A Level
Design and Technology

NEA Support

Common Issues 2024 Insights

- The use of feedback throughout the portfolio – The iterative question
- Client led proposals
- Irrelevant Research
- Specifications
- Quality of design work
- Modelling and Architectural modelling
- Quality of manufacture

Insight 1: The Iterative question

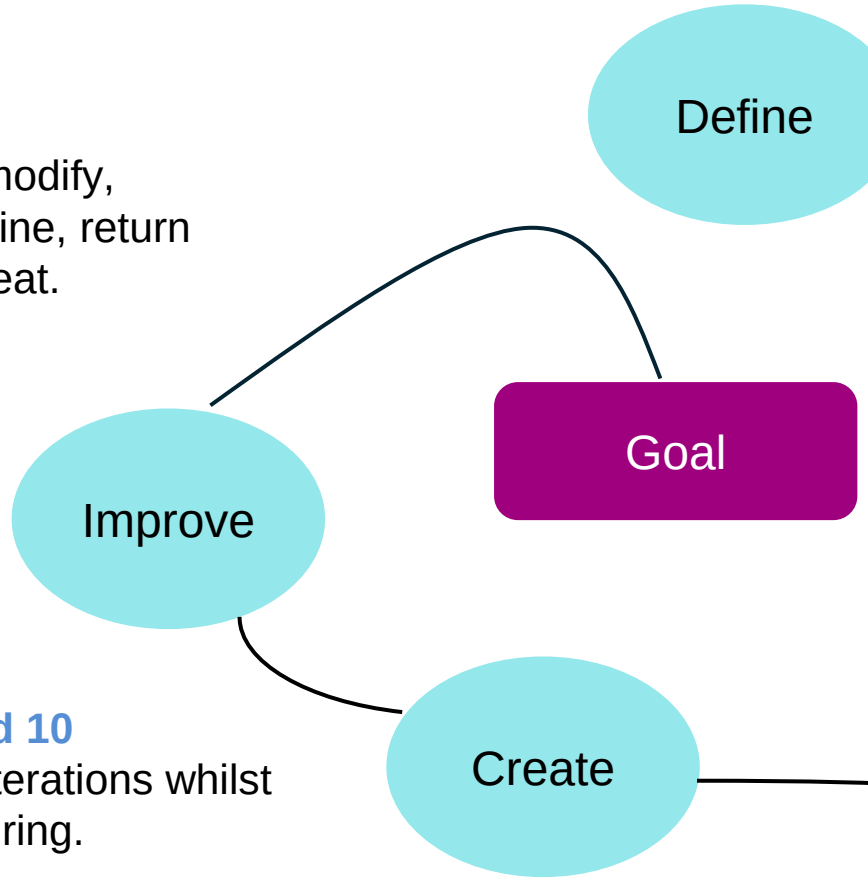
The qualification has at its heart the iterative design process. It is a fundamental objective of the qualification, and it underpinned the call for more rigour, both at GCSE and A level, when the qualifications were redeveloped in 2015/16.

Qualification aims and objectives

The aims and objectives of this qualification are, to enable students to:

- Use creativity and imagination when applying iterative design processes to develop and modify designs, and to design and make prototypes that solve real world problems, considering their own and others' needs, wants, aspirations and values

The Iterative portfolio – iterative design process



Grids 1, 2 and 3
Consult client and stakeholders. Trigger iterations.

Grids 4,5 and 6
Client designer relationship. Trigger iterations.

Grid 7
Review may trigger iterations

Grid 6 and 8
Plan and check for potential iterations.

Grid 9 and 10
Potential iterations whilst manufacturing.

Grid 11
Test, evaluate, modify, progressively refine, return to client and repeat.

Insight 2: Client led proposals

Grid One

This is the starting point of the portfolio and is therefore imperative.

Identification of a Design Possibility

- To work in a client centred/iterative way, candidates must identify the problems or needs (possibilities) of a client/user-group to develop a product that may fulfil those needs. The client/user-group could, for example, be a target market opportunity, a local business or organisation, or an individual client.
- Candidates can explore design possibilities, by undertaking market research, conducting identified user group interviews, or responding to a number of identified possibilities and justifying the choice of one.
- We expect that candidates will justify problem starting points from a range of positions. Some candidates will identify a range of problem starting points and others may focus on one and justify it. Working with the client they need to make a decision on the potential design possibility that they will be working on and then produce a preliminary design brief.
- Once candidates have identified the design possibility, they need a comprehensive investigation to identify the key information that needs to be researched to inform the design requirements.

Client led Proposal

Hose Holder exemplar

Introducing the client

Name: Peter Hodgkins
Age: 46
Occupation: Chartered Engineer

Mr. Hodgkins is a teacher at my school. He likes to spend time outside in his garden and likes to spend time with his cat and daughter. When he isn't teaching in the classroom, he goes to his daughter's squash competitions.

The property management market is increasing each day. People buying their first properties and having to fix problems and maintain the property once they have bought it. This is my focus for my product

Beech Leaves

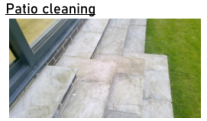
"This part of my garden is always untidy and because there are tall beech hedges next to it, the hedges shed their leaves at the end of spring and it's a big mess. Then they start rotting and clogging up drains and such."
How do you get rid of the leaves?
"Well to be honest I use to big boards like hands to scoop them up but as I get older, I won't be too keen on bending down all the time like that.

Analysis of main problem through discussion with client

I talked with my client about problems in his life that might be helped by a product. He said that he has a lot of bikes in his garage and that his garage is a mess. He also needs some way of safely receiving his mail deliveries without them being stolen. He also has general property maintenance and household maintenance such as cleaning out his gutters and drainpipes, having hoses everywhere and struggling with storing them or moving them easily, cleaning the patio, treating wood, counsel given clippings bin overflows after cutting the bushes, watering plants, cleaning his car, and when cutting the hedges, it is difficult to reach the top of the hedge.

Investigation

Patio cleaning



My client's patio gets dirty over time, and it is a hassle to get out all the proper equipment to clean it.

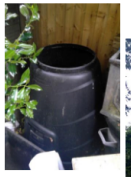
"It does require regular cleaning, but the problem is that it is next to glazed windows, the cleaning spray splashes on the windows. However, it doesn't get rid of all the algae and lichen. Also, it might damage grout due to high pressure of the water sprayer."

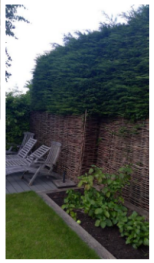
Compost bin

My client has an upright plastic cylindrical compost bin that regularly over fills and isn't as efficient as it could be

"If I put grass clippings into it, it does not compost well unless you turn it over regularly. For a lot of compost bins, stuff just sits there not properly composting because the layers aren't right it's not turned regularly, and bins like this it's difficult to turn without getting all of the compost out. Big open compost bins are handier because you can just take a shovel and turn it. I don't know if there is an option to have a rotating type bin where you don't have to get all of your compost out."

What do you do when your compost bin gets too full of the beech leaves?
" In the green waste collector bins, but they only come every two weeks and during the spring and summer and if you miss the collection you have to wait another fortnight so it's a month between collection, and you have to pay for it.



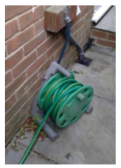


Design possibilities

I could make a bike rack organizer that stores the bikes efficiently in the garage and stores anything that the bikes would need e.g., pumps, patches, or attachable lights. I could also make a seat that the mail deliveries can safely go into. I could have a quick way of having the hose be packed away so that it doesn't kink and is easy to take off the mounting system. I could have a compost/ bin attachment so that the bin would be able to store more clippings. The gutter and drainpipes, I could make a tool that effectively cleans them better than the current tool used to clean it or I could make a product that helps with the cleaning of it. With the hedges I could make a product that helps you reach the top of the hedges that is easier to use than current market products

Hose management

My client has a hose reel that is too small and is very inconvenient for his garden.
"There is a hose reel for hose management, but it is really difficult to use. Because it is free standing if you put pressure on the hose then it twists round and jams the reel. If you are trying to wind it up, because its free standing, you have to put quite a lot of pressure to use the wheel to wind it up, it ends up moving all around, and there is simply not room on the drum for the length of hose I have. Also, it drips, and leaks and I trip over it because it is in a narrow area of my garden. It's generally a pain, but it's the best I've got at the moment."



Tall hedges

My client has trouble cutting the hedges due to their size and the un uniform nature of the ground in front of them.
"These are the hedges I have to cut periodically, at least once a year preferably twice, but I don't seem to have the time for it. Getting up high enough to cut and trim the bushes is a bit of a challenge, they must be approaching 4 meters high. "
Have you tried using a ladder to aid you reach the top?
"I do use a ladder, it's not very stable at the bottom. I've got a flower bed and other things in the way, and I usually do it on my own, so I haven't got someone to hold the ladder when I use it.

This candidate has a real focus on the client and talks through lifestyle, refining what the problem is with detailed dialogue that triggers a final proposal. This is a Level 3 performance.

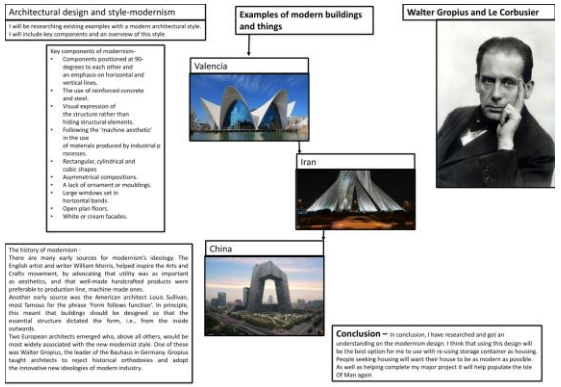
The candidate in this example does have a realistic narrative and identifies areas of potential. High Level 2 performance.

Rambling Research

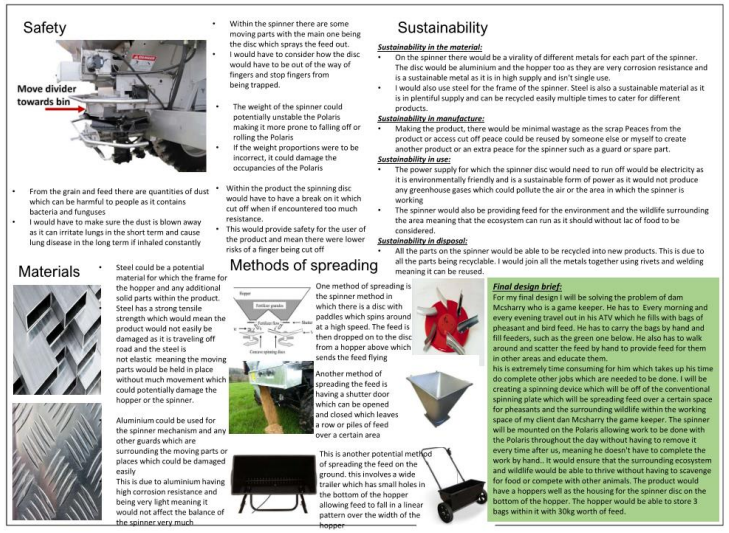
Investigation of needs and research

- Candidates should develop their understanding of the needs wants and values of the client/stakeholders
- Undertake relevant and focussed research as a result of a thorough dialogue with client/users/stakeholders
- Candidates will evidence an authentic link between the needs wants and values of the client, and the research undertaken
- The research will be perceptive, as a result of a close designer client relationship
- Candidates must avoid generic research, especially in terms of materials and processes

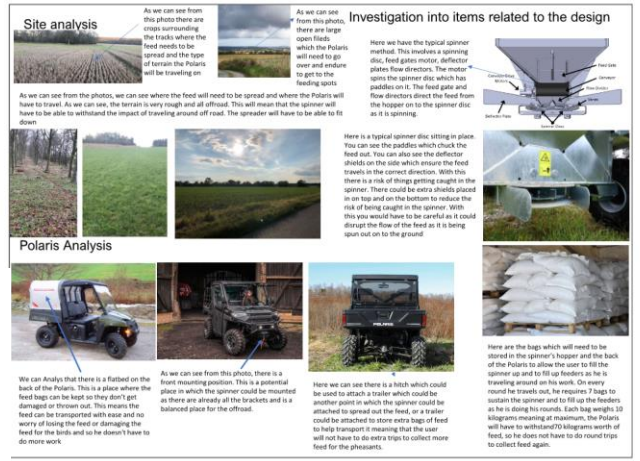
Insight 3: Rambling Research



It is somewhat difficult to understand what was learned from these two pieces of research.



Here we see relevant research with client input and focus.



Insight 4: Specifications

In this section we are expecting to see evidence of technical and measurable specification points that are a product of the focussed research undertaken. This should also be a product of a refining/renegotiation narrative with the client or a realistic target market/user group

- A refined design brief and specification must be produced
- At best, these will reflect the research and analysis previously undertaken and consider changes or renegotiations that have taken place between stake holders/client and designer during the research
- This narrative is imperative if the candidate is to fully justify the performance requirements
- The specification must have **technical, measurable** and **realistic** points. The approach should mimic commercial activity
- The candidates would benefit from a test specification methodology

Exemplar Specifications

This is a top-level specification.

This example shows measurable elements here.

Specification: In this section, I will be summarizing and creating a criteria to compare my final product, prototypes and ideas against to create a successful final product. This will branch off from my research analysis.

1. Cost:
1. The budget should not exceed 300USD (tier 3) and an effort will be made to ensure the budget is between $150 to $200 (tier 1,2), as agreed by both clients.
2. A value added calculation (estimation) compared against potential competitors and customer & client response will determine the addition of new parts (to stay in budget). Extra features/parts might be discovered during the design and development process that should be discussed with my clients to weigh up the value.

2. Aesthetics
1. The product must fit in with the surrounding environment to ensure it has a neutral aesthetic and doesn't look out of place.
2. I will follow the qualities of Bauhaus - putting function first then form. As it is a highly functional machine where the focus is on the product.
3. The design of the software must be minimal, spaced and not distracting. I will refer to Jakob Nielsen's heuristics 10 principles of user interface to test the software to ensure it is user friendly, easy to navigate and intuitive.

3. Ergonomics & Anthropometrics:
Design of the Machine:
1. The angle of the screen should be between 30 to 45 degrees from horizontal, to ensure a universal viewing angle that all people can look at, regardless of if they are sitting or standing.
2. An integrated power block/switch must be used to ensure the user can turn on/off the machine and to supply the varying voltages (5V & 12V) to the machine. This must allow for the power lead to be removable if broken or being transported to allow the user to easily repair/transport the RMM.
3. The electronics must be easy to access via a screw-able access panel so it can be unscrewed in the event of a repair - and screwed back on securely for safety to reduce the users access to the mains electric.

Design of the Software:
4. The software of the product must use symbols to allow non English speakers to operate the machine.
5. The software must have a consistent theme and menu system function buttons location to increase operator speed & the usability of the software
6. The screen must be able to be used with gloves (common PPE equipment) in a well lit environment with no flare (to allow the screen to be visible at all angles in case of an emergency).
7. The user must receive some sort of feedback, for confirmation of action execution, and utilize shortcuts to increase the speed of operations.
8. The software must include educational information about each parameter through the use of "i" help icons to allow the RMM to be used independently.
9. The software must include the option to select predefined values for specific molding materials while giving the user full & live control over the machine to appeal to both beginner and expert rotocasters.
10. The interface should only show relevant/essential information. The information should be as accurate (1dp or 2 sf) as required for the user to make a decision. It should be displayed in a simple, understandable form that can be used by the user.

Design of the control panel:
11. The controls should use the "preferred method of control" and the "expected effect must relate to the type of control" to reduce the learning curve of using the control panel. [From page 12]
12. Any buttons used must not be smaller then 16.7mm in diameter to allow users with larger fingers, or gloves on, to easily interact with the controls.

4. Transportation
1. The machine [Packaged] must not exceed 2000mm by 807mm (smallest). To ensure the machine can fit it inside a standard door.
2. The machine should not exceed 17.7 kgf in weight to allow the user to easily pick up the machine and transport it between storage/use.
3. The machine should have a simplified assembly that will allow it to be shipped in a small volume to reduce the overall cost of the machine and environmental impact.

5. Dimensions
1. Should have a minimum mold size of 240mm x 240mm x 240mm.
2. The footprint should not exceed 750mm x 750mm (LxW) (depth of table in Educational workshop + art).
3. The dimensions of the various standard components (Nema 17, potentiometer, etc) will be used in the design of the electronic housing.

6. Safety and Product Testing:
A risk test should firstly be taken of the prototypes/final product and an effort should be made to reduce the overall risk. When designing the product, the following safety standards will be taken into consideration:
1. ISO 12100:2010 Safety of machinery – Risk assessment and risk reduction
2. BS EN 5008 - Product Labeling and Electrical Requirements
3. ISO 14120:2015 - Safety of machinery
4. ISO 13854, Safety of machinery – Minimum gaps to avoid crushing of parts of the human body.
5. ISO 11429, Ergonomics – System of auditory and visual danger and information signals. The labels and signals used to display errors/danger should surpass ISO 11429.
6. ISO 13850:2006: Safety of machinery – Emergency stop.

7. Social, Cultural and Environmental Impact - Page 12:
1. An effort should be made to reduce the power usage of the machine when molding to reduce the effect it has on the environment.
2. An effort will be made to allow the machine to mold renewable materials such as wasted 3d prints [Tier 3].
3. The machine must be able to be easily repaired & maintained and should use accessible standard components to extend the product life.
4. The machine must be able to be flat packed and shipped to decrease the carbon footprint of the product as less units can be shipped with less fuel.

8. Material Properties:
1. When choosing the material for the body of the RMM, I will make sure the material has the follow properties:
   - Can be easily accessed in the workshop and not exceed the material budget.
   - Light weight - reduce the torque needed to turn the inner cores & stress on shafts.
   - Easy to machine/work with - The material should be able to be used in the workshop, with workshop tools.
   - Stiff & hard- should not deform under the weight of the mold & temperature [tier 3].
   - Strong in compression (to hold its own weight and he weight of the mold) and in tensile force (to ensure the material does not fracture or stretch under the load of the mold).
2. When choosing the material for the axles of the RMM, I will make sure the material has the following properties:
   - Can be easily accessed in the workshop and not exceed the material budget.
   - Rigid & stiff - to ensure the shaft does not bend and can support the weight of the mold + axis
   - High strength-to-weight ratio - the lighter a component is the less torque/stress applied to the machine, gears and motors.
   - Easy to machine and work with - should be able to be used on the lathe or other machines used in the workshop.
3. When choosing the material for any gears for the RMM, I will make sure the material has the follow properties:
   - Can be easily accessed in the workshop and not exceed the material budget.
   - Tough - to withstand the grinding force of the opposing gear.
   - Low coefficient of friction - to reduce wasted energy and allow the cores to spin with ease.
   - Good resistance wear - The more durable the gears are, the longer the machine can function for.
   - High strength-to-weight ratio - the lighter a component is the less torque/stress applied to the machine, gears and motors.
   - High tensile strength - allows heavier molds to be used, as motors can turn with a higher torque and the gears will not fracture.

9. Capacity:
1. Below is a list of components that must be included in the final product:
   - [Tier 1] Bearings must be used between shafts and the carcass; Shafts; either Toothed Belt with a Driver Pulley GT2 and/or Bevel Gears
   - [Tier 2] Nema 17 with either A4988 or L298; a 120mm PC fan; a TFT 1.8 inch for output; Potentiometer + Button for input; ON/OFF switch + Emergency stop; 12 Volt Power Supply & a Lead for a house hold wall socket; Arduino UNO/Mega and 100UF Capacitors
   - [Tier 3] Either a heat gun or Induction heater as the heating element, a 120mm PC fan for cooling and relays for control of mains voltage components.

10. Function & Machine (CONSUMER WANTS, NEEDS & VALUES):
10A. Primary Function of the Machine - Rotary mold hollow parts
1. The user must be able to easily fit, and center, a variety of molds into the machine.
2. The user must be able to, by themselves, navigate through the menu systems to get to various molding parameters, information pages and settings to have full control over the machine [Tier 2]. This includes:
   - X axis speed, Y axis speed, X & Y spin ratio, Molding time
   - [Tier 3] Heating temperature, Heating cycle time, Cooling cycle time
3. The user must be able to cold cast repeatable hollow parts [& polymer parts in Tier 3]. [Page 11 - Performance]
4. The machine must be able to reach and maintain a min & max speed of 2 to 20 RPM for 10 minutes to 8 hours to allow users to cast a variety of materials and use varying ratios. [Page 11 - Performance]
5. The machine must be able to use one or multiple ratios when molding to allow users to cast a variety of shapes.[Page 11 - Performance]
6. [Tier 3] The machine must be able to heat up the polymer granules in the mold and rotary cast at a consistent temperature of (minimum) 160˚C
7. The machine must be able to offer predefined values for common molding materials (plaster, easy flow 120, 2 part resin) to allows less experienced users to cast. The values, however, should be able to be changed for more experienced casters.
8. The mounting system must accommodate for both steel/metal molds, ceramic/resin molds and vacuum formed polymer molds to suffice for all mold creation techniques.

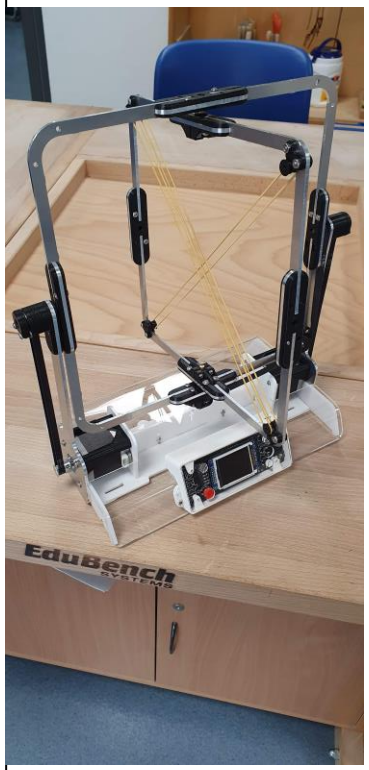
10B. Secondary Function of the Machine - Educational device
1. The user, in their time interacting with the product, must be educated about Rotary Molding and what the various parameters are and how they relate to the mold produced to allow the user to
2. They must be able to adequately use the machine to transform raw material into a hollow part - on their own in a safe manner.

Client Comments: [ART] Overall I'm pleased with the direction the product is taking - I'm glad there is a great focus on making the product intuitive and user friendly. [EDUCATOR] I am glad that Jack has included tier 2 & 3 spec points. However, I would like to see a greater emphasis on safe use of the machine and the educational value gained.

Developed Design Brief: I'm going to design and manufacture an RMM for the educational market, initially focused on D&T & ART teachers, capable of moulding cold resins, foodstuffs, plaster of Paris. It is to be part self-assembled by the user, to be sold at a cost of no more than 200 USD which must be capable of moulding for 1 minute to 8 hours with a rotational speed variation of 2 to 20 RPM with infinite options of variable cycle ratios. It must conform to current BSI standards with an intuitive user interface and preselected moulding menus that can be fully customised by the user.

More measurable elements here for example.

Here we see a re-worked brief, which draws on the research and client requirements.



The candidate looked at design styles and discussed this with the client, in the research section. They looked at the Deco style and a link to 'Smokey Jazz', including the styling and fashion. The discussion led to a high-quality specification point.

SPEC POINT

The proposal should develop the Deco theme and its connection to 1920's Jazz, measurable against other designs of this period.

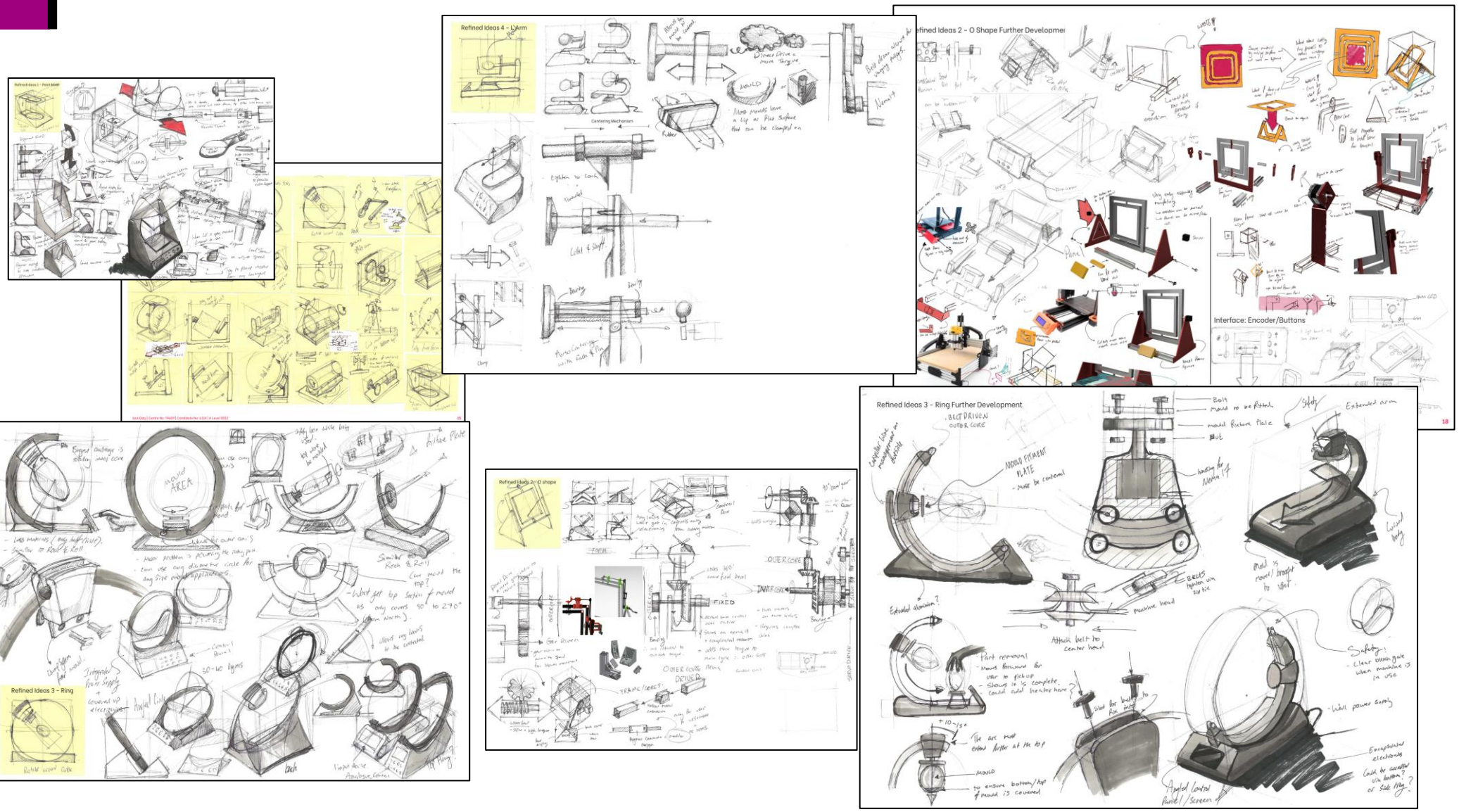
SHOWS THOUGHTFUL USE OF THE RESEARCH, A DISCUSSION WITH THE CLIENT AND A MEASURABLE OUTCOME.

Insight 5: Quality of Design Work

Design Ideas

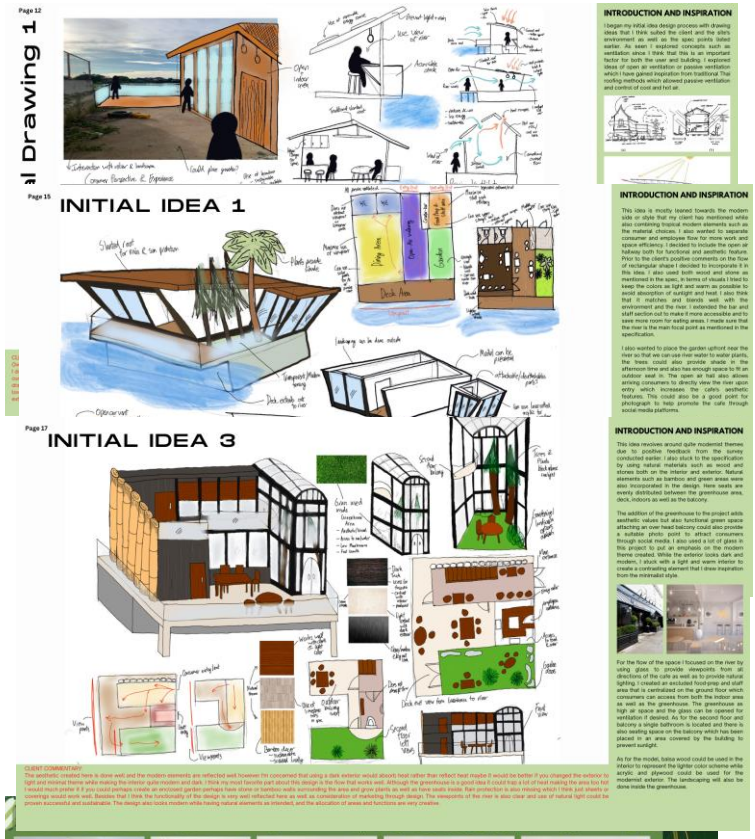
- In this section it is expected that a range of design strategies are used to produce a range of design ideas, that address the specification criteria from the previous section.
- Design strategies include drawn elements such as 2D, 3D, and subsystem details. Other strategies might include inspiration materials, work of other designers and cultural/historical influences where relevant.
- Candidates should be thinking like a commercial designer and apply their knowledge of technical skills and materials and back it up with the research they have carried out previously, plus any additional research that is required.
- It should be obvious that the work has considered the needs established prior to this section.
- Annotation should illustrate the candidate's knowledge and understanding of technical elements such as materials, processes and techniques that are relevant to the identified design area.
- Iteration should/could occur in this section – and beyond (you may see linear or cyclical designing.) However, the client/stakeholder input should be apparent.

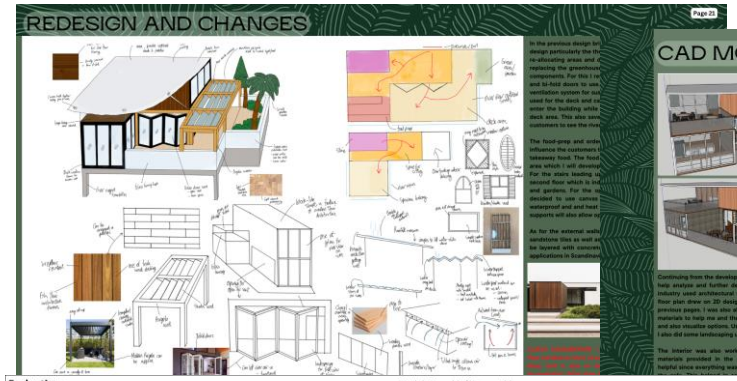
Insight 5

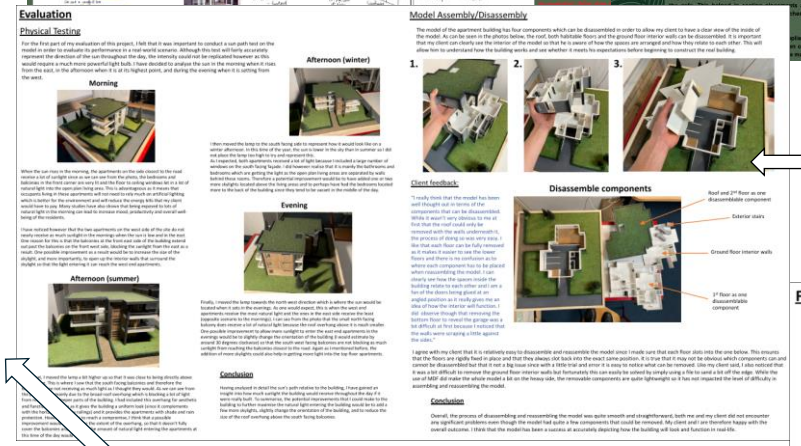


This is a superb example of fluid design work. The candidate has a sketching style that exudes confidence. The annotation shows a knowledgeable grasp of the important theoretical elements that are relevant to the design sketches. This is a top-level example of this assessment criterion.

Extracts from the work of Candidates who scored highly when taking an architectural approach







Candidate shows evidence of good evaluative commentary and well-made final model.

Candidate shows a good range of ideas and evidence of some sub-systems design

Insight 7: Quality of Manufacture Tools and Equipment

This assessment criterion can produce polarised outcomes, with very good performances at one end, or a lack of demanding A level processes at the other. Where candidates had modelled products, they were often at a low level, and on occasion, relied heavily on a CAM output, with limited interlocking parts. That said good quality modelling can allow access to the higher mark levels.

Positive

- ✓ Candidates should undertake real client dialogue
- ✓ Candidates should utilise demanding A level skills
- ✓ Candidates should select processes and tools that show sound technical understanding that are relevant to the design proposal

Negative

- × Candidates should be advised against submitting simplistic outcomes, using limited skills and processes
- × Candidates should aim to avoid work wholly CAM produced without complexity

Insight 7: Quality of Manufacture Quality and Accuracy

This section should be characterised by demonstrating high level making skills that evidence accuracy, leading to a quality artefact, that is a fully functioning prototype that meets the end user needs, identified in the specification. We should also see candidates being confident enough to consult with the interested parties and amend the design during the manufacturing as a result of this consultation, or indeed in response to issues during the manufacturing process, therefore evidencing an iterative approach during making.

Positive

- ✓ Candidates should undertake real client dialogue, illustrate an iterative process.
- ✓ Candidates should undertake A level demanding manufacturing techniques and making skills.
- ✓ Candidates should produce an accurate prototype that is well executed and finished.

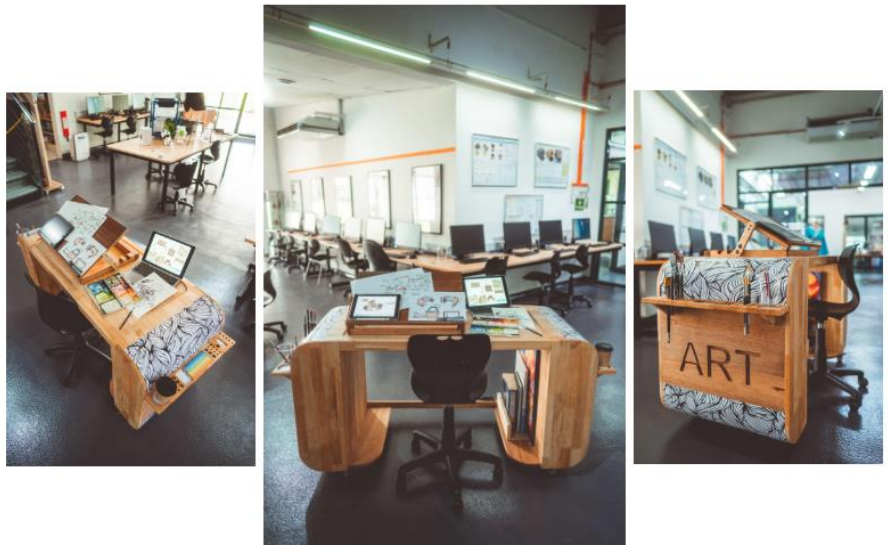
Negative

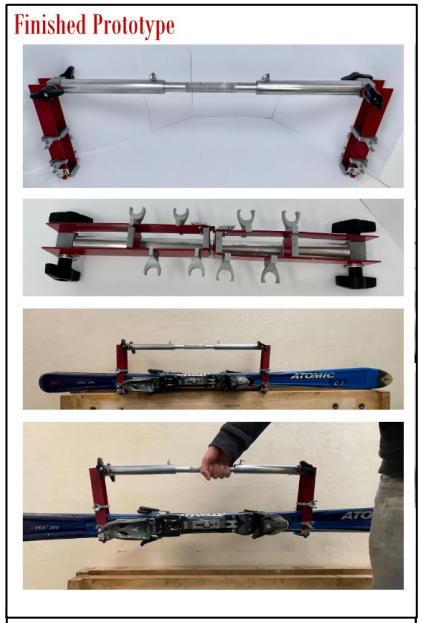
- × Candidates should avoid submitting simple outcomes.
- × Candidates should avoid submitting inaccurate scale models

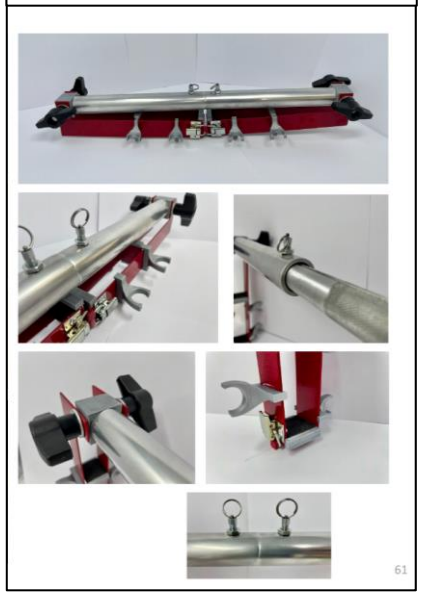
Insight 7: Quality of Manufacture

A range of high-quality products.

FINAL PRODUCT







NEA exemplar

We will now look at a single exemplar and use that to illustrate the moderation teams thinking as we work through a portfolio.

This portfolio is from this 2024 submission.

Algae Drying

Grid 1 Identification of design Possibilities

Prequel.

A brief background history of my story with my client.

In 2022, I became aware of the prevalent issue of the overproduction of algae in Thailand causing massive problems for farmers in Thailand. Every year an average Thai fish farmer spends thousands of baht for pesticides to remove these algae, which damage their produce.To combat this issue I had the idea of creating a sustainable alternative to single use plastic packaging made entirely from algae paper. Later in 2023, I had the opportunity to meet with Mr. Athawin, an owner of a salt farm directly affected by the over production of algae, and informed him of my idea. He was extremely interested and allowed me to take a sample of the algae to experiment with. After months of trial and error, I successfully created packaging made fully out of algae paper. Mr. Athawin, my client, was impressed by the project and, together with him, I worked with local fish farmers in the community to teach them how to make these alage papers from their waste alage. To this day, the local fish farmers are producing alage papers in their free time as a secondary source of income.

I also had the opportunity to enter this invention into the Diamond challenge hosted by the university of Delaware. There, I received the DSWA environmental sustainability award and was granted a sponsorship of $1500. This money was then allocated towards the fish farmers to further improve their production.

INTRODUCTION

Algal overgrowth has been a prevalent problem in Thailand over the past decade. These blooms have caused numerous problems for the local fish and shrimp farmers around Thailand due to the algae blocking light from reaching the depths of the farms. As a result, a large percentage of their pay has to be reimbursed into pesticides and chemicals to remove them.

To resolve this issue, local fish farmers in Samut Sakhon worked with a student enunciative to transform the waste algae into an alternative to single use plastic packaging made fully out of algae paper. However, the production process is slow and ineffective as the machinery the farmers require is incredibly specific.

To overcome this problem, Mr. Athawin, my client, has asked for my help in designing and creating a piece of machinery that will strengthen the projection process which will help the farmers become more efficient and boost the amount of profit made.

INTRODUCTION TO THE CLIENT

Ever since he could remember Mr. Athawin has always been involved with his families shrimp and salt farm. From a young age he would help around the farm whether it be feeding the animals or extracting salt during the low tides.This direct experience has let him come to a clear goal in life which was to inherit the families farm.

Now Mr.Athawin is a member of the provincial agricultural office of Samut Prakan. He helps oversees the provinces local farmers, prioritising their wellbeing and jobs. He is incredibly passionate in helping the community and does what ever he can to help support the farmers in business matters.

INTRODUCTION TO THE COMPANY

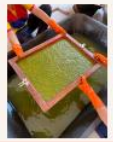
Mr. Athawin has been in the salt and shrimp farming business for over 40 years. He has years of experience and his products are being sold in reputable stores around Thailand such as OTOP. The farm has been battling the problem of algae over growth since its beginning. In 2023, the farmers worked with a group pf students to turn their waste algae into sheets which could then be turned into various resources. Through this they were able to cut the portion of their income spent on pesticides. The collaboration gained traction from various businesses and the farmers have sold over 1000 sheets a month. In the future Mr. Athawin hopes to expand his product line and customers.

DESIGN BRIEF

Due to a large customer demand, the farmers are required to make at least 1000 sheets of algae paper per month. However, as this is a source of additional income the farmers are unable to dedicate more than 4 hours of their day to the craft. Resulting in a struggle to meet the demands of their customers.

The production process of making the paper involves 4 simple steps. Firstly, the algae is collected and then blended with sodium hydroxide. Next, the pulp is set into a water mould for the sheets and then left out to dry in the sun. Yet the machinery the farmers are currently utilising for the production are in small scale such as commercial blenders and using benches to dry the algae sheets. With the added time taken for the algae sheets to dry the farmers can not afford to have an inefficient process that may be more costly in the long run.

Mr. Athawin has requested a product/machinery that would help him and the local fish farmers decrease the time taken for production of the algae sheets. The product should be rather large scale to help them create larger batches in one round. Not only that, the product should be durable and the weather conditions of the farm should be taken into account. Such as, rain, humidity and high temperatures. As the product will be directly handled by various farmers the product should be ergonomically friendly, this means i will need to consider thai anthropometric data (eg. finger, arm and hand length) when designing parts that are interacted with. Aesthetics wise Mr. Athawin suggested the product to be relatively minimal in design with muted dark colors. .



PROBLEM IDENTIFICATION

As the main need of the client is to keep production time to the minimum, the product will be centrally focused on speeding up the work flow through either larger or higher-speed machines. To truly get a picture of what would be most suitable to produce, the client suggested me to observe the production process of the manufacturing. This will allow me to understand the pain points more in-depth. The material used for the product will be important as it will need to be waterproof, easily cleaned and does not absorb oder. Moreover, a point that needs to be kept in mind is the fact that algae is a rather hard-to-work-with and slimly material which can easily clog up / get tangled in machinery.

CHALLENGES

The challenge is to not only design a machine that will suit the clients needs, but also to make sure that the cost of running the designed product does not exceed what they are currently using. Therefore, the properties and cost of materials have to be carefully balanced . Furthermore, the design process should take into account the significant impact of sustainability and environmental concerns.

DESIGN POSSIBILITIES

The production of algae sheets involves four primary steps: extraction, blending, moulding, and drying. Based on the information provided by the client, I have come up with several potential product concepts. These ideas were presented to the client during our initial meeting to save time
with the product selection process, thereby increasing the chances of delivering a
final product that precisely meets the
client's requirements.

PRODUCT #1

The first product a drying rack/unit which could be used to store the individual paper moulds to save space while drying. Moreover, an addition of a fan on the drying rack could help increase the drying time of the algae sheets allowing for a faster production process. This is because the drying process is the most time consuming step in producing the algae sheets.

CLIENT COMMENTARY: "It is certainly true that the drying time is the longest part of the production process. This. is a great idea. This will also save a large amount of space which is big advantage "

PRODUCT #2

The second product targets the blending part of the production process. As the company is currently using small kitchen blenders, i suggested to create a large scale blender specifically made for algae manufacturing. The blender design will take into account how well the algae blends and a drainage system for the excess chemical. This will allow for a larger amount of pulp to be created per usage, speeding the production process.

CLIENT COMMENTARY: "Although this is a great idea; however, I have concerns about the final cost of the product as machines tend to be expensive."

PRODUCT #3

The last idea i suggested was a mould that would allow creation of multiple sheets of algae paper per usage. The mould itself would have slots of varying sizes to help reduce time in cutting the algae papers to the spesific size required for each product.

CLIENT COMMENTARY: "What an interesting idea! I like that there are slots set to the individual sizes of products. The current moulds we are using a rather old as well so new ones would be appreciated "

Client interview

After my initial meeting with Mr. Athawin to discuss rough ideas of the product details, I met with him a second time to get a more detailed idea of his preferences and specific desired features of the product. This will helpful in moving forward with the design process when making sure the clients needs are met.

Would you like the product to be eco-friendly? would that be a major concern for your brand?
Yes definitely! Our algae paper is made from waste algae in the fish farms and can then be turned into an alternative to plastic packaging. Therefore, the environment is a huge priority in our business so opting for environmentally alternatives is important.

Can you describe approximately how many sheets of algae paper you are currently producing per day and how much do you aim to produce per day?
Currently we produce around 200 papers a day with the available resources that we have. However, if possible we would like to double this amount.

What are the specific sizes of each sheet of algae paper?
The size of each of our moulds and algae papers are a standard A3 size (297 x 420 mm)

Out of all the design possibilities we talked though which one did you like best?
after our discussion, Im leaning towards the drying rack idea. This is because the drying part of our production process if certainly the process which slows down the production time the most. So, i think if you were able to make that more efficient the overall process would be a-lot faster and efficient.

How would you feel about adding a fan onto the rack to speed up the drying process?
That would be a brilliant idea! I believe that would significantly reduce the drying time by a lot. The only issue I can think of is that if the air from the fan is not evenly distributed across the algae paper, it could result in warping on the paper's surface. So, be sure to consider that when designing the algae paper

Is there a specific colour or theme you were hoping for in the design of the product?
While I don't have any specific color or theme requests but i think it would be wise for the product to be rather dark in color as the algae has a tendency to stain lighter colors.

USER GROUP QUESTIONNAIRE

User Group Introduction

Due to the specific nature of the product specification, the user group will be the farmers/workers at the company.
This is because they will be the users interacting with the product directly and therefore their options should hold high value and be taken into consideration during the design process.

I have created an online survey which was handed out to the farmers during my market research visit to the company. The questionnaire covers the needs and wants of the workers which will aid me greatly in the design process. The question or is shown below.

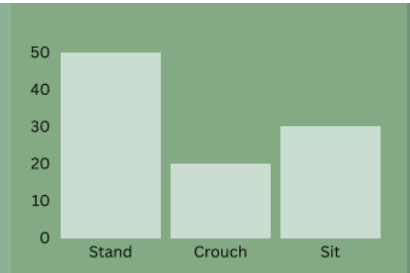
1. During the drying process do you mostly stand, crouch or sit when drying the sheets?
   a) Stand
   b) Crouch
   c) Sit
   d) Not applicable
2. Is the weight of the moulds a particular issue for you
   a) Extremely
   b) Yes
   c) No
   d) I don't mind
3. What material would you prefer the rack to be made out of?
   a) Wood
   b) Plastic
   c) Metal
4. When drying the sheets do you stack them on top of each other or lay them next to each other?
   a) On top
   b) Side by side
   c) Other
5. What colour palette do you prefer the most?

a)

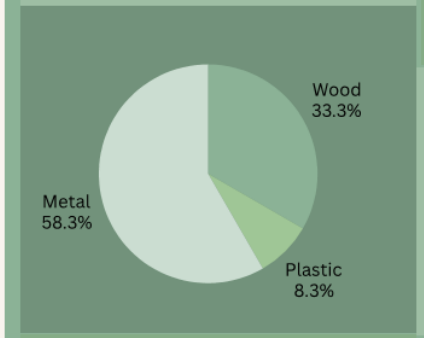
b)

c)

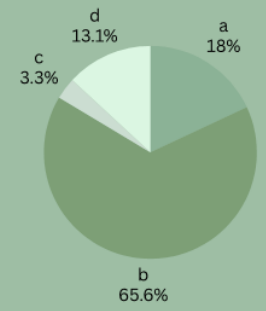
d)



The second question allows me to deduce what material the moulds should be made out of. As many people have chosen that the weight is of particular importance, perhaps a material that is more lightweight should be prioritised when making the design.

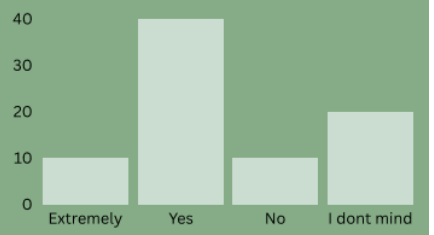


From the forth question it can been seen that a majority of the user group stack the moulds on-top of each other when drying. This information will help me decide on the orientation of the rack. This answer also links well with the first question (people mostly stand while drying the sheets) as stacking the sheets allow for a taller drying unit.

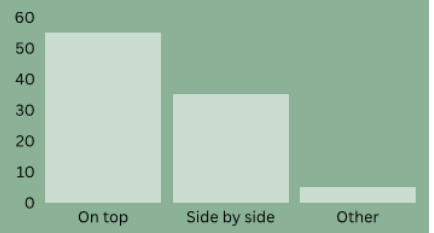


Questionnaire analysis

The first question in the questionnaire can help decide on the length and size of the drying unit. From the questionnaire, it can be seen that most of the workers stand while drying the sheets of algae Therefore, i will have to take height into consideration when designing the rack.



The results from this question in the questionnaire illustrated that the majority of the user group preferred using metal as the main material. As one of the main key points about the design is that it has to be waterproof, using a material like metal will defiantly be easier to work with. Not only that, plastic has been chosen the least as a potential material. This corresponds with Mr. อัศวิน, my clients, request of prioritising the environment and this shows that the user groups and Mr. อัศวิน goals and values are similar.



As over 50% of the user group has chosen b (monochrome colors) it is safe to say black tones are preferred. Not only that the least chosen choice was c (pastel color) meaning that when designing the rack i should focus more on darker colors. Not only that, this relates well with Mr.อัศวิน suggestion of keeping the colors of the product relatively dark as the algae has a tendency to stain surfaces that it touches

Level 3
Mark Range 7–9

- Evidence of in-depth investigation of pertinent design possibilities.
- Effective identification and justification of a design possibility.
- Comprehensive investigation of the needs, wants and values of the client/end user to inform design requirements.

Analysis evaluation of questionnaire

Based on the results gathered from the client interview and the user group questionnaire, it can be concluded that my client and the user group have similar values and opinions on what would be preferred from the design of the product. Such a conclusion has been reached based on the user group's general response and the client's personal preference.

The user group tends to prefer a taller type of drying rack rather than a wider drying rack. When regarding the visual aspect of the product both my client and user group lean towards darker tones and monochrome with preference to materials such as metal. Additionally, Mr. อัศวิน agrees with the idea of adding a fan to the design of the product to further improve the drying time.

PRIMARY RESEARCH

The main part of the primary research is the interviews conducted with the client. This makes sure the specific and unique requirements are reached. Not only that, the questionnaire with the workers will make sure the needs and wants of the main users of the product are met. a In addition, a visit to the company will provide details on the sizing and atmosphere of where the product will be stationed. This will aid the process of picking suitable materials for the product.

SECONDARY RESEARCH

The secondary part of the research will be assisted by local paper making factory's in thailand. Their process and machinery will be observed. Not only that, A sustainable paper making factory will also be observed as their production process will be more similar to the farmers algae paper making process. These observations will allow me to potentially integrate more convenient and efficient design practices into the product. In addition, similar products already available in the market will be analysed against the clients specification to develop a clearer understanding of the clients needs.

MARKETABILITY

Since this particular design is tailored to fulfil the requirements of my client, Mr. อัศวิน, its production will require high attention to detail. Consequently, a production approach involving either batch manufacturing or one-off production will be employed. This design holds the potential for commercial viability and marketability, as it is able to be repurposed for other needs such as art.

AREAS FOR RESEARCH

ERGONOMICS

I will need to research the weight of the current moulds for the algae sheets to see how the moulds can be made to be more light weight. Research about different sizes of moulds for different products will also be needed to see if various mould shapes can be created

ANTHROPOMETRICS

Anthropometric information about various heights of the user group will have to be taken into consideration for the length of the drying rack. Moreover, the arm length and hand size of the user group will be needed as well to design the sizes of the moulds.

LOCATION

A site analysis will be needed to determine the amount of space the company has for the drying rack. Not only that, the weather conditions of the site (such as dryness or humidity) will also need to be analysed so suitable materials can be selected.

FORM

While the product is purely function focused, it should blend in with its surroundings and not cause any unnecessary clashes with the existing environment.

SAFETY

Risks to the user group will need to be examined. This may include sharp edges, the chemicals used in production and how strong the user group is. The specific chemical used in the manufacturing process will have to be researched to evaluate how toxic it is to different materials and human contact.

MATERIALS AND FINISHES

A variety of materials will have to be researched to make sure that the product fits the requirements of both my client and the user group. Therefore, water resistance, weight and color will have to be kept in mind while deciding. Moreover, it should be kept in mind that the user group prefers metal out of all of the materials provided. A suitable finish will have to be researched to ensure the product is durable.

SUSTAINABILITY

Research will need to be done on how the design can be made more environmentally friendly in the construction, maintenance and final disposal. As a fan will be incorporated into the design, research should be done on how to make that component more sustainable.

FUNCTION

As the purpose of the rack is to dry the moulds of algae sheets, further research into the algae sheets will need to be conducted. Including how long it takes for an algae sheet to dry normally in the sun compared to a fan being used to dry the sheets.

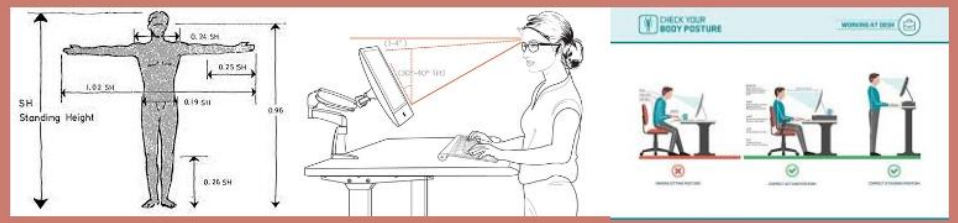
Client Commentary

"While i have not set a specific budget i would prefer if the costs could be kept to the minimal as this is a side project to the salt and fish farmers therefore we dont have a large amount of budget."

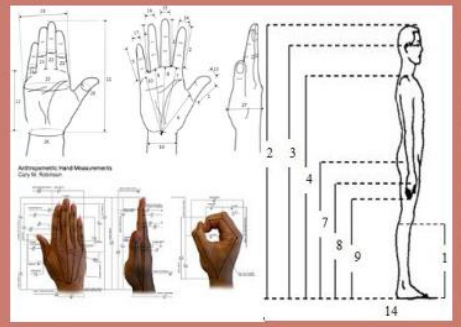
ERGONOMICS & ANTHROPOMETRICS

Ergonomics

Ergonomics is the science of designing products for human use in mind ie matching the product to the user. Ergonomics is an essential part of product design, using ergonomics should improve the peoples lives when using products by increasing their comfort and satisfaction. Ergonomics should be taken into account when designing the size of the product to make sure the user group is able to interact with the product comfortably. The diagrams below contain ergonomic data that may be relevant to the design of the drying rack which is suitable to be carried and used by the average human.



Anthropometrics



Anthropometrics is the systematic collection and collation of measurements of the human body in order to establish averages and variations in height and shape for example. It is the branch of Ergonomics that deals with body shape and size.

For this particular product the anthropometric data of heights of the average worker will need to be collected to determine the height of the product. Not only that, the sizes of hands and grip size will also need to be collected in order to determine a good fit for the frames of the mould.

Measurements data

As my product is dedicated towards Thai fish farmers I decided to use ergonometrics and anthropometric data of the average Thai labour forces. This should make the product as user-centered as possible.
To the right is a table of measurements for the anthropometic data of southern Thai workers. The data is taken from Dr. Kaweesak Chittawatanarat's study on Height prediction from anthropometric length parameters in Thai people .

Measurement parameters (cm)	Male* <60 yrs (n=500)	Male* ≥ 60 yrs (n=500)	*p*
Height	166.1±6.0	162.1±7.2	<0.01
Demispan	86.9±4.9	84.2±5.3	<0.01
Biaxillary length	38.8±3.5	36.3±3.6	<0.01
Neck length	10.3±1.2	9.8±1.2	<0.01
Humeral length	36.3±3.4	34.2±4.6	<0.01
Forearm length	25.0±2.3	24.5±2.4	<0.01
Hand length	18.4±1.2	18.1±1.4	<0.01
Sitting height	85.9±3.9	82.2±5.3	<0.01
Thigh length	39.3±4.0	38.7±3.7	<0.01
Knee height	48.6±3.3	47.3±3.7	<0.01
Foot length	24.9±1.5	24.4±2.1	<0.01

PRIMARY RESEARCH

- Visit to the fish farms

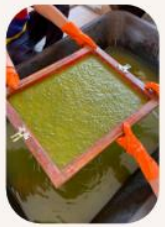
In order to create a product that best fits the clients needs and wants I decided to ask Mr. อัศวิน if i could visit his farms to observe the environment and understand the production process throughly. I had the opportunity to actual make the algae paper myself which gave me an even clearer understanding of the process itself.

*Photos taken from my visit to the fish farm in july 2023

Current situation - The farmers are currently drying the algae sheets in the sun in a large field which takes up a large amount of unnecessary space. However, with the addition of a new drying rack they have suggested to move the drying process in a shaded area of the building. While the area has a large amount of space, the area is also used as a common area for the local fish farmers. Therefore, the drying rack should not take up much space of this area to allow for a multi purpose space.

The production process

The moulds are left to dry in the sun



A mould is used to shape the pulp

Algae is blended with sodium hydroxide

Algae is collected from local fish farmers

4 → 3 → 2 → 1

5 Algae paper is produced

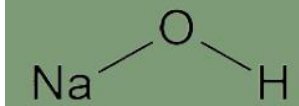
6 OEM manufacturers turn the algae paper into various products

SAFETY

Introduction

During the manufacturing process of the algae sheets a chemical is required to be added into the algae to pulpify it. The chemical used is sodium hydroxide (also known as NaOH). This can be a particular problem when designing to product based on how it reacts with different materials and human skin.
While powder sodium hydroxide is available, the production process of algae paper requires it in a liquid form.

What is it used for?



Sodium hydroxide is used to break down large pieces of algae into smaller stands which eventually turn into pulp through the help of a blender. It reacts with the lignin in algae and breaks it down into smaller molecules. This chemical is an essential part of the production process for these algae sheets.

Properties of sodium hydroxide

In terms of toxicity, sodium hydroxide is highly toxic to both humans and animals due to its corrosive nature. It can cause severe burns, tissue damage, and even death if ingested or comes into contact with the skin, eyes, or mucous membranes. It's essential to handle sodium hydroxide with proper protective equipment and follow safety guidelines when using it.

MATERIALS

Metals:
Sodium hydroxide can corrode or react with certain metals, especially aluminium, to produce hydrogen gas and heat. This reaction can be dangerous and cause the metal to weaken or disintegrate.

Organic Materials:
Sodium hydroxide can degrade organic materials like fabrics, paper, and wood due to its strong alkaline nature.

Some Plastics and Polymers:
Certain plastics and polymers can be affected by sodium hydroxide, leading to softening, swelling, or deterioration of the material.

Given its potent corrosive properties, sodium hydroxide should be handled carefully, and appropriate safety measures should be taken when working with it.

PRIMARY RESEARCH

The clients company works with OEM manufacturers to turn the raw algae paper into different products which include packaging, bags and boxes. All these products require different sizes and amounts of algae paper to manufacture. However, Mr. อัศวิน only has one mould size available. Therefore, the farmers will have to individually cut up the pieces of algae paper to the correct sizing. Because this process takes a-lot of time, I would like to find a way to minimise this time. To start this I researched the different products that the company sells and the sizes of algae needed to manufacture these products. This information will be bale to help me possibily create cutsom moulds.

Size of algae paper required for each product.

Cup sleeves
1 A4 sheet

Paper cushion
1 A3 sheet

Small box
1 A5 sheet

Medium box
4 A3 sheets

Medium bag
2 A3 sheets

Big box
6 A3 sheets

Small bag
2 A4 sheets

Big bag
4 A3 sheets

The following is the product line for my clients company. In total they currently produce 8 products (excluding the raw algae sheets). Each product is of difference in size and require a different amount of algae paper to make each product. The algae paper required ranges from 6 A3 sheets (Big box) to 1 A5 sheet. While the most common sizing of algae sheets required are A3 sheets (297 x 420 mm) there are a few products that require different paper sizes such as A4 (210 x 297 mm) and A5 (148 x 210 mm).

Therefore, to fully meet the needs of my client and save production time a custom mould should be made. The mould will hold the sizes required for the manufacturing process which will include A3, A4 and A5 to ensure the efficiency of the production process. Moreover, suitable materials will need to be utilised to build sturdier frames.

CURRENT MOULD

Currently, Mr. อัศวิน and his workers uses a A3 mould (297 x 420 mm) to make the algae sheets.

The moulds are made from old painting frames and recycled nets stapled together. This creates a very flimsy frame which breaks easily. Moreover, some frames are distorted which can cause huge problems for the production process as the sheets will not come out standardised. In addition, the wood used for the frames are worn down and the surface of the wood is prone to splitting and splintering. Overall, the conditions of the frame for the paper making are poor and adjustments will be needed to make the frames more duable.

Client Commentary

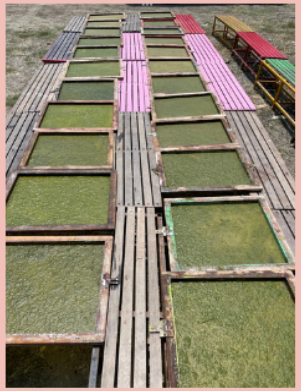
"The custom mould idea is an amazing idea, not only will this help decrease the time that we spend cutting the sheets of paper but it will also help us lower costs while working with the OEM manufacturers. It is also true the the moulds we are currently using are in rather bad condition, so an upgrade to those will be greatly appreciated"

Fan drying time

Primary research

Algae paper, undergoes a drying process that involves exposure to natural sunlight, albeit a time-consuming one. Once the algae fibers are carefully extracted and processed, the wet sheets are arranged in open-air spaces where they are left to dry under the sun's. This drying phase, while environmentally sustainable, demands patience as it can extend over a significant period due to the reliance on ambient solar energy.

To expedite the drying process of algae paper under the sun, a suggestion was made to my client which involves the strategic integration of fans into the drying rack setup. The fans will be able to facilitate the evaporation of moisture from the paper fibers at an accelerated rate.



PROBLEM

While employing fans to expedite the drying of algae sheets offers several advantages, there are potential challenges associated with this approach. One prominent issue arises from the uneven positioning of the drying racks. If the racks are not level or balanced, the airflow generated by the fans might impact the algae paper unevenly, leading to variations in drying rates across the surface. Consequently, this inconsistency in airflow distribution can result in the warping of the paper sheets. The warping issue, caused by differential drying, might compromise the paper's quality and usability for intended applications.

*Photos taken during testing in August 2023

The following photos are results from my tests with algae sheets that have dried with uneven amounts of air on them resulting in warps and unevenness .

Testing

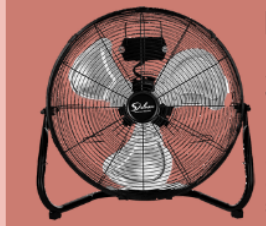
A variety of tests were done on the algae sheets to compare the differences in the drying time when comparing the sun (air drying) to the addition of a fan.

	SUN	REGULAR FAN	HEATED FAN
Time taken to dry	5-6 hours	1-1.5 hours	30 mins
Cost	Free	300-900 baht	900-1200 baht
Pros	• In-expensive • Sustainable • Even drying on surface	• Faster drying time • Even drying on surface • Not dependent on weather conditions	• Very fast drying time • Not dependent on weather conditions
Cons	• Long drying time • Takes up a large amount of space • Sependent on weather conditions	• Expensive • May not be environmentall y friendly	• Very expensive • Uneven drying on the surface of the paper • may not be environmentally friendly

Therefore, it becomes essential to ensure meticulous attention to the evenness of the drying setup when integrating fans, mitigating the risk of warping and maintaining the desired structural integrity of the algae paper.

ENVIRONMENT

Mr client, Mr. has expressed his importance in prioritising sustainability and the environment in the design of the product. While there are a variety of fans and heaters available in the market, they all vary in environmental impact.

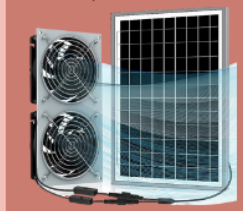


Regular fan

Fans are generally energy-efficient compared to many other appliances. A typical household fan consumes around 50 to 100 watts per hour, which is relatively low in terms of electricity usage. While fans have a relatively low direct environmental impact, their electricity consumption contributes to overall energy consumption and carbon emissions. However, the power consumption can vary based on factors such as fan size, speed settings, and usage duration.

Heated fan

Heated fans consume more electricity compared to regular fans. On average, a small heated fan can consume around 750 to 1500 watts per hour, considerably higher than a standard fan. The environmental impact of heated fans is higher due to their energy-intensive nature. Heated fans can be more costly to operate due to their higher power consumption.



Solar powered fan

Solar-powered fans harness energy from the sun, which is a renewable and sustainable source. These fans typically consume minimal electricity, as they primarily rely on solar panels to generate power. Their power usage is significantly lower compared to traditional electric fans or heated fans. They contribute to lower carbon emissions and other pollutants associated with electricity generation, making them an eco-friendly choice.

While the initial investment for solar-powered technology might be higher due to the cost of solar panels, the operational costs are minimal. Solar-powered fans don't rely on grid electricity, so they can help reduce energy bills over time.

DC powered fans

DC-powered fans are engineered for energy efficiency, consuming less electricity compared to traditional AC-powered fans. On average, DC fans can operate using around 10 to 30 watts per hour, significantly lower than conventional fans. DC-powered fans are cost-effective in terms of operational expenses. Their lower electricity consumption translates to reduced energy bills over time.

EVALUATION

Proper design and usage can enhance the eco-friendliness of fan use. For instance, using timers or turning off the fan when it's not needed can optimise energy consumption. To minimise environmental damage and costs the solar powered and DC powered fans look like the most appealing approach

Primary Research

Introduction

In order to ensure that the design aligns with the preferences of both the client and the intended user group, encompassing aspects of aesthetics, functionality, and ergonomics, I have conducted comprehensive research on existing products with comparable uses and appearances. The insights gathered from these firsthand investigations will serve as a valuable resource, informing my design process and enabling me to incorporate the insights leant into my deisgn process.

RACK #1

Above the line

The product is a drying rack marketed for soap; however, the drying rack can be multi-purposed into different types of papers and art as well. The product has a simplistic design and is mainly made of one material: wood.

The individual panels of the rack and able to slide outwards allowing for easy access to dry objects. Each individual drying rack is 35x40 cm. The bottom of the drying rack has 4 casters installed which allow for the rack to be moved around easiy.

The main part the user interacts with are the slide-able racks. However, there appears to be no grip which will easy the sliding process, perhaps the ergonomics can be improved with a handle

The whole rack is made out of plywood and a wax finish has been applied to the surface. This allows the rack to be easily cleaned from soap stains.

The build quality consists of various wood points including tongue and grove; mortise and tenon; and a lap joint. The casters are secured to the wood with screws at the bottom.

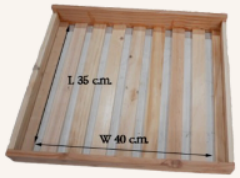
Cost: $160

Compared to other soap drying racks in the market (usually priced at around $200) this product is relatively lower in cost. This could be explained by the fact that it is produced at a batch scale and uses less expensive materials in the production process.

Below the line

PDF or plywood is the main material used in the production of this rack. Plywood is characterised by its layered construction, providing strength, stability, and resistance to warping or cracking. Not only that, it is lower priced compared to other types of wood and lightweight, allowing for the rack to be moved around easily.

To produce this rack sawing and milling have been used as well as a CNC. The assembly consists of various wood points including tongue and grove; mortise and tenon; and a lap joint. The casters are secured to the wood with screws at the bottom.



Sustainability

As the rack is made out of plywood it be considered moderately sustainable. Plywood is a renewable resource and is often manufactured with efficient use of wood materials.

Client Commentary

The design of this rack is quite nice and simplistic making it able to blend in with a-lot of surroundings. The pricing is attractive as well. My only concern is the material it is made out of, the color is very light which may not be suitable in terms of a darying rack for algae as it is prone to stain.

RACK #2

Above the line

This product is a screen printing drying rack. The main body of the drying rack is composed of three independent joinable parts, there are two tilted supports which can be micro adjusted from front to back ,and they can make the main rack be more stable. The user is able to interact with the individual racks and are able to move them around and position them to their liking. Including this design ensure users interact efficiently with the product as they are able to adjust the angle to what they are most comfortable with.

The frames are made from steel wire while the supports are made from steel plates making the rack extremely durable. This makes it reliable to last a large amount of time. Not only that, steel allows the product to be easily cleaned.

The build quality of the product is great and extremely well put together. This frames move smoothly without getting stuck.

Cost: $1,012

The price of this product is extremely expensive, around 5 times of the first product. This could be because steel is used as the main material which is expensive.

Below the line

Steel is used as the main and only material in the production of this rack. This is because steel is recognised for its exceptional strength, durability, and versatility in various applications.

The frames made out of steel wire have been galvanised (the process of applying a protective zinc coating to steel or iron to prevent corrosion) while the supports made out of steel plates have had a surface treatment of electrostatic spraying with stainless steel (a coating application method where charged particles of paint or other materials are attracted to a surface for even coverage).

Sustainability

A drying rack made out of steel might have a lower level of sustainability due to the resource-intensive nature of steel production. While steel is durable and can be recycled, its manufacturing process typically involves significant energy consumption and emissions. However, if the steel used for the rack is sourced from recycled materials and the product is designed for longevity, it could mitigate some of the environmental concerns.

Client Commentary

I like this design a-lot. Its spacious and allows for a-lot of material to be dried at the same time. The fact that the racks are moveable is very convenient. The material used feel durable and water resistance which is incredibly important. The fact that the steel have been galvanised and electrostaticaly sprayed really ensure the longevity of the product. However, the pricing of the product is rather expensive.

SECONDARY RESEARCH

RACK #1

Above the line

The package is designed with multiple layers to hold different prices of paper sheets. It contains a simplistic design and is mainly compiled of one material: metal, suggesting the rack should be durable and last. along time. Performance wise, the rack seems stable though the castor wheels at the bottom look small compared to the rest if the rack.
It seems like the product was mass produced hence its cheaper price.

Below the line

The metal parts are likely to be joined using welding and the small metal frames are likely to be made by excursion to create its rounded structure.
the black color suggests a colored varnished was used to achieve this color.

Sustainability

Using metal to construct a drying rack could be sustainable choice, given metal's recyclability, and potential for minimizing environmental impact through responsible production practices.

Client Commentary
I like the minimalist and simple design of this rack. It has a-lot of storage space which allows for many items to be dried at the same time. The color is dark which makes it suitable to be a rack that will hold items that could possibily stain.

RACK #2

Above the line

The drying rack is used to hang the papers from the ceiling which allows for the water to escape by dripping down. It is made of one material (wood) and includes pegs to hand the pieces.
The begs are made from plastic and seem flimsy are easily breakable. The rack is likely batch or one-off produced which explains its pricy cost. Furthermore, maintenance may be hard as it is stationed on a ceiling which could be hard to reach.

Below the line

Due to its simplistic design it should be relatively easy to manufacture as the frame is made of one piece. The wooden frame is likely to be hand cut using a tenon saw or band saw and then sanded down for a smooth finish. Brought in parts may include pegs and metal wires for the attachment to the ceiling. Given that the rack is hanging, the wood should be relaticyly lightweight and made out of soft woods rather than light woods.

Sustainability

Using wood and plastic to create a drying rack might not be entirely sustainable as plastic production contributes to pollution and resource depletion.

Client Commentary
I am not a fan of this design. The way the papers are hung seem very un-secure and because it is mounted on the ceiling it could easily fall. Moreover, the size is quite small compared to what i was envisioning.

RACK #3

Above the line

The product is a wall mounted drying rack that seems to be made out of steel. The racks are adjustable to the users preference. The product has many layers allowing for a large amount of paper to be dried at the same time. The aesthetics are simple, including 2 primary colors: black and white.

Below the line

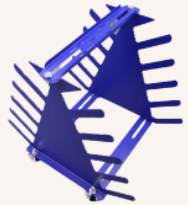
The white frames are likely to be made using the process of excursion, explaining its circular structure. The frames are likely to be joined together through welding. Brought-in parts include the wall mount hook which is likely to be screwed into the frame. The metal has been painted hence its black and white color.

Sustainability

A drying rack made out of steel might have a lower level of sustainability due to the resource-intensive nature of steel production. However, steel is able to be recycled.

Client Commentary
This product is similar to the first one and as i mentioned before i like this simplistic design. The adjustable frames are a great added bonus. The only thing i would improve is the colors of the individual racks to be darker. I do have some oncerns of how stable and secure the wall mounts are.

RACK #3



Above the line

Out of all of the products this drying rack has the most color giving it a visual appeal and it seems to be made out of aluminium. The racks are position at an angle allowing for water to escape faster. There are non-slip mats installed at the bottom of the rack, and it can be put on any platform stably.

Below the line

The aluminium has a painted finish allowing to achieve a bright blue color. The non-slip mats have been installed using crews and the individual aluminium pieces have likely been attached together through welding. The scale of manufacture appears to be mass or batch product explaining its price.

Sustainability

Creating a drying rack with aluminum and applying a colored finish can be a sustainable choice, as aluminum is recyclable and durable. However, if a plastic coating has been applied it may raise sustainability concerns due to the potential environmental impact of plastic usage.

Client Commentary
This rack has a very interesting design compared to the rest and i like that it is tilting. However, i think there should be more space for papers and the color is abit distracting.

Evaluation

To make informed aesthetic decisions for the product I intend to develop, I sought additional resources from online platforms. Many of these references were drawn from Pinterest, showcasing a variety of drying racks for a large amount. of products.
By researching these existing products, I've gathered insights into the desirable attributes commonly found in drying racks. These insights will inform the development of upcoming packaging designs. Additionally, I've shared these secondary resources with the client to gather more information about his preferences.

In general, Mr. อัศวิน conveyed his preference for minimalistic approaches and an affinity for utilising materials/ finishes that are darker in color for the construction of the drying rack. Furthermore, he expressed an interest in incorporating adjustable or moving parts within the racks to improve the connivence for the workers when using the final design. He also expressed his disinterest in racks that are wall mounted or hanging from ceiling as it could be a concern for safety. Finally, he prefers the rack to have alot of drying frames allowing for many papers to be dried at the same time.

Materials research

Introduction

The objective of this research segment is to explore a diverse range of materials suitable for the production of the proposed product. Given the nature of the product functioning as a drying rack, there should be emphasis on the selection of materials renowned for their durability, which includes wood and metal variants. However, it is important to note that client unlined the importance of sustainability throughout the material selection process. Therefore, a balance must be struck between durability and ecological considerations to align with the client's sustainability requisites.

WOODS

Oak wood

Due to its exceptional durability, oak wood has inherent strength that can withstand the weight and stress of wet items placed on the rack. It has natural resistance to decay, moisture, and insects, extending its longevity. Furthermore, in line with the sustainability aspect, oak wood is often harvested from responsibly managed forests, aligning with eco-conscious manufacturing practices.

Client commentary: While this wood seems perfect for the construction of the drying rack, Im abit concerned about of the price as you have mentioned that it is a hardwood.

Plywood

Plywood is composed of thin layers of wood veneer bonded together with adhesives. Plywood has exceptional strength, stability, and resistance to traits like warping or cracking. Its widespread use across furniture crafting and construction is because of cost-effectiveness and adaptability. However, while plywood is water-resistant, it is not entirely waterproof, and its performance in prolonged exposure to water may vary.

Client commentary: I dont think this wood is suitable as the rack will have constant exposure to water it will need to be completely waterproof.

Wood-plastic compote

parawood

Parawood is a versatile and sustainable type of hardwood. One of its notable properties is its eco-friendliness. Parawood is characterized by its light color and smooth grain, which makes it an ideal candidate for staining and finishing in various shades. It's density contributes to its resistance against warping and cracking. Additionally, parawood is receptive to different finishes, allowing for customization to suit a wide range of design preferences.

Client commentary: This wood seems perfect for the construction of the moulds out of all the woods shown. It's an added bonus that it is also sustainable.

METALS

Aluminium

Recognized for its exceptional strength-to-weight ratio, aluminum provides structural integrity without adding unnecessary weight, making it a practical option for a durable yet lightweight drying rack. Its resistance to corrosion ensures longevity, especially in humid or outdoor environments. Additionally, aluminum can be easily formed and shaped into various designs. However, While aluminum is corrosion-resistant, it might not be as resilient against physical impacts or heavy loads compared to some other materials.

Client commentary: "I like this metal a-lot. It snot a problem that it is not resilient against physical impacts. The price of the material is also attractive"

Stainless steel

Stainless steel offers structural support that can endure the weight of wet items placed on the rack. Its resistance to corrosion ensures durability. The sleek and modern appearance of stainless steel contributes to an aesthetic appeal that can seamlessly integrate into various environments. While stainless steel offers corrosion resistance, its weight might be higher compared to other materials, potentially affecting portability.

Client commentary: "The weight is not a problem as the rack will be immobile however, i do have some concerns over the cost."

Iron

Iron can provide a solid framework capable of withstanding the weight of damp articles during the drying process. Its malleability allows for intricate designs, while its affordability makes it an accessible choice. However, Iron is susceptible to corrosion, which might compromise the rack's longevity and appearance over time, particularly in environments prone to moisture. Applying protective coatings can remove this concern, but maintenance becomes essential.

Client commentary: "While this metal seems like a good choice , the lack of corrosion resistance could be a problem unless a protective coating is applied."

Brass

Because of its golden hue, brass has an elegant aesthetic to the rack that can complement various interior settings. Brass offers decent strength and corrosion resistance, making it suitable for withstanding the demands of a drying rack, even in humid conditions. However, Brass tends to be more expensive than other materials. Additionally, its susceptibility to tarnishing and discolouration over time requires regular maintenance.

Client commentary: "This metal is not suitable for the production of a drying rack."

FINISHES

Wood finishes

Wax finish

Enhances wooden furniture and provides wood protection against stains. In addition, wax finishes make the wood remain matte

Oil finish

An oiled wood offers a highly durable surface which resists water, dirt and stains. A very light sanding followed by a coat of oil and its done.

Varnish

A clear transparent hard protective coating or film. the distinctive tones and grains in the wood are intended to be visible. Varnish finishes are naturally glossy.

Lacquer

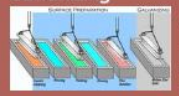
Lacquer is a modern wood finish that is commonly used on high end furniture. It is fast drying, impervious to water, and maintains its transparency as it ages.

Metal finishes

Case hardening

Adding carbon to produce a hardened outer skin. Prevents steel or irons from becoming brittle , increases wear resistance and makes it more durable

Galvanizing



Galvanising is the process of depositing a protective layer of zinc on steel or iron. It is a method used to prevent corrosion on metals.

Polished metal finish

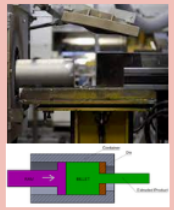
Polishing the metal gives it a shiny finish. It is most commonly done by buffing, sand paper or machines.

Manufacturing Processes

Introduction

This section will explore potential manufacturing processes. While not all of these methods will be employed in the product's construction, it's important to contemplate alternatives in case certain processes become unavailable. Comprehensive research will be conducted to examine each listed process, including their overall procedures, merits, and drawbacks.

Extrusion



This process involves forcing a metal billet through a die to create a continuous profile with a consistent cross-section. It's often used for producing long and straight components with uniform shapes, such as bars, tubes, and structural shapes.

Extrusion enables the creation of uniform profiles with consistent dimensions This process is efficient for producing simple designs while maintaining cost-effectiveness in mass production. However, its limitation lies in shaping complex or curved forms, which might require additional processing steps.

Client commentary: This production process seems like a great fit with the needs of a drying rack. Because the rack does not need much complex/ curved shapes this would work perfectly.

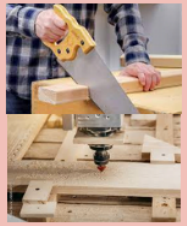
Welding

Welding involves joining two or more metal pieces by melting them at their junction and fusing them together. It's used to create strong and permanent connections.

Welding enables strong and permanent connections between metal components, ensuring the rack's stability. Welded joints can withstand the stresses of everyday use and offer a seamless appearance. However, excessive heat during the welding process could potentially distort or weaken the metal if not carefully managed.

Client commentary: Ive actually had experience in welding before so i am confident that this production process would be necessary for the rack to ensure the material is joined securely.

Sawing and Milling

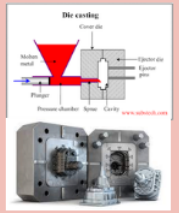


Traditional sawing and milling techniques involve cutting, shaping, and sizing wood using various types of saws, routers, and milling machines. These methods are versatile and can produce a wide range of shapes and sizes.

These processes allow for precise shaping and sizing of wood components, ensuring accurate dimensions for the rack's structure. Sawing and milling can efficiently produce straight cuts. But they are unable to create more complex shapes or intricate designs..

Client commentary: I like this process as it is able to provide accurate dimentions while being cost friendly.

Die-Casting



Die casting is a precision metal casting process where molten metal is injected into a mould (die) to produce complex and highly detailed shapes. It's often used for mass production of small to medium-sized components.

Die casting allows for the rapid production of intricate components with fine details. However, die casting's limitation lies in its complexity and tooling setup, which can increase initial costs, particularly for small-scale production runs.

Client commentary: This process could work well in the production of the frames for the rack. However, the cost could be a potential problem.

CNC machines

CNC machines can carve intricate shapes and patterns into wood using precise computer-controlled movements. Employing CNC machines presents distinct advantages for crafting a drying rack. CNC machining offers precise and consistent shaping, ensuring accurate dimensions and intricate designs. It also allows for customization and complex patterns. However, the use of CNC machines might involve higher upfront costs due to the required equipment and programming. Additionally, the process may be slower for intricate designs, impacting production timelines.

Client commentary: While this process seems like a great option, i can see that the costs could defiantly be a problem. I prefer a more simplistic way of sawing and milling"

WOOD JOINTS

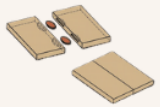
Box joint

This joint works at the end of two timber pieces to build a seamless right angle. You carve out a series of symmetrical slots to form rectangular projections called fingers. Once you glue the connection, the fingers get inserted to create a permanent bond that results in a solid corner.

Lap joint

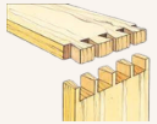
Lap joints can be used to connect two wood ends together for corner joints, or for connecting wood in the middle to make T-joints or cross laps.

Biscuit joint



Both ends of the timber get a slot cut into them to hold a small wafer that acts as a connection. When the glue gets added to the insert, it starts swelling until the entire carved-out area gets filled.

Dove tail joint



A dovetail joint has incredible strength, resistance to being pulled apart, and just gives a nice, classy finish. On one end of the wood, several protruding trapezoidal-shaped pins are cut, and on the other piece of wood, tails are cut for the pins to fit into.

Client commentary: "Out of all the joints that you have provided, I can seen the box and dove tail joint being most suitable for the production process. Perhaps the lap joint could be used to make the mould frames?"

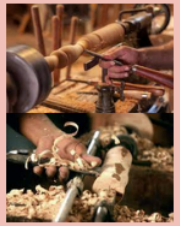
Forging

Forging involves shaping metal by applying pressure through a mechanical or hydraulic press. This process enhances the metal's strength by aligning its grain structure. It's commonly used for creating strong and durable components.

Forging offers strength and durability to the metal, ensuring a sturdy framework that can support wet garments. However, forging requires for specialized equipment and longer production times compared to other methods.

Client commentary: This production process appears quite hands-on and could be risky if not executed with care. I'd prefer if you opt for a process that demands fewer specialized tools or equipment.

Wood turning



Woodturning involves rotating a piece of wood on a lathe while using cutting tools to shape it symmetrically. This process is often used to create round or cylindrical objects like table legs and decorative spindles.

This process allows for the creation of rounded and cylindrical shapes, making it suitable for producing decorative elements like hooks and pegs. Though, wood turning focuses on rounded forms, which might not cover all structural aspects required for a drying rack.

Client commentary: I think wood turning would not be a suitable production process in making the drying rack as im finding it hard to locate any areas that would need rounded or cylindrical shapes.

Level 3
Mark Range 8–11

- Mostly developed assessment of the needs, wants and values of the user.
- Mostly developed assessment of the needs of the prototype with relevant consideration of form, function, sustainability and level of production.
- Sound links between the design needs and the research undertaken.
- Sound selection of research sources, including existing products, ergonomic information and standards, which provide a sound insight to the design context, showing a considered understanding of the design possibility and related design problems.

SPECIFICATION

Client values

The design and development of the rack should be in line with the clients values.
The client has requested to minimise the environmental impact caused by the drying rack as well as the production process. Not only that, the client has also requested to keep the production and running costs low. Both limiting the manufacturing processes and materials that will be used.

Client commentary:
What you've written in the design brief has been pretty accurate so far. Though, let me add this: while i prefer a standing drying rack, wall mounted or ceiling mounted racks are also okay if it can be ensured that they are stable and will not fall. Otherwise, you've summarised all my requested pretty nicely. Im looking forward to the results of this project.

Design brief

Throughout the entire project, I will. be designing a drying rack for the algae papers as well a customised moulds that fit the specific dimensions required for each product. In addition, the drying rack will have a fan to further speed up the drying process. The drying rack will be used by the workers of the company which will be able to speed up the drying process as well as save a large amount of space. As requested by the client, the product should be minimal in design.
The rack should be stationed on the floor as well as able to hold a great amount of algae sheets. When deciding which fan to use, environmental sustainability should be kept in mind as well as costs. The fan also must ensure uniform drying of the algae papers to minimise warps and deformities.

According to the information gathered from my clients inquires and the user group survey, the weight of the moulds are of particular importance to them. Therefore, a lightweight material should be selected. In addition, both my client and user group agree the color scheme of the design should be muted/monochrome as algae has a tendency to stain.

In conclusion, the main objective of this project is to produce a functional, minimalistic and durable drying unit for algae papers, decreasing the production process time and lowering costs.

Introduction

The following specification draws upon the insights earned from research documented in prior sections. This combines findings from primary and secondary research as well as input from the client. Serving as a reference, this specification will guide the entirety of the design and manufacturing journey, assuring alignment with the client's and user group's requirements. Each specification component will encompass both quantitative and qualitative data, ensuring precise assessment and thorough testing procedures.

Function

The main function of the drying rack is to help speed up the process of drying the individual sheets of algae paper. The drying process will be quickened with the addition of a fan. The sheets of algae should be easily stored with no complicated components. Finally, the unit should be stable and durable ensuring longevity.

In addition, this product has a secondary component which will be the algae sheet moulds. The moulds will be design to suit the size requirements of the products the company makes while still maintaining the same characteristics of the currently used moulds.

Quantitive data

The drying rack should hold a minimum of 20 sheets in a single round. The design for the moulds should include sizes of A3,A4 and A5.

Qualitative data

Once the products prototype is created, testing in this area will take place. Algae samples will received from the company to test the moulds and the functionality of the drying rack.

Client commentary:
I agree with all the listed points. Please note that although the specific sizes of the product require A3,A4 and A5, addition surface should be left to ensure the product is able to manufactured if any difficulties occur.

Ergonomics

In terms of ergonomics, the drying rack should not exceed the height of an average Thai fish farmer. Any element intended for interaction with human hands and fingers should possess adequate surface area, and the mold's weight should not be excessive.
The rack must not require any unnecessary effort when inserting and removing the alage sheets.

Qualitative data

Once the size and shape of the product are determined, both the client and the workers will undergo testing to determine the comfort of holding the molds. Additionally, the average height of the workers will be gathered to ensure the appropriate height is employed.

Client commentary:
I agree with all the these points. It is important to ensure my workers are able to use this product comfortably.

Quality

As the product is meant to be used for years as a permanent addition to the company, it is an essential requirement that the product must be durable and long-lasting.
Due to the nature of the drying process, the rack should be water-proof as well as force resistant. Not only that, the unit should be able to be cleaned easily and should not leave stains on the rack.

Quantitive data

The rack should be able to hold at least 2000 grams of weight without suffering breakage or deformation.

Qualitative data

The product will be put though tests with products of similar weight to see if it can withstand the weight and force of the algae sheets.

Client commentary:
The way you have decided to test the product should reflect with the actual moulds well.

Aesthetics

As requested by the client, the aesthetic appeal of the rack is not important at all as the main goal of the product is rather function forward. The product should not hold any excess unnecessary design and maintain a minimalistic feel. However, it is important that the rack blends in with its surrounds creating no direct distractions for the production process.

The more specific requirements of the products include muted and dark colors to reducing staining, a geometric and dimensional design (allowing it to be situated in the common area of the companies location.

Quantitive data

The exact dimensions of the racks has not been provided. However, the current measurements. of the A3 moulds used have been acquired: 297 x 420 mm. Therefore, the design should be able hold at least 20 of moulds similar to the size of those.

Qualitative data

The shape of the rack should be rectangle accompanied with a flat surfaces allowing it to be situated between other items.

Client commentary:
Your points are great. However, if you would like to add any stylistic approaches that you see fit i do not mind. Although, a simplistic design would defiantly lower costs and decrease environmental impact.

SPECIFICATION

Cost

A fixed cost hasn't been established for packaging production. Nevertheless, the client emphasises the necessity of maintaining a low product cost. The client has provided the production cost for a single algae sheet, which should be a guiding factor during the product design phase.

In summary, costs hold utmost significance in material and manufacturing process decisions.

Quantitive data

The final cost of the project should be calculated before the production has started and checked with the client before moving forward.

Client commentary:
Well put, please check with me before starting the production of the project.

Sustainability

Both the client and their company hold the environment and sustainability in high regard, making eco-friendly approaches a large consideration in the rack's design. When selecting materials, the energy expended in extraction should remain a focal point. The utilisation of environmentally detrimental materials, like plastics, should be minimised. Moreover, energy consumption from the fan and other sources should be kept at a sustainable minimum.

Throughout production, efforts will be made to minimise manufacturing processes, thereby reducing energy consumption. A hands-on approach, such as using hand saws, will be employed whenever feasible, reducing reliance on machine-driven energy. When cutting product components, meticulous attention will be paid to align the cuts in a manner that minimises waste generation.

Quantitive data

I will strive to uphold the minimization of energy-intensive manufacturing processes, thereby ensuring a balance between environmental impacts and the client's production costs.

Qualitative data

Heavy machinery processes will only be employed when deemed absolutely essential. It's important to acknowledge that these processes are unavoidable, as certain parts of the rack necessitate them to ensure durability.

Client commentary:
I agree with the points outlined. I recognise that striking a balance between environmental considerations and costs can pose challenges, but I urge you to make your best effort. Both my company and I place significant importance on environmental concerns, so any steps taken to ensure the rack's sustainability while preserving its essential functionalities would be highly appreciated."

Scale of manufacture

The product will be designed to enable batch production due to the fact that the company is growing at a steady rate and may require more drying racks in the future. However, as of right now, I will be manufacturing a one-off version of the product to allow the client to test and comfortably integrate the rack into the production process first. Once the client is comfortable will the product the rack can be adjusted for batch production.

To summarise, the initial package piece will be crafted as a unique production to enable the client to conduct a preliminary test. If additional racks are requested, the process will then transition to batch production. To ensure a seamless shift from the initial one-off production to batch production, certain automated machines will be employed in the initial phase

Quantitive data

Upon completion of my involvement in the production process, a solitary product piece will be created. Subsequently, the rack will be handed over to a distinct batch production company to facilitate batch manufacturing.

Client commentary:
While, I will oversee the batch production phase, It would be advantageous if the manufacturing methods employed for crafting the 'reference rack' align closely with those for batch production. This alignment would facilitate a seamless transition into the larger production process.

Safety

Due to the product being in regular usegae daily, centain safty requirmnets msut be met. As the rack is a relativtly large product, its stabilty must be strictly evaluated in order to prevent falling which could cause serve damange if it were to fall ontop of someone. Not only that, the mechnaics of the fan must be evaluated as well. Instalation, mounting, connections, wiring and relocation of the fan should be done by someone with suffiecient experince. Moreoever, maintence and insepctions hsould be done by technically wqualiyfied personal. The fan should be stored in environmenrs where the relaticte humidity is 20 to 85 pervent with no sudden chnages and no condensation, not subjected to direct sunlight and not subjected to vibration or shockn

As the drying rack is regualry exposed to water, the fan should have protective casing or be at a relaticte distance from the moulds inorder to prevent harmful voltage shocks or malfuctionings.

Additionally, the rack itself must not contain sharp corners or edges that could potentailly harm users upon contact.

Qualitative data

The product's surface level safety (sharp corners, edges) will be tested from observation and general touching. The fan should be installed with the help of someone with suffiencint experitise in order to minimise safty hazards.

Client commentary:
" I agree with your points. Safety is definitely a primary concern espially when it comes to products that include complex components requiring electricity. We should be extremely careful when designing to minimise th epotential harm that could occur and cause significant damage. "

Materials

For this product, the main materials that would be used is metals and woods. Specifically, metal for the rack itself and wood for the frames of the algae paper moulds. When choosing the materials the cost and durability should be taken into careful consideration. For the inner parts of the mould, thin metal wire nets should be used to ensure the algae pulp does not pass through.
Casters could potentially be installed at the bottom as well to provide easy relocation of the rack.

The client requested that the rack must be water resistant and durable. Therefore, finishes should be applied to the surface of the materials chosen to ensure longevity and durability Addition, enviromental concerns and sustainability should be considered when choosing these finsihes.

Quantitive data

Ideally, only a few different materials will be used during production. The material range will be minimised as much as possible to save both resources and production costs.

Qualitative data

Tests will need to be conducted to make sure that the product is sufficiently water proof and durable. In addition, the material should be tested against the weight of the moulds in order to ensure its toughness in carrying heavy load.

Client commentary:
Certainly, I'd greatly appreciate it if you could minimise the range of materials utilized. This would lead to cost savings in terms of both materials and manufacturing processes. Additionally, I emphasise the importance of ensuring the rack's waterproof capability.

EVALUATION

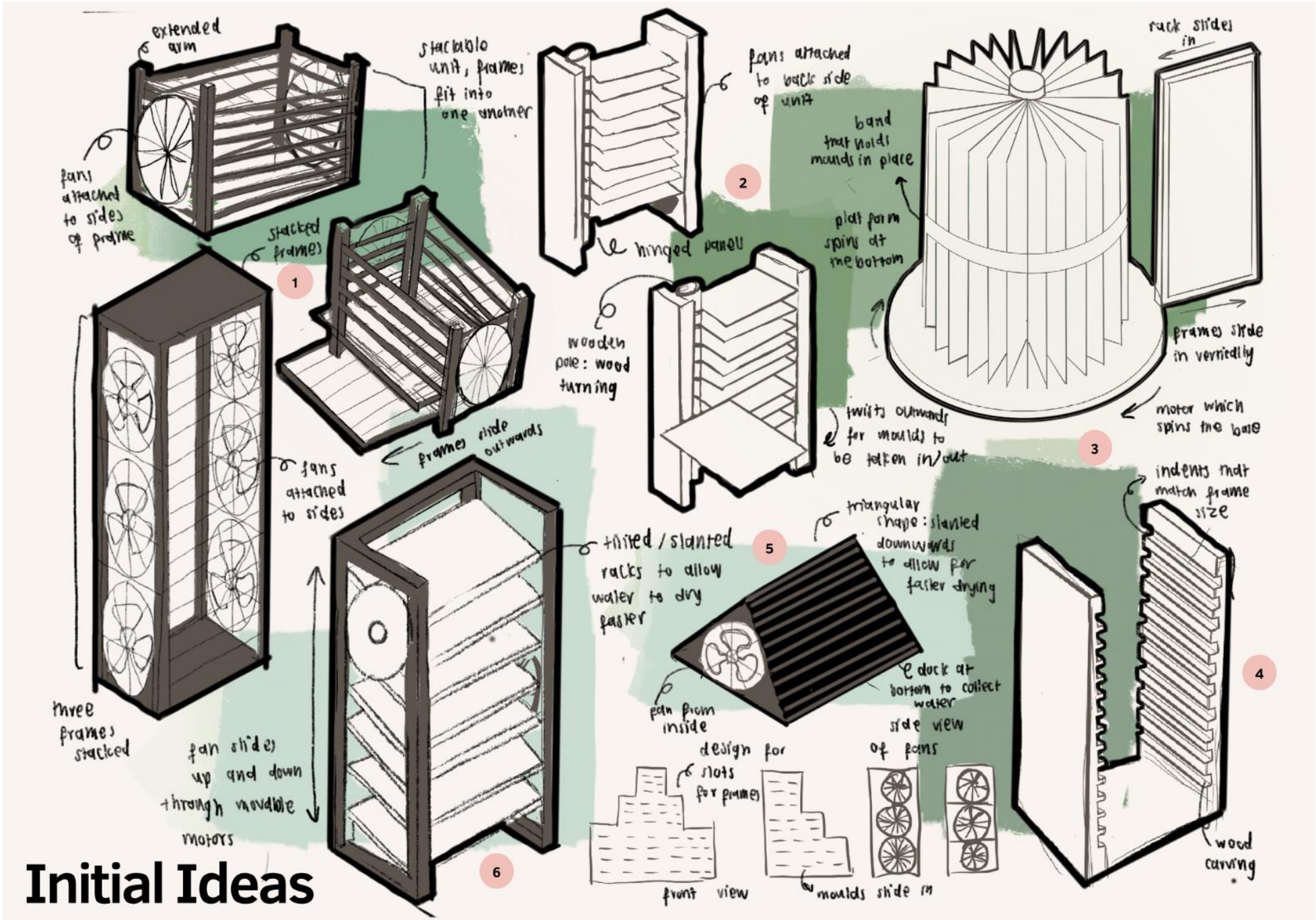
In essence, this specification showcases the client's desires and necessities, thoughtfully categorised for clarity. The client had the opportunity to provide feedback on each point, ensuring alignment with his specific needs and by extension, those of the user group.

As previously mentioned, this specification will serve as a pillar throughout the forthcoming design and manufacturing phases. This ensures the product's success in fulfilling its intended purpose while upholding the client's requirements, needs, and values. Should any challenges arise during the project's timeline, referring to this section can aid in identifying optimal solutions.

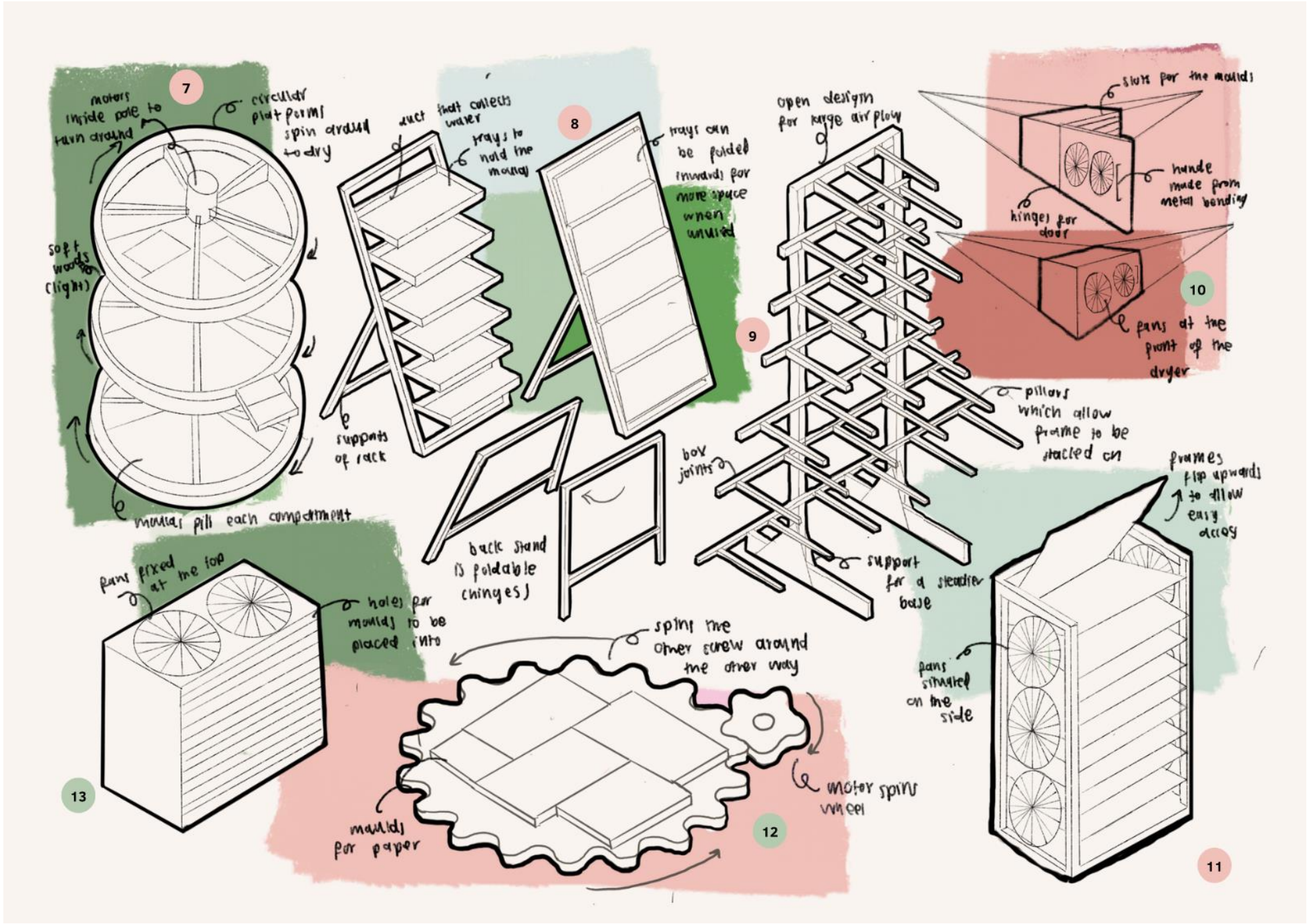
I will only deviate from the points in this specification if the client expressly requests such actions or if adjustments are made to the original design brief based on the client's preferences.

Level 2
Mark Range 4–6

- Considered design brief that reflects most of the investigated needs, wants and values of the client/end user.
- Developed range of specification points which are realistic, technical and measurable in relation to an effective design problem.
- Sound justification of the performance requirements for the prototype.



Initial Ideas


7
motors inside pole to turn around
circular plat forms spin around to dry
soft woods (light)
moulds fill each compartment
8
duct that collects water
trays to hold the moulds
supports of rack
trays can be folded inwards for more space when unused
back stand is foldable (hinges)
9
open design for large air flow
box joints
pillars which allow frame to be stacked on
support for a steadier base
10
slots for the moulds
handle made from metal bending
hinges for door
fans at the front of the dryer
frames flip upwards to allow easy access
fans situated on the side
11
12
spins the other screw around the other way
motor spins wheel
moulds for paper
13
fans fixed at the top
holes for moulds to be placed into

Evaluation : Initial Ideas

chose bets diegsns to evaluate

Design 1

The first design comprises of a modular drying rack with side-mounted fans. The unique feature of this design is the sliding frames that hold the algae paper. These frames can be easily accessed since they can slide in and out. Additionally, the frames' tops have indents that can be used for stacking them on top of each other. This stacking system enables easy expansion and storage of the algae paper. Each frame layer is fitted with netting to allow for quick airflow.

I like this design because it meets the client's request to make the most of their available space by allowing for multiple stacking options. This design is not only practical but also efficient in its operation. However, connecting all the fans stacked together into one electrical source might be challenging and will require further development.

Client commentary:
This idea is really great. I love the idea of it being modular and stackable to make efficient use of space. However, i do agree with your point that connecting the fan together may be complex and i would rather you design something that allows for one quick and easy switch.

Design 2

This design is an unconventional drying rack concept. The wooden frame features panels that can tilt outward for easy placement of the moulds and then be twisted back into the frame. Each panel is supported by a wooden pole with hinges, allowing for a smooth twisting motion. Fans are attached to one side of the unit's back.

This unique design is a typical drying rack but is just as effective. It can be mounted on a wall or on the floor, making it versatile. However, as the design is made primarily of wood, it may not be as durable or waterproof as other materials. Additionally, it may be quite heavy and difficult to move around.

Client commentary:
Wow this is really interesting it really does have a unique mechanism. Though Im quite concerned with the amount of panels that can be situated in the frame. In the sketch it looks like only 10 can fit in one frame which could be quite inefficient as a-lot of algae paper needs to be dried at the same time,. Also the fact that the panels are made out of wood concern me as airflow might be diffucult.

Design 3

The third idea features as circular component that spins from the bottom which allows the algae paper inside to dry. The middle of the design is a pole which has panels coming out. Each of these slots allow a mould to slide in vertically. A band is used to hold the moulds in their slots. Under the base is a motor which allows the model to spin.
While this design is interesting it is rather impractical. The alage papoer may not dry at the correct shape as the mouls are placed vertically. Not only that, the spinning force of the base may not be fast enough to dry the lagae paper compared to a regular fan

Client commentary:
Wow this is really interesting it really does have a unique mechanism. Though Im quite concerned with the amount of panels that can be situated in the frame. In the sketch it looks like only 10 can fit in one frame which could be quite inefficient as a-lot of algae paper needs to be dried at the same time,. Also the fact that the panels are made out of wood concern me as airflow might be diffucult.

Design 7

This unique design features three circular layers attached to a center pole. Motors situated beneath each layer turn them like fans, allowing you to place moulds in the five compartments located within each layer for drying. Each layer can be individually controlled, conserving energy by only spinning when necessary. This feature also makes it easy to access each layer to place or retrieve moulds.

One problem i have with this design is the fact that each layer is circler where as the moulds are rectangular. This could be a problem as it may be inconvenient to place the moulds on each layer or there will be excess unused space which is not environmentally friendly as there is a waste of space. Not only that, there is the issue of if the layers will spin fast enough to efficiently dry the algae paper.

Client commentary
I agree with your points completely but i also have to add that since there are only three layers there will be quite a limit in how many sheets can be dried at one time which is a main concern as I want something that can hold multiple sheets.

Design 8

This idea features six layers of trays attached to a frame that holds the sheets/ moulds. Each tray can fit around two to three moulds and when not in use the trays can be folded upwards. Each tray is attached the a wooden frame with hinges allowing the angle to be adjusted. Not only that the frame is attached to a back stand which can also be folded when not i use. This allows the frame to be easily stored with efficient use of space.

This design is defiantly the best in terms of making use of space when not in use. It also holds a lot of moulds. However, this design doe snot feature a fan which could be a problem as one of the main goals if to dry the papers quickly.

Client commentary
The use of space in thsi deisgn is very appealing however i do agree that the fact that this diegsn does not have a fan or a spinning component attacted into it could make it diffiflt for a effeicnt drying speed. Perhaps the backs of the raeys could have a fan attached to it? Im not sure how that would work though.

Design 12

The twelfth design in our series incorporates gears and motors to dry paper. The motor is attached to a small gear, which then spins and turns a larger gear. The large gear is where the paper molds are placed, allowing the gears to move and dry the paper.

However, this design is not without its challenges. It is difficult to ensure the design will perform well, and there is no way to securely attach the molds to the gears. This could result in the molds falling off while the gears are spinning.

Client Feedback
This design is my least favorite out of all the options because it looks unfinished and I'm not confident in its ability to perform well. However, I do like the concept of incorporating gears into other, more suitable designs.

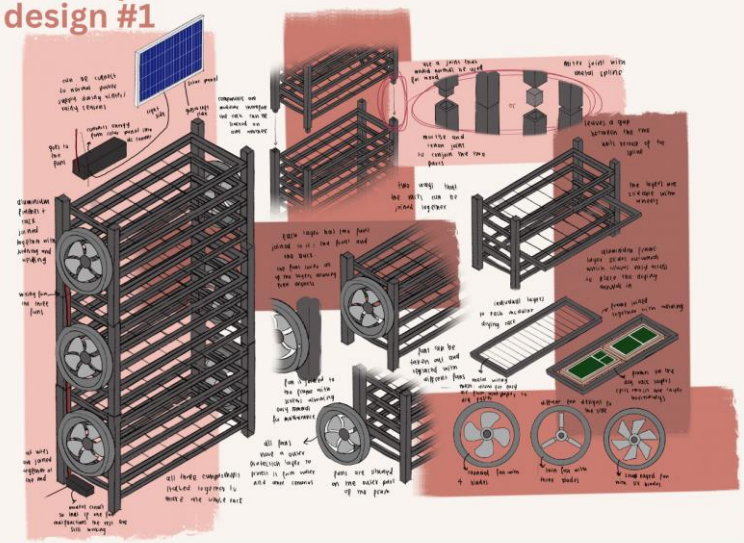
Level 2
Mark Range 4–6

- Considered selection and use of design strategies to inform decisions.
- Present ideas that show sound consideration for the user needs and specification parameters.
- Effective use of aesthetic features with sound consideration of historical and cultural influences showing a sound understanding of the intended use of the prototype.
- Ideas demonstrate a sound understanding of relevant materials, processes and techniques.

INITIAL IDEAS : DEVELOPMENT

Further development of evaluated initial ideas with rendering and improvements.

Developed design #1



EVALUATION

This is an enhanced Version of one of the Design Concepts Discussed in Section 1: "Initial Ideas: Sketches."

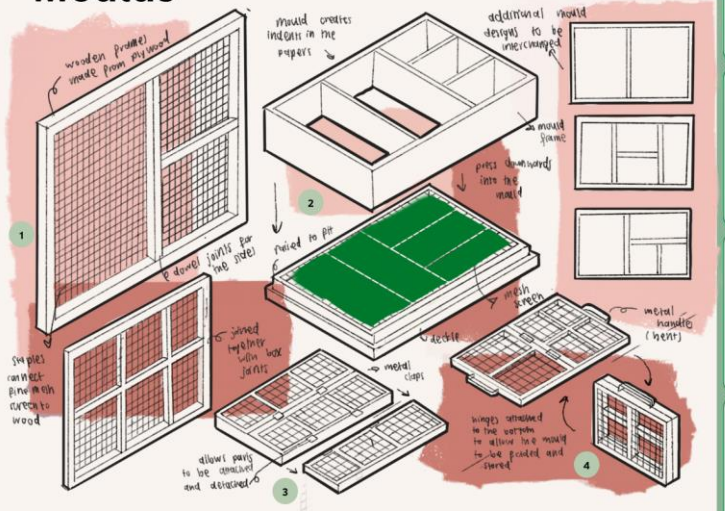
Two joint methods have been developed for the modular racks. One method uses a mortise and tenon joint (for metal) to create a seamless fit between the two parts. The other method uses a miter joint with a metal spline to connect them together, but leaves a gap between the two frames. The mortise and tenon joint provides a slicker finish to the rack and is, therefore, more suitable.

Moreover, a mechanism has been designed to allow a power supply to the different fans on each model. The wires for every fan will be connected together in a parallel circuit, so if one breaks, the others will still be able to work. All wires will be pointed together at a power supply that will convert energy supplied from the solar panels into a DC current, which can be used by the fans.

Further developments will need to be made for the fan casing to ensure it is not affected by water when the wet frames are placed on the rack. Additionally, further research should be conducted to determine if switching between a different/normal power supply (AC) and a solar panel one is possible during season where sunlight may not be abundant..

Client commentary: The adjustments you made are exactly what I was looking for! Thank you so much. Now that you've devised a mechanism for the fans, I truly believe that this idea is perfect. I appreciate the removable fans with the use of screws, and having all the wires connected to a single energy supply makes it much more convenient. I agree that further research on switching power supplies is needed, especially considering Thailand's extensive rainy season when sunlight may be limited. If possible, that would be a significant improvement.

Moulds



Evaluation

Design #1

This design is a typical paper mould design with a wooden frame around and a mesh inside. However, the design features multiple paper sizes allowing the client to make paper for many products at a time.

Client commentary:
I like this a-lot, its simple and easy to use. Also i can see that you've created a-lot of designs and patterns that can be made with this type of frame and i think thats an amazing idea.

Design #2

Design two is a two part moulds and deckle. Firstly, the algae is screened on the mesh screen in the deckle and then a mould is pressed downwards to create indents into the algae. The mould can then be removed and the paper is left to dry on the deckle.

Client commentary:
I feel like this idea is complicated and would require additional time which is not what im looking for. The mould seems to be quite large in size and might not fit in the drying rack.

Design #3

This design features rows of moulds that can be joined together with a metal clasp. Because of the nature of the design only small sizes of algae paper can be created with this mould.

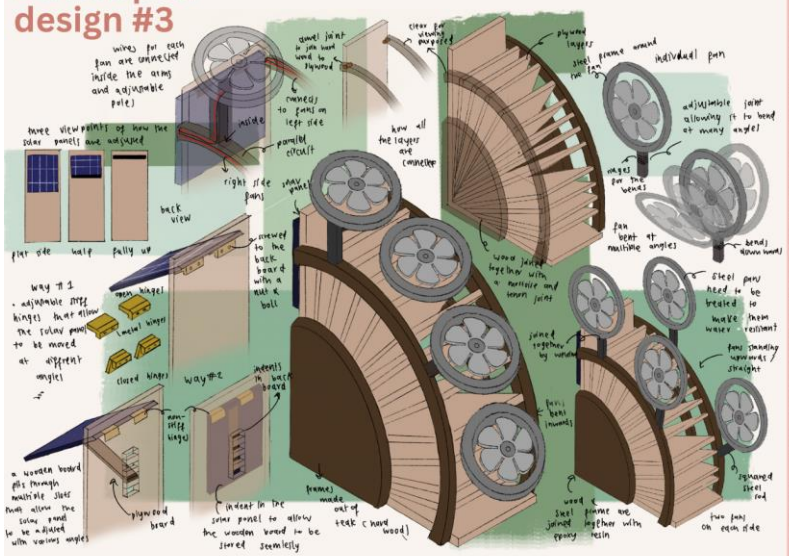
Client commentary:
This is interesting, the fact that the moulds conjoin together is really nice tough i think that this mould is very constricted in ranges of sizes it can make and could therefore not be in ranges of sizes it can make and could therefore not be suitable.suitable.

Design #4

The forth design is a mould which features hinges in the middle so that the two sides can fold up together. The tops have a handle so the moulds can be easily carried.

Client commentary:
Its nice that these moulds are portable however i think i mentioned before that when the papers are dried vertically it does have a quite high risk of the paper falling/ deforming therefore i think that this

Developed design #3



EVALUATION

This is an enhanced Version of one of the Design Concepts Discussed in Section 1: "Initial Ideas: Developed."

This design concept has undergone significant development since its inception. The design frame remains unchanged, but major additions have been made to improve the overall functionality.

A fan system has been installed on top of the frame, with each fan featuring an adjustable joint that can be bent inwards or outwards depending on the user's needs. Fans can be snapped back when not in use or when certain molds are not needed, while others can be pushed forward.

The back frame of the design now features a solar panel, with two unique designs created. The first design has adjustable hinges that allow the solar panel to be adjusted to different angles, while the second design features a wooden panel that fits into multiple slots within the backboard, each slot adjusting the angle of the solar panel. The first design is more practical as it requires less complexity and minimizes material wastage as hinges are used in both designs.

Finally, a wiring method has been developed that threads inside the frame, connecting the fan to the solar panel.

Improvements that could be made include better protection for the fans from the environment, as they are quite exposed and prone to breakage due to constant adjustments.

Client commentary: Aestheically wise the frame of this deisgn is the most beatiful in my opinion. However, the fans around the out side do look quite tackly and feel like they could break off at any moment. Perhaps a cover should be added to ensure durability? Not only that, Some of the layers are vertically faced which i have mentioned before would be quite imprcatical as the paper might warp if it is stationed vertically. The diesgn look quite difficult to move around as welll but i do love how the solar panel is adjuatable to suit where the sun is at that time. I feel like this should be implemated in the other designs youve developed as well.

PRIMARY RESEARCH : FANS

Introduction

To better understand the scale and size of my design, I conducted various experiments on crafting fans using scraps and recycled materials. I also made sure to prioritise environmental sustainability by testing different materials. My experiments included using a range of plastic bottles, as well as varying the sizes of the fans.

Experiment #1 : CPU Fan

Here i used a fan from a CPU that had been discarded before and connected to a 9 volt battery

A 9-volt power supply can provide a sufficiently fast spinning speed for the fan, making it a viable option for use with the drying frame. However, due to its small size, using a single fan to match the size specifications of the drying rack would be impractical and expensive.

Experiment #2 : PC fan

In this experiment i used a 12 mm computer fan to test with the same 9 volt battery. The fan has a square frame and is relatively heavy compared to the CPU

Because the fan has a square frame, it is better suited for a drying frame as no additional frames would need to be manufactured around the fan. However, as the plastic used was more heavy the fan did not spin as fats as the CPU fan with a 9 volt power input.

EXPERIMENT #3 : NORMAL PLASTIC WATER BOTTLE

To enhance the environmental sustainability of my design, I undertook an experiment to create fans using repurposed plastic water bottles. Initially, I cut the water bottles in half and then further divided the section with the lip into six fan blades. Employing a heat gun, I shaped these blades into a fan formation. Subsequently, I drilled a hole into the lip of the bottle and inserted a 6-volt motor through it, securing the motor in place with hot glue. Finally, I affixed the 6-volt motor to a battery supply for operation.

The fan's plastic components were too delicate to be shaped correctly, resulting in blades that were uneven and unable to move air efficiently. This, in turn, caused the fan to push less air than intended. Additionally, the hole was not punched in the exact middle, throwing off the center of balance.

EXPERIMENT #4 : LARGER PLASTIC WATER BOTTLE

I tried making the fan with the same design again however this time with a larger water bottle as it would fit the size specifications of the client more accurately.

While using this fan, I noticed it had the same issues as the smaller plastic version. The bottles' plastic material is too fragile. However, this larger size allowed me to visualize the design more accurately and meet the client's specifications more effectively.

EXPERIMENT #5 : DISH SOAP PLASTIC BOTTLE

I decided to experiment with a more robust and durable material for my fan, opting for a dish soap plastic bottle made of HDPE. Working with this material proved to be efficient, especially when using a heat gun. Unlike previous attempts, the HDPE did not warp or bend too quickly, resulting in a fan design that outperformed all others.

Although shaping the plastic was a bit challenging due to its resistance to twisting, it ultimately led to the best results among my various trials. The fan turned out to be stable, with all blades remaining straight. When the fan was turned on, a noticeable airflow was achieved.

TRIAL AND TESTING

When considering reusing plastic bottles, I had doubts about the durability due to the thinness of the plastic. During my research, I discovered a project that involved shredding various types of plastic to create items like bowls, plates, and bracelets. This innovative process, known as reforming plastic, includes shredding different colored plastics into granules, melting them in an oven, pressing them into a mold, and allowing them to cool. This method seemed fitting for my design requirements as I needed a thicker material that was also environmentally friendly.

I began my initial experiment with the existing plastic granules available, which included a mix of different colors. To ensure a cohesive design, I opted for clear/white plastic to avoid distracting from the drying rack's aesthetic. For the molds, I used two metal trays stacked on top of each other.

During my first attempt, I used clear plastic and placed it in the oven at 210 degrees for 20 minutes. However, after 20 minutes, I observed that the plastic did not melt and instead started to burn. Upon removal, it was unable to be pressed into a sheet. This was due to an imbalance in the types of plastics used; I discovered that solid colored plastic had a lower melting point than clear plastic.

For the next trial i decided to work with only white plastic and the results of this test were better, the plastic melted and bonded togethe rbut this time i used too little plastic which resulted in the plastic coming out not as a full sheet,

Later on, I attempted the same process with additional plastic granules. I kept the plastic in the oven for 20 minutes. Upon removal, I placed another metal tray on top and secured both trays together using a wooden block in between to apply more pressure and prevent the clamp marks from indenting the metal.
After cooling down, the plastic was removed. This time, the plastic had melted into one solid piece; however, some edges appeared slightly burnt, possibly due to the temperature being too high or leaving it in the oven for too long.

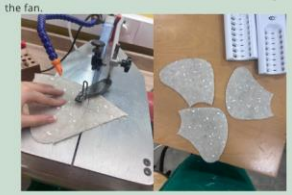
After careful consideration, I concluded that plastic molding techniques are best suited for developing the drying rack design. This approach enables the adjustment of sheet thickness to the desired level, ensuring durability. Moreover, I adopted a sustainable practice by repurposing discarded milk bottles from my school.

To produce the design, 0.4 kg of plastic granules is necessary. The material should undergo heating in an oven at 200 degrees Celsius for 10 minutes. A tailor-made mold must be crafted to meet the design requirements since the current molds are insufficient in size.

To test the plastic, I began by separating the clear granules from the white ones as carefully as possible. Next, I placed them in the oven at 250 degrees. Once it was finished, I removed it, clamped it, and waited for it to cool down.

The end result was a flawlessly thin piece of plastic. However, since I didn't separate the plastics completely, there were tiny white specks in the final product. While the plastic did display some texture and small holes, it was not significant enough to require reheating and filling.

After marking the required sizes of the fan blades, I proceeded to cut them out using a fret saw. This resulted in three thin fan blades that were ideal for the design of the fan.



Here we see the candidate undertaking further relevant research, this enhances the development section and illustrates an iterative approach. This work could be included as part of the initial research but, in this case the candidate benefits from this work as a progressive refining of the proposal.

Brazing

To evaluate the design i tested welding aluminium poles together to understand the process, time and aesthetic finish of the first design.

Before i started to weld steel together i needed to cut and prepare the steel. I used 1mm sqaured steel and 1mm angled steel for the trial. I cot them into appropriate lengths. Next i used a metal file to sand down the parts that would come into contact with each other when i was going to braze to create a even and clean slate for the brazing rod / brass.

I first started by turning on the flame from low heat to a high heat flame by adding more oxygen. Then i placed the two steel pieces on the table in the position i wanted them to be. I then heated the parts of the steel that would be joined together until the metal was red. After i heated the brazing rod lightly then dipped it until flux to help it stop oxidising. I then heated the brazing rod again into the contact points of the two parts. Finally i dipped the peice into water to allow it to cool off.

With tis i tested how well the joint between the two modular pieces would turn out. I used two angled steel peices and one sqaured steel rod to create the joint effect. I also brazed two sqaured metal rods together to see how i would create the frame the the drying rack.

Evaluation

Although the process of brazing was successful as the brazing rod was made out of brass the joints had a yellow color. Therefore, i will need to sand and finsih it with a darker color during the actual production process of rge drying tack. I also conclusded the the joint of the modualar parts should be inside of the sqaured rod instead of outside the rod for a better look.

Evaluation

While making the rack i found that teh size i had originally planned was abit too big anf i would need to make new adjustements to the measurements of the actual rack. Not only that, i found that the joint of the two frames should be insde rather than outisde in the model which would create a more clean and seamless look. Ive also conclusded that drawer stoppers were not nessessary to each layer and i could just use manual sliding in and sliding out with hands.

Tesing the joint

When i was testing the joints of the two modualr racks, I a 1mm wooden sqaured block to mimick the actual size of the materila i would use when making the rack. I used flat playwood strips to createa a casing arounf one strip. This allowed the other strip to fit into the slot allowing a seemless sconnection between the two strips.

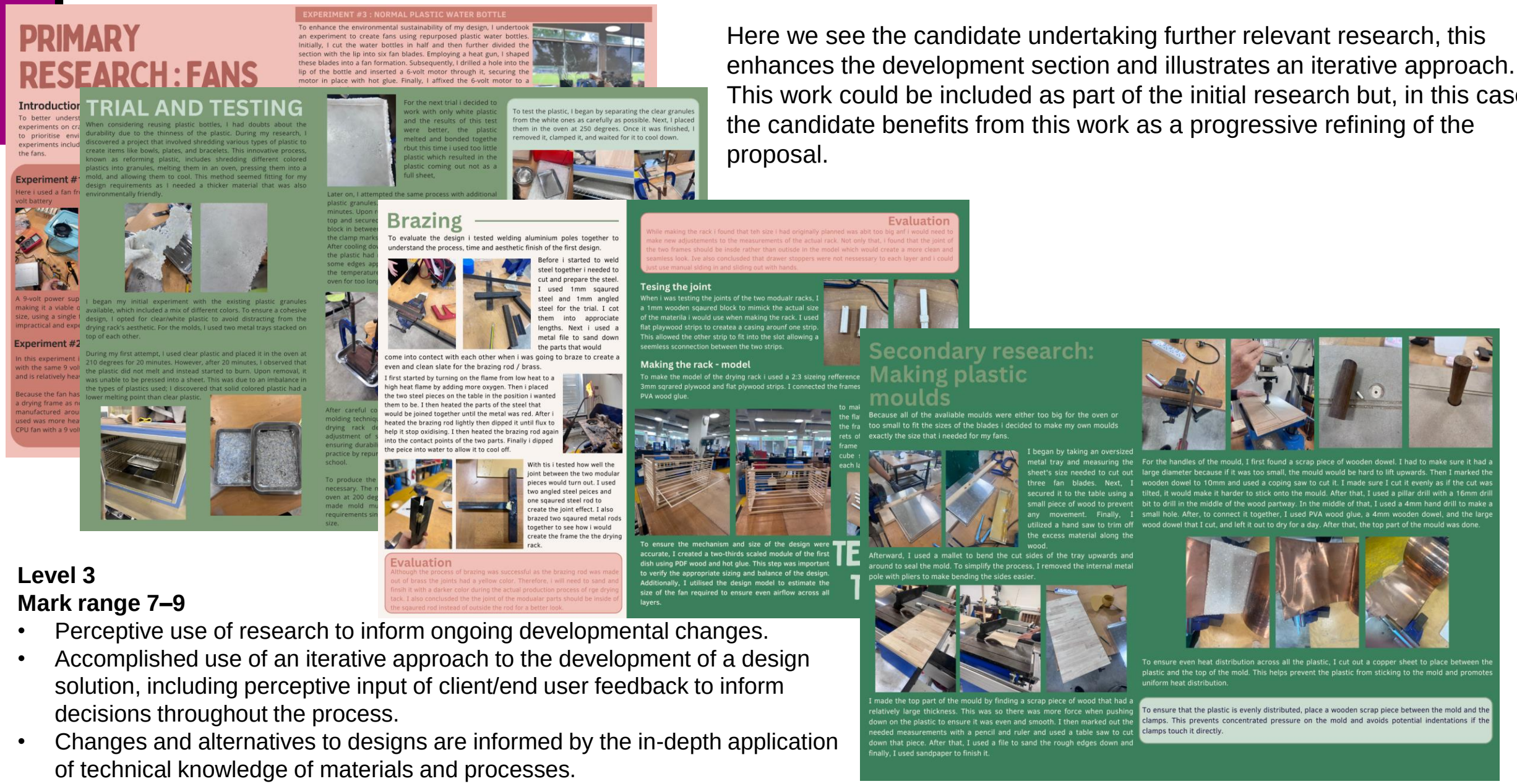
Making the rack - model

To make the model of the drying rack i used a 2:3 sizeing refference. I made the main body out of 3mm sqrared plywood and flat plywood strips. I connected the frames with a hot glue gun and made PVA wood glue.

to make each indidiualr rack i glued the flat plywood strips to the sides of the frame to create a support for the rets of the rack. Then to make each frame i used a smalled 1mm plywood cube strip. The final reuslt allowed each layer to be slid out.

To ensure the mechanism and size of the design were accurate, I created a two-thirds scaled module of the first dish using PDF wood and hot glue. This step was important to verify the appropriate sizing and balance of the design. Additionally, I utilised the design model to estimate the size of the fan required to ensure even airflow across all layers.

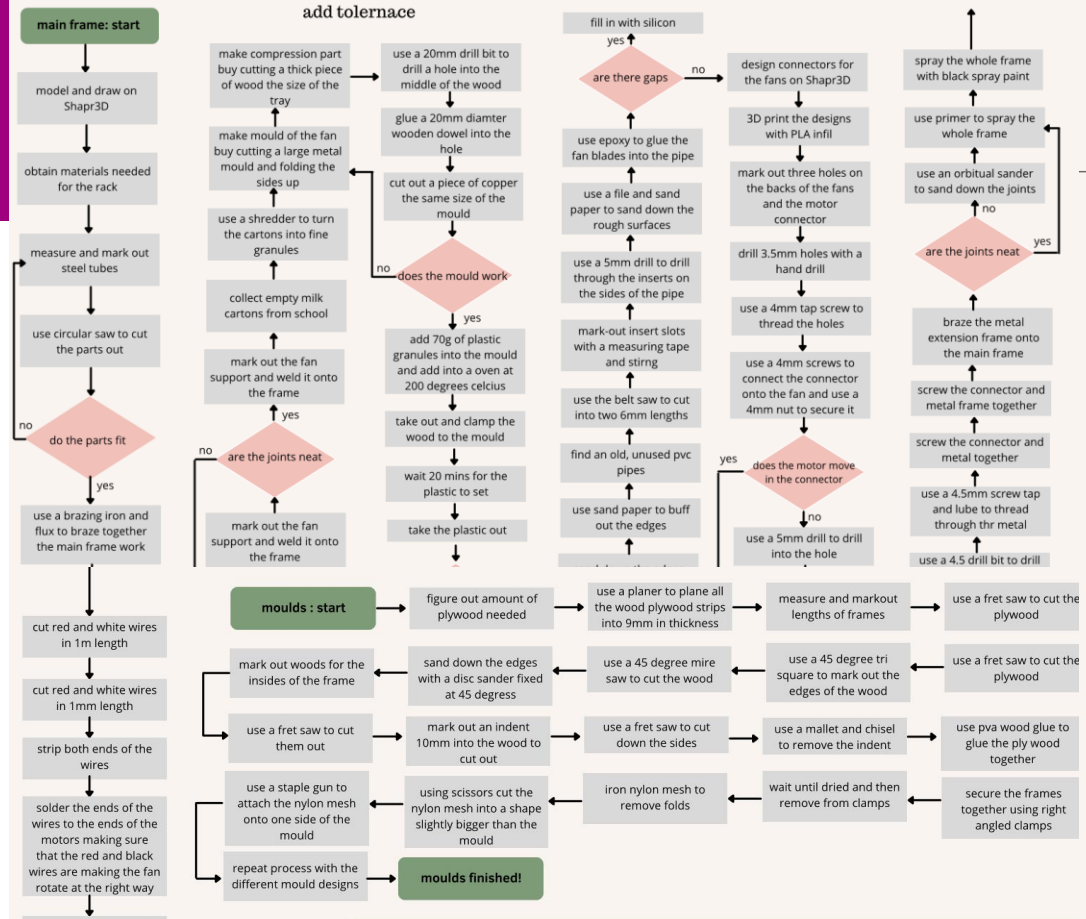
TESTING & TRIALING



Here we see the candidate undertaking further relevant research, this enhances the development section and illustrates an iterative approach. This work could be included as part of the initial research but, in this case the candidate benefits from this work as a progressive refining of the proposal.

Level 3
Mark range 7–9

- Perceptive use of research to inform ongoing developmental changes.
- Accomplished use of an iterative approach to the development of a design solution, including perceptive input of client/end user feedback to inform decisions throughout the process.
- Changes and alternatives to designs are informed by the in-depth application of technical knowledge of materials and processes.
- Sophisticated application of modelling/simulation techniques to inform decisions showing an in-depth understanding of the need for testing in the development of a final prototype.



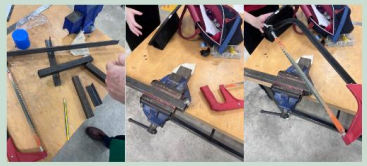
Gantt chart

PRODUCTION PLAN

week	dec 1	dec 8	dec 15	dec 22	dec 29	jan 5	jan 12	jan 19	jan 26	feb 2	feb 9	feb 16	feb 23	mar 1	mar 8	mar 22	mar 29	apr 5
1. planning and finalising measurements																		
2. making a cutting list																		
3. mark out metal and cut out																		
4. weld together the main framework																		
5. weld layers of the frame work																		
6. cut out metal for fan extensions																		
7. weld fan extension parts																		
8. shred milk cartons into granules																		
9. make mould for fan																		
10. melt plastic to mould into fan																		
11. cut pipe out and assemble fan																		
12. create CAD design of fan attachment																		
13. 3D print fan attachment and attach the fan onto metal frame																		
14. weld fan extension frame onto the main frame																		
15. attach two fan motors to a solar power panel																		
16. mark out and cut wood for frames																		
17. assemble frames																		
18. final check																		

TRIAL AND TESTING: Brazing

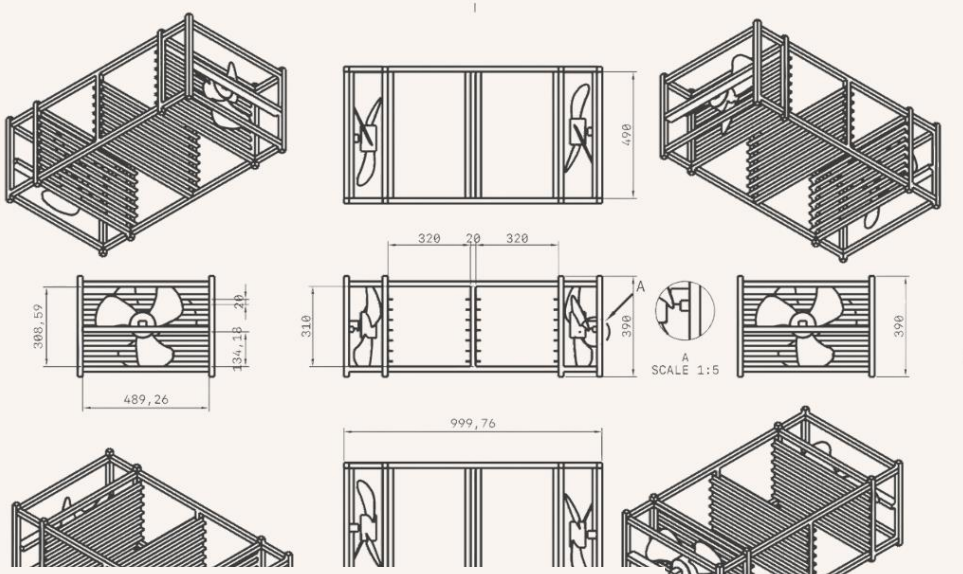
First, I utilized a steel tri square, scribe, and ruler to indicate the desired lengths on the steel. For the prototype, I employed 1-inch square steel and one-inch angled steel. Subsequently, I employed a metal saw to cut the metal to the specified lengths. Following this, I smoothed the edges of the steel by sanding them to ensure they were sleek and prepared for brazing.



To braze the steel, I started by igniting the carbon dioxide and creating a flame. Then, I activated the oxygens and adjusted the levels until a bluish flame appeared. Following that, I heated the joints to a red color for brazing. After heating the brazing rod and dipping it in flux (which prevents the rod from burning), I applied it over the joint. Once the joints were joined, I cooled the metal with cold water and repeated the process for the remaining joints.

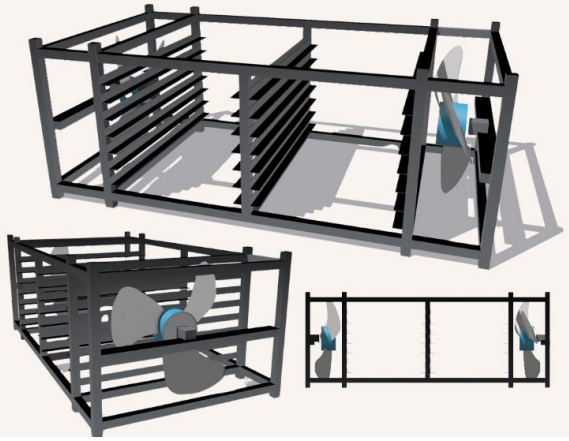
The results were impressive; however, the brazing rod, being golden/brown, left a mark on the grey steel. This indicates that a finishing touch (like spray painting) will be necessary for the metal once it is assembled.

MEASUREMENTS AND MATERIAL LIST



Materials	Measurements	QTY
Square steel tube	1000mm	9
Angled steel tube	500mm	28
Milk cartons	-	20
Motor	12V, 6mm radius	2
Circular pipe	12mm radius, 30mm length	1
ply wood	500mm length, 20mm width	20
nylon fabric	100x100cm	1

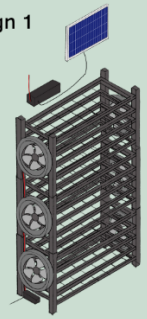
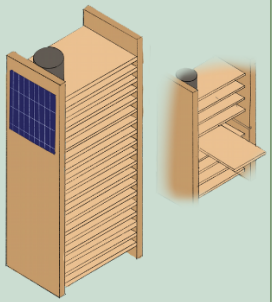
FINAL DESIGN



Level 2
Mark Range4–6

- A manufacturing specification that effectively addresses the needs and wants of the client/end user is presented that includes effective technical details to allow mostly accurate interpretations by a third party.
- Effective refinement of design proposals to generate a design solution that effectively meets the requirements of the design specification.
- Effective project management including application of calculations to determine material quantities and costs related to the production of the prototype, showing an effective understanding of methods which can be applied to reduce wastage.

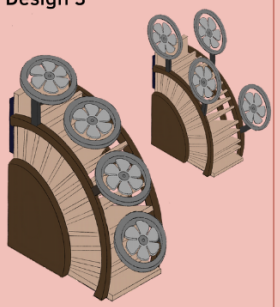
EVALUATION AGAINST SPECIFICATION: DEVELOPED DESIGNS

Design	Function & Ergonomics	Aesthetics	Cost & Saftey	Materials	Sustainability
Design 1 	/ Can hold 10+ pieces Because the design is modular, there can be a multitude of moulds fit into one drying rack. / Stable and Durable The rack features four legs making the design both stable and easy to move / Contains a fan The rack contains two fans on each side of each modular rack / & X Rack is appropriately sized The rack doe snot exceed the heigh of an average fish farmer. However, if the client requires they can add additional segments to the rack	/ Minimalistic feel The rack does not contain any intricate designs and patterns / Function forward The rack is designed based on its intended use and visually looks like what it is meant to be doing / Muted and dark colors The design is mainly made out of steel which is typically available in dark colors.	/ Low cost As the design is made almost completely out of steel, it is a low cost material. Not only that, brazing will be used which is significantly lower cost than welding. / Stable The design is stable with no parts than can easily break off and fall X Fans have protective casing The fans do not feature a protective casing which can protect them from water and direct sunlight	/ Metals and wood The main material used in this will be steel which fits the specification X Water resistant Steel is not a water resistant material and is prone to rusting therefore the material should be treated with protective coverings before to ensure longevity and durability.	/ No use of plastic Throughout the design any type of plastics are not chosen / Minimal variety of materials used This design features only one material which is steel / Few manufacturing processes The main process of this rack is welding however, other than that the entire manufacturing process will be a primarily hands on process.
Design 2 	/ Can hold 10+ pieces The new developed design has been modified to hold multiple drying racks / Contains a fan The rack contains two fans on the back part of the rack / Rack is appropriately sized The rack doe snot exceed the heigh of an average fish farmer. In addition, it is not too large in width allowing it to be eays to store and move around X Stable and Durable The rack features two thin legs which could make in rather unstable as the wet sheets of algae paper can carry a significant amount of weight. Not only that, the racks are constantly moved around which may cause the rack to fall over	/ Minimalistic feel The rack does not contain any intricate designs and patterns / Function forward The rack is designed based on its intended use and visually looks like what it is meant to be doing. However, the contraction behind the layers can be viewed as complicated. X Muted and dark colors The design is mainly made out of softwood which is mainly avaliable in lighter colors.	/ Low cost The design is made out of steel and lightwood/plywood. These materials are known to be available at a lower cost compared to their other counterparts. X Stable The design is not stable as it only features two supporting legs. X Fans have protective casing The fans do not feature a protective casing which can protect them from water and direct sunlight	/ Metals and wood The materials in this design fit the specification completely being steel, beech wood and plywood. X Water resistant Steel is not a water resistant material and is prone to rusting therefore the material should be treated with protective coverings before to ensure longevity and durability. Wood is also not water resistant and will need to be finished with wax.	/ No use of plastic Throughout the design any type of plastics are not chosen / Minimal variety of materials used This design features only three materials: steel, plywood and beech wood / Few manufacturing processes Most of the manufacturing process is a hands on process when working with the wood. However, metal turning will need to be used when manufacturing the steel rod.

EVALUATION AGAINST SPECIFICATION: DEVELOPED DESIGNS

Design	Function & Ergonomics	Aesthetics	Cost & Saftey	Materials	Sustainability
Design 1	/ Can hold 10+ pieces Because the design is modular, there	/ Minimalistic feel The rack does not contain	/ Low cost As the design is made almost	/ Metals and wood	/ No use of plastic

EVALUATION AGAINST SPECIFICATION: DEVELOPED DESIGNS

Design	Function & Ergonomics	Aesthetics	Cost & Saftey	Materials	Sustainability
Design 3 	/ Can hold 10+ pieces The new developed design has been modified to hold multiple drying racks / Contains a fan The rack contains four fans on the outer layers which are all adjustable X Stable and Durable The rack features two thin legs which could make in rather unstable as the wet sheets of algae paper can carry a significant amount of weight. Not only that, the racks are constantly moved around which may cause the rack to fall over X Rack is appropriately sized The rack is rather small compared to the average fish farmer and will require them to bend down to comfortably use.	/ Function forward The rack is designed based on its intended use and visually looks like what it is meant to be doing. However, the fan mechanism can be viewed as unnecessary. / Muted and dark colors The design is mainly made out of hard dark wood and steel. X Minimalistic feel The drying rack has complicated mechanisms around the outer parts.	/ Stable The design features a flat surface making it one of the most stable designs. X Low cost The design is made out of hard wood which is commonly know to be more expensive than its other counterparts. X Fans have protective casing The fans do not feature a protective casing which can protect them from water and direct sunlight. Out of all the designs, this one is the most flimsy in the fan compartment.	/ Metals and wood The materials in this design fit the specification completely being steel, oak wood and plywood. X Water resistant Steel is not a water resistant material and is prone to rusting therefore the material should be treated with protective coverings before to ensure longevity and durability. Wood is also not water resistant and will need to be finished with wax.	/ No use of plastic Throughout the design any type of plastics are not chosen / Minimal variety of materials used This design features only three materials: steel, oak wood and ply wood / Few manufacturing processes Most of the manufacturing process is a hands on process when working with the wood.

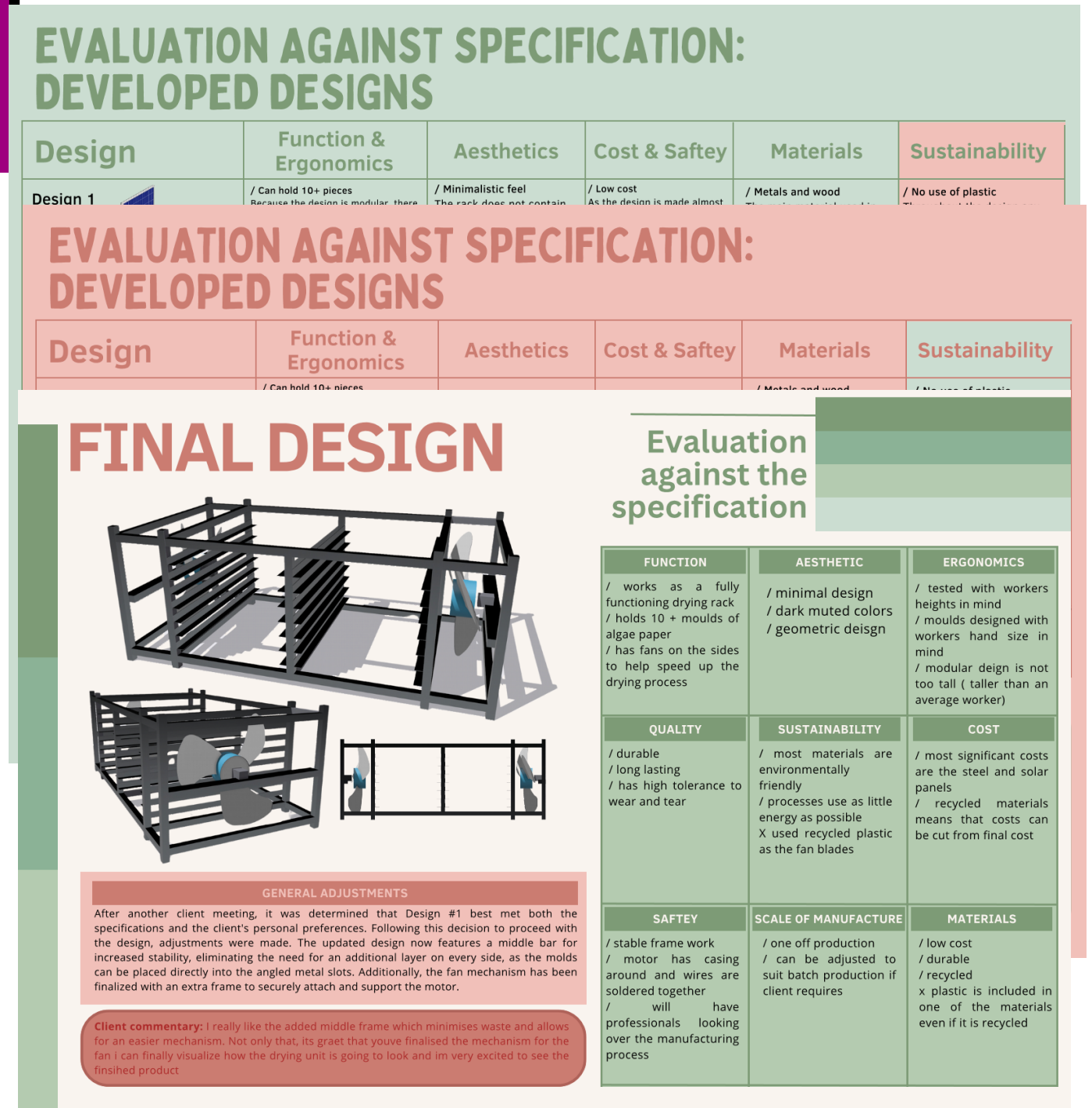
CLIENT COMMENTRAY

While design two is visually appealing, I believe that design one is the best option for practicality. Its simplicity makes it easy to use, and being made of a single material ensures its waterproofing. Additionally, the modular design makes it convenient for workers. Design three, while interesting, is ultimately impractical, as its slanted design would not work. Therefore, I choose design one as the most practical and logical design for my needs.

EVALUATION

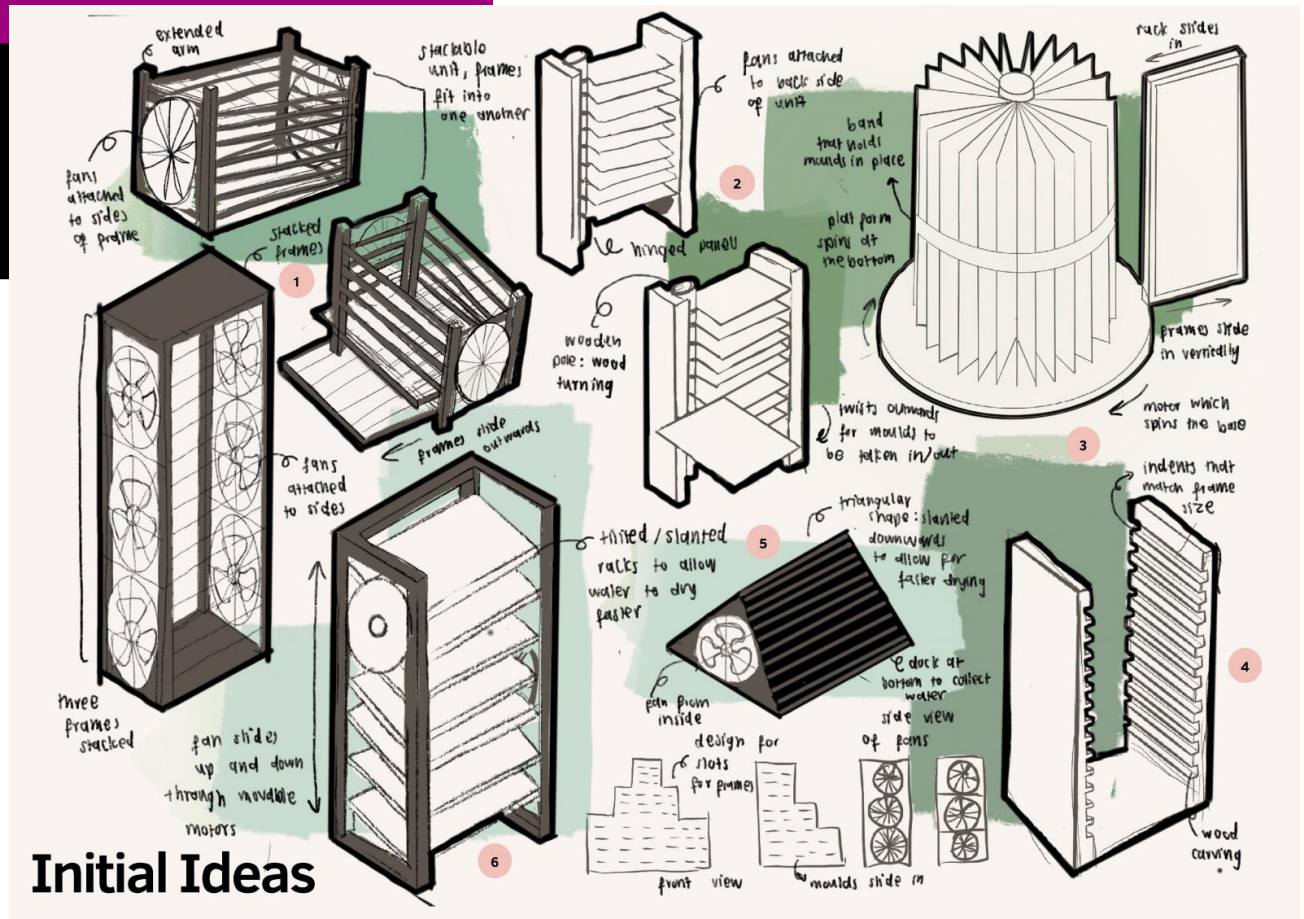
To summarise the data in the table: when evaluating against the specification, Design #1 is most fitting, followed by Design #2 and the least fitting one being Design #3.

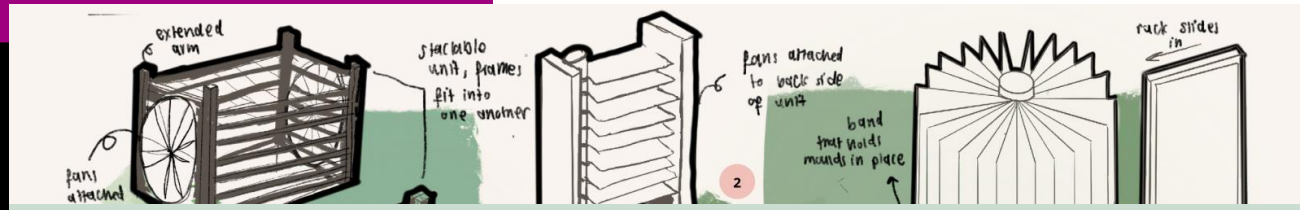
Due to this data as well as the comments made by the client, I can conclude that I will proceed with Design #1.



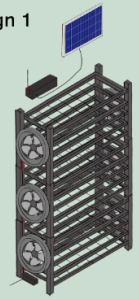
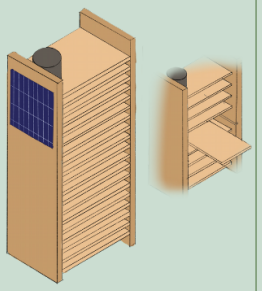
Level 3
Mark Range 7-9

- Mostly developed analysis of the refinements made to designs throughout the development process, mostly relevant references to feedback made by others and consideration of materials, components and manufacturing techniques.
- Sound and mostly balanced evaluation of the refinements made to designs through the development process, which is used to draw sound conclusions about the appropriateness of the final prototype in meeting the needs of the specification.
- Mostly developed analysis of the designs and prototypes made by others, which considers a mostly relevant range of factors and makes mostly relevant connections between elements of the design.
- Sound and mostly balanced evaluation of the designs and prototypes made by others, which effectively informs their own design decisions


extended arm
stackable unit, frames fit into one another
fans attached to sides of frame
stacked frames
1
fans attached to back side of unit
2
hinged panel
band that holds moulds in place
platform spins at the bottom
rack slides in
wooden pole: wood turning
twists outwards for moulds to be taken in/out
motor which spins the base
frames slide in vertically
3
frames slide outwards
fans attached to sides
three frames stacked
fan slides up and down through movable motors
tilted / slanted racks to allow water to dry faster
5
triangular shape: slanted downwards to allow for faster drying
duck at bottom to collect water
fan from inside
side view of fans
design for slots for frames
front view
moulds slide in
indents that match frame size
4
wood carving
6
Initial Ideas



EVALUATION AGAINST SPECIFICATION: DEVELOPED DESIGNS

Design	Function & Ergonomics	Aesthetics	Cost & Saftey	Materials	Sustainability
Design 1 	**/ Can hold 10+ pieces** Because the design is modular, there can be a multitude of moulds fit into one drying rack. **/ Stable and Durable** The rack features four legs making the design both stable and easy to move **/ Contains a fan** The rack contains two fans on each side of each modular rack **/ & X Rack is appropriately sized** The rack doe snot exceed the heigh of an average fish farmer. However, if the client requires they can add additional segments to the rack	**/ Minimalistic feel** The rack does not contain any intricate designs and patterns **/ Function forward** The rack is designed based on its intended use and visually looks like what it is meant to be doing **/ Muted and dark colors** The design is mainly made out of steel which is typically available in dark colors.	**/ Low cost** As the design is made almost completely out of steel, it is a low cost material. Not only that, brazing will be used which is significantly lower cost than welding. **/ Stable** The design is stable with no parts than can easily break off and fall **X Fans have protective casing** The fans do not feature a protective casing which can protect them from water and direct sunlight	**/ Metals and wood** The main material used in this will be steel which fits the specification **X Water resistant** Steel is not a water resistant material and is prone to rusting therefore the material should be treated with protective coverings before to ensure longevity and durability.	**/ No use of plastic** Throughout the design any type of plastics are not chosen **/ Minimal variety of materials used** This design features only one material which is steel **/ Few manufacturing processes** The main process of this rack is welding however, other than that the entire manufacturing process will be a primarily hands on process.
Design 2 	**/ Can hold 10+ pieces** The new developed design has been modified to hold multiple drying racks **/ Contains a fan** The rack contains two fans on the back part of the rack **/ Rack is appropriately sized** The rack doe snot exceed the heigh of an average fish farmer. In addition, it is not too large in width allowing it to be eays to store and move around **X Stable and Durable** The rack features two thin legs which could make in rather unstable as the wet sheets of algae paper can carry a significant amount of weight. Not only that, the racks are constantly moved around which may cause the rack to fall over	**/ Minimalistic feel** The rack does not contain any intricate designs and patterns **/ Function forward** The rack is designed based on its intended use and visually looks like what it is meant to be doing. However, the contraction behind the layers can be viewed as complicated. **X Muted and dark colors** The design is mainly made out of softwood which is mainly avaliable in lighter colors.	**/ Low cost** The design is made out of steel and lightwood/plywood. These materials are known to be available at a lower cost compared to their other counterparts. **X Stable** The design is not stable as it only features two supporting legs. **X Fans have protective casing** The fans do not feature a protective casing which can protect them from water and direct sunlight	**/ Metals and wood** The materials in this design fit the specification completely being steel, beech wood and plywood. **X Water resistant** Steel is not a water resistant material and is prone to rusting therefore the material should be treated with protective coverings before to ensure longevity and durability. Wood is also not water resistant and will need to be finished with wax.	**/ No use of plastic** Throughout the design any type of plastics are not chosen **/ Minimal variety of materials used** This design features only three materials: steel, plywood and beech wood **/ Few manufacturing processes** Most of the manufacturing process is a hands on process when working with the wood. However, metal turning will need to be used when manufacturing the steel rod.

EVALUATION AGAINST SPECIFICATION: DEVELOPED DESIGNS

Design	Function & Ergonomics	Aesthetics	Cost & Saftey	Materials	Sustainability
Design 1	/ Can hold 10+ pieces Because the design is modular, there can be a multitude of moulds fit into	/ Minimalistic feel The rack does not contain any intricate designs and	/ Low cost As the design is made almost completely out of steel, it is a	/ Metals and wood The main material used in this will be steel which fits	/ No use of plastic Throughout the design any type of plastics are not chosen

INITIAL IDEAS : DEVELOPMENT

Further development of evaluated initial ideas with rendering and improvements.

Level 3
Mark Range 5–6

- Perceptive selection and accomplished use of traditional/manual graphical techniques to communicate design proposals.
- Perceptive selection and accomplished use of computer-aided design (CAD) techniques to communicate design proposals.
- Perceptive selection and accomplished use of written techniques to communicate design proposals.

MANUFACTURING
main frame

Firstly, I acquired the metal that I needed for the project and marked them out with a metal scriber and a ruler. Then, I organised them into piles of the same length so that it was ready to be cut.

After measuring, I utilized an angle saw to accurately cut the metals to the right size, ensuring precision to avoid the need for further filing. To stabilize the metal and prevent any uneven cuts, I placed a plastic box at the end for support.

While doing thsi procedure i made sure to wear gloves, eye proyection, ear protection and an apron to ensure my saftey.

Once all the metals were cut, I figured out the layout of the frame and then moved to the brazing process. First, I marked out where I wanted each metal piece to go with a permanent marker and scriber. Then, I laid down each piece of metal on a flat surface and made sure it was in the correct position that I wanted it. To further ensure this, I also used a tri square to make sure the corners were at ninety degrees. Then, I placed two heavy rocks on each piece of steel to make sure that they would not move during the brazing process.

To braze the metals together, I first turned on the flame lightly and then added oxygen until the flame turned blue. Then I heated the brazing rod until it was hot and then dipped it into flux. The flux is used to prevent the brazing rod from burning. After, I used the flame to heat the parts of the metal that were going to be joined together until they were red. Next, I heated the brazing rod on the joint and made sure that all of the liquid covered the joint. After they were joined, I dipped the joints into cold water to allow the metal to cool off and make it touchable.

I then joined the remaining parts of the sides of the main frame with the same method, making sure to check for correct measurements and making sure it was completely squared along the way. After that was done, I measured and marked out where the angled steel layers would be situated on those two frames. I made sure the layers were in the same position as each other on the other frame and I also made sure they were square with a steel tri square.

MANUFACTURING
main frame

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Once all the metals were cut, I figured out the layout of the frame and then moved to the brazing process. First, I marked out where I wanted each metal piece to go with a permanent marker and scriber. Then, I laid down each piece of metal on a flat surface and made sure it was in the correct position that I wanted it. To further ensure this, I also used a tri square to make sure the corners were at ninety degrees. Then, I placed two heavy rocks on each piece of steel to make sure that they would not move during the brazing process.

MANUFACTURING
main frame

I then repeat the steps above with the middle parts of the design. First, I marked out the measurements of the framework and the seals that I wanted on it, then I used the vertical steel rod to braze onto the middle of the horizontal rod. Then, I marked out the angled steel plates that would be on it, making sure they were square using a try square, and I also brazed them on using the same technique. Finally, I cooled the framework with cold water to make sure it was okay to touch.

Next, I welded together the bottom part of the frames, making sure to check with a try square again. If they were angled, to ensure that the steel was touching one another, I used a large clamp to keep the steel in place.

After that, I welded the top parts of the frame on both sides. I made sure to check if it was square again, with a try square, and I used the same large clamps to ensure that the steel was touching one another to make a complete and strong joint.

One of the issues that I had was because the steel slightly bent, due to the heat of the flame, it cause some of the steel to misshapen so it was hard to apply the braising rods as it was too big of a gap. Therefore I used the large clamps to push the top and bottom of the stairs to touch the middle part insuring a clean joint.

Then, because the framework was getting too big to fit on the brazing station, and too big to dip into the water, I used tissue soaked in a bit of cold water to rub on the parts that have been joined together with the brazing rod. This allowed for the joints to cool down without a lot of difficulty. Finally, the main frame was complete.

MANUFACTURING
main frame

Once all the metals were cut, I figured out the layout of the frame and then moved to the brazing process. First, I marked out where I wanted each metal piece to go with a permanent marker and scriber. Then, I laid down each piece of metal on a flat surface and made sure it was in the correct position that I wanted it. To further ensure this, I also used a tri square to make sure the corners were at ninety degrees. Then, I placed two heavy rocks on each piece of steel to make sure that they would not move during the brazing process.

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MANUFACTURING
main frame

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Finally, I cooled the framewor
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Next, I welded together the b
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the steel was touching one an
steel in place.

MANUFACTURING
main frame

Following that step, I welded the lower section of the frames, confirming their correct alignment with a try square. I then used a large clamp to hold the steel pieces together firmly.

To address the issue of uneven joints, the initial step was to smooth out the bumps and cracks using a metal file to prepare it for the sander to function properly.

Following that, I utilized an angle grinder to smooth down the joints of all components on the primary framework, ensuring they were even and seamless with the steel. I took care to apply gentle pressure to avoid damaging the steel. Additionally, I remained cautious about my positioning while sanding, as sparks could potentially emerge, posing a risk if they come into contact with the skin.

MANUFACTURING
side frame

First, I outlined the measurements of the side frames using a square steel rod. To ensure accuracy, I utilized a metal scriber, a permanent marker, and an engineering square. Additionally, I shaded the areas that required cutting to avoid any confusion and prevent potential mistakes when cutting the measurements.

MANUFACTURING
main frame

Once all the metals were cut, I figured out the layout of the frame and then moved to the brazing process. First, I marked out where I wanted each metal piece to go with a permanent marker and scriber. Then, I laid down each piece of metal on a flat surface and made sure it was in the correct position that I wanted it. To further ensure this, I also used a tri square to make sure the corners were at ninety degrees. Then, I placed two heavy rocks on each piece of steel to make sure that they would not move during the brazing process.

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MANUFACTURING
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MANUFACTURING
main frame

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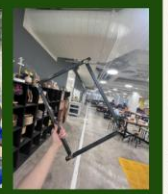
Following that step, I welded the lower s
confirming their correct alignment with a try
large clamp to hold the steel pieces together

To address the issue of uneven joints, the init
out the bumps and cracks using a metal file
sander to function properly.

MANUFACTURING
side frame

Afterward, I utilized an angled saw to trim the steel square rod to the measured sizes, ensuring precise cuts to avoid unnecessary sanding. Additionally, I employed the plastic box to align the steel rods for a clean and accurate cut.



After arranging the pieces on a level surface to align them with the measurements and ensure squareness using a tri square, I prepared the brazing rod with flux. Heating the metal, I proceeded to braze the remaining corners together. To cool it down, I submerged the frame in cold water and for safety, I wore gloves when handling the frame.

I repeated the same process on the other side using identical techniques, resulting in two frames for the main frame's sides. To check their alignment, I stood them up and ensured they were angled correctly with the main frame.

To smooth the joints, i used an angle grinmd to sand them down until the were level with the main stell rods. I carefully made sure i didnt sand too much as if i did it would ruin the finish of the metal and make everything unbalanced.

I repeated this step with the other side of the frame to ensure they were smooth and level. This will make it eaiser for the spray paint to stiick.

MANUFACTURING
main frame

Once all the metals were cut, I figured out the layout of the frame and then moved to the brazing process. First, I marked out where I wanted each metal piece to go with a permanent marker and scriber. Then, I laid down each piece of metal on a flat surface and made sure it was in the correct position that I wanted it. To further ensure this, I also used a tri square to make sure the corners were at ninety degrees. Then, I placed two heavy rocks on each piece of steel to make sure that they would not move during the brazing process.

Firstly, I acquired th
marked them out with
them into piles of the

After measuring, I uti
the right size, ensurir
stabilize the metal ar
at the end for suppor

While doing thsi proc
ear protection and ar

MANUFACTURING
main frame

I then repeat the steps above
First, I marked out the meas
seals that I wanted on it, ther
onto the middle of the horizon
steel plates that would be on i
a try square, and I also braze
Finally, I cooled the framewor
okay to touch.

Next, I welded together the b
to check with a try square aga
the steel was touching one an
steel in place.

MANUFACTURING
main frame

Following that step, I welded the lower s
confirming their correct alignment with a try
large clamp to hold the steel pieces together

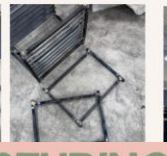
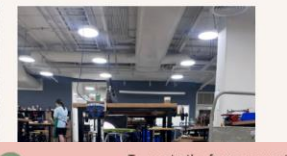
To address the issue of uneven joints, the init
out the bumps and cracks using a metal file
sander to function properly.

Following that, I utilized an angle grinder to smooth down the joints of all components on the primary framework, ensuring they were even and seamless with the steel. I took care to apply gentle pressure to avoid damaging the steel. Additionally, I remained cautious about my positioning while sanding, as sparks could potentially emerge, posing a risk if they come into contact with the skin.

MANUFACTURING
side frame

Afterward, I utilized an angled saw to trim the steel square r
measured sizes, ensuring precise cuts to avoid unnecessary
Additionally, I employed the plastic box to align the steel rods for a
accurate cut.

After arranging the pieces on a level surface to align them
measurements and ensure squareness using a tri square, I pre
brazing rod with flux. Heating the metal, I proceeded to braze the
corners together. To cool it down, I submerged the frame in cold wa
safety, I wore gloves when handling the frame.

MANUFACTURING
side frame

Firstly, I smoothed down the uneven and unbalanced connecting parts of the side frame to prevent any issues during brazing.

Then, make sure the connectors were in place when I brazed them together. I clamped the side frame onto a flat wall and put the steel in between to hold it in place. I then repeated the welding process on all four sides, making sure they were at right angles to the main frame using a try square.

I then repeated the process with the second frame as well. Finally, I cooled the frames off using cold water. However, I still made sure to use heat protective gloves when handling them.

To make sure the side frames were level with the main frame, I stood them up and made sure they were angled with the main frame using a tri square. Then the main and side parts of the frame were finished.

To create the frame connecting the fan to the main frame, I begin by measuring the correct dimensions with a permanent marker, ruler, and triangle square. Next, I carefully cut the pieces to the desired lengths using an angle saw, ensuring precision and accuracy throughout the process.

Then I used the band saw to cut the vertical parts of the measurements. As the band saw width is rather large, I made use to cut on the inner parts of the metal to make sure there are no inaccurate measurements when brazing it to the frame. As the measurements are awkwardly placed, I couldn't use the band saw to saw the other side so something else would need to be used.

Next, I placed the steel into a bench vice and used a hacksaw to cut into the other part. I repeated this with the other part. And finally, the fan connectors were done.

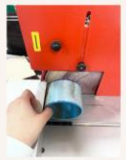
The hacksaw was very hard to use as it wouldn't cut through the steel easily. Therefore, to solve this problem, I sprayed anti-rust oil on it to loosen it up and make it easier to cut.

MANUFACTURING

fan

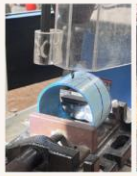
To maintain the environmentally friendly factor of my project, I used an old recycled blue tube found in the bin of my school that was around the right size to make my fan. I then marked out the length of pipe I needed with a permanent marker.

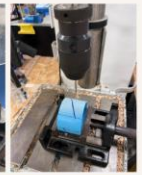
To cut the pipe, I used a band saw to carefully cut around the lines, making sure to be aware of the saw blade's size.



Next i smoothed out the rough edges using a disc sander.

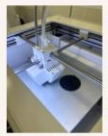
Because the surface of the pipe is rounded, I first mark out all my sections and measurements on a string. I then wrapped the string around the pipe and used it to mark on the pipe. Finally, I did the final calculations and markings with a permanent marker.

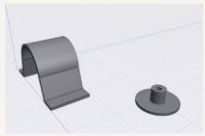




Cutting at a 25-degree angle was very challenging, so I opted to use a 4mm drill bit to create small holes along the marked lines instead. This method enabled me to achieve a precise and accurate opening that perfectly fit the fan blades.

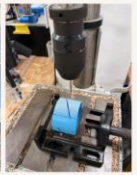
To ensure the holes drilled with the drill were smooth and continuous, I used a small file to eliminate any bumps around the holes. Then, I employed rough sandpaper to refine the surface until it was completely smooth. Lastly, I removed the remaining marks from the permanent marker by rubbing them with alcohol.





After designing motor connectors and fan connectors in Shapr 3D to securely attach my fans to the project frame, I proceeded to 3D print the designs using PLA. I chose PLA for its biodegradable properties, aligning with my environmentally friendly approach. The printing process took two hours, and the final sizing matched perfectly.

MANUFACTURING
fan



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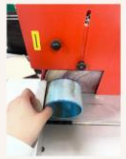


Next i smoothed out the rough

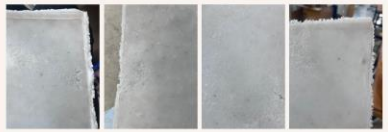
MANUFACTURING
fan

To make the fan I used recycled milk cartons from high school lunches that have been already used because if it's in the theme of my environmentally sustainable design. firstly I wash the milk cartons to get rid of the milk inside and then I cut the milk cartons in half using a craft knife next. I then removed the blue parts of the milk cartons with scissors as i wanted the fans to be the same color.

Afterwards, I placed the milk carton particles in a shredder to transform them into particles, and then incorporated them into my tray, ensuring each tray had a precise measurement of 5 grams.

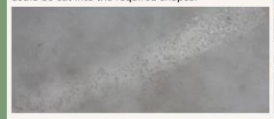
Then I put the trays in the oven at 250°C to make sure the plastic melts on top of the plastic. I put a copper sheet to make sure the heat was evenly circulated around the plastic. I left it in the oven for 15 minutes.

After melting it, I use heat-protective gloves to remove the tray and carefully place it on the table. Then, I place the top part of the mold over the tray and secure it with clamps to ensure even distribution of the plastic around the tray. After 30 minutes, the set plastic can be taken out from the tray.



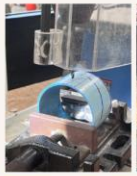
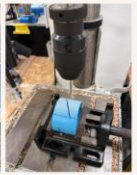
When the plastic was first made, it had several imperfections like holes, unevenness, and cracks on the plastic. To address this, I filled the holes with a small amount of plastic granules, then reheated and pressed it again in the oven to smoothen out the surface.

The end product was a sleek plastic material that could be cut into the required shapes.



However, the sheets were thicker than preferred. To address this issue, I employed a handheld sander and an angled grinder to gradually sand down the sheets to achieve the desired thickness. It's crucial to work slowly with the grinders to prevent excess friction that could potentially melt the plastic.

MANUFACTURING
fan

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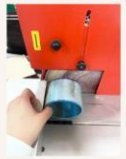

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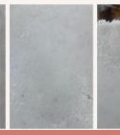

Afterwards, I placed the milk carton particles in a shredder to transform them into particles, and then incorporated them into my tray, ensuring each tray had a precise measurement of 5 grams.

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MANUFACTURING
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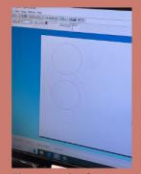


To create the ends of my fan, I utilized 2D design to sketch a 6mm circle. Subsequently, I used a laser cutter to outline the desired circle sizes.

Then i used a fret saw to cut the sheets into the circles that i needed.

After i cut the circled out i sanded the edges down with fret saw. i further sanded them down with a file and sand paper.

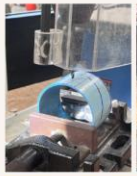
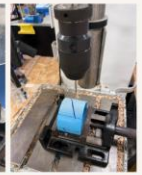
However, there was a problem with this design, as it was hard to pinpoint the centre of the circle, and therefore, if it was fixed on the fan and not in the complete centre, it would make the fan turn around at an uneven speed and make it less efficient. Therefore, to fix this problem, I needed to redesign the circles to have a centre piece the size of the fan connector to ensure it was directly in the centre.

I redesigned the pieces and repeated the process useing the lazer cutter, fret saw and a disc sander.

Then i drilled through the middle of the connector onto the the circular plastic to ensure the centre. Then i put a wooden dowel thorugh the hole to secure in place while i drilled the rest of the holes.

After that i drilled the sides of the connect so i would be able to tap it and connect it to the motor securely.

MANUFACTURING
fan

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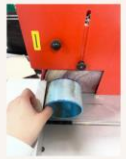

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MANUFACTURING
fan

Next i used a sander to sand down the side of the mototr to allow a flat surface for the screw to tighten onto the motor.

Then i tapped the screw through using a 4mm tap to the holes that i made on the connector.

I used a 4.5mm screw and fastened it with a screwdriver. However, I discovered that one of the screws couldn't fully tighten because the infill of the 3D printed connector was insufficient to hold the thread. Additionally, the excessive friction on the motor led to its damage, prompting the need for a new design. Moreover, the fan connector turned out to be too thick and lacked sufficient support at the bottom.

Therefore, I redesigned the connectors to be exactly the correct size for the motor. Then to make sure they fit better, I drilled the holes again with a 4mm drill.

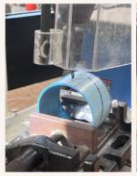
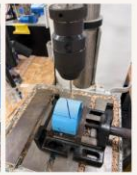
Then I marked out where the holes should be drilled. I made sure that they all were balanced with each other to ensure that the fan wouldn't be wonky. I then used a pillar drill to drill through those holes.

The first holes i drilled were too close to the connective part so i redrilled them with further apart from the original holes. Then i used a 4.5mm thread to thread though the holes to allow the screws to fit. Tje first screw i used were too long for the holes i drilled so i switched to a different screw to which was a perfect fit.

The secure the screws onto the cirles i used a 4.5mm nut and a werch to secure the nuts onto the screw.

I then used 2D to draw the shape of the fan blades. Then I used a laser cutter to mark out the shape that I wanted. To ensure that the cut was noticeable, I made sure to repeat the laser cutting process multiple times. This is because the plastic sheet was too thick for the laser to completely cut through.

MANUFACTURING
fan

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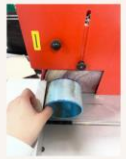

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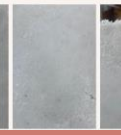

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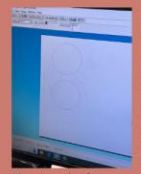

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MANUFACTURING
fan

I then used a marker to color the outlines so they were more noticible and cut the shapes out with a fret saw.

Next, i sanded the sides down using a disc sander and a rotational sander. After that i further sanded it down with sand paper to make sure it was completely smooth

As the blades have some unevenness on the surface, I used a hand-held sander to sand down the edges to ensure a clean finish. I made sure to go slowly so the plastic wouldn't warp.

To secure the fan together, I used epoxy resin to carefully glue the bottom parts and the blades onto the pipes. I let it dry for 24 hours and repeated the same process with the other side of the fan.

There were gaps left in the fan as the epoxy resin could not fill them so to combat this issue, i used a silicone gun around the edges of the holes

To ensure the motors were functioning properly, I linked the wires from the solar panel to the motor and then connected them to the voltage meter. By confirming that the motors indeed spun and reached a sufficient voltage to operate the fan, I verified that both the motors and solar panel were in good working order for the parallel circuit setup.

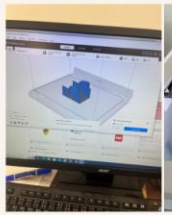
MANUFACTURING
fan

Afterward, I tested the motors with the fans attached to them to see if they would run. Ultimately, they functioned perfectly. However, I discovered that the fans were spinning in the wrong direction, blowing air away from the rack instead of towards it. To rectify this issue, I switched the motors on one of each of the fans, enabling them to spin correctly as intended.

To attach the fan connector to the metal, start by outlining the dimensions of the connector on the metal using a permanent marker. Next, secure the connector to the metal with small clamps. Finally, use a 3.5mm drill to bore through the plastic and metal.

After that, i used a 4.5mm drill bit on a hand drill. This hole is bigger than the hole in the metal because the plastic part will be a countersunk hole which allow for the screws to fit cleanly and evenly.

MANUFACTURING
assembling



As the first fan connector i printed was too big, I carefully adjusted the dimensions and material properties to ensure a precise fit. With the updated design, I delicately crafted each fan connector using PLA infill. Opting for 100% infill this time, I aimed to guarantee the thread's durability and integrity as I secured it onto the metal surface.

Because the metal was hard to thread i had to use cutting compound on the tip of the tapping screw. Then i used 4.5mm tapping screw to make indents into the metal.

To ensure the motor connector was secure, I applied silicone inside the connector. This helped it adhere to the motor, keeping it stable during operation.

MANUFACTURING
fan

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MANUFAC
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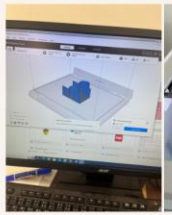
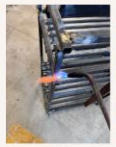
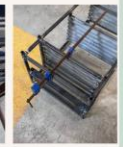


MANUFACTURING
assembling

Next, I joined the fan metals to the side frame by using a brazing rod coated in flux. Heating the metal joints with a flame, I brazed them together. Subsequently, I submerged the frame in cold water to facilitate cooling. This process was then repeated on the other side. Following this, I attached the motor connectors to the frame using a 4mm screw and a screwdriver on both sides.

I then connected the side frames to the main frame of the drying rack by brazing it together. To ensure that each of the joints are connected properly with clamps. I then used an angle grinder to sand down the uneven bumps until they were smooth.

To link the motors to the solar panel, I began by cutting out 1-meter lengths of red and white wires. Next, I prepared the motor for soldering by applying solder to the connecting plates.

I repeated the preparation process for each side of the stripped red and white wires. Next, I applied a small amount of solder to both ends and connected the motors together.

Then to secure it together i cut a small piece of rubber cover around the joints and then used a heat gun to shrink it to the right size and make sire it was secure. And then i repeated this process with the other motors.

Then i stripped the wires of the solar panels and then i connected them onto the push cable connectors. Next I i twisted the two red wires of the motors and the two black wires together and then added them to the push cable connectors making sure the black parts met the black and the red parts met the red parts.

After testing the model outdoors, we discovered that if one of the motor wires touched the connector more, it would cause that motor to spin faster. To resolve this issue, I ensured that both wires were twisted together equally and made contact with the connector evenly.

MANUFACTURING
fan

Afterward, I tested the motors wit
run. Ultimately, they functioned pe
spinning in the wrong direction, bl
it. To rectify this issue, I switched
them to spin correctly as intended.

To attach the fan connector to the metal, start by outlining the dimensions of

MANUFACTURING
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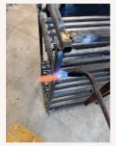

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MANUFACTURING
final touches

Next i coated my frames with a primer. I made sure to apply light coats to not create uneven clumps of spray paint on my rack

To begin priming my fans with spray paint, I first covered the fan blades with taped paper to protect them from the paint. Next, I applied a light coat of primer to the remaining sides. After letting it dry for 10 minutes, the rack was successfully primed.

At last, I applied the last coat of black spray paint lightly to avoid creating any unevenness on the rack's surface.

Afterward, I utilized a wire wrap to bind the two motor wires together securely, enhancing the overall appearance of the setup. Subsequently, I fastened the wires to the framework using black zip ties. Ensuring a neat finish, I trimmed the ends of the zip ties for a polished look.

MANUFACTURING
Frames

To make the moulds i used plywood strips of 20mm in width. To make sure alll the strips were in a standardized height. I used a planer to decrease the height. I slowly decreased the settings of the planer by 0.5mm every roundto avoid potentailly breaking the wood and allow for a smoother finish. I repeated this process until i had enough wood.

Then i mark out the measuremeants with a pencil and tri square and first use a fret saw to cut them down. Then i mark out 45 degree angles with a mitre sqaure and use a hand mitre saw to cut the angles out.

MANUFACTURING
fan

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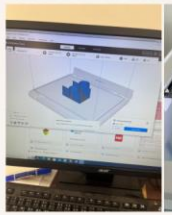

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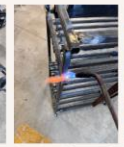

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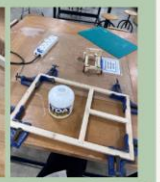
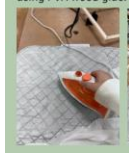


I smoothed the wood using a disc sander set at a 45-degree angle. Next, I connected all the pieces together using PVA wood glue along with right-angled clamps, allowing a few hours for it to dry.

Some molds had different designs that required connections within the outer frame. To create the indents for these connections, I began by marking 0.5mm rectangles on the wood using a pencil. Next, I used a fret saw to cut the vertical lines and a chisel with a mallet to remove the horizontal part. Finally, I assembled it using PVA wood glue.



For tghe netting i used nylon and placed a cloth over it before i ironed it to prevent it from maelting. AFter i cut the nylon into sizes slightly larger than the frames and then used a staple gun to c onnect the nylon to the frame. I made sure to strech it completely to make sure there were no uneveness on the papers.

Secondary research: Mesh fabrics

NYLON MESH

Nylon mesh, woven from nylon fibers, is durable and versatile, used in filtration, screen printing, and industrial applications. It is strong, tear-resistant, lightweight, and flexible but can degrade in sunlight and chemicals. Retaining moisture may lead to mold. Despite these drawbacks, its availability and cost-effectiveness make it popular in various industries.

METAL MESH

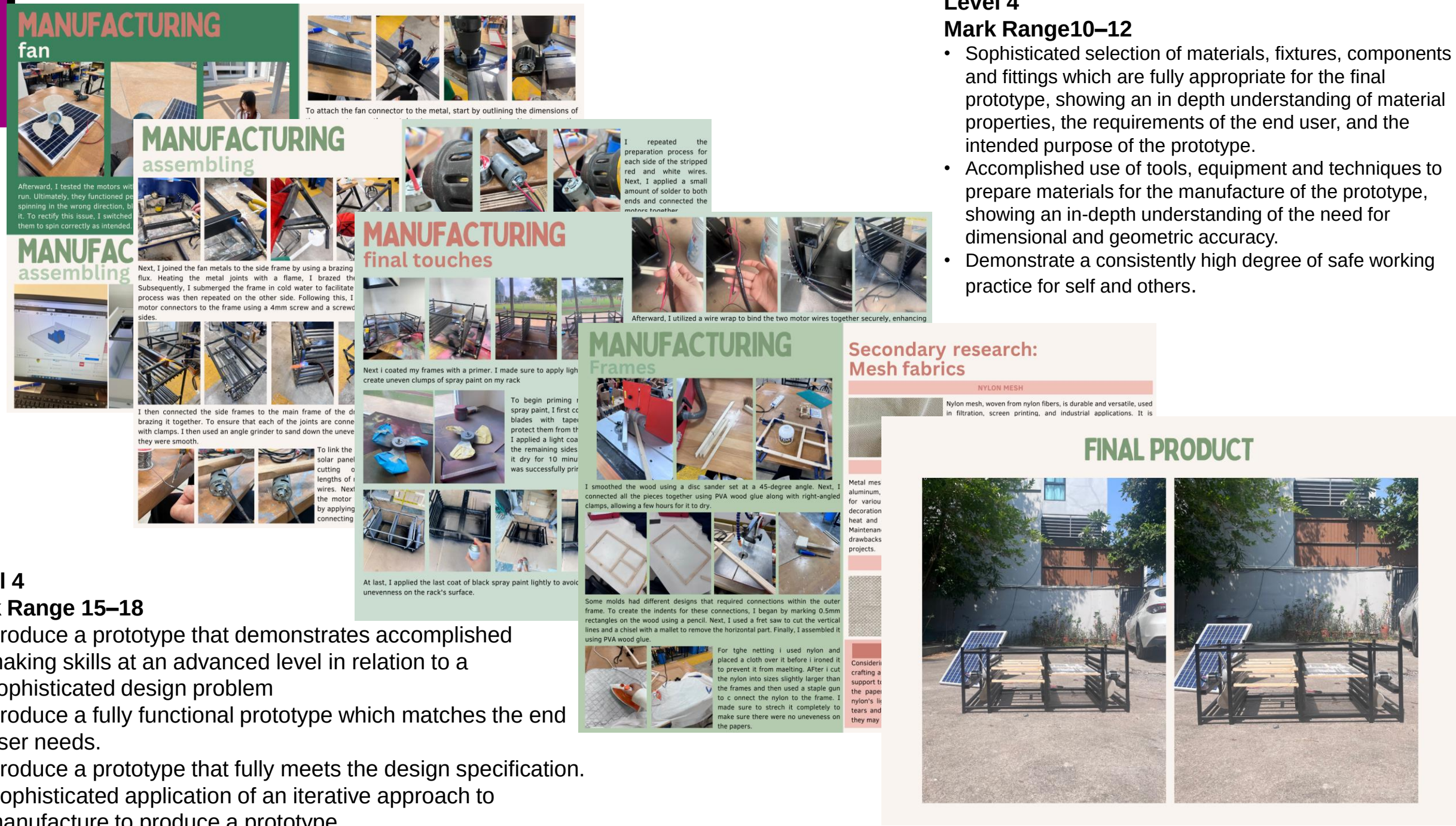
Metal mesh, made of interlaced metal wires like stainless steel, aluminum, or copper, is durable and corrosion-resistant, suitable for various applications including architecture, filtration, and decoration. It offers high tensile strength, load-bearing capacity, heat and electrical conductivity, but can be costly and rigid. Maintenance is needed to prevent debris buildup. Despite drawbacks, it remains popular for industrial and architectural projects.

LINEN

Linen, a fabric from the flax plant, is valued for its breathability, durability, and elegance. It is lightweight, absorbent, and becomes softer with each wash. The fabric's antibacterial properties and resistance to static are appealing. However, linen wrinkles easily and dries slowly. Overall, it remains a popular choice for comfort, durability, and elegance.

CONCLUSION

Considering the qualities of various materials, nylon emerges as the most suitable choice for crafting a frame for a paper mold. Its strength and resilience make it ideal for providing sturdy support to the paper mold. Nylon's durability ensures that the frame can withstand the rigors of the paper-making process, including repeated use and exposure to moisture. Additionally, nylon's lightweight nature facilitates easy handling and manipulation, while its resistance to tears and abrasions ensures longevity. While other materials like metal mesh offer durability, they may lack the flexibility and lightweight properties that nylon provides.

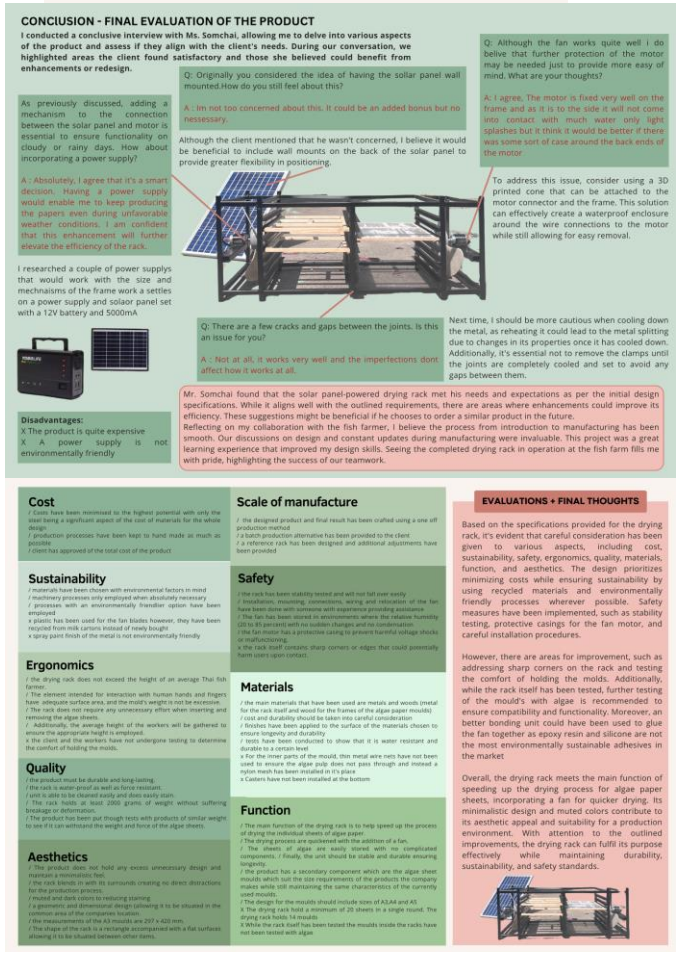


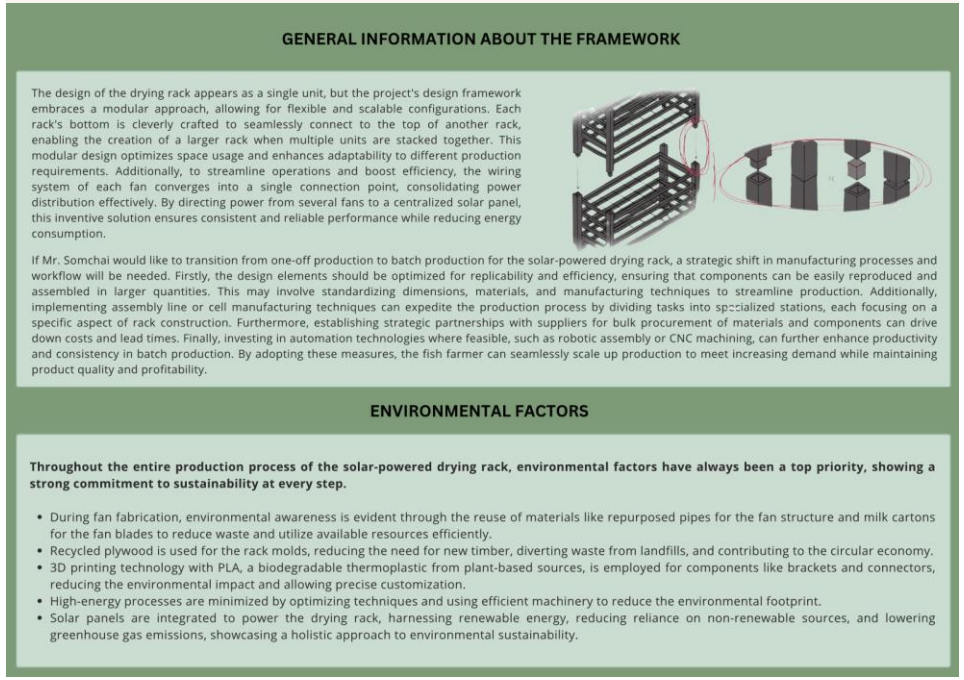
Level 4
Mark Range10–12

- Sophisticated selection of materials, fixtures, components and fittings which are fully appropriate for the final prototype, showing an in depth understanding of material properties, the requirements of the end user, and the intended purpose of the prototype.
- Accomplished use of tools, equipment and techniques to prepare materials for the manufacture of the prototype, showing an in-depth understanding of the need for dimensional and geometric accuracy.
- Demonstrate a consistently high degree of safe working practice for self and others.

Level 4
Mark Range 15–18

- Produce a prototype that demonstrates accomplished making skills at an advanced level in relation to a sophisticated design problem
- Produce a fully functional prototype which matches the end user needs.
- Produce a prototype that fully meets the design specification.
- Sophisticated application of an iterative approach to manufacture to produce a prototype.





Level 2
Mark Range 5–8

- Developed analysis of the prototype, taking into account refinements implemented during the development and the client/end user specification, showing a sound approach to testing against measurable criteria.
- Sound evaluation of the prototype, taking into account the iterative design process and the intended purpose of the prototype, drawing mostly balanced conclusions from testing against measurable criteria.
- Developed analysis of the social, moral, ethical and environmental impact of materials and manufacturing processes of the prototype
- Sound evaluation of the social, moral, ethical and environmental impact of the prototype.

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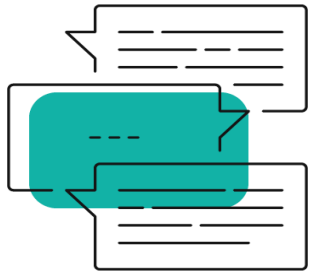

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