Cambridge International AS & A Level Design & Technology 9705

Component 4: Project 1

General comments

This project followed on from the AS Level project submitted by the candidate. The design folder is set out well, being easy to follow and creating a feeling of genuine and meaningful design work.

Criterion	Comments	Mark
Product Development [10]	The candidate divided the proposed product into three parts and developed each in turn. The development is easy to follow although reasons for choice are sometimes missing. There is evidence of in-depth material testing and consideration of the link between the product's size and items to be carried. Ergonomics and Anthropometrics are considered in a meaningful and relevant way.	9
Product Planning [4]	The realisation has been planned thoroughly with refined drawings and appropriate detail.	4
Product Realisation [20]	Different views of the product can be seen in the range of illustrations showing it in use. It has clearly been produced to a high standard and appears to meet the design requirements	18
Testing and Evaluation [6]	Thorough testing has been carried out in a meaningful environment. This has led to evaluation against the specification and recommendations for improvements.	5
Total [40]		36

DESIGN & TECHNOLOGY COURSEWORK 2019
CAMBRIDGE GCE ADVANCED (A LEVEL)

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RECAP

The theme for my coursework is **Food And Drinks** where I designed a lunchbox that has unique features and at the same time multi-functional making , lunch packing more convenient for the users. **In 2018, I did my As level and came out with 5 different designs .**

1

This design is a modified version of paper noodle box where users can bring 3 different kinds of food.

3

This unit is suitable for teenagers since it has modern and simple design. It is a convenient product and is made up of metal and plastic.

5

This unit has a neat and simple design but blends in well to any surrounding. It could store food containers as well as drinks.

2

This product emphasises the original colour of wood. It could store cutleries such as spoon,forks and even chopsticks. Also, users can bring 3 different kinds of food when using this product.

4

This unit has the most unique design compared to the others. It has a special feature which is mini whiteboard where users can write messages or notes on it. Also, this unit is able to store bottles.

In this section, I will evaluate each models / design depending on different aspects.

Evaluation	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5
					
Function The unit must be multi-functional. (Able to store drinks, cutleries, snacks)	Cutleries and drinks cannot be stored **2/5**	Cutleries can be stored but not drinks. **3/5**	Water bottles and food containers can fit into the unit. **2/5**	Could store 3 different food and can store water bottles. **3/5**	Water bottles and food containers can fit into the unit. **3/5**
Ergonomics How comfortable is the unit ?	Comfortable enough since the strap is made up of leather **3/5**	Quite comfortable since is has wide straps **3/5**	Not so comfortable because the unit is quite heavy **3/5**	Unit may topple easily since it is not that stable. **2/5**	Has wide strap and a mini handle for griping. **4/5**
Design / Aesthetic Does the unit has a design that suits majority of people?	Design may only suitable for teenagers but not for office workers **3/5**	Suitable for both females and males. Also, can be used when going for a picnic. **4/5**	Suitable for office workers as it minimalistic. Also suits for university students **4/5**	Design is quite unique and futuristic. Suit for females since it has a curvy shape. **4/5**	Suitable for teenagers and students since it has minimal but modern design. **4/5**
Health and Safety How safe is it to use the unit?	Quite safe but the unit has sharp corners **3/5**	The unit has no sharp corners. **4/5**	Quite safe but the unit has sharp corners **3/5**	The unit has no sharp corners. **4/5**	Quite safe but the unit has sharp corners **3/5**
Manufacture Process Is the unit easy to manufacture?	Containers with specific sizes need to be made **3/5**	Need to make our own containers **3/5**	Dealing with metal might be quite difficult **3/5**	There ~~to~~ are too many curves to bend. **2/5**	Quite easy since the dimensions are simple. **4/5**
TOTAL	**14/25**	**17/25**	**15/25**	**15/25**	**18/25**

Pre-Conclusion

From the result of the previous evaluation, I decided to manufacture **Model 5.**

Reasons why i chose Model 5:

- ★ The manufacture process is quite easy compared to other model.
- ★ Model 5 serves the most function than the others (multifunctional).
- ★ Design suits people taste in general.

Improvements that should be included into the product:

- The size should be altered so that users can bring more food.
- Add more function to the unit.
- Unit should be convenient for the users.
- No sharp edges.
- Product should be made up of food-safe material.

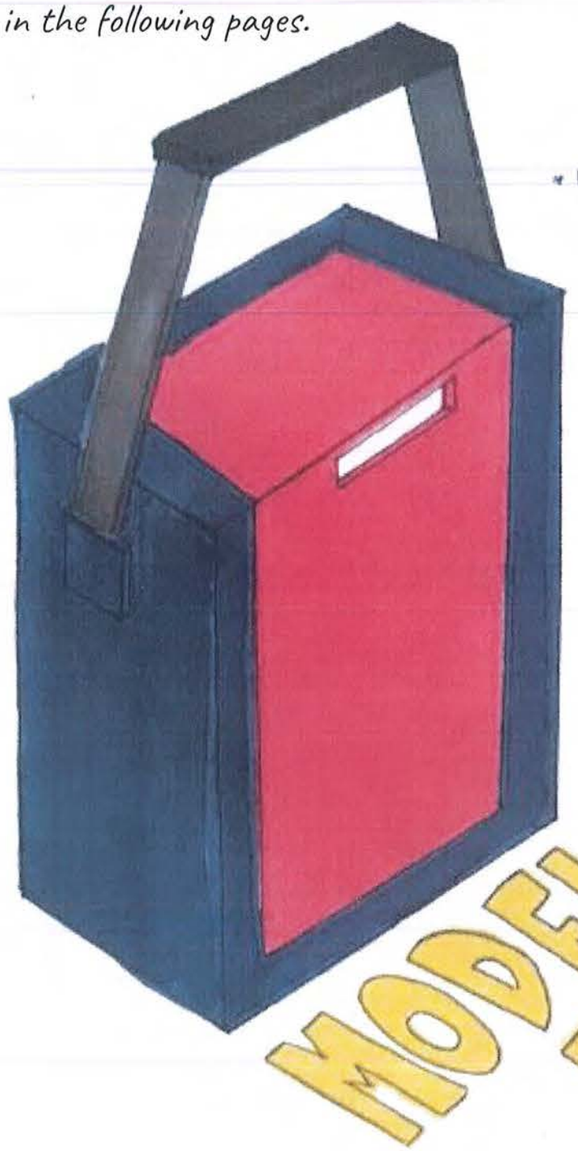
PRODUCT DEVELOPMENT

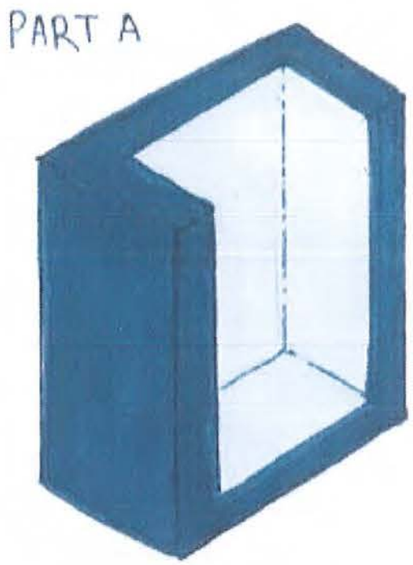
Final design
Research on Ergonomics and Anthropometry
Test on different materials

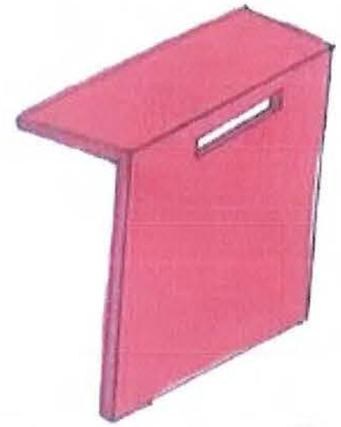
Final Design

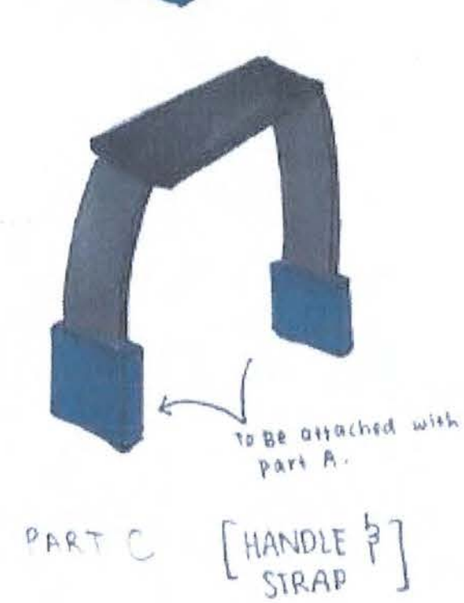
To make it more simpler and easier to understand, I catogorised and divided my product into 3 different ~~points~~ parts.

This is the unmodified version of the unit. The actual design will be in the following pages.









Improvements that needs to be made:

- ✓ No sharp edges
- ✓ The unit should be multifunctional and could make lunch packing more enjoyable
- ✓ Should have a nice design (aesthetic purposes)
- ✓ Unique features must be included in the unit, making it more convenient for the users.

DEVELOPMENT OF IDEAS

PART "A"

Main problem of the design >>

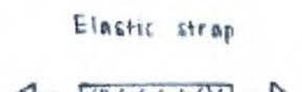
- *Edges are too sharp*
- *Containers / bottles not secure*
- *Not able to trap heat efficiently*

THINGS TO ADD :

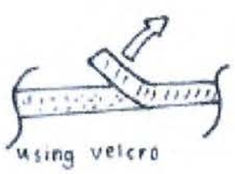
Strap to secure bottle

Idea 1

Elastic strap



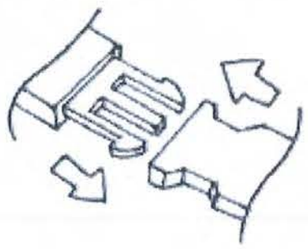
Idea 2



using velcro

Idea 3

using clip / buckle.



Selected idea + improvements :

Elastic strap

why - Convenient & easily available at stores ✓

do you why ~~is the~~ need to include white board + marker?

Mini Whiteboard + Marker Holder

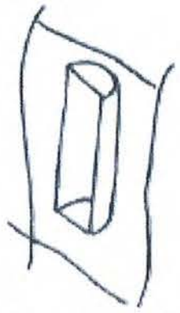
Idea 1

clip.

Idea 2

packet.

Idea 3



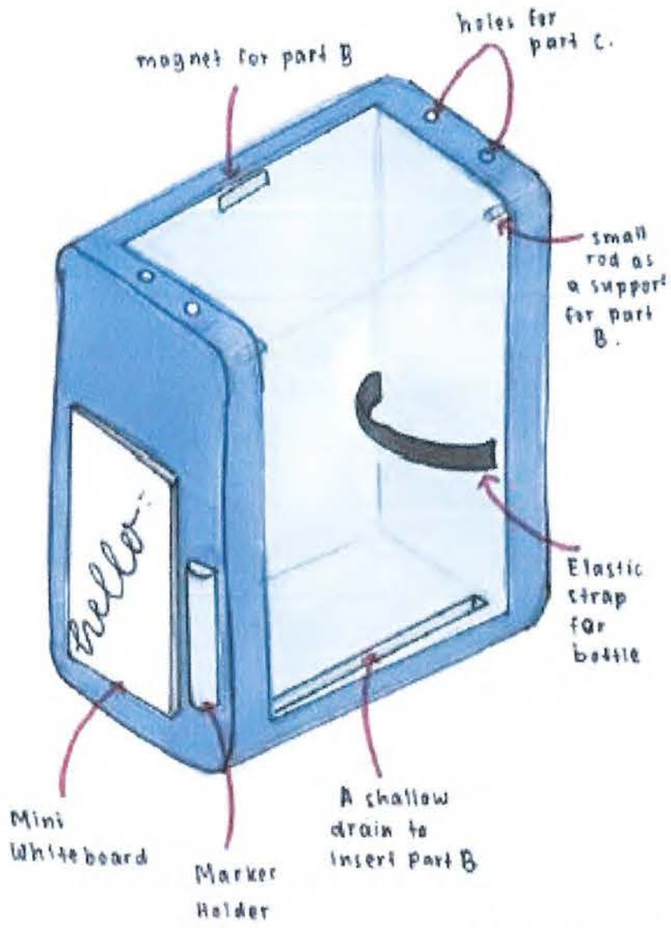
shaped-in pocket.

Selected Idea + improvements :

Idea 2 :

semi circle.

FINALISED DESIGN



Materials needed:
- plastic ⟶ for the
- elastic strap
- wood rod for pivot
- magnet

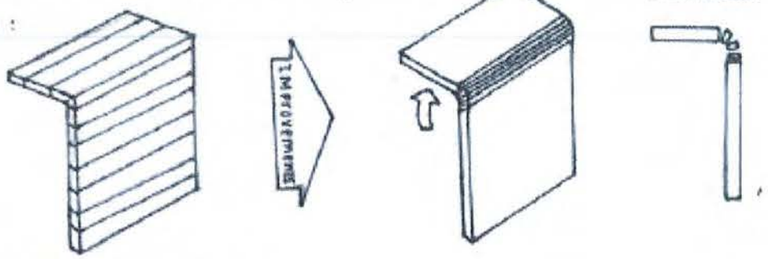
DEVELOPMENT OF IDEAS

PART "B"

Main problem : - too stiff ; users may break the unit easily
- need to improve the storage for cuttery.
- need to improve the mini handle design

• How to make part B flexible ?

Idea :

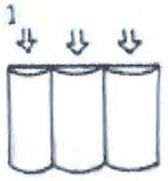


Side view:

But, the unit would be too flexible

• How to improve the storage for cutleries

Idea 1



Idea 2

Idea 3

clips

Selected Idea + Improvements:

Idea 1

made of fabric net.
↓
for hygience purposes.

• How to make the handle better ?

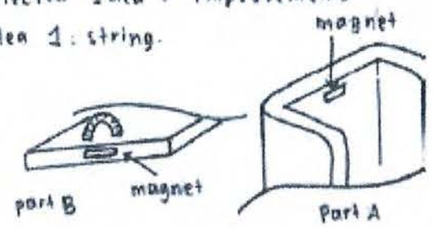
Idea 1 : using string.

Idea 2 : rectangular handle.

Idea 3 : Hollow hole

Selected Idea + improvements

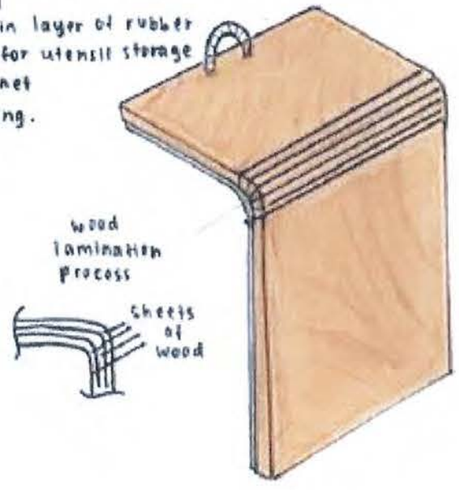
Idea 1 : string.



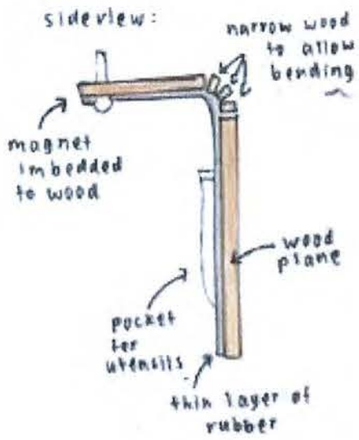
FINALISED DESIGN

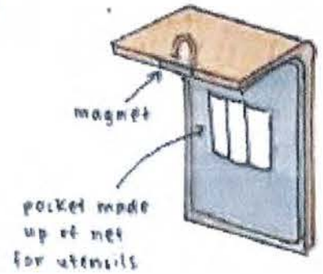
design made of : WOOD

Materials needed:
- wood
- a thin layer of rubber
- net for utensil storage
- magnet
- string.



Side view:





DEVELOPMENT OF IDEAS

PART C

Things need to be improved :
- the handle [edges too sharp]
- Strap - finalise the materials
- the method of attaching part C to part A.

HANDLE

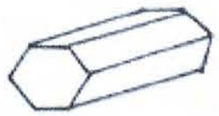
Idea 1

cylindrical rod.

Idea 2

leather strap.

Idea 3



hexagonal-shaped rod.

Selected idea + Improvements.
Idea 1

oval-shaped rod.

STRAP

Idea 1

chain

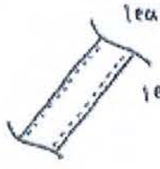
Idea 2

fabric strap.

Idea 3

fabric string

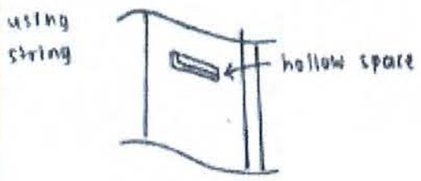
Selected idea + improvements.
Idea 2 → instead of using fabric strap, we use leather strap.



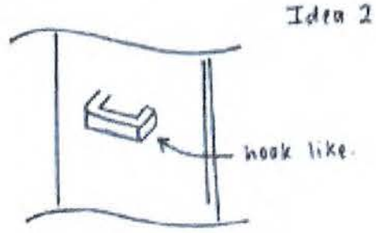
leather strap.

Methods of Joining to Part A

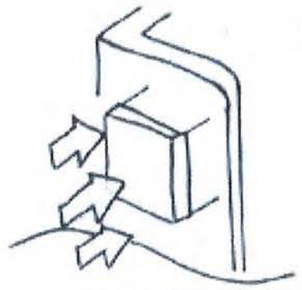
Idea 1:



Idea 2.

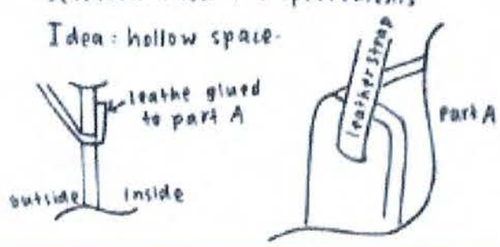


Idea 3.



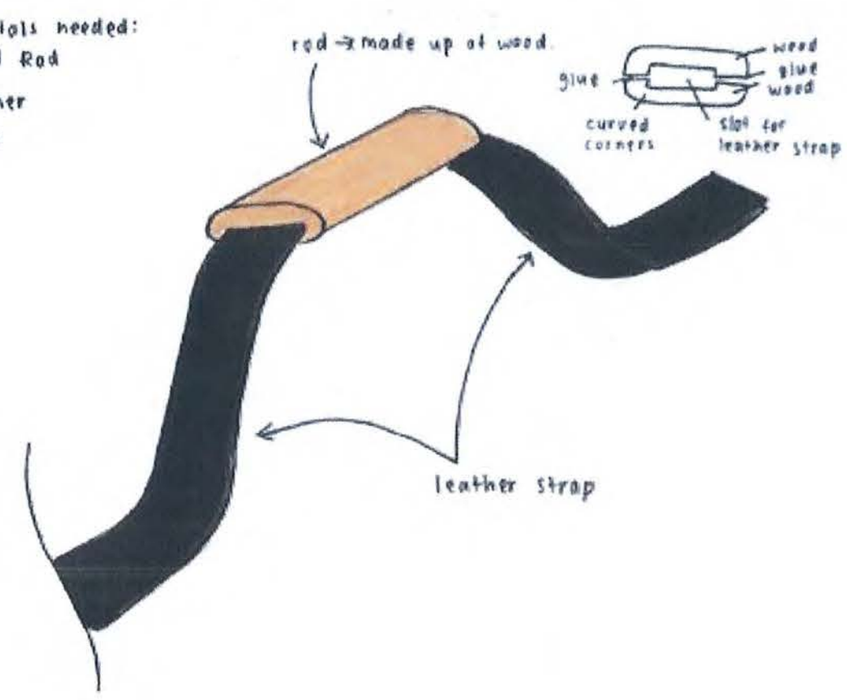
selected idea + improvements

Idea : hollow space.



FINALISED DESIGN

Materials needed:
- wood Rod
- leather
- glue



Research on Ergonomics & Anthropometry

What is ERGONOMICS ?

- Ergonomic is the study of how human beings interact with our environment.

What is ANTHROPOMETRY ?

- Anthropometry is the study of measurements of human body and its movement.

Ergonomics

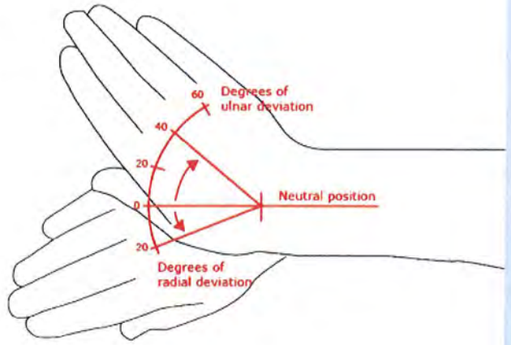
Human hand consists of a thumb, index finger, middle finger, ring finger, little finger, and a palm.

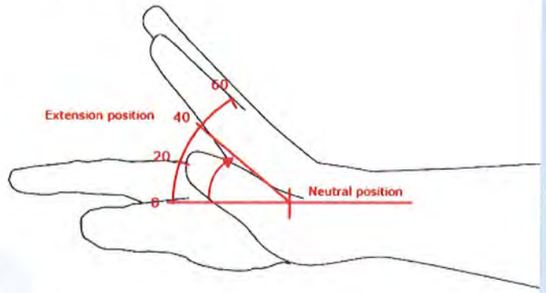
When doing work, our hands may be in awkward position repetitively. Hence, this results to hand discomfort and injuries.

These effects may lead to several outcomes not only physically but also psychosocially. Examples of psychosocial effect are pain, fear of pain, and also fear of re-injury.

To prevent this, ergonomic design of a tool-handle is important to ensure that the product is safe and can be used comfortably.

Larger or increasing the surface area of the handle bar attributes to lower pressure on the contact surface on our hand/fingers. Thus, preventing extensive hand deformation which may result to pain.





Source of research :

- en.m.wikipedia.org
- www.sciencedirect.com

Anthropometry

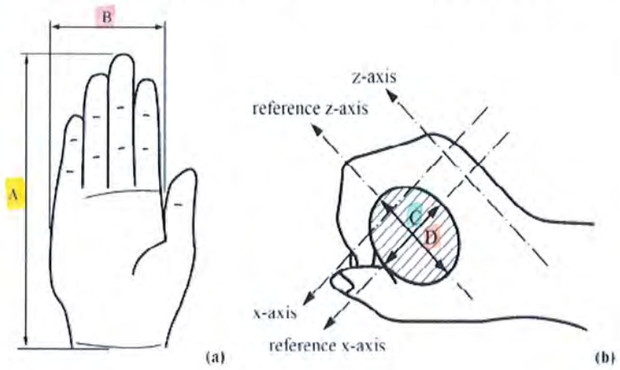
Anthropometric measurements are important to ensure that we produce a comfortable and efficient product.

For this whole section, I will be focusing on the dimensions of a human hand.

As we all know, males and females have different lengths of body parts where males are known to have bigger, wider or longer body portions.

To avoid my product from being biased, it is best for the unit to have measurements that are suitable for an average human grip.

This are the measurements of a human palm:



		Average length /mm
A	Length of palm.	177.9
B	Width of palm	79.4
C		38.3
D		30.7

Source of research:
Department of Industrial design, Tatung University, Taipei City 104, Taiwan
National Yunlin University of Science and Technology, Douliou, Yunlin City 64002, Taiwan

ADDITIONAL RESEARCH

I prepared 5 different food packaging and observe them individually. This section would help me to specify the dimensions for my product and the features that should and should not be included in my product.

	MEASUREMENTS	PROS	CONS
 	Length : 23.0 cm Height : 15.5 cm Width : 5.0 cm	• Has 6 partitions for 6 different kinds of food / snack • Neat and very simple design	• No handle • Partition is too small hence only snacks or desserts can be stored.
	Lenght : 22.5 cm Height : 7.5 cm Width : 5.0 cm	• Has transparent sheet to see food • Has a string for handle	• Only suitable for cakes or desserts • Unable to store wet food
 	Length : 13.0 cm Height : 6.5 cm Width : 10.5 cm	• Simple and effective • Disposable container • Suitable for storing food lunch	• No handle • No transparent sheet
	Lenght : 16.0 cm Height : 7.5 cm Width : 16 cm	• Large quantity of food can be stored • Has transparent plastic sheet • Has a handle	• Not waterproof therefore could only store dry food.
 	Length : 24.5 cm Height :7.5 cm Width : 5.0 cm	• Simple and neat design • An effective way to store food	• Only suitable for dessert or delicacies • The cover is not transparent • No handle

Conclusion : By calculation, a food storage should have an average length of 19.8cm, height of 8.9cm and 8.3cm wide.

Material Test

All of the tests conducted are based in school workshop. Advance material test that requires complicated processes or professionals will be based from internet research.

The material test are :

1. Density test
2. Hardness test (Indentation test)
3. Permeability test
4. Toxicity test

Density test

The reason why we conduct Density test is to know the weight of a particular material.
If a material has high density, it means that it is heavier and has more weight.
For my product, it is important to use light materials to suit its portable feature. This is to reduce pressure on the user's fingers hence avoiding injuries.

Volume and mass are recorded and measured to find density.

Materials that are being tested are :

- Plywood
- Blockboard
- Pine
- Meranti
- MDF (12mm)
- MDF (9mm)
- Acrylic
- Polystyrene

Length, height, and width of material blocks are measured to get volume.


Mass is measured using Electronic Balance.

Material	Mass / g	Lenght / cm	Height / cm	Width / cm	Volume / cm^3	Density / g/cm^3
Plywood	21.207	10.1	1.1	3.0	33.33	0.636
Blockboard	37.962	10.1	1.8	3.1	55.80	0.680
Pine	16.132	10.1	1.2	3.1	37.57	0.429
Meranti	30.861	10.0	2.0	3.0	60.00	0.514
MDF (12mm)	28.787	10.0	1.2	3.0	36.00	0.799
MDF (9 mm)	22.073	10.0	0.9	3.1	27.90	0.791
Acrylic	23.353	9.7	0.3	7.2	20.95	1.115
Polystyrene	11.455	9.7	0.2	7.1	13.77	0.832

Conclusion:

- Pine is the lightest wood. (0.429 g/cm^3)
- Polystyrene is lighter than acrylic.

Hardness test (Indentation test)

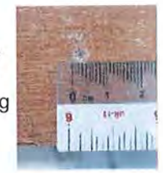
Hardness is the ability of a material to resist deformation, indentation or abrasive wear.

Main objective of the following procedure:
Dropping a dot punch from a certain height to create a dent on the wood.

The bigger the dent, the softer the material.


1. A hollow metal rod is used to ensure the height is consistent throughout the process.


2. Dent is produced due to the impact from the falling dot punch.


3. Diameter of dent for each type of wood is measured and recorded. The results are then compared.

Results :

Material	Diamenter of dent /mm
Blockboard	5.0
MDF (12mm)	2.0
MDF (18mm)	1.5
Plywood	3.0
Pinewood	5.0
Meranti	3.0

Conclusion :
Based from the result, softest materials are Blockboard and Pinewood.
Toughest would be MDF.

Permeability test

Permeability test could help us to identify which material resists water the most.
This is an important feature for my product to ensure that it is long-lasting.

Instructions to conduct Permeability test:

1. ~~Bocks~~ Blocks of wood are placed inside a bucket.
2. Fill in water until all of the blocks are fully submerged.
3. Leave the soaked blocks for several days.
4. Observe the appearance of the blocks.

Start soaking on :
2 / 3 / 2019

Observation on 4/3/2019 :

Blocks are taken out, observed and then compared.

Blockboard shows the most unpredicted result as it swells and is completely damaged. Hence it is proven that blockboard is not permeable to water.

MDF turns out to be soggy but better in its condition compared to blockboard.

Meranti, Pine and Plywood has the least effect and are still in good condition . Hence, it can be concluded that these 3 types of wood are the most permeable to water.

Toxicity test

Source of research :
www.wood-datbase.com
www.woodmagazine.com
en.m.wikipedia.org
www.chemicalsafetyfacts.com
www.plasticfoodservicefacts.com

Toxicity is the ability of a substance to produce an unwanted effect when the chemical has reached a sufficient concentration at a certain site in the body.

Acrylic	• Made up of polymer (polyacrylonitrile). • A plastic which does not leach toxic chemicals such as BPA. • Categorised in Group 7 which mostly used in baby feeding bottles.
Polystyrene	• Made from monomer styrene • Categorised in Group 6 which is used in styrofoam food trays, egg cartons, and in disposable cups and bowls, as well as in opaque plastic cutlery and carry out containers. • All of the above proves that polystyrene is food safe as it is used for centuries.
Aluminium	• Non-toxic, non-absorptive and splinter-proof metal. • Has thin surface layer of aluminium oxide which prevents further oxidation on the metal. Therefore making aluminium as one of the corrosion resistive metal. • It is food safe since it is used as tin cans (aluminium cans) and foils (aluminium foils)
Pine	• Proven by Denmark's food safety authority (Fødevarestyrelsen) that Nordic wood such as pine is safe when in contact with food. • Pine dust can cause runny nose, asthma, and irritation to foils both skin and eyes. • Food safe varnish can be used to avoid those harmful outcomes.
Meranti	• Meranti dust can lead to irritations to our eyes, skin, throat as well as lungs. • But it is usually used in the manufacture of salad bowls coated with food safe varnishing such as pure tung oil, mineral oil or shellac.

Production Planning

In this section, I included the layouts to manufacture the unit. I also listed out the material that will be used and a Gantt chart to keep me on track.

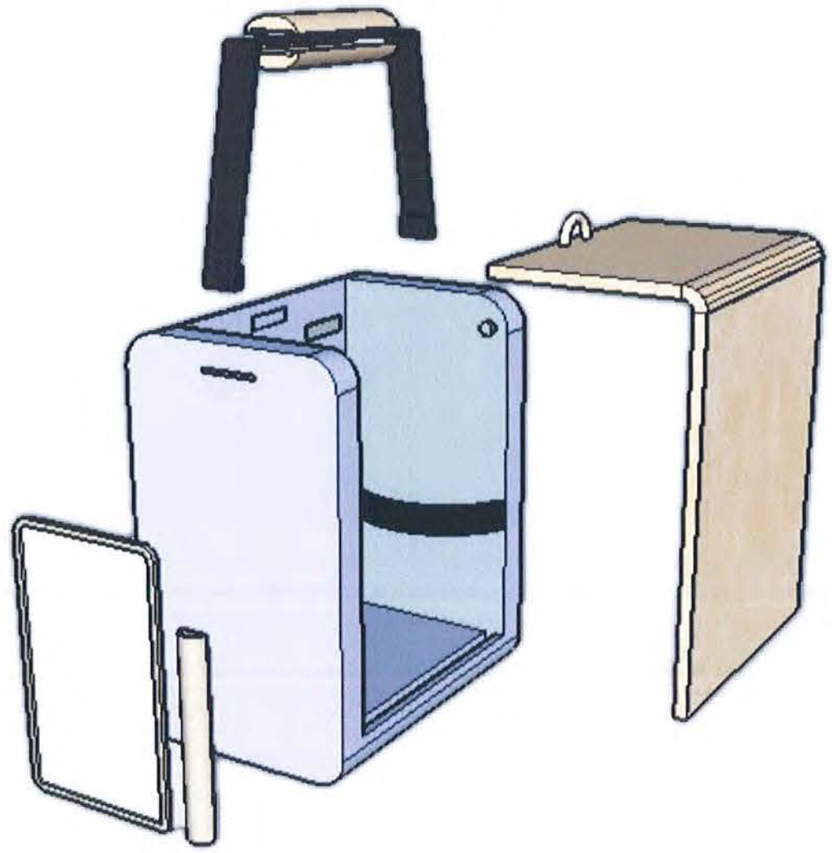
Exploded Diagram

I have divided the unit into 4 different parts which are the main body, the cover, handle and strap, and the whiteboard.

D

HANDLE & STRAP

The strap will be attached to the main body. Handle is designed so that the user will feel comfortable when carrying the product.



B

COVER

The cover has a function to store utensils.

C

WHITEBOARD

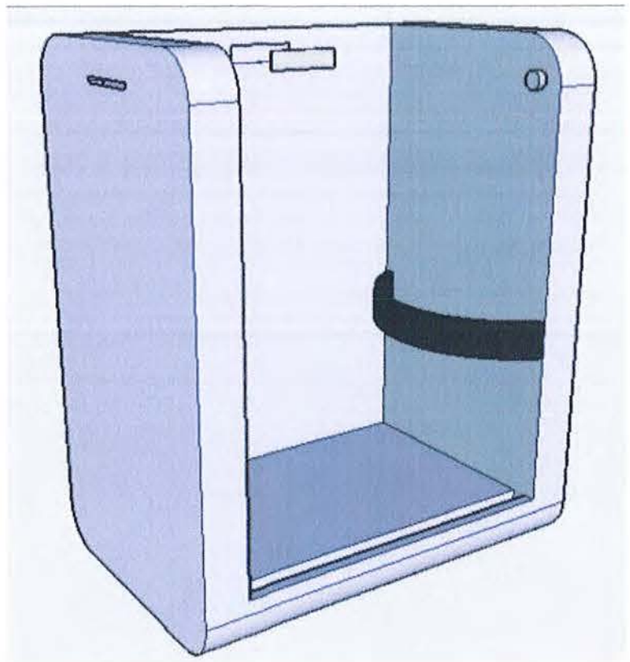
Users can write notes or reminders onto the whiteboard.

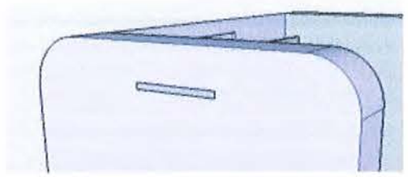
A

MAIN BODY

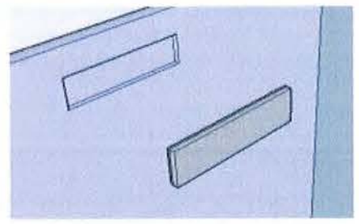
This is where the food containers and drinking bottles will be stored.

PART A MAIN BODY

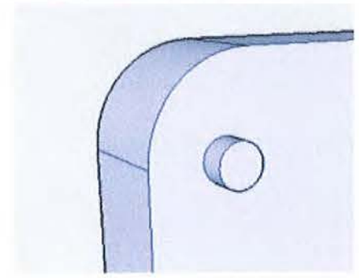




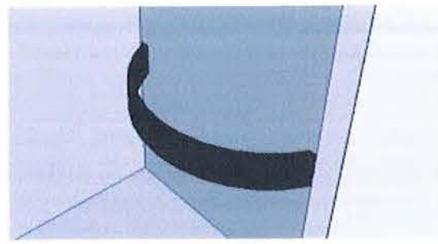
A hollow rectangle to insert the strap of the handle (Part C).



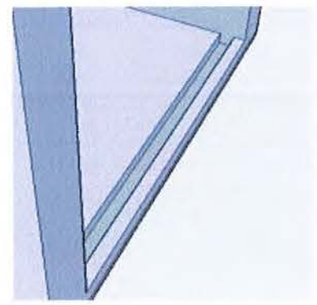
A rectangular magnet is implanted to the unit. Rectangular dent must be made on the surface of the unit.



Small cylindrical rod is placed on the unit's surface depending on the height of Part B.



An elastic strap is placed on the side. The length of strap is : approximately 15cm



There is a narrow drain on the bottom of the unit. This is to where the bottom of the cover will be inserted.

Steps / procedure : Vacuum Forming is used in this process.

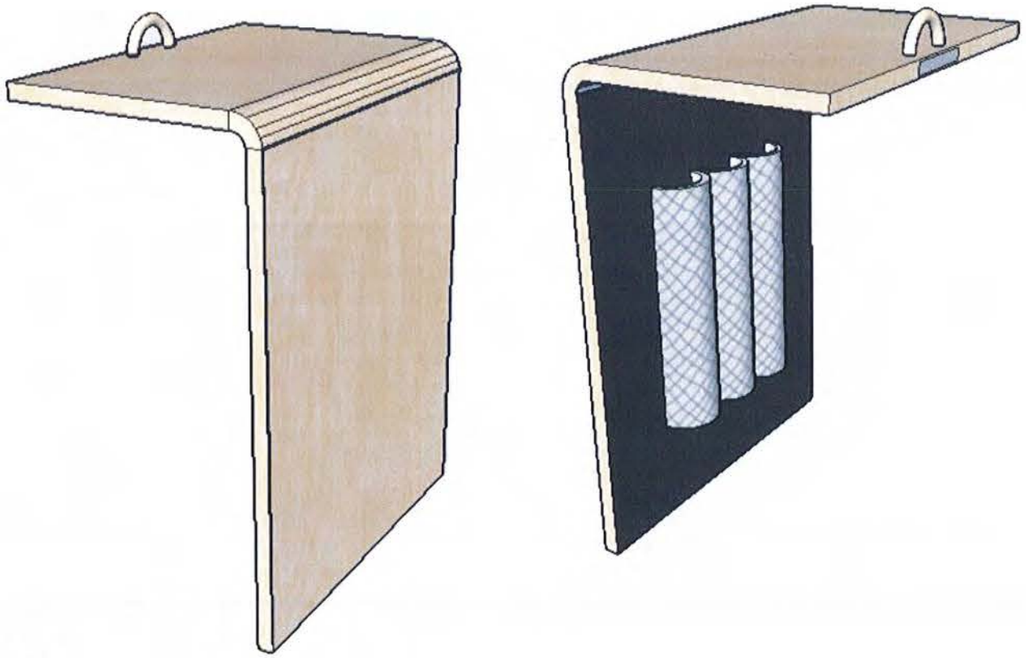
Draw a template of the unit. Make sure to include all the details.

Make a mould or die depending on the dimensions of unit. Need to consider the measurements of the details too.

Manufacture the unit by using Vacuum Forming machine with acrylic sheet as the main material.

Add the details included in the design. Example: magnets, bottle strap and small cylindrical rod.

PART B THE COVER

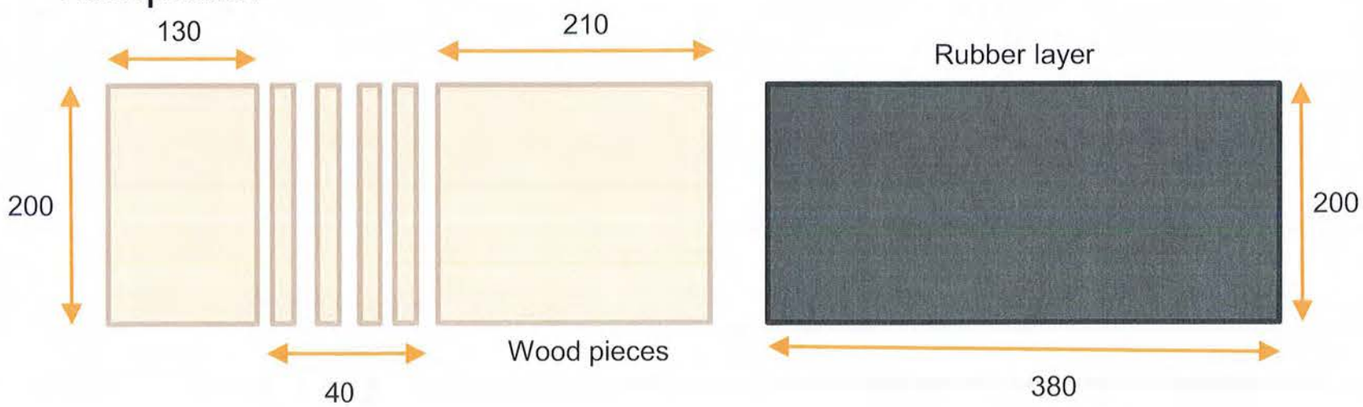


Draw a template of the unit depending on the dimensions. Make sure it fits to part A.

Cut wood and rubber layer into specified measurements. Take into account that there are holes to be drilled on the wood piece. Magnets and nets must be ready before proceeding to the next step.

Assemble all parts by using a suitable glue and techniques. Surface finishing might be needed such as sanding and polishing wood surface using a non-toxic furnishing.

Template:

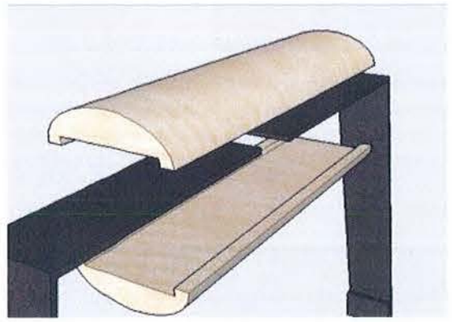


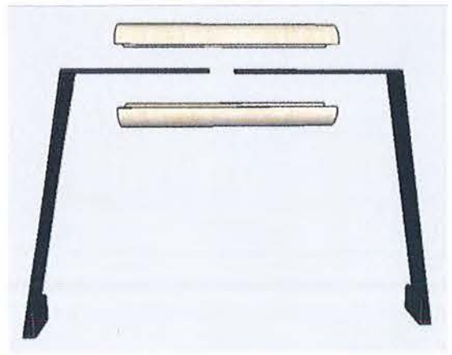
(measurements in mm)

The steps to manufacture part PART C and part PART D is quite similar. So, I combined the processes into 1 page.

PART C

HANDLE AND STRAP



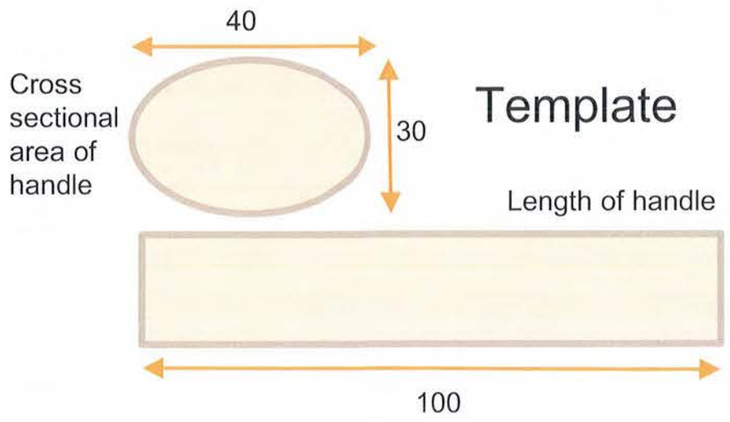


Draw a template depending on the measurements and sizes.

Prepare all the materials (pine wood and leather) and cut into specified dimensions.

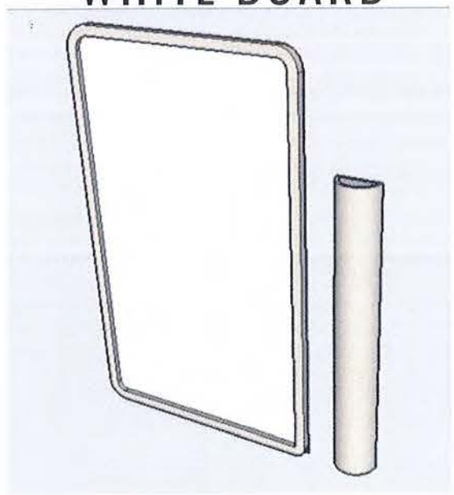
Prepare all material (mini whiteboard and acrylic sheet). Cutting and bending process is needed in this stage.

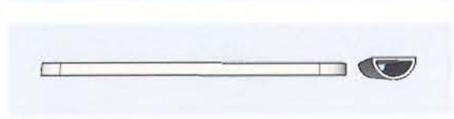
Assemble all parts using a suitable glue. Finishing might be required at the end of the process.

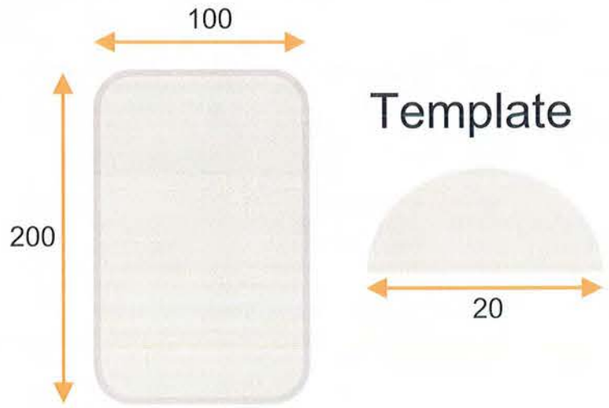


PART D

WHITE BOARD







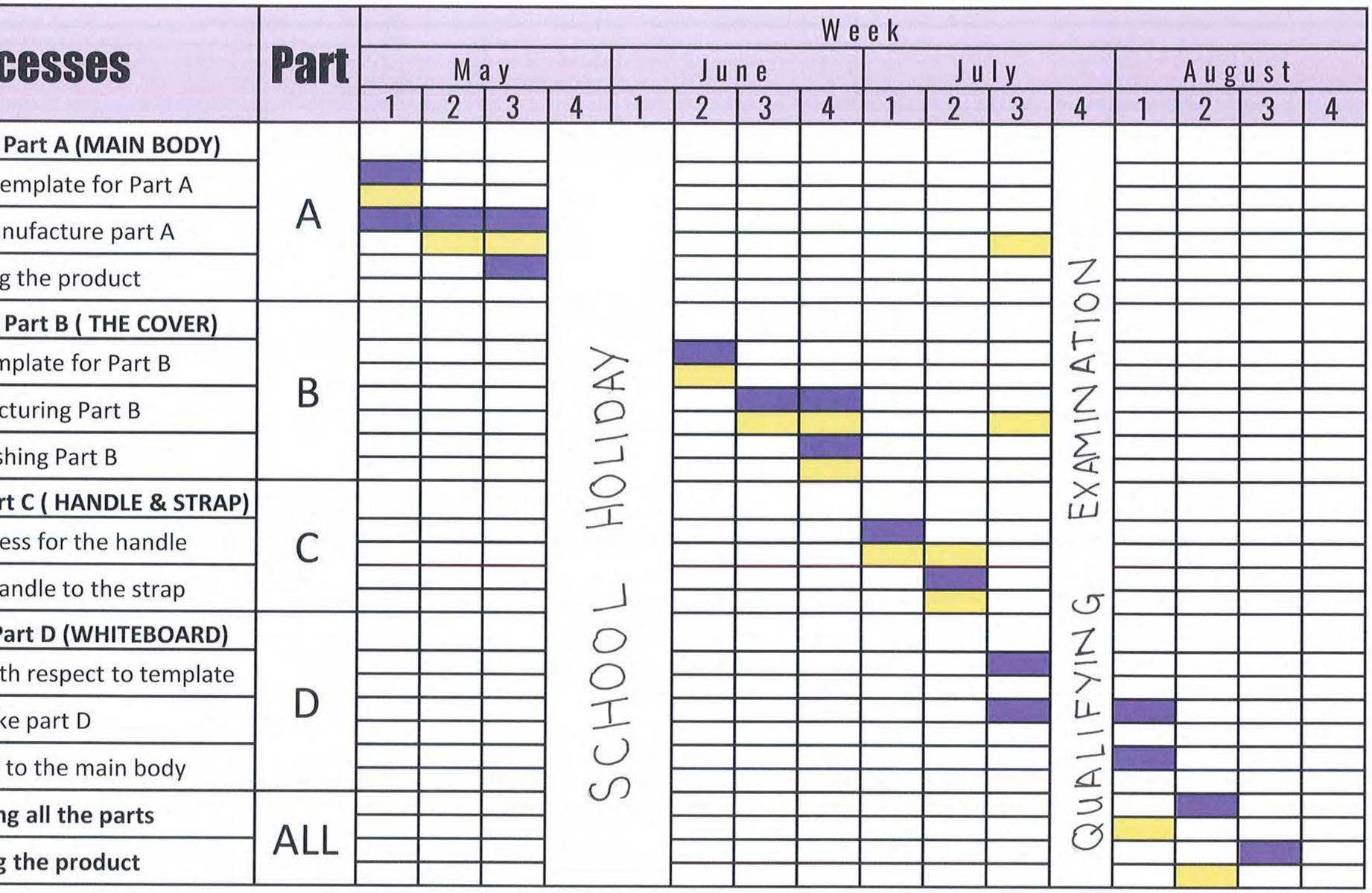
Material List

	Part	Material	Dimension / mm	Quantity	Remarks
A	Mould / Die	MDF (12mm)	350 x 250	2	MDF is cut using table saw or band saw
	Plastic Cover	Polystyrene	160 x 250	2	Size depends on the vacuum forming machine
	Elastic Strap	Fabric elastic strap	140 x 25	1	Available in craft stores
B	Wood plank	Pine	200 x 450	1	Need to be thin (about 1cm thick)
	Rubber Layer	Any thin rubber material	200 x 400	1	A mouse pad can be used as a replacement
	String	A normal yarn	200	1	Must fit into the holes drilled
	Net	Fabric net	140 x 300	1	Can be found in craft stores
C	Handle	Pine	15 x 40 x 100	2	Same material as the cover (Part B)
	Strap	Leather	30 x 700	1	Use recycled leathers (either from old leather bags or jackets)
D	White Board	Acrylic	200 x 100	1	Acrylic sheet is cut using acrylic cutter
	Marker Holder	Acrylic	160 x 20	1	Need to use Hot strip wire to bend acrylic

GANTT CHART

A Gantt chart is used to mark down the schedule for every processes. This is to make sure that I am on track so that my product can be finished before the deadline.

No.	Processes	Part
	Manufacturing Part A (MAIN BODY)	A
1	Making the template for Part A	
2	Start to manufacture part A	
3	Polishing the product	
	Manufacturing Part B (THE COVER)	B
4	Making template for Part B	
5	Manufacturing Part B	
6	Varnishing Part B	
	Manufacturing Part C (HANDLE & STRAP)	C
7	Making process for the handle	
8	Attach the handle to the strap	
	Manufacturing Part D (WHITEBOARD)	D
9	Cut out acrylic with respect to template	
10	Make part D	
11	Install part D to the main body	
12	**Assembling all the parts**	ALL
13	**Polishing the product**	



PRODUCT REALISATION

- Materials used for every component
- Methods of construction
- Assembling
- Finishing

Materials used

For the strap of my unit, I'm using a piece of plastic mat as a replace for the rubber layer (refer to production planning).

Plastic Mat

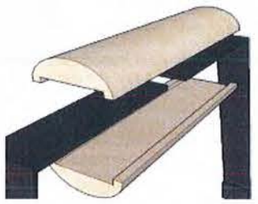
This plastic mat will be cut into strips, stitched, and attached onto the handle and the cover (Component B)

Acrylic sheet

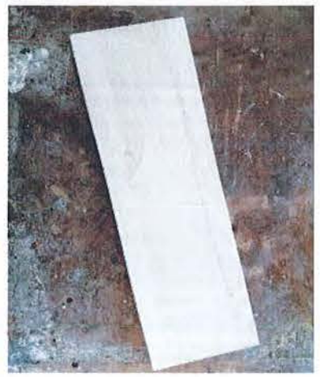
Since the unit that I'm making has to be waterproof, the most suitable material for the main body would be acrylic.

Acrylic plastics are easy to clean and are suitable in manufacturing the unit since acrylic can be cut and bent.

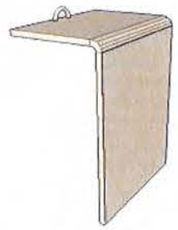
For the handle, I used Paulownia wood as it is light and can be trimmed and shaped by only using simple tools in the school workshop.



I used paulownia wood as a replace for pine wood since the pine wood in the school workshop are all too thick and are not in the specific thickness that I want.



Paulownia wood



Paulownia wood are also relatively cheap and can be found in craft or hardware stores .

For the cover, I'm using the same type of wood as the handle due to its light weight and most importantly Paulownia wood are fined-grain hence, a perfect material for the cover.

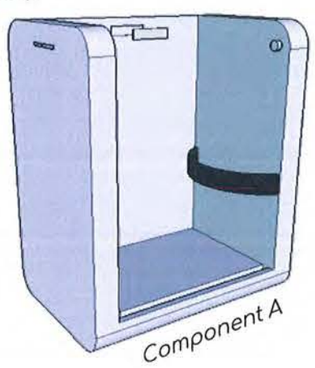
MANUFACTURING PROCESS FOR

COMPONENT/PART A

THE MAIN BODY

Blow moulding / vacuum forming is supposed to be used to manufacture this product (as what have been mentioned in the production planning) .

But due to several circumstances, change of plans happened where acrylic is cut into sheets and later assembled together so that it resembles close enough with the original design.



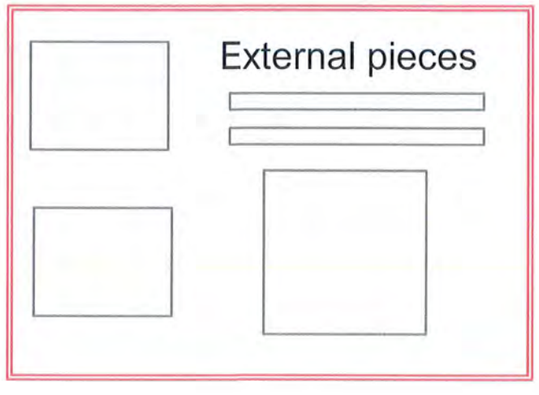
Component A

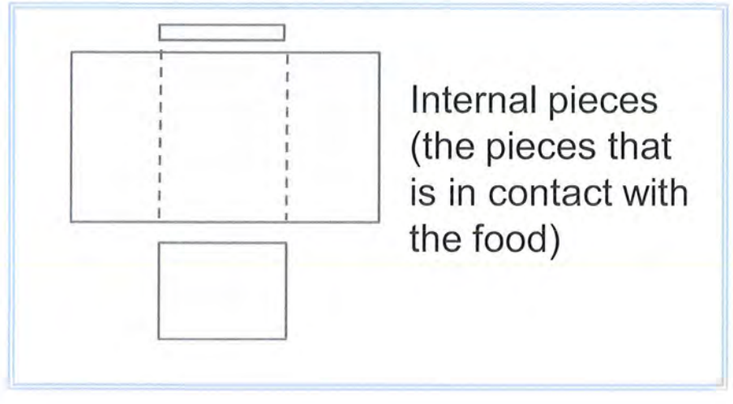
Material used:
White acrylic plastic sheet (thickness 0.3cm)

Marking

After finalising the dimensions for my unit, marking has to be done since i was given a large sheet of acrylic plastic. The main focus is to cut out the internal layers and then assemble the internal parts. Next, measure out again the dimensions for the external part. This is to prevent from incorrect cutting measurements which hence leads to wasting of acrylic sheet.

Tools needed to mark:
-pencil
-long ruler
-engineer square (to ensure that every angles or corners are 90°
-measuring tape





Internal pieces (the pieces that is in contact with the food)

Cutting

Various tools and machines can be used to cut the acrylic sheets, but for this process, I am only using acrylic cutter and metal ruler.

How to cut acrylic:

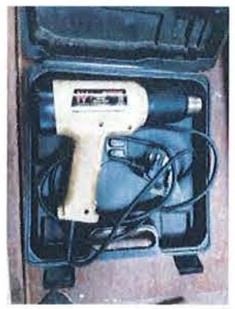
1. *Place a metal ruler along the margin where you have marked.*
2. *Run the tip of the acrylic cutter along the acrylic sheet from one end to another end.*
3. *After half of the thickness had been cut, snap the acrylic sheet either using our bare hands or with the help of vice bench.*

Cutting of acrylic is not the same as cutting a piece of paper using normal paper cutters. Arranging the template and planning where to snap or cut is important to prevent wastage of acrylic sheets.

Bending

To bend acrylic sheets, we use hot strip machine or a hot air gun.





Precautions when handling hot strip machine / hot air gun:

☆ use heat gloves to protect hand from the hot surface.
☆ try to prevent the plastic from over heating as it will create a burnt surface and bubbles may be formed inside the plastic.
☆ it is better to use engineer square when bending the plastic at 90°.

Sanding

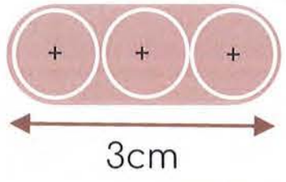

The curved corners are done by using a disc sanding machine.

Precautions when handling disc sanding machine:
☆ use face mask to prevent inhaling of plastic dust which are chemically dangerous.
☆ do not touch the sanded surface immediately because it might be hot due to friction.

Slots are made to insert handle strap. This is done by drilling 3 conjunction holes using a drilling machine.

It is important to use G-clamps when drilling to avoid plastic sheet from cracking.

File the holes to make a narrow slot, enough to fit in 3cm wide strap.



Assembling

Duct tape is quite handy when glueing the plastic pieces.
Paint brush can be used to spread the glue evenly so that there are no gaps left.

The glue that I'm using is silicon glue.
Reasons to use silicon glue:
☆ silicon glue are easy to handle where mistakes can be corrected immediately as silicon only hardens after several hours.
☆ silicon glue is water resistant. Therefore preventing liquids to enter the small holes in my product.

Disadvantages of using silicon glue:
☆ need much time to harden the glue.
☆ the tip of the glue dispenser easily got stuck as the silicon glue hardens inside the tip.
☆quite a messy procedure as the silicon may smear onto our clothes.

I intentionally leave out the back piece exposed. This is to east when inserting the handle strap. Also, the hollow space will be filled with foam.
Therefore, it is best to glue the back piece at the end of the manufacturing process of the product.

MANUFACTURING PROCESS FOR

COMPONENT/PART B

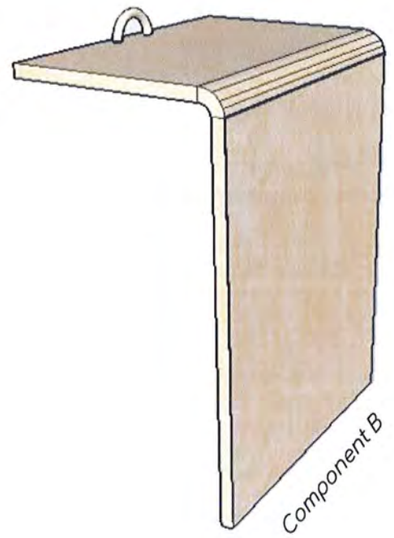
THE COVER

Material used :

- Wood plank (Paulownia wood)
- A wooven plastic mat
- Polyurethane Stained Varnish

Tools / Device / Machines used:

- ☆ Table Saw
- ☆ Hand drill and Drilling Machine



Cutting

The machine used to cut the wood is table saw machine where an accurate cutting can be easily obtained.

Cutting the wood into strips will allow the cover to bend.

The wood that I planned to use is supposed to be pine. But due to lack of pine wood in the workshop, I decided to use Paulownia wood which has a number similarities to pine wood.

Properties of Paulownia wood :
☆very light, fine-grained, and warp-resistant.
☆ it is known as the "Aluminum" of the timbers due to its light and strong features.
☆it is relatively cheap and easily available in DIY shops.

Sanding

Sand Paper Grit: 600cw

The purpose of sanding is to smoothen the rough part or edges of the wood.

Since the surface of the wood plank is already quite smooth, only minor sanding is needed.

It is important to ensure that you have to sand down the wood grain. This to enhance the aesthetic feature of the wood hence, eliminate visible scratches.

Need to mark each pieces with numbers to avoid confusion when assembling. This also to ensure that the grains in every pieces is connected to each other.

Coating

The varnish used is Polyurethane Stained Varnish.

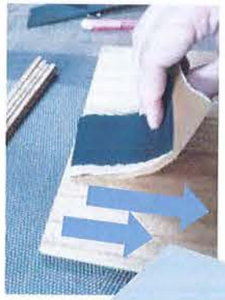
Steps / Procedure on how to apply varnish:

1. Mix well the paint or varnish using a stick.
2. Use a brush to apply the pain
3. Wait for the coat to dry.
4. Repeat the above procedure 3 times.

For every coat, sanding is necessary to ensure that the surface is smooth. The abrasive paper used is 1000CW.

The higher the grid of the abrasive paper, the smoother the surface will be.

1st coat + light sanding



When sanding, it is important to sand along the wood grain. This is to avoid visible scratches to the wood surface. Also, only apply minimal pressure when sanding. (Light stroke)

Repeat coating

2nd coat + light sanding

After the first coat have dried and smoothed, apply the second coat using the same varnish and sand using 1000cw sand paper.

3rd coat + no sanding

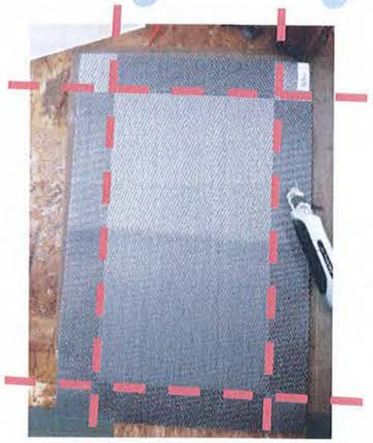
The 3rd coat will be the last coat. Sanding is not required so that the surface remains shiny.

Finished surface

For other wood product, more coating can be applied depending on our own liking. But for this product, I am satisfied with just 3 coats.

Finished surface should have a smooth, shiny surface as what is seen in the picture above.

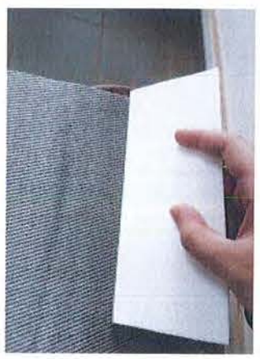
Gluing



A plastic mat is used and glued to the wood pieces.
Before gluing, the edges of the mat are trimmed using a cutter with respect to the size of wood pieces
Dimension: 20cm x 37cm

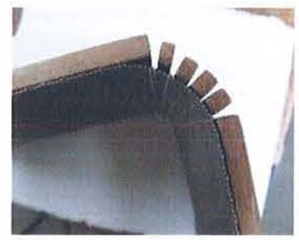
Before applying the glue, it is important to sand the surface of the plastic mat. This is to allow greater adhesive so that the plastic mat will not fall off easily.

The glue used is hot glue. This is because of the rapid drying and curing. Thus, easy handling.



While the glue is still hot, instead using our bare hands, I used a plastic sheet to spread the glue evenly.

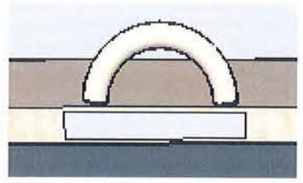
Paper strips are inserted between the wood pieces to prevent the pieces to stick together.



This is how the unit looks like after gluing procedure is done.

Finishing

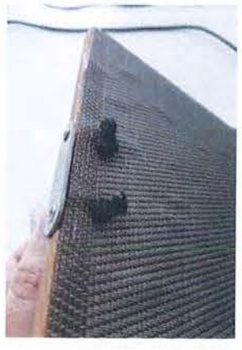
A thin metal piece is screwed on one of the wood piece.



Picture from sketch up

To make the small handle, 2 holes are drilled onto the wood piece using a hand drill.

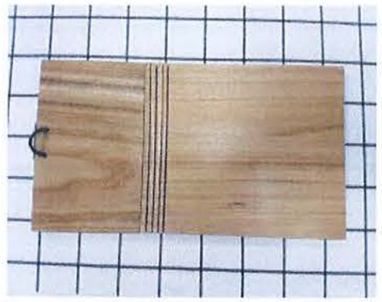
Since I'm drilling into a softwood, it is important to have a stiff and stable grip during the drilling process. Or otherwise, a drilling machine can be used to avoid awry drilling.

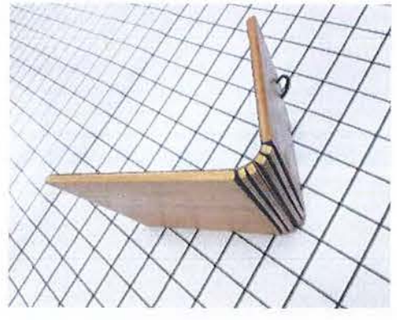


A hand braided string is tied onto the holes, making a small handle for the unit.

Component B is now done!!

Component B completed





MANUFACTURING PROCESS FOR

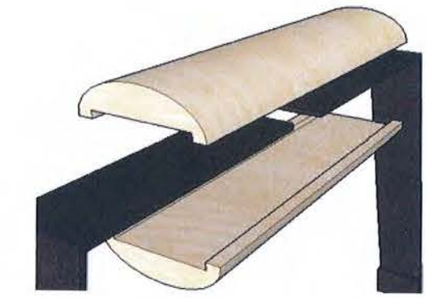
COMPONENT/PART C

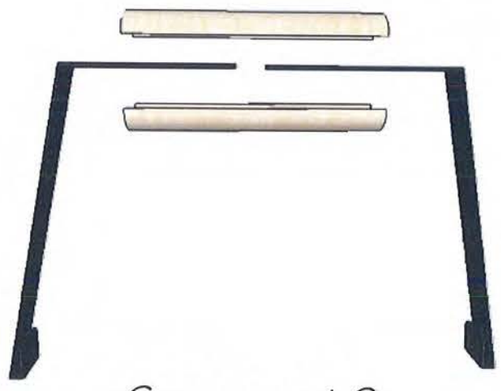
THE HANDLE

Material used :
- Wood plank (Paulownia wood)
- A wooven plastic mat

The material used for Component C and Component B are same thus, saving up budget.

Tools / Device / Machines used:
- ☆ Table Saw
- ☆ Hand drill Drilling Machine
- ☆ Drilling Machine





Component C

Gluing

Mark and cut out 3 pieces of wood with dimension: 4cm x 10cm Mark using a pencil & a table saw machine to cut.

Apply glue to the surface of wood pieces. Wood glue is used.

Stack the 3 wood pieces on top of another, creating a total thickness of 3cm. Using a bench vice , clamp the pieces together and leave it to set.

Shaping

After the wood pieces have set, trim out the corners using a small metal smoothing plane.

Sand the wood piece to smoothen out the surface. The grit used is 1000cw.

Trim the corners of the wood piece until its cross section is slightly an oval.

The wood piece is clamped onto an engineer vice for easy trimming.

Cutting

After shaping is done, the wood piece is cut into half by using a Band Saw machine.

Band saw
-used to cut materials in straight or curved lines.

Since the wood piece is too small, I can't use my bare hands to push the wood piece against the metal blade. So, to overcome this problem, I used a wood pole instead.

After cutting process is finished, the wood piece should now look like this :

Wood piece is perfectly cut into half.

Drilling

1

Before drilling, mark out 2 points on the edges of the wood piece.

2

Drilling process is done using a Pillar Drill. First, drill the holes using a twist drill.

3

Next, a center bit is used to drill half the depth of the wood piece.

In this process, a G-clamp should have been used. This is mainly for safety purposes. But, since I am confident enough, I managed to drill accurate holes safely.

Screwing

I used Nut and Bolt to assemble the pieces together.

First, drill a screw into the holes with the handle strap underneath.

A piece of wood is placed beneath to prevent from damaging the table.

Next, sandwich the strap with the wood pieces ,insert bold and nut into the holes, and screw them tightly.

Strap

I hand sew the ends of the strap and inserted into the slots on Component A.

First, I hand sewed the strap using a yarn.

Then, the ends of the strap is inserted into the slots in Component A.

Buckle

I sent my product to a shoe repair shop to help me to install a plastic buckle onto the strap.

The strap can now be adjusted into different lengths. Unbuckling the strap will make it easier to open the cover of the unit.
(will explain further in page .42.)

At this stage, all of the components of my unit is completed. But, there are some details that need to be done.

The details are as such:

- Spraying Foam Filler into the hollow space in Component A.
- Cover the back part of Component A using acrylic sheet.
- Gluing small acrylic pieces onto Component A.

Spraying Spraying Spraying

1

Before applying the foam, it is necessary to clean the surface that is in contact with the foam. I cleaned the acrylic surface using wet cloth and brush to remove dust.

2

This is after foam is sprayed into the gaps.

It is important to not over-fill the gaps because the foam will expand once it is sprayed.

3

After 2 days, the foam is already dried and harden.

4

Trim excess foam using a normal paper cutter.

5

The exposed part of Component A is now ready to be covered. A sheet of acrylic is cut and glued to the surface of the foam.

To ensure that it is really set, we can poke a wooden stick into the foam. If the stick comes out clean, it shows that the foam is fully cured. This simple method is also used in baking cakes!

Steps how to correctly spray foam filler into gaps:

1. Clean surface from dust & dirt.
2. Spray water onto the surface.
3. Shake the foam filler can for 20mins before spraying.
4. Place the straw nozzle on the foam filler and invert the can.
5. Fill half-depth of the gaps. This is because the foam will expand further.
6. Let the foam to cure for at least 8 hours.

Gluing Gluing

An acrylic piece is soften using a strip heating machine.

It is then bent to 90°.

The acrylic pieces are glued to Component A using Epoxy glue.

More acrylic strips are also glued to the bottom part of Component A. This is to stop Component B to slip off the unit.

Reason to use epoxy:

- Easily available in shops
- Easy and safe to use.
- Quick setting

Precaution when working with epoxy:

- ✓ Better to use protective gloves when mixing and applying
- ✓ Mix well the resin and hardener carefully.
- ✓ Apply the adhesive using a suitable tool.

Polishing Polishing

We have come to the end of the manufacturing process!

For the final touch, a plastic polish is applied to the unit to clean out any marks, dirt, and glue residue.

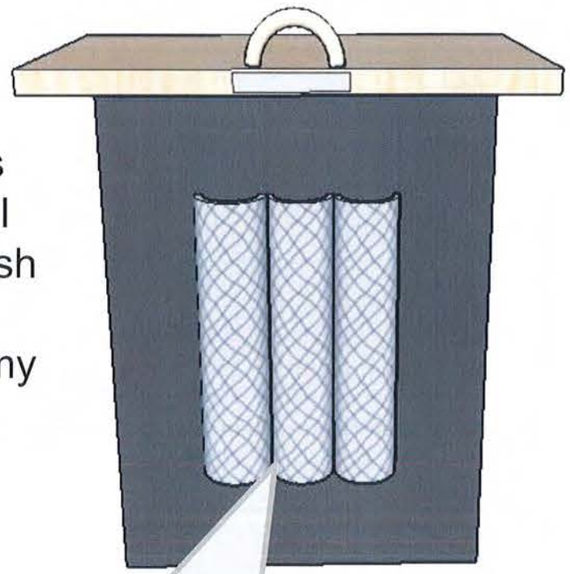
Apply the ~~glue~~ polish onto a clean cloth and wipe it onto the surface.

Now, my unit is completely finished!

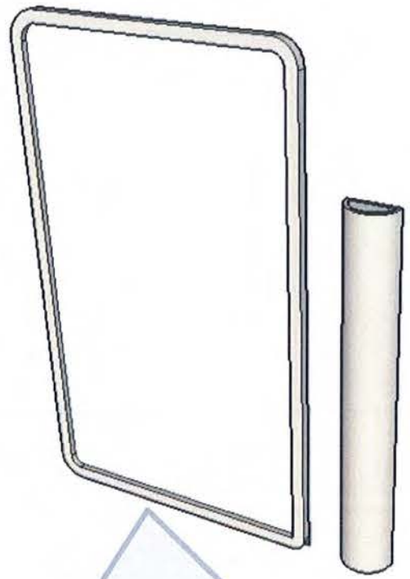
MISSING FEATURE

There are some details and parts that I have not included. This is due to the shortage of time. It is also difficult to find the perfect material for the unit in stores or shops.
The details that I have not included are :

I accidentally left this feature out because I was too eager to finish the product.
I also realized that my planning processes were lacking.



Net to store utensils in Component B



Whiteboard that should have been installed on Component A

Due to time constraint, I do not included this feature in my product.

I also believe that this feature is not really necessary in my product since the main function is to store food and drinks.

TESTING AND EVALUATION

In this section, I will carry out various experiment procedure to test whether my unit meets the Design Specification.
Photos from different angles were taken as well as a source of evidence.
Any weaknesses and flaws to the artefact are recorded and will be given solutions right after.
Multiple feedbacks from real life users are also included which will then help me to improve my unit.

How the overall unit works

Before we proceed to product testing, I would like to explain how my product works. This will give us a clear view on how to use the product.

① 

First, unclip the buckle of the strap.

② 

Next, use the string to pull out the lid of the cover and detach it from the unit.

③ 

Place your lunch box and bottles into the unit.

④ 

Arrange your food and drinks to your own liking.

⑤ 

Attach the cover back into the unit and close the lid.

⑥ 

After that buckle back the unit. You can also adjust the length of the strap.

⑦ 

Now, the unit is ready to be brought to your destination.

Product Testing

In this section, I tested my product with various kind of food and drinks. I also placed some lunchbox containers and water bottles into my unit.

2 Tupperware water bottles and 3 medium size food containers can fit into my unit.

A complete lunch set including spoon and fork can fit into the unit .

4 canned drinks and 2 plastic bottles can fit into the unit

A female student.

A male university student carrying the unit.

I have included some pictures of models and edited the background to visualize how it would look like in real life situations.

I have found out that my unit is suitable not only for students but also suitable when going out for a picnic or any outdoor activities.

I am surprised that my unit is also suitable for both male and female regardless of their background age.

Unit is brought for a picnic / outdoor activity

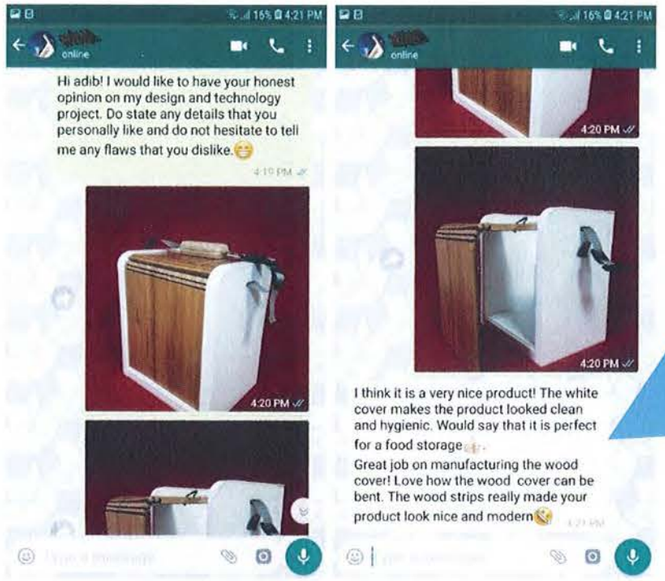
Product Evaluation

Design Specification (AS D&T 2018)	Does the unit full filled the specification?	Comment(s)
The users of the unit must be students or school staff who bring their home cooked food for their meal in the school.	✓	Not only for high school students, but also university students. Both female and male can use the product.
The main function of the unit is to store home cooked food and drinks as it is more healthier lifestyle and teaches users to save money.	✓	Store bought and home cooked food can be stored into the unit. Various kinds of food containers and water bottles can also fit inside. Snacks and fruits can also be brought into the unit.
The unit must have healthy features that protect the food and drinks from contamination. To be specific, the unit must be water-proof, dust-proof, and pest-free.	✓	The unit is water proof since it is made up of acrylic. There is also a lid to cover the unit to protect food from contamination
It is important for the unit to not hurt the user's arm or fingers while carrying the unit.	✓	A handle is attached to the strap. The handle has rounded corners and no sharp edges. The size of the handle is also designed to promote a comfortable grip.
The design must not be too childish but at the same time not too dull. It should also has a nice and modern design to suit the taste of users which are mostly students.	✓	I purposely used wood for the cover as a highlight of the design and emphasizes the texture of the wood grains. The colours of the product are also subtle and blends well to any surrounding.
The size of the product must not be too big and not to small.	✗	I would say that my unit is too large for a student to bring to their school. I think it suits well for other occasions like having a picnic or having outdoor activities
The material of the unit must be waterproof and dustproof.	✓	The unit is made up of acrylic plastic which can be cleaned easily. The wood cover are varnished so that it can withstand moisture and would last long.
The weight of the unit must be as light as possible.	✗	The weight of the unit is about 1500g which I thought is quite heavy for ordinary students. Thus, bringing food and drinking bottles would add more to the weight.

Feedbacks

For this section, I have selected a few people to give me their opinion on my product.

Person A is impressed by the design of the unit. She also stated that she prefer the product to come in many different sizes (preferably smaller). She thinks that the unit is too large which might be less convenient. Furthermore, she believes that the material of the product is too hard, making it unsafe especially for children.

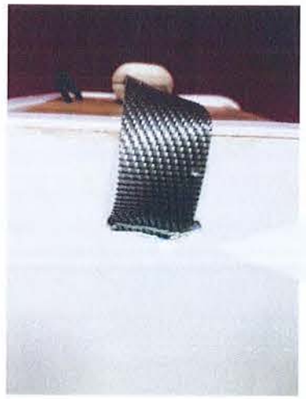


Person B said that he liked the white cover which he thinks that it made the product looked more clean and hygienic. He also love the bending feature of the product.

This is a review from one of the models from the previous section. She posted a picture of her carrying the product and wrote some comments. She stated that she loved the colour and it suits her well. She personally think that the unit is over sized but she would buy it if it is a little bit smaller.

Flaws and Weaknesses + Improvements

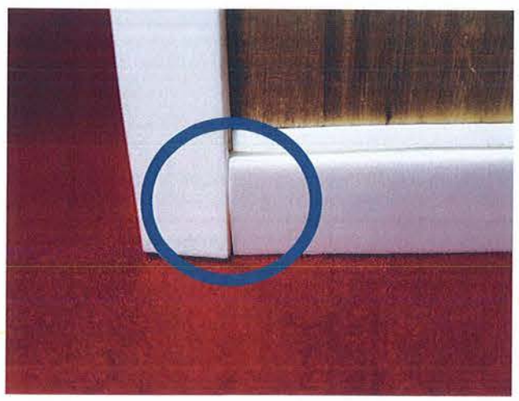
The unit has sharp corners which might not be safe for users.



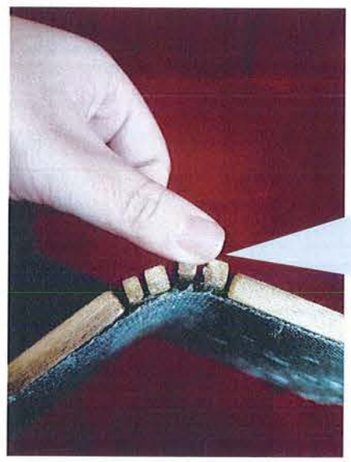
There are uneven edges on the unit.

There are stains of extra glue on the edges of the unit. There are also pen marks on the sides of the unit.

Dimensions were incorrectly measured.



Joints are distorted due to incorrect gluing method.



Some of the wood strips on the cover are not glued properly.

Personal Evaluation + Solutions

I think that my product is too space consuming for users and is too heavy.

- I would have chose a more lighter material and minimizes the dimensions of my unit. Furthermore, I should have designed a food storage ~~so~~ that users can adjust its size.

There are some measurement errors and extra glues on the edges.

- I would say that my skill in manufacturing my product is still lacking. I believe that I am not exposed enough to all the advance machines in the school workshop. Thankfully I have my teachers and friends to ask every time I am in doubt. They have shown me some techniques that I am not familiar with and they were not hesitate to guide me on how to handle each and every tools correctly without hurting myself.

The product did not meet my final design. There are some features and details that are not included when manufacturing the product.

- Some of the features are storage for utensils, a magnet inside the main body, and a whiteboard. All of the corners of the unit should be curved. The reason why I ignored and leave out these features because I was eager to finish the product as there were no much time to complete it. If I were to redo this product, I would plan the manufacturing process thoroughly and would start a month earlier.

All in all, I gained a lot of experience and knowledge. I am very proud and happy that I managed to finish this product on time. This project made me realise that there are solutions to every problem that we encounter. We should never be afraid to ask for help and never be too stingy to help others.