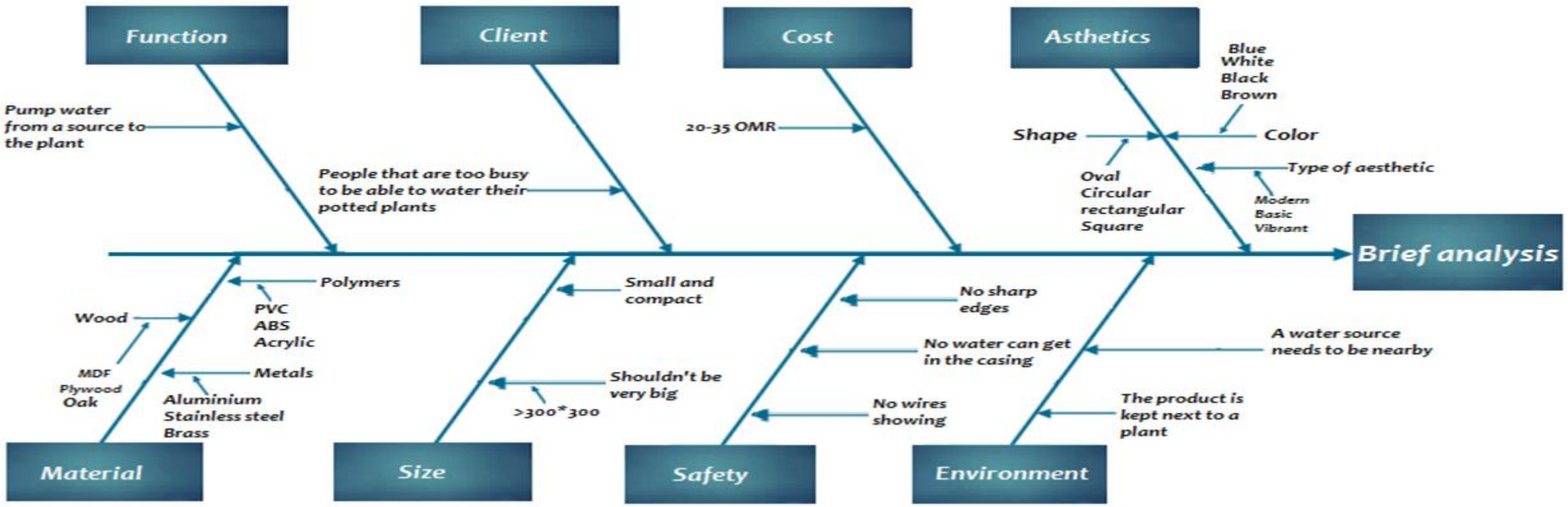
Problem statement

There are a lot people that like plants, that could be for vegetables or even for aesthetic purposes, although they might not be able to water their plants because they can't find the time to do so and hiring someone to water them can be expensive and asking someone can sometimes be uncomfortable and even if they do ask someone the person might not be willing to which leads to their plants being un-watered and possibly dying

Design brief

I am going to make and design for people that are having a problem with watering their plants on daily bases an automatic plant watering device that will allow to not have to worry about their potted plants whenever they can't water them themselves, the device should be able to automatically water the plant whenever it needs it using a sort of activation system or a sensor that would allow the device to know when the plant needs that would then activate a water pump that would water the plant.

Brief analysis



Existing products

Brief

I will search on different websites to find existing products that are similar to mine so I could know any of the advantages and any problems they have

Client feedback:
I should know the client feedback as by looking at the review score and most importantly the individual reviews that can tell you if the product is good or not and can also tell you if there are any problems with the product that aren't noticeable in the marketing such as the durability.

To implement:
I should take notes of any advantages that the product I have so I might be able to implement them in my own

To avoid:
I should also take note of any problems with the products I am going to search so I could avoid them and not make the same mistake

Product 1

From: Amazon

Product 2

From: AliExpress

Product 3

From: AliExpress

Product 4

From: AliExpress

Product 5

From: Amazon

Product 6

From: Amazon

Product 7

From: AliExpress

Product 8

From: Amazon

Product 1

Client feedback

Overall the client feedback to this product was very good, no clients seemed to have any issues with the product when getting it and neither did they have any issues after having used it for a while, the reviews for the product were great and a lot of people were suggesting it with very few negative reviews that were just minor issues with the product.

Advantages	Disadvantages
• Small and compact • Easy to use • Long battery life • Multiple charging	• Messy tubes • Expensive

Verdict

The product looks aesthetically pleasing but the tubes that come with it can be a bit messy after setting It up, it is made out ABS and uses a timer based water dripper that can adjusted manually, it is around 100x100x75 so it is pretty small and compact which seems to be a good thing with consumers, it uses AA batteries and a USB port for power which gives the client more options and freedom and has a good battery life , it also has no safety issues and the overall product is good but a bit expensive compared to some other products (18 OMR) which could repel some clients from purchasing the product but due to the many positive reviews it seems like a worthwhile purchase.

Points to implement or avoid

To implement:
Consumers of this product seem to really like the fact that it is small and compact so maybe I should make mine around the same size if I could, I should also try to make my tubes better than the ones in the product as the ones here were being messy and getting all over the place which after a while could turn into a nuisance for the client or at least have a way for the cline to be able to easily organize the tubes.

To avoid:
The product doesn't really have any major issues that I should make sure to avoid.

Product 2

Client feedback

This product had a bit of a mixed feedback from the clients but the majority were on the negative side. A lot of people were saying that the product had many issues and that it didn't last long and overall they didn't have a good experience with it, even though the product was way cheaper than a lot of the others on the market the bad quality did lead to a lot of negative reviews.

Advantages	Disadvantages
• Water proof • Cheap	• Pipes disconnect easily with high water pressure • The hoses can get messy easily • Hoses are thin and weak • Unappealing

Verdict

One of the main points about the product is that it doesn't look very appealing, the product uses a timer based water tripper that can be adjusted manually, the same problems occurs with this product as some of the others is that the pipes can be get very messy and untidy, a really good point is that the hose timer is water proof so even if there is some leaking the electronic components won't be damaged the product requires AAA batteries to work, there's one major problem with the product and it is that it only uses a water tap as the source and that limits the amount of locations it can used in, it is very bad when it comes to the quality as it the hoses easily disconnect with high water pressure and the ones that come with the product are thin and weak, although the product is pretty cheap (8.5 OMR) the lack of quality does repel a lot of clients.

Points to implement or avoid

To implement:

I should make sure that the enclosure of my product is water proof just like this one because if any water does get into it that would short circuit all the electronic components and since a lot of water is evolved with the product spillages are likely to happen so this is a very important point that I should implement into my product to insure that the electronic components don't get short circuited.

To avoid:

I would want to avoid using a water tap the only source of water for the product as that would really limit the amount of areas my product can be used in.

Product 3

Client feedback

The majority of the feedback that this product received was negative as it had a lot of issues and it didn't function the way it was expected to at times, the consumers of the product mostly had a pretty bad experience with it and most of the reviews were about problems that showed bad quality, overall, the product wasn't received very well.

Advantages	Disadvantages
• Aesthetically pleasing • Easy to set up	• Bad battery life • Hard to see the LED display in daylight • Unreliable water pressure

Verdict

The product looks aesthetically appealing, the enclosure is made out of ABS and the product is easy and simple to set up. A problem that the product faces is that the pressure of the product is very bad and not reliable as it sometimes is too strong which is not good for the plant, it uses a timer based water dripper that is easy to program and use and it works using AAA batteries for power, another problem with the product is that the battery life is very short and it also has a bad LED display that is barely visible in daylight which some consumers were complaining about. The price of the product is not expensive but neither is it cheap (13 OMR).

Points to implement or avoid

To implement:
I should try to make my product easy to set up so any consumer of my product can use without having to worry about how to set it up and even if it turns out to be a bit complicated to set up I should have clear manuals on how to do it.
To avoid:
If I am going to make my product portable I need make sure that I has very good battery life as some people might depend on it to water their plants while they're away and if it has bad battery life that could potentially kill their plants. Also, If I am going of use an LED screen it should be clear at any part of the day.

Product 4

Client feedback

This product was received very well and had extremely good feedback from the clients as it almost had a perfect review score and a lot of people were suggesting it with almost none criticizing the product except when or two users but they only had tiny issues that weren't really significant to the overall performance of the product.

Advantages	Disadvantages
• The product is aesthetically pleasing • Easy to use • Easy to set up • Multiple charging options • Very cheap	• The pipes can get messy • Limited placement options • Product can fall off easily if it gets hit

Verdict

The product looks simple and aesthetically pleasing although just like a lot of the other product the pipes make it look a bit messy. The enclosure is made out of ABS and the product drips water using a timer based dripper than can be set manually and is fairly easy to use and set up. One problem with the product is that it needs to hang from something to work well so that kind of limits the locations you can have the product in and it could fall off easily if it is accidentally hit. It uses AA batteries for power and can also be charged using a USB port. The size of the product is also pretty small and compact at around 82x57x37.5mm, the product is also very cheap compared to some of the other product on the market (6 OMR).

Points to implement or avoid

To implement:

I should try to make my product cheap although that might not be possible if I use expensive components but I should still try to make as cheap as possible while still maintaining the same amount of quality it should have and same as I said for some of the other products, I should try to make it easy to set up and use.

To avoid:

I should try to find a way so that the pipes that I use for my product can be easily organized and I should also try to make it so my product isn't limited when it comes to the placement options.

Product 5

Client feedback

This product was mostly received negatively as any of the positives the product had were outweighed by the negatives. Most people were pointing out all the bad aspects of the product such as the bad overall quality, that's not to say that the product is terrible although most clients of it had a bad experience with rather than a good one.

Advantages	Disadvantages
• *The addition of the solar panel*	• *Doesn't look appealing* • *Bad water pressure* • *Expensive* • *Buttons don't function very well after a short duration of being used*

Verdict

The product looks aesthetically appealing although the sticker on the front would make it seem cheap to some potential clients. The enclosure of the product is made out of ABS. It uses a timer based dripper. One of the main features of this product is that it comes with a solar panel for charging but can also be charged via a USB port, the solar is quite big although it does a good job in keeping the product charged. The product has a bunch of problems that would repel some customers from it such as the pressure on the water pump is bad and can sometimes pump too much water to the plant, another problem is that the buttons don't function properly after a short duration from purchasing the product. The product is also a bit on the expensive side (23 OMR).

Points to implement or avoid

To implement:

There isn't really any major point that I could implement from this product to mine other than the solar which I probably won't because it takes too much space and it would increase the price of the product by a lot.

To avoid:

I should make sure that the pressure on the water pump I am going to use is suitable and is not too low or too high. I should also make sure that if I do use buttons on my product that they are of good quality and make sure that they would have a long life span. I should also avoid using stickers for aesthetic purposes.

Product 6

Client feedback

This product was received extremely well and had very good feedback from all the clients that used it, almost no review of the product talked about anything negative about it, rather, most people were suggesting and praising the product for the it's amazing quality. Overall, over 95% of the reviews were good and the client feedback was amazing

Advantages	Disadvantages
• *Sturdy and strong design* • *Aesthetically pleasing* • *Can water multiple plants* • *Easy to use* • *Easy to set up* • *Multiple charging options*	• *Expensive*

Verdict

The product is small and compact and is aesthetically pleasing, the enclosure for the product is made out of ABS and is pretty strong and sturdy. The product uses a timer based water dripper that is pretty easy to set up and use and can be easily adjusted manually. The device can also water up to 15 plants at once with good water pressure being sent to all of them. The product is powered using 4 AA batteries or it can be charged using a USB connection. Overall the product is very good and doesn't really have any downsides that effect it other than it might a bit expensive for some clients (18 OMR) although for the product's quality a lot of clients would feel like it is worth the price.

Points to implement or avoid

Implement:
I should make the enclosure that would hold all the electronic components of my product strong and sturdy so even if it gets hit accidently by the client it won't get damaged. I should also try to make sure that the water pressure from my water pump is strong enough to be able to water multiple plants. The same point as some of the other product, I should try to make my product easy to use and set up.
To avoid:
This product doesn't really have any problems that I should take note of and avoid making in my own product

Product 7

Client feedback

This product mostly had positive feedback from its users but a lot of people were complaining about it not having any other color options as they didn't like the color it came in. Other than that most of the reviews were good and were complimenting the product's good quality especially for the very low price tag it was given.

Advantages	Disadvantages
• Multiple charging options • Adjustable pump pressure • Can water multiple plants at once • Multiple location options • Cheap	• Does not look aesthetically appealing • Hard to set up

Verdict

The enclosure of the product is small and compact and is made out of ABS although the color that is used on it did cause some clients to dislike the product's aesthetics. This product uses a timer based water dripper that can be adjusted manually although some clients complained by saying that it was a bit difficult to set up at the beginning. The product and uses a USB connection or AA batteries for power. The pressure for the pump can be adjusted and is able to water multiple plants at once. The product also has a sort of hook on the side that can be used to hang on items which gives the user more location options. A big point about the product is its price as it is very cheap (5 OMR).

Points to implement or avoid

To implement:

I should make my product cheap and even if I can't make it cheap I should still try to make as cheap as possible. I should also try to make my product small and compact.

To avoid:

When making my product I should avoid using very bright colors as it seems like a lot of people don't like that. Just like some of the other products the other problem that I should avoid is making product complicated to set up and if mine is I should try to have a sheet that can explain how to work the product

Product 8

Client feedback

The client feedback to this product was mostly negative as a lot of people said that it worked as it was intended although it had a short life span due to leaking problems with the product. Most clients that used the product didn't' have a good experience with it and the product mostly had reviews talking about issues with it.

Advantages	Disadvantages
• Lots of options for settings	• Not durable • Limited location options • Does not look aesthetically appealing

Verdict

This product does not look aesthetically appealing and isn't very attractive to the client appearance wise. The product uses a timer based water dripper and require a water tap as a water source which limits the locations you can place the product in. The product has a lot of options to pick from due to the big switch in front of it which gives the consumer a lot of freedom when using the product. Overall the product works as intended although a major problem with it is it's durability as after a while of being used it starts leaking water to the inside of the enclosure which would short circuit the electronic components. The price of the product is also not very expensive but neither is it cheap (12 OMR)

Points to implement or avoid

To implement:

The only thing that I could implement from this product to mine is the fact that it has a lot of options so if I am going to use a LED screen I should probably give the consumer a variety of options to pick from to give them more freedom when it comes to the settings of the product

To avoid:

I should make sure that the enclosure of my product is durable and waterproof as if any water leaks into the product which would short circuit the electronic components. The same problem with this product as many others is that I should make sure my product isn't very limited when it comes to location options

Existing ideas summary

Brief: *There are mainly to sections of points that I took out of researching existing products like mine and those are the points that I should try to implement into my product if I could and the point the mistakes or problems that some of the existing products had and I should avoid.*

Points to implement

- *My product should be aesthetically pleasing*
- *My product should be small and compact*
- *Use better tubes and make them easy to organize*
- *My enclosure needs to be water proof*
- *Strong and sturdy enclosure*
- *Good water pressure*
- *My product should be as cheap as possible*
- *Should have multiple charging options if possible*

Points to avoid

- *Avoid limiting locations my product can be placed in*
- *I should avoid having a bad battery life*
- *I should make sure no water can leak through my casing*
- *I should make sure my product has a long life span*
- *I should avoid making my product complicated to set up*
- *I should make sure my LED screen can be visible at any time of the day*

Why these points?

Implement

My product should be aesthetically pleasing because that would cause clients to be attracted to the product immediately even before knowing it's specifications. The product should be small and compact as that would allow clients to easily place the product wherever they want to and a smaller product is also generally better aesthetically. Having good tubes means that would decrease the chances of leaking and also being able to organize them makes the product look more neat and tidy. An important point is that my product should be waterproof since it is working with water if any leaks into the enclosure of my product all the electronic components would get short circuited. The enclosure should also have a strong and sturdy enclosure so even if the client hits the product accidently it wouldn't easily break. The water pressure should be suitable as a very high or low water pressure could over-water the plant which could cause the plant to die. I should also try to make my product as cheap as possible as a high price tag would repel potential clients from buying the product. I should also try to have multiple charging options just to give more freedom to the client and if one charging option isn't available to them they can use the other.

Avoid

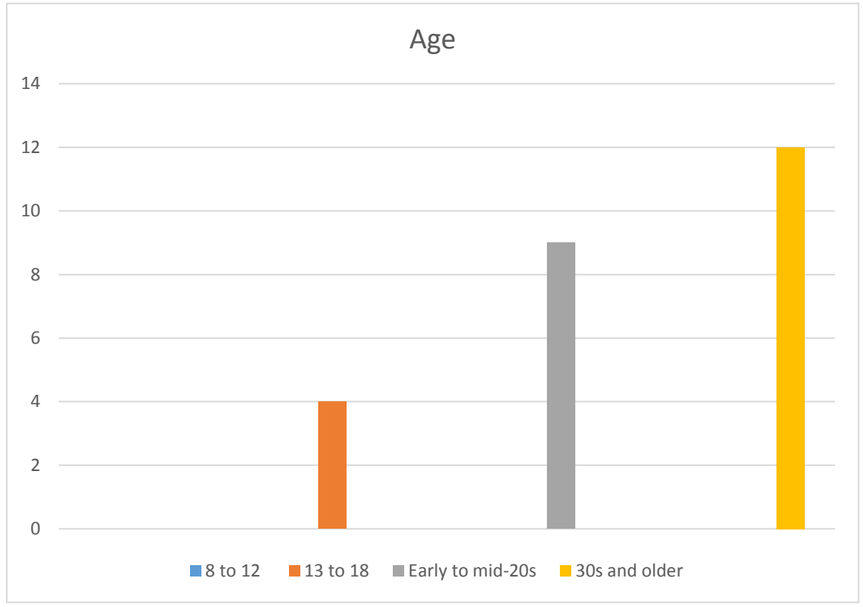
I should avoid limiting the location my product can be placed such as using a water tap as the only water source because some clients might have their plants somewhere that does not have a water tap which restricts the client by a lot thus leading to them not wanting the product. If my device is portable I should also make sure that it has a very good battery life because if there battery runs out and the client is not anywhere near to charge the product that could cause the plants to die. I should also make sure when manufacturing the enclosure for the product that the material I use is not hygroscopic (eg: most natural timber) or that there isn't any way that water could pass through the enclosure because if it does that would lead to the electronic components getting short circuited and since the product works with water all the time the chances of spillage occurring are likely. I should make sure that the durability of my product is good and I can do that by using good quality components and material because a product with a short life span is not worth buying and clients would stay away from it. I should also make sure that my product is pretty easy to set as having a complicated to set up product can annoy the client. Also, I should make sure that if I use an LED screen that it is visible at any time of the day and that it is clear to seen even in the day.

Questionnaire

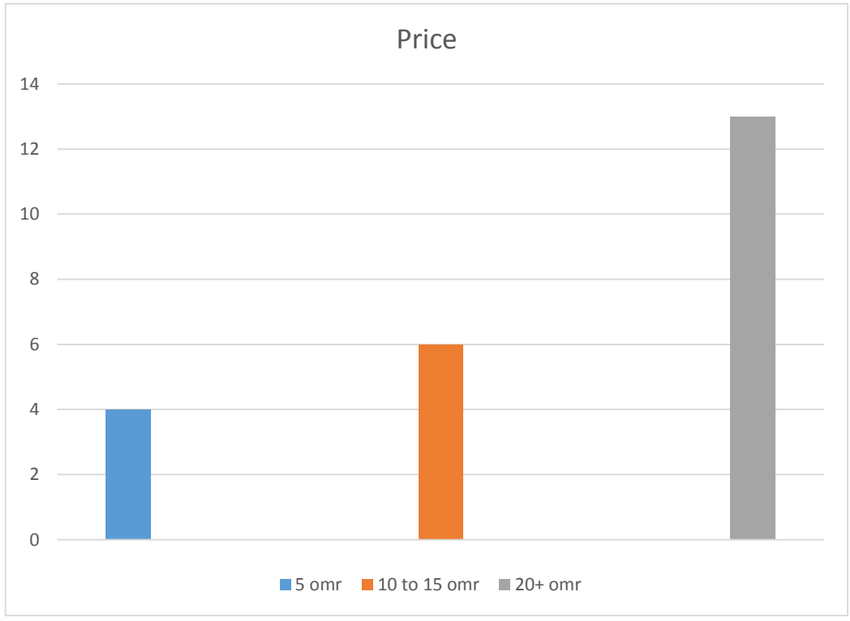
Brief: *I'm conducting a questionnaire to know what potential clients of my product might be expecting from it. Even though a questionnaire won't give me in depth answers it would still give me an idea of how they want the product to be.*

User profile

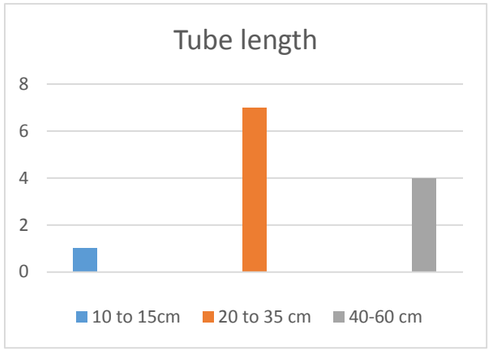
I'm expecting the potential customers for my product to be in their mid-20s or older as that is when most people start settling down and wanting to decorate their homes with plants but are still busy that having a product that can water them automatically for them would be very helpful so those are the people I'm going to target the most when doing the questionnaire but anyone from most age groups should be able to use the product.



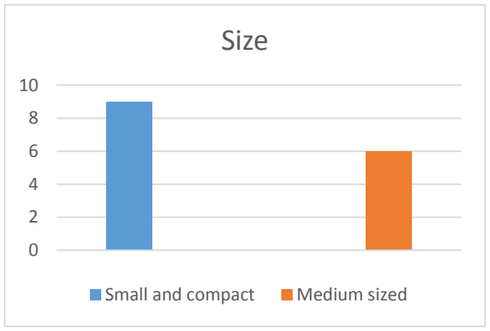
From this I know what age group I should focus more into when marketing the product, this means the marketing should be more mature to target people of the age group that is most likely going to use the product.



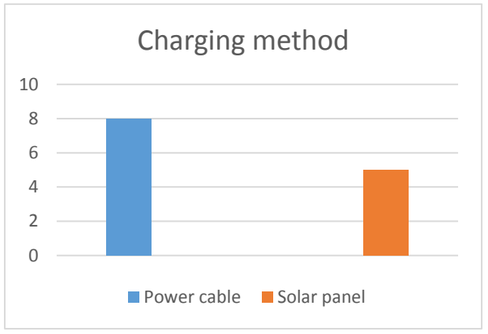
Most people thought that paying over 20 OMR would be worth it for the product as long as it delivers. This tells me that I shouldn't use cheap electronic components or material for the sake of lowering the price as I have a pretty decent budget to work with



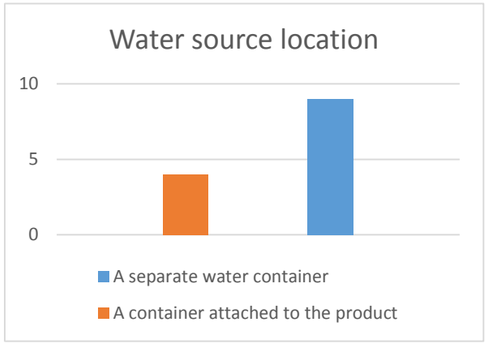
From this I know that I should use 20-35 cm long tubes as that seems to be the length that most consumers feel is the best for a distance between the product, plants and source.



Same with the existing ideas the majority of people want for the product to be small and compact as it look neater and there is no point in it being bigger.



Most people answered that they would prefer power cable than a solar panel, this might because I solar panel limits the locations of where the product could be placed while with a power cable you can use the product as long as you have a power socket

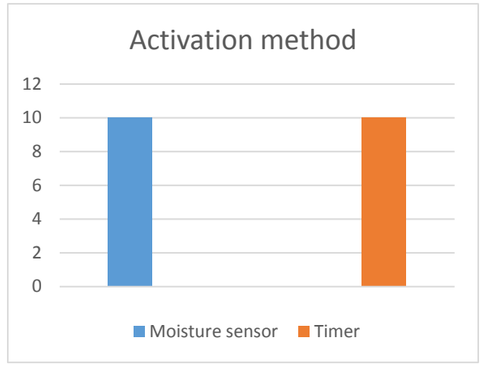


With this I know that I shouldn't make the water source connected to the product, as this will cause the product to be very big and also the amount of water depends on the consumer's needs and adding a water source to the product also means a higher chance for water to leak inside and an increase in the price

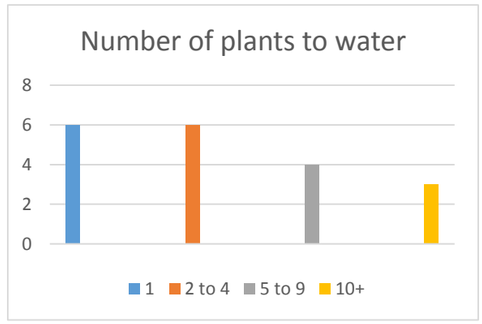
Questionnaire points:

- *Age group: 30+*
- *Price: 20+OMR*
- *Tube length: 20-35 cm*
- *Size: Small*
- *Charging method: power cable*
- *Water source: Separate water container*
- *Activation method: Tie*
- *Number of plants: 2-4*
- *Color pallet: Modern*
- *Location: indoors and outdoors*

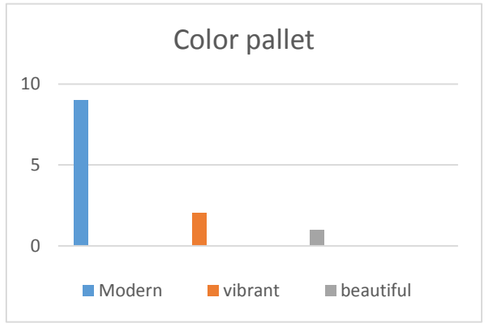
This question got a tie between the moisture sensor and timer based water dripping meaning I should decide which one would be more beneficial to the client.



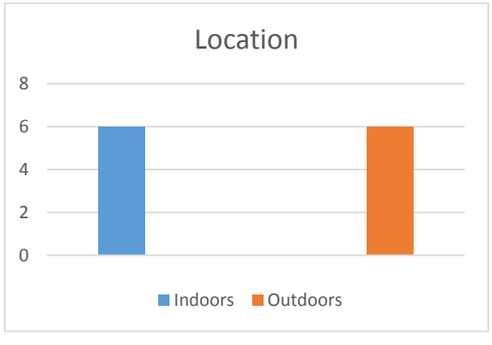
There was a tie in votes between 1 and 2 to 4 plants, I'm going to try to make it the product capable to watering 2 to 4 plants as if the product was able to water that many plants it would have no problem watering only one.



From this question I know that most people would want the color pallet of the product to be modern which included colors such as white, dark blue, grey, matte black, meaning I should try to include them in the product either by painting it or by used material with said colors



This question shows me that my product should be able to function properly both indoors and outdoors without it having any big setbacks if it is used in either type of environment



Interview

Brief: *I'm conducting an interview with my mom about the product as she is a suitable person to be interviewed for it. I am doing this interview so I can have exact details of what a potential client of the product might want or expect from it as compared to a questionnaire even though I am getting a lot of answers none of them are in depth.*

User profile:
I'm doing this interview with my mother as she really loves plants and likes to decorate the house with them and she enjoys taking care them but has recently been very busy and would want something that can do it for her automatically.

Main points asked:

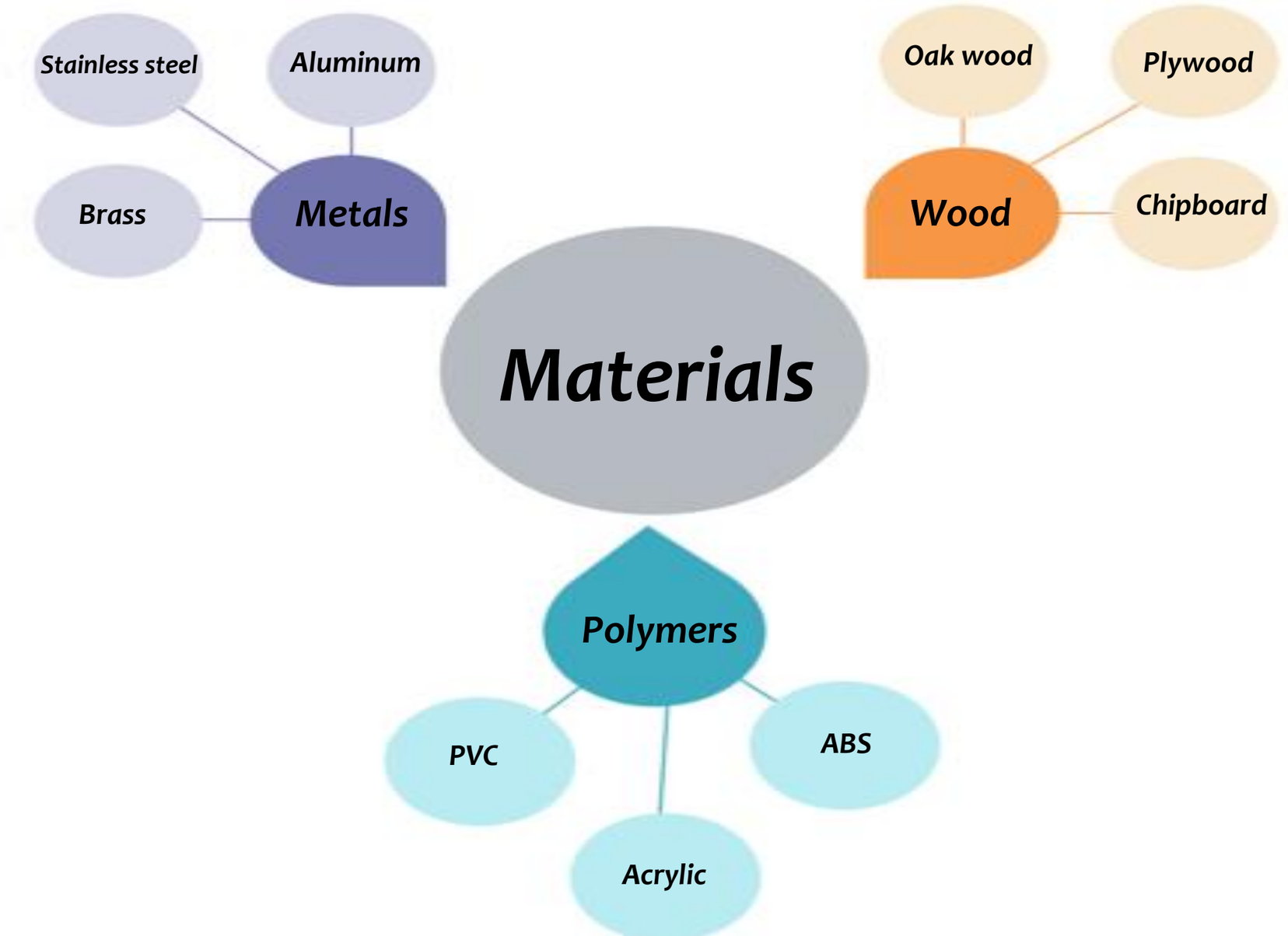
- *Location of the plants*
- *Color of the product*
- *Amount of plants*
- *Charging option*
- *Wanted material for enclosure*

Written interview:

I asked my mom to interview her about my product, I told her a brief of what the product is and then started asking her questions about it. I started by asking her where exactly would she want the product to be placed so I know a sense of where a client might want to place the product and if a solar panel would be suitable for said location. She told me that a plant that she usually waters is on her dressing table inside her room meaning a solar panel wouldn't be suitable. I then proceeded to ask her how many plants is she going to water using the product, which she replying by saying that there is only 1 plant in particular that she wants to water using the device.
After asking my mom about the location and amount of plants I went on to ask her about the material the case/enclosure of the product should be made out of, I asked her if I should use plastics, woods or metals, I explained to her the pros and cons of each and she chose plastics as even though timber is good, it is not water-proof and since the product deals with water there is a high chance for spillages to happen and if any water leaks into the enclosure it could possibly short circuit the electronic components inside and for metals she just didn't think they would be suitable for the product. I then asked her about the charging option if I should use AA/AAA batteries, solar panels or a charging cable, she said that she would be prefer a charging cable as there isn't much sunlight where she would be placing the product meaning s solar panel wouldn't be effective and also she might forget to change the batteries and if she is going to depend on the product to water the plant for her it could die if the batteries are not checked on regularly which would defeat the purpose.
Finally, I asked her about what color she would like the enclosure of the product to be and she said either fully white or green and brown.

Materials comparison

Brief: *I am going to do some research on different materials to know their properties so I am able to choose one depending on how suitable it is with my product*



Stainless steel

Why use stainless steel:

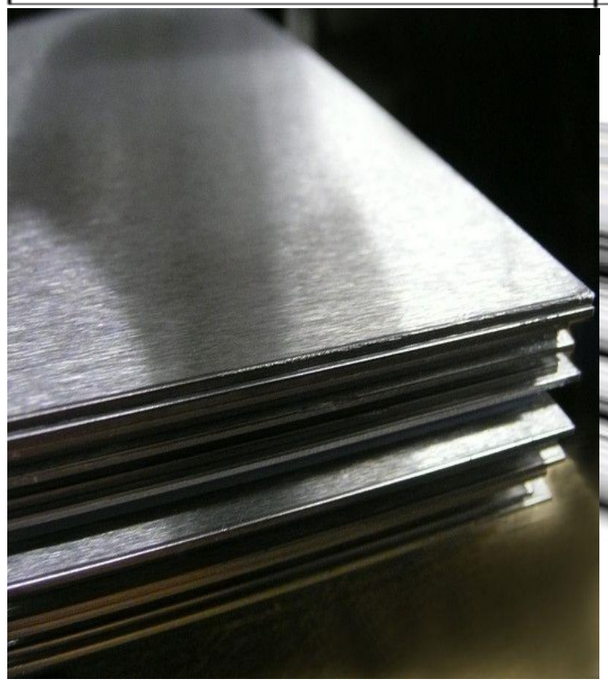
Stainless steel is a very common type of steel that is used a lot as it does not rust compared to other types steel which do easily, this is very important for my product as it could be used outdoors so if I would use stainless steel it wouldn't rust and ruin the enclosure as rust causes the materials to become weak and it will also affect the aesthetics of the product.

Stainless steel also has a shiny, easy to clean and maintain surface which means it could be a good material to use for a products that demand a good looking surface. Stainless steel is also a strong material which means it won't break easily if force is applied to it.

Why not use stainless steel:

One of stainless steel's main points is its very high price, not only that but the finishing and polishing of the material is also very expensive. Stainless steel is a difficult material to handle which could result in the need to re-do some parts which could also be very expensive. It is also hard to weld because of its fast dissipation of heat, also, a case made out of stainless steel would be very heavy which wouldn't be a good thing for product as it would be annoying for consumers and it also could limit the places you can put it in if the surface it is on can't hold heavy objects

Advantages	Disadvantages
• *It is corrosion resistant*	• *It is very expensive*
• *Has a Shiny surface*	• *Requires expensive finishing and polishing*
• *Has an easy to clean surface*	• *It is a very difficult material to work with*
• *It is a strong material*	• *It is difficult to weld*
	• *A case made out of stainless steel would be very heavy*



Aluminum

Why use Aluminum:

Aluminum could be a great material for my product as it is water and corrosion resistant, this means if consumers were to use the product outdoors they don't have to worry about corrosion and neither will they have to worry about the electronic components getting short circuited due to any spillages or leaking of water.

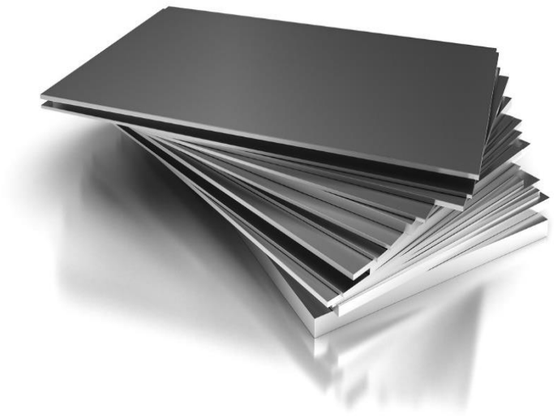
Aluminum is almost the third of the weight of steel which means if I use for my product it will be lighter than using stainless steel for the case. A case made out of aluminum will also be stable and long lasting. Aluminum is also a pretty malleable material making it relatively easy to work with.

Why not use aluminum:

Aluminum is not hard which means it can get dent and scratched more easily meaning consumers could easily scratch the enclosure by mistake and this could result in the enclosure to look bad after a while of the product being used.

Aluminum also requires a special type of welding called gas tungsten arc welding which can be very expensive compared to other methods of welding because the equipment used for it are more sophisticated.

Advantages	Disadvantages
• *It is corrosion resistant* • *It is water resistant* • *It is lightweight* • *It is malleable*	• *It's not a hard material meaning it can get scratched and dent easily* • *Expensive type of welding*



Brass

Why use brass:

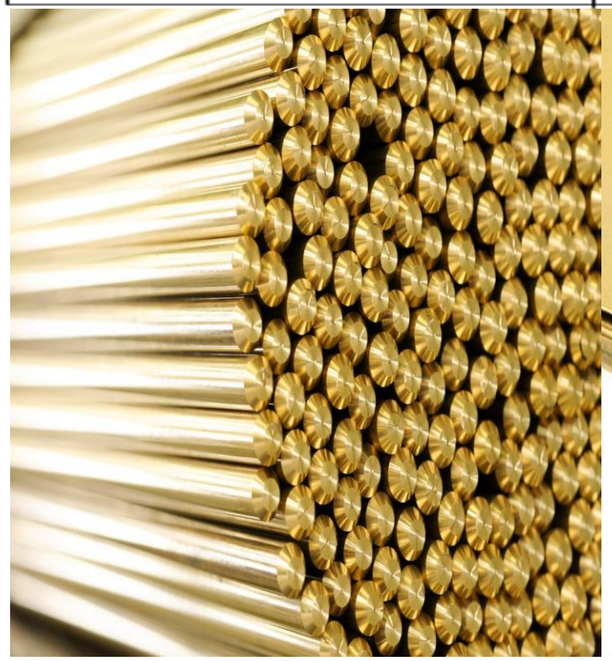
Brass is a tarnish resistant material which is really good for my product since it could be placed outdoors. It is also a highly malleable and easily machine material which makes it an easy material to work with. Brass also has very good polishing and finishing properties that can enhance the aesthetics of the enclosure.

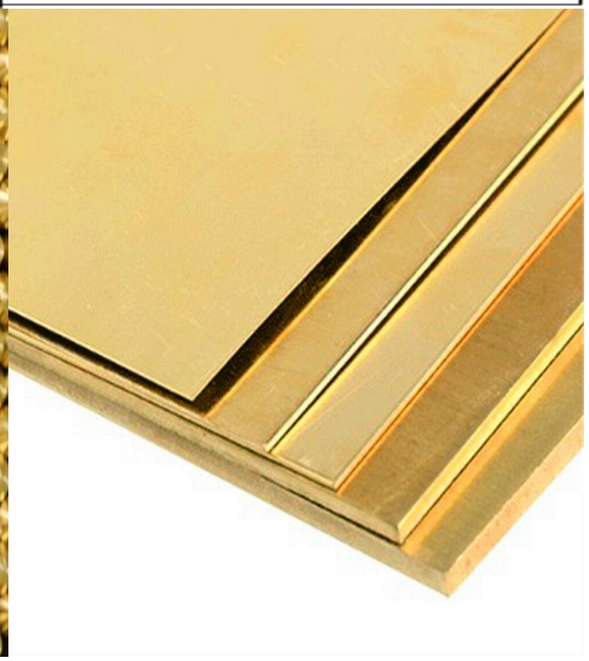
A very good point about brass is its aesthetics, because it shows a high class look it which resembles gold and even though that isn't the sort of aesthetics meant for the product some clients might really like. Brass is also fairly inexpensive which is a good point as if I do use it I will be able to focus my budget more on the electronic components of my product rather than the material.

Why not use brass:

Brass needs a lot of maintenance as if it does corrodes it can get black tarnish over it which is difficult to remove and would ruin the aesthetics of the product. Brass is also a pretty soft material meaning it can get dents and scratches on it pretty easily

Advantages	Disadvantages
• A good corrosion resistant material • Easy to machine • Great polishing and finishing attributes • Has good aesthetics	• Can get black tarnish over it • Difficult to remove tarnish • It's a soft material





Acrylic

Why use acrylic:

Acrylic is a lightweight material which is a good thing as I don't want my product to be overly heavy for no reason. One of the main point to use acrylic is that it comes in many colors, this means I don't have to worry if a color will fit the chosen material. It is also a very easy material to shape which makes it an easy material to work with. Acrylic is also resistant to most detergents, which means chemicals such as oils and fats and different inorganic chemicals won't ruin the enclosure. Acrylic is also a very cheap material, even though clear acrylic sheets are way more expensive I'm not going to use them if I pick acrylic as my material as they don't match the type of aesthetic I'm looking for.

Why not use acrylic:

Acrylic is a very weak and brittle material, this means that even a fall from a short distance could break the case which immediately makes it not a viable choice as if the enclosure breaks the product would also break quickly. Acrylic can also be scratched easily which can ruin the aesthetics of the product if the client scratches it by mistake.

Advantages	Disadvantages
• Comes in many colors • It is lightweight • It is easy to shape • Resistant to most detergents • It is cheap	• It is very weak and brittle • It can be scratched easily

Polyvinyl chloride

Why use PVC:

PVC is a lightweight material which is good as I don't want my product to be very heavy. PVC is also very strong which will help in maintaining the stability of my product. PVC also has a very long lifespan unless it is in contact with UV rays. It also has good abrasion resistance meaning the surface of the material can't be scratched away easily, it also can be shaped and joint fairly easily, adding that with the fact that it is a pretty lightweight material means it is easy to handle and work with. A very good point about PVC is that it is also a cheap material meaning I would be able to focus more of my budget on the electronic components of the product rather than the enclosure leading to better overall quality.

Why not use PVC:

PVC.is a brittle material and I don't want for my product to break easily due to a small impact, PVC also degrades when in contact with UV lights (The sun's rays), it doesn't degrade by much but if it is kept outside it will decrease its lifespan although that can be easily countered if the material is sprayed with paint for the finishing as paint would be a good UV resistant finish that would be able to protect PVC from degrading.

Advantages	Disadvantages
• *It is lightweight* • *It is strong* • *It is very durable* • *It is cheap*	• *It is brittle* • *Degrades if in contact with the sun's rays (can be easily countered)*

Acrylonitrile butadiene styrene

Why use ABS:

ABS plastic is a material that is easily machined, easy to handle and work with, and is also takes adhesives well making it a pretty easy material to work with. It is also pretty resilient and hard making it scratch resistant which is good for my product as if it could get scratched easily that would ruin the aesthetics of the product quickly. It also has high gloss which a lot of customers might be attracted to. A major point of ABS is that it is fairly cheap making it easier for me to focus my budget on the electronic components of the product rather than the material.

Why not use ABS:

One problem with ABS plastic is that it degrades quickly when it gets in contact with UV rays, even though this could be a major problem as some clients might use the product outdoors, it could be easily solved by painting over it when finishing the product because paint can act as a UV resistant barrier that would protect that material from degrading. ABS also has a low melting point but that doesn't really matter when it comes to my product.

Advantages	Disadvantages
• *Very easy to work with* • *It is a strong material* • *It is durable* • *It is easily machined* • *It is inexpensive*	• *It is not UV resistant (can be painted over to help with that)*

Plywood

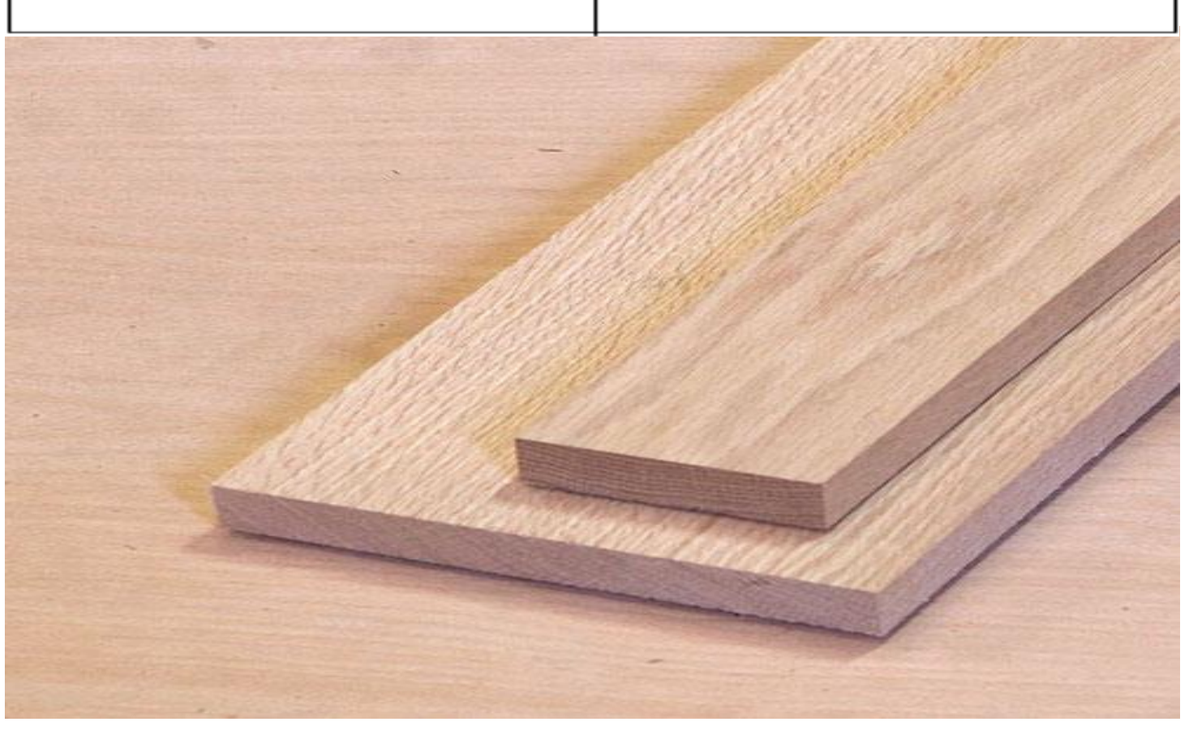
Why use plywood:
Plywood has good surface stability meaning that it won't degrade due to changes in temperature when it is in contact with moisture which is a very good thing for my product as it could be placed outdoors. It also has high impact resistance so it won't break easily if it gets hits by something on accident. Plywood also has a very good strength to weight ratio so even though the material is not very heavy it is still a strong and reliable material.

Why not use plywood:
Plywood's surface can be easily peeled off which could ruin the aesthetics of the product after a while of it being used. It also has exposed edges that don't look aesthetically pleasing but there are multiple way to cover the edges such using a piece of veneer and using an adhesive to stick it on the edge or adding another piece to cover the edge so this shouldn't be a big problem. Plywood can also get stained easily which could ruin the aesthetics of the product after a while of it being used especially is it is used outdoors which users of the product might.

Advantages	Disadvantages
• *Good surface stability* • *High impact resistant* • *Good strength to weight ratio*	• *The surface can be easily peeled off* • *Exposed edges (can be easily covered)* • *Stains easily*

Oakwood

Advantages	Disadvantages
• It is hard • Has a good finishing • Nice and distinct look	• Easily stained • It is expensive • It is hygroscopic



Why use oak wood:

Oakwood is hard meaning its surface won't get scratched easily. It is also tight grained which helps with getting a good final finish. Because of Oakwood's wavy grain it has a nice and distinct look which is both unique and aesthetically pleasing thus leading to more client being attracted to the product. Oakwood is also resistant to warping meaning it won't get bent or damaged easily due to the exposure of heat which could easily happen if the product is used outdoors.

Why not use oak wood:

Oak wood can get stained easily which will ruin the aesthetics of the product quickly and after a while of it being used will make the product it will look unappealing. Oakwood is also relatively expensive and will not help me in maintain a good price. Oakwood is also a natural timber meaning it is hygroscopic (absorbs water easily), this is very bad because the product deals with water, thus, spillages are bound to occur and because it easily absorbs water that would short circuit the electronic components inside the enclosure if it is made out of oak wood.

Chipboard

Why use chipboard:
Chipboard is an inexpensive option for material which makes it very good as I can focus more of my budget on the electronic components rather than the material. Chipboard also has a lot of options for finishes which could make the product look aesthetically appealing.

Why not use chipboard:
A major problem with chipboard is it has extremely bad water resistance, the material soaks water a lot meaning it is immediately not a viable choice for my product as if any spillage occurs the electronic components inside the enclosure would get short circuit. It is also prone to splitting and cracking easily and if I'm going to use nails for fitting, the grains are most likely going to split especially if I'm driving nails near the edge of the board. It also doesn't cut very well and leaves rough edges when the material is cut. Another problem with chipboard is that if adhesives aren't applied well and the joint pieces have to be removed the adhesive would pull out large pieces of the material. Chipboard is also a particleboard meaning it is very weak and can't withstand much pressure and even though it is a pretty cheap material the fact that it can crack easily would lead to a lot wasted material which could lead to a major increase in price.

Advantages	Disadvantages
• *Inexpensive* • *Lots of finishing options*	• *Poor water resistance* • *It is prone to splitting and cracking* • *Weak*

Health and safety

Brief: *abiding by all the health and safety rules and wearing all the necessary safety equipment is very important when working in a workshop environment as a lot of the tools could cause serious injuries and the machine in the workshop could even lead to fatal ones and by following all the simple workshop instruction I could make sure that I am safe from potential hazards.*

Workshop rules

Never use the workshop alone, at least have one person with you

Use tools and machines only for their intended purpose

Do not do something you are not sure you are capable of

Place any broken tools in a safe location

Always have a clean work space around the entire workshop

Be in a ventilated area when using toxic adhesives

Keep walking areas clear for anyone to pass by easily

Know the emergency button location for all the machines

Never run in the workshop

Always wear your personal protective equipment when working

Safety equipment

Caps: *Caps will protect my head from sharp items falling from above such as bits of materials being launched from machines or nails and screws that are placed on a high location like a cupboard*

Overalls: *Overalls are outfits that are meant to get dirty so I don't have to worry about any dangerous chemicals getting on them, I should also make sure that my sleeves are up as they could get caught on a machine*

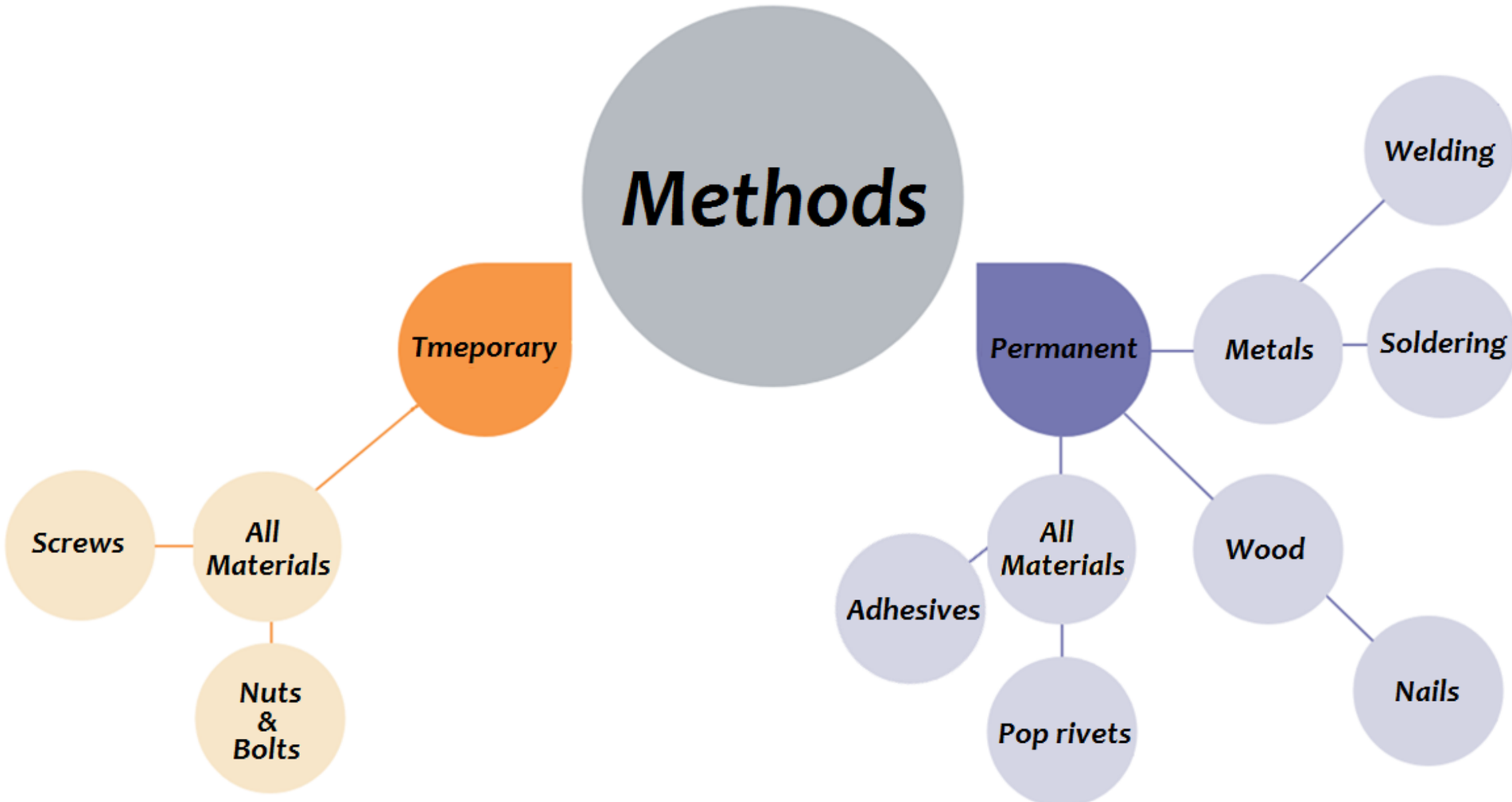
Safety goggles: *Safety goggles will protect my eyes from any little bits of material that could get launched, this is could happen especially when working witch machines*

Safety boots: *Safety boots are going to be a necessity as there could be dangerous tools on the floor that I could step on by mistake such as nails or screws or even sharp parts from materials.*

Fume mask: *wearing a fume mask would protect me from any toxic fumes when working with toxic adhesives, and also if I'm going to use spray paint as my method of finishing technique.*

Fixings and fittings

Brief: *All types of materials have different methods of fixings and fittings. I'm going to research the most-used permanent and temporary methods that would suit my product the best.*



Nails

Brief: *Nails are sharp pointed fasteners that are made out of metal and are used for* ***woods****. They are hit into the material (usually by a hammer) to fix pieces of wood in place and are used as a* ***permanent*** *fixing solution.*

Different types of nails:

Round wire nail: *These nails are usually used for carpentry when the aesthetics aren't important but strength is. It is likely that they split the grain of wood when they are hit on it so if I do use I should take care not to use them on the edges and not to hit them very hard into the wood.*

Oval wire nail: *These nails are mostly used for timber joinery. The way their head is shaped means they can be hammered to be just under the surface of the wood. They're also less likely to cause the grains of wood to split.*

Lost head nails: *These nails are ideal when you have to tuck away the head of the nail or when using normal round nails could cause the grains of the wood to split. They are usually used for door jabs, floor boards and skirting boards. These nails are good when the aesthetics of the material is important.*

Panel pin nail: *These nails are used on fragile materials as they are less likely to split the piece of wood that is being worked on. There are used for cabinet making and veneers.*

Clout nails: *These are short nails with big and flat heads. They are used to nail felts and tiles to roofs and are made out of galvanized steel (usually mild steel) so they can handle the weather better. Making them for product that are used outdoors.*

Advantages	Disadvantages
• Inexpensive • They're quick to use • You can easily put them in • It's hard to extract them	• Will split a piece of wood of it is nailed on the edge • If a lot of nails are put in one line of grain it will split • Removing nails could cause damage to the appearance of the material

Conclusion: *If I'm going to use nails as my method of fixing and fitting my product I am going to use lost head nails as it is less likely that the piece of timber will split and I don't want for the nails to be showing as nails can sometimes ruin the aesthetics of the material.*

Screws

Brief: *Screws are small pins that are threaded with a slotted head that can be turned using a screw driver. They are made out of metal and a type of fasteners that can be used for a**ll types of materials** and are used as a **temporary** way of fixing and fitting.*

Different types of screws:

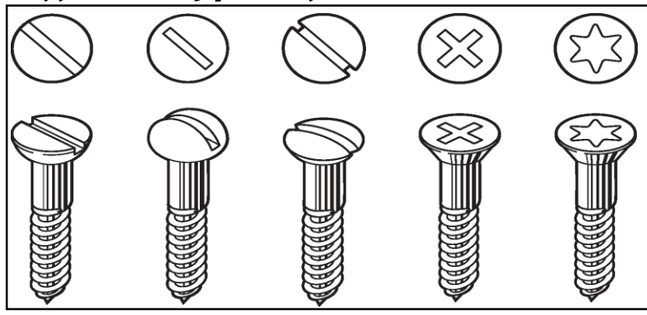
Countersunk screws: *These screws are called countersunk as they lay flat on the surface their put in like they are "sinking". They are used for when you want to cover them up using a screw cap or a piece of the material making them good for maintaining the aesthetics and are usually used for mounting door hinges or mounting cabinets.*

Round head screws: *These screws have a curved head that is flat at the bottom. They are used when the product requires good aesthetics and are used mostly used for machinery and sometimes in electrical outlets and hand rails.*

Raised head screws: *Raised head screws are a mixture between round and countersunk screws as they are not curved as round head screws but neither are they as flat as flat head screws. They're usually used when countersunk screws are needed but you want a better looking screw.*

Advantages	Disadvantages
• They are Strong • They are easy to use • Can be easily replaced/removed	• They can tear through a material if it is weak

Different types of screw drives:



Philips, Slotted, Hex, Robertson and Trox screw drives:

All these screw drives are used by a lot of people but arguably the most common one is the Philips screw drive so if I'm going to use screws I should use it as I would be sure that most people would have a screwdriver that can fit that slot.

Conclusion: *If I am going to use screws as my temporary method of fixings and fittings I'm going to use raised head screws as I want something that is decently strong and in the same time looks aesthetically pleasing. For the slot/drive I'm going to use the Philips drive as it is the most common one used.*

Pop rivets

Brief: *Rivets are a type of fasteners that consist of a hollow head with a cylindrical steel pin going through the middle of the rivet. They can be used on* ***all type of materials*** *when you have access to one side. They are a* ***permanent*** *method of fixing and fitting materials together. To use them you need to have a hole going through both sides of the material and you insert them using a pop rivet gun, the rivet is inserted into the gun and the handle is pushed, when the handle of the gun is pushed, the steel pin is pulled from the rivet until it deforms to hold the materials and the pin snaps.*

Different types of rivets:

Countersunk head rivet: *These rivets have a flat surface that tapers towards the screw body and are used when a round head is going to interfere in the product. They usually used in sliding tracks and rollers*

Flat head rivet: *These rivets have a cylindrical head and have a better and more aesthetically appealing look compared to most of the other rivets. They are used in flat metal sheets.*

Snap head rivets: *These rivets have a round head and are used when the product or structure needs strength thus they are usually used in manufacturing or construction and are not necessary for my product.*

Bifurcated rivets: *These rivets are split in the middle (they are also known as split rivets) making a sort of two legged shape. When the rivet is installed those legs fold back to join the 2 pieces together. They're used on soft material and are usually used for leather items such as clothing and carrying cases and they require special tools to be used.*

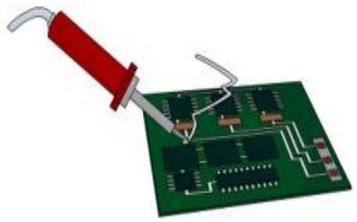
Advantages	Disadvantages
• They are quick to insert • They are inexpensive • They are traditional	• They don't look aesthetically appealing

Conclusion: *If I'm going to use pop rivets as my method for permanently fixing and fitting pieces in my product I'm going to use flat head rivets as I think they look the best and are strong thus I think they would suit my product the best.*

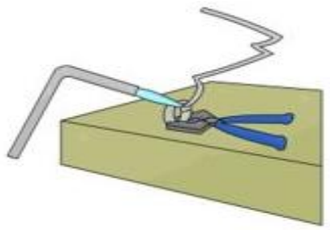
Soldering

Brief: *Soldering is a method for* ***permanently*** *joining pieces of* ***metal****. It is done by heating a solder (a piece of material that has a low melting point) by a soldering iron or a blow torch and then letting it cool down on the pieces you are trying to join.*

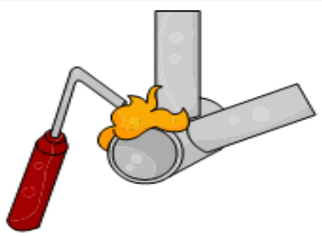
Different types of soldering methods:



Soft soldering: *This type of soldering is mostly used to join electronic components in a circuit board but it can also be used for small items. The solder that is used for soft soldering consist of tin and zinc and is melted using a soldering iron at around 180 to 360 degrees Celsius and usually takes 10 seconds to cool down.*



Silver soldering: *This solder consist of zinc, copper and silver and has a higher melting point than soft soldering at around 620 to 900 degrees Celsius and it is melted using a soldering torch and cools off after 10 seconds as well. This type of soldering is only used on jewelry making it not viable for my product.*



Brazing: *This type of soldering is used to join large pieces of metals together and is mostly used on mild steel as it has a high melting point. The solder that is used for brazing consist of copper and zinc (Brass) and is melted using a blow torch. It has a melting point of around 900 to 940 degrees Celsius. The surface of the material being brazed has to be very smooth and flux has to be applied to prevent oxidization.*

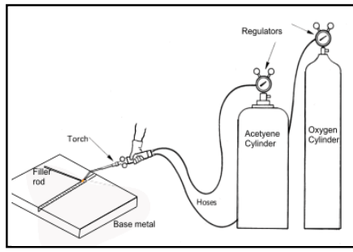
Advantages	Disadvantages
• Requires low power • Thin materials can be joined • Easy to use	• Don't look aesthetically pleasing • Fluxes can be toxic • Risk of fire

Conclusion: *If I'm going to use soldering as my method of permanently joining pieces in my product I'm going to use soft soldering because it is the only one viable for my product as silver soldering is used for jewelry and brazing is used on large pieces of metal while soft soldering can be used on small pieces of metal.*

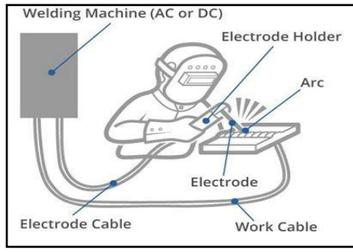
Welding

Brief: *Welding is a* ***permanent*** *fixing method and can be used on* ***metals*** *only. Welding is the process of melting two pieces of metal or the base metal and a filament and making them fuse into each other, this is usually done using a blow torch at really high temperatures.*

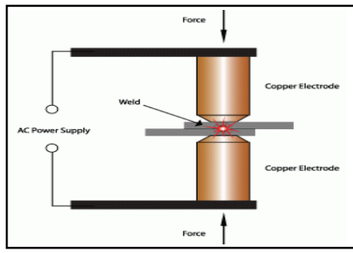
Different types of welding methods:



Oxy-acetylene welding: *This type of welding (also called gas welding) is done by mixing oxygen and acetylene in a blowpipe or a hand held torch so they can combust. The flame caused by this reaction can be about 3200 degrees Celsius. This type of welding can be used on most metals.*



Arc welding: *This type of welding is done by supplying enough electricity to a metal rod (called an electrode) to give out enough heat to melt metal then touching the base material with it. This causes an electric arc between the electrode and the two pieces which causes them to fuse. This type of welding is used when the quality of the weld is really important such as bicycles or aircrafts.*



Spot welding: *Spot welding is done by having both pieces of material on top of each other and applying force to them using 2 copper electrodes that are supplied by electricity to get the heat from the electric current. This type welding is used for sheet metal as thick material is difficult to spot weld.*

Advantages	Disadvantages
• Welded joints are strong • Reasonable cost	• Welded joints are brittle • Difficult to detect problems such as incomplete penetration of welding • Risk of fire

Conclusion: *If I'm going to use welding as my method of permanently joining I will use oxy-acetylene welding as it can be used on almost all type of materials and spot welding can mostly be used on sheet metals only while arc welding requires a lot of training compared to oxy-acetylene welding.*

Nuts, bolts, and washers

Brief: *Nuts and bolts are a type of fasteners that are used for **any type of material** as a **temporary** method of fixings and fitting. The nut is a circular cylinder with a threaded hole and the bolt is a threaded cylindrical piece of metal with a head at the end. These two are always used to together to join the pieces of material and **washers** are used with the nut and bolt to keep them from loosening, washers could also be used to distribute the pressure to a larger area to prevent the material from cracking.*

Different types of nuts:

Wing nuts: *These nuts (also known as butterfly nuts) have two tabs on the sides that are allow for easy tightening or loosening by hand.*

Nyloc nuts: *These nuts are made out of a round part that sits on top of a hexagonal nut. These nuts are very difficult to loosen even under intense vibration.*

Flange nuts: *These nuts are a hexagonal nut with a flange on one end that works as an in integrated washer. This helps distribute the pressure of the nut and bolt from the part that they are on to prevent any damage they could cause to the surface of the material they are used on.*

Different types of washers:

Plain washers: *These are the most common type of washers (they are also called flat washers). They do not having a locking mechanism which means the nut can be easily loosened. They are used mainly used to protect the surface the nut and bolt are being used on from cracking.*

Lock washers: *These washers are round and have an opening with one end being higher than the other, they are used to prevent nuts from being loosened by getting unscrewed and they have to be tightened to a certain torque that is lower than other washers.*

Spring washers: *These washers (also called coiled washers) are used to prevent nuts from coming loose due to vibration unlike the lock washer which are used to prevent loosening from being unscrewed.*

Advantages	Disadvantages
• Easy to install • Strong bolts are way stronger than rivets • Can be easily replaced	• They don't look good • Break easily under stress

Conclusion: *If I'm going to use nuts and bolts as my main method of temporarily fixing my product I'm going to use a hexagonal bolt as the carriage bolt can be very difficult to remove once it rusts and I don't have a need for a penta-head bolt. For the nut I'm going to use a wing nut as I want for the consumer to be able to easily open the enclosure if they wanted to. For the washers I'm going to use a plain washer as I my product doesn't need a spring washer because it won't be vibrating and it won't need a lock washer because I want for the product to be easily accessed.*

Adhesives

Brief: *Adhesives, also known as glue or paste can usually be used on **all types of materials** but that differs from one adhesive to another. They are a form on **permanent** joining method. Adhesives are usually made from polymers and can create really strong joints. Applying adhesives is done differently depending on what type of adhesive is used but it is usually done by adding it on both surfaces of the materials you're trying to join and leaving them on top of each and then apply some pressure, then the adhesive will later dry out and form the joint*

Different types of adhesives:

PVA: *PVA (stands for polyvinyl acetate) is a type of adhesive that is used for joining wood. It comes already mixed and it is easy to use. It is not good for any wet conditions although it does have a waterproof version and it dries fairly quickly as it takes only around 2-4 hours.*

Synthetic resin: *Cascamite or also known as synthetic resin is a powder based adhesive that has to be mixed and it used for wood. It is stronger than PVA and is used for boats meaning it is waterproof. It can be used as a gap or chip filler and usually takes 1-2 hours to dry.*

Contact adhesive: *This type of adhesive is used on all types of materials and can be used to join two dissimilar materials. After applying the adhesive on the materials they will stick immediately and they have to be lined up perfectly as it can't be adjusted and takes around 15 minutes for it to dry. This type of adhesive should be used in a well-ventilated area because of the fumes it gives off.*

Epoxy resin adhesive: *This adhesive is widely used and can be used on all types of materials and it comes in two packs, the adhesive itself and the catalyst/hardener, both of them have to be mixed together when they are being applied to the surfaces. Although this adhesive is expensive it creates a very strong joint and takes 24 hours for the joint to fully dry. This type of adhesive is also waterproof*

Tensol cement: *Tensol cement (also called tensol 12) is used to join acrylic only. This type of adhesive require a large surface to work well. The surfaces of the acrylic must be in contact before the adhesive is applied as it is put on the sides and then it dissolves the acrylic and causes the pieces to join. The adhesive dries in 3 hours and the pieces shouldn't be machined for at least 24 hours. To use this adhesive you would need to be in a ventilated area as the fumes from it and the dissolved acrylic are bad for your health.*

Advantages	Disadvantages
• They form really strong joints • Most of them are waterproof • Can bond well with different types of surfaces	• Difficult or can't be disassembled • Requires careful preparation

Conclusion: *When it comes to the type of adhesive I can't specify which one I am going to use as it really depends on the type of material I am working with although from all the adhesives I prefer Epoxy resin adhesive as it creates a really strong joint and it is waterproof.*

Tools and machines

Hand tools

File: *I'm going to use a file to clear any sharp edges from my enclosure, create curves and smooth out rough sides.*

Steel rule: *A steel rule is going to be necessary for taking measurement when cutting the material.*

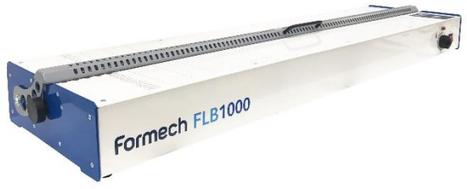
Screwdriver: *I'm going to need a screwdriver if I will use screws for fixing and fitting the enclosure.*

Wire stripper: *I am going to use a wire stripper to strip and cut the wires when making my circuit*

Scriber: *I will use a scriber to mark the locations I want to cut my materials in as it is more accurate than a pen.*

Machine tools

Pillar drill:
I am going to use a pillar drill as if I use screws or I want to use rivets I will need to drill a hole through my material, it is also more powerful and can give me better results compared to a hand drill.

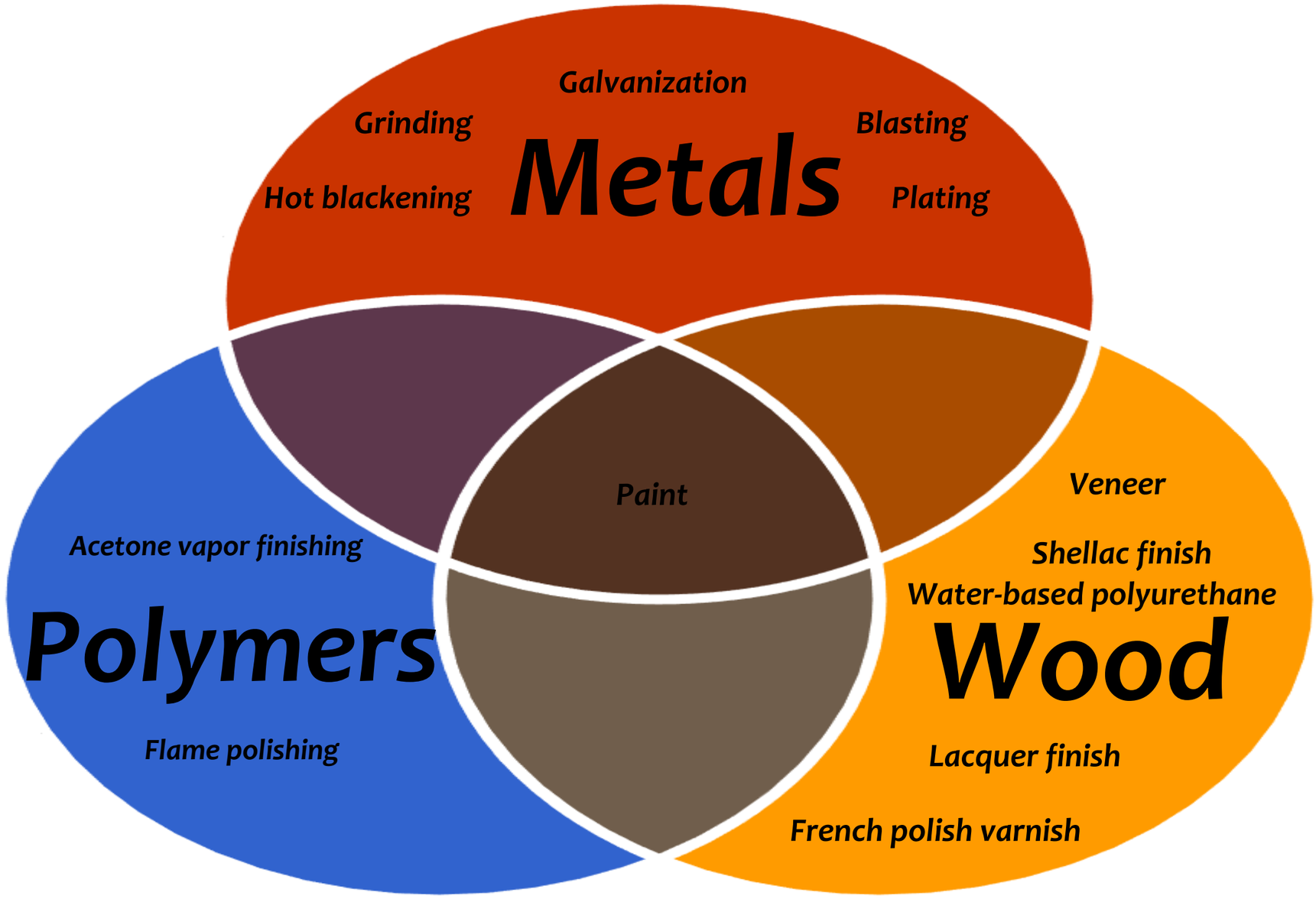


Line bender: *The line bender is going to be used if I am going to work with plastics for my enclosure. It will allow me to shape my enclosure easily without much trouble.*

Band saw:
I am going to use the band saw when cutting the different pieces for my enclosure as using the band saw would be way more accurate and less time consuming than using a hack saw.

Finishing techniques

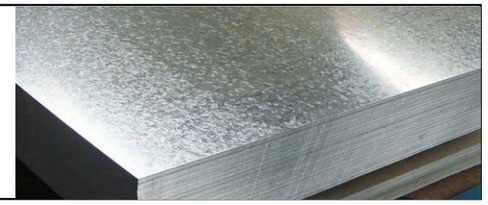
Brief: *This step is going to be the final step when making my enclosure in which I'm going to add any necessary addition that will either improve in the quality and durability of the product or the aesthetics.*



Metals

Galvanization:

Galvanization is the process of coating of either steel or iron with molten zinc which gives the material a corrosion resistant coating, this is very helpful as my project might be used outdoors however this coating has a noticeable crystal like pattern that is shiny and yellowish and doesn't look very pleasing, this method is also way simpler than other method that give a corrosion resistant coating.



Hot blackening:

This method is done by a hot blackening machine which spreads a thin layer of black oxide onto the material, this gives the material a matte black look which is aesthetically pleasing also gives the material high abrasion resistance, although when the material is touched it could leave black smudges which will be an annoyance to the consumer.

Electroplating:

Electroplating is covering the base piece of material with a thin layer from another one, this method of finishing is done by passing an electrical DC charge through a solution called electrolyte, the positive charge is passed through the plating material and the negative is passed through the base metal which then causes molecules from the plating material to be attracted to the base metal, this gives the base metal the same properties as the ones that the plating material has which can be very useful although it also takes away the aesthetic properties of the base metal, this type of finishing is also very expensive.

Blasting:

This method is done by launching a stream of either sand, metal pellets or steel shots into the material at high speeds, this gives the material a clean texture and a smooth surface, this type of finishing is usually done on soft metals which I might not be able to use if I apply it on a material with a hard surface.

Grinding:

This method is done by using a grinding machine. The grinding wheel of the machine is made out of material containing small particles of grit, the material is put on top of the wheel as it is turning, and this gives the material a smooth and nice finish however it requires a skilled worker to be able to handle the machine well.

Conclusion: *If I am going to use a metal for my enclosure I will finish by galvanizing it as I feel it is the easiest way that will give me the result I need, it gives the material a corrosion-resistant coating which I will need for my product and for the bad look of the coating I can just paint over it. Electroplating is very expensive which could lead to me having to resort to cheap electronic components and I don't want to do that. Blasting could be a great option if I use a hard surfaced material although I still need my material to be corrosion resistant. Grinding could be good but I would not use unless it is necessary to avoid damaging the material*

Woods

Veneer:

This method is done by cutting a thin layer of another piece of wood and joining it on top of the material you are working with, the piece of veneer is usually glued on the material using an adhesive. It gives the piece of wood you are using the aesthetic properties of the wood used for the veneer and It is also way cheaper to add a thin layer of veneer made from good timber on a piece of plywood than to work with a full block of expensive wood.

Shellac finish:

This finish is made of resin that is made by insects, this finishing makes the wood look warm and rich which is aesthetically pleasing, it is also water resistant which is very important for my product. It is also scratch resistant and is more durable than lacquer finish, this type of finishing can also be easily applied using a rag or a brush, this type of finishing also dries up fairly quickly.

Lacquer finish:

Lacquer is made out of shellac that is dissolved in alcohol, this type of finishing g improves on the quality of the grains. The color that the lacquer gives can also be changed to give the wood a darker or lighter look. It also dries fairly quickly and gives the material a hard coating that protects it from scratches, it is also water resistant and pretty cheap. A lacquer finish give options compared to varnish as it has a bigger range of gloss.

French polish varnish:

This type of finish is an oil based varnish, the polish is made by dissolving thin layers of shellac in denatured alcohol and depending on the grade of the shellac it could change the color of the of the polish/finish, it also gives a very high gloss. This type of finish is applied using a rubbing pad by applying very thin layers of the polish onto it, linseed oil is then dripped onto the rubbing pad to lubricate it. The major problem with this finishing is that if it gets in contact with water it gets water stains easily and since the product revolves around water, water spillages are likely to happen and that could ruin the aesthetics of the product.

Water-based polyurethane:

Water-based polyurethane (also known as a waterborne finish) is made up of acrylic and polyurethane that are put in water with glycol ether or any slow evaporating solvent. This type of finish gives the wood a lighter and a more milky color. It also preserves the natural look if it is used on hardwoods. This type of finish is also scratch and water resistant which would be really beneficial for my product.

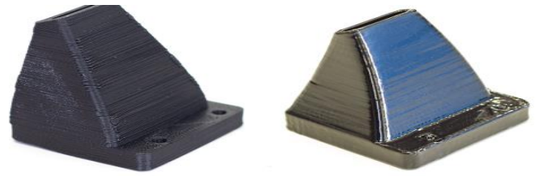
Conclusion: *If I'm going to use wood as my material for the enclosure I'm going to finish the enclosure with a lacquer finish as it is water-resistant and I would need that for my product, this means I can't use a French polish finish because it gets water stains easily. A lacquer finish is also scratch-resistant which means even if the product gets hit on accident it won't get scratched easily and ruin the aesthetics of the enclosure. I would prefer a dark color for the enclosure meaning I'm not going to use a water-based polyurethane finish as that is going to give the material a more milky/light color while a lacquer finish will give it a darker color. Varnish is also a good choice although it is more expensive than a lacquer finish, I also don't want to use veneer as it can come off after a certain amount of time of the product being used which would ruin the material's aesthetics.*

Polymers

Brief: *Most plastics come fully finished in the process of them being manufactured and molded although there are still some finishes that can be used to enhance the aesthetics and the properties of different types of polymers.*

Acetone vapor finishing:

This method is done by using acetone and is usually used for 3D printing but it is not limited to that. It is done by putting acetone inside a container or a can and have the material hang on top of the acetone, then you boil the acetone in the can, the vapor from the acetone causes the material to have a very smooth and aesthetically pleasing finish although this method is very dangerous as the vapor of acetone is very toxic and if the acetone can't escape from the can it will explode.

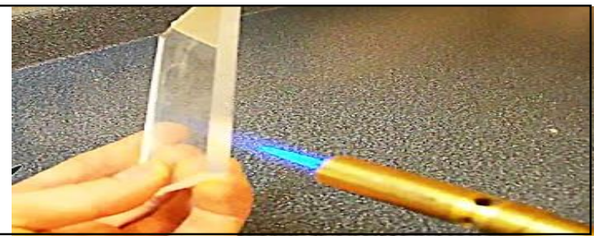


Spray painting:

Spray painting is a simple method that can be used on all types of materials although it more useful on plastics as some types of plastic are not resistant to UV rays and simple paint can act as a barrier between the material and the UV rays coming from the sun. Spray painting also gives me more options when it comes to picking the color of the enclosure.

Flame polishing:

This method is done by applying heat to the material usually by a flame until the surface of the material shortly melts, this allows for the surface tension of the material to smoothen it out and to remove any marks or scratches. This method requires a lot of skill and is also very risky as it could cause discoloring or for the material to deform.



Conclusion: *If I'm going to use a polymer as my material for the enclosure I'm going to finish it by spray painting the enclosure as acetone vapor is a really dangerous method that requires a lot of training to use. Flame polishing while it may prove to be very useful although since it also require quite a bit of skill to use it is also a really risky method that can ruin the material. Spray painting is the cheapest method that can enhance the aesthetics of the enclosure and give me a lot of freedom in choosing what color I want it to be and can also acts as a UV resistant barrier which would be very useful as some polymers degrade under UV rays.*

Specifications

Brief: *For the specifications I am going to use all the research I did to know what exactly I want for my product, I am going to use* ***ACCESS FM*** *to determine what are the main point I am going to focus on to know how the end result of my product should be.*

What is ACCESS FM?

Aesthetics

How the product is going to look when it comes to the color and type of look (Modern, vibrant etc.), the aesthetics are really important to attract potential clients to the product and to preserve the beauty of the environment.

Cost

How much would it cost to make the product, it is best to keep the price low as it would be able to attract more potential clients to the product as a high price point could deter some customer from buying the product.

Client

Who are the people that are most likely going to buy and use my product, knowing the clients for my product would help know how I can target them and make a product that would attract them.

Environment

Where is the product going to be placed and also would the product have any effects on the environment and would the environment effect the product, it is important to know the environment to make sure the product is suitable for it

Size

The ideal size for the enclosure of the product, it is necessary to know this so I know what enclosure would suit my product best and so I don't waste any material making an enclosures that won't fit all the electronic components.

Safety

Any potential hazards that the product could have and how I can prevent them, I need to know any safety problems as it is very bad product design if it harms the user in any way.

Function

How the product is going to work and how is it going to get its power, and also what electronic components will the product need, I should know this to know any necessities for the final design of the enclosure and circuit.

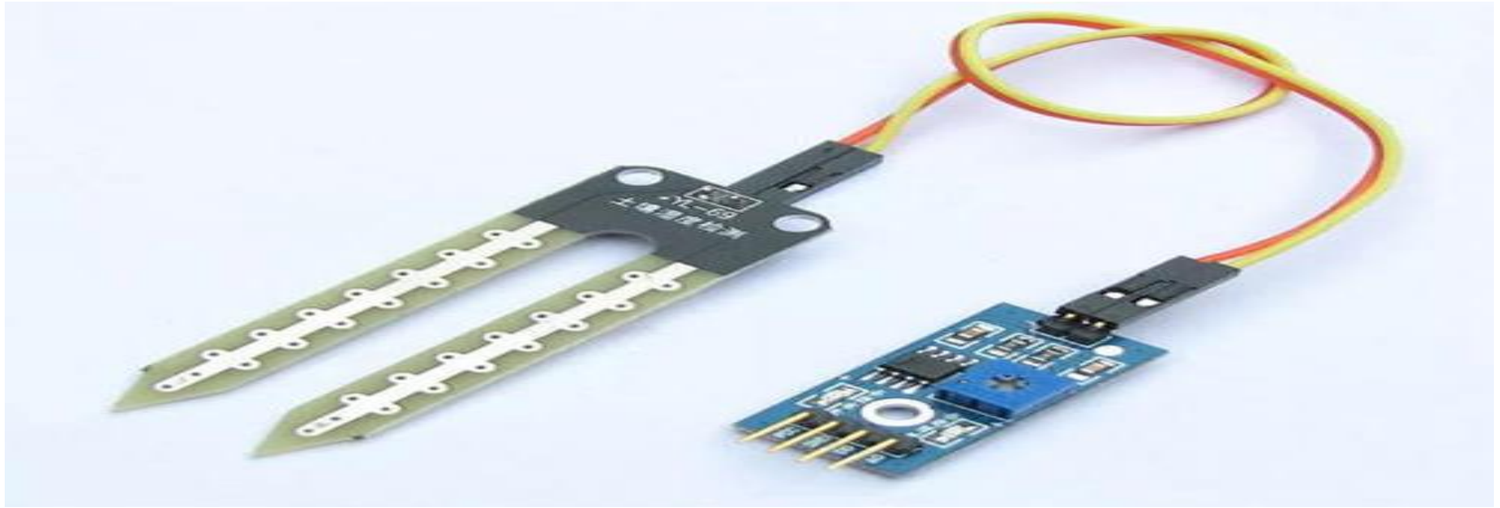
Material

What is the material of choice and joining and finishing of said material. The material I'm going to use depends on its properties and if they suit my needs for the product, I need to know this as making the enclosure out of a bad material could ruin the product.

Function

Brief: *I have two different ideas when it comes to how the product might function, a timer or a moisture sensor based water dripper, I am going to compare both of them and see which one would be better for me when manufacturing the product and which will result in better life quality for the consumer.*

Moisture sensor: *The moisture sensor would be placed in the soil of the plant and whenever it detects less than 40% moisture in the soil it will send a signal to the Arduino that will then send a signal to the relay and activate the water pump*



Advantages	Disadvantages
• Easier for the consumer to set up • More accurate • Easier to program	• Messy • More prone to breaking

Consumer perspective:

Using a moisture sensor based water dripper will be easier for the consumer as they won't have to do anything other than put the sensor in the soil, it will also be more accurate than using a timer based system and as it will drip water exactly whenever the plant needs watering and the consumer won't need to know the timing for when the product has to drip the water if they were using a timer based water dripper, on the other hand, using a moisture sensor would mean there would be more wires coming out of the enclosure of the product which might affect the aesthetics of the product and the wire could get damaged if not taken care of

Manufacturing perspective:

When making the product if I am going to use a moisture based sensor I will face the challenge of trying to hide the wires and trying to make look as neat as possible, I will also need to use very good sheathing so I am sure that the wires are waterproof and also safe from any damage, using a moisture sensor will also be way easier when it comes to coding the product as the code for the moisture sensor would be easier to program than an LCD shield for the timer based dripper.

Timer: *The client will have to set the timer using the LCD shield. When the time runs out the LCD shield will send a signal to the Arduino which will activate the water pump. After that, the timer will reset to what the client has set earlier and it will keep looping until it is stopped manually.*

Advantages	Disadvantages
• *Looks better* • *More options* • *Easier to cover wires*	• *The LCD screen is not water resistant* • *Consumers have to time when the plant needs watering* • *Harder and takes longer to program*

Consumer perspective:

I feel like using a timer based water dripper would seem more professional to the consumer and it would look neater as unlike the moisture sensor the wires would all be covered up, a timer based dripper would also give more options and freedom to the consumer although none of those setting would be necessary if the product uses a moisture sensor as a moisture sensor will automatically know whenever the plant needs watering unlike the timer were the consumer would need to know whenever the plant would need watering and they would have to set it up themselves, another major problem with using a timer based water dripper is that an LCD screen is not waterproof, even though they come with a water proof cover it wouldn't help if it gets too wet and since my product involves the flow of water from one place to another the probability of spillage is high.

Manufacturing perspective:

When making the product if I use a timer based dripper it would be way easier for me to cover up the wires as all of them would be inside the enclosure and no wires will be showing, a problem with using a timer based water dripper is that it would be way harder to program compared to a moisture sensor as I would have to program the buttons for the LCD keypad shield as well which would be challenging and time consuming.

Evaluation: *I am going to use a moisture sensor for a couple of reasons, it would be easier and less time consuming while still resulting in the same or even better result and because it would be more accurate and easier to use than a timer based dripper unless the consumer knows how to judge if the plant needs watering which most consumers might not, and for the wires if I use a water proof and cut resistant sheathing the exposed wires won't cause any problems.*

How will the product get powered?

The product is going to use a 12V power supply that is going to be connected to an electrical socket, since the product is going to be stationary most of the time when it is watering the plant I don't have to worry about it being very easily portable.

Components list:

Arduino UNO:

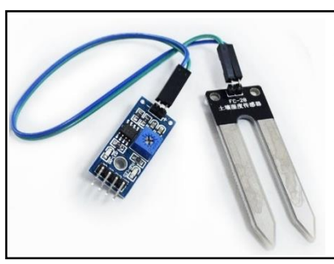
The Arduino UNO is a microcontroller and it is going to be connected to the circuit. I am going to program it to automate the function of the product.

12V power supply:

The 12V power supply is going to be connected to an electrical socket and it is the components that is going to give power to the Arduino and the entire circuit.

12V water pump:

I am going to use a 12V water pump as it is going to be ideal for the product because it has enough power to take the water from the source to the plant for a good distance.

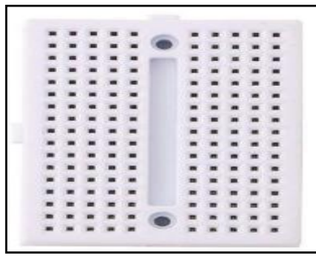


Soil moisture sensor:

The soil moisture sensor is going to be put into the soil of the plant that is being watered and whenever it detects that the soil is dry it is going to send a signal to the Arduino.

Relay:

The relay is used as switch, whenever the moisture sensor detects that the plant needs watering it is going to send the needed voltage to the water pump for it to work.



Mini solderless breadboard:

I am only going to need a mini breadboard as I won't have to connect a lot of wires to it, it is the components that is going to send the electricity from the Arduino to the relay and the sensor module.

How will the electronic components be held inside the enclosure?

All the electronic components would be joined either to the bottom or to the side of the enclosure from the inside using epoxy resin adhesive as it won't affect them and would results in a strong and reliable joint.

Materials

Brief: *I'm going to compare the different materials by comparing the needed properties for my product that are going to help the final result for the enclosure and the overall quality of the product.*

Material properties	Stainless steel	Aluminum	Brass	Acrylic	PVC	ABS	Plywood	Oakwood	Chipboard
Strength	Very strong (5/5)	Strong (4/5)	Decent (3/5)	Decent (3/5)	Strong (4/5)	Strong (4/5)	Very strong (5/5)	Very strong (5/5)	Weak (2/5)
Hardness	Scratches easily (3/5)	Soft (2/5)	Soft (2/5)	Easily scratched (3/5)	Dents and scratches easily (2/5)	Scratches easily (3/5)	Easily scratched (3/5)	Hard (4/5)	Very soft (1/5)
Toughness	Decent (3/5)	Decent (3/5)	Brittle (2/5)	Brittle (2/5)	Brittle (2/5)	Tough (4/5)	Depends on adhesive and veneer (3/5)	Brittle grain (2/5)	Decent (3/5)
Durability	Very durable (5/5)	Durable (4/5)	Durable (4/5)	Durable (4/5)	Degrades in sunlight but still durable (4/5)	Degrades in UV rays but has an easy solution (4/5)	Extremely durable (5/5)	Durable (4/5)	Prone to cracking over time but durable overall (3/5)
Water resistance	Water-resistant(4/5)	Water-resistant (4/5)	Water-resistant (4/5)	Water-resistant (4/5)	Waterproof (5/5)	Water-resistant (4/5)	Absorbs water (1/5)	Water-resistant (4/5)	Soaks in a lot of water (0/5)
Weight	Very heavy (1/5)	Light (4/5)	Medium weight (3/5)	Light (4/5)	Extremely light (5/5)	Lightweight (4/5)	Medium weight (3/5)	Heavy (2/5)	Light for the thickness I'm going to need (4/5)
Ease of use	Difficult to work with (2/5)	Easy to work with (4/5)	Easy to work with (4/5)	Easy to work with (4/5)	Easy to work with (4/5)	Very easy to work with(5/5)	Easy to work with (4/5)	Easy to work with (4/5)	Easy to use (4/5)
Appearance	Aesthetically pleasing(4/5)	Looks decent (3/5)	Aesthetically pleasing (4/5)	Comes in many colors and looks aesthetically pleasing (4/5)	Looks decent (3/5)	Aesthetically pleasing (4/5)	Stains easily but is aesthetically pleasing overall (3/5)	Unique and aesthetically pleasing (5/5)	Has a variety of finishes that can make it look good (4/5)
Price	Very expensive (1/5)	Decent price (3/5)	Expensive (2/5)	Inexpensive (4/5)	Very expensive (1/5)	**Inexpensive** (4/5)	Depends on the grade of the wood (3/5)	Expensive (2/5)	Very cheap (5/5)
Total points	**26/45**	**30/45**	**26/45**	**32/45**	**30/45**	**36/45**	**30/45**	**32/45**	**26/45**

Material of choice

I'm going to use ABS as the material for my product as it is suits almost all of my needs for the product. ABS is also very easy to work with making it easier for me when making the enclosure of the product, it is also Strong and tough. It can scratch easily there are ways to prevent that from happening. It is also extremely durable. Even though ABS degrades when it is in contact with UV rays, paining over would be enough UV resistance for the material and should solve that problem, it is also lightweight and it is aesthetically pleasing. Lastly it is an inexpensive material, which means that I can focus my budget more on the electronic components that I'm going to use in the product rather than the material.

Finishing technique	Joining method
Spray paint: *I am going to use spray paint as my finishing technique as it gives the ABS a UV resistant coat that would prevent the enclosure form degrading as ABS has poor UV resistance and degrades under sunlight.*	***Adhesive:*** *I am going to use Epoxy resin adhesive for my permanent joint as it is strong and reliable* ***Screws:*** *I will use screws for my temporary joints as they won't ruin the aesthetics of the enclosure compared to nuts and bolts*

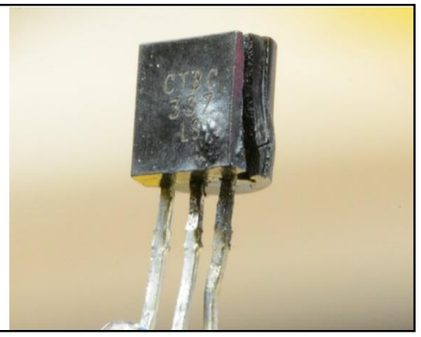
Safety

Brief: *I need for my product to be safe for the consumer which means I should know any potential hazards that could occur while the product is being used and also how I can prevent these problems from happening, safety should be a very important part of my product and I should take make sure that the product would not harm the consumer or has any safety issues.*

Exposed wires: *This occurs when the sheathing of the wire is cut and the metal part that conducts the electricity is exposed, this can cause harm to the user of the product as they can get shocked if they touch the exposed part of the wire*

How to prevent: *I can prevent this from happening by making sure that the wires are all inside the enclosure and that they are not showing, I can prevent that by using good quality sheathing for my wires so the consumer can't cut them by mistake.*

Overvoltage: *This happens when a component in the circuit gets an amount of voltage that exceeds its limit, it could cause for the component to blow up and potentially hurt the consumer*



How to prevent: *I have to make sure that the voltage that goes into the electronic components of my product doesn't exceed their maximum and I can do that by using the needed resistors and compatible power supply.*

Sharp edges: *Having sharp edges on the enclosure of my product could cut the consumers by accident if they touch the edges, this could get annoying for the consumer as they have to be careful whenever they pick up the product*

How to prevent: *I have to make sure that I get a good finish on my product so that all the edges are smoothed out and there is no chance that they could hurt someone, I can do that by roughly sanding the edges of the material*

Size and environment

Brief: *I am going to measure the size of the electronic components that are going to be inside the product so I can know the size of the enclosure and how much material I would need to get, after that I am going to check how the size of the product is going to suit the environment/location the product will be placed in and if the location could have any effects on the product or if the product could have negative effects on the environment*

Environment:

By knowing the environment I would know two main things, the ***maximum size*** *for the enclosure, and any effects the environment might have on the product.*

Environment and effects:

The plant is going to be placed on a dressing table, the environment around the product would not affect the function of it in any way nor will the product negatively affect the environment.

Maximum size:

I measured the size of the environment I am planning on putting the product on and the maximum size was ***500x220*** *and there was nothing that could block the product when it comes to the height, I am not going to use the entire size but it is good to know that I have a lot of room to work with although I still want to make the product as small and compact as I can.*

Size:

Size of components:

- *Arduino UNO: 70x55*
- *Power supply: 160x100*
- *Breadboard: 40x30*
- *Relay: 50x25*
- *Water pump: 55x35*

Minimum size:

I measured the different sizes of the electronic components except the moisture sensor module as I am going to joint it to the side of the enclosure so it wouldn't really effect the base size. The minimum size is ***185x170x40mm***

Conclusion:

I feel like a good size of the product should be a bit bigger than the minimum so the electronic components have some space between each other, I think an ideal size for the enclosure would be around ***190x185x50mm***

Client

Brief: *For the client I should know who the people that are going to be the consumers of the product are and how I can target them and be able to make a product that pleases them.*

Who are the potential clients of the product?

When it comes to the client I am mainly targeting people who are very busy and have potted plants that they can't take the time out of their busy day to water. Even though the product can be used by anyone from any age group as even kids might want something to help them water their plants if they forget to but mostly it is targeted at adults. The product is also non-gender specific as both males or females might like potted plants, another important point about knowing your potential clients is also knowing their likes and dislikes and for people that like plants they most likely would also be keen on protecting the environment to so having an environmentally friendly product that also won't harm their plants at all in the long run would attract more potential clients

User profile:

- ***Age:*** *Any age group but mainly teens and adults*
- ***Gender:*** *The product is not gender specific.*
- ***Likes/interests:*** *Plants and protecting the environment*
- ***Needs:*** *A device that can automatically and accurately water their plants*

How can I target the potential clients of the product?

Aesthetics:

I feel like the aesthetics is a big part in attracting the client and considering the age group a modern look would suit the product best.

Efficiency:

The product being efficient and functioning well is a must when it comes to attracting a client, because of that I should use electronic component that have a long life span that are not going to break easily.

Uniqueness:

A product being unique can attract client towards it and compared to other product on the market there aren't many that use a soil moisture sensor as their method of activating the water pump

Environmentally friendly:

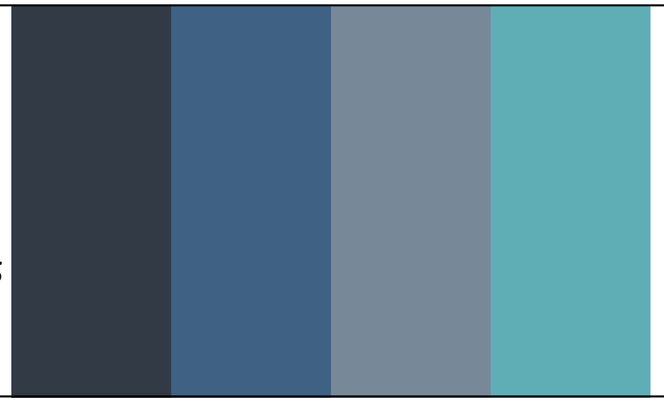
Moisture sensors are known to degrade after being used for a while and that could harm the client's plant and to prevent that from happening I am going to use a special type of moisture sensor that would prevent that from happening to ensure a long life-span for the product.

Aesthetics

Brief: *For the aesthetics I am going to see how I want the final product to look depending on what type of aesthetics I want it to be (Modern, beautiful, vibrant etc.) and also what type of finishing technique I would want to use on my enclosure.*

Type of aesthetics:

An important aspect when it comes to the aesthetics of the product is the color and I can determine what color I would want to use by knowing the color pallet, from the questionnaire that I did I found out that most people would like the product to be modern when it comes to the color meaning I should include colors like white, matte black, dark blue or grey for the final colors of the enclosure



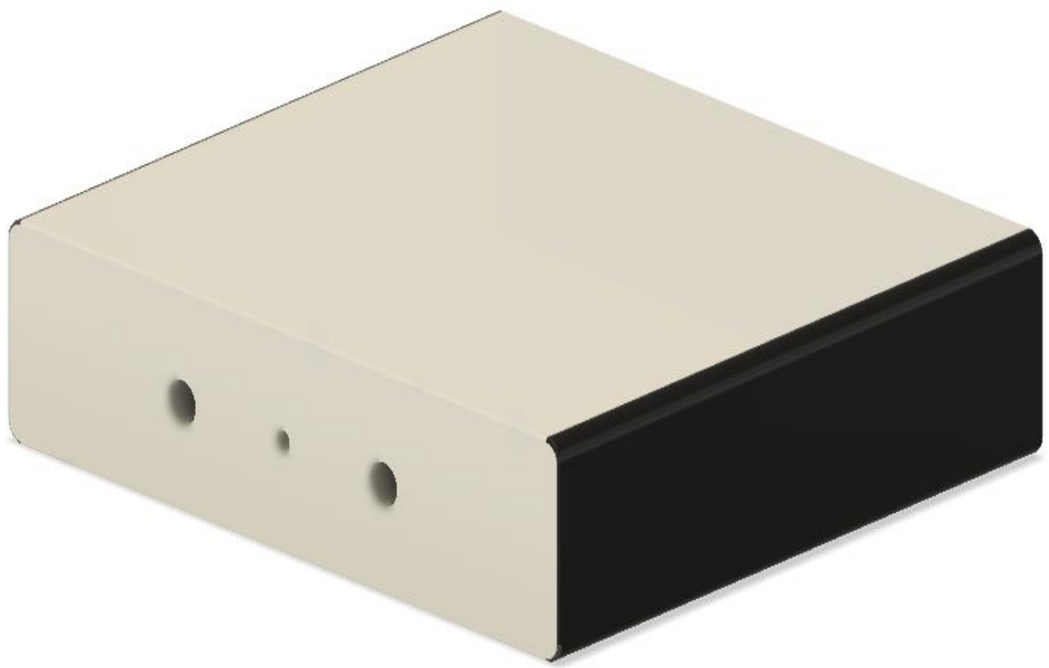
Finishing technique:

The finishing technique can make or break a product. I am going to use paint as the finishing technique as it gives a lot of options and freedom when it comes to color of the product and it is also easy to apply and allows me to easily have multiple colors on the product

Joining method:

Some method of joining can ruin the aesthetics of the product such as nuts and bolts as they look bulky and are not aesthetically pleasing so I am going to use screws for any temporary joints because they don't really interfere with the aesthetics of the product.

Example of the design:



Cost

Brief: *There are two different categories that are going to determine the price of the product, they are the cost of the* ***enclosure's production*** *(material, finishing, joining) and the cost of the* ***electronic components****. I have a very good budget so I don't really have to worry much about the total price of the product although I still don't want it to be too expensive.*

Electronic components

Arduino UNO: ***8.5 OMR***

12V power supply: ***9 OMR***

A mini breadboard: ***0.5 OMR***

Soil moisture sensor: ***0.5 OMR***

12V water pump: ***3 OMR***

Relay: ***0.5 OMR***

All needed wires: ***2 OMR***

Total: 24 OMR

Enclosure production

Material: ***7 OMR***

Spray cans: ***2.5 OMR***

Screws: ***0.2 OMR***

Epoxy resin adhesive: ***3 OMR***

Total: 10.7 OMR

Total: 34.7 OMR

How is the price compared to other existing products?

The price is higher than most other products although the uniqueness and advantages of the product will still be a selling point for any potential clients that are interested in it

Summary

A

Aesthetics:
For the aesthetics of my product I want it to be modern and I am going to use paint as my finishing technique, I want the product to have a mix of white and matte black for the color.

S

Safety:
I am going to take some safety precautions to make sure that my product is safe for the consumer and they are: making sure my electronic components don't get too much voltage, making sure I hide any wires that shouldn't be visible and use good sheeting and having smooth edges.

C

Cost:
Enclosure manufacturing cost: 10.7 omr

Electronic components cost: 24 omr

Total: 34.7 omr

S

Size:
Minimum size: 185x170x40mm

Maximum size: 500x220mm

Ideal size: 190x185x50mm

C

Client:
How can I attract any potential clients?
My product should have good aesthetics, a long life time and it since it is unique compared to other products on the market it would attract more clients.

F

Function:
The product is going to use a soil moisture sensor to detect whenever the plant needs watering, the product will use the following electronic components: (Arduino UNO,12V PSU, mini breadboard, moisture sensor, relay, 12 V water pump). The water pump is going to take the water from the soil to the plant, the product is going to get its power from a 12V power supply connected to an electrical socket.

E

Environment:
Location: *The product is going to be placed on a dressing table*

Environmental effects: *The environment of the product would not interfere with its function.*

M

Material:
Material of choice: *I am going to use ABS as it matches a lot of the qualities I want for the product*
Joining: *Epoxy resin adhesive for permanent joints and screws for temporary joints*
Finishing: *Paint, as it will prevent Abs from degrading under UV rays*

Designs

Brief: *There are two main points when it comes to each design, the necessities and the specification, the necessities are things that all of the proposed designs must have for the product to be functional while I am going to evaluate each one of them based on how well they follow my specifications for the product.*

Necessities and specification requirements

Necessities

Two 7mm holes: *These holes are going to be used for the input and output water tubes which are 8mm in diameter, the holes are going to be a bit smaller from the tubes as having smaller holes is useful to make sure to make sure that there aren't any gaps between the tube and the hole and the tube.*

One 3.5mm hole: *This hole is going to be used to pass the wires of the moisture sensor, the radius of the jumper wire that I am going to be using is around 3.2mm so I would the hole to be just a bit bigger so I can pass the wire through.*

One 6mm hole: *This hole is going to be on the back of the project and it is used for the charging cable.*

Big enough to hold all electronic components: *For the design to be functional it has to be big enough to be able to hold all the required electronic components.*

4.5mm holes: *These holes are for screws and they would be made using a countersink bit. The head would be 4.5mm and the shaft would be 3mm. The number of holes depends on the design*

Specifications

Aesthetics: *To look modern and aesthetically pleasing*

Cost: *For the amount of material used to not cost much*

Client: *For the design to be unique for it stand out to clients.*

Environment: *To be suitable for the environment the product is going to be placed in*

Safety: *to not have any sharp edges and not be very heavy as that could cause harm to consumer of the product*

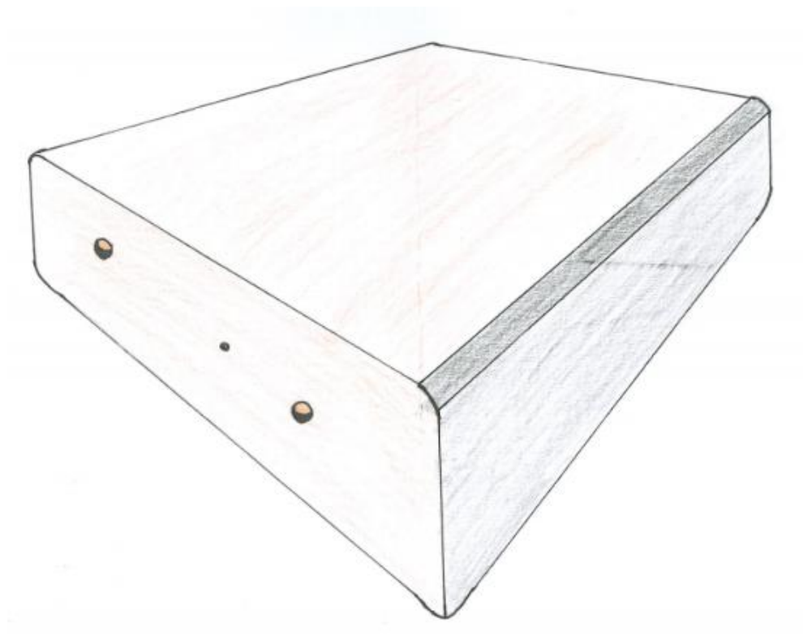
Size: *To not be very big while still having enough space to hold all the electronic components*

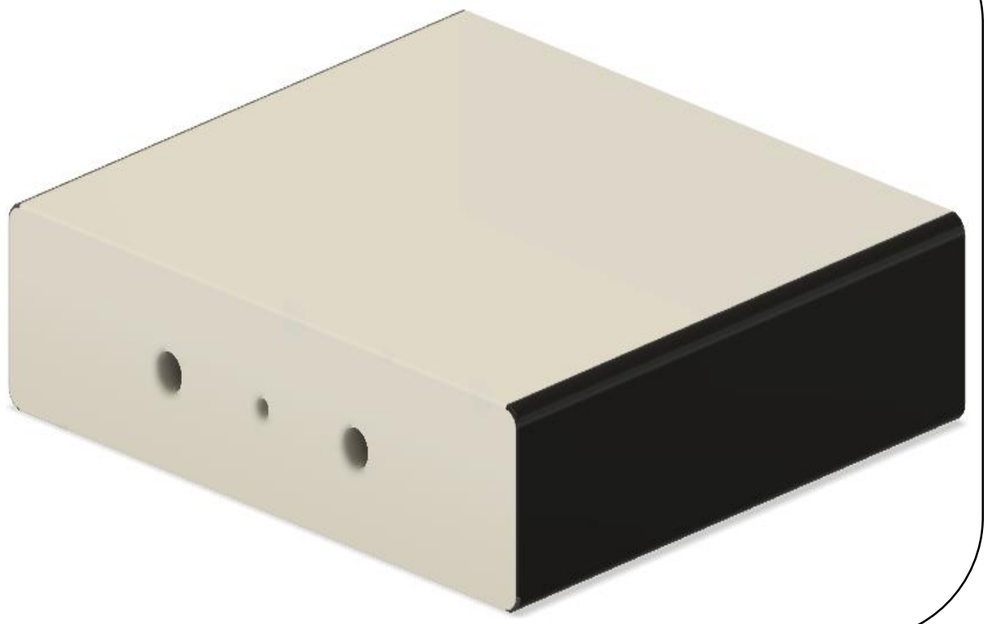
Function: *To be able to hold all electronic components without interfering with the use of the product*

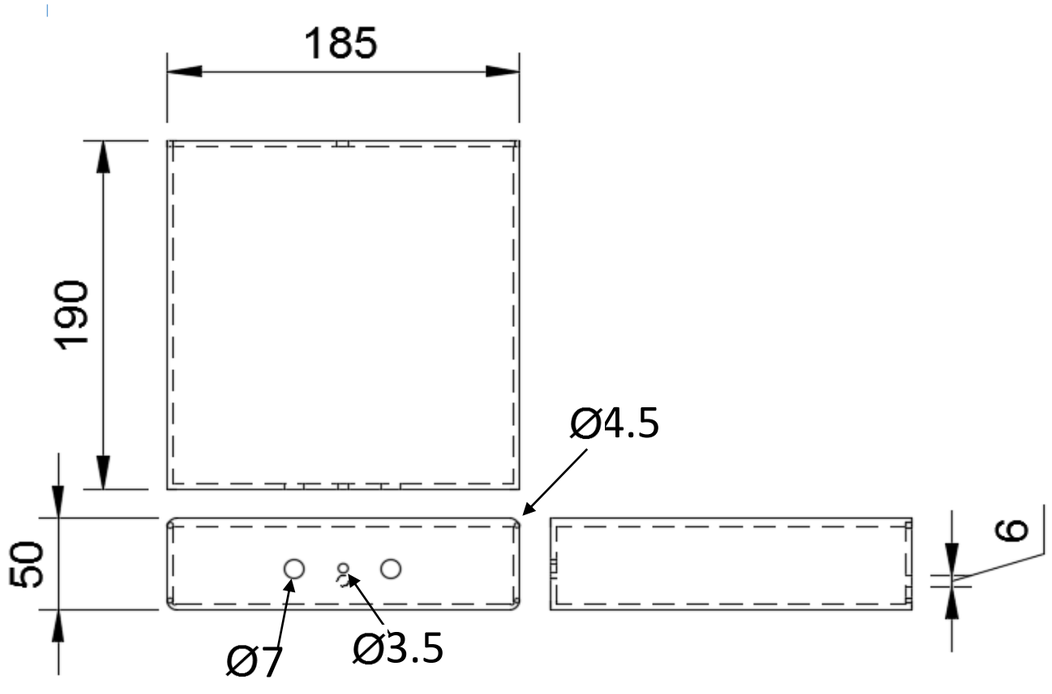
Material: *The designs are going to be made out of ABS plastic*

Design 1

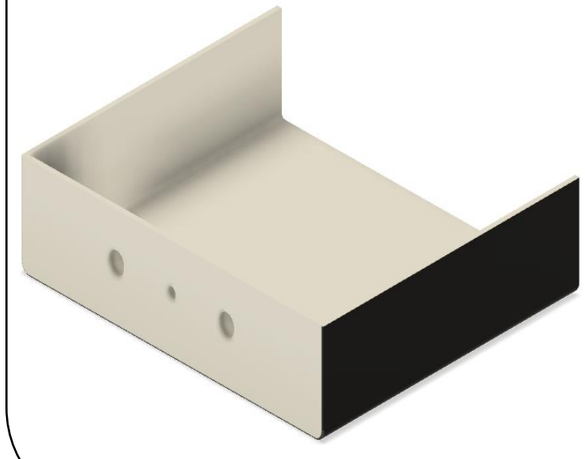
Drawing	Model





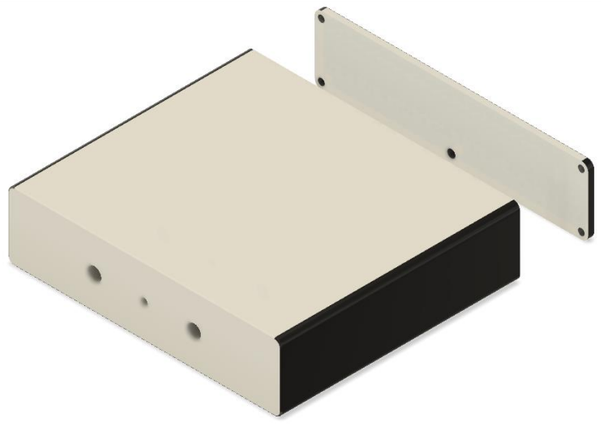


Base of enclosure



*The enclosure of the product is going to be made by having a flat sheet of **ABS** that will be bent using a line bender from 3 of the sides of the sheet. The base would have the 3.5mm hole that the moisture sensor wires would be coming out of and the two 7mm holes that are going to be for the input and output tubes coming from the water pump/*

Part: *The part is the* ***top*** *of the enclosure. It is made out of* ***ABS*** *and it is a square piece with edges that would later be rounded using a file to then smooth them out with sand paper.*
Joint: *The base and the part are going to be joint together using* ***epoxy resin adhesive*** *that would go around the edges of the top piece, this join made so I can first add all the electronic components into the product.*



Part: *The part is the* ***back*** *of the enclosure and is made out of* ***ABS****, the edges of the part are going to be rounded using a file and then smooth them out using sand paper, it has four 4.5mm holes for screws on the edges and one 6mm hole in the middle for the charging cable. All the holes are going to be made using a pillar drill.*
Joint: *The joint is going to be done using* ***screws*** *and the point of it is so the consumer can access the inside of the product if they wanted to or if I ever want to make any adjustments to the product after closing the enclosure*

About this design:

The design is a simple box shape. This is the design I had in mind as the basic shape of the product, it follows most of the specifications and the design is pretty simple and would be pretty easy to make. The design is not that special and there's a lot of product like it aesthetics wise meaning it does not stand out to potential clients.

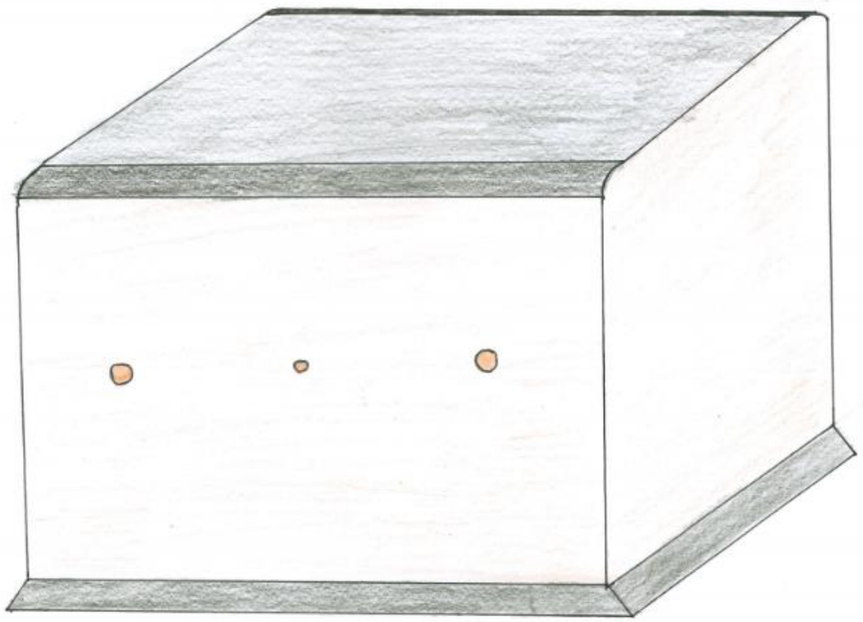
Evaluation of design

Aesthetics: *The design looks simplistic, modern and nice and wouldn't ruin the look of the environment around the product.* ***(4/5)***
Cost: *The product doesn't require a lot of materials to make as it is pretty small meaning the cost of materials to make it would be pretty cheap.* ***(5/5)***
Client: *The design doesn't look very unique so it doesn't stand out compared to other product on the market.* ***(2/5)***
Environment: *The design can be placed easily on any place meaning it is pretty accessible for most environments.* ***(5/5)***
Safety: *The design doesn't have any sharp edges and neither is it heavy and wouldn't hurt the client.* ***(5/5)***
Size: *The design is pretty small and compact and it is the ideal size for the product although it could be smaller.* ***(4/5)***
Strength and durability: *Because the design is pretty compact it is strong and wouldn't break easily.* ***(4/5)***

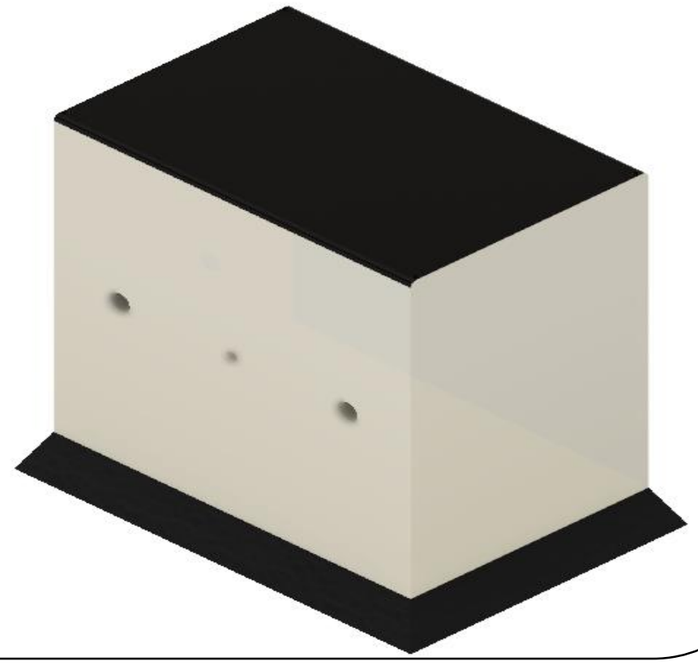
Total: 29/35

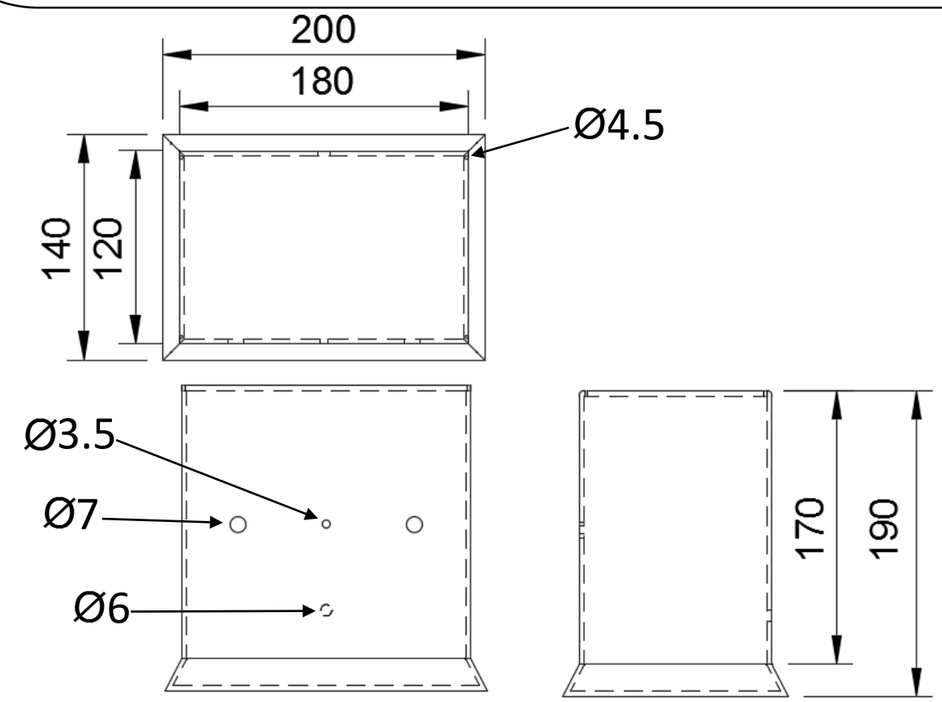
Design 2

Drawing

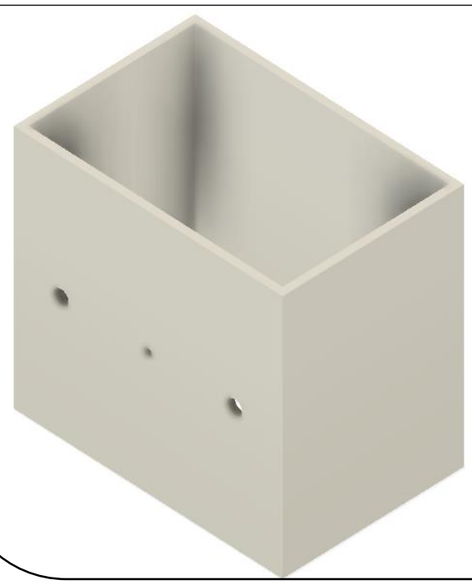


Model



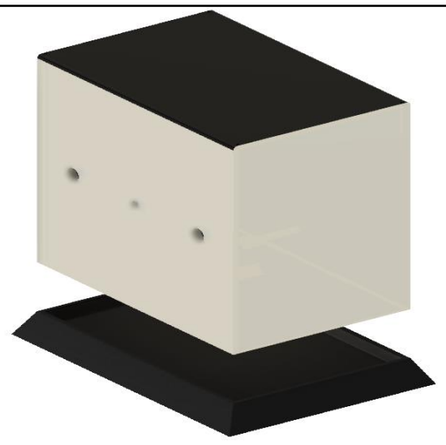


Base of enclosure



*The main part of the enclosure is made by adding 4 sheets of **ABS** together using an epoxy resin adhesive to shape a hollow cuboid, the sheets are going to be cut using a band saw and one of the sheets would have the two 7mm holes for the tubes and one 3.5mm holes for the moisture sensor wire, the sheet opposite to this one would have the 6mm hole for the charging cable.*

Part: *The part is the* ***top*** *of the enclosure and it is just a simple piece of* ***ABS****. The part has 2 rounded edges, and the curves are going to be made by filing them and then smoothed using sand paper.*
Joint: *The base will be joint to the part using* ***screws****. The joint is used to give access to the inside of the product if the client wanted to or if I wanted to change something after joining the enclosure.*



Part: *This part is a trapezoid made out of ABS, it is* ***used to balance*** *by acting as a stand. it is going to be made by adding sheets of* ***ABS*** *at an angel to the flat bottom sheet.*
Joint: *The base and the part are going to be joint with* ***epoxy resin adhesive*** *that would be applied to the top edges of the base. The point if the joint is to add a stand to balance the design.*

About this design:

For this design the power supply is going to stand vertically to give more space for the other electronic components meaning the product would be pretty tall but smaller in width and length. The design is a tall rectangle with a base to hold and balance it. It looks fairly nice and modern and it's pretty unique which would attract potential clients.

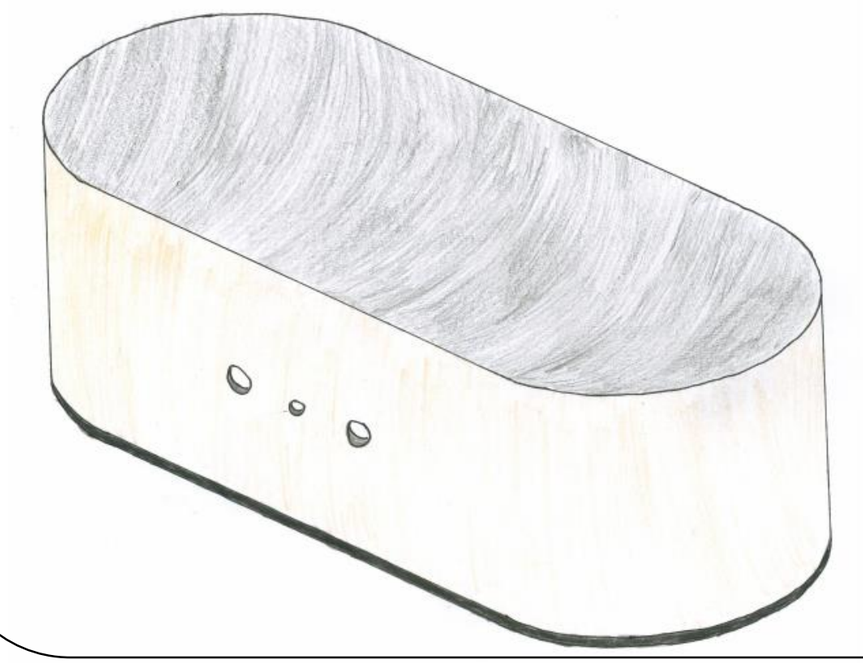
Evaluation of design

Aesthetics: *The design looks unique, nice and modern and it looks aesthetically pleasing overall.* ***(4/5)***
Cost: *It will require more material to make this design than some of the other ones although the cost wouldn't be too high.* ***(2/5)***
Client: *The design looks unique and different compared to other products in the market so it would attract potential clients.* ***(4/5)***
Environment: *The product could be effected by the environment if there is something blocking it from the top.* ***(3/5)***
Safety: *The design doesn't have any safety issues other than it could be a bit heavy due to its height.* ***(3/5)***
Size: *The design is small when it comes to width and length but it is tall which could be a problem for some clients.* ***(3/5)***
Strength and durability: *The product could get damaged easily if it tips over but as long as the electronic components inside are placed securely it should be fine.* ***(3/5)***

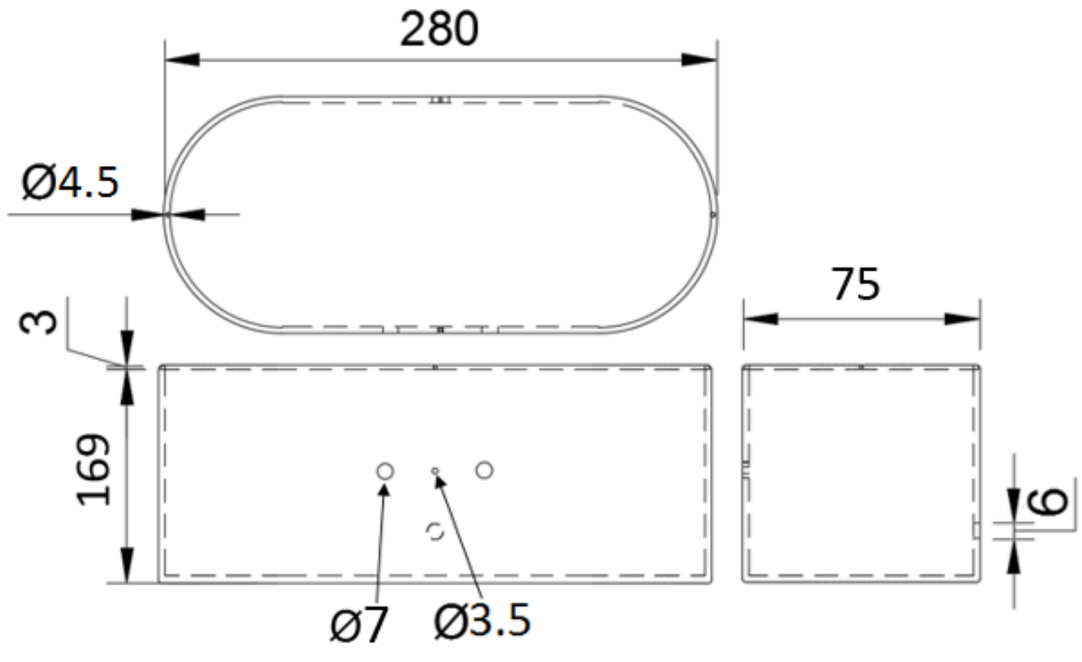
Total: 22/35

Design 3

Drawing



Model



Base of enclosure

*The main part of the enclosure is made by getting a long sheet of **ABS** that will be bent using a line bender to form a hollow ovoid that would be closed off later with other parts. The open ends of the part will then be joint using epoxy resin adhesive, this piece will have the two 7mm holes for the tubes and the 3.5mm hole for the moisture sensor wire.*

Part: *The part is an oval shaped piece of* ***ABS*** *and it is the* ***top*** *of the enclosure, it will be cut to the wanted shape using a band saw and will have four 4.5mm threaded holes for screws. The edges are going to be rounded out using a file and then smoothed using sand paper.*
Joint *The part is going to be joint to the base using* ***screws*** *and this joint is made to give the consumer access to the inside of the product and for me to change anything if I in the circuit mid-production*

Part: *This part is the* ***bottom*** *of the enclosure, it will be made out of* ***ABS****, it is going to be cut and shaped using a band and the edges are going to be rounded out using a file to then be smoothed out using sand paper just like the top piece, the only exception is that it won't be have any holes for screws.*
Joint 2: *The piece will be joint using* ***epoxy resin adhesive****. The point of this joint is so I can place all the electronic components in the bottom piece as it will be easier for me to place them there first and then close off the enclosure.*

About this design:

For this design the power supply is standing vertically so it is tall and due to the electronic components placement it is also very wide. The overall design looks aesthetically pleasing and modern although there are some product like it on the market meaning it is not very appealing to potential clients

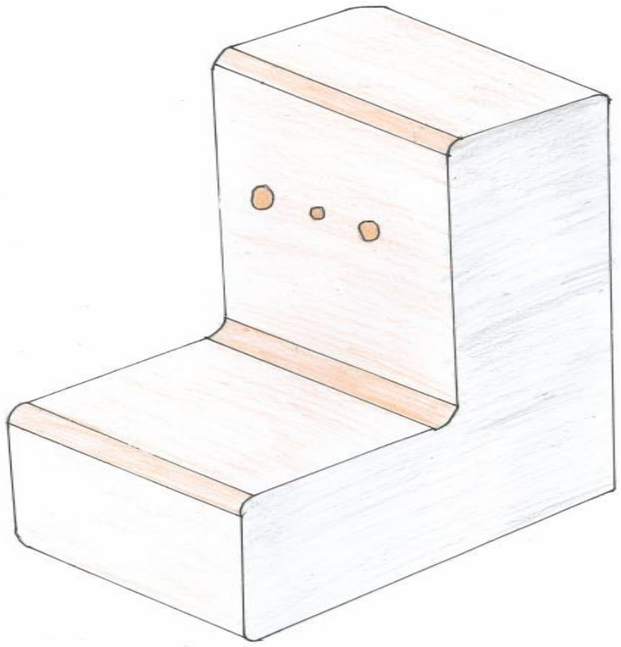
Evaluation of design

Aesthetics: *The product looks simplistic although it doesn't look like something that would attract clients to the product.* **(2/5)**
Cost: *The cost of the design shouldn't be too expensive design although it wouldn't be very cheap either.* **(3/5)**
Client: *There isn't very unique and doesn't really stand out compared to existing ones on the market.* **(2/5)**
Environment: *The product could be effected by the environment if there is something that is blocking it from top as the design is tall.* **(3/5)**
Safety: *The product has smooth edges all around and doesn't have anything that could cause any safety issues.* **(5/5)**
Size: *The size of the design is very long and it is also tall which could be a problem to a lot of clients.* **(0/5)**
Durability and strength: *The product is strong and durable and the electronic components inside the design wouldn't break if it is hit unintentionally* **(4/5)**

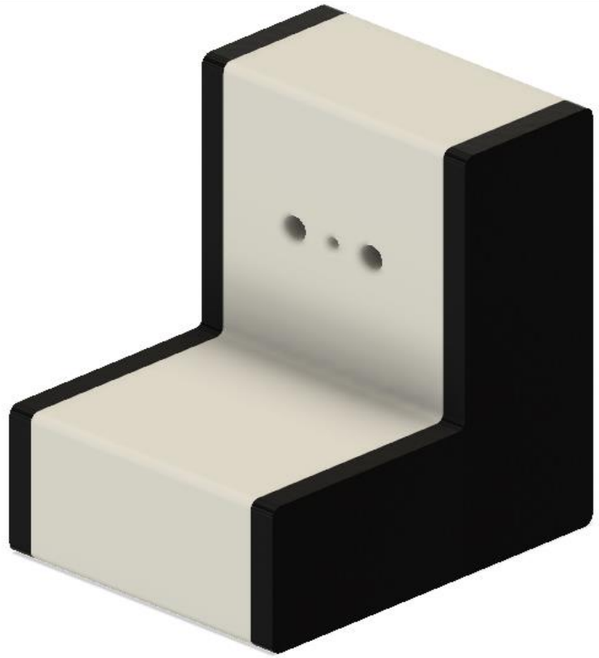
Total: 19/35

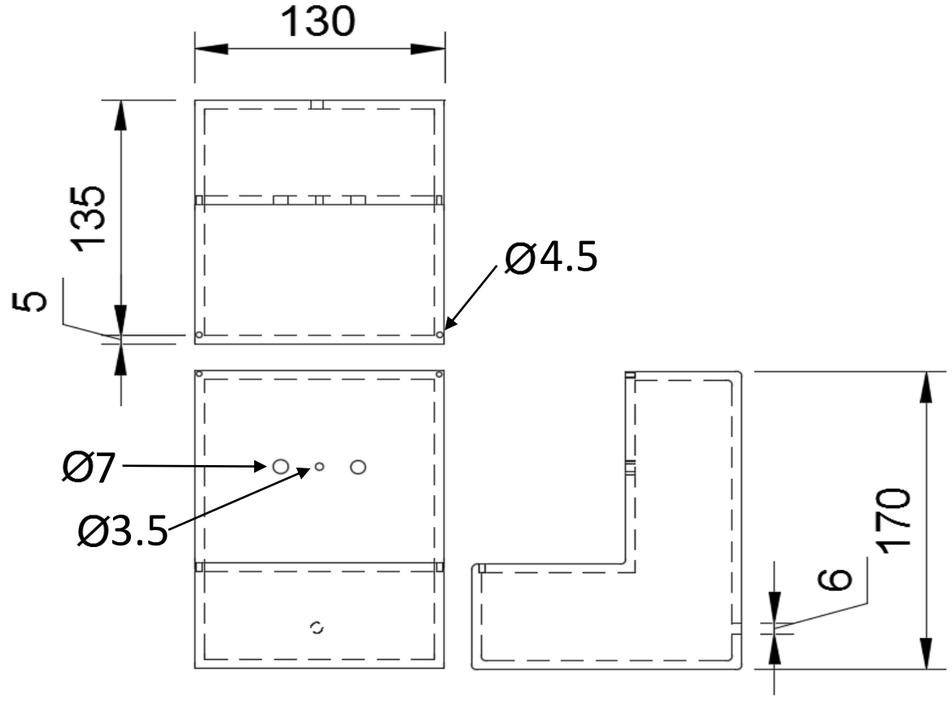
Design 4

Drawing

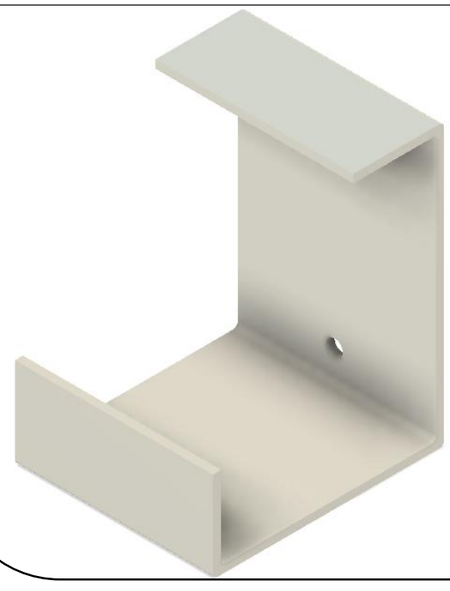


Model

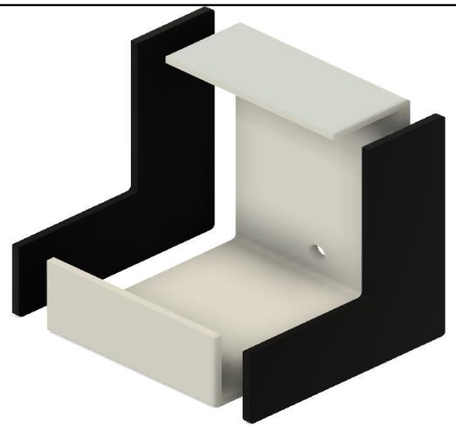




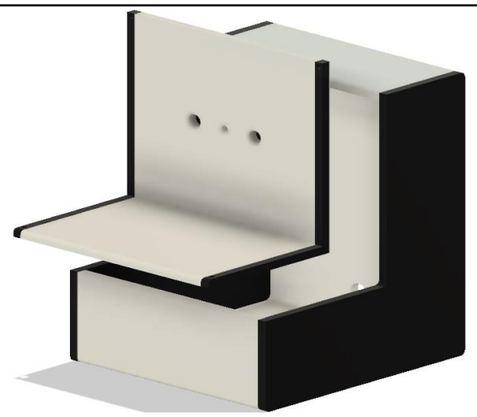
Base of enclosure



*The base of this design is in an "L" shape with two extended bits at the end. It is going to be made by using a long sheet of **ABS** and bending it using a line bender. All edges of the base are going to be smoothed using sand paper except the ones at the end as they will later on be covered. The base also has the 6mm hole for the charging cable.*



Part: *The parts are two identical pieces used to* ***close off the sides,*** *they are made by cutting a sheet of* ***ABS*** *into the shape of an L and then rounding the edges using a file and smoothing them out using sand paper.*
Joint: *Both pieces are joint to the base of the enclosure and are going to be joint using* ***epoxy resin adhesive.*** *The joint and the parts are a part of making the shape of the enclosure and the purpose of the joint is to make it easier for to place the circuit.*



Part: *The part is a thick piece of* ***ABS*** *used to* ***cover the front*** *of the enclosure. The piece would be bent into an L shape using the line bender. It has the four 4.5mm threaded holes on its edges for the screws and also has the 7mm tube holes and 3.5mm moisture sensor wire hole.*
Joint: *The piece will be joint to the base using* ***screws*** *as a temporary joint to give the client access to the inside of the product if they wanted to open it and if I wanted to modify anything later on with the circuit.*

About this design:

This is an "L" shaped design in which the power supply will be standing up right to give more space for the other electronic components. It modern and unique but some potential might find it looking weird which could deter them from buying the product.

Evaluation of design

Aesthetics: *The design looks modern although it looks weird so some clients might not like it.* **(2/5)**
Cost: *The price to make the product wouldn't be cheap nor would it be very expensive.* **(3/5)**
Clients: *The design looks unique which could attract some potential clients towards the product.* **(4/5)**
Environment: *The design could be effected by the environment if there's something blocking from top due to its height.* **(3/5)**
Safety: *The design doesn't have any safety problems and wouldn't hurt the client.* **(4/5)**
Size: *The width and length of the design are ideal although it is very tall when it comes to the height.* **(3/5)**
Durability and strength: *The design is strong and can sustain any small unintentional hits.* **(4/5)**

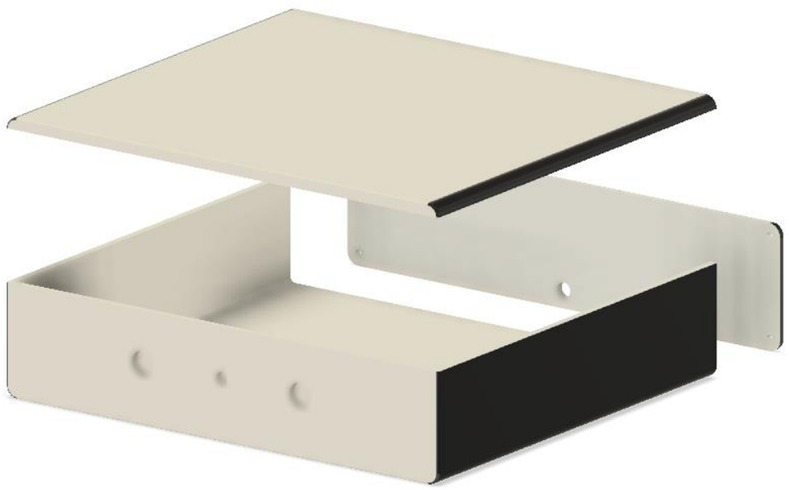
Total: 23/35

Development of solution

Design of choice

*I am going to use **design 1** as my enclosure as it fits all my specifications in a great way. The design looks aesthetically pleasing and simplistic. It would be pretty cheap to make which would allow me to focus more of my budget on the electronic components rather than the material. The design has no safety issue and the overall design is great for my product. There is some room for improvements that I could add later on but for now I am going to use this design moving forwards in developing the product.*

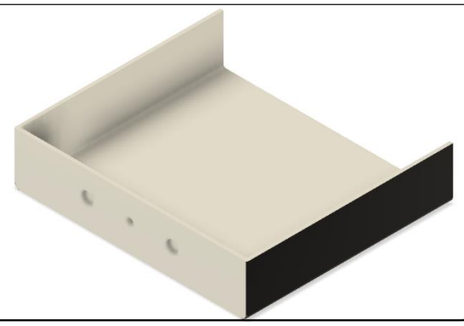
Exploded view



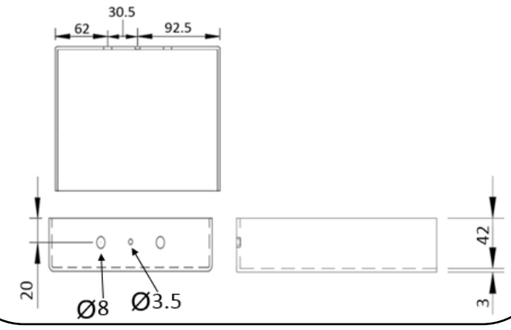
Brief:

The design consists of three parts, they are the base, which will hold all the electronic components and have the holes for the water tubes and also the hole for the moisture sensor's wire, the second part is the top, this part will cover the top of the base and it will be joint as a s permanent joint using epoxy resin adhesive and finally, the third part which is the back of the design, this part will be joint with as temporary joint using screws and it will have the 4 screw holes and also the hole for the power cable.

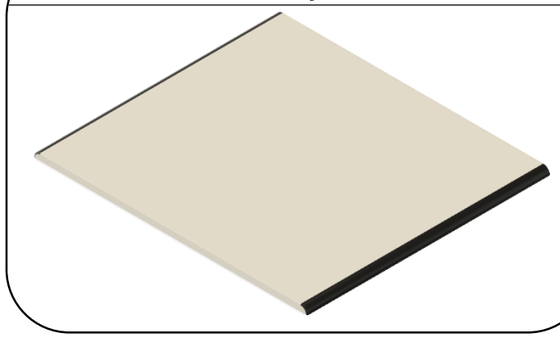
Base



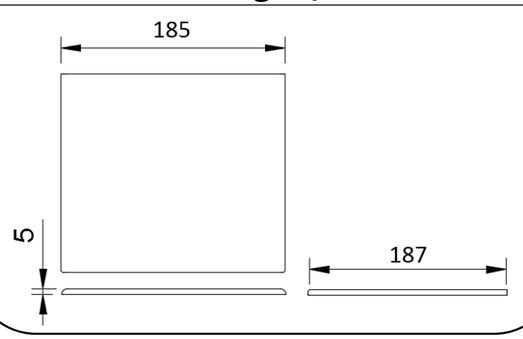
Orthographic



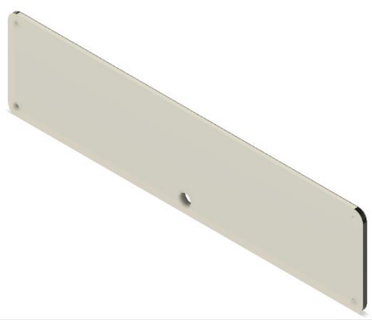
Top



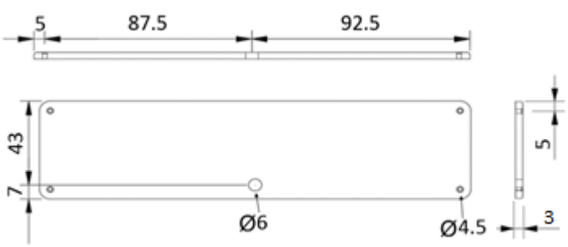
Orthographic



Back



Orthographic



Trailing

Brief: *I am going to measure the sizes of all the electronic components that will be used in the product again to make sure that everything would fit perfectly in the enclosure. This would prevent me from wasting material as not knowing the exact measurement could lead to me to making an enclosure that would not fit which will not only be time consuming but it would also lead to me spending more of my budget on materials.* **Note:** *measurements are shown as L*W*H*

Arduino UNO

70*55*15

Power supply

160*100*45

Breadboard

40*30*10

Water pump

55*35*40

Relay

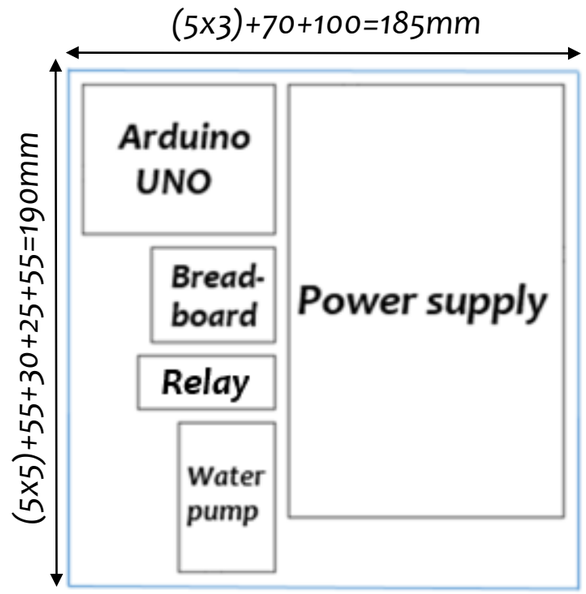
50*25*19

Trailing

How will I check if the components would fit?

To make sure all components would certainly fit inside the enclosure of my product I am going to make a model of the bottom part only of my current enclosure on fusion 360 and on top of it add the sizes of the components. I will not include the moisture sensor's module because it is pretty small and I will just have it standing on the side of the enclosure. There is a 5mm distance between each components and also between the components and the edge of the enclosure, this distance is to give enough space for the wiring of the components and for some breathing room.

Note: *The blue lines are the enclosure*



Conclusion

Should there be any necessary changes?

After measuring all the necessary components that would affect the size of the enclosure and checking if they all would all fit perfectly inside the current size of the enclosure I found out that they would fit without needing to increase the size of the design. The height of the designs also shouldn't be changed as it is currently 50mm and the tallest component which is the power supply is 47mm.

How will the components stand still inside the enclosure?

All components would be joined to the base of the enclosure using epoxy resin adhesive

Problems with the proposed solution

Brief: *I have to know of any problems with the chosen design and fix them, this has to be done to improve the overall quality of the design, I should also add any features that would suit the design and help increase the product's quality of life, doing this would also cause more potential clients to be interested and attracted to the product.*

Problems with solution

The solution could be smaller:

I feel like I could make the solution smaller if I change the layout and placement of all the electronic components, making the design smaller would make it so it is easier for the client to place the product wherever they want and it would just make the design look better.

Messy wires and tubes:

When the product is not being used the client can't really tidy up the wires and tubes coming from the product which would lead to it being messy and possibly causing a safety hazard if they are just not tidied up as if the product is kept on the floor someone could trip on them.

Features and fixes

Changing the layout of the electronic components:

The biggest factor when it comes to determining the size of the enclosure is the electronic components and the way they are placed. The component placement determines the overall size of the design//product and I feel like I don't have the most practical components layout so if I change it I could possibly make the size of the enclosure smaller.

A place to wrap the tubes and wires around:

What I could do to make it easier for clients to organize the tubes and moisture sensor wires for the product when it is not being used is to have a place where they could wrap the tubes and wires around. The object should be small and on top of the enclosure to not ruin the aesthetics while still being big enough to wrap the moisture sensor and both tubes around it.

Layout

Brief

How will I change the layout?

The biggest thing that is effecting the layout is the power supply as it is the largest component and it is placed vertically, what I will change is that I will place the power supply horizontally and all the components under it compared to the old layout where the power supply was placed vertically and all the components were sitting next to it, there is a 5mm gap between each electronic component and the edges of the enclosure to give space for the wires although that shouldn't affect the size by a lot. I didn't show the moisture sensor as I can easily place it standing on the side of the enclosure.

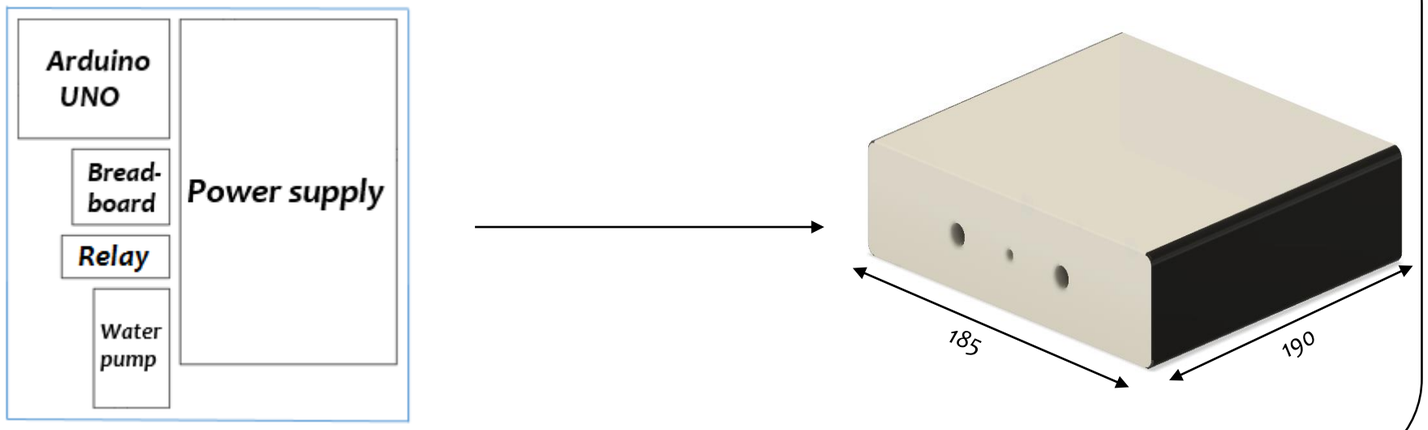
Benefits of changing the layout:

- *It will make the size of the enclosure smaller*
- *for my product, smaller enclosure looks more aesthetically pleasing*
- *More clients will be able place the product more freely with a smaller enclosure*

Disadvantages to changing the layout:

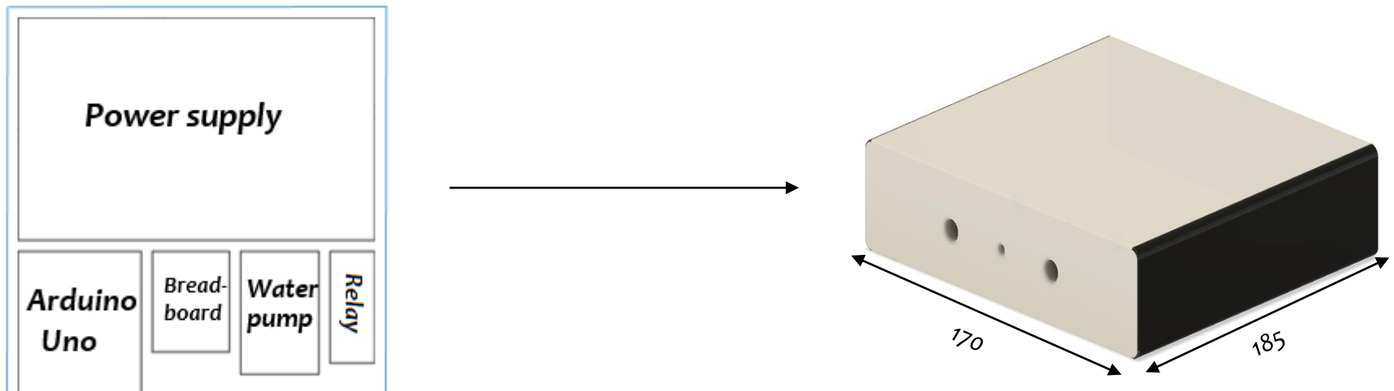
There aren't any disadvantages to changing the layout as the main purpose of doing so is to make the enclosure smaller and there isn't any downgrades when it comes to that.

Old layout



Key: Enclosure; Components

New lavout



Wires manager

Brief

How will I make and add the feature?

The feature is a handle like shape. It is a components that would be bought and is made out of aluminum and will be joined to the top of the enclosure using epoxy resin adhesive. The part should be big enough so that the client can easily wrap the two water tubes and also the soil moisture sensor around it and it will be placed on the front of the enclosure from the top where it will be closest to the wires and tubes.

Benefits of adding the feature:

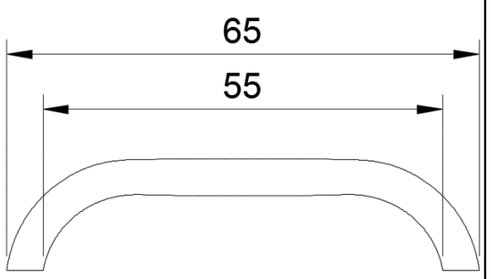
- *Will make it easier for the consumer to wrap the wires with the enclosure itself*
- *Will make the product look more tidy when it is not being used to water a plant*

Disadvantages to adding the feature:

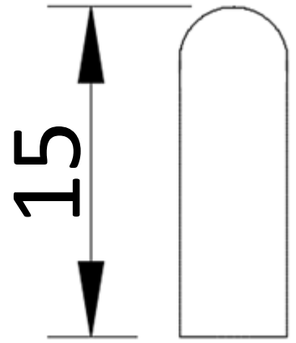
- *The product might look less aesthetically pleasing as the handle would seem like an object that is out of place although its benefits outweigh the disadvantages as it would be a helpful feature to the consumer as it would help keep the product neat and tidy when it is not being used.*

Dimensions

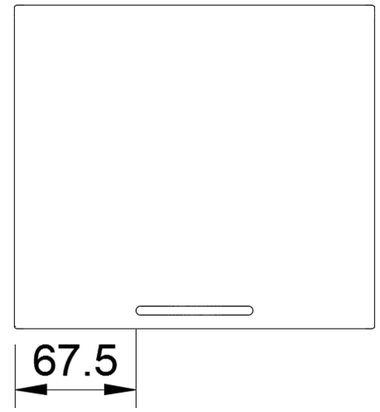
Front



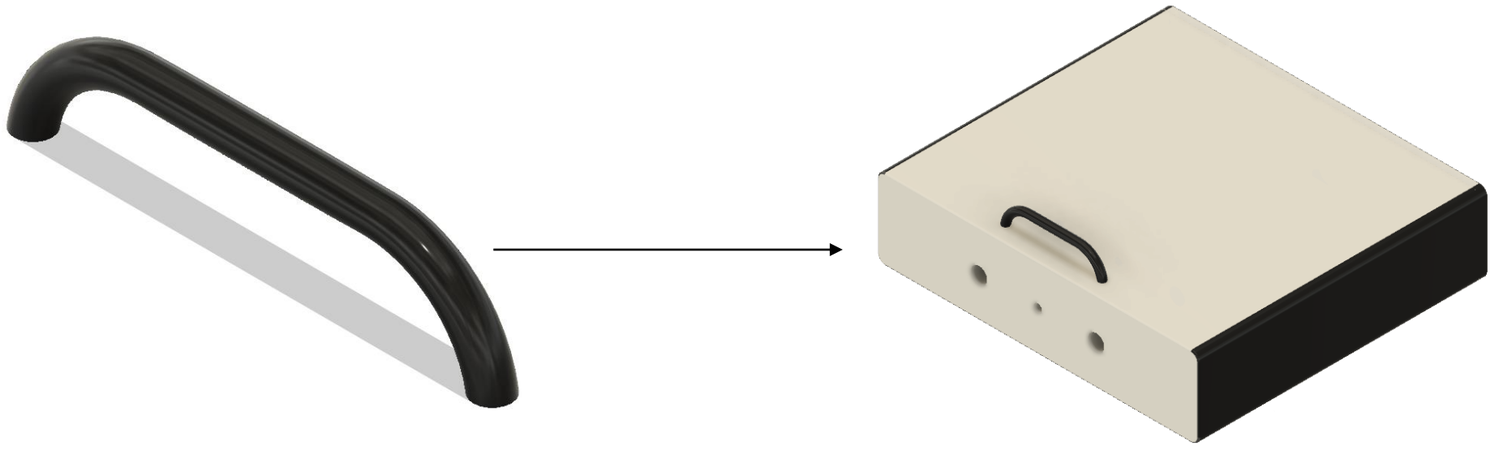
Side



Position on enclosure

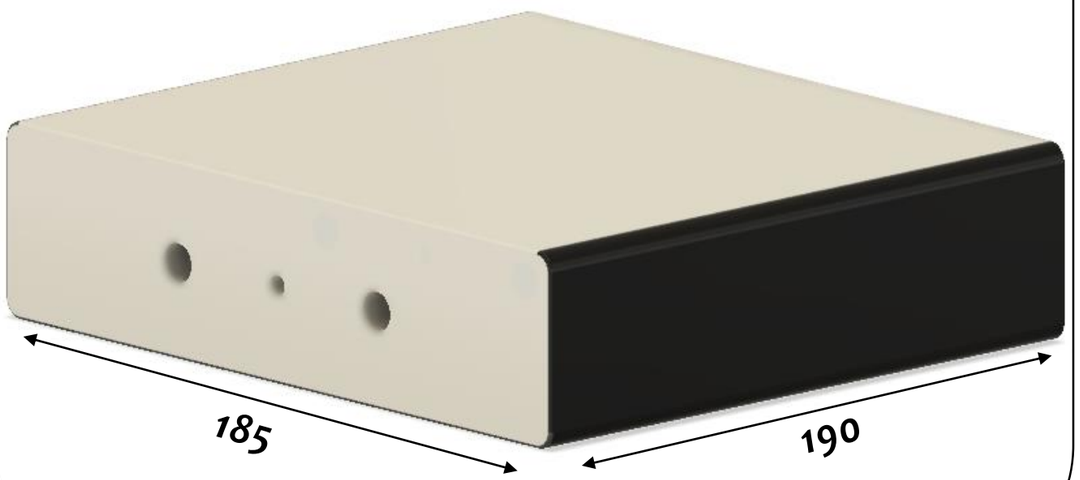


The feature on the enclosure

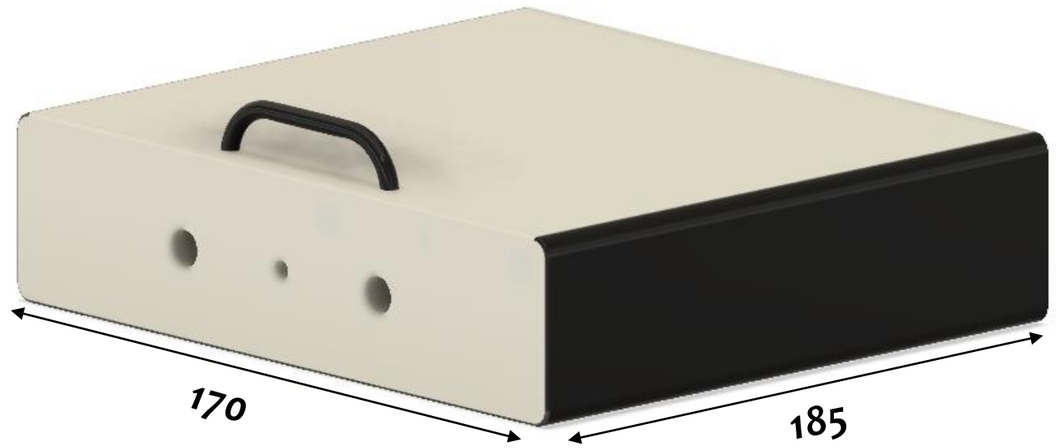


Conclusion

Old solution



New solution



Improvements

What were the improvements made when developing the solution?

- ***Decrease in overall size:*** *The overall size of the enclosure was decrease by changing the location in which the electronic components of the product were going to be placed, this lead to a small decrease in size by 15mm in width and 5mm in length, although the decrease was small it is still helpful as not only there aren't any downgrades into having a smaller enclosure it also decreases the amount of material that is going to be used which decreases the price even if it is by a small amount and making it makes the product look more appealing.*
- ***Adding a wire manager:*** *By adding a small handle to the enclosure this allows clients to be able to easily wrap around the moisture sensor wire and also the water tubes when the product is not being used which would make the product and the location it is placed in more tidy when it is not being used. Although there are some drawbacks into adding this feature which such as the handle looking of place which could affect the aesthetics of the product and it will also increase the price but the feature is going to be really helpful for a lot of people so I am inclined to thinking that the advantages of adding it outweigh the disadvantages.*

Production planning

Brief: *I am going to show all the steps I'm going to take in manufacturing the product with how much time each step will take and what machines, tools and any safety equipment they are going to need and also what quality control precaution I'm going to take in them. This will give me a clear view of the process I am going to take which will allow me to have an understanding of how the manufacturing of the product should go.*

Time table

Production steps	Weeks taken									
	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
Material selection										
Cutting										
Drilling										
Filing										
Shaping										
Coding										
Circuit building										
Joining										
Finishing										
Testing										

Material selection

Getting and bringing in all the needed items for the product.

Health & Safety	Tools	Machines
N/A	N/A	N/A

Cutting

Cutting the pieces of material I am going to use to the appropriate size.

Health & Safety	Tools	Machines
Safety goggles	N/A	Band saw

Drilling

Drilling all the needed holes for my product.

Health & Safety	Tools	Machines
Safety goggles	Countersink & spiral drill bits	Pillar drill

Filing

Filing and rounding any edges or sides that require it.

Health & Safety	Tools	Machines
N/A	File	N/A

Shaping

Shaping the base of the product to the required shape using a line bender

Health & Safety	Tools	Machines
N/A	N/A	Line bender

Coding

Writing the code that the Arduino UNO us going to run on.

Health & Safety	Tools	Machines
N/A	Male to male mini USB wire	N/A

Circuit building

Making the circuit my product is going to function on.

Health & Safety	Tools	Machines
N/A	Wire strippers Multimeter	N/A

Joining

Making all the primary and temporary joints for my product.

Health & Safety	Tools	Machines
Fume mask	Screwdriver	N/A

Finishing

Spray painting the enclosure and smoothening any rough sides or edges.

Health & Safety	Tools	Machines
Fume mask	Spray paint	N/A

Testing

Making sure my product is on par with the required quality.

Health & Safety	Tools	Machines
N/A	Multimeter	N/A

Materials selection

Process	Quality control
This is the first step for starting the manufacturing process for my product. I will go to a local store in which I will get a big 3mm thick (325x325mm) sheet of ABS and a small 5mm thick sheet of ABS (195x195mm). I will also get the aluminum handle/wires manager.	When picking the sheets I'm going to use I need to make sure that they're all in good shape.

Drilling

Process	Quality control
I will be drilling 8 holes using a pillar drill. Four 4.5mm threaded holes on the back piece using a countersink drill bit and one 6mm hole also on the back piece for the power cable, two 8mm holes on the front for the water tubes and one 3.5mm hole for the moisture sensor wire all using a spiral drill bit.	I will be marking out the location of the holes before drilling use a steel rule and a scriber.

Shaping

Process	Quality control
For this step I am going to use a line bender to shape a sheet of ABS that is 260mm by 230mm into the base of the product by bending the sheet from three of its sides and leaving the last side as it is going to get covered by the back piece.	I will mark out the place that I'm going to start the bend from using a steel rule and a scriber to make sure all bends are equal.

Circuit building

Process	Quality control
For building the circuit I will start by connecting a power socket to the PSU via a power cable but not turning the socket on for safety protocols, after that I will connect a positive wire from the PSU to the VIN and a negative one to the GND of the Arduino UNO, then I will connect the GND and the 5V port to the mini breadboard, from the breadboard a positive and negative wire will be going to the moisture sensor module and the relay, after that I will connect a wire from the relay to the positive port of the water pump and will connect another positive and negative wires from the PSU, the positive wire will be connected to the front of the relay and the negative will go to water pump.	Using a multimeter I will measure the voltage going through the wires before connecting them to the components.

Finishing

Process	Quality control
For the finishing I will start by sanding the entirety of the enclosure and then spray painting it with black on the sides and white everywhere else, I will also spray paint the wire manager black for it to better suit the aesthetics. The wire manager will be spray painted before joining it to the enclosure.	When spray painting I will cover the parts that I do not want to spray paint with a certain colour with cardboard to make sure that they do not get any unwanted paint on them.

Cutting

Process	Quality control
When cutting the sheets I'm going to use for the enclosure I will start by marking out 2mm more than the required sizes and then I will cut them out using a band saw and file the extra 2mm after that just to ensure accuracy.	I will mark out the sheets with a steel rule and scriber and have 2mm of excess materials on the sheets to be filed out.

Filing

Process	Quality control
For this step I am going to file all the edges that require it from the three parts of the enclosure to make sure that all of them are smooth and rounded not only will this prevent a safety issues of the edges being sharp but it will also make the product look more aesthetically pleasing.	I need to frequently check that the edges I round are equal and that none of them are rounded more or less than the others.

Coding

Process	Quality control
I'm going to code the Arduino UNO by making it so whenever the moisture sensor detects that the soil is less than 40% moist it will send a signal to the Arduino which will in turn send a signal to the water pump causing it to activate.	Before using the Arduino UNO on the product I will first use it to turn on a small LED to make sure that the code works.

Joining

Process	Quality control
There are two joints, the first joint is a permanent join that is between the top piece and the base and is going to be done using epoxy resin adhesive that will be applied to the top edges of the base, this will be done after joining the electrical components to the base, after the adhesive has dried out the second joint will be made, it is a temporary joint between the base and the back piece that will be made using screws. When joining the parts I need to make sure that I pass the power cable and moisture sensor wire through the parts they are going to be coming out of before joining the product because I want the moisture sensor to be out of the enclosure but the wire to be mostly inside, same with the power cable. I will also join the aluminum handle/wire manager to the top of the enclosure using epoxy resin adhesive.	I should make sure to not try to work on the product before the adhesive fully dries out (24 hours after applying it).

Testing

Process	Quality control
For testing the product I will start by checking the quality of the enclosure and making sure it has a nice and smooth finish from every side. After that I will be testing and seeing the product's performance over a span of two weeks and making any changes if deemed necessary.	I need to make sure not to skip any points that I have to check even if I was confident with my work in them

Product evaluation

Evaluation

Aesthetics	Cost	Client	Environment	Size	Safety	Function	Material
I feel like my product looks aesthetically appealing even though it doesn't have many finishes that enhance its aesthetics the colors used for the paint give it a nice and modern look.	When it comes to the price my product is certainly on the higher side due to it being way more expensive than other existing products similar to it on the market and that will negatively affect the client attraction to the product.	My product would be able to attract clients as it is unique due to it using a moisture sensor instead of a timer for the activation method. Although the product doesn't stand out when it comes to its design.	The product doesn't have any negative environmental affects and for that it could attract more clients. The product is a bit limited when it comes to placement options due to it needing a power socket although it is meant to be stationary so that shouldn't be a major issue.	I feel like the size of the product is ideal as I think the components' layout that I used allows the enclosure to be at a minimum size while still preserving functionality as there is enough distance between each component for breathing room and wiring.	The product doesn't have any safety issues that could be deemed as hazardous to the client as there aren't any sharp edges on the enclosure and all wires except the moisture sensor's are hidden although that can be easily countered by using good sheathings for them.	The way the product functions is not only unique but also accurate due to moisture sensors being good at detecting when plants require watering. The 12V water pump also has ideal pressure that won't over nor underwater the plant.	I feel like ABS as the chosen material for the enclosure is ideal and suits the product as it is a cheap, strong and durable material that also looks aesthetically appealing and since the enclosure will be painted I wouldn't have to worry about it degrading under UV rays.

Recommendations

These are some recommendations that could potentially help anyone that might be thinking about manufacturing a product that is similar to mine.

Cost

When it comes to the manufacturing cost of the product I would highly suggest trying to decrease the price by around five to ten OMR less than mine as a higher the price is the lower chances of the product being successful, although you have to also make sure not to sacrifice a lot of the quality or functionality of the product when doing so.

Possible ways of decreasing the price:

- Using a cheaper microcontroller
- Using a water pump that requires less voltage; that would decrease the pump's price and the price of the needed PSU

Design

Although this entirely depends on the manufacturers or their client's specifications I would still recommend trying to make the product's design look unique and interesting. Of course functionality should still be the main priority but having a unique design could improve the client attraction. To make sure your product looks unique and different to most similar product's on the market you should try to stray away from a box like design, in my case that is what suited my specifications so that's what I went for but if having a different design would not affect the product's quality and functionality you should go for that.