore a method of distribution could be to **hire a delivery company to deliver it to the clients directly**. Another option is to deliver it via couriers which will place the product on **pallets measuring 1200x1000mm** which will fit one of my products on at a time. This would be shipped at a relatively low cost, but may also take more time to deliver.

One way to reduce the delivery time is to deliver to retailers beforehand, and have the clients buy the product themselves in these shops, this works particularly well because **my product has been designed to have a flat pack option in mind**, hence no gluing has been involved. This flat pack could be assembled by either the customer or by the retailer or even have the option kept open for the client to decide. If flat pack was the option of delivery, it would **save space within each box meaning there would be less trips necessary for the truck to drive, reducing greenhouse gasses' emissions**. Another method of reducing this delivery time is by possibly working with a **high speed delivery company which uses trains that run on a tight schedule to deliver the products to different storage branches**. And from the storage branches, the product can be driven to the respective homes a lot quicker as the distance by car is much less than the distance by train, increasing the speed and efficiency.

Use of the Product:

Having tried out my Product in the space intended with the clients, I can say that my design and functionality of the product is of a **high standard**, as well as being relatively aesthetically pleasing. It provides an easily accessible and easy to use product to store the cameras safely and securely, which these are the main points of my project.

When the product is being used, it is useful to keep in mind that it should be checked once a week for any faults and any repairs that are needed. If the product is used properly, there should be no problems with the product besides the fact that the durability may decrease over time due to use of the product as well as the durability of the materials itself. **Woods should also be re-finished again once in a while to maintain the protective layer**. As for the Mild steel rod in the middle, If it starts to deteriorate, a layer of paint finish could work as the finish for the metal. A good thing about the acrylic sheet is that **a circle can be ordered in and because I have cut it once on the laser cutter, we can order another sheet and put the exact same settings on the laser cutter to cut out the new sheet** if anything were to happen to the existing acrylic now. This makes it easy to replace. Screws should also be checked to see if they are suddenly loosened, as that can seriously affect the overall strength of the product.

If the prototype was to be made industrially and on a large scale, lots of the **stock standard component parts would have to come with spares** as they will be part of the flat pack. Because the product also consists of many hard component parts to make or replace, I may design the outer frame in **more than 2 semicircles but as 4-5 parts because the advantages of this include: not warping as seriously, it will also be easier to make replacements/spare parts for the flat pack**. This is a better way of maintaining the product in case some large problems arise with one of the semicircle parts. Another way of making sure the product is being used as it should, is putting an **instruction manual** with the product, explaining how the product works briefly and also with a cutting list so that any faults in the packaging can be checked, and parts can be returned/replaced.

End of Life:

It is always important to think about the factors that influence the product and how the product also influences the environment towards the end of the lifespan of the product.

All my components are **dry assembled**. This means that they can all be taken apart to form a flat pack. The advantage of this is that all the stock standard component parts can be **reused** as well as any useful bits such as the mild steel rod or some of the brass parts. Recycling these metals will be very useful as they can save the environment by not having to mine more of it. If this was in industry, I would try to ensure that the metals that I have been using are **mainly recycled metals or at least a high percentage** of it because this will generate a smaller **carbon footprint**. As for the Woods (Birch-Plywood + Flexi-plywood) They would have to be shredded down and made into MDF unless the pieces can be reused under some other circumstances.

I stated in my specification that my product must last around **10 years**, and I think that realistically, it would be possible with **more layers of finish and care to the product once in a while**, hence I think this **prediction is still relatively accurate**.

Modifications

Ratchet Wheel Acrylic sheet

This idea came after we tested the Acrylic sheet's **spinning**. Because of the added weight of the lock, the Acrylic sheet can spin slightly on its own up to a certain point because the weight is imbalanced. This means that whilst retrieving cameras, the sheet may spin and gently hit your hand which may be quite annoying after multiple times. However, because we added **cook pads** beneath the acrylic sheet, it increased the friction of the spinning and **reduced the self spinning problem**. Even so, when the acrylic sheet spins while you are getting some cameras out, you could hold the acrylic sheet in place but that can be slightly annoying.

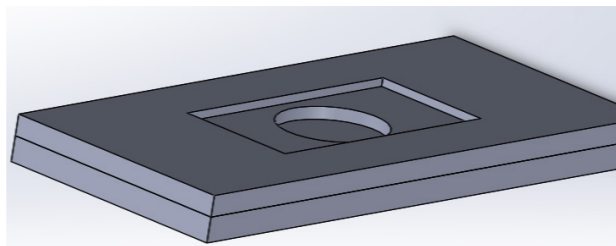
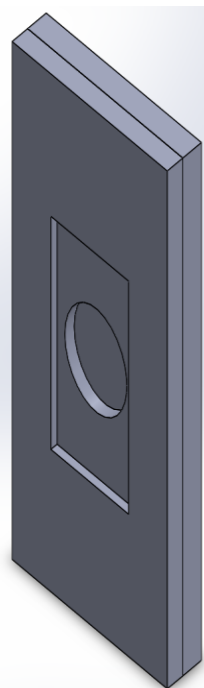
Therefore I have proposed that a **ratchet wheel** could be used to limit the movement of the acrylic sheet. For my project, a circular type ratchet would have to be used so that the limiting of movement would extend around the entire circle. If I wanted the acrylic sheet to stop at intervals where the hole of the smaller cameras on the acrylic sheet matches the holes in the wooden components. This would allow the movement of cameras to be much easier and smoother.

However, this ratchet will increase the amount of friction within the product because the acrylic sheet will be **clicking into certain slots**. This could mean that the acrylic sheet may need to be switched earlier because it may wear down quicker, reducing its life span to maybe 5 years. The ratchet wheel would also limit the movement of spin to only one direction but in this case, it doesn't matter as much. One more thing to remember if I was to install such a modification is that the **initial stop of the ratchet wheel must line up to the position of the lock** as the lock is more precise and therefore all measurements should be based from there.

Buttery card slots

One thing that I have not kept in mind is the **Buttery card slots**. This however can be solved by changing the design of the separating panels for the 13 cameras. This can be done by **drilling a hole in the middle of the pieces and also cutting an indent the size of the buttery cards using the router machine**. This would allow the buttery cards to sit well in the indented hole and also easy to remove by just poking your finger through the hole. However, one minor problem I can think of is that towards the top of the device, where the panels are vertical, it may be hard to keep the buttery card in place, so there might need to be a hinge added to keep the card in place.

Adding this feature would allow the camera's borrower to be identified so that when cameras go missing, they can be found by asking the student who has left their buttery card in the device. **One Ergonomic note is the size of the average human index finger, Radius of about 2cm would be perfect** for putting it through the hole to retrieve the buttery card when the person has finished using the camera.



These Photos show the new developed part which I could attach to the small camera panel dividers. This extra part would help the buttery card fit well with **dimentions 8.6mm x 5mm**. The hole would also allow the user to take their card out after putting it into the tight fit that is the indented rectangle on the top sheet. the 1st picture also shows a side view, meaning the modification would just be put on top of the existing panel. **(1st photo - Example Card)**

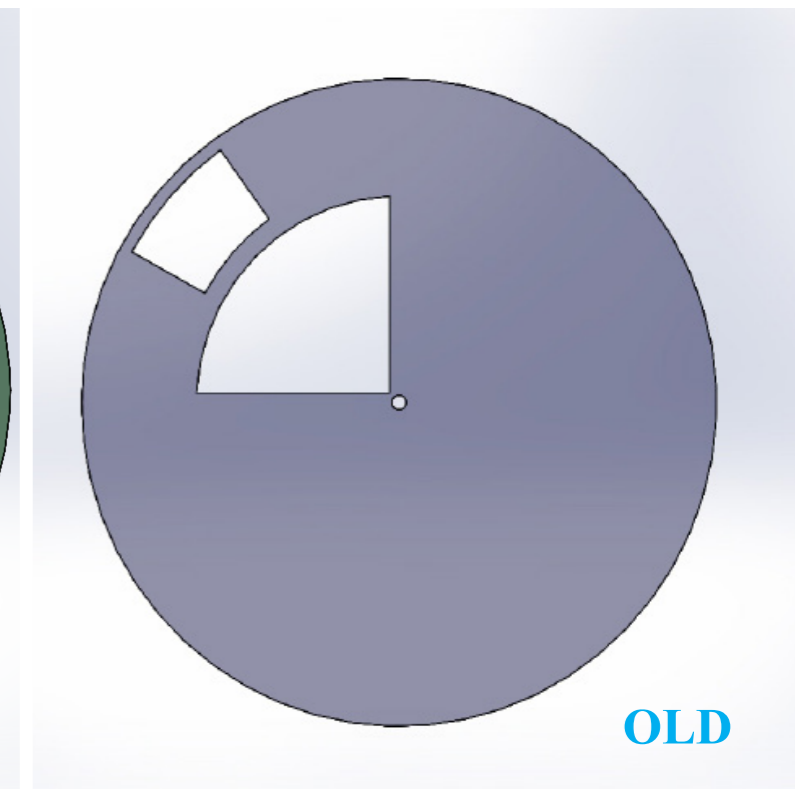


On the Left, There is a picture showing some **ratchet wheels**. These serve the purpose of having teeth at points where the motion of the wheel needs to be stopped. This is exactly the type of thing that I am proposing if my product were to have this modification installed. One minor detail that I would say about this photo is that the **size of the teeth are too large**, for my product I would like the teeth and the new ratchet wheel which would be the acrylic sheet to be **less visible** and much more hidden than this one is. This will allow the product's main **aesthetics to be unchanged** whilst also reducing the health hazard from having indents/teeth that are too big.

Acrylic sheet design modification (Already done)

During the production of my Acrylic sheet, I have thought about the **overall strength** of the product. This allowed me to identify one flaw in the design of the acrylic sheet which is the middle section of plastic in between the two holes to retrieve cameras. This section of the acrylic was much weaker due to the lack of supporting material around it. This also meant that the strength decreases and therefore ultimately the **durability of the product decreases leading to a lower usability time frame**.

Therefore, I have changed the design of the acrylic sheet slightly to make it more suitable for using over a longer period of time. The aesthetics of it in my opinion is about the same, if not even better but because of the strength benefits, I think that this is a necessary modification.



Bibliography

Camera Cabinet:

Camera Cabinet examples - www.amazon.com
www.pentaxforums.com
lifehacker.com
www.toysforhobbies.com
www.oishi-ele.co.jp

Ergonomics - www.danmacleod.com
https://mpatkin.org/ergonomics/handle_checklist.htm

Materials Research - www.smsamas.com-en.wikipedia.org
tyumen-plywood-plant-limited.safestchina.com
www.collisdiy.co.uk
home.howstuffworks.com
knowyourmeme.com

Finishes Research - <https://www.reddit.com/r/woodworking>
<http://www.diynetwork.com>
<http://www.floorcompanion.com/waxing-wood-floors/>
<https://s3.amazonaws.com/PDFPlans/wood-dyes.html>

Lamination - <http://www.airpress.co.uk/bag-press.php>
<https://www.vacupress.com/vacuum-pressing-bag-system/>
<http://www.vacuum-press.com/bags.html>

Collar Grubs - <http://www.ebay.co.uk/itm/171958072878>
<http://www.ruland.com/images/Shaft-Collar-SC-F.jpg>

Ratchet Wheel - <http://thumbs2.ebaystatic.com/d/1225/m/mmVjWxnLlvAXSKs-LuVS4nw.jpg>
<http://kmoddl.library.cornell.edu/stillImages/Clark/small/049.jpg>

