3D PRINTED ALGAE LIGHTING.

Sam Bird Smith

Key.

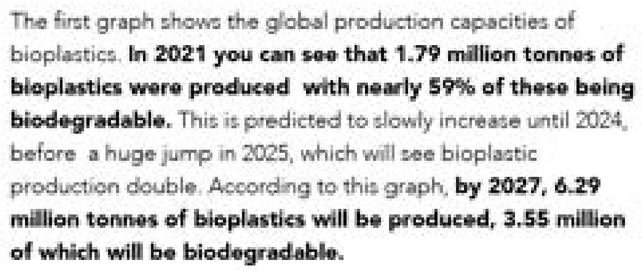
Any red text, typed or hand written, acts as analysis/evaluation/reflection/my thinking etc.

Any bold text (excluding titles) acts as important information

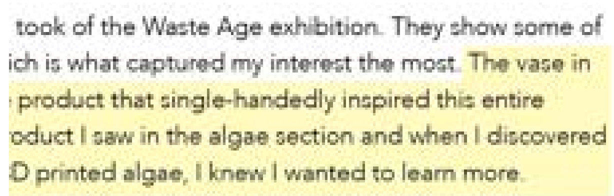
Anything highlighted in yellow acts as vital contributions to my final design. These are the most important parts of the document and the yellow highlights portray a shortened narrative of the project and emphasise the key areas. Some pages have small amounts of text highlighted, as these may be the most important bits of the page, however other pages simply have the title highlighted, which indicates the entire page is very important.

Red hand written = analysis/evaluation/reflection/my thinking etc.

Red typed = analysis/evaluation/reflection/my thinking etc.



Bold text = important information



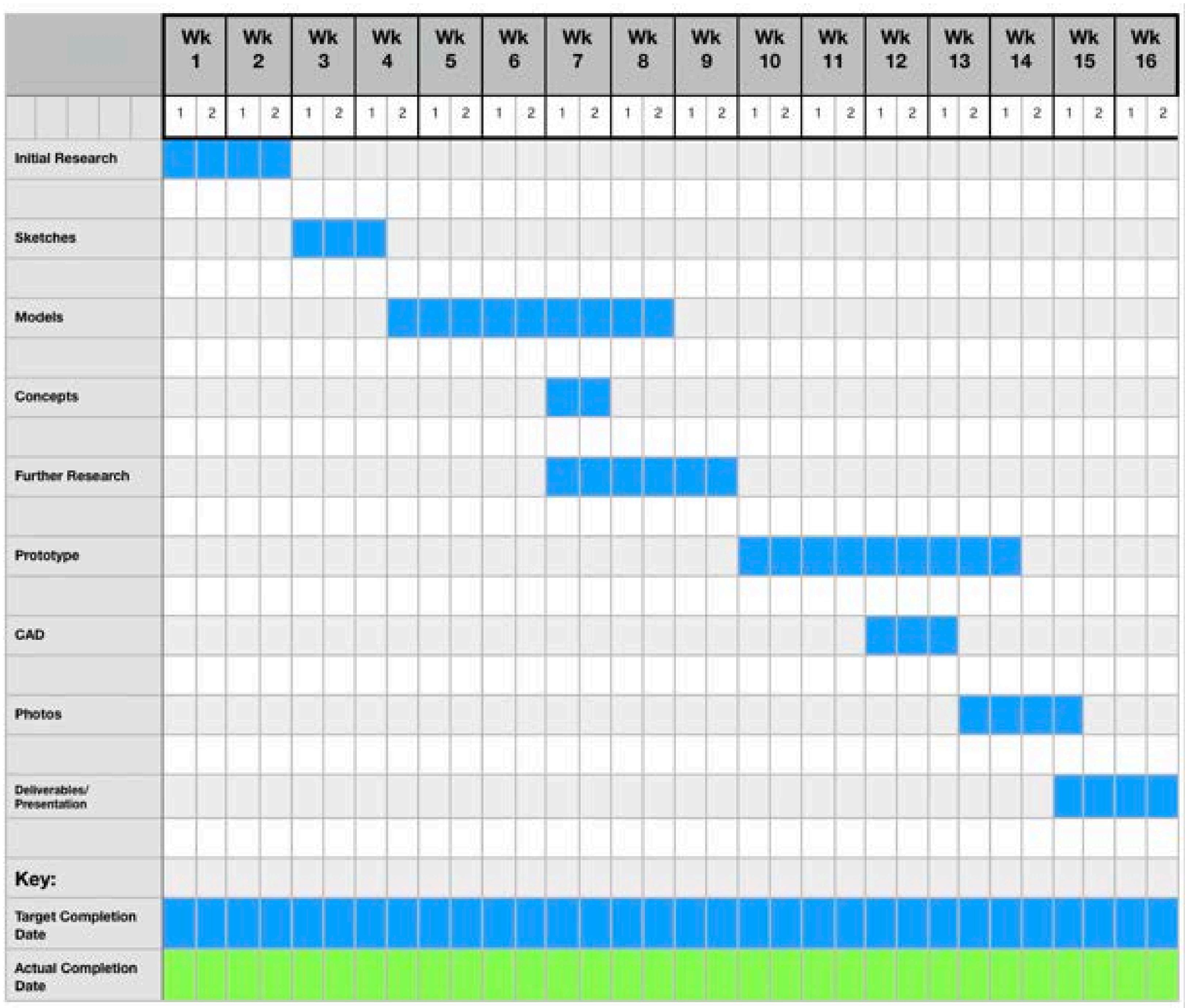
Yellow highlighted text = this section is vital to overall narrative of project

Yellow highlighted title = this entire page is vital to overall narrative of project

Time Management.

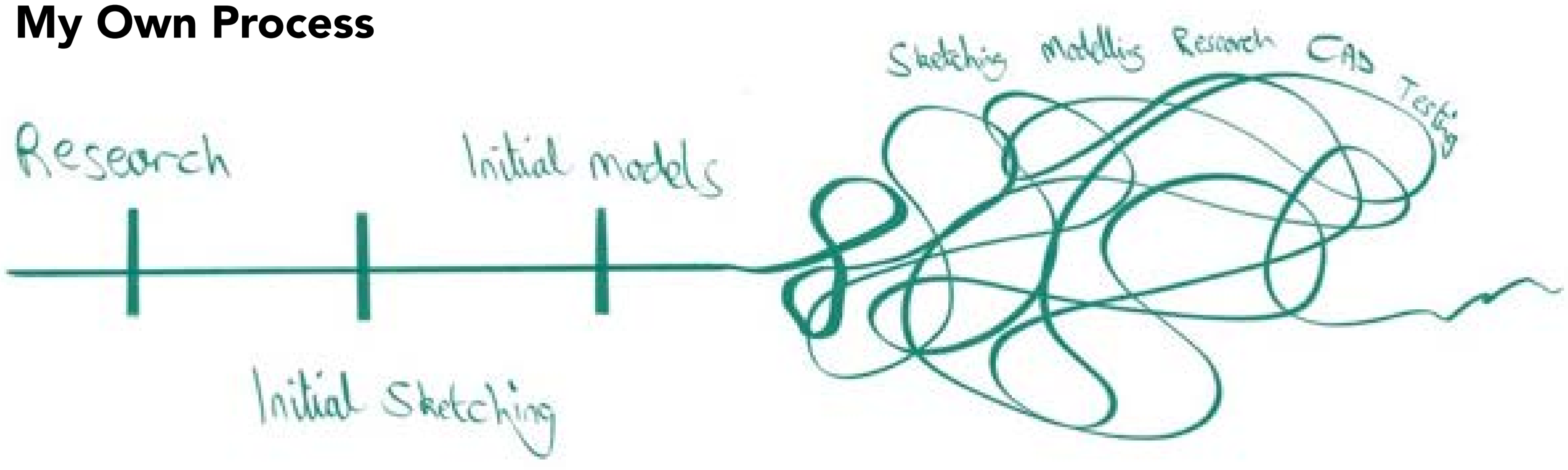
Gantt Chart

This is the Gantt Chart I created at the beginning of the project. It lays out a rough guide of everything that needs completing throughout the next 16 Weeks. I have split each week into 2 halves, to give a slightly more precise time plan. The blue squares show when I aim to complete the section and my predictions for when I will be working on the tasks on the left. This is only a very rough guide, as it is extremely difficult to predict how the project will go, before it has even started, however it good to have a plan that I can loosely stick to, so I know I won't run out of time. I will attempt to stick to this time plan as closely as I can and will also complete weekly 'to do lists' to break up my work more precisely.



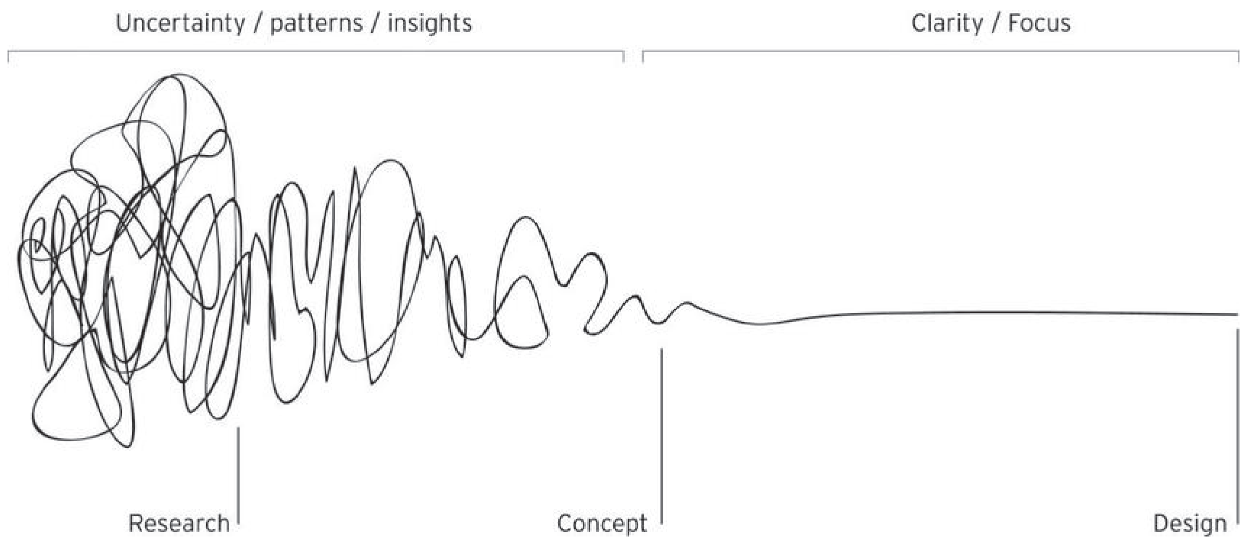
Design Process.

My Own Process

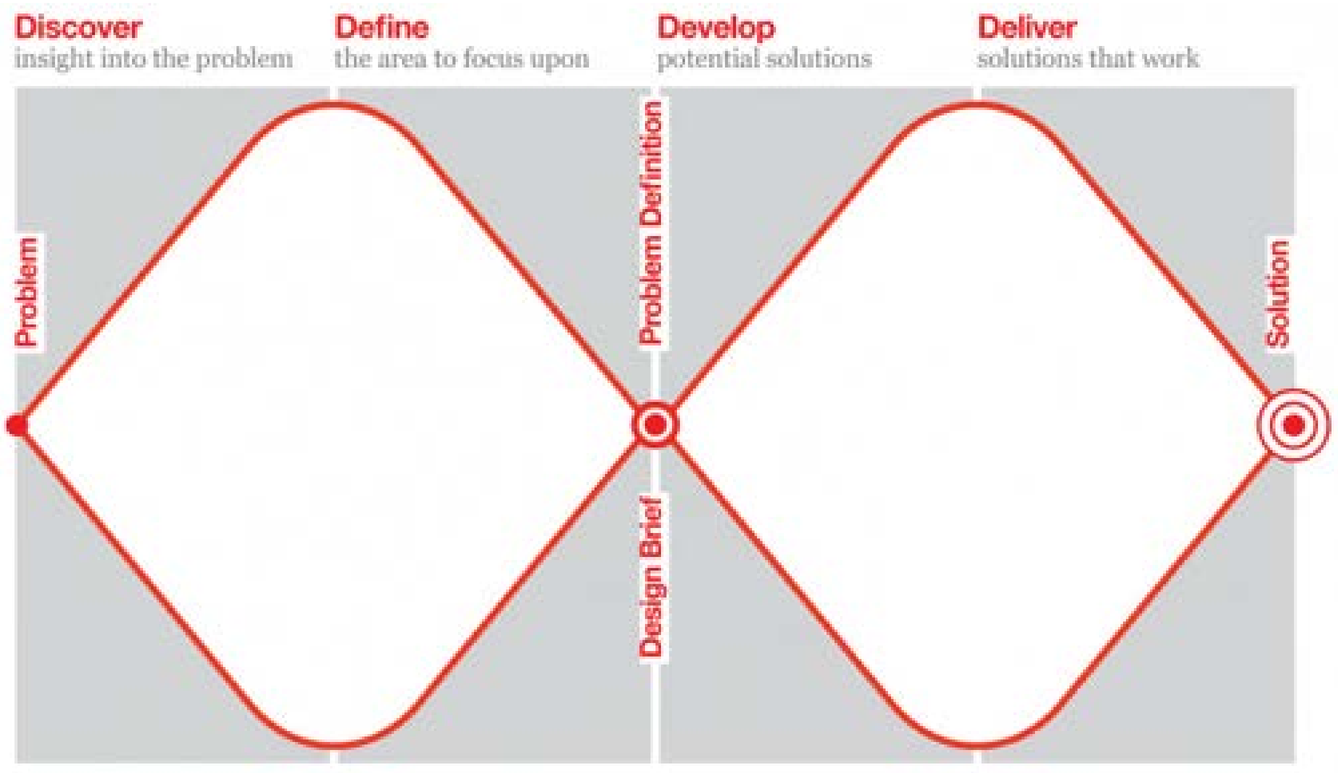


Above is my own interpretation of the design process. This is the way I tend to work and a rough structure of how I normally approach projects. It is a combination of the the double diamond process and the design squiggle. I always begin with resarch, before moving into initial sketches and initial models. After this I complete a range of sketches, models, resarch, CAD, testing etc depending on what I feel is most beneficial to the project, before finally deciding on an outcome. I will attempt to stick fairly closely to the process this time, however, over the course of this year, I have really discovered the importance of modelling and so sometimes I have found modelling and sketching switch places.

Design Squiggle



Double Diamond



Time Management.

To ensure that I manage my time to the best of my ability, I will create a weekly to do list on the Monday of each week of the project. This will consist of all the tasks which I aim to complete and all of the sessions I must attend over the course of the week. In Week 1, I managed my time very efficiently and completed a large chunk of initial research. I attended all of my sessions and stuck more or less to a 9-5 routine, which I found most productive. This allowed me to complete a good quantity of work in the 1st week.

Week 1

09.01.23

To Do List

- Inspiration for brief ✓
- Design museum exhibition ✓
- Write own brief + analyse ✓
- Ethics checklist form ✓
- Plastics research ✓
- Bioplastics research ✓
- PLA + PHA ✓
- Bioplastics market ✓

To Attend

Monday – Studio : 9-5 ✓

Tuesday – Work from home ✓

Wednesday – Lectures : 10-12 ✓

Thursday – Studio : 9-5 ✓

Friday – Thesis tutorial : 12-12:30 ✓

CAD : 2-3:30 ✓

Inspiration.

In January 2022, I visited the ‘Waste Age’ exhibition at the London Design Museum. The part I found the most interesting was the renewable materials section. This was were I first saw algae being used as a material and was instantly fascinated with the outcome. Of the whole exhibition, it was this that stood out to me the most and I knew then the potential it had to be taken into a final year project. This was one of the first exhibitions I had been to that really captured my interest and held it from start to finish and I knew how important it was for the self-directed project to be on something I was passionate about - renewable materials

Inspiration.

At the 'Waste Age' exhibition, the algae section showed a number of different bowls, cups and vases, as shown in the photo on the right. They had been 3D printed from algae-based plastic filament. I found the products beautiful and loved the way in which the bits of algae showed through in the material and added a unique texture and aesthetic. I also was drawn to the natural colour pallette that it produced and was impressed by the fact that a green, slimy organism could produce such a beautiful product.

However, in the exhibition, the 3D printed algae had only been used to create some sculptural pieces, like vessels, yet these were not functional, as the material is not currently considered food safe. Therefore, for my final project, I want to explore other uses for the material and create a more functional product that shows how this incredible material can be utilised in our homes.

Exhibition.

These are some photos I took of the Waste Age exhibition. They show some of the section on algae, which is what captured my interest the most. The vase in the bottom right was the product that single-handedly inspired this entire project. It was the first product I saw in the algae section and when I discovered it had been made from 3D printed algae, I knew I wanted to learn more.

Brief.

"Produce a range of lighting designed to be made from 3D printed algae"

Brief.

I created a detailed brief in the same style as the briefs we usually receive from the University. This highlighted areas for me to explore and briefly outlines my project and where it could lead.

Sam Bird Smith

Self-Directed Project - BA Furniture and Product

Brief.

3D-PRINTED ALGAE LIGHTING.

“A new bioplastic made from algae could replace oil-based plastic completely according to its inventors, potentially turning the manufacturing industry from a source of CO_2 into a destroyer of the greenhouse gas.”

“Dutch designers Eric Klarenbeek and Maartje Dros have developed a bioplastic made from algae. In the lab, the duo cultivate the living algae, which they then dry and process into a material that can be used to 3D print objects.”

https://inhabitat.com/new-3d-printed-algae-could-revolutionize-the-way-we-make-things/

Research and explore the potential of algae-based bioplastics and how they can be used within the manufacturing method of 3D printing, as an ecological alternative to unsustainable materials used in the lighting design industry.

Consider the differences between algae-based bioplastics and regular plastics, analyse the current impacts of 3D printing and its future potential, appraise algae as a natural organism and its other uses.

Brief.

The highlighted parts of the brief show the most important areas and offered pathways to research further into. For example, "the manufacturing method of 3D printing", promted me to research into the pros, cons, limitations and future potential of 3D printing etc. I annotated these areas with some analysis and key questions I had, that I would need to answer in ny research.

Sam Bird Smith

Self-Directed Project - BA Furniture and Product

Brief.

3D-PRINTED ALGAE LIGHTING.

"A new bioplastic made from algae could replace oil-based plastic completely according to its inventors, potentially turning the manufacturing industry from a source of CO2 into a destroyer of the greenhouse gas."

Look at current impacts of plastic industry + Problems with synthetic plastics

Statistics on environmental benefits of algae – how is it better than regular plants

How does it respond to CO_2

"Dutch designers Eric Klarenbeek and Maartje Dros have developed a bioplastic made from algae. In the lab, the duo cultivate the living algae, which they then dry and process into a material that can be used to 3D print objects."

How is it dried + processed? is this energy consuming? does it require lots of heat?

How much better is it than manufacturing regular plastic?

https://inhabitat.com/new-3d-printed-algae-could-revolutionize-the-way-we-make-things/

Research and explore the potential of algae-based bioplastics and how they can be used within the manufacturing method of 3D printing, as an ecological alternative to unsustainable materials used in the lighting design industry.

Where is 3D printing currently used?

What materials are commonly used in lighting industry?

How much wastage is there?

How can this be improved?

Consider the differences between algae-based bioplastics and regular plastics, analyse the current impacts of 3D printing and its future potential, appraise algae as a natural organism and its other uses.

Current impacts of 3D printing - pros + cons

How can it be improved?

Future potential

Alternative uses for algae, such as food, medicine etc.

↓

Other reasons for growing algae

Ethics

Sam Bird Smith (username: N0840816)

Attempt 1

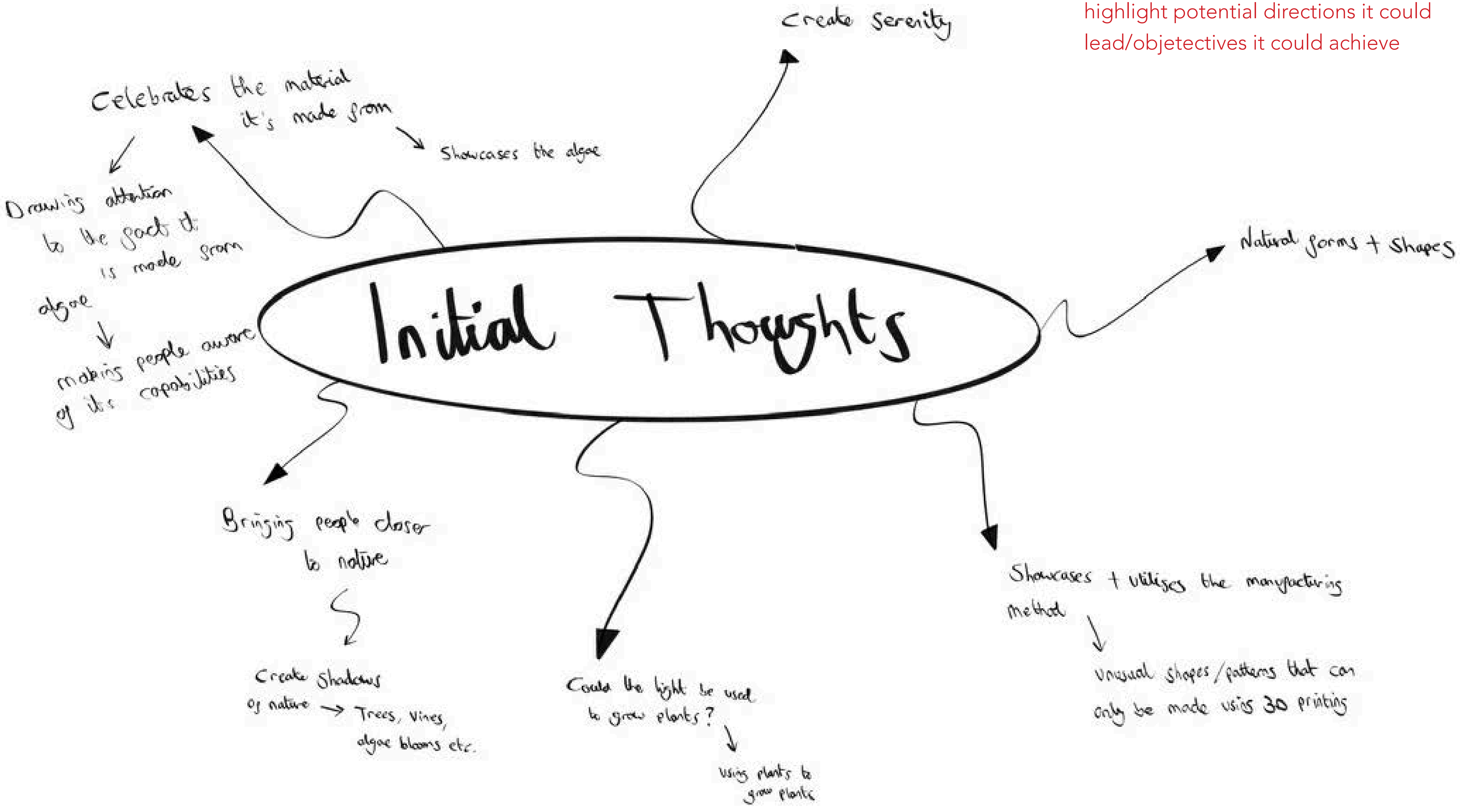
Written: 03 January, 2023 3:21 PM - 03 January, 2023 3:22 PM

Submission View

released: 06 September, 2019 3:44 PM

Congratulations, your project has obtained a favourable ethics opinion!

I created a mind map of some inital thoughts surrounding my project to highlight potential directions it could lead/objetectives it could achieve



Plastics.

How can more sustainable materials be used to replace plastic and help reduce the amount going to landfill? Could it solve the problem of single use plastic, by either being long-lasting, or by making single-use plastic biodegradable, reducing the amount of plastic going to landfill?

Synthetic polymers are substances that are obtained from crude oil. Plastics are particular types of synthetic polymers that are notoriously damaging to the environment.

Plastics are used in a huge variety of industries across the globe, with "**140 million tonnes** being manufactured worldwide each year."

There are 2 main issues with plastics. Firstly, they are derived from crude oil, the extraction of which causes huge amounts of air, water, visual and noise pollution. Oil is a fossil fuel that produces harmful greenhouse gases, contributing to global warming.

Secondly, the majority of plastics are extremely resistant to physical and chemical degredation. "Around **80%** of all plastics consumed worldwide end up in landfill, or the natural environment". When in landfill, plastics may not decompose for thousands of years, releasing harmful and toxic chemicals into soil and water.

"Around the world, one million plastic bottles are purchased every minute, while up to five trillion plastic bags are used worldwide every year. In total, half of all plastic produced is designed for single-use purposes – used just once and then thrown away." - United Nations Environment Programme

Plastics.

Over the past decades, the use of plastic has rapidly increased, due to a number of reasons. For example, a rising global population, improved quality of life and higher income etc, has created a throw-away society that relies on cheap, easily accessible and single-use products. What is the need to fix a broken product, when we can afford to quickly and cheaply buy a replacement? This attitude and way of life is part of the reason plastics have become such a popular material for manufacturers. However, the devastating effects they are having on the planet, means it is time to move away from and rely less on this unsustainable material.

Bioplastics.

Bioplastics, by definition, are plastics made from renewable biomass sources, such as plants or other biological material. They are an alternative to plastics made from petroleum.

The majority of bioplastics are made from vegetable oils and starches, most commonly found in crops, such as corn and sugar cane. These are renewable resources, meaning the source of the plastic can be infinitely regrown and will never run out.

In contrast, synthetic plastics are derived from fossil fuels, which are not a renewable resource and will eventually run out, as they are in limited supply.

There are two main types of bioplastics - Polylactic acids (PLA) and polyhydroxyalkanoates (PHA)

Do bioplastics have the potential to completely replace synthetic plastics? I need to explore the different types of bioplastics, look into what they are currently used for and analyse the pros and cons. Are they as good as they sound?

Does the processing of the bioplastic require high amounts of energy/heat? If so how does this compare to regular plastic and is it anymore beneficial? Look into properties of the material and look into alternative bioplastics.

PLA.

PLA is generally made from the sugars found in cassava, sugarcane or corn starch.

To create plastic from corn, the kernels are submerged in hot water + sulfur dioxide to break them down into protein, starch and fibre. They are then ground to separate the oil from the starch and mixed in with some citric acids.

This creates a polymer with a chain of molecules, which is very similar to that of plastics derived from petroleum.

PLA is commonly used in 3D printed prototypes, biodegradeable medical devices, food packaging and disposable tableware

There is an assumption that because PLA is a bioplastic that this automatically means its the perfect solution to fossil fuel based plastics. It is also labelled as being biodegradeable, so it is assumed that it can be composted. However, PLA is not as perfect as it seems and whilst it is significantly more environmentally friendly than synthetic plastics, there are still a number of drawbacks.

PLA.

Here I have compared the pros and cons of PLA. Whilst it is a bioplastic and there are certainly a large number of benefits, which make it more sustainable than regular plastic, there is also a long list of negatives. This shows that it is by no means a perfect solution and there is still lots of room for improvement when it comes to finding a sustainable alternative to plastic. Could algae-based plastic be a solution?

+

+ Made from renewable materials
+ Reduced carbon footprint compared to plastics derived from fossil fuels
+ Crops absorb CO_2 whilst growing
+ Less greenhouse gas emissions to source and produce than synthetic plastics
+ Lower melting point means less energy required to process
+ No toxic fumes when processed
+ Cheap for a bioplastic
+ Compostable (but only in industry conditions)
+ Sequesters carbon
+ If incinerated, emits less toxic fumes than synthetic plastics
+ When decomposing, they only release the carbon they sequestered back into the environment, making them carbon neutral

−

- More expensive than fossil fuel based plastics (this could change as oil prices increase)
- Uses food crops, which takes up valuable agricultural land
- With an increasing population, food crops are becoming more and more vital to prevent food shortages. It could be argued that using food crops, such as corn, for plastic rather than food is a waste.
- Crops are also often grown using harmful pesticides, fertilizers and growth hormones. Growing more encourages this
- Will not compost in natural conditions
- Doesn’t add nutrients to soil when it composts
- Makes soil more acidic
- Lower melting point means it can’t be recycled alongside other plastics and it is not commonly used enough to have its own recycling network
- Higher permeability means not suitable for long term food packaging

PHA.

PHA comes from microorganisms that produce a plastic from natural materials

To create plastic from the microorganisms, they are "deprived of nutrients like nitrogen, oxygen and phosphorus, but given high levels of carbon." This prompts them to produce PHA, which can be harvested and used, as its chemical structure is similar to regular plastic.

PHA is most commonly used for medical applications, like skin substitutes, bone plates and slings. Also used for single-use food packaging

PHA is a relatively new material and therefore is not widely available on the market. However, once implemented properly, it has the potential to be a much better alternative to both synthetic plastics and PLA. However, again this is not a perfect solution and there are still a variety of issues.

PHA.

When comparing the pros and cons of PHA, I learnt that it seems to be a more sustainable material to both plastic and PLA. Its list of disadvantages is far shorter than other matierals, however, these are quite difficult negatives to overcome, such as expense and difficulty of production. Whilst PHA is more sustainable than both plastic and PLA, there is still a way to go before it can be used on a large scale.

+

+ Made entirely from renewable resources
+ Completely biodegradeable in natural conditions
+ Completely compostable in natural conditions
+ A PHA plastic bottle can biodegrade in natural conditions in less than 5 years and sometimes just 18 months
+ In industry conditions can compost within just 90 days
+ Doesn’t leave behind any microplastic particles when decomposing
+ Biocompatiable, which means they can be used for medical devices
+ Don’t require agriculatural land use
+ Completely non-toxic

−

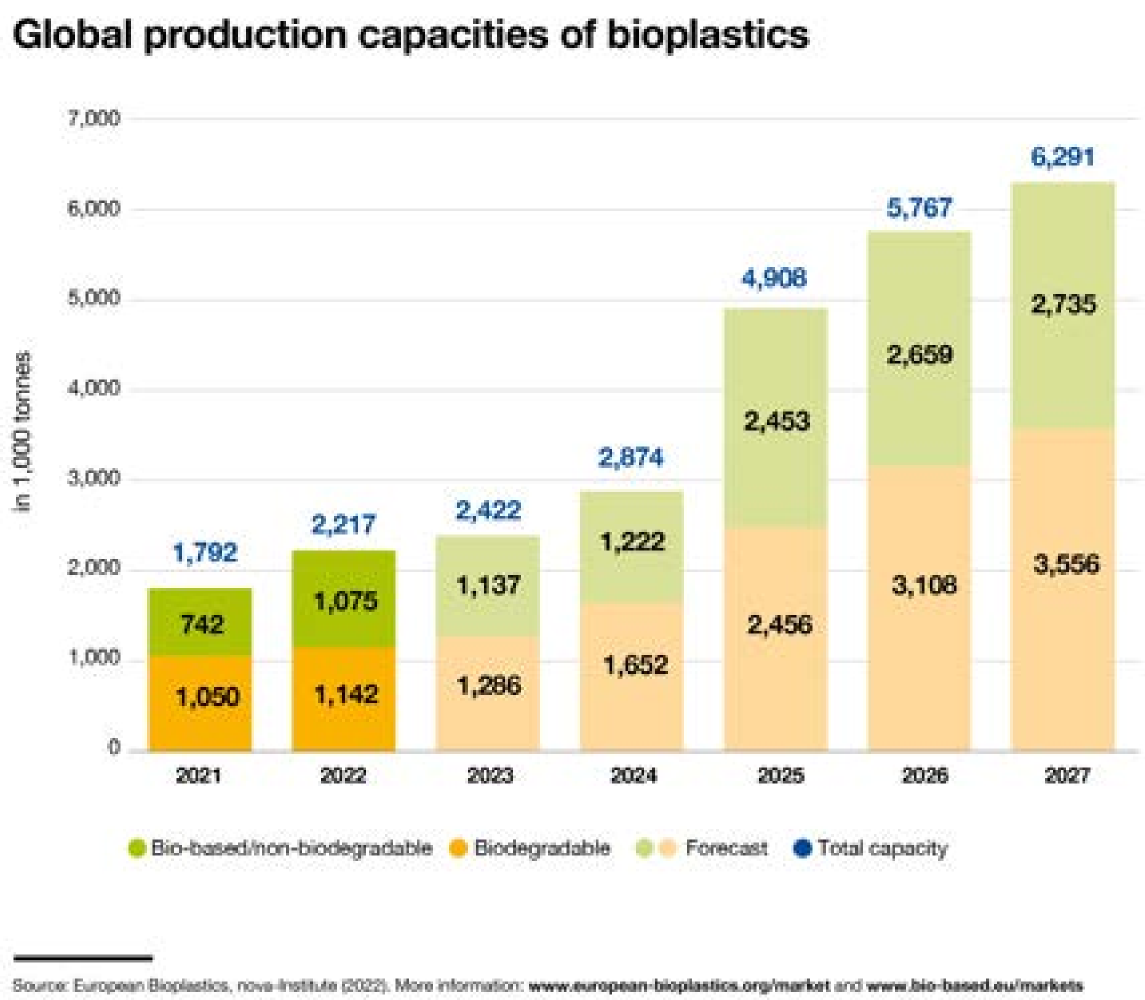
- Still in early stages, so not commercially available
- Genetically engineering the bacteria/microorganisms can be challenging
- Expensive to produce
- Small production amounts, as made from microorganisms, yet high cost

Bioplastics Market.

The bioplastics market has rapidly accelerated in recent years and is predicted to continue doing so. This shows the potential that bioplastics have and the belief in them to benefit the environment and act as a sustainable alternative to plastics made from fossil fuels.

These 2 graphs show how the bioplastic market has grown in the last couple of years and how much it is predicted to grow in the coming years.

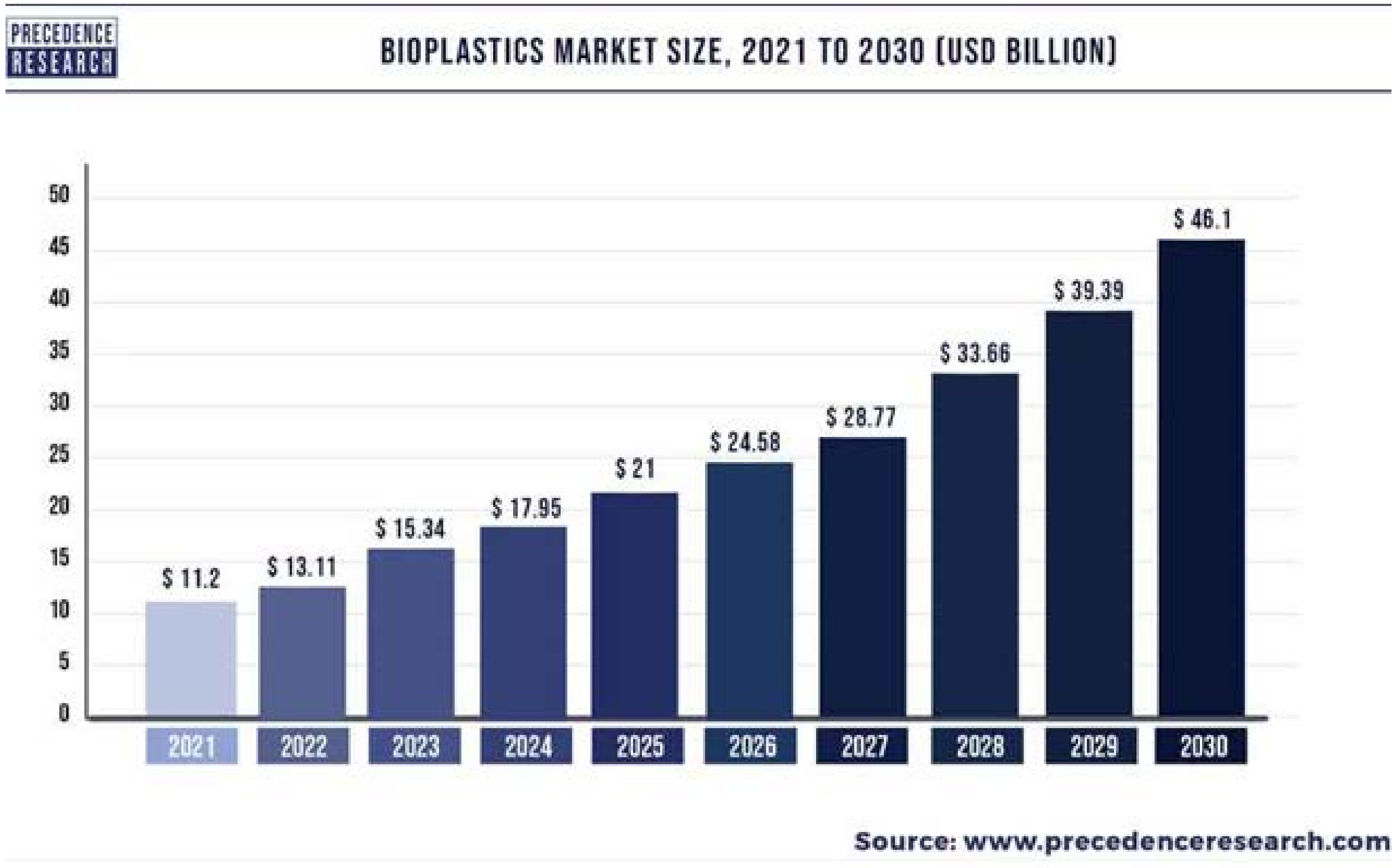
The first graph shows the global production capacities of bioplastics. **In 2021 you can see that 1.79 million tonnes of bioplastics were produced with nearly 59% of these being biodegradable.** This is predicted to slowly increase until 2024, before a huge jump in 2025, which will see bioplastic production double. According to this graph, **by 2027, 6.29 million tonnes of bioplastics will be produced, 3.55 million of which will be biodegradable.**



Bioplastics Market.

The second graph shows the economical potential of bioplastics. **In 2021, the industry was estimated to be worth $11.2 billion USD.** This is forecasted to more than quadruple in the following 9 years, resulting in an industry **worth $46.1 billion in 2030.**

The rapid growth of the bioplastic industry in recent and coming years is evidence of their perceived value, both economically and environmentally. As the market grows, more and more bioplastics will be produced, hopefully reducing our reliance on synthetic plastics. This reinforces the potential of my project and shows that bioplastics are looked at as the future of materials.



Time Management.

In Week 2, I only planned a small amount of work to do, as we were going on the trip on Thursday morning. However, once I had completed this work, I also managed to do a few initial sketch pages, which I hadn't included in the time plan. This meant that I was more productive this week than I planned to be, which benefitted me more going forward, as I completed extra work.

WEEK 2

16.01.23

To Do List

- Start research into algae ✓

  ↓

  what is it? How does it compare to trees? Properties, other uses? ✓

- Contact Luke + Chris about using 3D printers with algae filament ✓

To Attend

Monday – Studio: 9-5 ✓

Tuesday – Work from home ✓

Wednesday – Lectures: 10-12 ✓

Thursday –
Friday – TRIP! ✓

Algae

What is it?

Algae is a diverse group of aquatic plants that consists of seaweeds and single cell organisms. There are 2 main types of algae based on cellularity - Microalgae and macroalgae.

Macroalgae are larger, multicellular organisms, such as seaweed. Microalgae are much smaller, microscopic single-cell organisms.

Algae grows in bodies of water, such as ponds, lakes, rivers and oceans. It is a photosynthetic organsim, meaning that algae absorbs C02 from the atmosphere and produces oxgyen in return, purifying the air and the water it grows in.

Algae

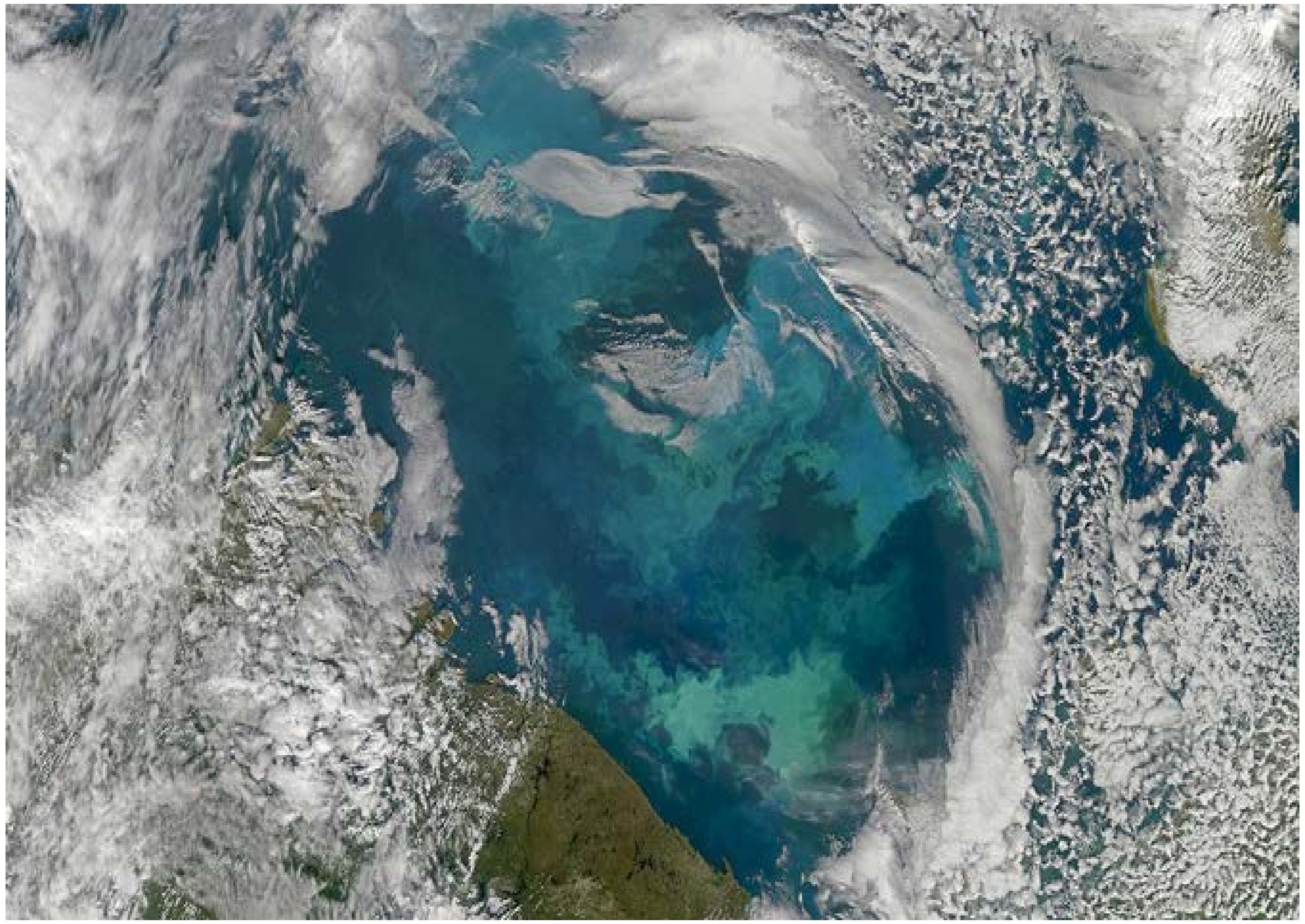
Algae vs Trees

If algae is so much better at absorbing carbon and producing oxygen than trees, then why do we view trees as the best solution to capturing carbon and providing oxygen? Could we grow more algae to help fight climate change. Could the algae being grown be used for other purposes?

Algae is incredibly benficial for the environment in a number of ways and could be a key factor in fighting climate change.

Algae is much more efficient at photosynthesizing than trees and its ability to remove C02 from the atmosphere is something which needs to be utilised more. Just one acre of algae can remove around 2.7 tonnes of C02 per day from the atmosphere. That is at least 50 times faster than the equivalent in terrestrial plants. It is also much faster growing and covers a vastly greater area than trees, therefore absorbing far more carbon.

Additionally, it is commonly assumed that trees are largely responsible for the production of oxygen in the earth's atmosphere. However, only around 28% of the Earth's oxygen is produced by inland plants and trees. The remaining 70% is produced by phytoplankton (microalgae) and other aquatic plants.



An ocean filled with phytoplankton

Algae

Other Uses

Aside from its incredible environmental benefits, algae also has an array of alternative uses. Algae is used in everyday circumstances that we are unaware of and is also predicted to become more widely used in the near future.

Food

- Algae is gradually becoming a ‘superfood’ and has many nutritional benefits that make it stand out from other plant-based food sources, such as soy. Microalgae is around 50-60% protein and (unlike soy) the protein doesn’t have to be isolated to remove it from the food. All of the microalgae can be used as a food source, as it also contains huge amounts of nutrients, such as vitamins, minerals, fibre, fats and is a great source of Omega 3.

- “One study showed that compared to a crop like soybeans, a single hectare of algae ponds generates 27 times as much protein.”

- Algae is predicted to become a much more prominent food source in the future. The ever increasing population will cause food shortages, meaning that more crops will need to be grown, taking up more land space. Algae grows in water, meaning it takes up no agricultural land space.

Algae

Other Uses

By looking into the other uses of algae, it provides even more justification for growing it. For my project, I am looking into using algae as a plastic, however all of these other functions prove how beneficial it could be to grow and utilise more algae, not just for environmental benefits.

Materials

- Algae is being used in plastics, carbon fibre and even in the fashion industry for clothes and shoes. It can be used in conjunction with other materials to create new, biodegradable and environmentally friendly alternatives to synthetic materials

Medicine

- Marine algae is being used in the pharmaceutical industry, playing a role in anti-cancer drugs, antibiotics, antiviral medicine and targeted drug delivery

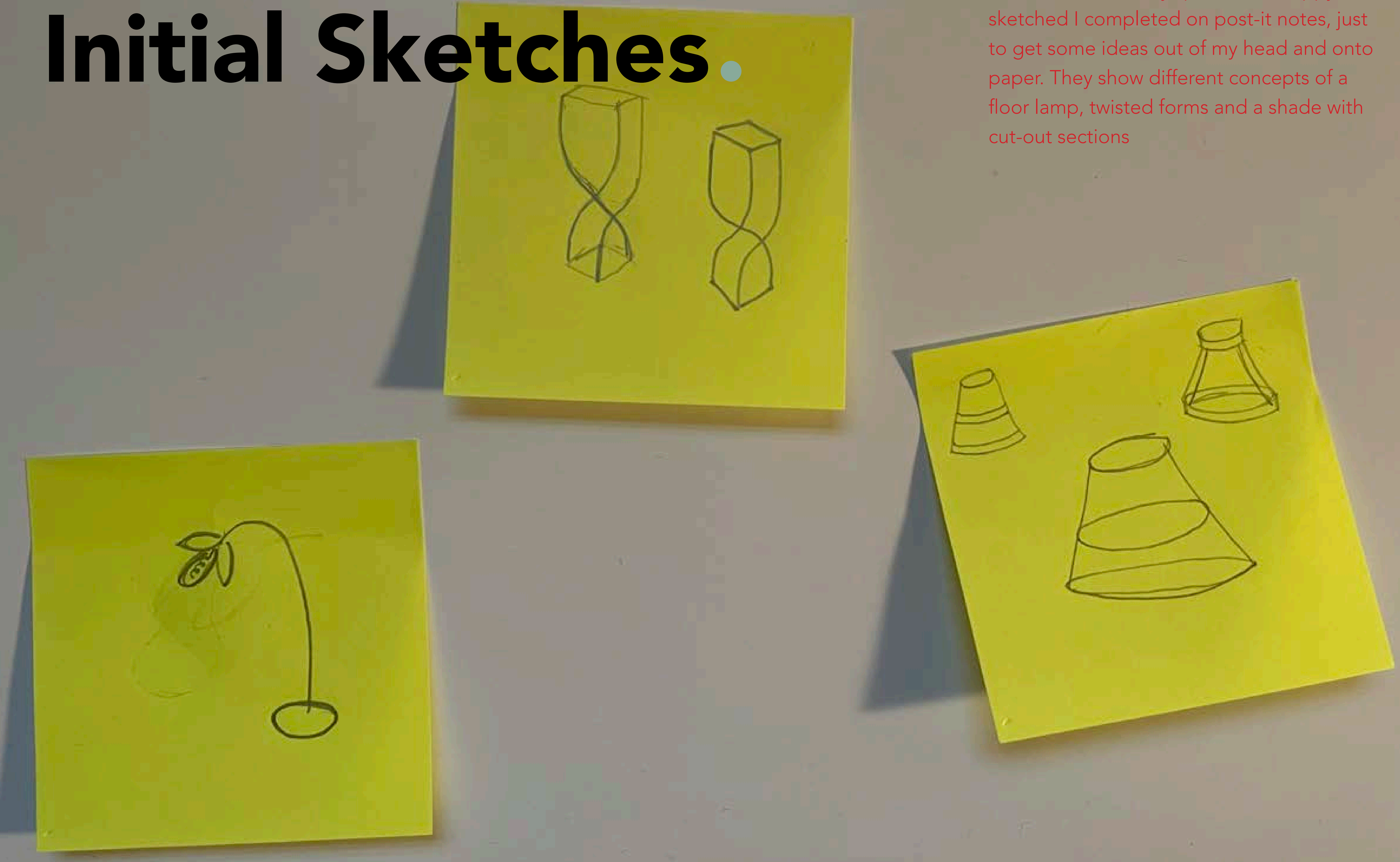
Further Uses

Algae is also being used in:

- Vegan eggs
- Food colouring
- Bio diesel - just one acre of algae can produce 2000-5000 gallons of fuel
- Bio jet fuel
- Animal feed
- Fertilizers
- Cosmetics
- Lubricants

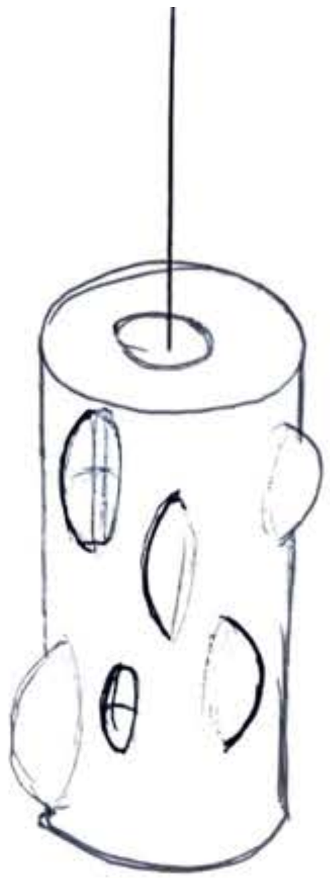
Initial Sketches.

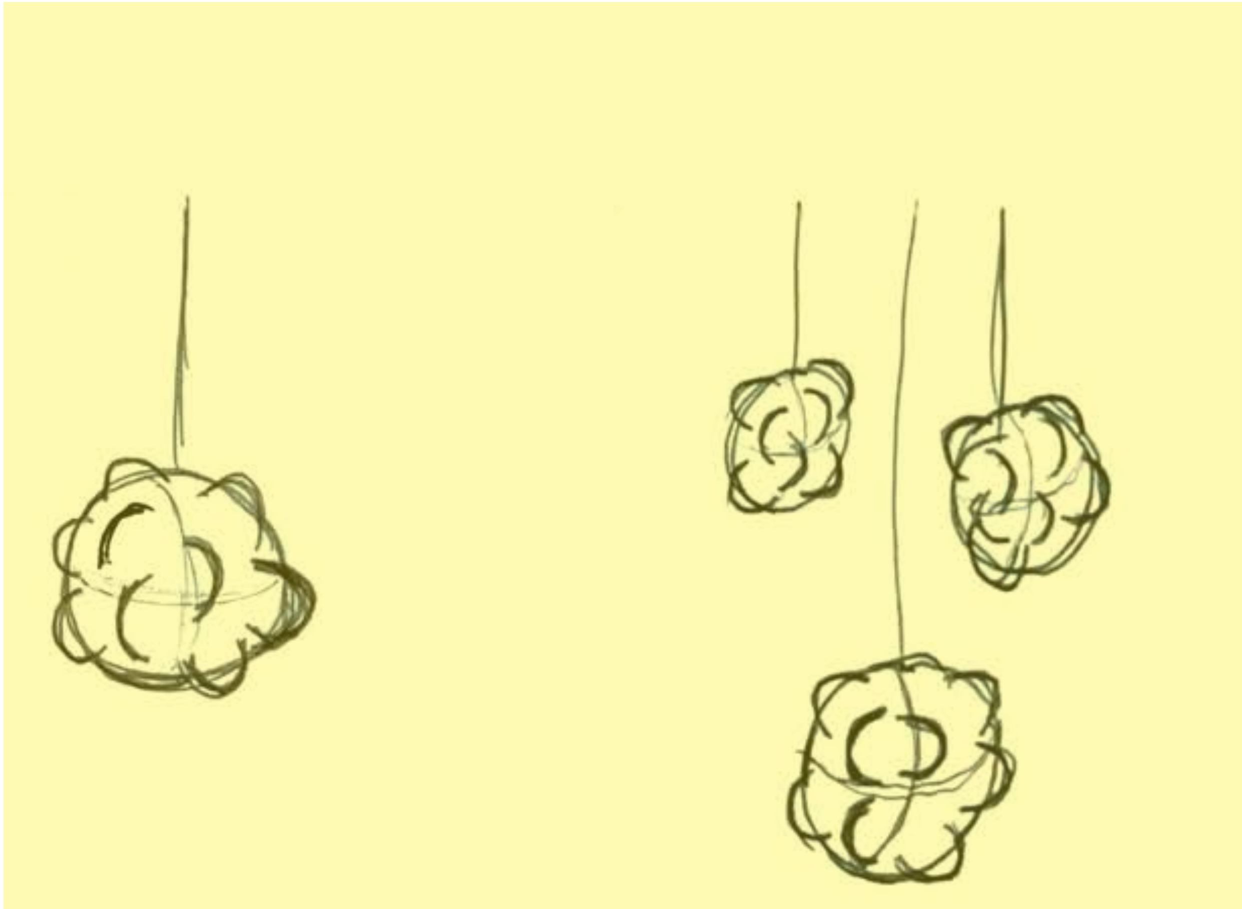
These are some very quick and scrappy sketched I completed on post-it notes, just to get some ideas out of my head and onto paper. They show different concepts of a floor lamp, twisted forms and a shade with cut-out sections



Initial Sketches.

Here are some sketches of initial ideas. I used the Crazy 8 method, where you start with an idea and divide the page into 8 sections, spending 1 minute on each design to develop the previous sketch. I find it a useful technique for rapid ideation.





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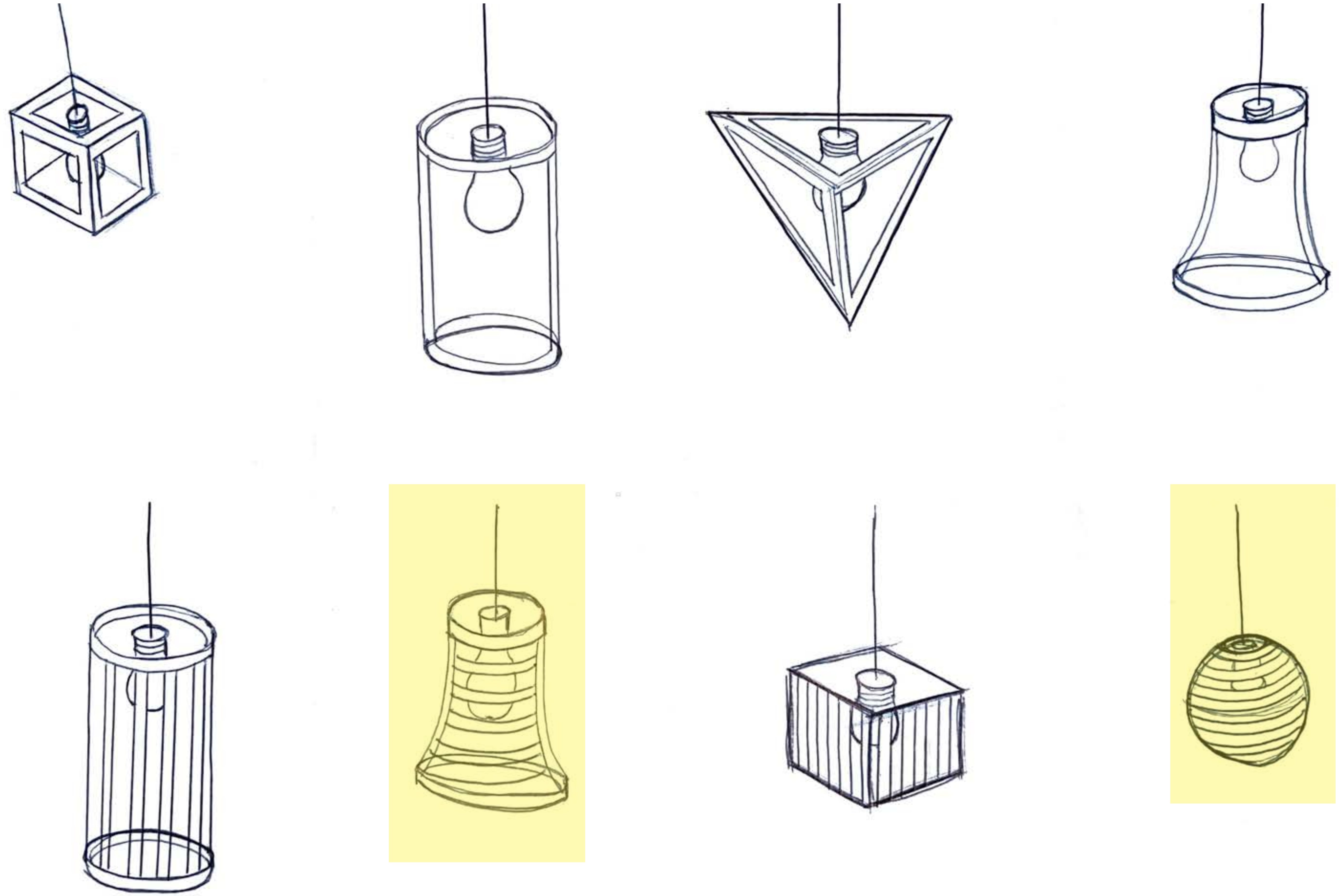

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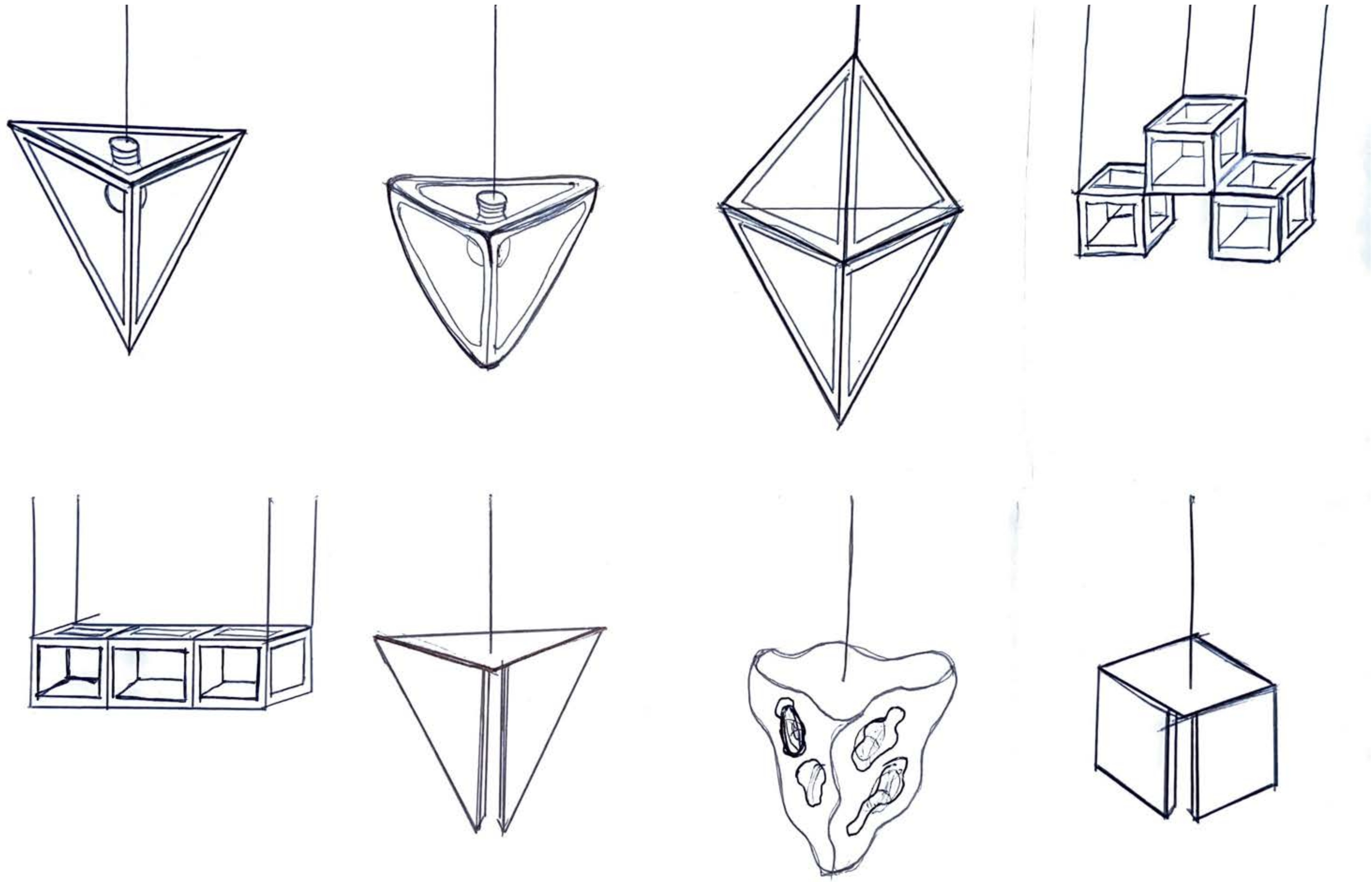

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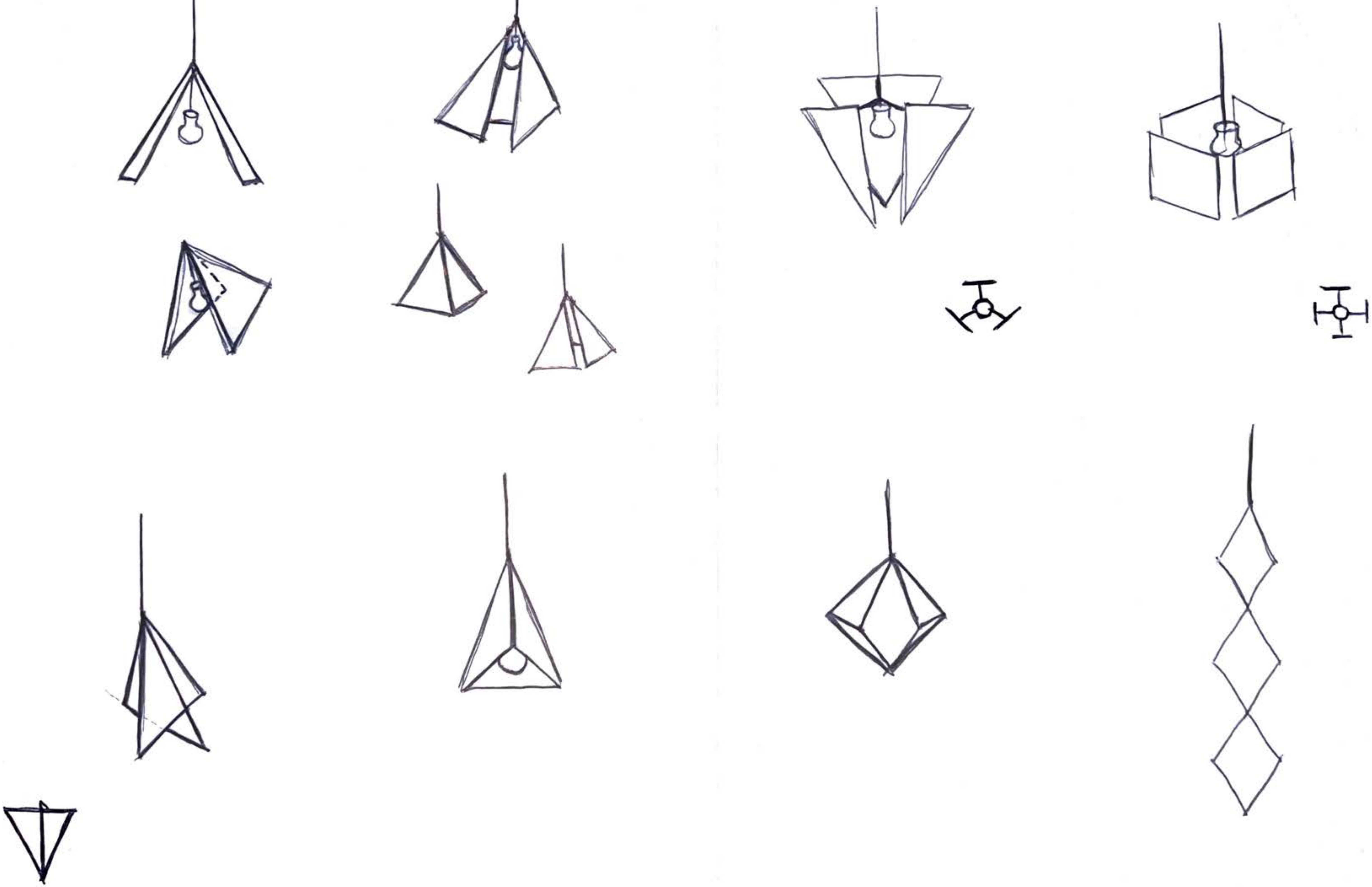

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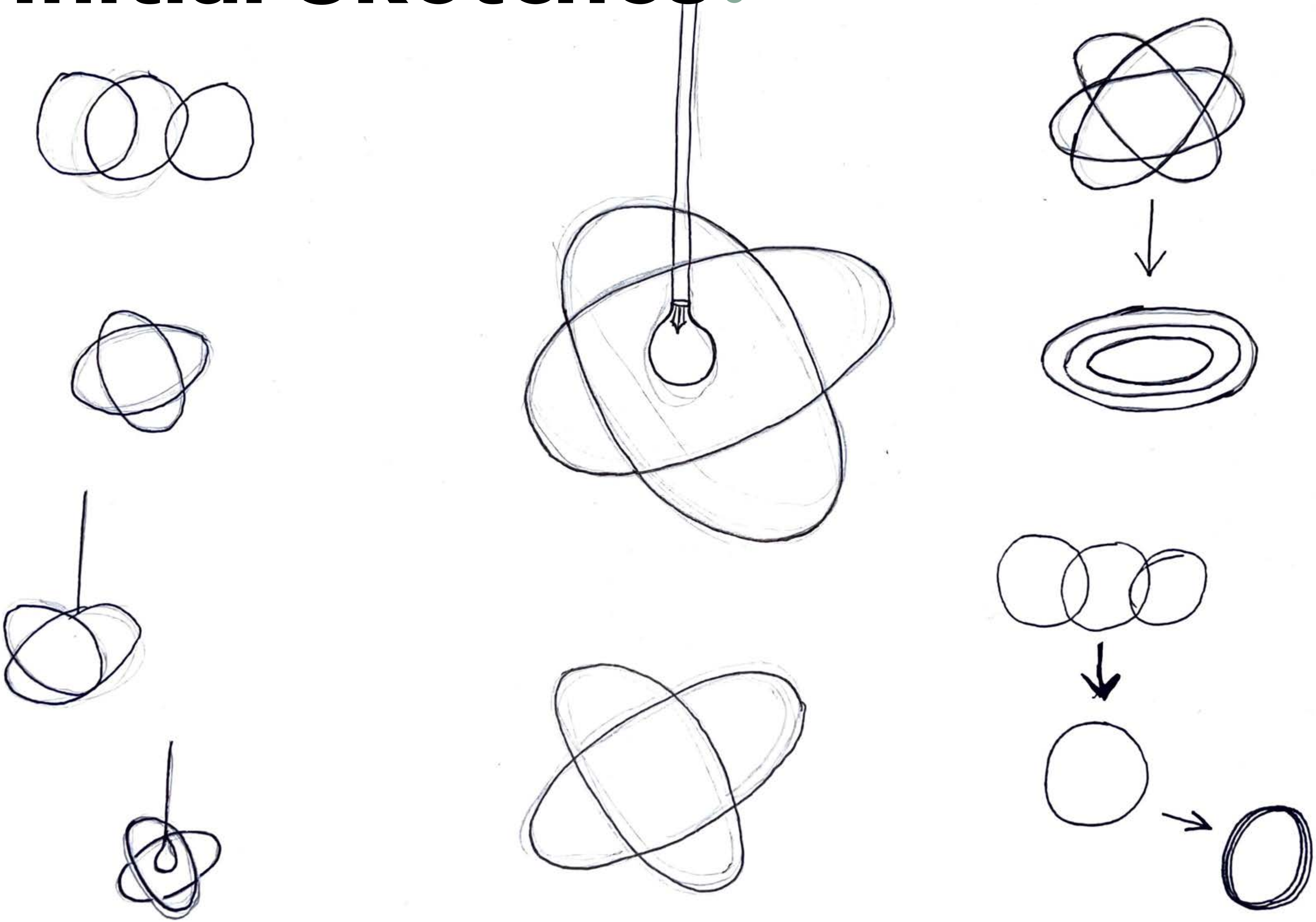

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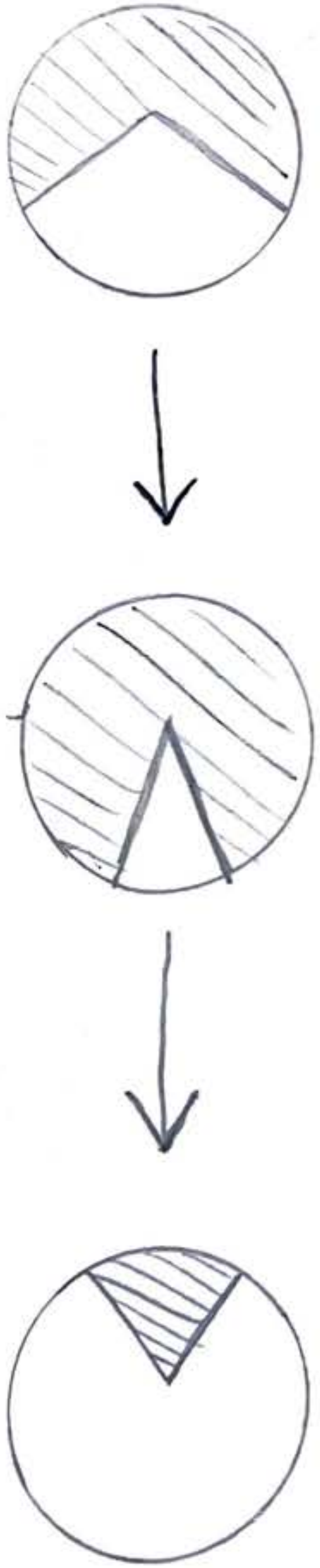

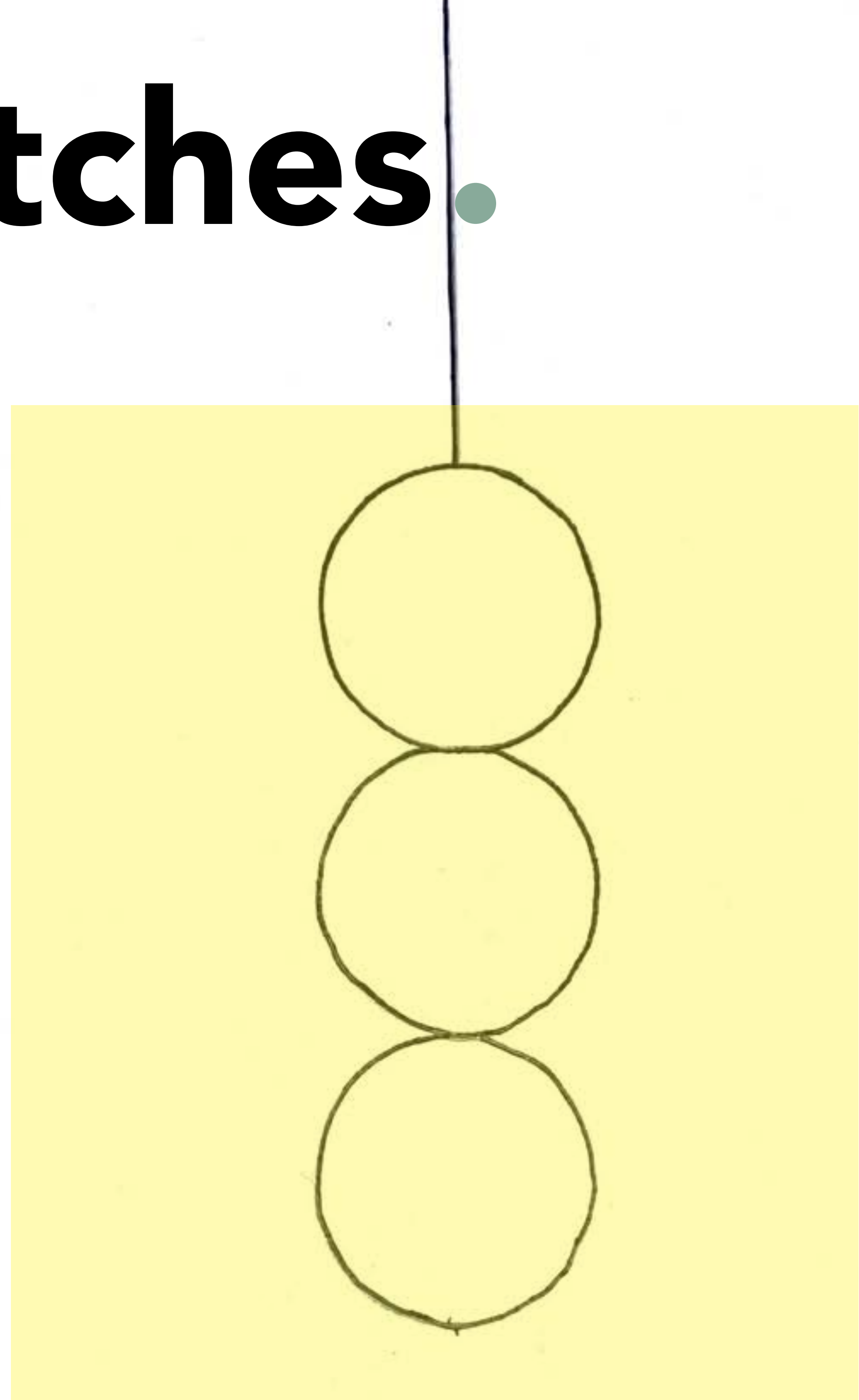

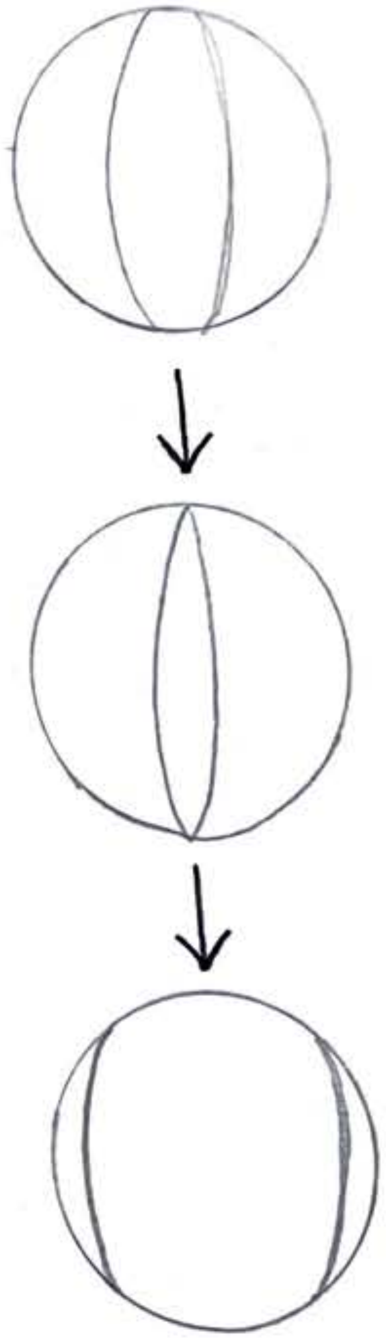

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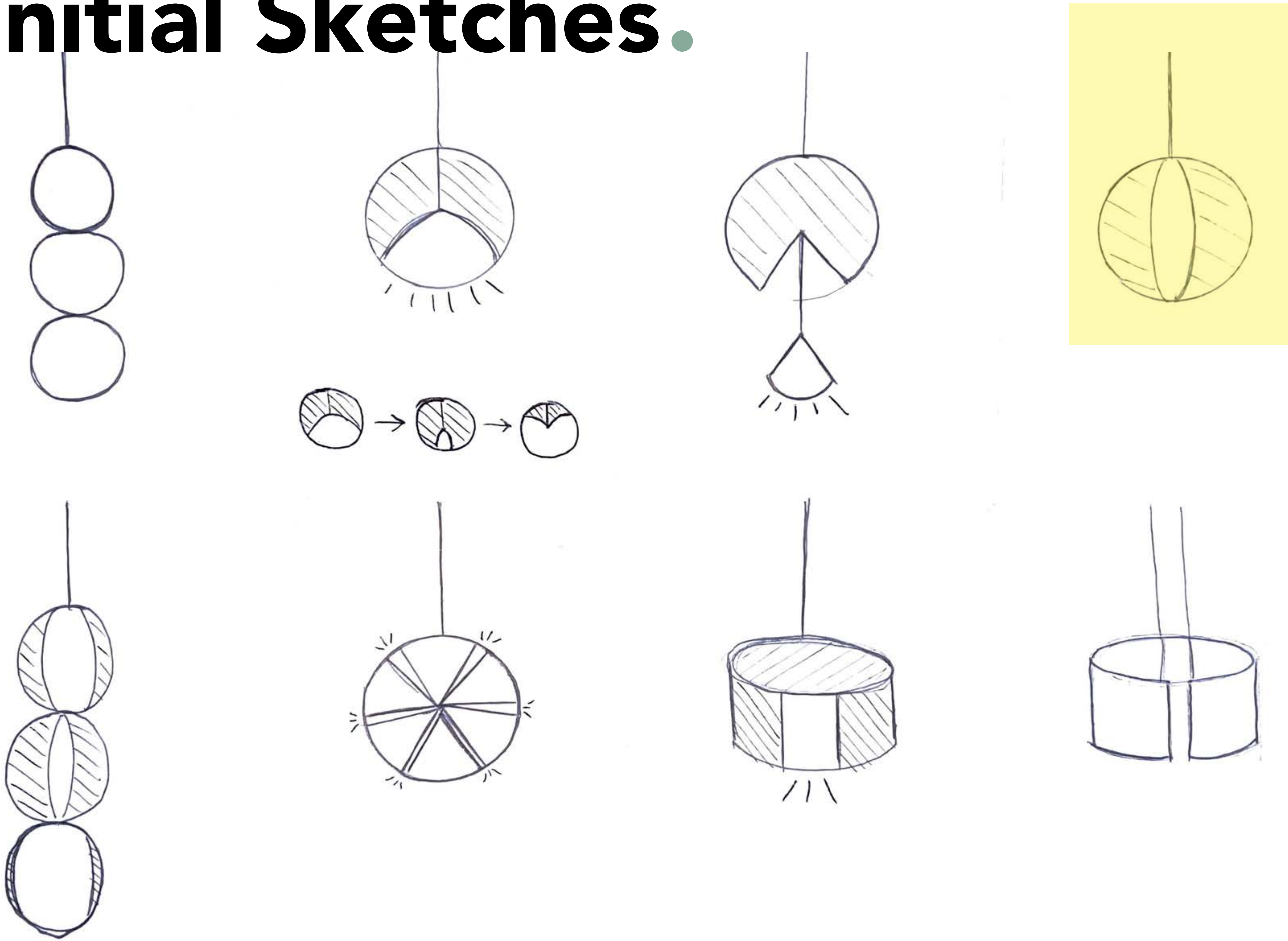

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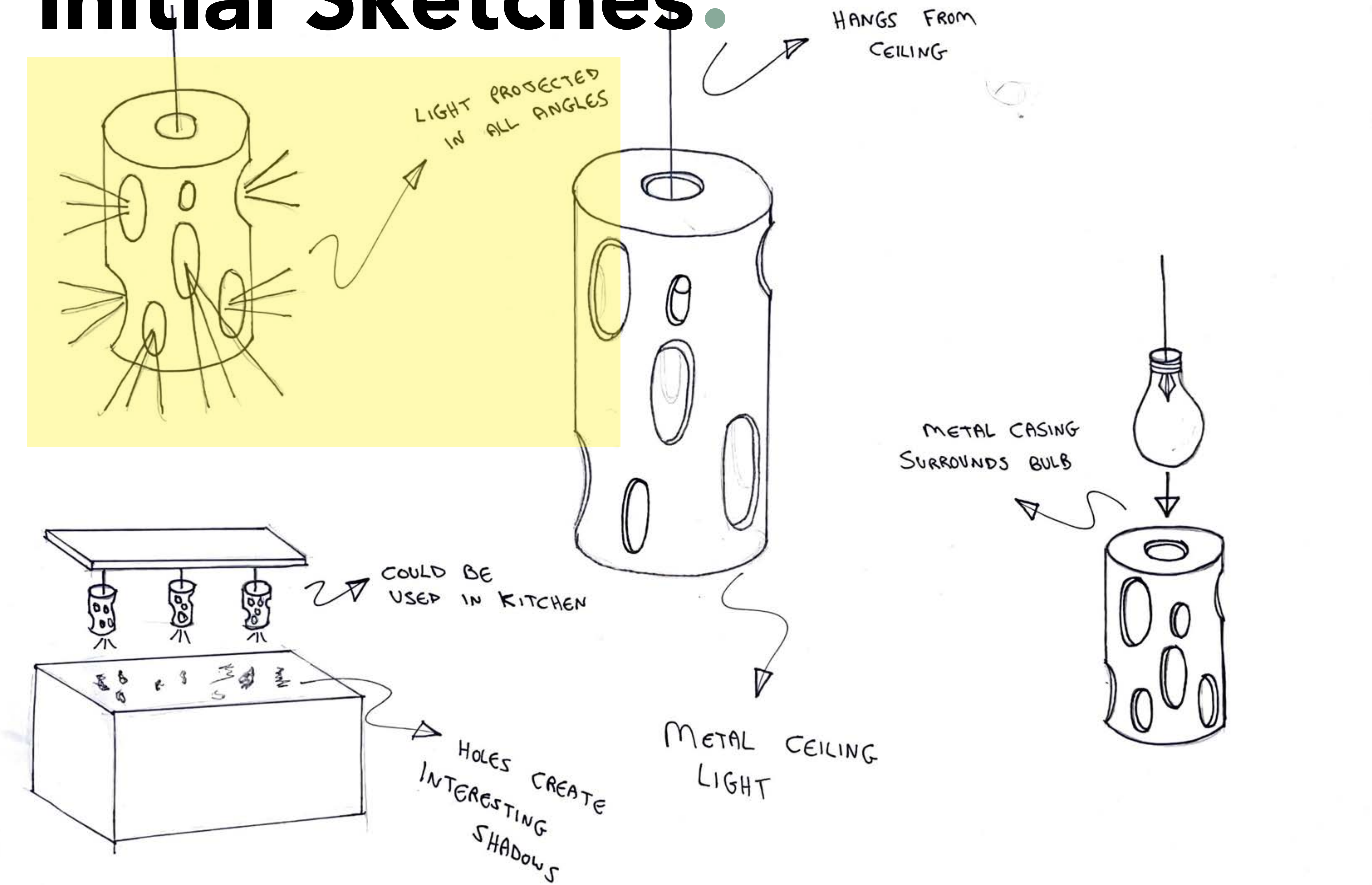

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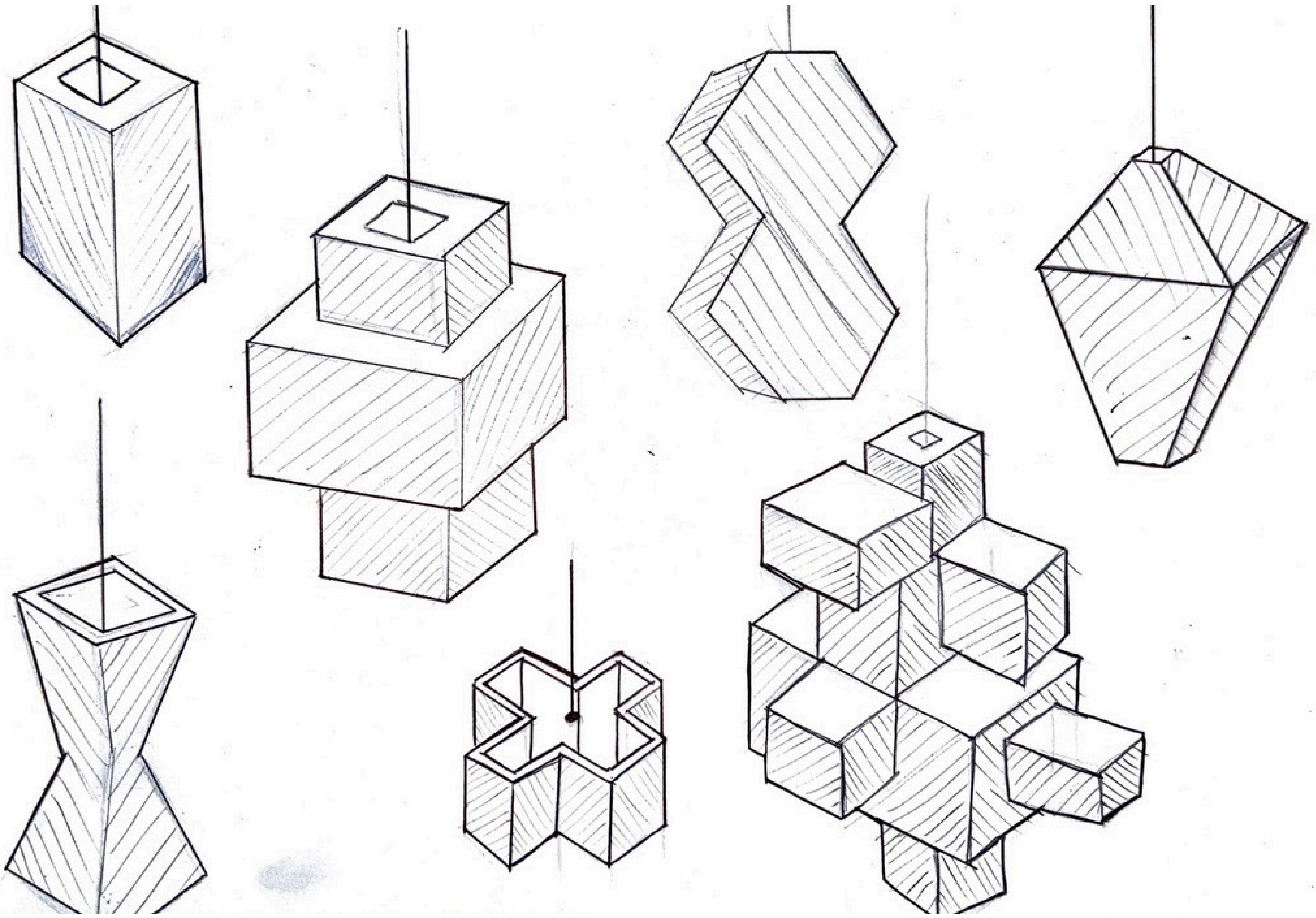


Time Management.

In Week 3, we were also on the trip for the first 2 days, so I did not get as much work done as I would've liked. However, I still managed to get some important research completed and most importantly 3D printed some samples out of algae filament. This was vital to my process, as I had to test the filament to ensure it printed accurately on the Creality printers at the uni.

Week 3

23.01.23

To Do List

- Further research into algae ✓
  ↓
  Toxic algae, algae blooms ✓
  Pros + cons of algae ✓
- 1 trillion tree pledge – why it's not as good as it seems ✓
- Print different algae samples ✓
  ↓
  Test how well it prints + what objects + shapes it is capable of printing

To Attend

Monday – TRIP! ✓
Tuesday –
Wednesday – Lectures : 10-12 ✓
Thursday – Studio : 9-5 ✓
Friday – Thesis tutorial : 12-12:30 ✓
CAD : 2-3:30 ✓

Algae Experimentation.

I found a recipe and video online with instructions on how to make algae-based plastic from your kitchen. I will not be using this for my porojext, as it cannot be 3D printed (which is what my project is about), however it is a good experiment to show the capabilities of algae and highlight how accessible it is.

Agar-Agar Base:

240ml water

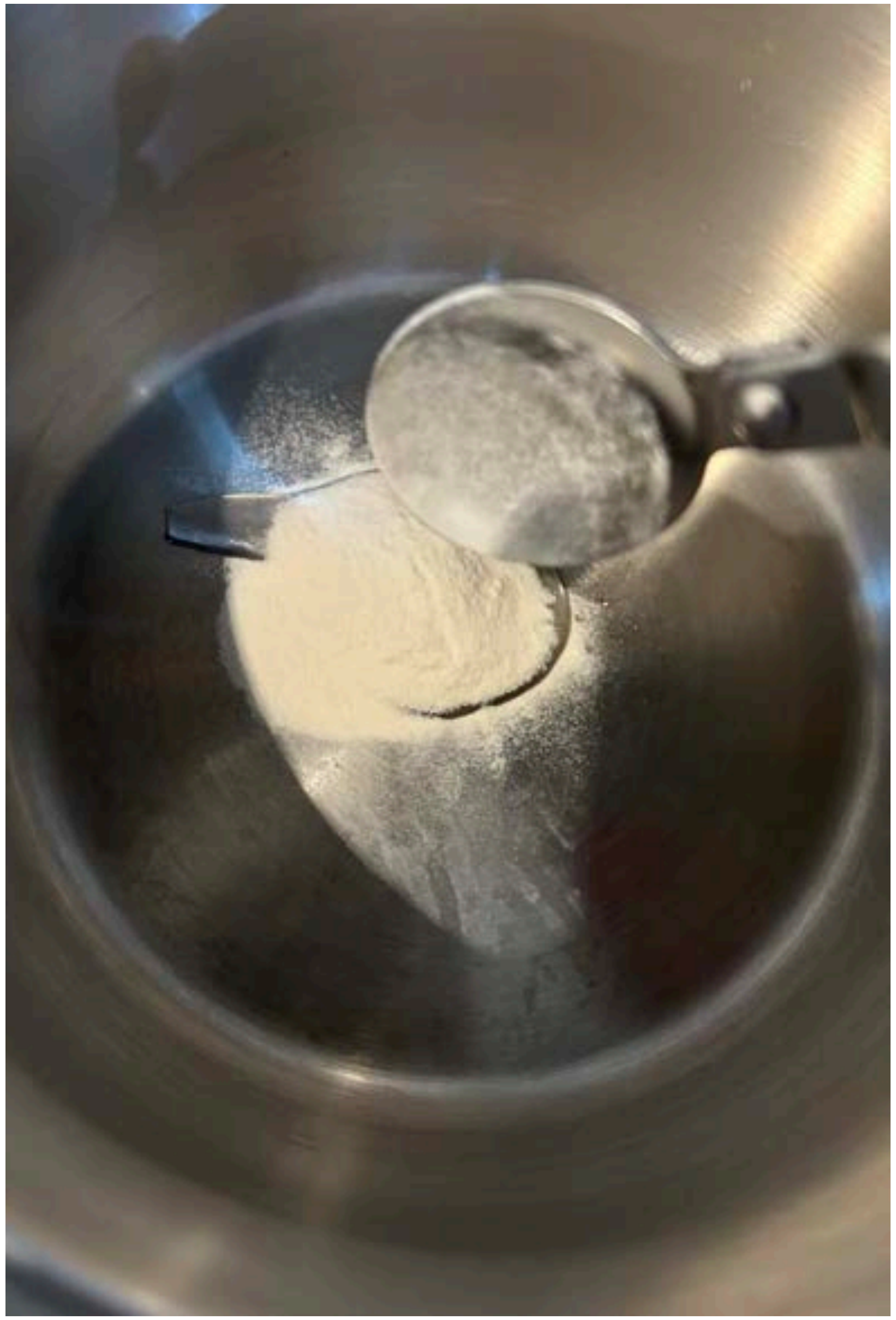
5g agar agar

5g dulse flakes

5ml glycerol

Experiment.

I began by making a mould using scrap pieces of wood and then glueing the sides together to make a frame. I also sealed the inside edges with hot glue to ensure the liquid would not leak out and sanded down the bottom so that it would sit flat on the surface.



Experiment.

Next, I weighed out all the ingredients and mixed them together in a pan, before bringing them to a boil. At first it was a very watery liquid, but after heating it became thicker and more viscous.

Experiment.

After boiling the mixture, I then added the spirulina (a bacteria from algae) for natural colouring. I mixed it in with some water before adding it to the pan and heating further. Finally, I poured the mixture into the mould and waited for it to set.

Experiment.

Once the mixture was in the mould, I waited a couple of hours for it to set, before lifting it off the baking paper to allow it to air dry. After around 6 hours it still was not any more dry in the slightest, so it was clear it would take at least a few days to dry, if it was going to dry at all, which is another reason why this version of algae-based plastic is not practical.

Experiment.

This was the final result of the experiment. The homemade algae plastic took about a week to dry out and even after that it still had a wet feel to it. The texture is strange and jelly-like and you could easily push your fingers through it, so it is not strong at all. However, I do like the appearance of the material, as it really looks natural.

Experiment Conclusions.

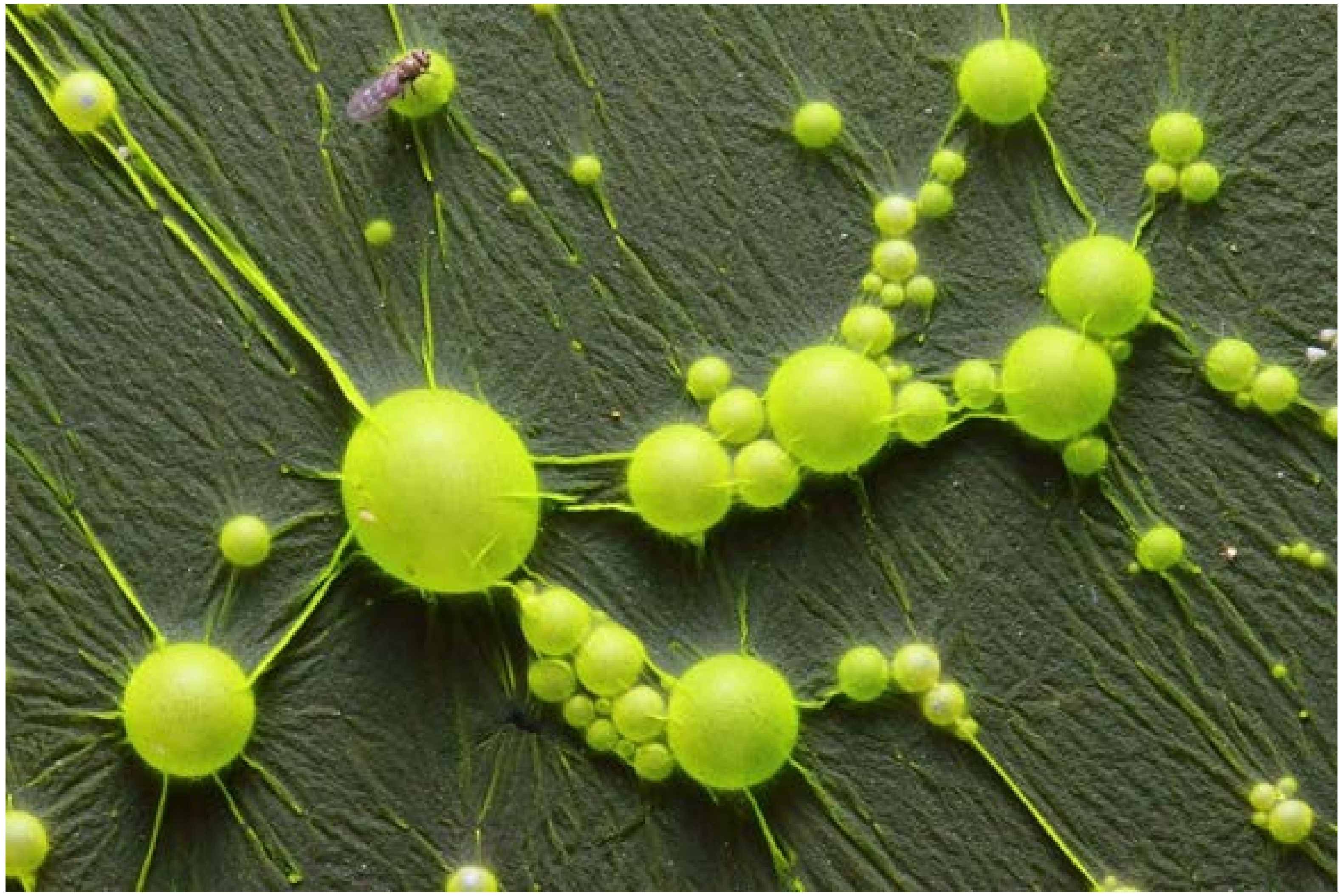
I carried out this experiment to test the capabilities of algae and see how potentially easy it was to manufacture algae-based plastic. I found it extremely easy to do and was pleased with the results, however, whilst it was an interesting experiment, I will not be using this material going forward, as it cannot be 3D printed, which is what my project is about.

I liked appearance of the material, however aside from that it would not be practical to use at all. It is very weak and can easily split/tear. It takes a huge amount of time to dry, meaning it would be very difficult to make larger pieces with or pour into a mould, as it just would not set.

By understanding the negative sides to algae, as well as the positives, it allows me to provide a balanced argument for the material I have decided to use. It also highlights areas for me to explore which could possibly counteract the negative aspects. For example, is there a method of safely using toxic algae or reducing the amount in our water?

Algae

Toxicity



Whilst algae has numerous environmental benefits, it is by no means perfect and there can be some negative consequences if not managed correctly.

Blue-green algae occurs naturally in bodies of water. It consists of cyanobacteria, which can be toxic to humans, animals and marine life. In small amounts, blue-green algae is not particularly concerning, however there are a number of factors which can cause the algae to rapidly multiply.

Toxic algae thrives in warm, still and salty water. Climate change is causing global warming, rising sea levels, storms and draught, all of which help create the perfect environment for toxic algae to grow. As the Earth's temperature increases, more and more toxic algae will begin to grow, polluting our water sources.

Algae

Blooms

Algae blooms are another negative impact of algae. They happen when algae begins to rapidly grow in a body of water, multiplying until it completely covers the surface. When it reaches an uncontrollable level, these harmful algae blooms can suck all the nutrients out of the water and block any sunlight and oxygen from penetrating the surface. They also release toxins, contaminating the water and killing off marine life, such as fish and other aquatic plants.

Algae blooms form when there is an excess of nutrients in the water, such as nitrogen and phosphorus. Toxic fertilizers and pesticides used for agriculture run off from the soil and seep into water sources. These contain the excess nutrients which rapidly accellerate the growth of the algae, leading to harmful algae blooms

Algae

This pros and cons list of algae seems fairly balanced and at a glance thereare quite a few negative impacts. However, all of these negatives are fairly easy to manage and the pros far outweigh the cons. Additionally, the toxic algae and algae blooms can still be utilised for materials, turning these negatives into positives

+ Absorbs large amounts of CO2 and produces oxygen
+ Purifies air and water in surrounding areas
+ Easily grows in any water source in varying conditions
+ Very fast growing (can double in size in 1 day)
+ Far more efficient at absorbing carbon and producing oxygen than trees and land plants
+ Responsible for 70% of Earth's oxygen
+ Numerous nutritional benefits means it is a superfood
+ Can be used for materials, medicine, fuel, cosmetics etc
+ Grows in water, so doesn't take up any agricultural land space, unlike other biomass sources

- Surface run off from agricultural land can add too many nutrients to water, causing certain types of algae to grow rapidly and become out of control
- Some algae is toxic and can be harmful to humans and marine life in surrounding areas
- The warming climate means that more toxic algae is growing
- If it gets out of control, algae blooms can form, which completely cover the surface of a water source, blocking any sunlight and oxgyen from reaching the marine life below
- Rotting algae in algae blooms releases methane - a potent greenhouse gas

1 Trillion Trees

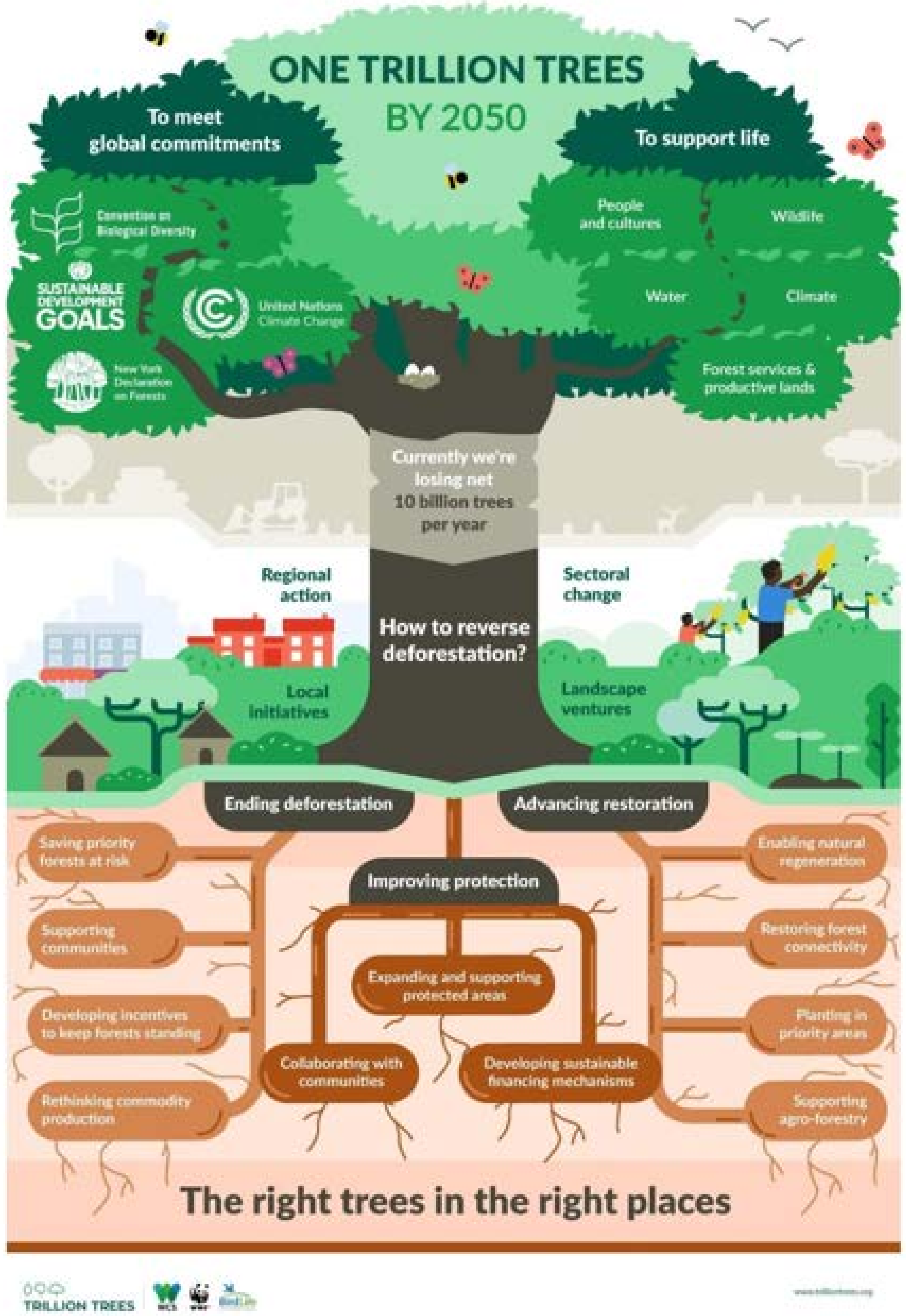
The Aim

The World Economic Forum has recently announced a new pledge to conserve, restore and plant 1 trillion trees worldwide. The goal is to restore biodiversity and combat climate change. Studies were carried out to provide the science behind this pledge, stating that it could help remove up to 1-2 thirds of all emissions in the atmosphere caused by humans.

However, whilst this pledge seems like a great solution, there are concerns surrounding the accuracy of the studies and the feasability of planting so many trees.

Critics claim that the studies have massively overestimated the amount of carbon that the trees will capture and it will actually only be around half of what was stated.

Could algae potentially be used as an alternative to this fairly unrealistic solution, but achieve the same outcome?



1 Trillion Trees.

The Problem

Algae could be a solution to a lot of the issues associated with planting this vast number of trees. It grows in water, therefore not taking up land space, grows rapidly and in a wide range of climate conditions.

There are a number of problems associated with such a large goal, particularly one seemingly without the proper research to back it up.

- Planting trees in areas that they don't belong can harm ecosystems

- Non-native trees can cause problems for local wildlife

- Planting trees in snowy environments that usually reflect the sun and heat back into the atmosphere, could turn these into dark patches that absorb heat instead, actually contributing to global warming

- 1 trillion trees will take up landspace equivalent to the entire USA and Canada combined and there is not enough land space available for this, especially with a growing population

- Trees don't grow quickly and can take up to 100 years to mature, meaning that even 1 trillion new trees won't be effective for a while

- Afforestation of this scale will use up valuable land space, which could instead be used for farming and food crops. The IPCC predicts that afforestation like this could increase food prices by 80% in the next 30 years, driving millions more people into starvation

Samples.

I created some 3D printed samples using Algix algae-based PLA, which I research in more detail in a later page. I printed some simple shapes just to test if it would print properly and accurately, as our printers are not the most reliable and experimental filaments can sometimes fail. I was pleased with how it turned out and I found the aesthetic of the material beautiful.

Samples.

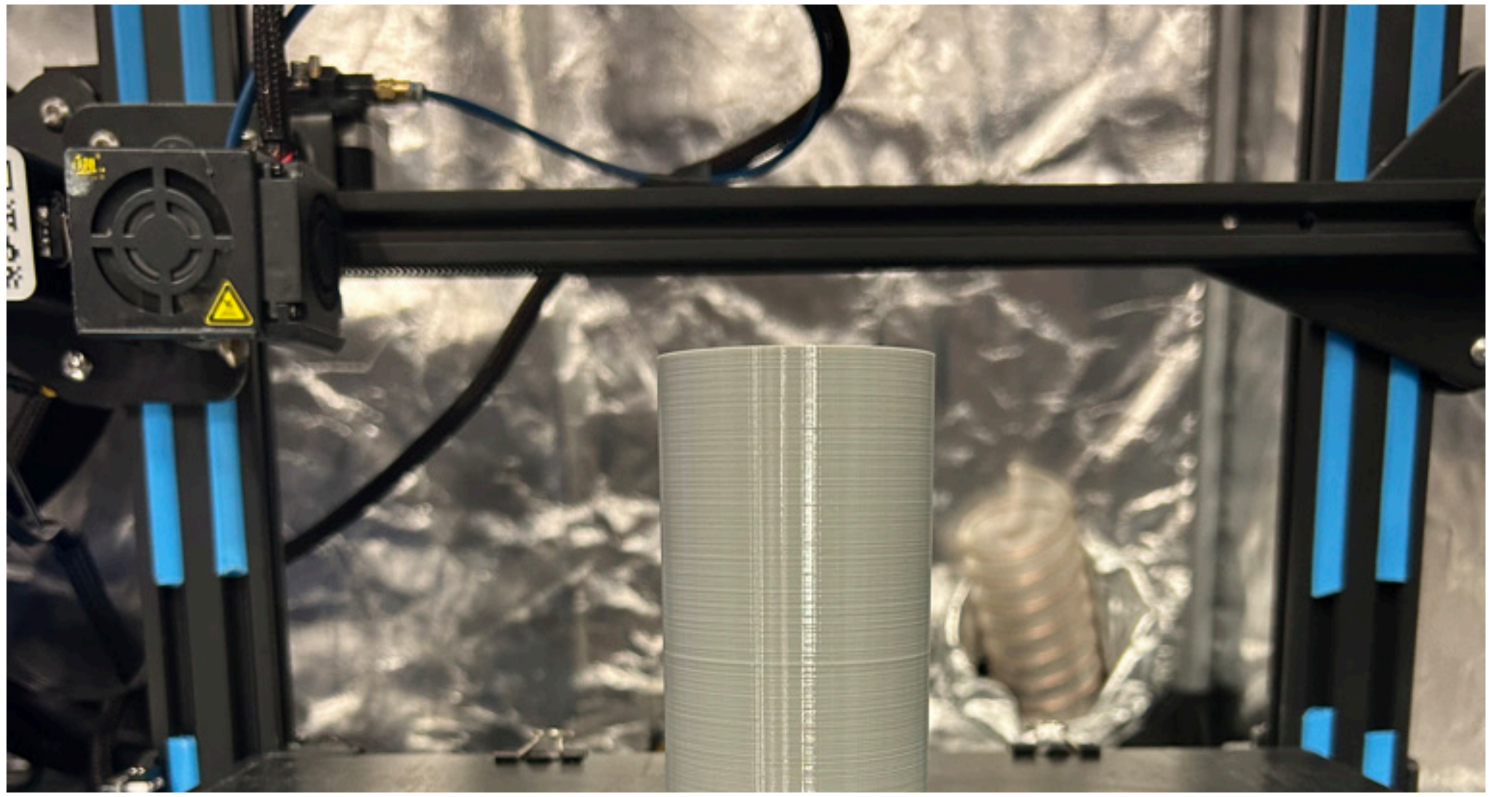
Here I printed one cylinder using regular PLA and one using algae-based PLA. This shows the difference in materials and allowed me to compare aesthetics and how easily they printed. I found the regular PLA slightly more consistent when printing, however this was only a marginal difference and the overall aesthetic of the algae filament I believe is much better and looks far more natural and less plasticy.

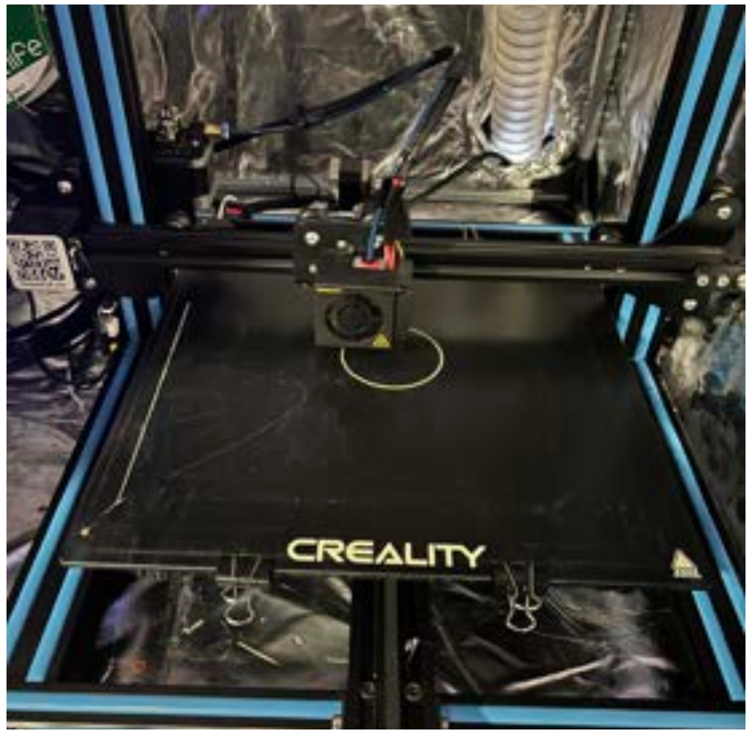
Samples.

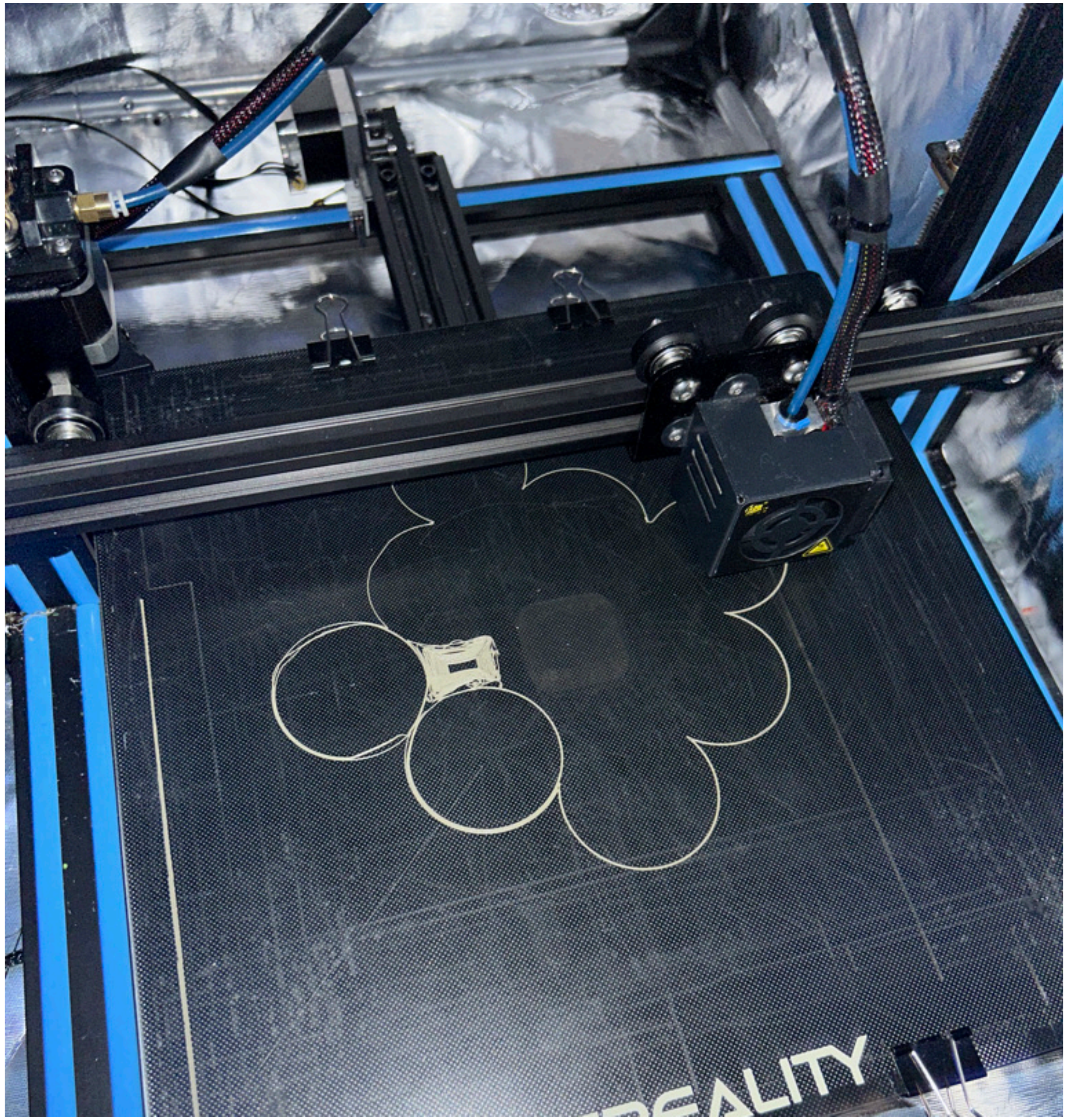
I then printed some samples of cylinders in various thicknesses to test how the strength varies between thicker pieces. For some reason this print stopped half way through, potentially due to the nozzle being clogged by the filament. Despite this the shapes turned out fine, just shorter than they were meant to be. The filament also creates some string, which intially looks messy, but peels off easily.

Errors.

Initially, I found the printer difficult to work with, especially when using the algae filament. I ecountered some problems which can be seen in these photos. For example, the filament wasn't extruding properly and was stringing and clogging the nozzle. It also wasn't sticking to the bed properly causing failed prints. To overcome this, I reduced the temperature of the nozzle from 210-195 degrees and found it printed much neater and more accurately.





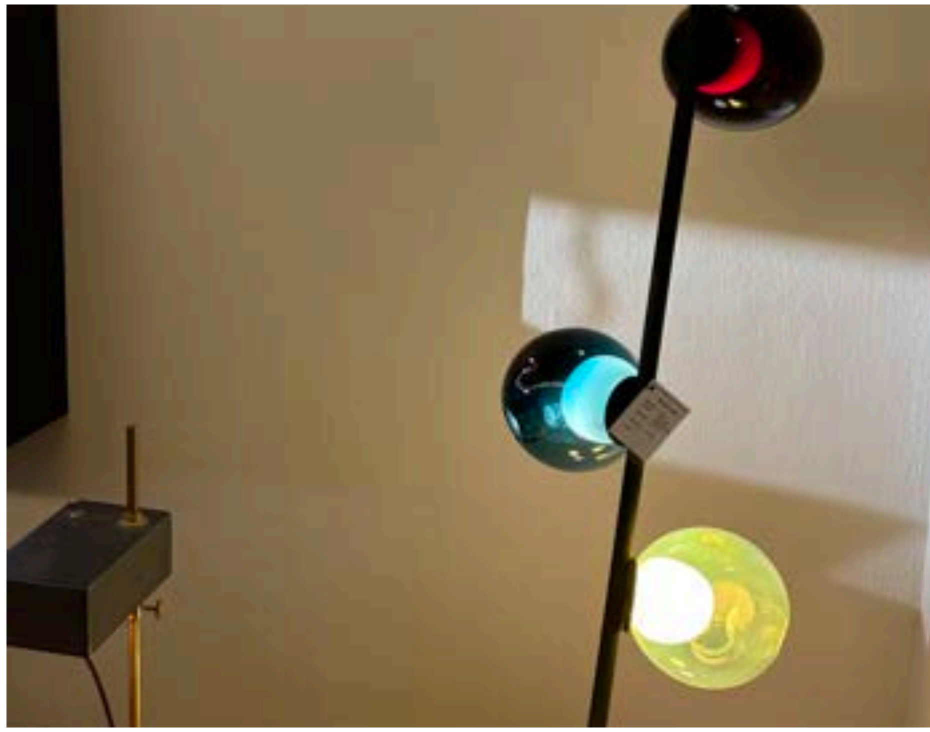


Amsterdam Trip.

The following pages are a collection of photos I took whilst in Amsterdam in various design shops. Whilst not all of them are completely relevant to my project, these shops were definitely influential in my ideas and provided inspiration for this project and the aesthetics of my design. We also booked a boat tour of the Amsterdam Light Display, which was particularly inspirational for this project.

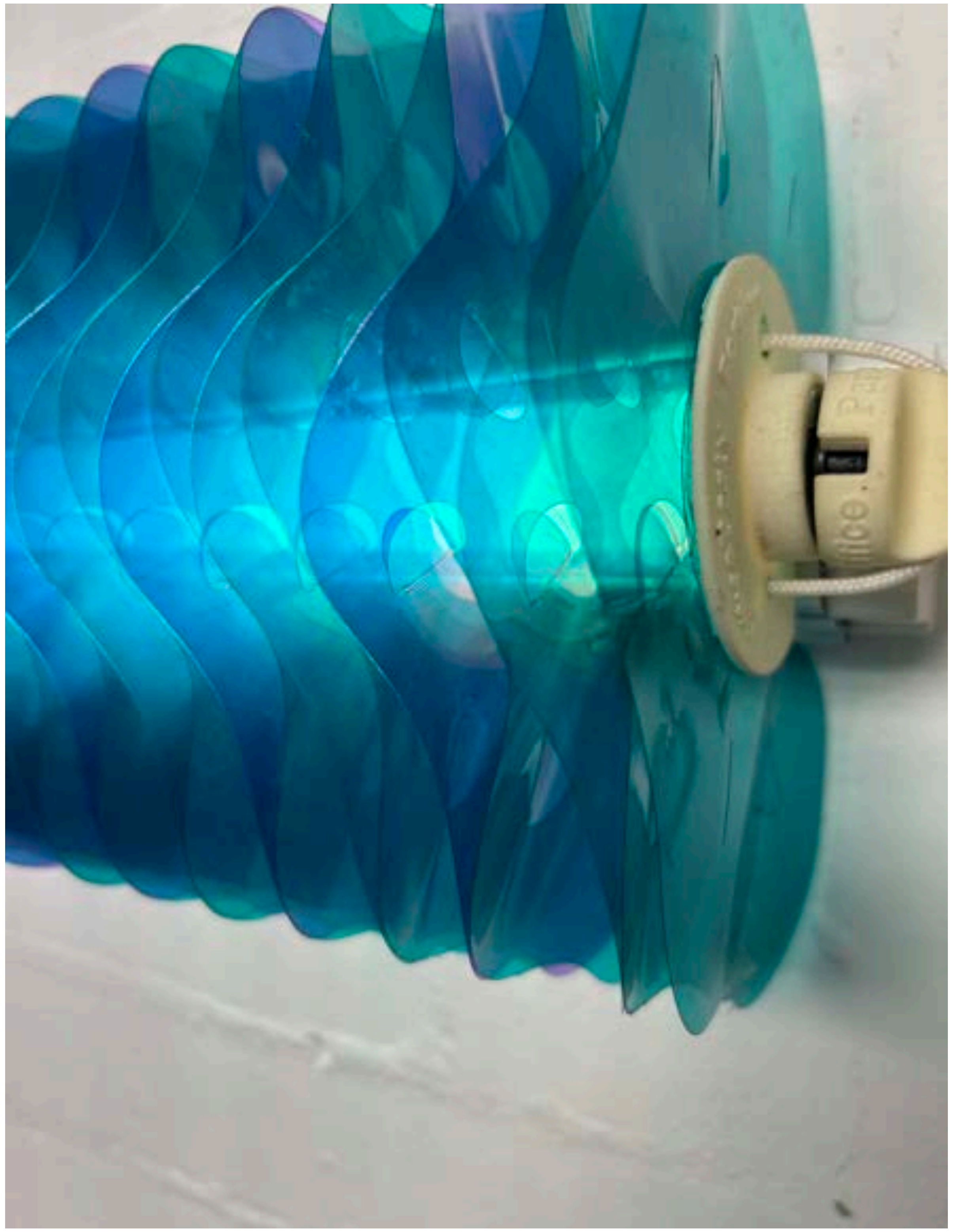
Trip Photos.



Trip Photos.

Trip Photos.

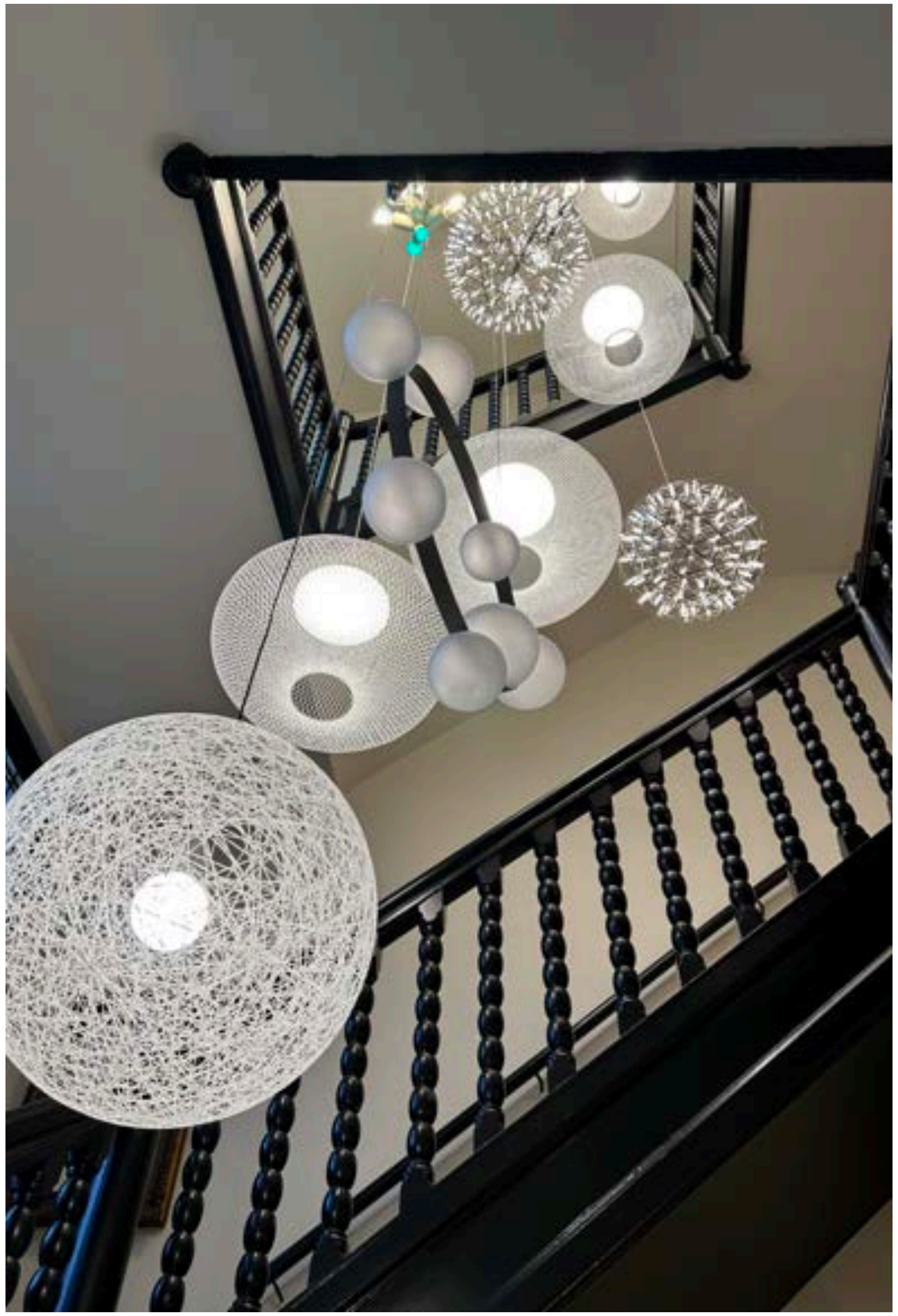






Trip Photos.

Trip Photos.



Trip Photos.

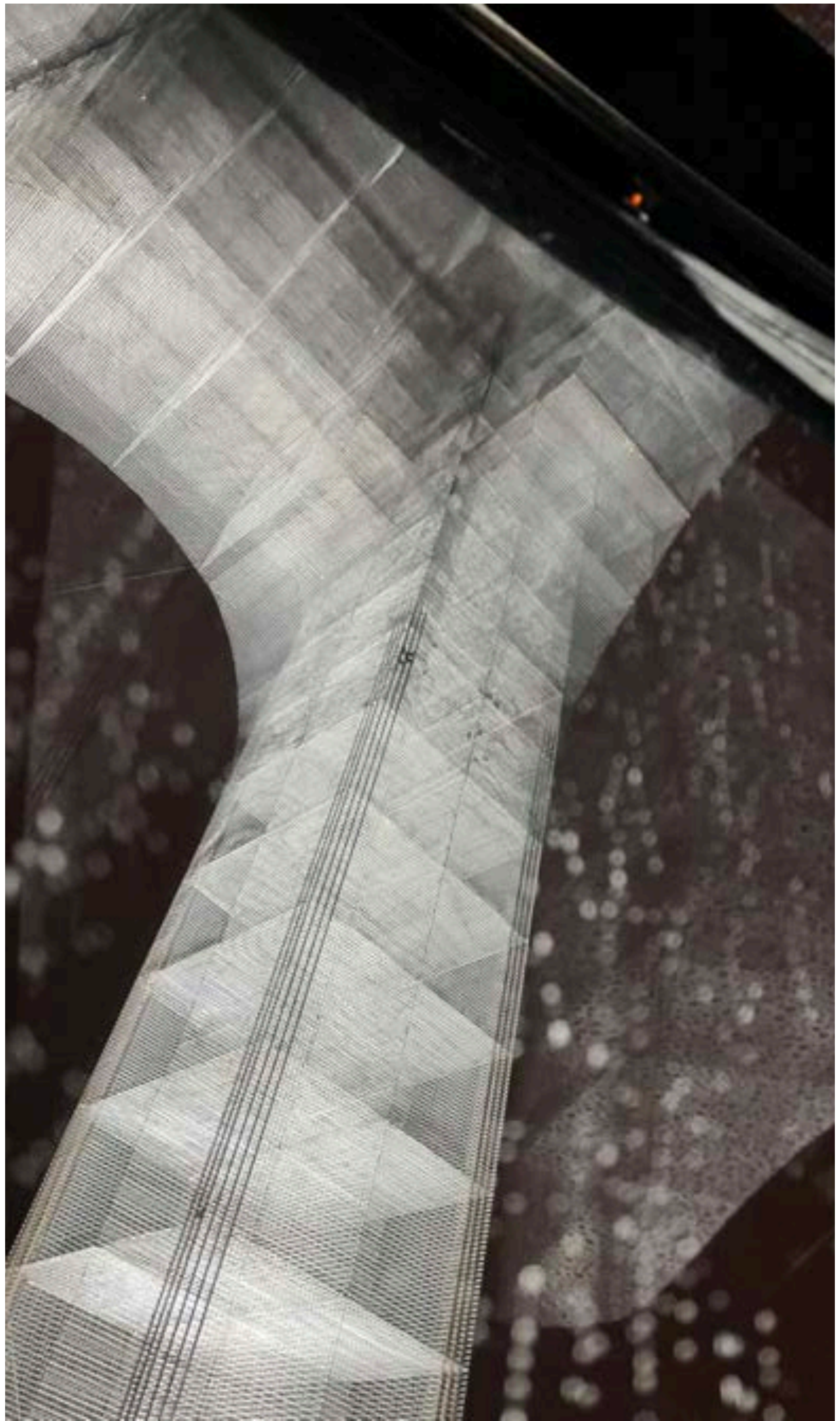
Trip Photos.

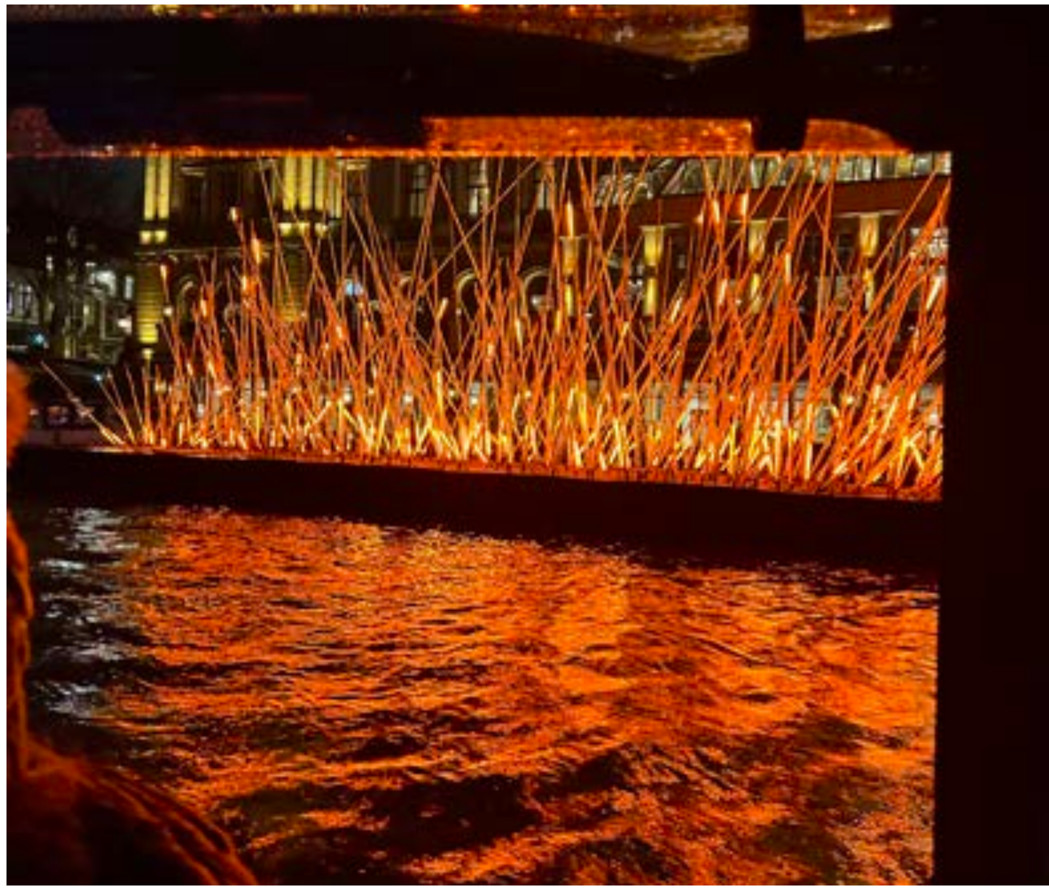






Amsterdam Light Tour.

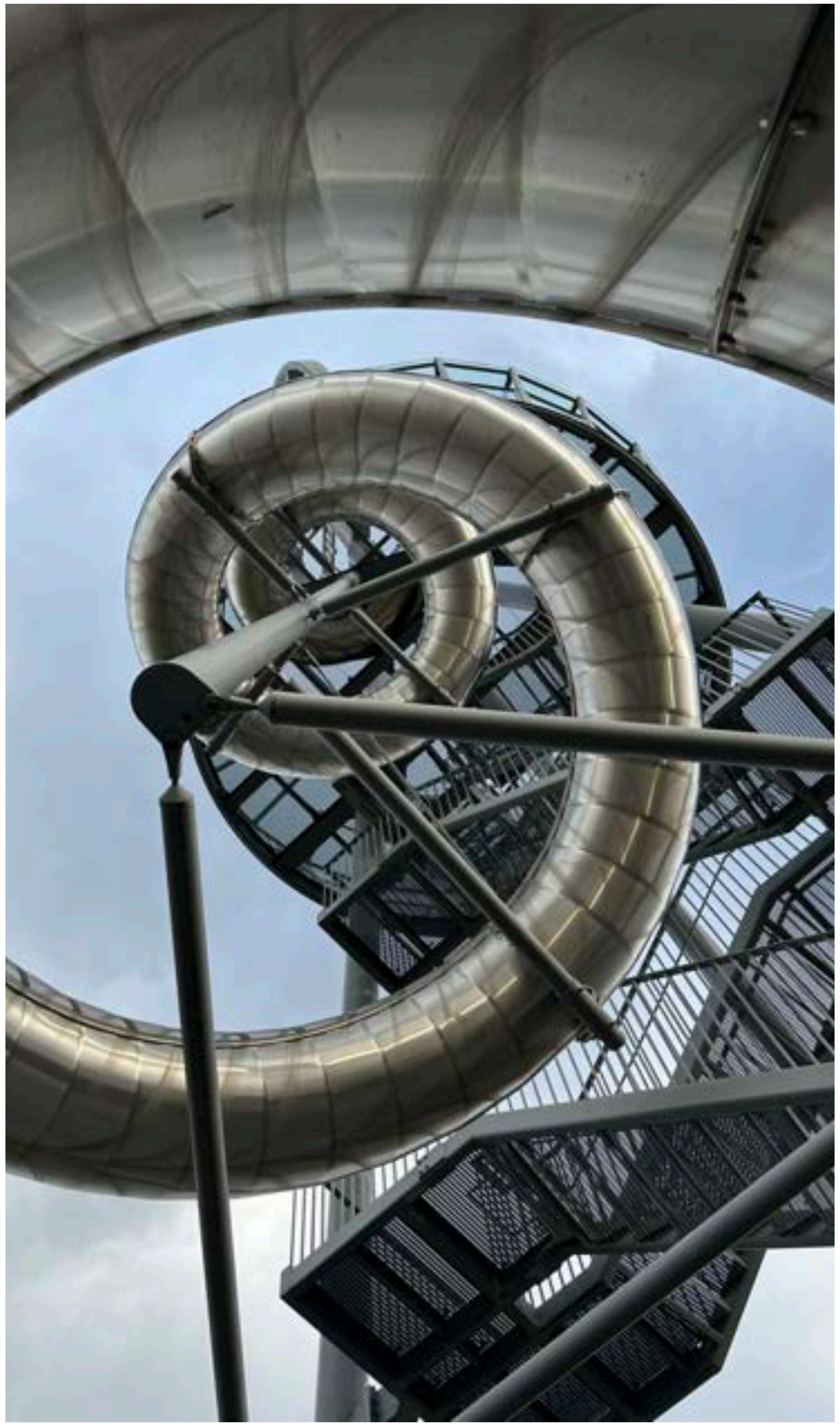




Switzerland Trip.

The following page contains a selection of my favourite and most influential photos from our visit to Switzerland and Vitra. Again whilst not all of these are relevant to a lighting project, the forms and shapes I photographed have definitely influence some of this project.

Trip Photos.



Trip Conclusions.

After looking back through the photos from the trip, it is clear to see the style I am personally drawn to and where I have got inspiration for my project from.

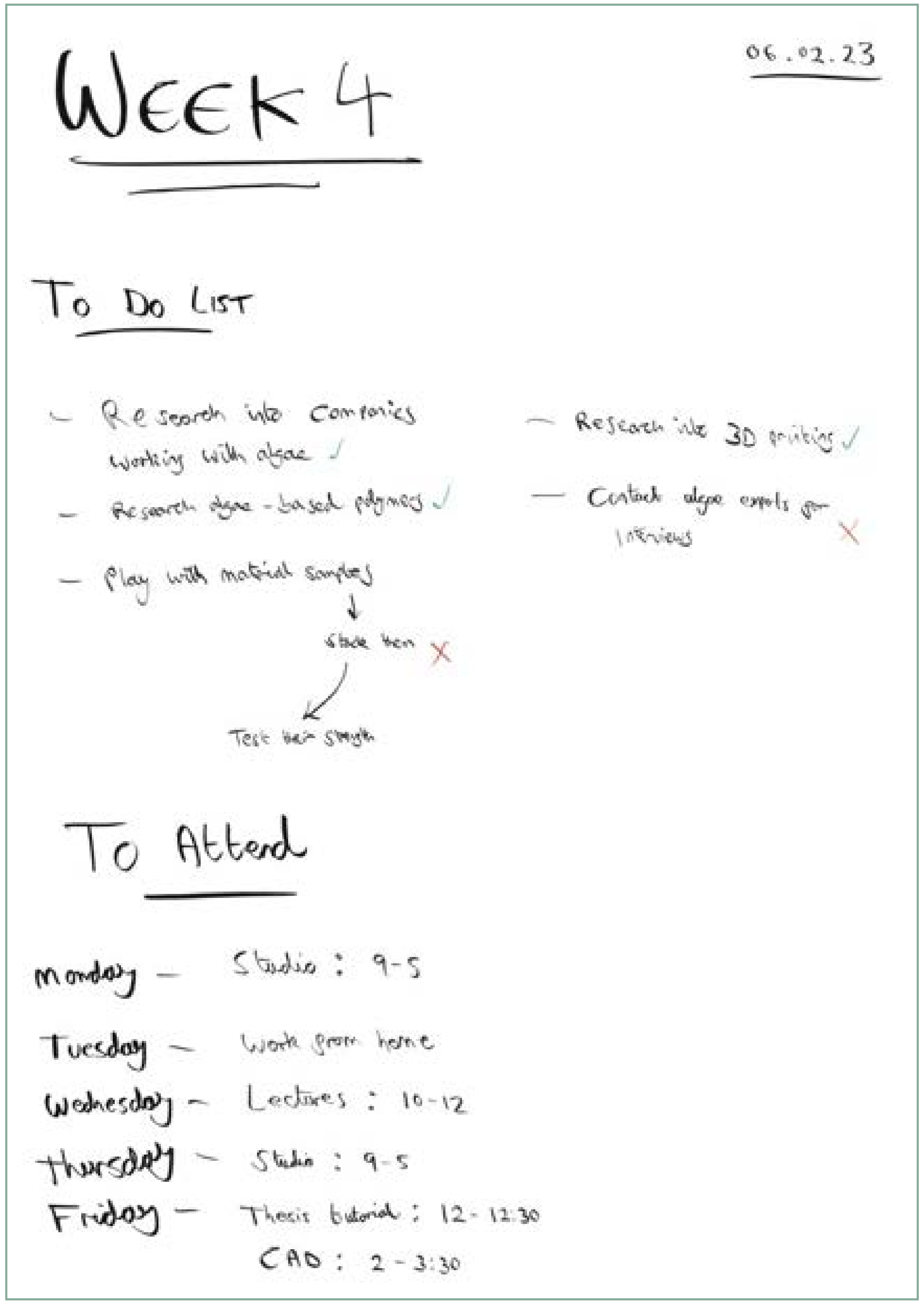
Many of the photos are similar and focus on:

- Lighting
- Organic Shapes
- Curved and Spherical Forms
- Spirals
- Asymmetry

These are all common features between the photos I took and I will take some of these forward into my design, as I am clearly drawn to these and find them the most aesthetically pleasing.

Time Management.

In Week 4, I managed to complete quite a large amount of research, which I was pleased with, but I didn't manage to play around with the samples I had printed, which is something I aspired to do in this week. Additionally, I found myself working later than normal, so I was starting my day later and finishing later, which meant I was getting less sleep and being less productive during the day. As the project continues, I will try to stick more till the 9-5 routine, as this is when I feel most productive.


WEEK 4

06.02.23

To Do List

- Research into Companies working with algae ✓
- Research algae-based polymers ✓
- Play with material samples
  ↓
  Stack them ✗
  ↓
  Test their strength
- Research into 3D printing ✓
- Contact algae experts for interviews ✗

To Attend

Monday – Studio : 9-5

Tuesday – Work from home

Wednesday – Lectures : 10-12

Thursday – Studio : 9-5

Friday – Thesis tutorial : 12-12:30

CAD : 2-3:30

Tutorial – Alex

Combination of solid + perforated shapes / surfaces

Portable light

Carry it round with you

Camping light

Hang up in tent

Take to beach

Lantern ?

Handle at top of light allows it to be carried

Mirror disc at the top reflects light

Light must look beautiful on + off

Lighthouse ?

Relates to beach + algae

Play around with stacking the samples

Elemental shapes

All samples having the same diameter allows them to fit together well

Algae-Based Plastics

Due to its numerous environmental benefits, algae is now being used to make more sustainable alternatives to synthetic plastics.

Algae is harvested, dried, ground and added to a plastic base to create algae-based plastic. This base can be regular synthetic plastic, or bioplastic such as PLA or PHA. Algae-based plastics are usually biodegradable, making them a more sustaiable option than synthetic plastics which cannot be recylced and end up in landfill.

Algae-based plastics typically contain around 10-30% algae, so whilst they are not made from 100% algae, adding this small percentage can have some very beneficial outcomes.

There are various different companies that produce algae-based plastics, such as Notpla, Bloom, Atelier Luma and Algix, however due to it being a very new concept, not all are commerically available yet, so it is quite difficult to obtain on a small scale.

Adding Algae To Plastic.

This is a bullet-pointed summary of the benefits of adding algae to plastic. I found this useful to condense into a more readable format, as I had to do a large amount of research into the material for both this project and my thesis. This simplified format provides a large amount of the justification for using this material.

Benefits

There are a number of different benefits to adding algae with plastic to create a new material. Firstly there are all of the benefits of algae as an organism which are highlighted in the pages above. Some more advantages are:

- Adding algae to plastic/bioplastic can alter its properties, changing its flexibility, durability, toughness and even to the point of making it fireproof

- During its life, algae absorbs large amounts of carbon. Once harvested, dried and added to plastic, it doesn't release this carbon and instead sequesters it, meaning that objects made from algae plastic act as carbon sinks

- Largely reduced greenhouse gas emissions in comparison to 100% synthetic plastic

- Algae comes in a variety of unusual natural colours and textures, meaning it has the potential to add unique, natural and beautiful aesthetics to the material.

- If algae from toxic algae blooms is used to make plastic, then the process of harvesting it removes it from the water source, purifying the water, restoring oxygen and marine life

- Using algae plastics reduces demand for synthetic plastics, lessening the reliance on fossil fuels

- If used with a biodegradable plastics base, adding algae to plastic drastically accellerates the biodegrading time

- Processing algae-based plastic uses far less energy than materials like ceramic or glass

- Uses less land, water and energy than other bioplastic crops such as corn and soy

Bloom.

Who Are They?

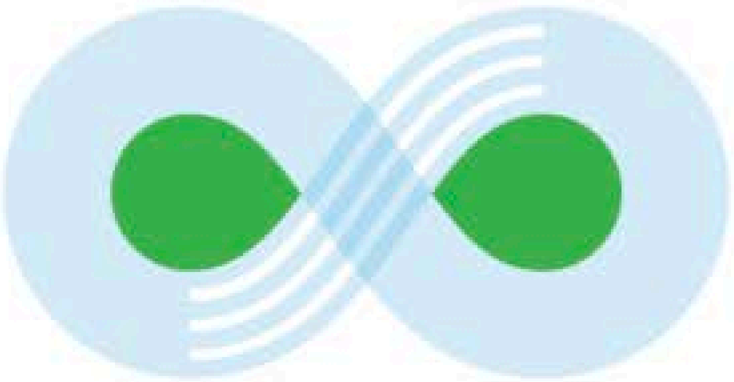
Bloom was started in 2007, by Ryan Hunt, who believed that algae could be used to "help remove the harmful levels of phosphorus and ammonia present in industrial and agricultural waste-water that is causing ecologically harmful algae blooms and water quality issues." During the research, he discovered that when placed under heat and pressure, the algae went through a plasticization process.

Now Bloom create an algae-based plastic flexible foam and have collaborated with huge companies such as Adidas, Puma and Tommy Hilfiger to create footwear made from the sustainable material.

Bloom

Goals

This is a screenshot from the Bloom website which summarises their current achievements and future aspirations. It shows the multiple benefits of harvesting and using algae as a material, further justifying my decision to use it



CLEAN WATER.

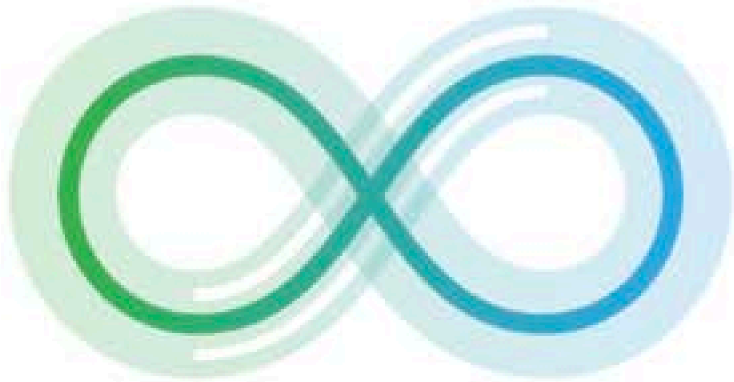
The rise in global temperatures, excess nutrient runoff, and human activities have lead to harmful effects like massive algal blooms in ecosystems around the world. Water pollution is an invisible problem made visible by rampant algae growth.

At Bloom, we're determined to reverse the effects of water pollution by working with natural resources like algae to create sustainable materials, generate clean water, and maintain healthy ecosystems.

CLEAN AIR.

Large-scale agriculture, manufacturing, transportation, the meat industry, and other human activities have contributed to a detrimental rise of CO2 levels in our atmosphere.

Bloom utilizes the power of natural resources like algae to collect and sequester CO2, sealing it up in useful products, while displacing the use of harmful products and materials that could further contribute to the problem.



TREAD WELL.

In the U.S. alone, the average person buys up to 5 pairs of shoes every year, fueling a global shoe industry that produces nearly 30 billion pairs of shoes every year.

That's why we partner with shoe brands all over the world to implement sustainable materials on a large scale, helping the footwear industry Tread Well as we work to regenerate and maintain healthy ecosystems.

Bloom.

Process

Bloom have created a machine to extract microalgae from the water so that it can be used to create algae-based plastic. They target harmful algae blooms all over the world, which are causing damage to marine life and creating water pollution. They extract the harmful algae from the water using this machine, which cleans the water in the process, restoring marine life and removing pollution. This way, water and air is being purified and a new material is being made at the same time.

Bloom.

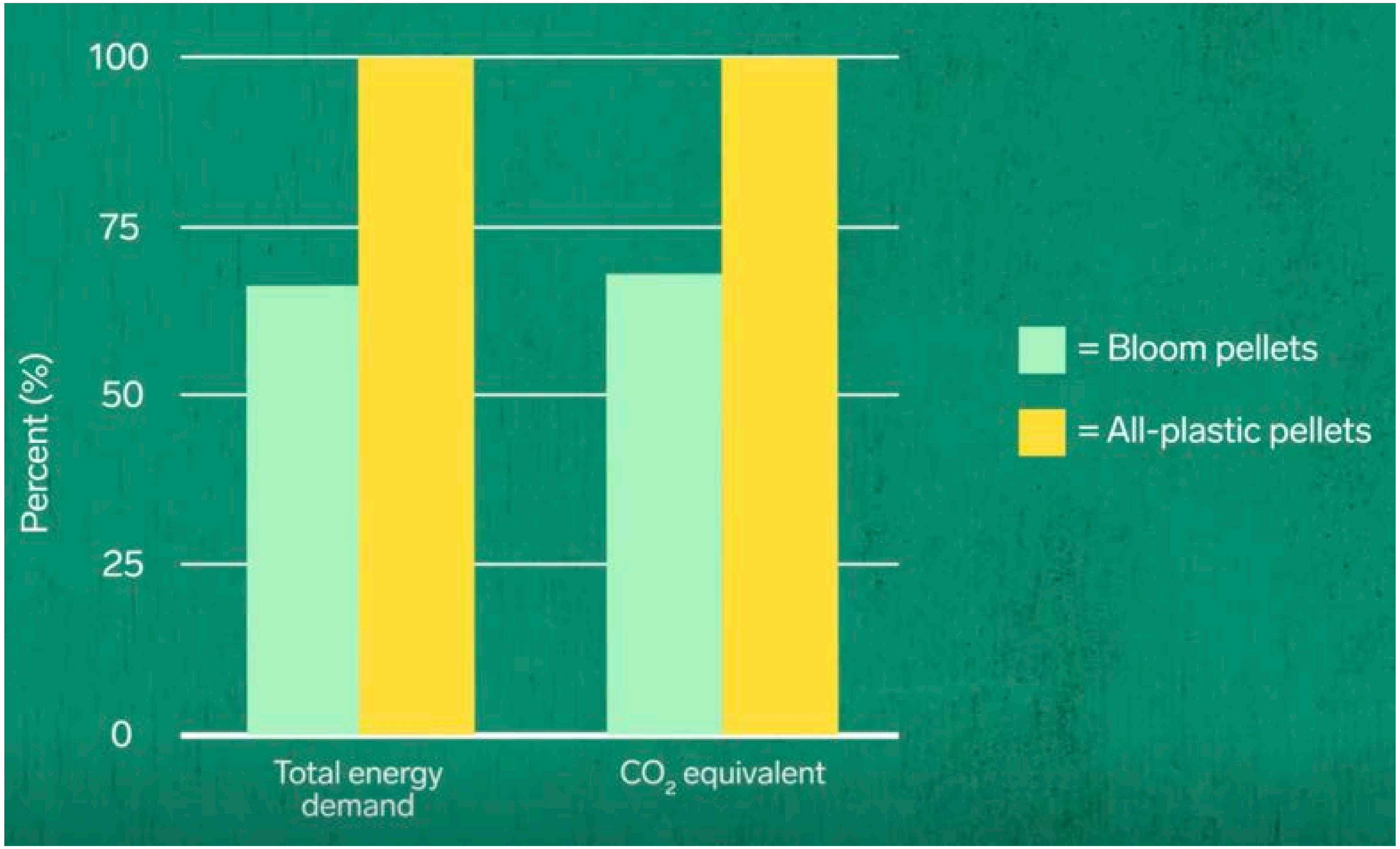
Process

Bloom take this algae and grind it to a fine powder, before mixing it with plastic pellets to create algae-based plastic pellets. These are then used to create a foam-like material used in footwear and inner-soles.

However, seeing as the algae is mixed with synthetic plastic, it is not recyclable or biodegradable, which may seem counterproductive and unsustainable. Yet, when regular bioplastics biodegrade, they release all the carbon they had sequestered back into the atmosphere. By having a permanent, non biodegradable product, it means that the carbon will forever be locked inside this product, keeping it out the atmosphere. Additionally, using just a small percentage of algae drastically reduces the environmental impact of the material and Bloom's main focus is cleaning the water in the process of extraction.

Bloom.

Impact



Despite still using synthetic plastic as a base, bloom pellets which contain just 10-30% algae, hugely reduce the environmental impact of the material, making it a far better alternative to regular plastic.

Using algae massively reduces the emissions from drilling for oil, extracting it and refining it into plastic. Converting algae into plastic pellets also requires much less energy.

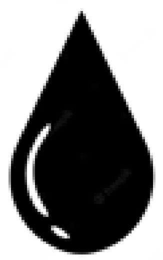
Aside from the improvement in emissions, Bloom also cleans massive amounts of water in the process of extraction, restoring marine life in the area. This proves how much more beneficial Bloom plastic is in comparison to regular plastic.

This graph shows how the emissions from Bloom plastic pellets compare to the emissions from regular plastic pellets. Whilst they are by no means perfect, it shows that just by using a percentage of algae, it has a very positive impact on harmful emissions.

Bloom.

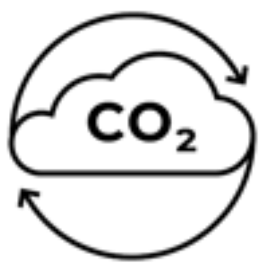
Achievements

Aside from using algae to make a more sustainable alternative to traditional plastics, Bloom also clean water, air and reduce CO2 within the process of extracting harmful algae from polluted water. Their website has a live counter of the amounts they have cleaned and it also shows how many litres each company they have collaborated with have been responsible for helping to clean. Currently these are the statistics.



1.47 billion Litres of water cleaned

1.1 billion Metres Cubed of air cleaned



800 thousand Kilograms of C02 captured

Notpla.

Goals

Notpla, which is an abbreviation of Not Plastic, is a company whose goal is to "make packaging disappear". They offer a range of different packaging made from all-natural materials, all of which can be composted at home. This packaging is designed to replace synthetic plastic packaging, addressing the issue of single-use plastic ending up in landfill

Notpla offer a range of different plastic substitute products, ranging from takeaway boxes, to water containers, to rigid plastic

Notpla.

Products

Notpla Rigid

Notpla have created a plastic alternative that has many similar properties to rigid synthetic plastic. It is made from a mixture of seaweed and plants and can be used in the form of pellets or injection moulded.

The best thing about this material is that it can dissolve in water in just a few hours and the water can then be used as fertiliser for plants. It can also quickly biodegrade in natural conditions, unlike PLA which needs industrial conditions to biodegrade.

This material helps emphasise the capabilities of algae, showing that when mixed with other sustainable materials, it can be utilised to make a rigid plastic-like material disappear in a matter of hours, leaving no toxins behind. This could help solve the issues of single-use plastic ending up in landfill - a problem I would like to address in my project.

Notpla.

Products

By looking into some existing companies working with algae, it has given me a greater understanding of the capabilities of algae and its potential to be used as a material. It has showed me the huge range of different uses it can have, justifying my choice to use algae, due to its beneficial properties that can be utilised for plastic substitutes.

Ooho

Notpla have also created an edible, biodegradable liquid container. Ooho is a bubble made from seaweed, designed to replace the need for single-use plastic.

It can be used for water, condiments, cocktail ingredients and any other liquids. It is edible or it can be thrown away in food compost and will decompose within a few weeks. It is 100% biodegradable, vegan and plastic free.

One of the best uses for Ooho is at sporting events. Notpla collaborated with Lucozade to address the issue of plastic cups and energy gel sachets at marathons. They provided 36,000 Ooho bubbles at the 2019 London Marathon, to remove the need for disposable plastic cups.

Atelier Luma .

Who Are They?

Atelier Luma is a research and design laboratory, set up in 2016 in the Parc des Ateliers region of Arles, France. They use local natural resources to develop ecological solutions to help the environment.

One section of their company, The Algae Lab, is dedicated to harvesting and cultivating algae from the local regions. They collaborate with specialists and designers to explore ways of integrating algae into the urban environment, through material applications.

Atelier Luma have used different varieties of algae to produce textiles, dyes, materials, architecture and food.

Atelier Luma

Collaborations

Atelier Luma are the company that were responsible for producing the 3D printed algae vases that were on display at the Waste Age exhibition at the London Design Museum. As highlighted at the start, this was the main driver for the inspiration for this project.

They collaborated with designers Eric Klarenbeek and Maartje Dros to produce a range of vessels from 3D printed algae-based plastic. The material and products looked beautiful and the manufacturing method of 3D printing was something I was interested in exploring.

However, there was very little information on the material available, so I managed to get an interview with the project manager at Atelier Luma, which allowed me to see if I could find out some more about the material, to see if it was feasible to use for my project.

Tutorial - Fiona

Could the bulb fitting be incorporated into the 3D print?

Lights could be angled to shine light on the exterior of each sphere

Bottom of the sphere could be weighted, so the sphere could rock side to side + return to original position

Could they also be storage containers?

Gareth Neal

Focus on the spherical, solid shape

Show / represent where algae comes from

Look at cell structure of algae

could the aesthetics be based on this?

Light reflects nicely off outside surface

Leave the support on

Could the sea be used in the design? Waves?

Interview.

Atelier Luma

1. How is the algae harvested?

“A sample of algae is grown in a lab by adding nutrients such as starch to the microalgae. Once enough has grown, it is then separated from the salt in the water, however you have to be careful, as the algae is quite delicate.”

2. What are the ingredients of the algae bioplastic you use to 3D print?

“I cannot say the exact ingredients, however a base of either PLA or PHA is used along with different types of microalgae.”

3. How is the algae processed into bioplastic?

“It is harvested and then dried out, before being mixed with nutrients and a bioplastic base.”

4. What benefits does adding algae to bioplastic bring?

“Initially the aim was to add microalgae to bioplastic to alter the colour. Algae comes in a range of unique natural colours, such as green, yellow, orange, red and even purple and blue. However, it can also alter the properties of the plastic, such as flexibility, opacity, heat resistance and even the potential to be fireproof.”

5. Is making the material a costly process in terms of money, energy and emissions?

“The material can work with classic machines in the plastic manufacturing industry, such as injection moulds, 3D printers etc, so no new machinery is needed and the infrastructure is already in place. It requires temperatures of under 200 degrees, so is not too costly in terms of energy and the transformation time for the material is very quick. Algae is quite sensitive to the process, so it has to be a quick and gentle process to limit the degradation of the material. It is far better in terms of energy consumption than materials like ceramic and glass etc.”

6. What conditions are needed for the material to biodegrade?

“For the PLA base, it biodegrades in industrial conditions, however the temperature required is not too high, only around 60 degrees. For the PHA base it will degrade in compost.”

7. What products can it be used for?

“It is currently being used for wall tiles, electronic entry cards and vases. It can be used in injection moulding, thermocompression, laser cutting, thermoforming, engraving, 3D printing etc.”

8. What future uses do you see for this material?

“Mostly injection moulding, as this is so widely used in the plastic industry already and is probably the easiest way to use the material. It is also rapid and allows the highest percentage of algae to be used.”

Interview Analysis.

Atelier Luma

I interviewed Anne-Claire Hostequin, a project manager at Atelier Luma, who works on the algae-based bioplastic projects. It was very interesting and useful to get some further information on the material, as there is only such a limited amount available online, due to how new and experimental it is.

Some of the key things I learned from this interview were:

- The material operates at lower temperatures than materials such as ceramic, glass and regular plastic

- Different types of microalgae can effect the properties of the material

- Algae comes in a wide range of colours, even blue and purple

- It not only can be used in 3D printing, but also injection moulding

Whilst this interview was extremely beneficial to understand more about algae and its capabilities as a material, I was still unable to find out exact details, such as percentages of algae and its exact properties. Therefore this means I will have to get some of my own algae-based plastic ASAP to experiment wwith and learn more about first-hand.

Algix

Who Are They?

Algix is the parent company of Bloom and works in the same way - harvesting algae from harmful algae blooms to utilise as a renewable material. They are based in Mississippi and specialise in producing sustainable plastics made from algae.

To source their algae, they currently collaborate with catfish farmers. They use their harvesting technology to pump pond water containing algae blooms. The machine extracts the algae from the water and pumps clean water back into the pond, purifying it in the process and removing the harmful algae that is starving marine life of oxygen and sunlight. The algae is then dried and turned into plastic. This benefits the farmers, as it improves the health of their fish and removes algae from their ponds.

Algix source algae from all over the world - wherever has algae problems. They receive algae from countries such as USA, China and Jamaica.

One of the great things about algae, is that it can grow easily all over the world, very quickly and it a wide range of different climates. This means that if algae became a more widely used material, it could almost always be sourced locally, reducing the environmental impact of shipping. This is another benefit of using algae-based materials.

ALGIX®

ALGA Filament.

This is the algae-based PLA filament which I will be using for my product. It is the only commercially available algae-based filament that I can purchase, as most others are in very early experimental stages and so not available on the market. I believe this filament has a huge number of benefits in comparison to very few cons and is therefore a much better solution than regular 3D printing plastic filament.

Algix have made a 3D printing filament from the algae that they harvest. The filament is made from 20% algae and the remaining 80% is made from PLA.

Some of the **benefits** of this algae filament are:

+ Made from nuisance algae (algae from harmful algae blooms)
+ Produces natural and earthy colours
+ Each batch varies slightly in colour
+ Textured finish
+ 100% biodegradable
+ Non-toxic
+ Requires lower temperatures than regular 3D printing filament, so is more sustainable and energy efficient
+ Adding algae to the filament rapidly accellerates time for biodegrading
+ Small parts can biodegrade in as little as 3 weeks

Some **disadvantages** of this filament are:

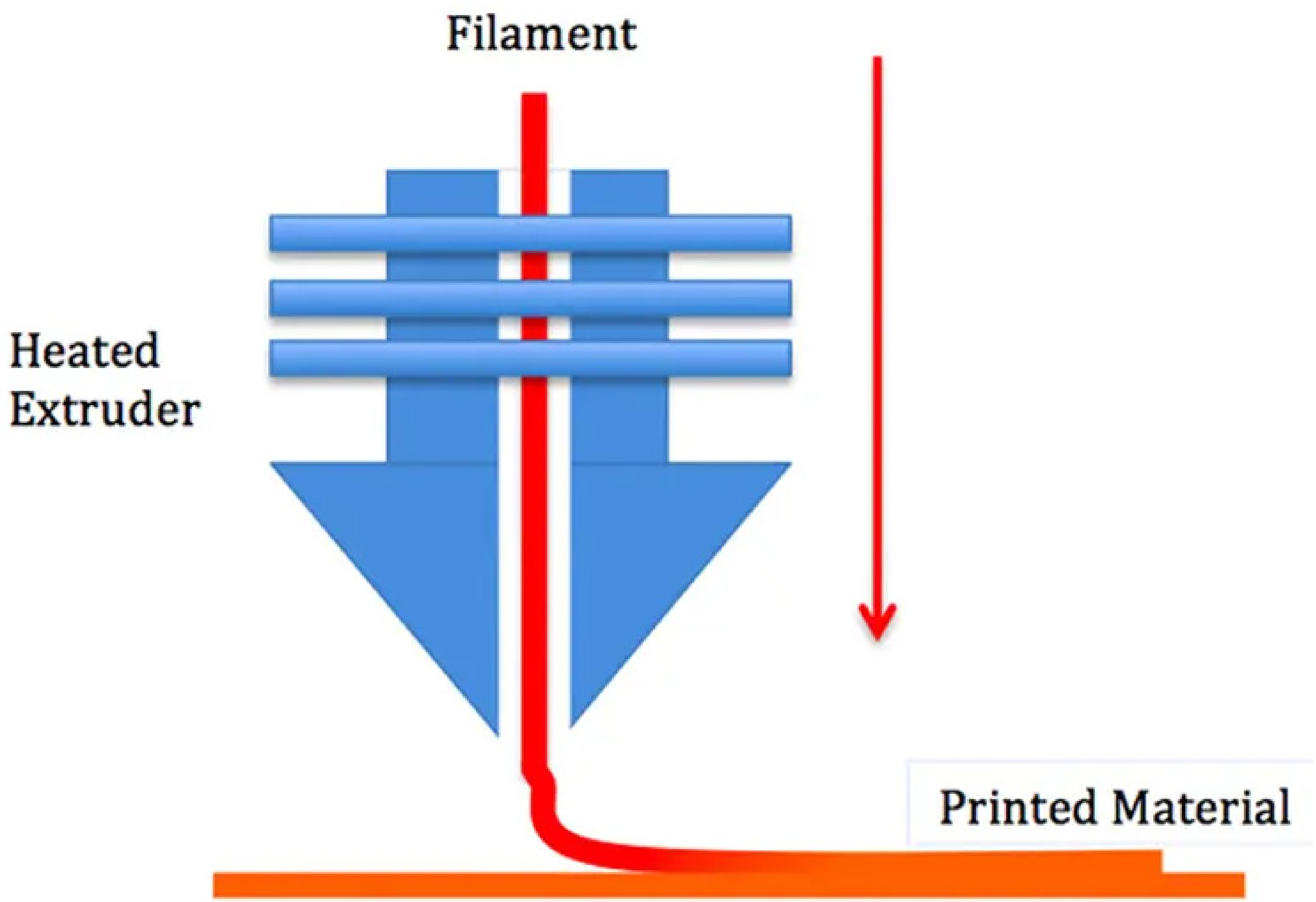
- It can be slightly more unreliable than regular filament, resulting in more failed prints
- Whilst it is biodegradable, it needs industrial conditions, as it has a PLA base

3D Printing.

How Does It Work?

There are lots of different types of 3D printing, however the type I will be using for this project is Fused Deposition Modelling (FDM 3D printing). This is where a polymer based filament is forced through a heated nozzle and deposited in flat layers on a bed. These layers build up slowly and fuse together whilst they are hot to create 3D objects. This process is shown in the diagram on the right.

FDM is the most widely used method of 3D printing, due to it being so accessible, quick and easy to use. The most commonly used types of thermoplastic for FDM are ABS and PLA, however other plastics like PETG are sometimes used as well.



3D Printing.

Where Is It Used?

3D printing is used in multiple different industries, most commonly in:

- Aerospace
- Medical devices
- Dentistry
- Mechanical Engineering
- Automotive
- Tool making

This is due to its ability to create complex shapes and patterns, whilst producing strong components made from a variety of materials.

However, 3D printing hasn't fully taken off yet and traditional manufacturing methods are often preferred. Experts believe this a due to a couple of reasons.

- It fulfills very specific needs and there isn't wide need for it
- It requires specially trained people to operate and so is not easy to integrate without technology such as AI to operate it

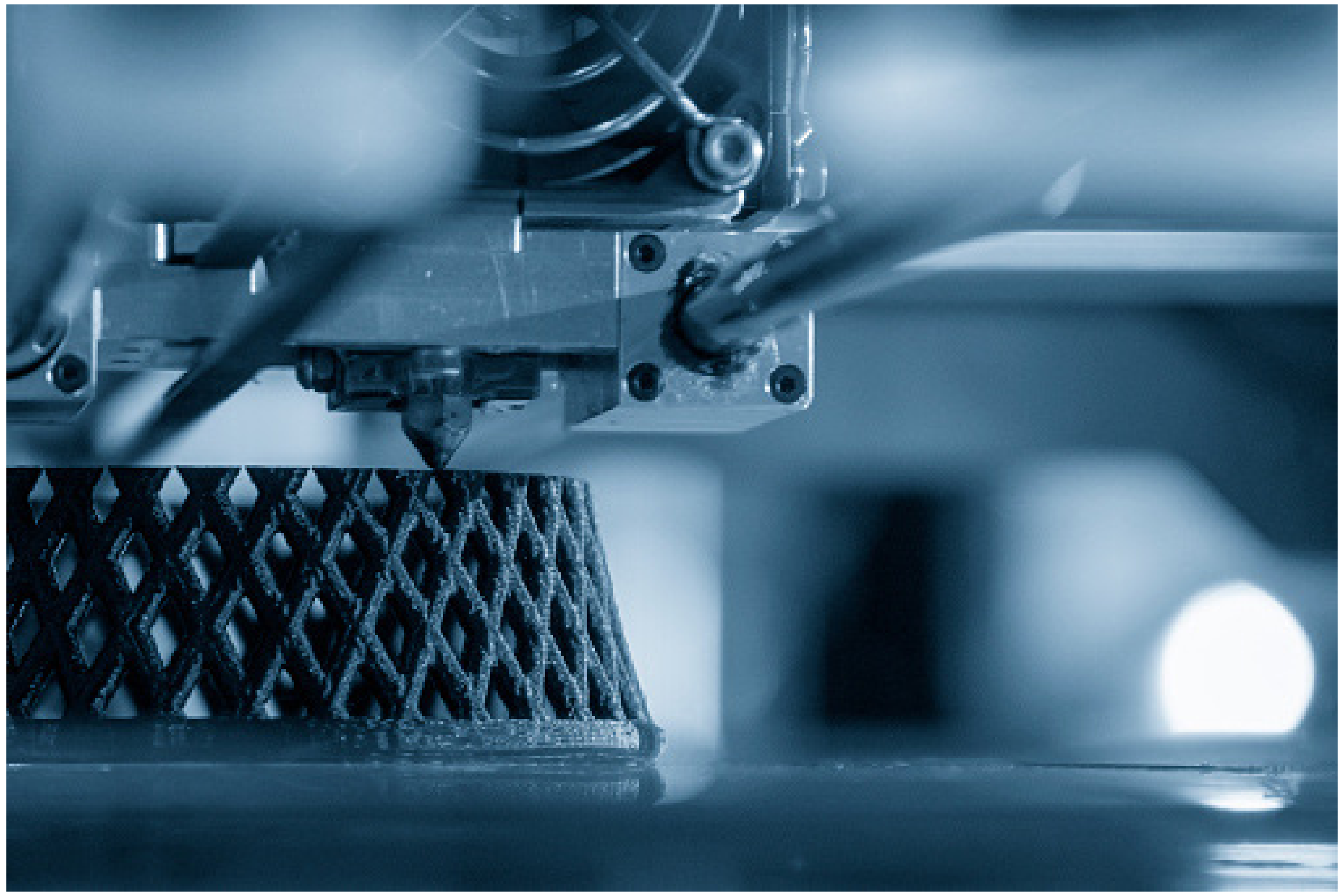
This feels lazy, as 3D printing has so many beneficial features, so why isn't it being used more widely? It should be integrated more in different industries.

3D Printing.

Benefits

One of the best and most valuable aspects of 3D printing is locality. In the future, once it becomes more widely used and integrated into society, 3D printing could hugely reduce the need for shipping products. In theory, every town could have 3D printers that produce products for the area, eliminating transportation of products from overseas. It could even reach the point where people have printers in their own homes and rather than purchasing a product and getting it delivered, they could purchase the file and print the product in their own home. Reducing the need for transportation would dramatically lower greenhouse gas emissions from transport vehicles and money for fuel.

Another benefit is that operating a 3D printer is much more energy efficient than other manufacturing methods, such as casting or machining. 3D printers use minimal amounts of energy, only the equivalent as 1 or 2 incandescent light bulbs.



3D Printing.

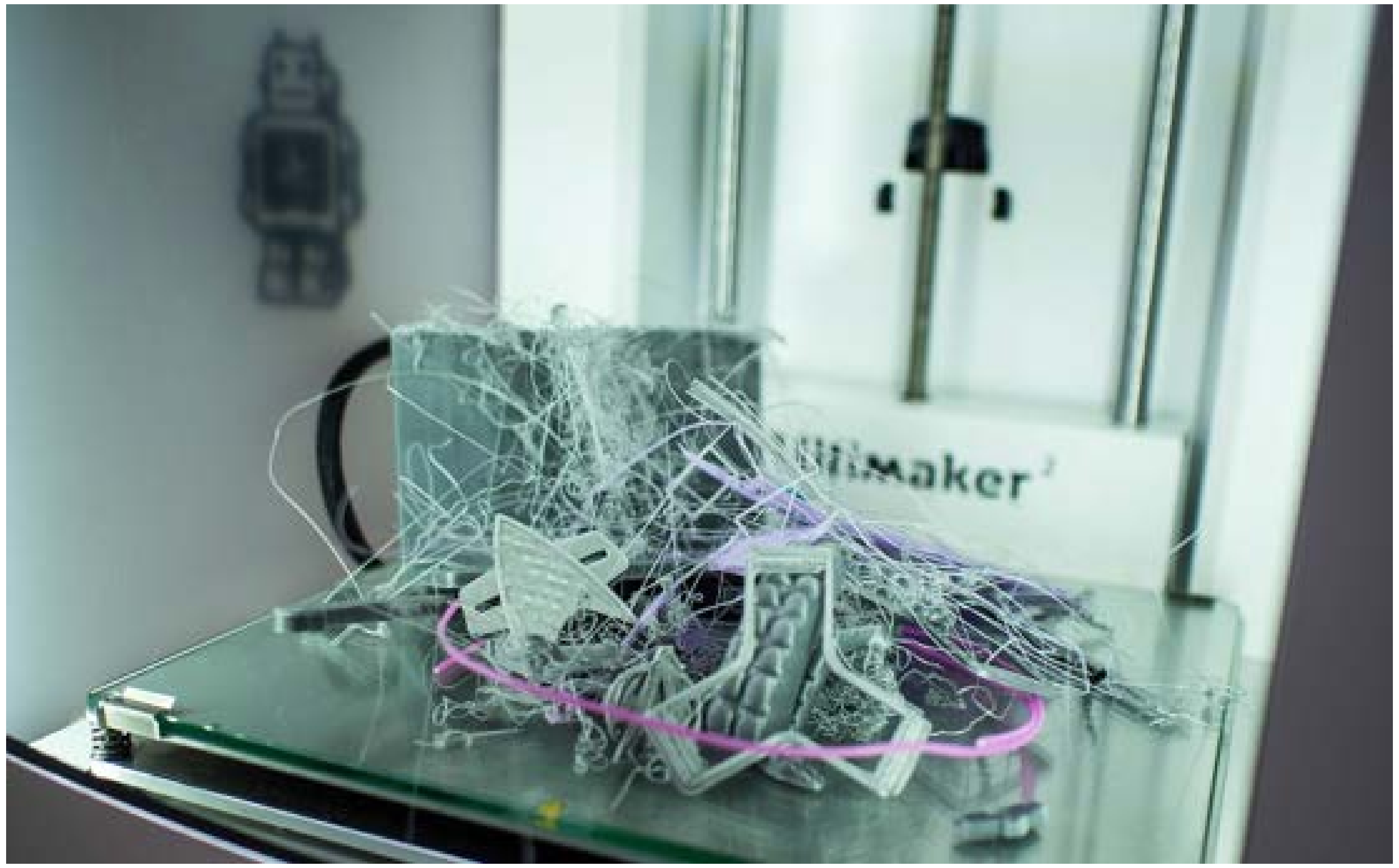
Drawbacks

There aren't many drawbacks to 3D printing, however one of the biggest one is the problems that failed prints can cause.

Firstly, failures can easily happen on 3D printers. The machines are very sensitive to factors, such as temperature, humidity, vibrations, materials and malfunctions. These can all lead to failed prints, meaning that the whole process has to be completely restarted. If it is a print that takes days to make, that is days of work lost.

Secondly, if the prints fail midway through, there is no use for the partially printed object, meaning it is wasted. However, often the materials used in 3D printing are not recylcable, leading to lots of failed prints going to landfill and polluting the environment.

This is why PLA and other bioplastics such as algae-based PLA need to be used more frequently in the 3D printing industry to make it even more sustainable and allow the failed prints to be recycled or to biodegrade.



3D Printing.

Pros and Cons

I created a pros and cons list of 3D printing to highlight in bullet point format the key aspects. The list shows that the benefits of 3D printing far outweigh the cons and it is a valuable manufacturing method that needs to be utilised more.

+

+ Very quick printing
+ Low cost to size ratio
+ Cheap
+ Range of material choices
+ Any shape that can be made on CAD can be printed within reason
+ Unusual shapes and complex forms can be easily printed that would be difficult to manufacture using other methods
+ Creates rapid prototypes for testing
+ Print on demand - means that there's no need for bulk buying or storing large amounts of products in warehouses
+ Reduced wastage as only the neccessary parts are printed
+ Easily acessible
+ No need for transport or shipping of products, as they can be produced anywhere in the world using a printer and materials
+ Could reach a stage where people can print products in their home all over the world
+ More energy efficient than machining and casting

−

- Relatively thick layers means it isn't ideal for small detailed parts
- Doesn't have the smoothest finish
- Not the strongest products produced
- Restricted build size
- Failed prints and parts that go wrong just go to waste and most cannot be recylced
- Reduction in manufacturing jobs

3D Printing.

In The Furniture Industry

The 3D printing industry is growing rapidly at over 45% each year and was valued at 17 billion dollars in 2022.

It is also becoming a more popular manufacturing method within the furniture industry, due to its versatility and range of capabilities.

3D printing rapidly produces prototypes, reducing time spent on hand made prototypes, offering a cheap alternative. It also allows complex shapes to be made quickly, without the need for expensive moulds or difficult joints/ fastenings

It has opened up possibilities to create far more aesthetically interesting unique furniture. For example, the Batoidea Chair on the right would be drastically more expensive to produce if it wasn't 3D printed. The metal chair would produce large amounts of waste, due to the cut out holes, yet there is zero waste with 3D printing.

However, it is not widely enough used in the furniture industry yet and is a process that needs to be utilised more.

Time Management.

In Week 5 I spent quite a lot of my time writing my thesis for the draft submission and so did not complete as much of my project work as I would've liked. However, I did test/stack and play with the samples I had printed to gain some inspiration as to where to go next with my designs and I found it very helpful for my process.

WEEK 5

13.02.23

To Do List

- Write thesis for draft submission ✓
- Play with samples – Stack + photograph them ✓
- Sketching ✓
- Order materials to make own algae plastic ✓
- Print big 200x200 sphere ✓
- Print bone shape to test strength ✗

To Attend

Monday – Studio : 9-5 ✓

Tuesday – Work from home ✓

Wednesday – Lectures : 10-12 ✓

Thursday – Studio : 9-5 ✓

Friday – Thesis tutorial : 12-12:30 ✓
CAD : 2-3:30 ✓

Tutorial - Fiona

Each sphere could be its own individual light

Could the surfaces be textured

How is each light positioned?

Could they be angled to shine light at each other?

Indented sections?

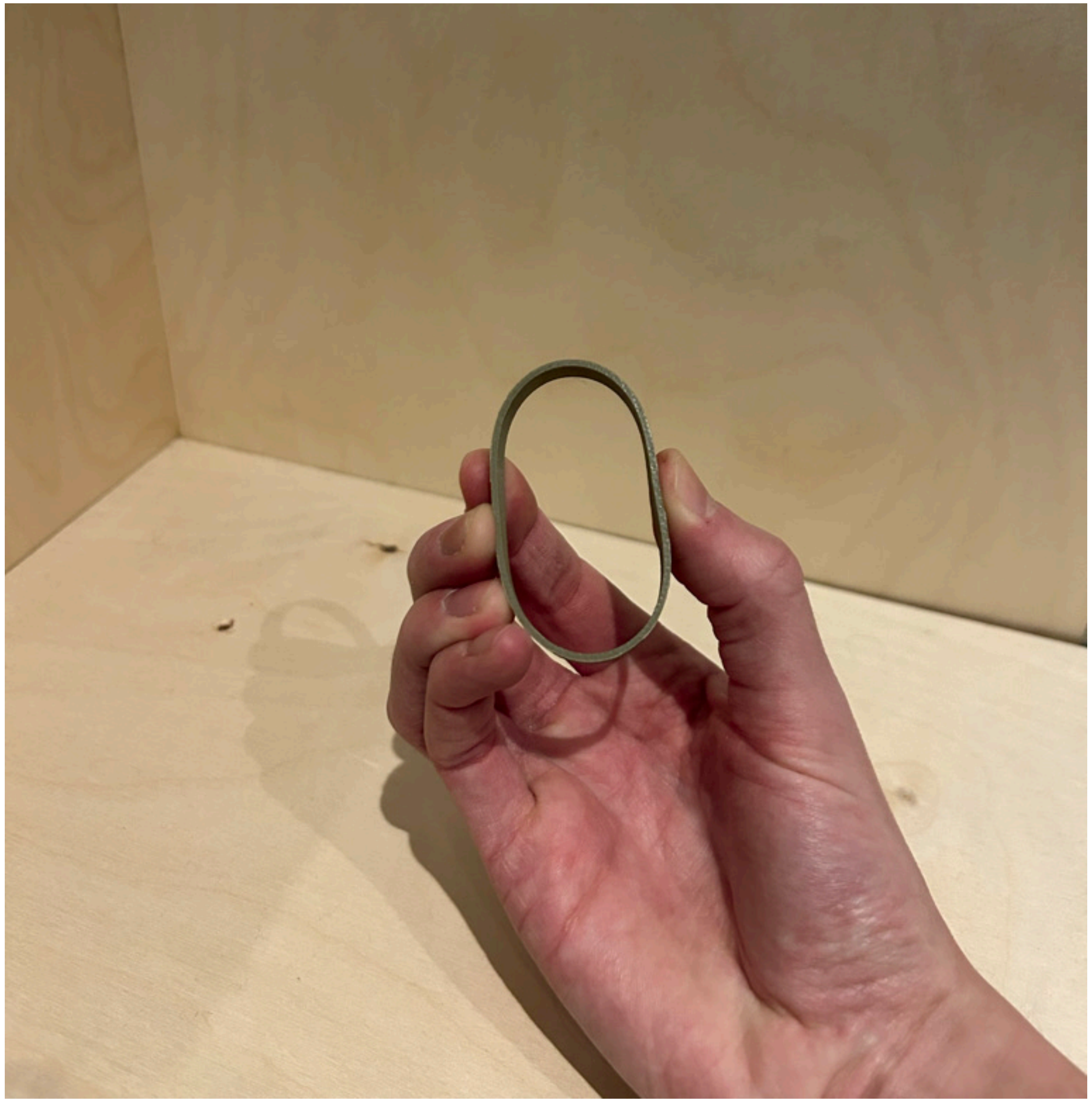
Spheres rest against each other in indents

Different sized spheres arranged together

Think about how spheres could be arranged together

Samples.

This is one of the samples I printed with the algae filament and is a hollow ring shape. As you can see in the photos, I found it was quite flexbile when squeezed, more so than the regular PLA. However, I don't believe it was strong enough for flexibility to be utilised as a property, as it would snap when squeezed too hard.

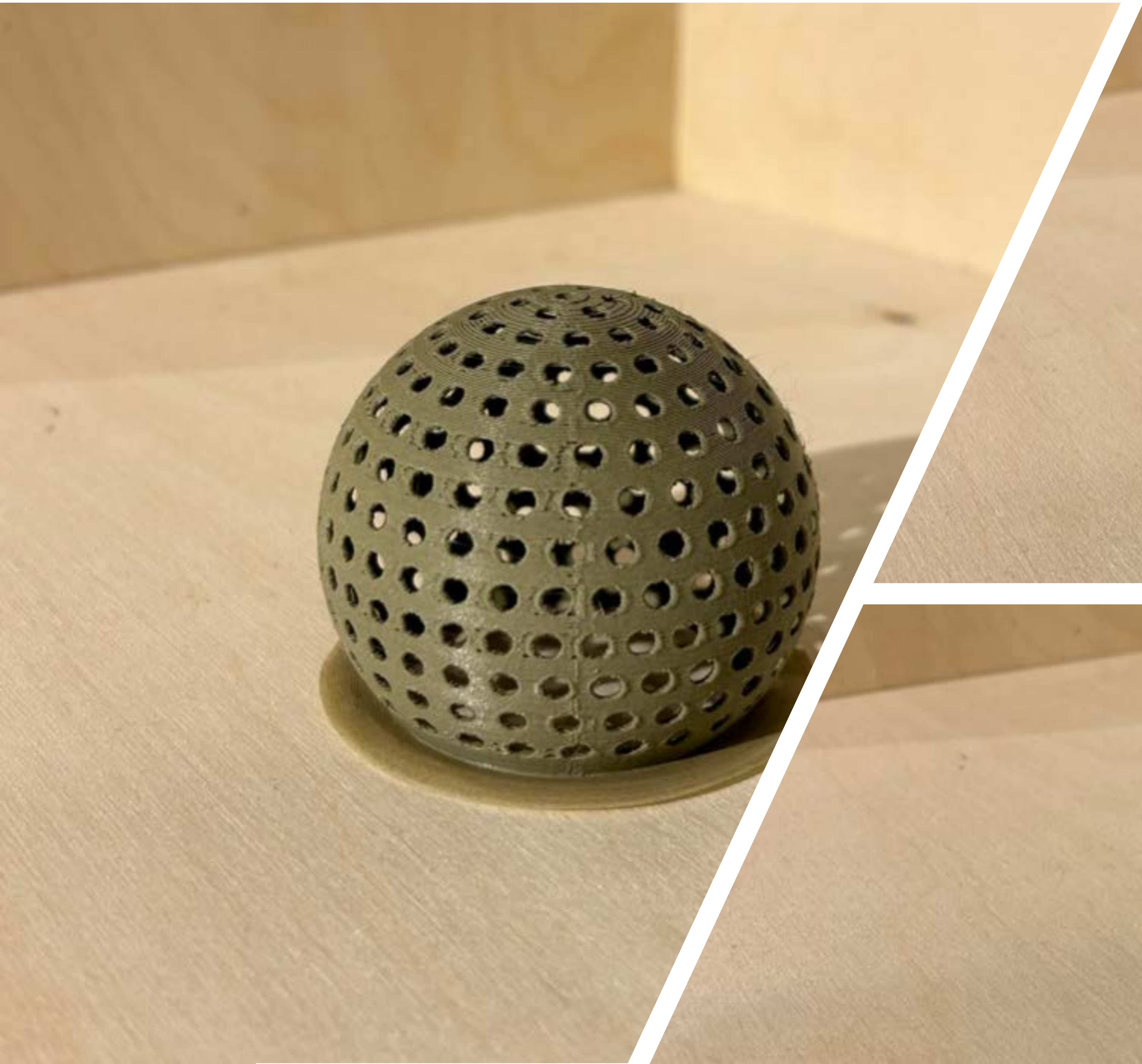


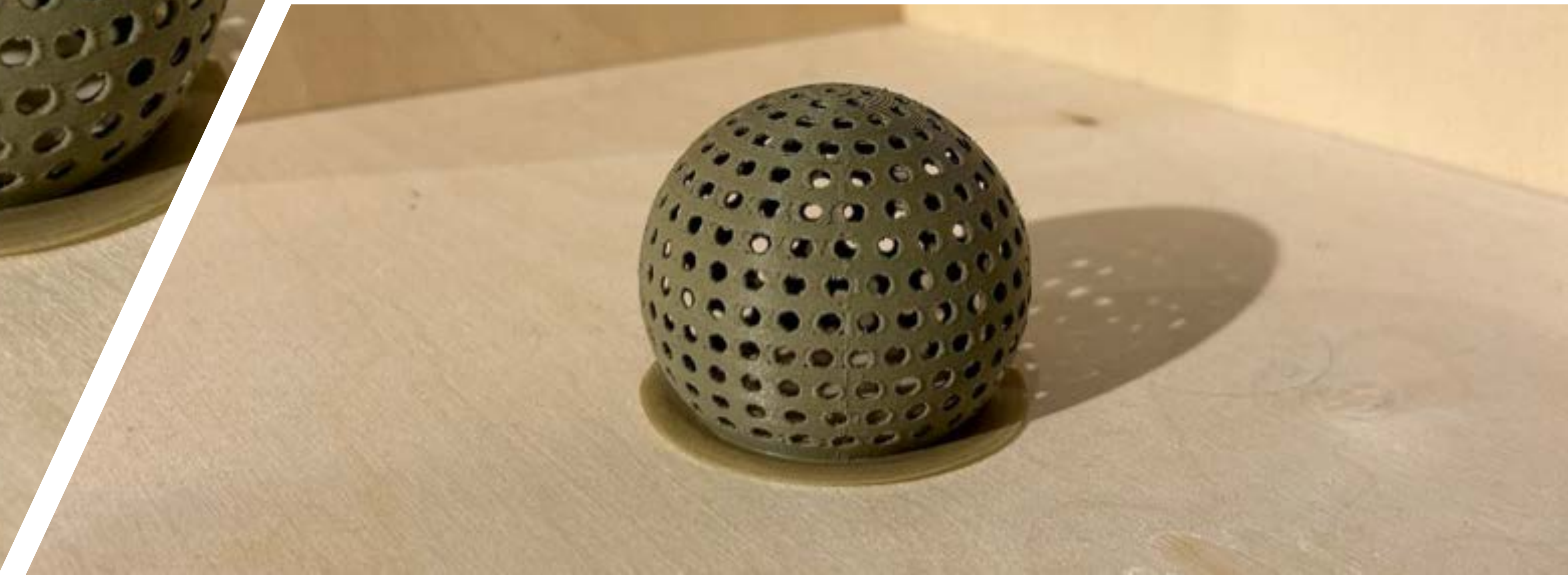
Samples.

This is a hollow sphere that I printed. I was very pleased with how smooth the surface turned out and think the overall shape, colour and way it catches the light is beautiful. I definitely want to explore spherical shapes moving forward.

Samples.

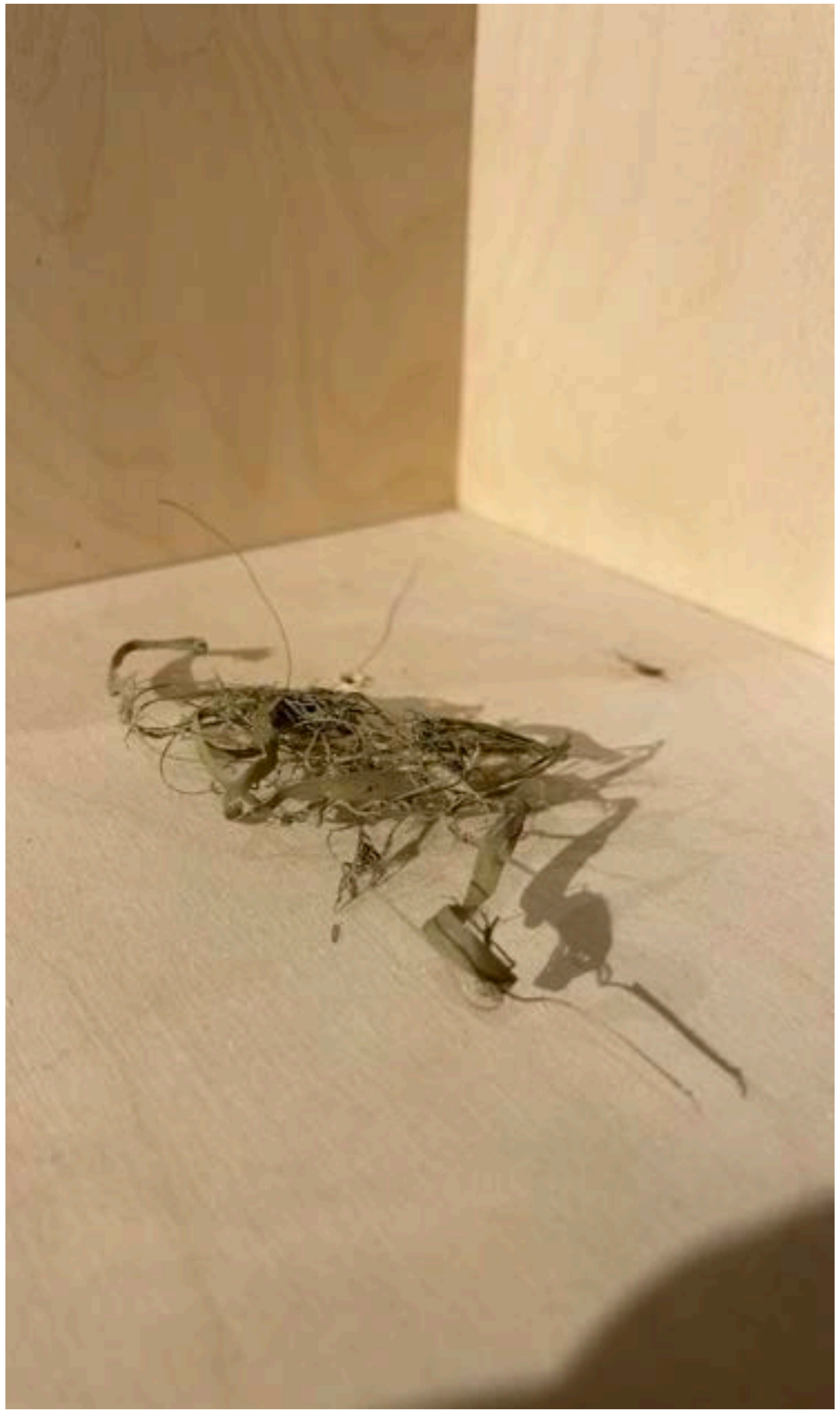
Here I printed a hollow sphere with holes cut out. This was to test how accurately the printer could print and if I could print details into the surface. Whilst I was pleased with how accuratlely it could print, the surface of the sphere became rough due to all the holes and lost its beautiful smoothness. I need to test other ways of creating cut outs in the surface without affecting the smoothness.





Failures.

These photos show some of the problems and failures I experience when printing some of my samples. The first photo shows the sphere splitting due to the print being too thin. This can be solved by increasing the thickness on CAD. The second photo shows the stringy mess that was produced when I first tried to print using the filament. I found that the temperature was too high and by lowering it I got more successful prints. Finally the photo on the right shows what happens when the thickness of the shape is incorrect. The nozzle of the printer is 0.4mm, meaning that all thicknesses must be in multiples of 4 to print correctly. Here I used a thickness that was not a multiple of 4, resulting in the gaps in the walls of the shape.



Samples.

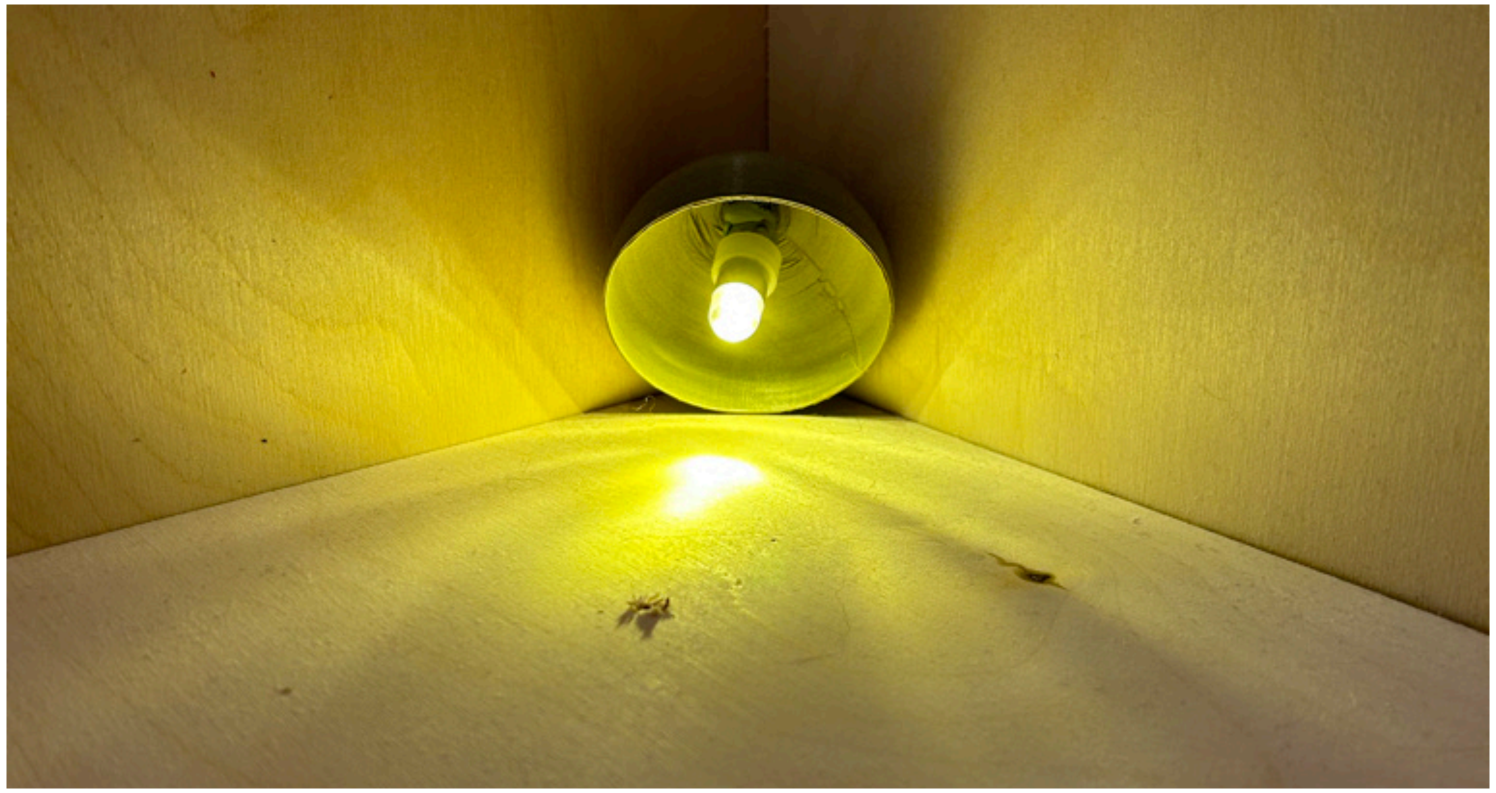
Here I began stacking multiple samples on top of each other for inspiration on forms and potential directions I could take my design. I did not print the samples with the intention of using those shapes, they were just test pieces, however doing this opened up some new possibilities. I really liked the way the smooth curved pieces reflect the light and this is an area I want to explore further.

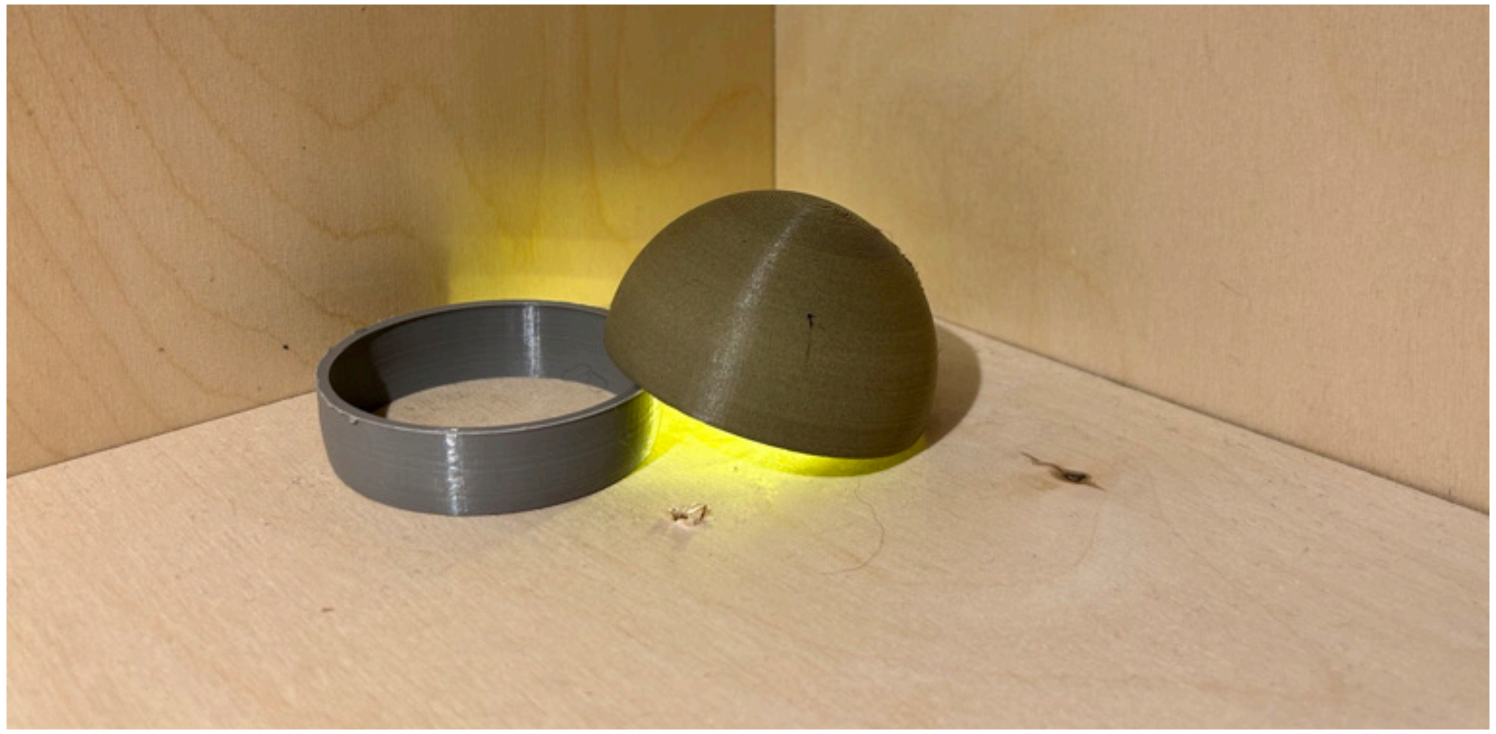
Samples.

This shows some more stacking examples. The shapes almost look like lanterns. Could this idea be explored if I go down the route of a table lamp?

Testing.

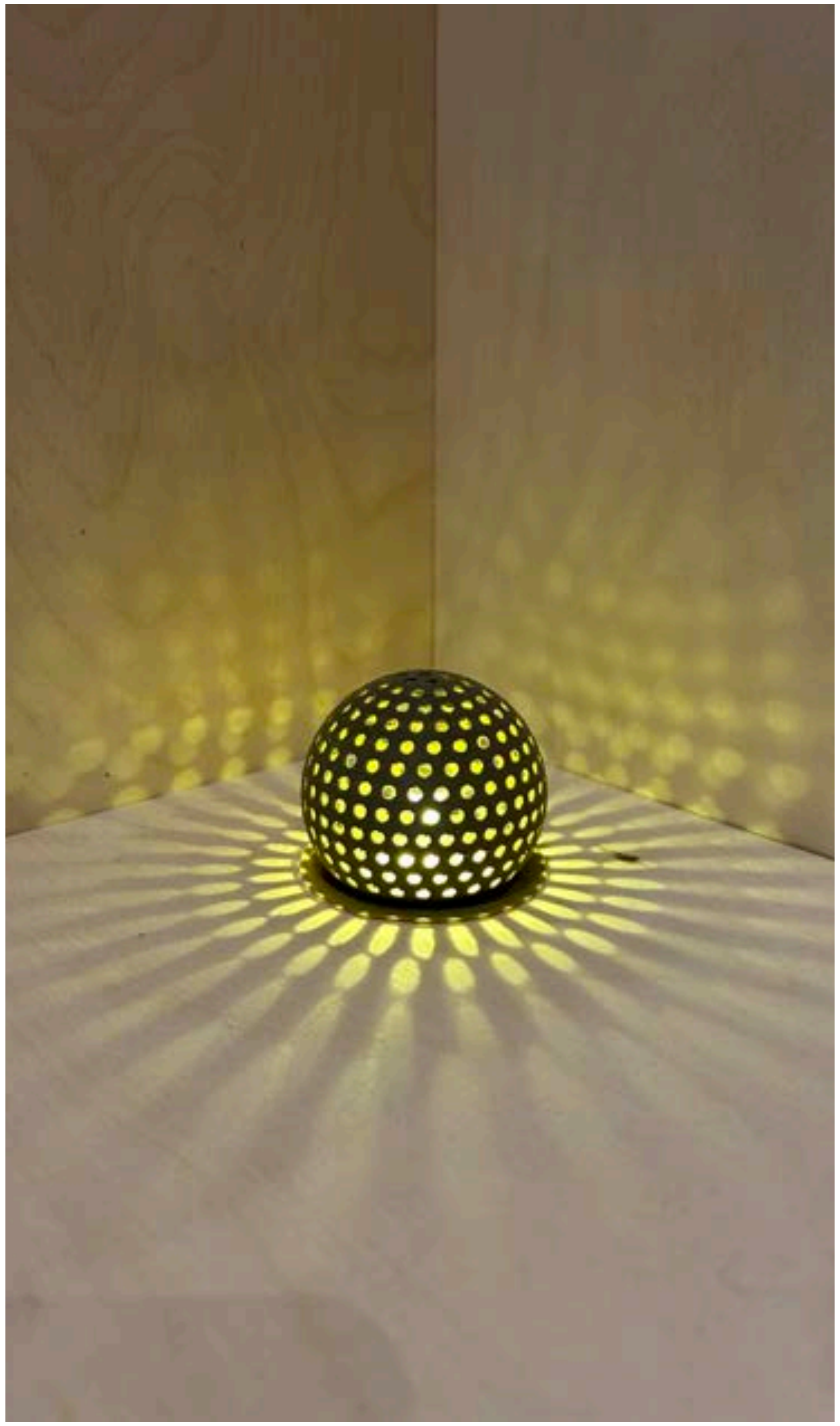
Next I began testing the samples with lights inside to see how the respond to light. I found that the material did not allow any light to shine through it and was completely opaque. Therefore I realised the light would have to come out of the shade rather than through it.

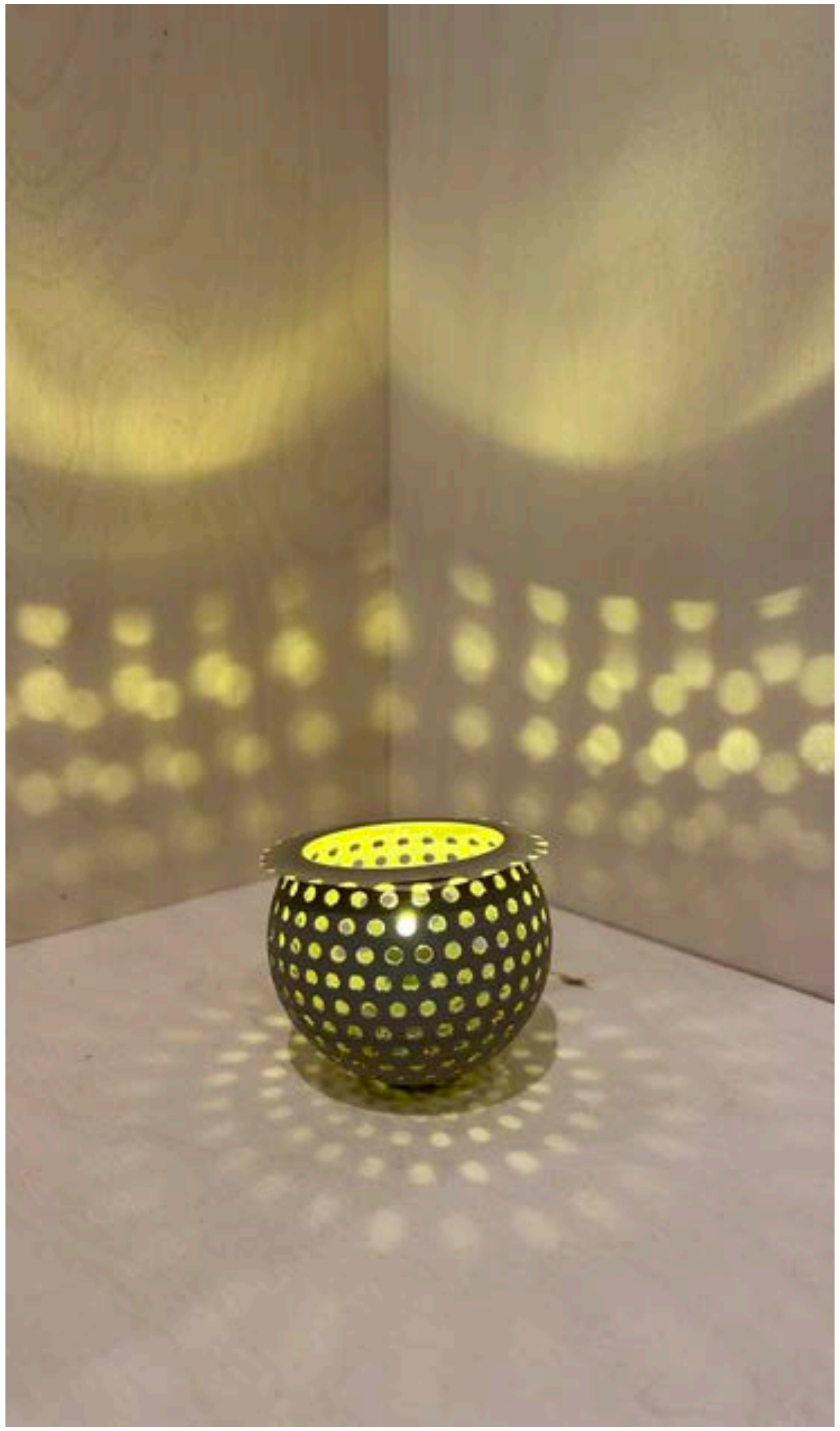


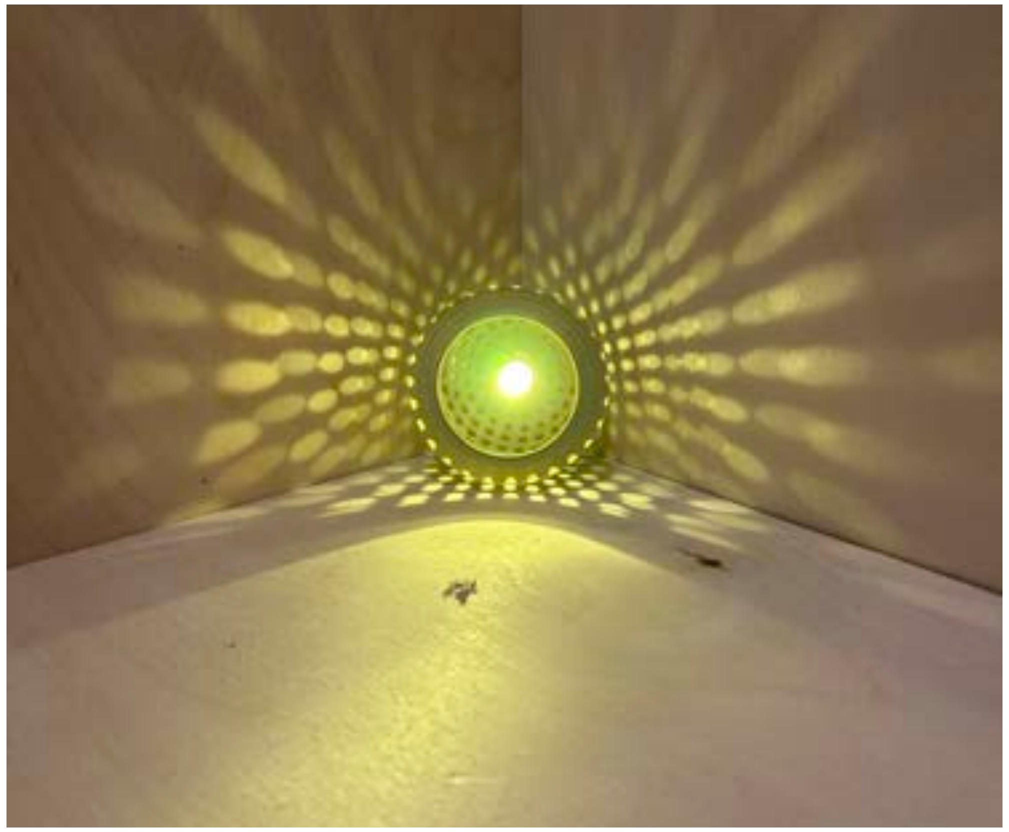


Testing.

Here I tested light inside the sphere with cut out holes. The shadows created were beautiful and with the light inside, the sphere looks very impressive. However, as explained earlier, when the light is off, the exterior of the shape looks rough and ugly. This begs the question can I create unique shadows like this, without ruining the exterior surface? Could I use smaller/less frequent cut out shapes?





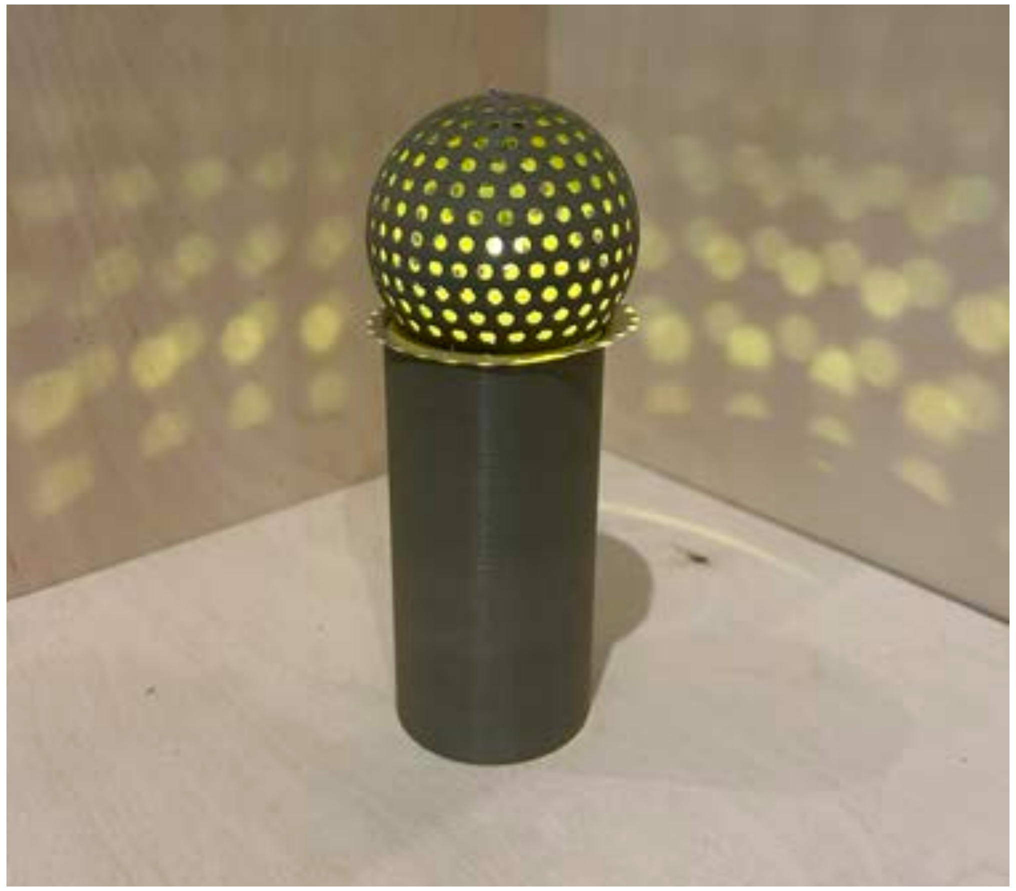


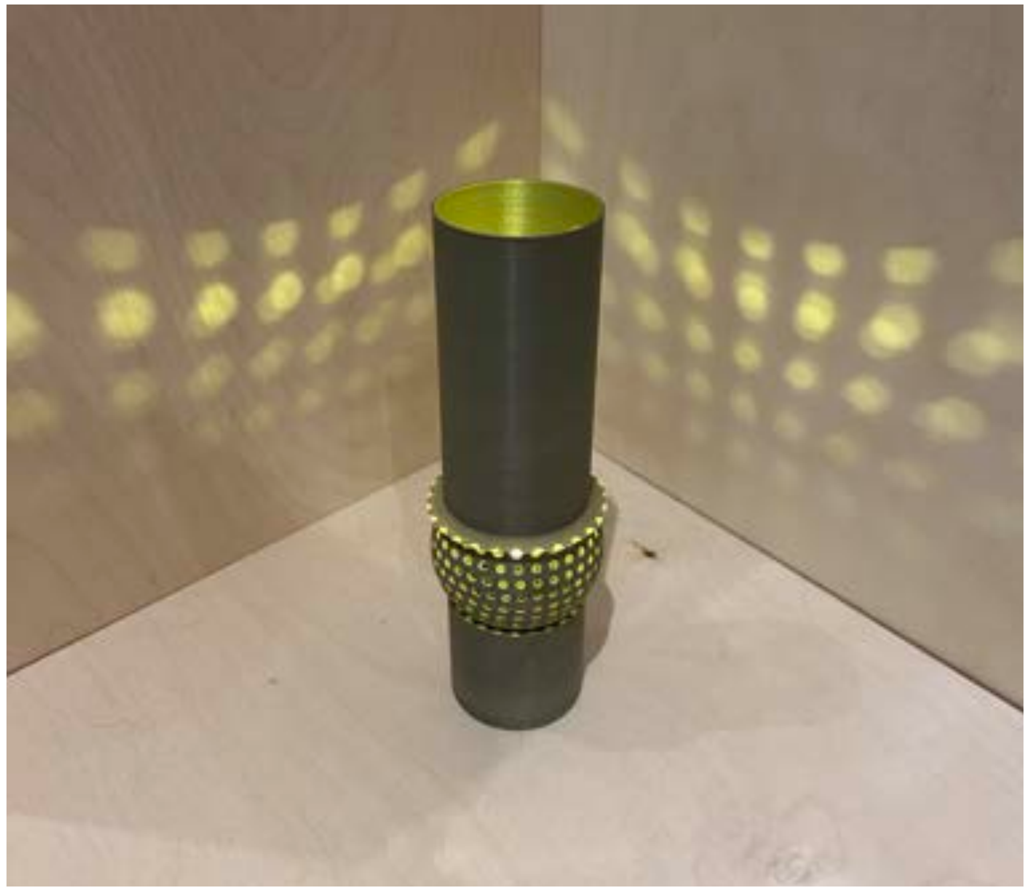
Moroccan Lighting.

This is a moodboard of Moroccan Lighting. It reminded me of the sample I had just made with the holes in. I like the way unique shadows are created and cast all over the room. If I choose to go down the route of perforated material, perhaps I could use this as inspiration.

Testing.

This shows some light inside the stacked samples. I found the tube shapes acted like a torch, encouraging the light to shine out the top and point in a certain direction. Perhaps I could use this somehow in my design for a task lamp where the light needs to be directed?





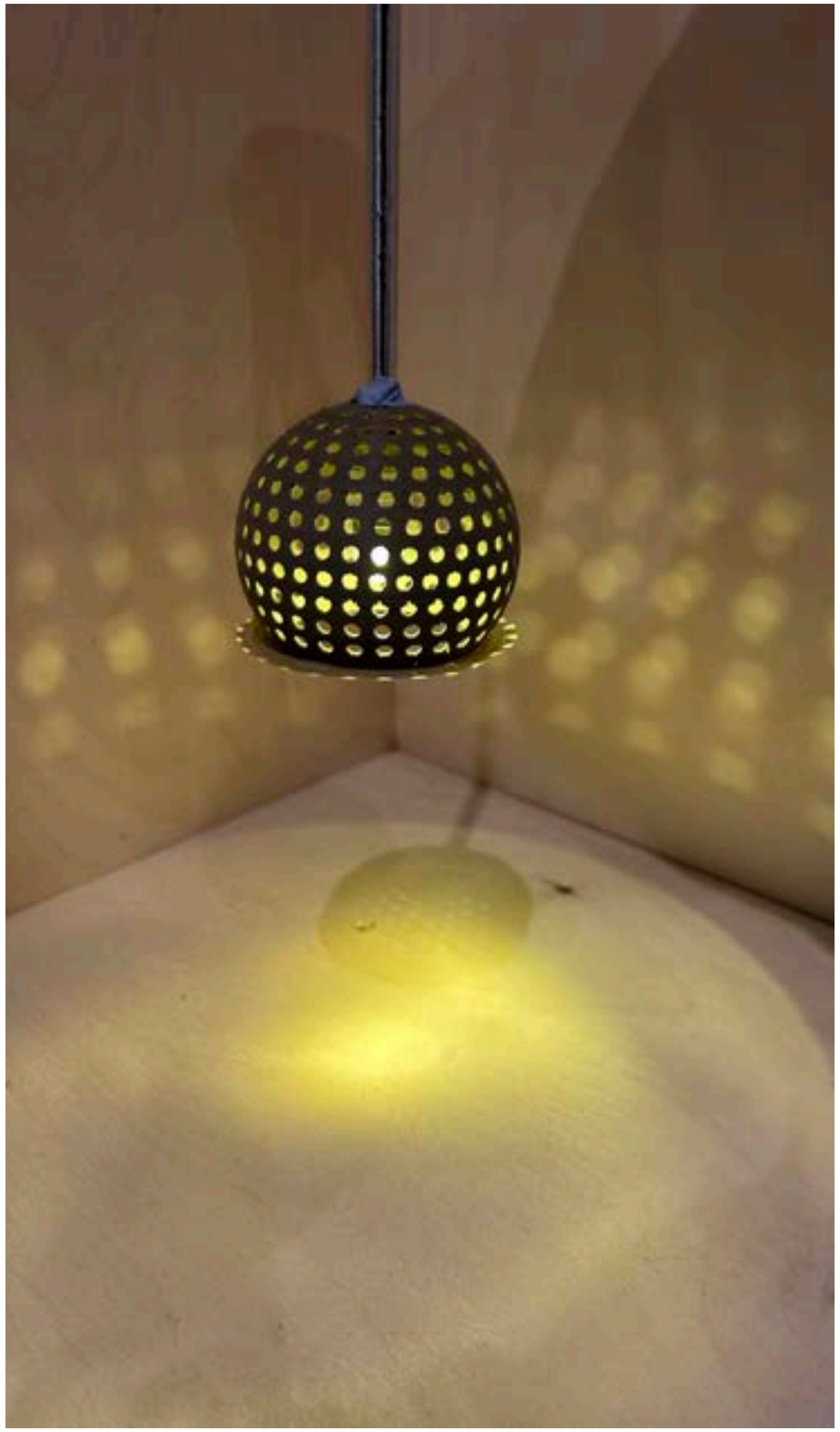
Testing.

Through the initial samples, sketching and testing, I concluded that I wanted to design a pendant ceiling light. I believe the forms I am currently working with lend themselves best to this kind of light. Additionally, the material I am using looks beautiful when printed and a pendant light normally consists mainly of the lampshade and minimal other materials, so it will show off the material I am using

Here I used blue tack to attach straws to some of the small spheres I had printed. I then placed a bulb inside each one and held them in the air and photographed them to gain a better understanding of how they would look in reality.

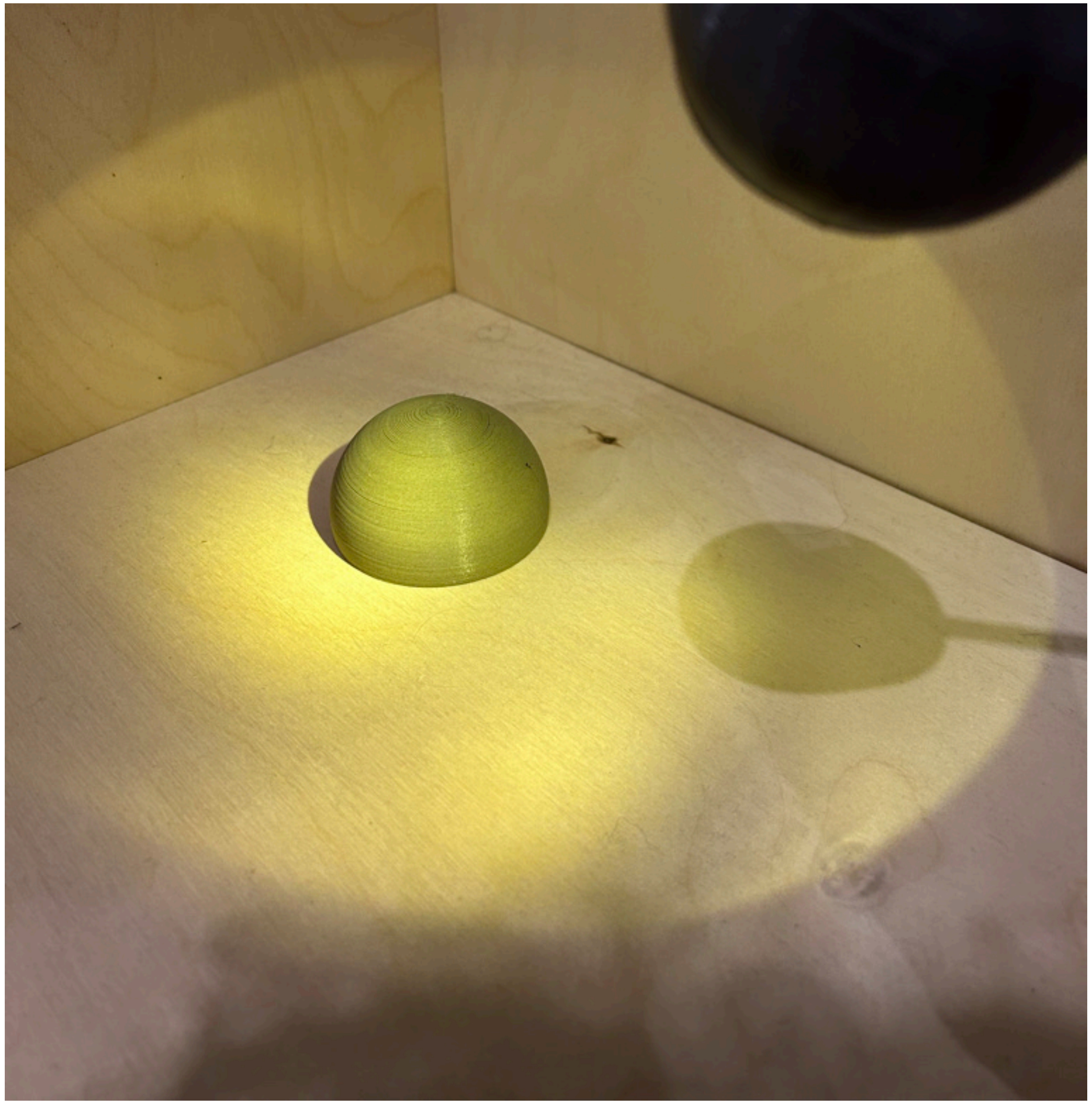
Testing.

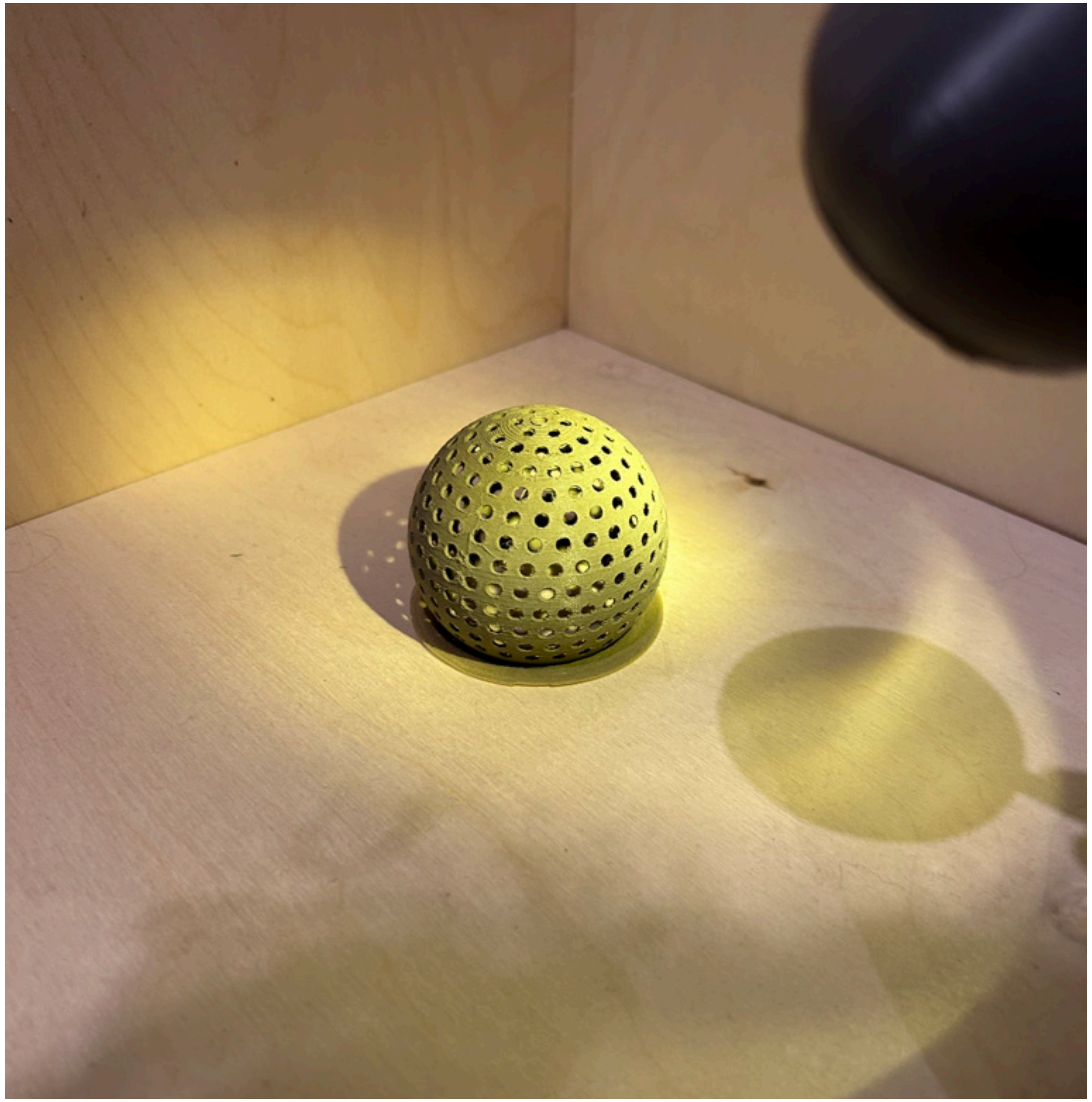
Here I used the sphere with cut outs to see how it would look hanging from the ceiling and understand how the shadows would work when not touching the ground. I was pleased with the overall effect, however as you can see on the left, when moved further away from the wall, the shadows show up less. If this was a large ceiling light in the centre of a room, would these unique shadows be created?



Testing.

After noticing how nicely the material reflected light, I decided to compare the smooth surface to the surface with holes in. As you can see, when light is shined on the exterior of the smooth sphere, it creates a line of reflection off the surface that takes the shape of the sphere. The sphere with holes in doesn't do this and looks rough and messy. Perhaps my design could utilise the idea of light shining on the outside of the spheres, as well as coming from within.





Conclusions From Samples.

From printing and testing these samples I have learned:

1. The material is completely opaque. No light is able to shine throught the material at all, therefore I must find other ways to let light out, e.g out the bottom or through gaps

2. The exterior reflects light very nicely. The material has a matte finish with a slight shine to it, which causes light to reflect off it nicely. Beams of light conform to the shape of the object when light shines onto the surface

3. Rounded shapes reflect light the best. From the prints I did, spherical shapes reflected light in the nicest way. Tubes and spheres both worked well, but the flat disk did not look as good with light shining on it.

4. Small detailed perforations ruins exterior of materal. By creating multiple small holes next to each other, it ruined the smooth surface of the material, due to the way it prints. Should I do much larger holes, or leave the idea of perforation all together?

Time Management.

In Week 6 I was probably less productive than I planned to be and had been in previous weeks. I believe this was due to waking up later and going to bed later, which meant I sometimes wasn't starting work until the afternoon, making me less productive. Additionally I probably gave myself too many tasks to complete at the start of the week, creating an unrealistic goal. I did still manage to complete the majority of the tasks, so overall it was a successful week.

Week 6

20.02.23

To Do List

- More sketches ✓
- Print large squashed sphere ✓
- Print lots of small parts of spheres ✓
- Stack spheres in different arrangements ✓
- Photograph samples with bulbs inside ✓
- Email people for interviews ✗
- Test wet + dry paper on samples ✗
- Print bone strength Test ✓

To Attend

Monday – Studio : 9-5 ✓

Tuesday – Work from home ✓

Wednesday – Lectures : 10-12 ✓

Thursday – Studio : 9-5 ✓

Friday – Thesis tutorial : 12 - 12:30 ✓
CAD : 2 - 3:30 ✓

Tutorial - Rob

Create new shapes from layering spheres

Think about a range of lighting

Floor lamp
Pendant / ceiling light
Desk lamp

Print lots of small sections of spheres + stack them in different arrangements

Could the light come from areas other than the bottom ?

Could spherical shapes be made with gaps in the 3D print to allow light to escape ?

Snail shell shape with gaps ?

Slits or curves to allow light out

What I Want My Light To Achieve.

Aside from its obvious function as a light, there are 2 main specifications I would like my product to meet.

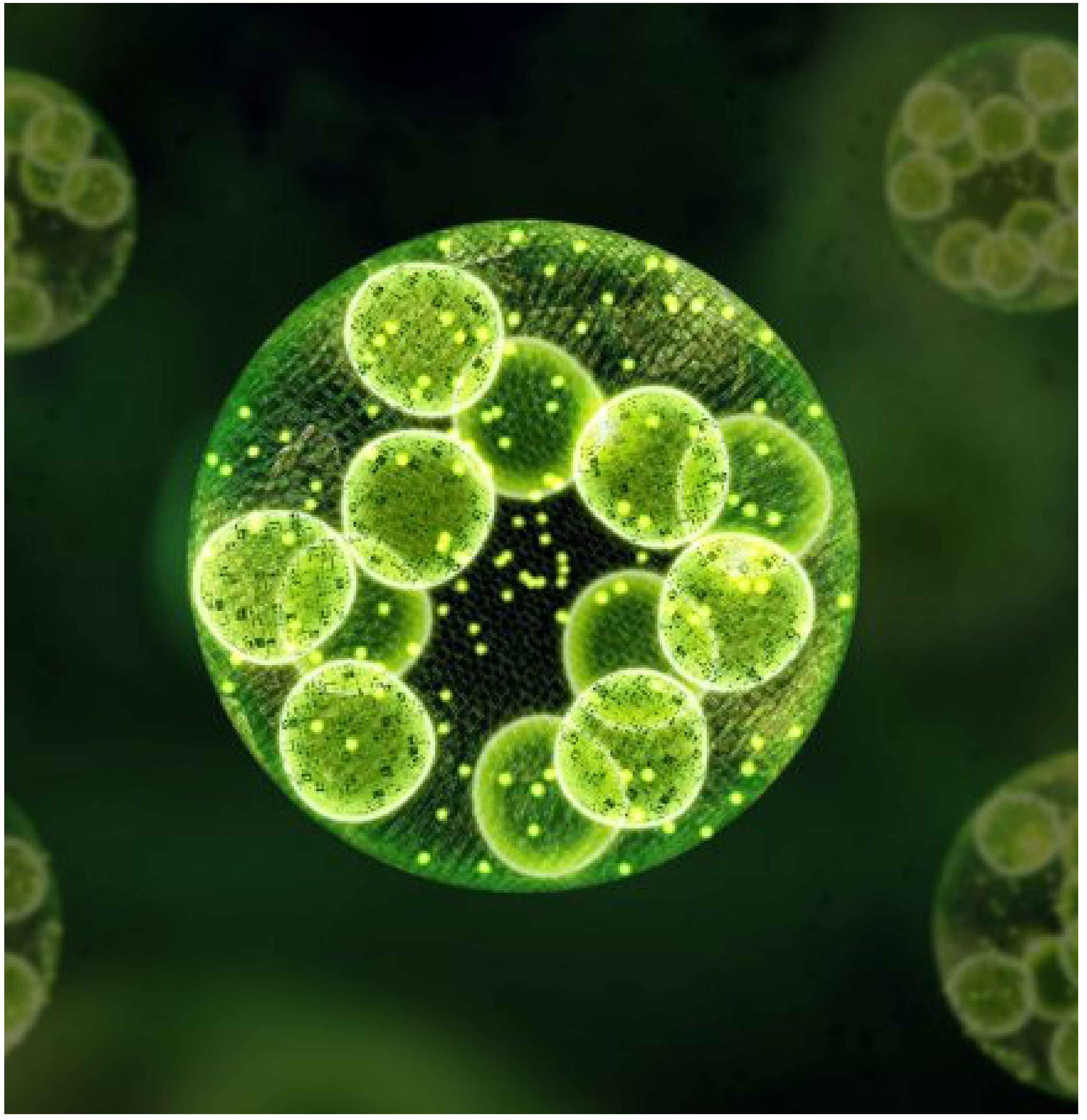
1. Justify the use of 3D printing - the majority of the light should use shapes and forms that lend themselves to 3D printing. They should be shapes that are difficult to create using any other manufacturing methods, but can be manufactured through 3D printing fairly easily.

2. Pay homage to the material - the light should reference the source of the material in some way. For example, it should somehow represent algae or something related to algae, as a nod to where it has been sourced from to highlight the naturalness and sustainability of it.

Algae Under A Microscope.

To gain some inspiration for how I could reference algae in my design, meeting my second specification, I looked at how algae appears under a microscope.

This is one example of how algae can look under a microscope. As you can see in the photos, it appears in clusters. These clusters consist of rounded, spherical shapes, however they are not perfectly round. If you look closely, they are slightly squashed. **Perhaps I could include the idea of clusters of squashed spheres into my design, as a reference to the cell structure of algae to pay homage to the source of the material. This also relates to the concept of biomimicry.**



Biomimicry.

By definition, biomimicry is the "design and production of materials, structures, and systems that are modelled on biological entities and processes." Essentially, this means designs that are inspired by, or based on nature.

This is a photo I took of the spiral staircase at Vitra. As you can see, it quite clearly originates from the spiral seen in a snail shell. This is an example of biomimicry.

By basing the form of my light on that of algae under a microscope, I am using biomimicry in my design, as I am imitating the cell structure of a natural organism. Whilst this is only a subtle use of biomimicry, it provides a deeper connection to nature within my design, further highlighting the use of a natural material.

Biomimicry.

Values.

Value Hierarchy

Honest

Tribute

Inducing

Honest - I want the design to be honest in terms of the manufacturing process and the material used. Therefore it should not matter if there are imperfections and inconsistencies in the print, as I want it to show that it has been 3D printed using a new, experimental material.

Inducing - My design should encourage conversations on sustainability. The unusual shapes and colouring should hopefully be enough to create a conversation surrounding the product. Most importantly, algae is an unusual and interesting material, which will almost certainly create conversation surrounding the material and its origin and therefore sustainability.

Tribute - I want my product to pay homage to the material that is being used. This will be achieved by replicating the cell structure of algae in the design, by using squashed cluster forms.

In terms of my value hierarchy, 'Honest' and 'Tribute' are almost of the same level of importance right up the top. Then "Inducing" is further down in importance. Whilst it is still important, I belive the other two values are more key to my design and "Inducing' is almost an added bonus of the design and material choice.

Lighting Designers.

Tom Dixon

Tom Dixon is a luxury UK designer who specialises in lighting. His light designs are my personal favourite and I have definitely taken some inspiration from them for this project.

When looking at Tom Dixon's lights, I noticed some common features between them. The vast majority are unusual and very organic, curved shapes. This is a style which I have always liked, as opposed to more angular shapes, and is an aesthetic I would like to take forward into my own design. It links in well with my project, as I identified that algae takes the shape of spherical clusters and that was something I would like to replicate with my own light to pay homage to the material.

Some other common features include:

- Organic shapes
- Curved lines
- Asymmetry
- Polished metals

Lighting Designers.

Niamh Barry

Niamh Barry is another lighting designer I have taken inspiration from for this project. Again, I love the use of organic, rounded shapes and how unusual the forms are. I also like the use of polished metal, however I am not sure this would be suited to my project, considering the material I am working with.

Could I potentially do something as large as this, or would that not be practical, seeing as I am using 3D printing? The printers at uni can only go up to 400x400mm, so perhaps it will have to be a smaller scale light.

Experimental Designers.

ITG Studio

Interesting Times Gang are a small company based in Sweden, who experiment with different materials and processes to create unique and sustainable products. I carried out an interview with Alexander Westerlund to find out more about the company and what they do.

These chairs are part of the "Kelp Collection" and are manufactured using large 3D printers and a material made from recylced fishing nets and wood fibres. **It shows how 3D printing can potentially be used in the furniture industry in the near future,** with these chairs only taking a couple of hours to print at a time.

It also evidences the potential for the use of experimental materials withing the furniture industry.

This justifies my choice to use a new and experimental material for the project.

Interview.

ITG Studio

1. What are the main goals of your company?

"Working with new and experimental materials and trying to develop our own materials. We also experiment with large-scale 3D printing. We want to create these materials for affordable prices. Sometimes these types of products cost 4 or 5x the amount of the regular versions and people just don't want them. We want to shower bigger companies that it can be done."

2. Is sustainability a key driver for your company?

"Yes, it is hard to design unsustainable products now and sell them. This is driven by market, but also our own conscious"

3. Could you tell me a little more about the Kelp Collection Project?

"For this project we wanted to use large-scale 3D printing to create furniture. We were hired by a michelin star restaurant to design their furntiure. The material we used was wasted fishing nets mixed with wood fibres. Fishing nets are a wide source of plastic waste, so we wanted to use this for the material."

4. Where can you see this, or similar materials being used in the future?

"The great thing about this material is that it can be repeatedly ground down and used over and over again, building a circular loop. People can send back the chair, have it ground down and turned into a new product. The material is also non-biodegradable, however this is not a bad thing, as it means it can be infinitely used. Biodegradable plastics don't create that loop."

5. Did you come across any limitations when 3D printing experimental materials like this?

" Yes, there were lots of failed prints in the beginning and also inconsistencies in the products produced, such as colour variations and inconsistencies in texture. However, this is not necessarily a bad thing, the key is just being honest with the client."

6. Do you think that this material and other alternative experimental and sustainable materials should and will be used more in the furniture design industry??

"Yes, there is a new wave coming. Some big brands are beginning to use them and more will continue to do so. However, maybe the reason they are not being used so widely yet, is because their perfect application is yet to be found, similar to 3D printing. It is difficult, when oil-based plastics are so cheap."

Interview Analysis.

ITG Studio

I interviewed Alexander Westerlund, head of design at Interesting Times Gang, who has worked on designing 3D printed furniture using experimental materials. It was very interesting and useful to get some insights from someone in the industry, who has done a similar project to mine and get his opinions on it.

Some of the key things I learned from this interview were:

- Sustainable or experimental products are often much more expensive and people don't always want them. They need to be affordable to implement into our lives more

- Inconsistencies in the final product aren't necessarily a bad thing

- Products that can't biodegrade can actually be beneficial to the environment

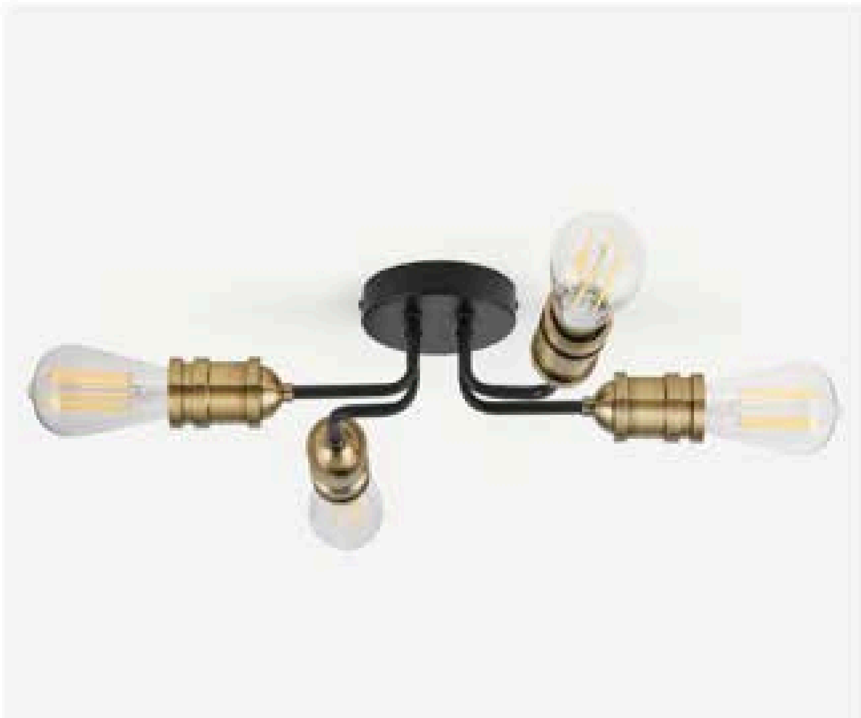
- There is definitely a place for these materials in the industry and they will be used more frequently in the near future

I found this interview invaluable to my project, as it is so similar to what I am doing. I expect to experience lots of imperfections in my design, due to the process and material I am using, however this proves that could be a good thing. One of my key values is honesty, which highlights this. It also confirmed to me that my product and similar products, definitely have their place in the furniture design industry

Copper

Curved

Natural



Rounded

Brass

Neutral

John Lewis.

I visited the John Lewis shop in Nottingham and had a look at the lighting section. I photographed a selection of the pendant lights they currently sell. I found that they were all quite similar, using metal combined with a bulb. Perhaps I can challenge this by using algae-based plastic, as this is quite an alternative material.

Pendant Lights.

Pendant Lights.

Analysis

This is a selection of existing pendant lights. It is noticable that they all use curved, organic shapes. This is something I want to replicate in my own design, as it fits my brief well. Algae is a natural material, so I want to reflect that by using organic, natural looking shapes, rather than angular harsh shapes.

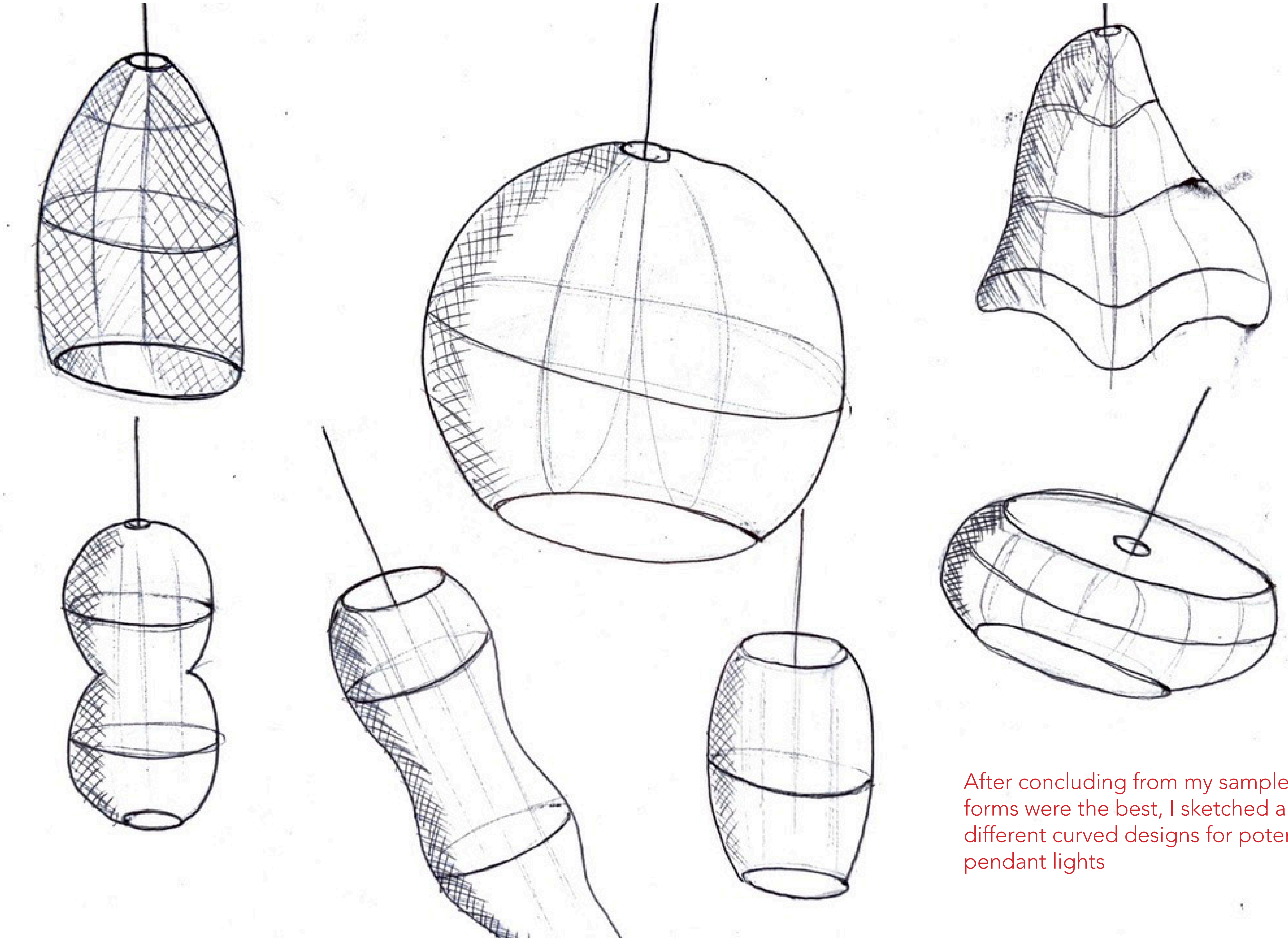
3D Printed Lights.

3D Printed Lights.

Analysis

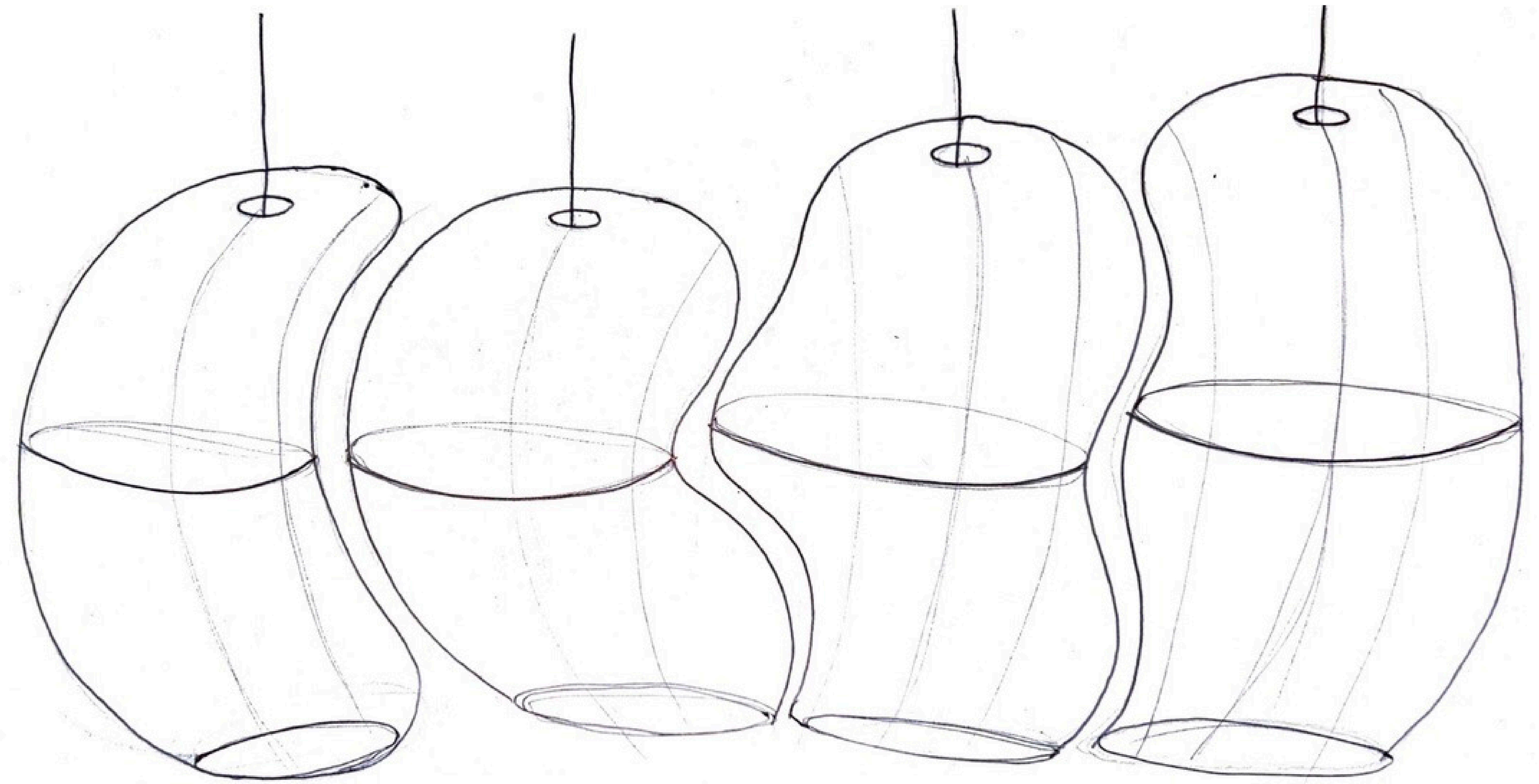
This is a selection of existing 3D printed lights. I like the way they are unique shapes that cannot be made using other manufacturing methods. I also like the way they create interesting shadows. These are 2 aspects I definitely want to use in my design. However, some of them are a bit too unusual and look almost alien-like, which is not something I want to replicate in my own design. Additionally, the material I am using is not transparent at all and so will have to explore other ways to allow light out.

Development Sketches.



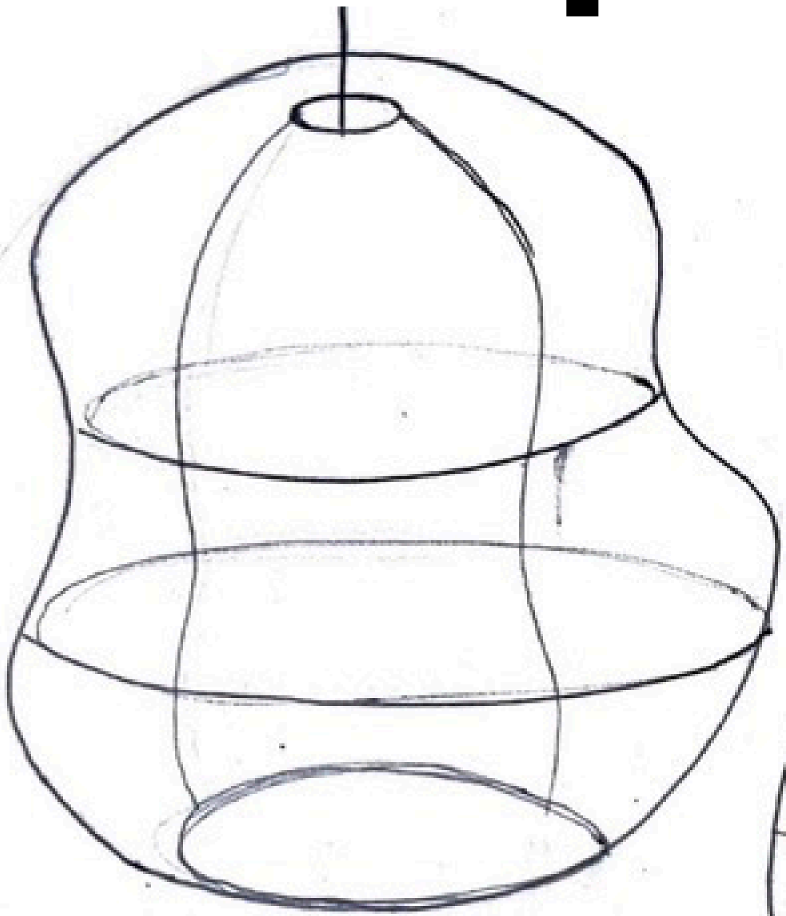
After concluding from my samples that curved forms were the best, I sketched a variety of different curved designs for potential shades/ pendant lights

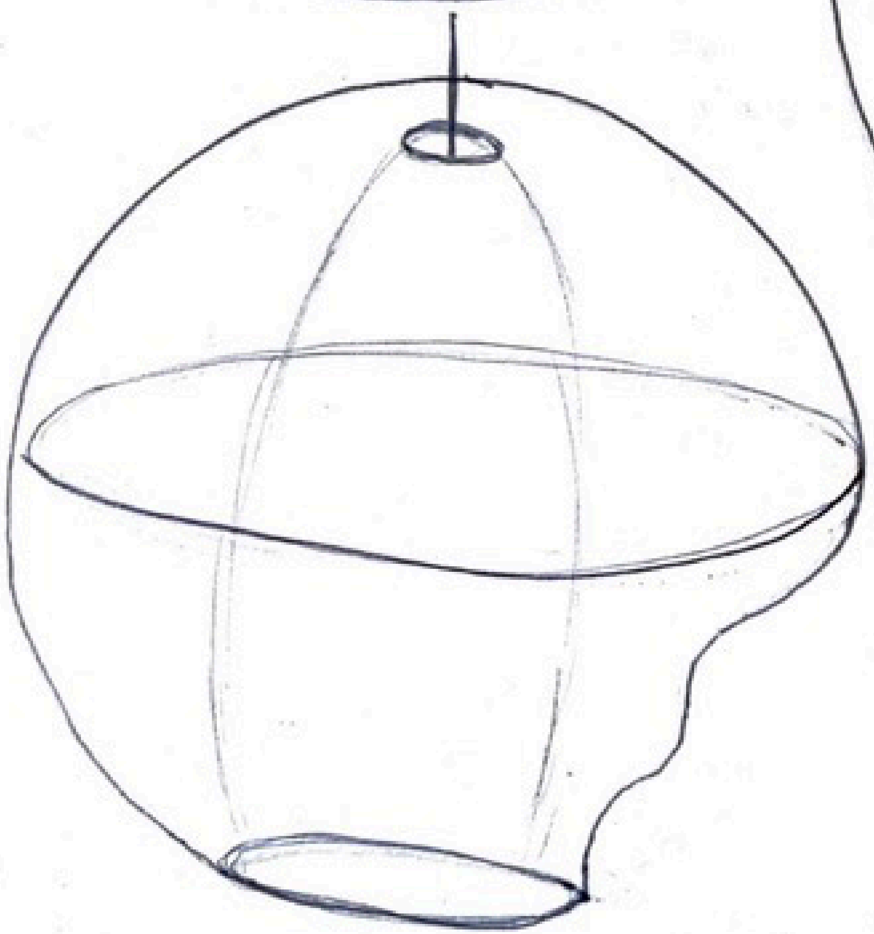
Development Sketches.

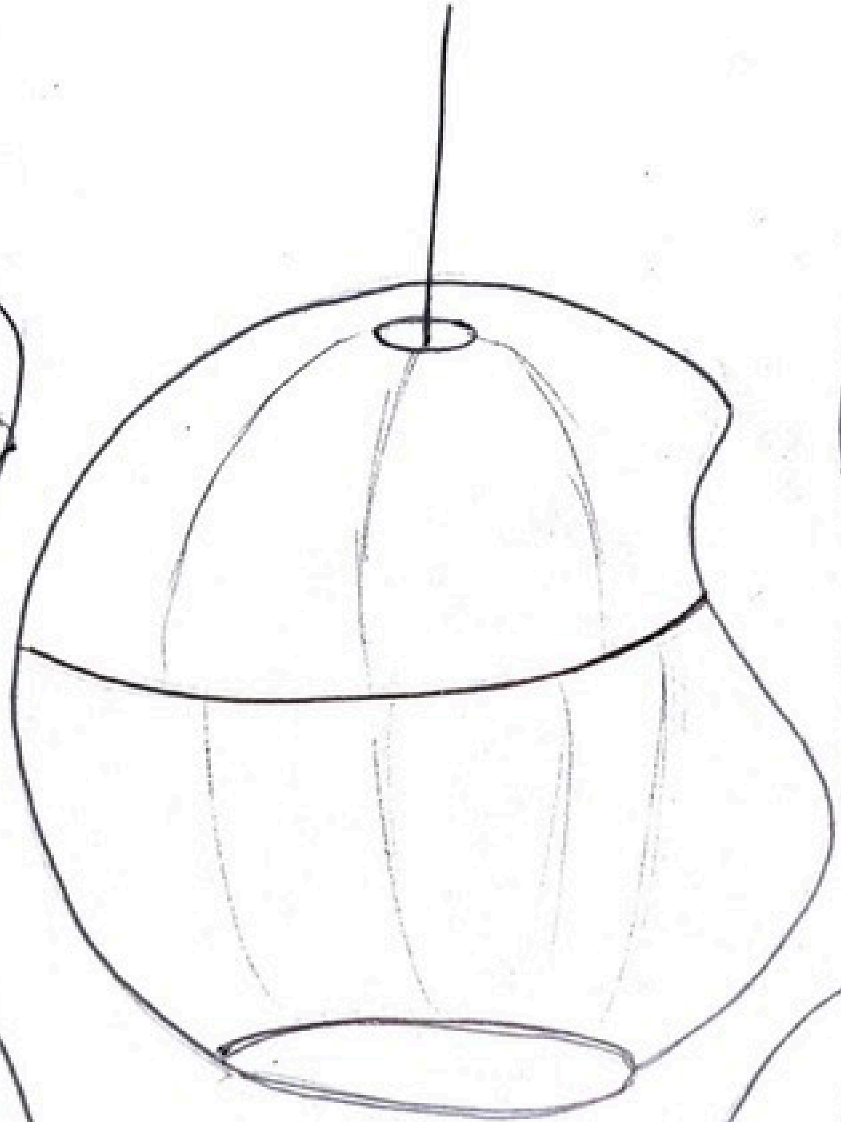


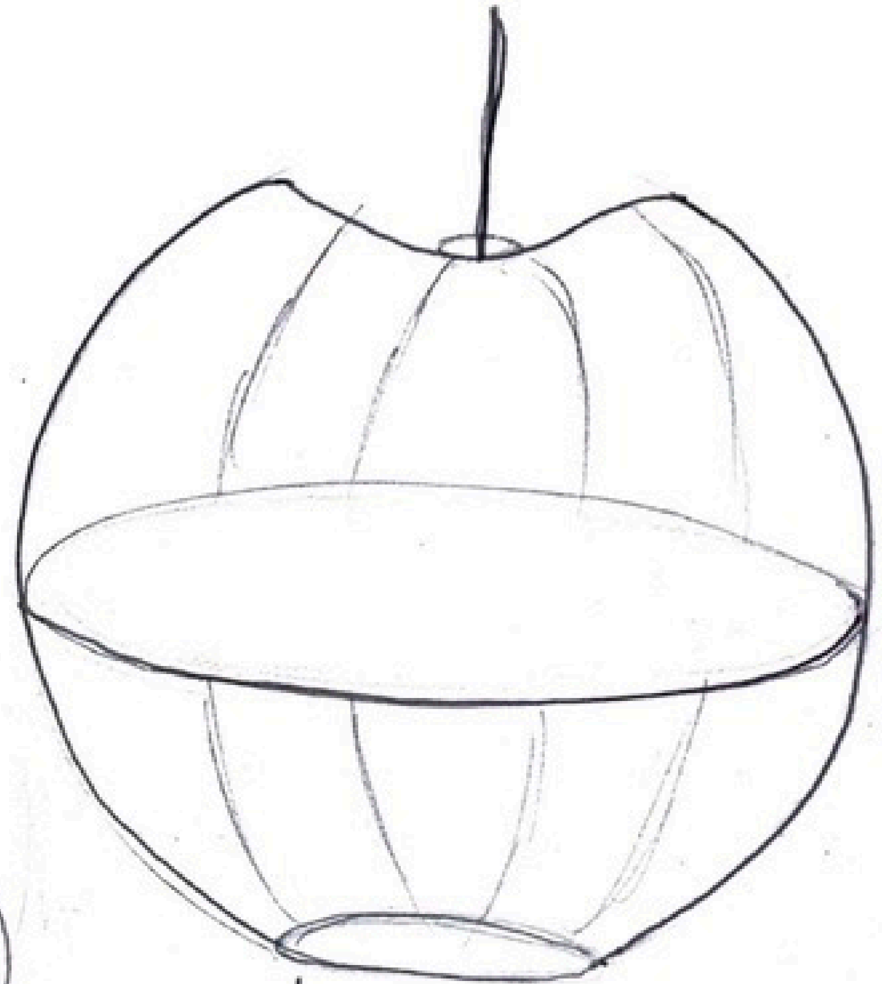
This concept explores the idea of squashed, curved forms fitting together in an arrangement. The squashed sections would compliment each other and be shaped to fit together

Development Sketches.

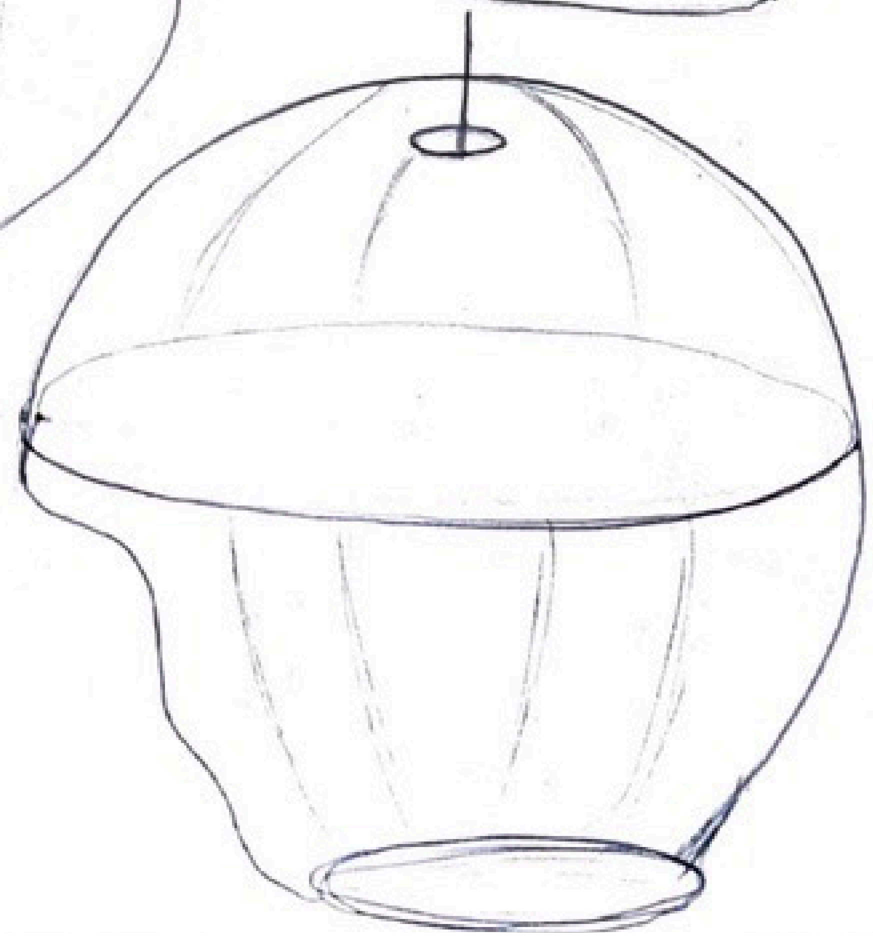




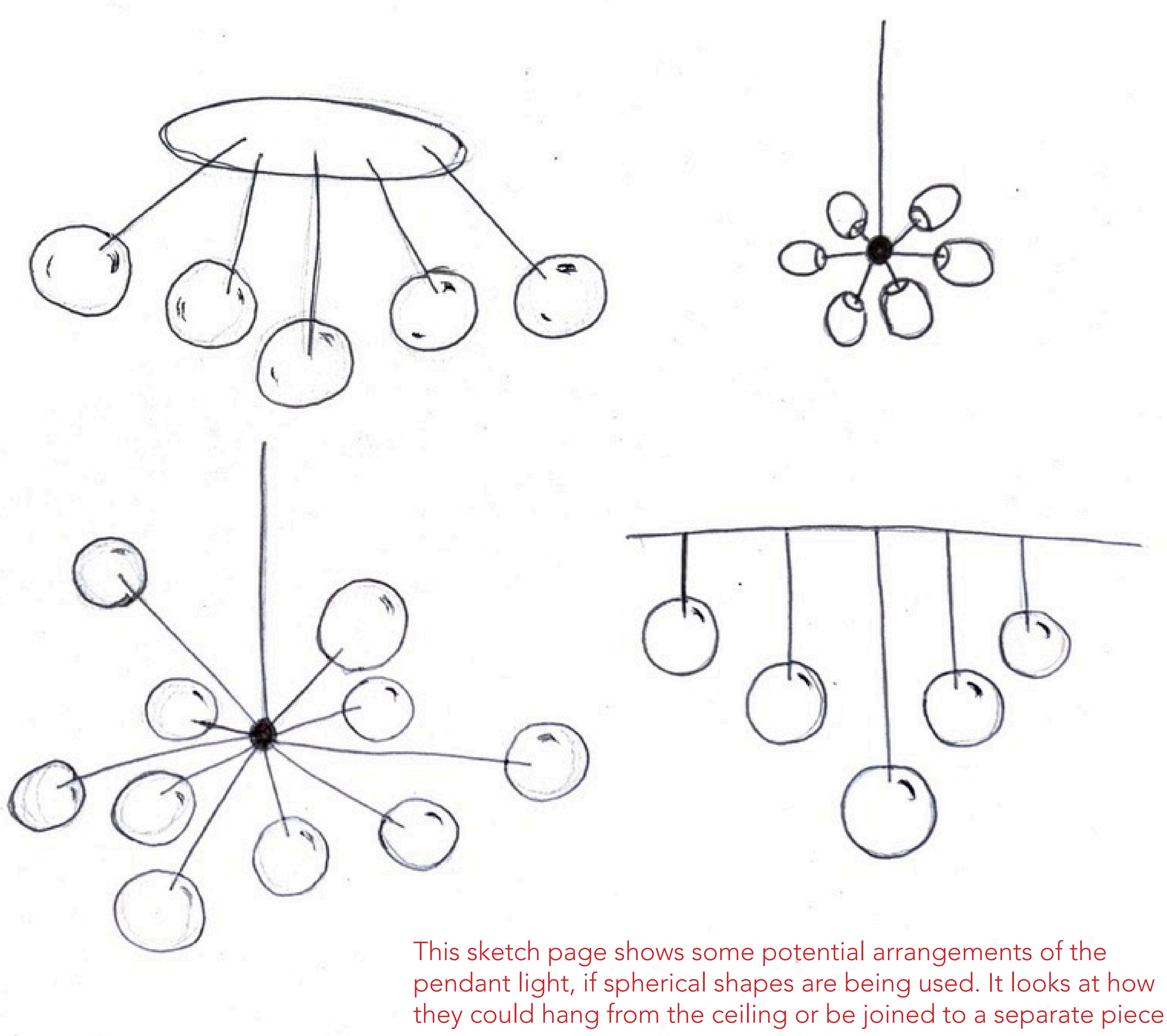




Here I explored some different squashed spherical shapes to try and replicate the cell structure of algae, as explained earlier

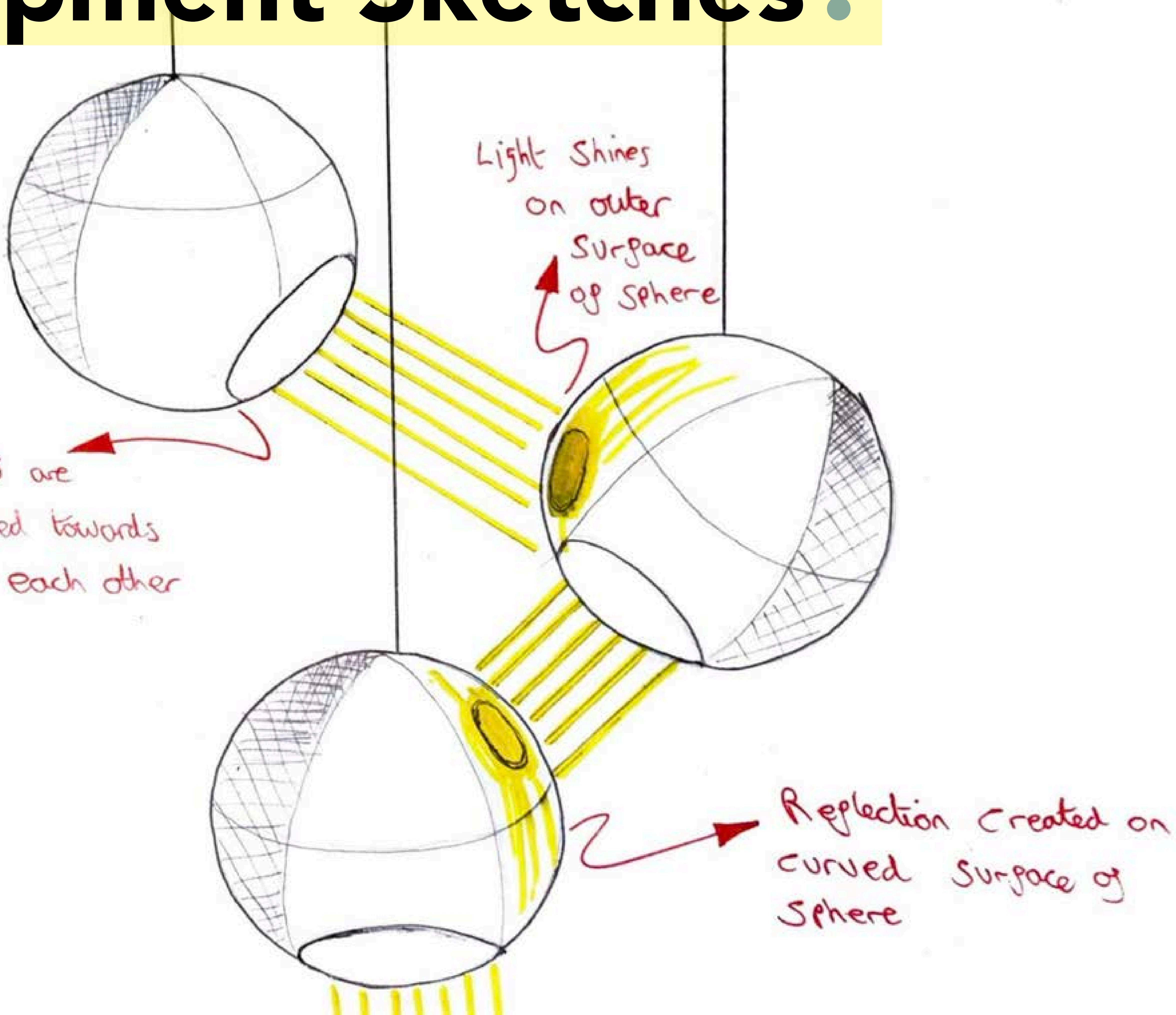


Development Sketches.



This sketch page shows some potential arrangements of the pendant light, if spherical shapes are being used. It looks at how they could hang from the ceiling or be joined to a separate piece.

Development Sketches.



Samples.

I used the 3D printer to print some much larger 200x200mm spheres. This was to test if larger shapes like this would require supports to be printed. I found that it didn't require any support which is brilliant, as it massively reduces printing time and neatness. I used regular PLA for these tests, as it is far cheaper than the algae-based PLA, which I didn't want to waste on tests like this. I like the way the light reflects off the surface, however, the print has created some square shapes on the sphere and at the top it becomes more messy. Is there a way to change the settings to print more smoothly overall?

Samples.

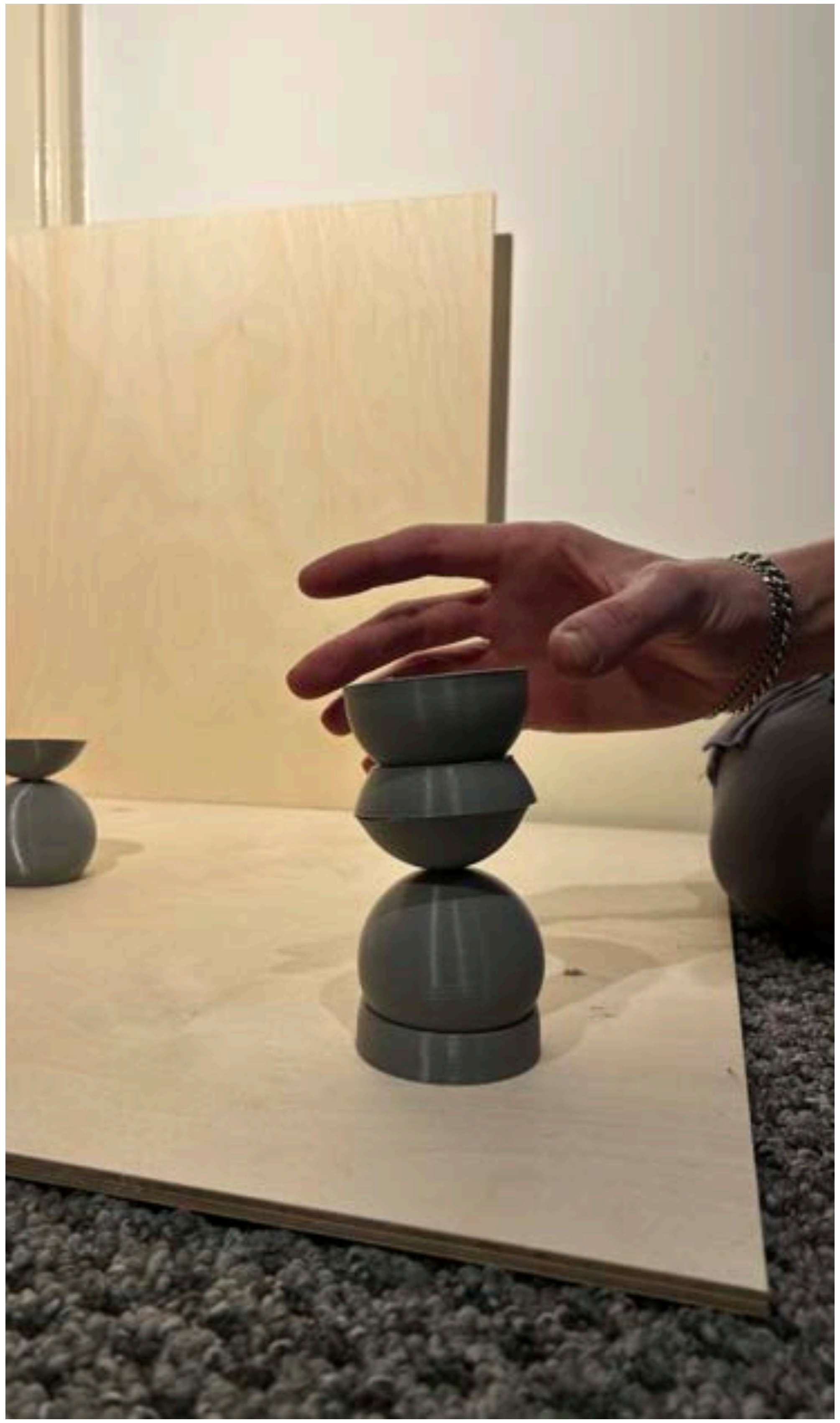
I then printed a squashed spherical shape that I created on CAD. This also printed pretty well and didn't require support. I love the way in which the light bounces off the surface and follows the shapes of the sphere, conforming to the curves and squashed parts. This is definitely the concept I would like to take forward.

Samples.

Here I printed some smaller spheres, both squashed and regular. I then used CAD to split the spheres into different sections to get pieces like this. I managed to print them all in one print, which saved a lot of time. The reason I printed these was to see if I could stack the sphere to perhaps create some new unusual shapes.

Samples.

This shows me experimenting with the pieces of the spheres and stacking them in different ways for some further inspiration on forms. Whilst the shapes I created were unique and interesting, I am not sure they lend themselves to a pendant light and I personally prefer the simpler spherical shapes.



Samples.

These are some of the shapes I made by stacking the regular sphere pieces. As you can see in the photo, the light follows the form of the objects beautifully and this is something I would definitely like to pursue.



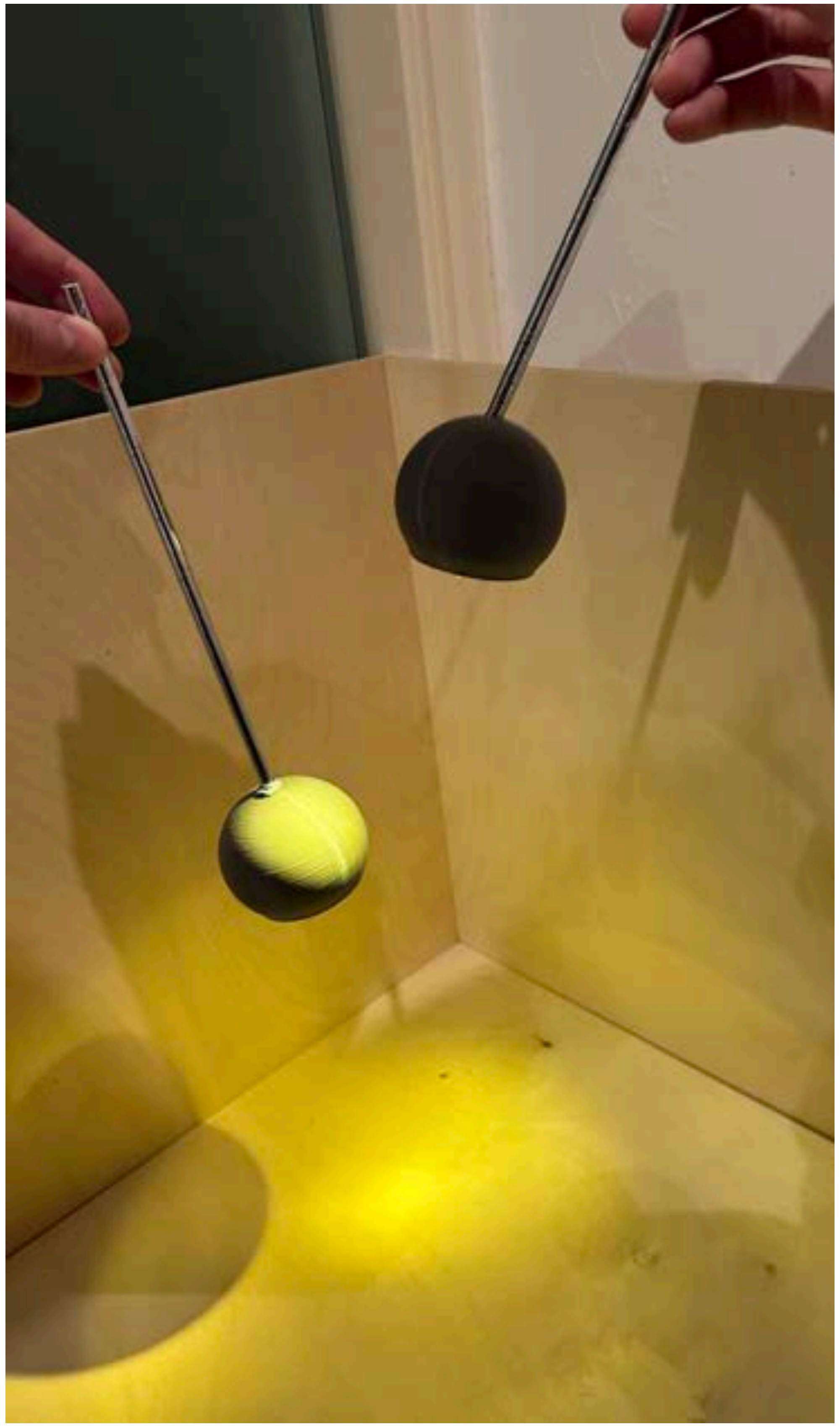


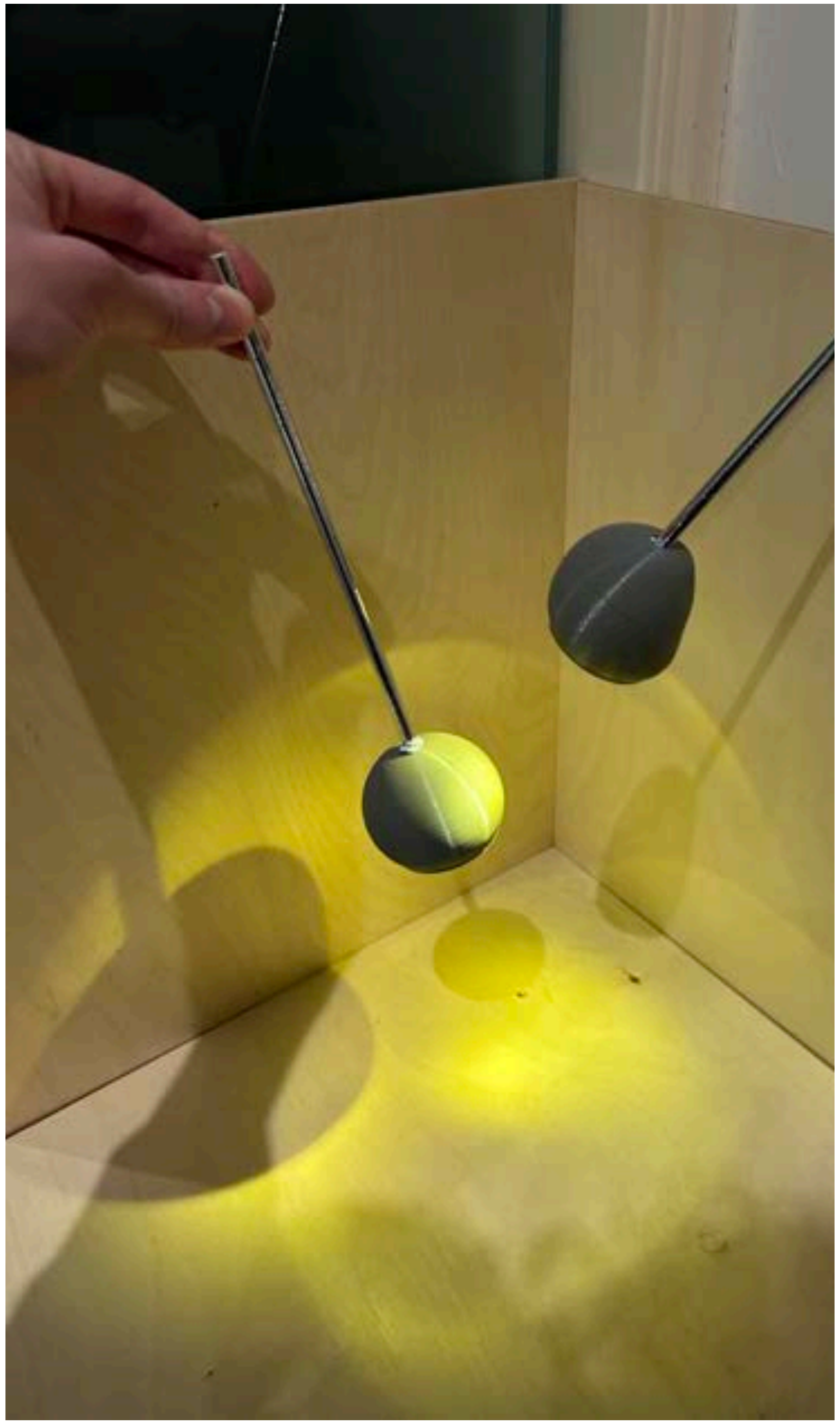

Samples.

These are the shapes made using the pieces of squashed spheres. They did not stack as well and made some wonky looking shapes, which I did not like as much. The squashed shapes looked much better as a larger, simpler sphere by itself.

Testing.

Here I tested the idea explored in my previous sketch page, to have the lights aimed at each other to shine on the exterior surface. As you can see in the photos, this creates a lovely reflection off the surface of the light being shined on. Perhaps I could have multiple lights arranged in a way so that they all shine on each other, becoming connected by the beams of light.





Time Management.

In Week 7, I spent the majority of the week catching my process document up to date. I had falled behind on annotations and analysis in previous weeks, so I went back and annoted the pages I hadn't done. This took much longer than expected and so I achieved less in this week than I initially had planned to. This meant that I didn't stick as closely to my time plan as I would've liked, so next week I will try and follow it more closely.

Week 7

27.02.23

To Do List

- Catch up on process doc annotation ✓
- Organise interviews ✗
- Use strength test machine ✗
- Use wet + dry on samples ✓
- Buy fittings for big bulb ✗

To Attend

Monday – Studio : 9-5 ✓

Tuesday – Work from home ✓

Wednesday – Lectures : 10-12 ✓

Thursday – Studio : 9-5 ✓

Friday – Thesis tutorial : 12 - 12:30 ✓

CAD : 2 - 3:30 ✓

Tutorial - Alex

Eclipse

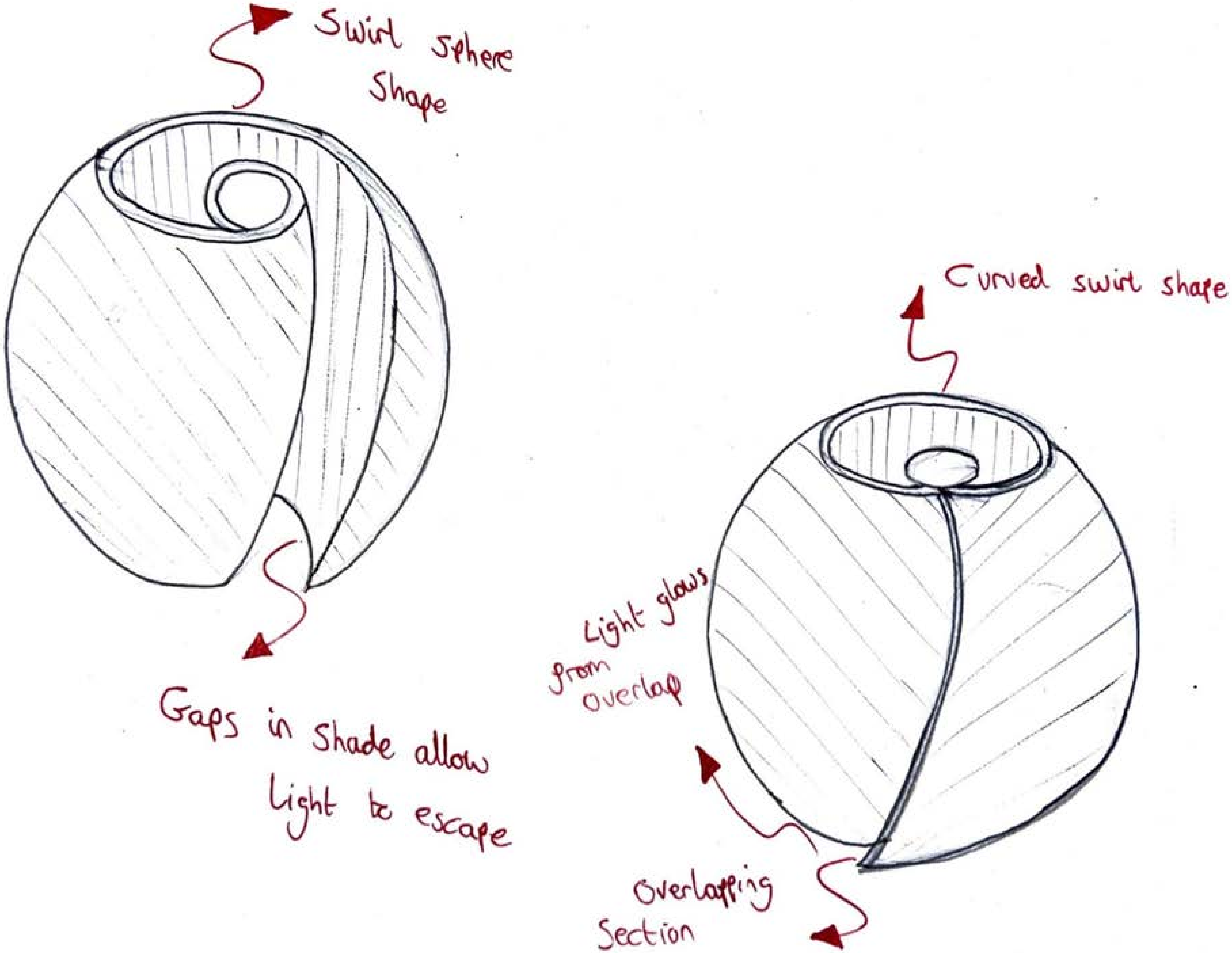
Could the surface that the light shines on to be flat?

Like mirrors that reflect onto each other

Light beams connect spheres adding to material

Still play with stacking, especially if doing a table lamp

Development Sketches.



In this sketch page, I looked at different potential ways of allowing light out of the shade. Whilst I like the idea of it coming from the bottom, I feel like that is too basic and it needs another element to it, such as having slits or gaps in the surface to allow more light out.

Market.

After researching various different well-known furniture and lighting shops, I created this table, ranking them from the highest to the lowest end.

Baccarat is an extremely high end lighting shop that sells crystal chandeliers reaching £425,000. In contrast, Ikea is at the opposite end, selling lights for as little as £6.

The bold red writing shows where I would like my product to sit in the market. Whilst I have not calcualted the overall costing yet, the material I am using is very cheap, compared to other materials like wood, metal, glass, crystal etc, which are often used in lighting. Therefore, I would not be able to justify making my product really expensive, when using such a cheap material. I believe my product should sit in the lower end of the middle market.

Baccarat

Artemest

Nest

Conran

West Elm

My Product

John Lewis

Ikea

Market.

This page looks at a selection of 3 lighting shops from the list on the previous page. I found the lowest and highest priced item of lighting from each website to offer some comparison between the different shops. I would like my light to sit somewhere between John Lewis and the Conran Shop.

NEST

Nest is similar to Conran in the way that they sell various products from different well known designers. Again, the majority of their products are higher end

Lowest Price Item: **£65**
Highest Price Item: **£25,700**

CONRAN

Conran is a higher-end furniture store. They sell much more expensive lighting from various different designers.

Lowest Price Item: **£46**
Highest Price Item: **£13,750**

JOHN LEWIS

John Lewis is a much lower end store, compared to Conran and Nest. They have a much smaller range of lighting from only a few different designers

Lowest Price Item: **£10**
Highest Price Item: **£3,458**

Lighting Trends.

According to 'The Lighting Company', the current and predicted trends for 2023 are as follows:

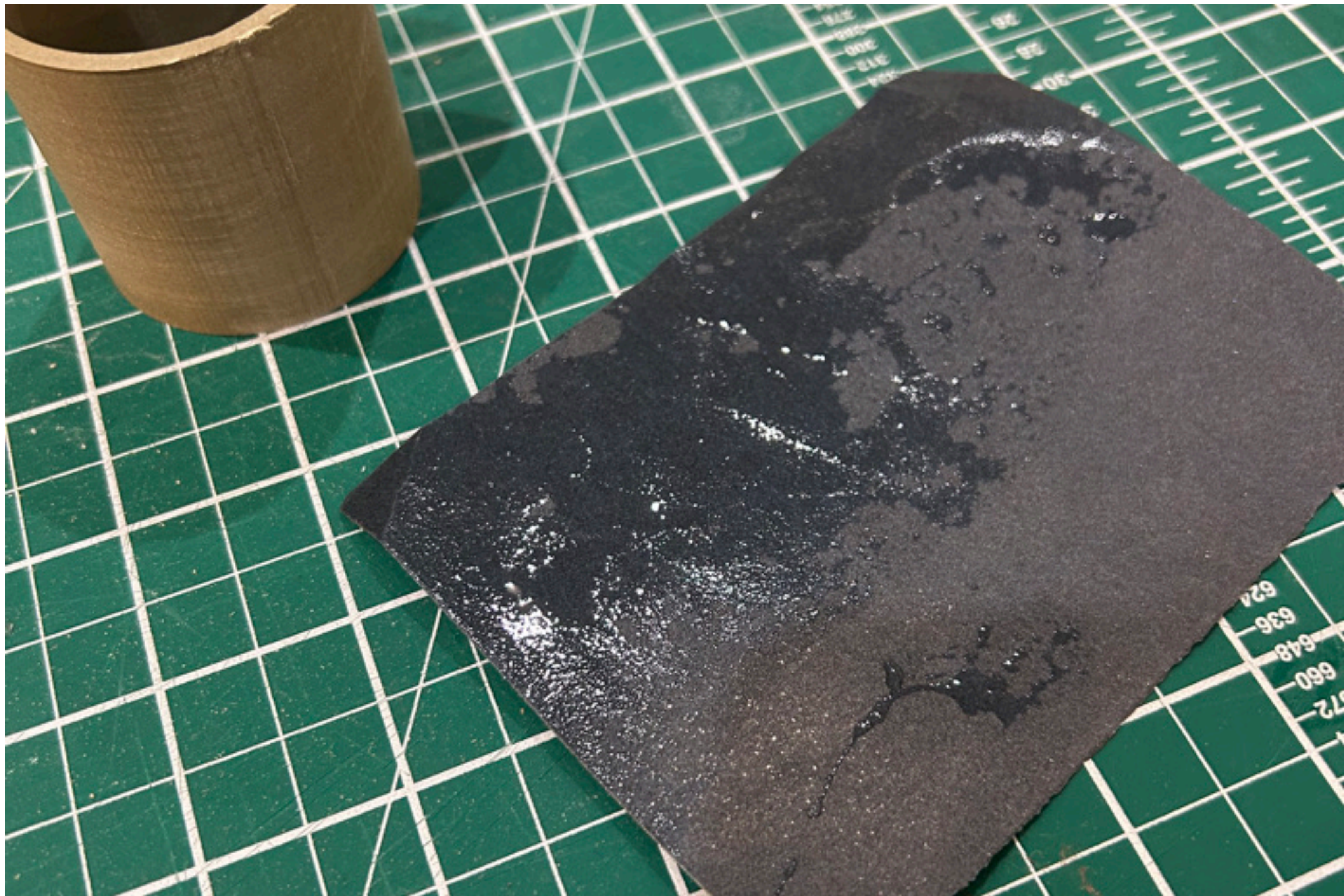
- **Bubble lights** - "globe shaped lights will be massive in 2023 and are a shape that never goes out of style"
- **Big lights** for dining rooms
- Floor lamps
- **Sculptural shapes**
- Milky glass

The trends in bold apply to my design well. I have already decided that I want to use clusters of spherical shapes, which suits the 'bubble light' trend perfectly. Additionally it proves that these shapes are timeless, meaning people would be less likely to want to replace my design, improving the longevity of the product.

Lighting Trends.

Testing.

To do some more testing on the material, I used some wet and dry paper to sand some of the samples I had created. Some of them had some rough patches on from where it hadn't printed perfectly and most had a seam running down the middle, something which happens on all of the prints. I used the sand paper to try and remove these minor marks and make a smoother surface. However, the test wasn't particularly successful and the material does not respond well to being sanded. **Furthermore, some minor imperfections from the printer could be seen as an advantage, as it represents how the product was made and pays homage to the process.**



Testing.

Algae-Based PLA

BEFORE

- Some rough patches/imperfections from printing
- A clear seam
- Nice reflective shiny surface

AFTER DRY

- Lots of scratches
- Rough appearance
- Still a clear seam
- Loses its reflectiveness and sheen
- Loss of colour

AFTER WET

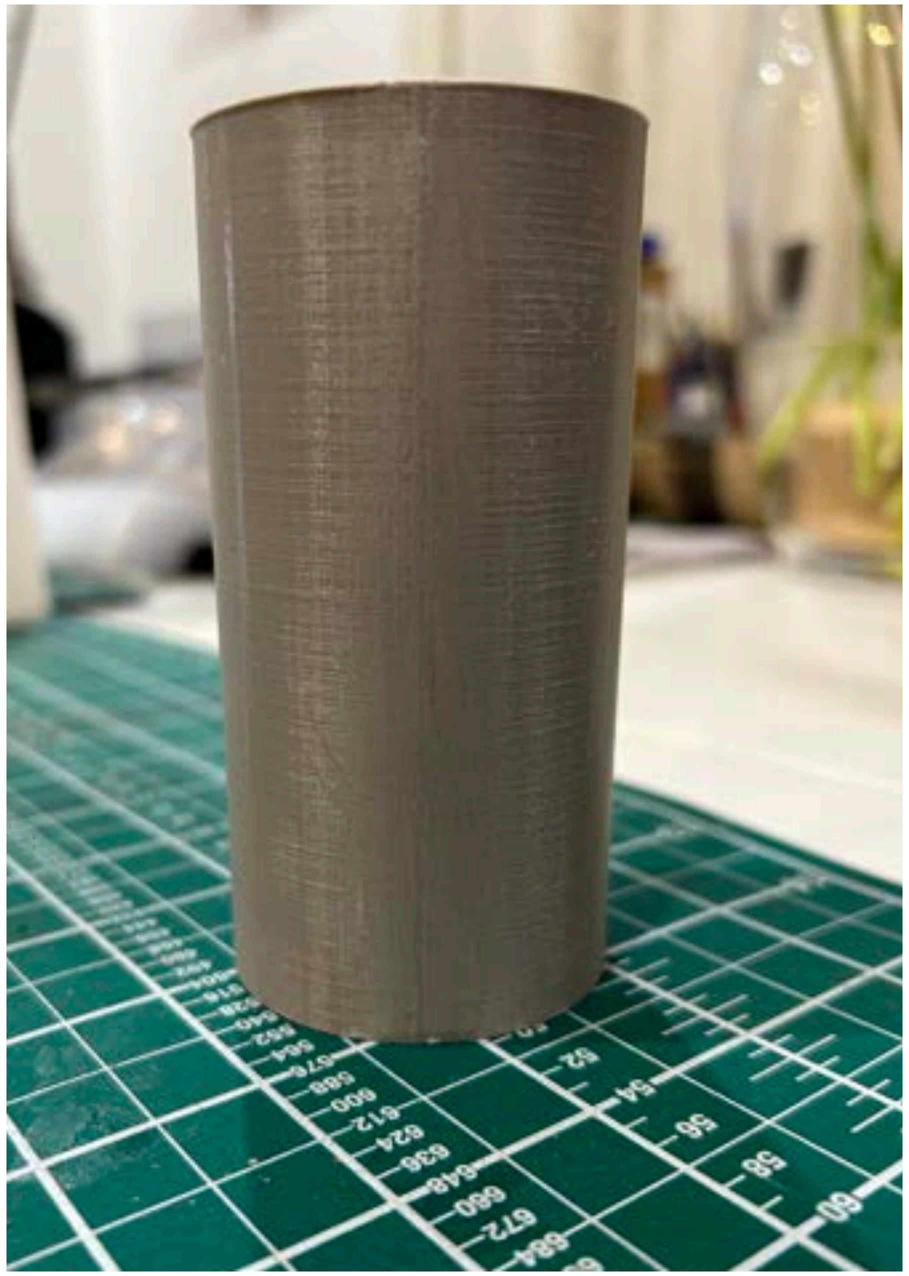
- Less scratches
- Slightly smoother surface than after dry, but still less smooth than before
- Starts to wear away layers and reveal underneath
- Loses its reflectiveness and sheen

Testing.

Regular PLA

BEFORE

- Some rough patches/imperfections from printing
- A clear seam
- Nice reflective shiny surface



AFTER DRY

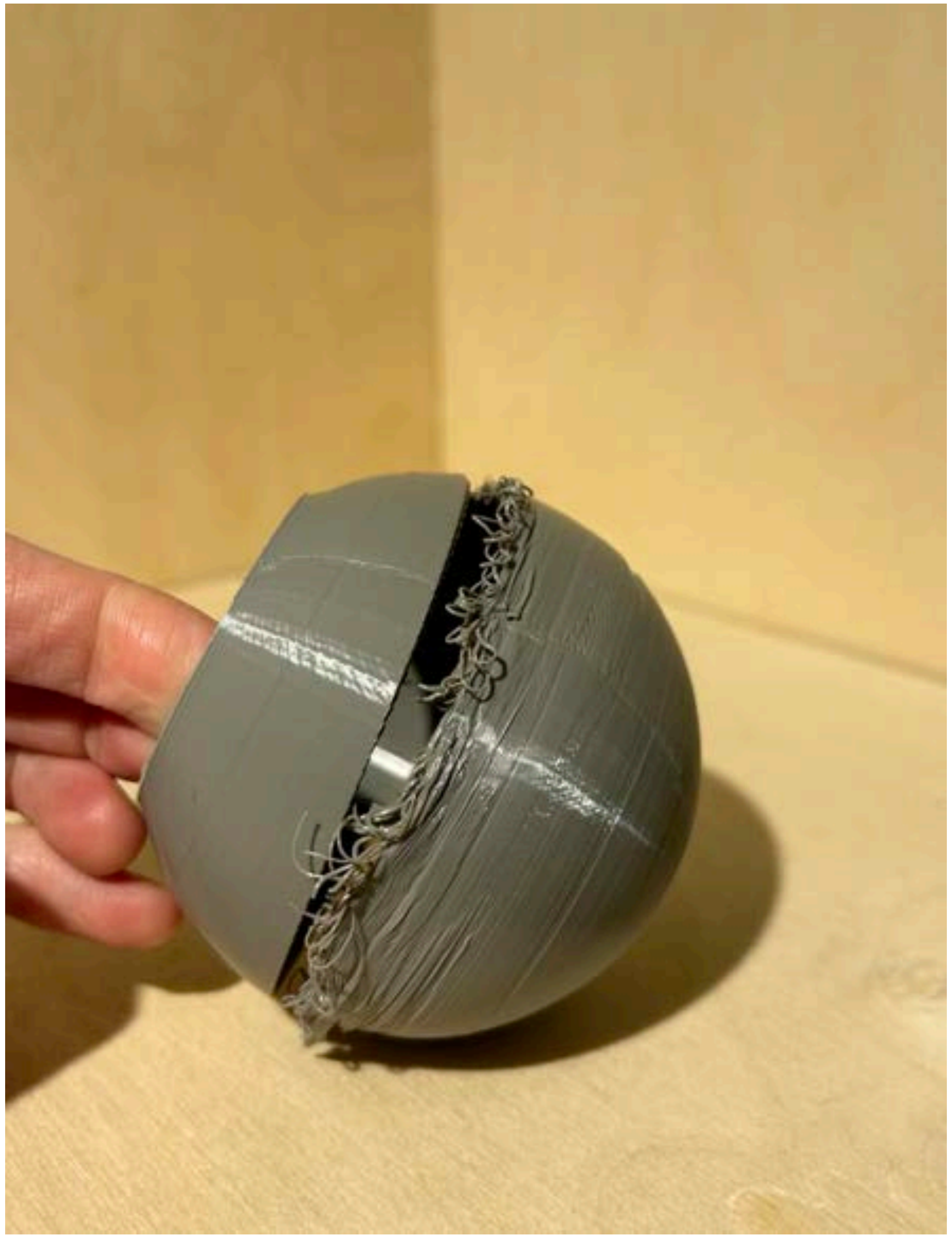
- Lots of scratches
- Rough appearance
- Seam has mostly faded
- Loses its reflectiveness and sheen
- Loss of colour

AFTER WET

- Less scratches
- Slightly smoother surface than after dry, but still less smooth than before
- Starts to wear away layers and reveal underneath
- Loses its reflectiveness and sheen
- Seam still visible but more flat and protrudes less

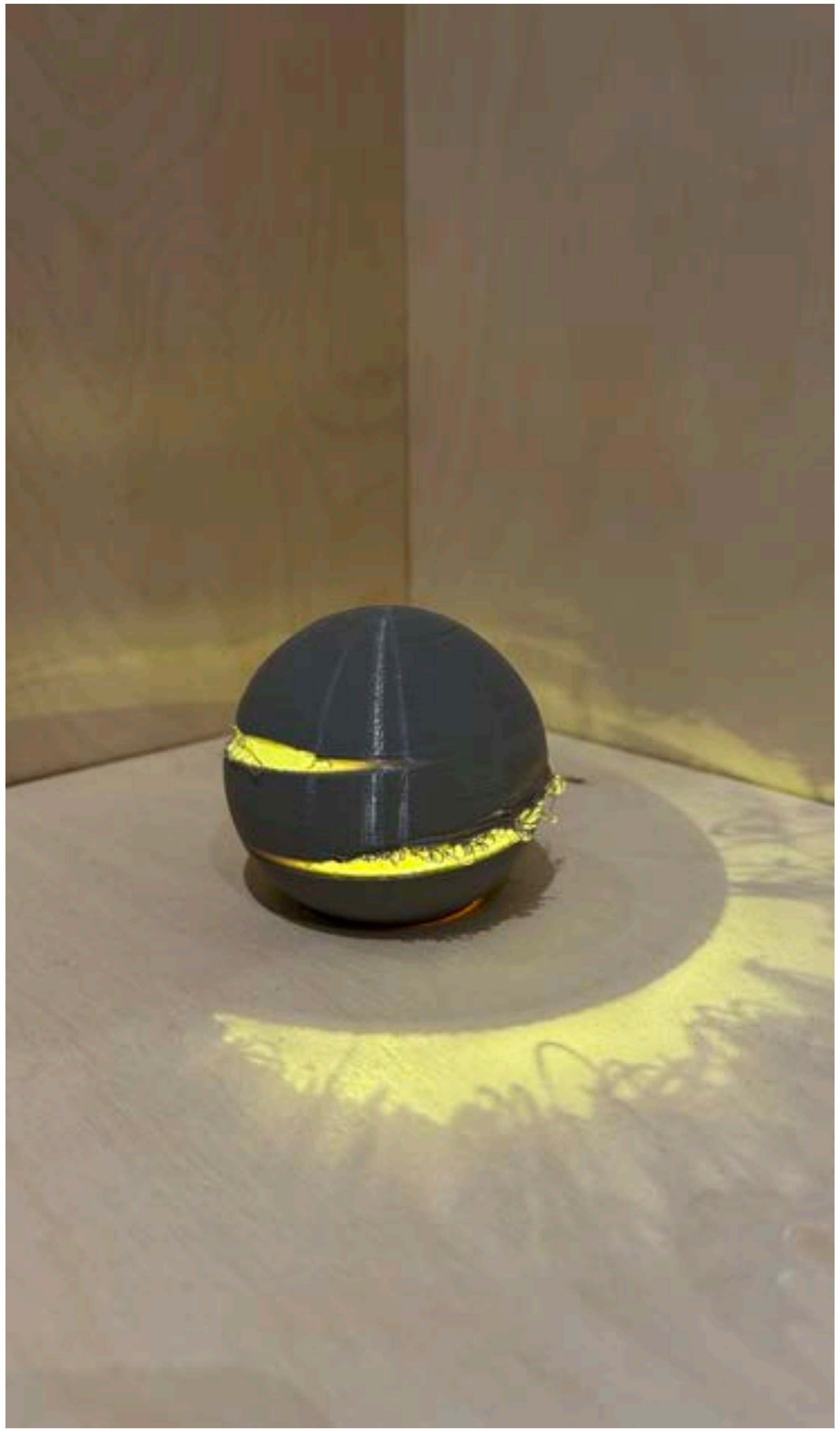
Samples.

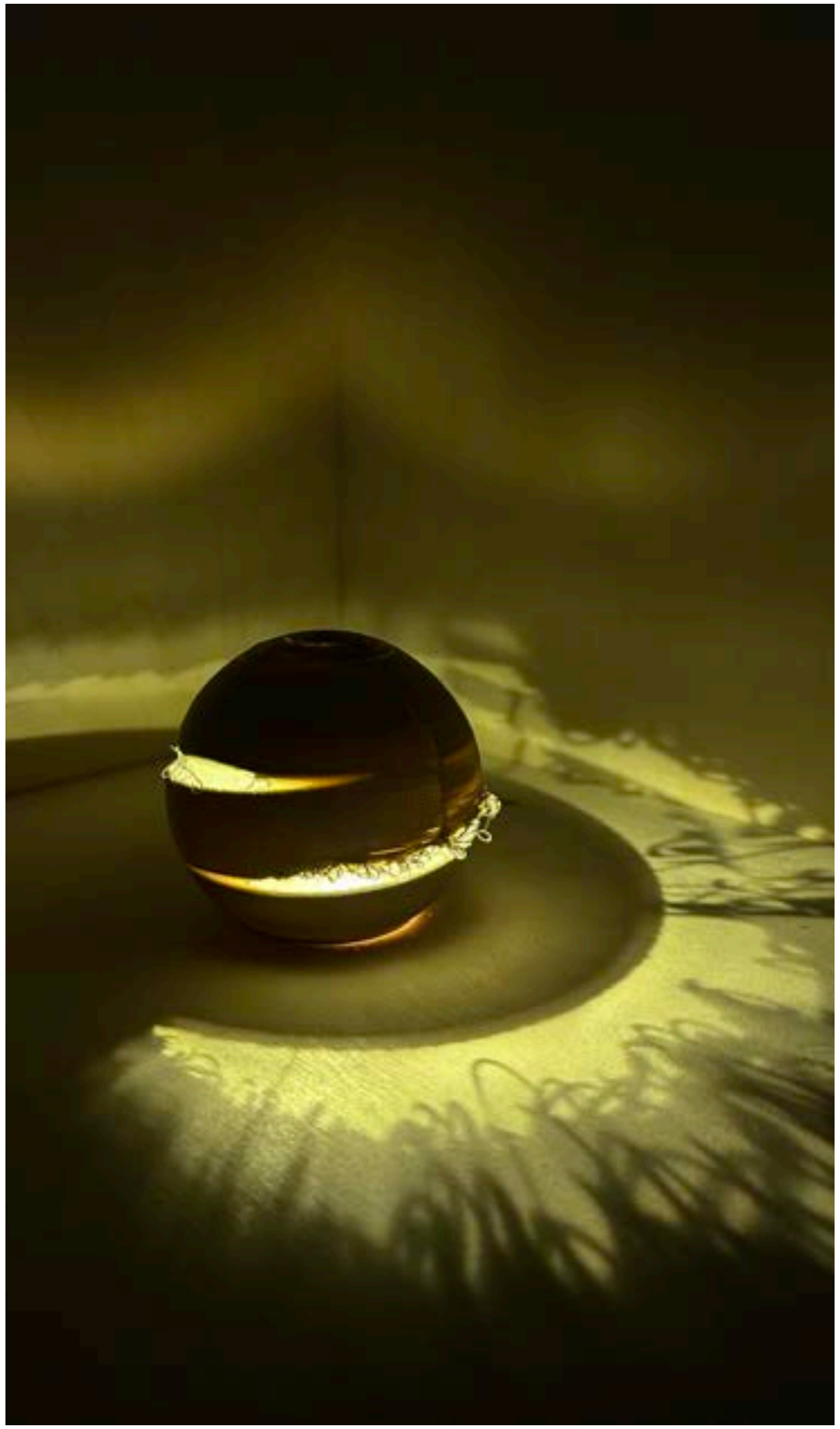
Previously, I identified that I should try to find anothey way to let light out, rather than just through the bottom of the shade. Here I printed a sample with cut out sections around the sphere. However, as you can see it did not print very well and left the shape very messy. This is because having horizontal cut out sections means that they are printed in mid air, meaning the filament doesn't have a surface to rest on and so doesn't stick properly to the shape. From this I learned more about how 3D printing works and what its possible to achieve without supports. Therefore I will not be using horizontal cut outs in my design.



Testing.

Here I tested the shape with horizontal slits with a bulb inside. It actually looks much better with light and produces some very unique and intersting shadow, however it looks ugly without the light on and also this was a result of a failed print so would not be possible to print messy bits like this consistently or deliberately.





Samples.

Here I printed a very thin shape that required supports to be printed. For a change I experimented with using 'Tree' supports rather than regular supports. This is quicker to print and creates a tree like structure inside the shape to hold it in place, as shown in these photos. I was pleased with the improvement in printing speed, however printing a shape like this makes it too flimsy and the edges are very messy. This is due to printing horizontal cut outs again.

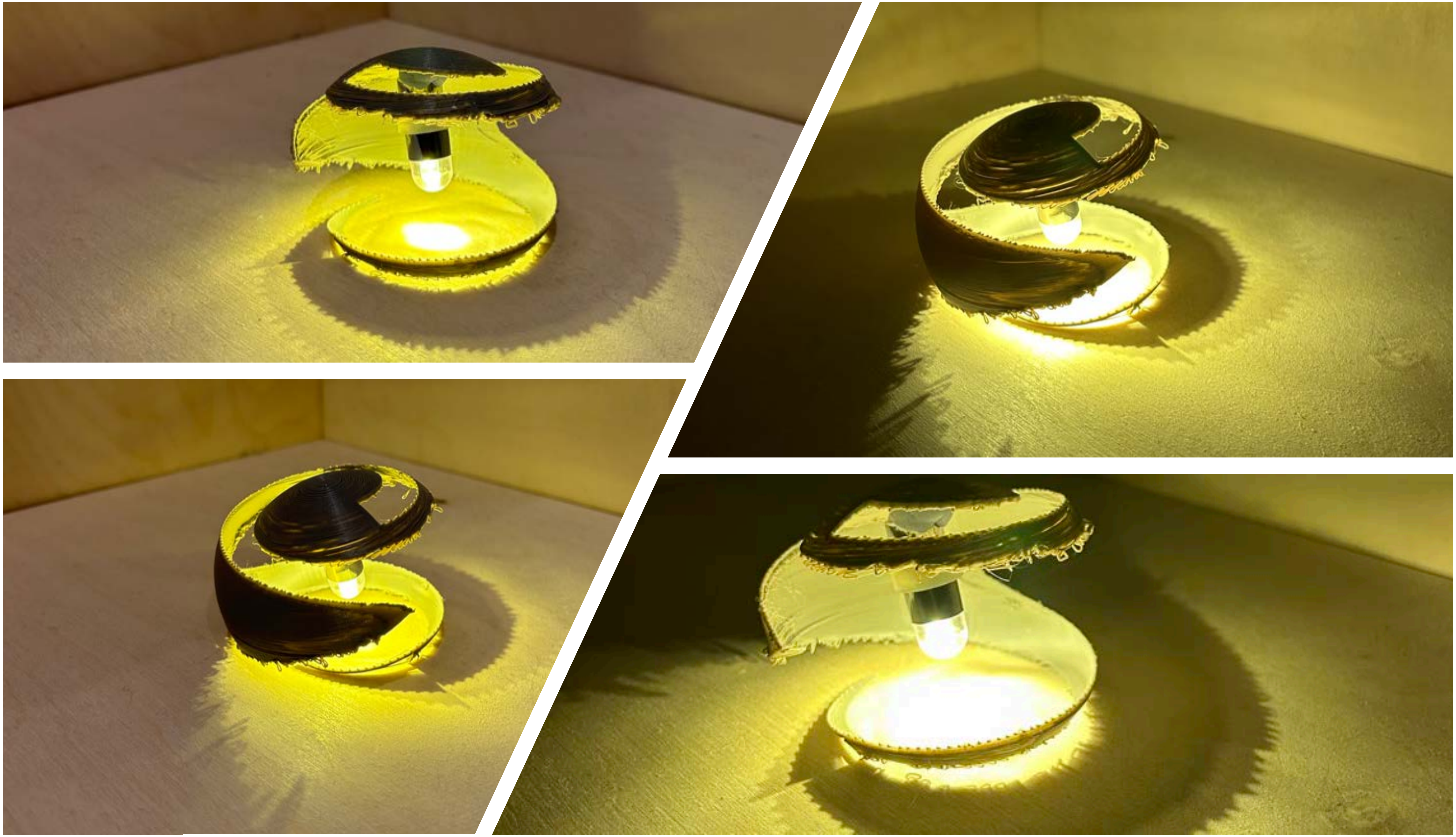
Samples.

This is the shape from the previous page after the tree support has been removed. The shape was unique and interesting, but it was far too flimsy and messy/inaccurate.




Testing.

This is the thin coil sphere with a light inside. The way it wraps around the bulb is quite nice, but overall it looks untidy. It is also too thni and allows uneven light through the material.



Persona.

- Young professional

- 25 years old

- Recently got a new job after graduating University

- Environmentally conscious

- Lower end of income

- Rents a property

- Likes bringing nature into the home, lots of plants etc.

- Would like to lead a more sustainable life, but struggles due to low income (sustainable products tend to cost more)

- Home has a natural/neutral interior style

- Likes designer products, but can't afford them

Persona Analysis.

Environmentally conscious

My product should be sustainable in order to appeal to the market of environmentally conscious people. I believe my material choice already achieves this

Likes designer products, but can't afford them

My product should be stylish yet affordable, so it is appealing to people with a range of incomes and doesn't freeze out lower income people from buying it. Additionally, sustainable products are often more expensive than their unsustainble counterpart, so my product shouldn't be too expensive so that people who want to lead more sustainable lives, but may feel it's unattainable due to their low income, can purchase this product.

Natural/neutral interior

My product should fit into different types of interior, but especially suit interiors that use neutral and natural tones, with plants etc. This will be achieved due to the beautiful natural colouring of the algae PLA.

Reframed Brief.

Original Brief

Research and explore the potential of algae-based bioplastics and how they can be used within the manufacturing method of 3D printing, as an ecological alternative to unsustainable materials used in the lighting design industry.

Reframed Brief

Design a pendant ceiling light to be made from 3D printed algae-based PLA. The light should justify the use of 3D printing as a manufacturing method and also pay homage to the origin of the material.

My original brief started out very broad, so I reframed the brief to narrow down my project focus, based on the direction my project had taken following my initial research and testing etc. I am now focusing on designing a pendant light and have decided on some things I want my light to achieve.

Specifications.

1. Justify the use of 3D printing - shape of the light should be difficult to make through any other manufacturing method and lend itself to 3D printing.

2. Pay homage to the material - the light should act almost as a tribute to the material, by representing algae in some way.

3. Ambient light - my light should be an ambient light that hangs in the centre of a room, or above a table.

4. Warm light - the bulb should be a warm white colour, not a blue-white.

5. Affordable - shouldn't be too expensive, due to the cheap material being used and to make it available to peopel of all levels of income.

6. Shade should be the focal point - I want the shade of the light to be the focal point, therefore the cables and ceiling rose should not be too elaborate, so as not to retract from the design.

Time Management.

In Week 8 I managed to develop my design further and do a lot more testing, which is vital to my process. I was pleased with the way I tested the different lights and shapes and slots etc. However the one change I would make to this week would be to start work earlier in the day, as some days I was working until very late.

Week 8

06.02.23

To Do List

- Develop design ✓
- Test proper built in samples – light sources ✓
- Use strength test machine ✓
- Organise interviews ✓
- Look at El Ultimo Grito Mallinus light ✗

To Attend

Monday – Studio : 9-5 Workshop Triage ✓

Tuesday – Work from home ✓

Wednesday – Lectures : 10-12 ✓

Thursday – Studio : 9-5 ✓

Friday – Thesis tutorial : 12-12:30 ✓
CAD : 2-3:30 ✓

Consider ceiling fitting
+ electronics

Mathmos light by El Ultimo Grito

Workshop Triage – Jenny + Fiona

Internal
structure
of shade

Design a slot
in light to allow
cable through
+ light out

Identify light source

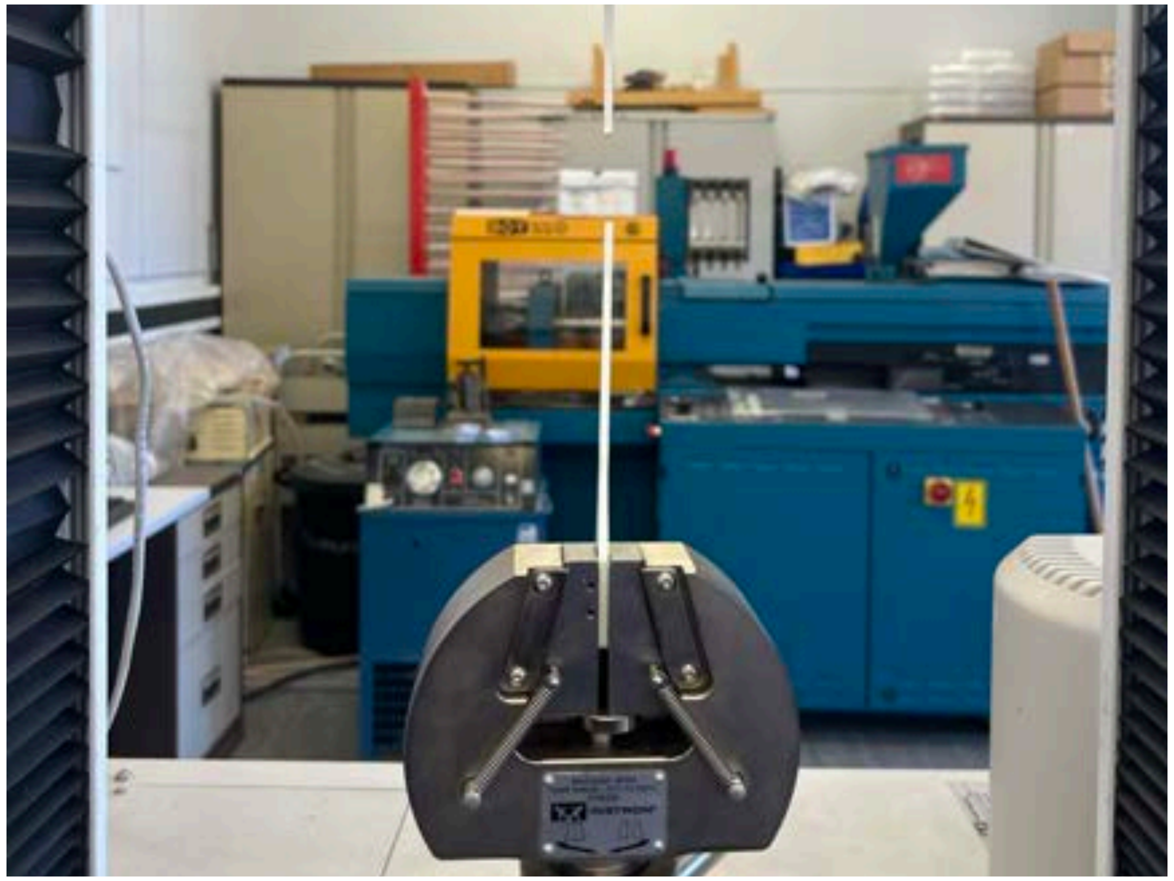
Type of bulb
+ type of
fitting

Testing.

In order to test the strength of the material, I 3D printed some dog bone shapes to test on the Instron Machine. I tested algae-based PLA, regular PLA and Nylon 66 in the machine the compare their strengths. Graphs are then produced after the tests, which allow visual and numerical comparisons between the materials and compare how they vary in strength

Testing.

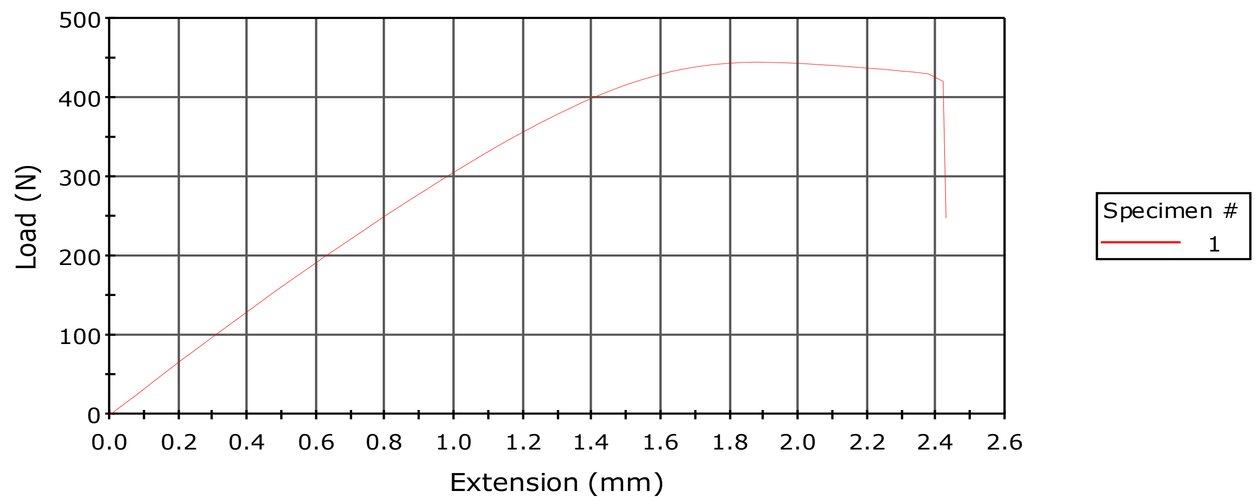
This is the Instron Machine testing the dog bone samples. It clamps them in place and gradually pulls them apart, stretching it until it becomes elasticated and then eventually breaks



Testing.

For each type of PLA I did 2 tests to allow for any errors or differences. This is the alge-based PLA. The graph shows how much force was applied and how much this caused the material to extend. The end of the graph shows when the material snaps under the force. Here you can see the algae-based PLA can withstand an average of around 435 N before snapping.

Algae-Based PLA 1

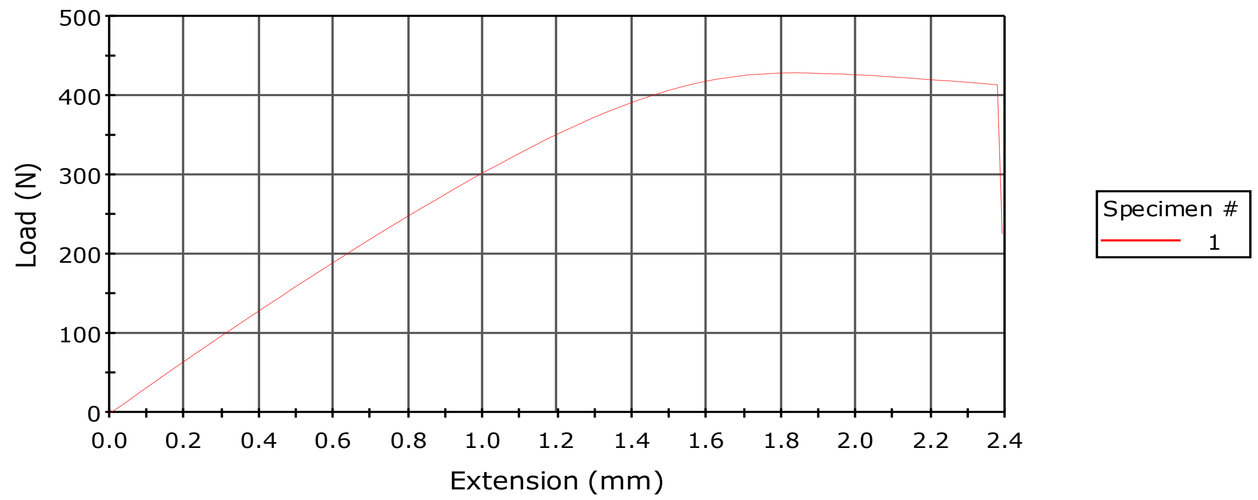


	Specimen label	POLYMER TYPE	Maximum Load (N)
1	ALGAEPLA	<None>	444.51753

	Rate 1 (mm/min)	Extension at Maximum Load (mm)	Thickness (mm)
1	5.00000	1.87505	4.00000

	Width (mm)	Length (mm)
1	6.00000	80.00000

Algae-Based PLA 2



	Specimen label	POLYMER TYPE	Maximum Load (N)
1	ALGAEPLA2	<None>	428.73605

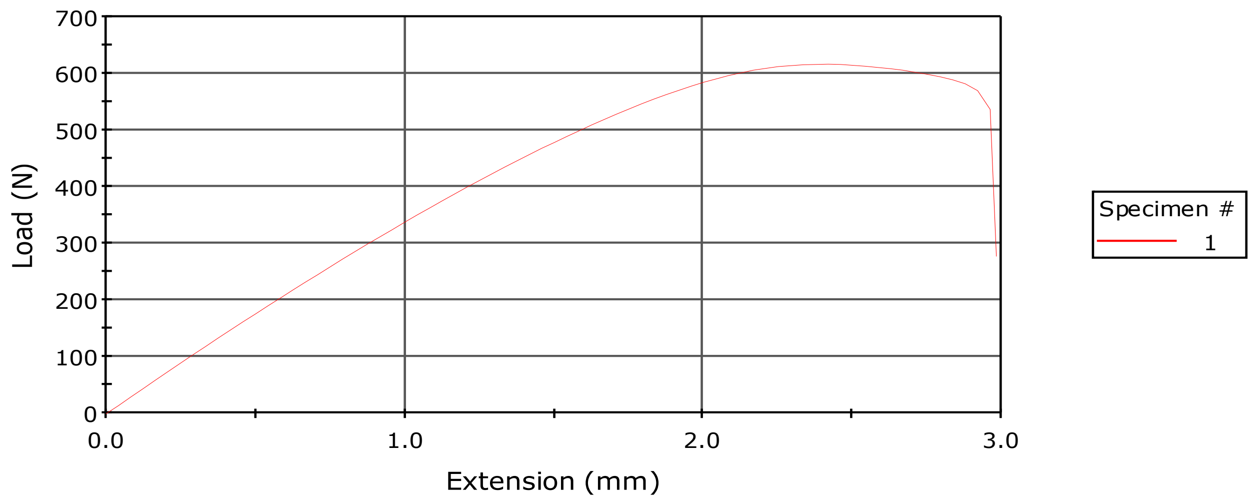
	Rate 1 (mm/min)	Extension at Maximum Load (mm)	Thickness (mm)
1	5.00000	1.83332	4.00000

	Width (mm)	Length (mm)
1	6.00000	80.00000

Testing.

This is the regular PLA. The graphs show it can withstand an average of around 620 N before snapping. This proves that regular PLA is slightly stronger than the algae-based PLA. Therefore, my design should be careful not to be too flimsy or something which is interacted with lots, as it may not fare as well.

Regular PLA 1

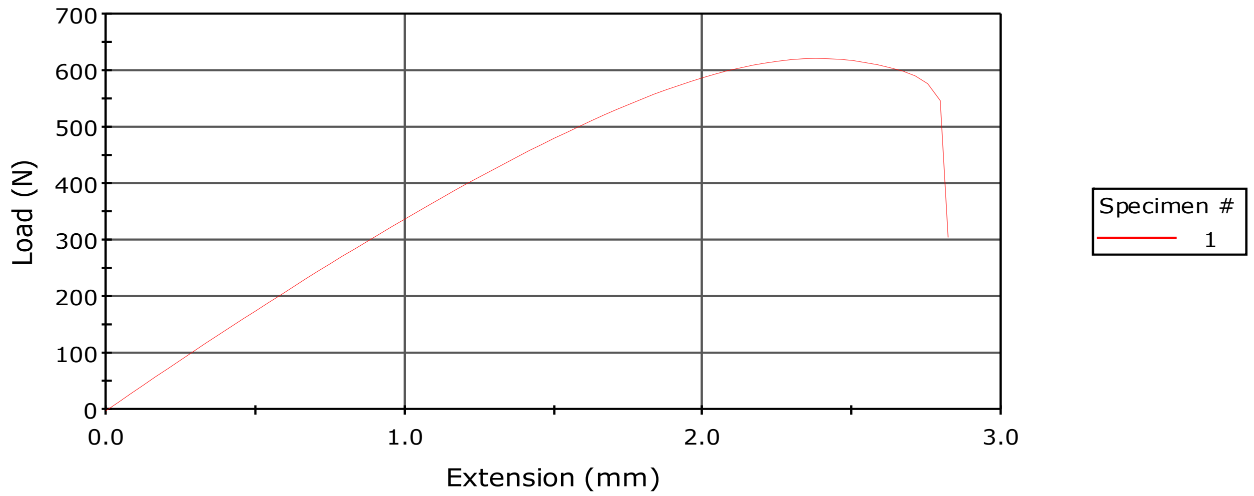


	Specimen label	POLYMER TYPE	Maximum Load (N)
1	PLA1	<None>	616.04708

	Rate 1 (mm/min)	Extension at Maximum Load (mm)	Thickness (mm)
1	5.00000	2.41661	4.00000

	Width (mm)	Length (mm)
1	6.00000	80.00000

Regular PLA 2



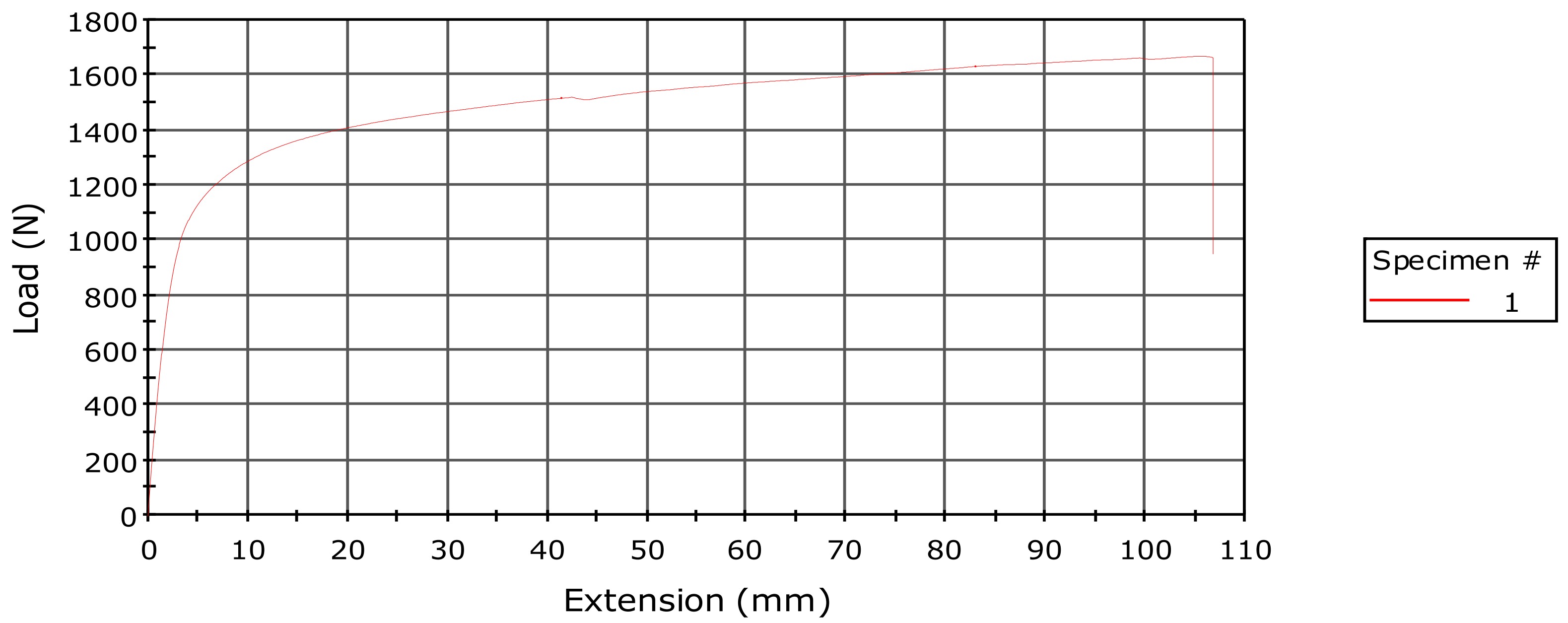
	Specimen label	POLYMER TYPE	Maximum Load (N)
1	PLA2	<None>	621.40150

	Rate 1 (mm/min)	Extension at Maximum Load (mm)	Thickness (mm)
1	5.00000	2.37498	4.00000

	Width (mm)	Length (mm)
1	6.00000	80.00000

Testing.

This is the test for nylon 66. It is a much more flexible material than PLA and isn't made for 3D printers or similar in any way. However, it was good to test as a comparison and to use as the first sample to ensure the machine was functioning properly. The graphs show it can withstand an average of around 1600 N before snapping. This proves it is a hugely flexible material in comparison to PLA and much much stronger.



	Specimen label	POLYMER TYPE	Maximum Load (N)
1	Nylon 66	NYLON 66	1667.73520

	Rate 1 (mm/min)	Extension at Maximum Load (mm)	Thickness (mm)
1	5.00000	105.41655	4.00000

	Width (mm)	Length (mm)
1	10.00000	80.00000

Samples.

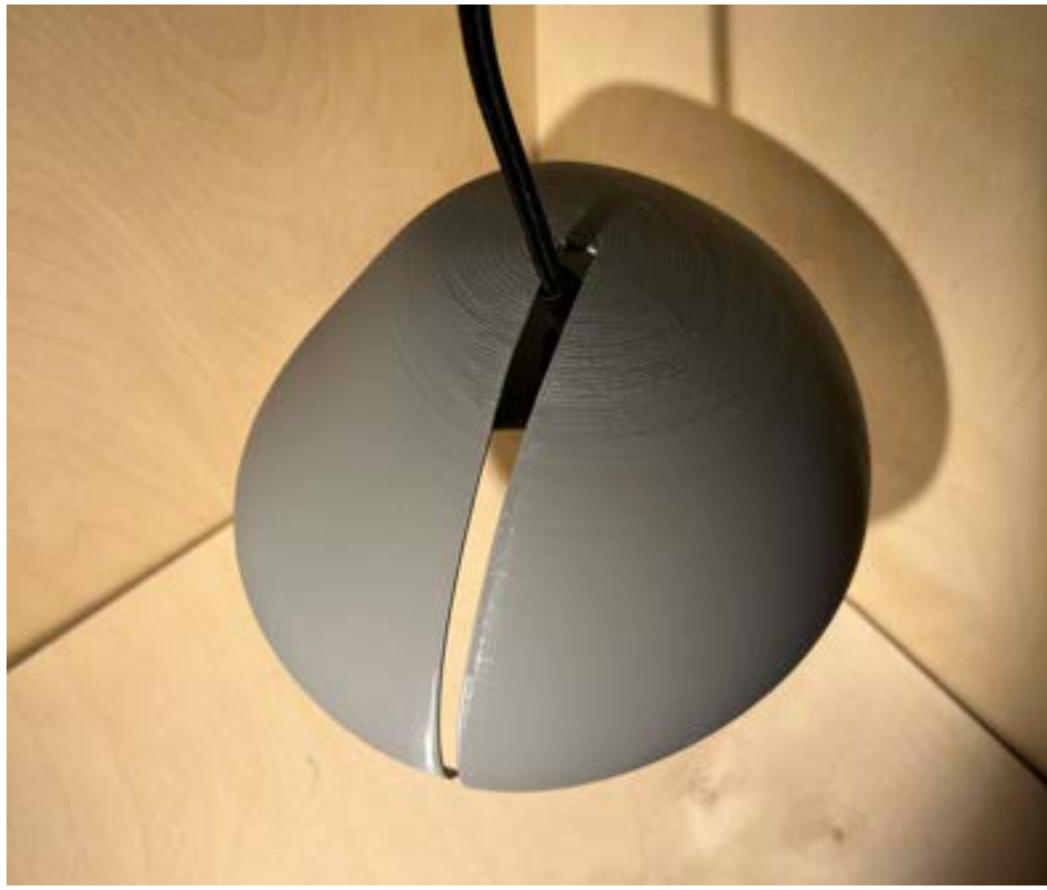
Here I printed a new squashed sphere shape with a slit in. This slit will allow light to escape, providing a new element to the design, rather than light just coming out the bottom. However, in my opinion the slit is too big and too square and it would look better if it was thinner and followed the shape of the sphere better, rather than being straight down.





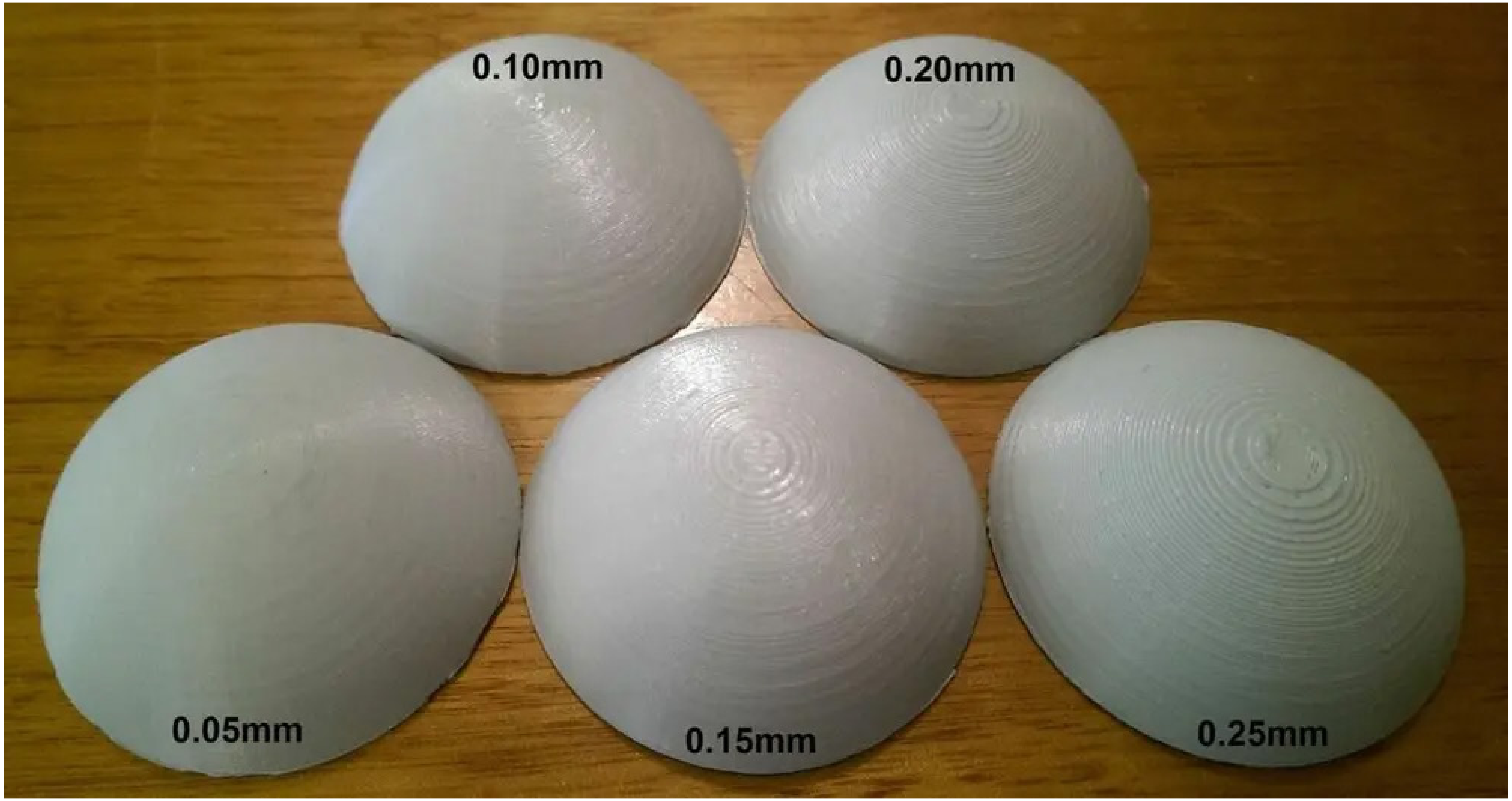

Samples.

This shows the design with a cord inside for a light fitting. It shows how the light could hang and how the cord slots through the slit to reach the top. However, the shade doesn't sit completely flat, so the slit may need to be more suited to the light fitting to hold it in place better.



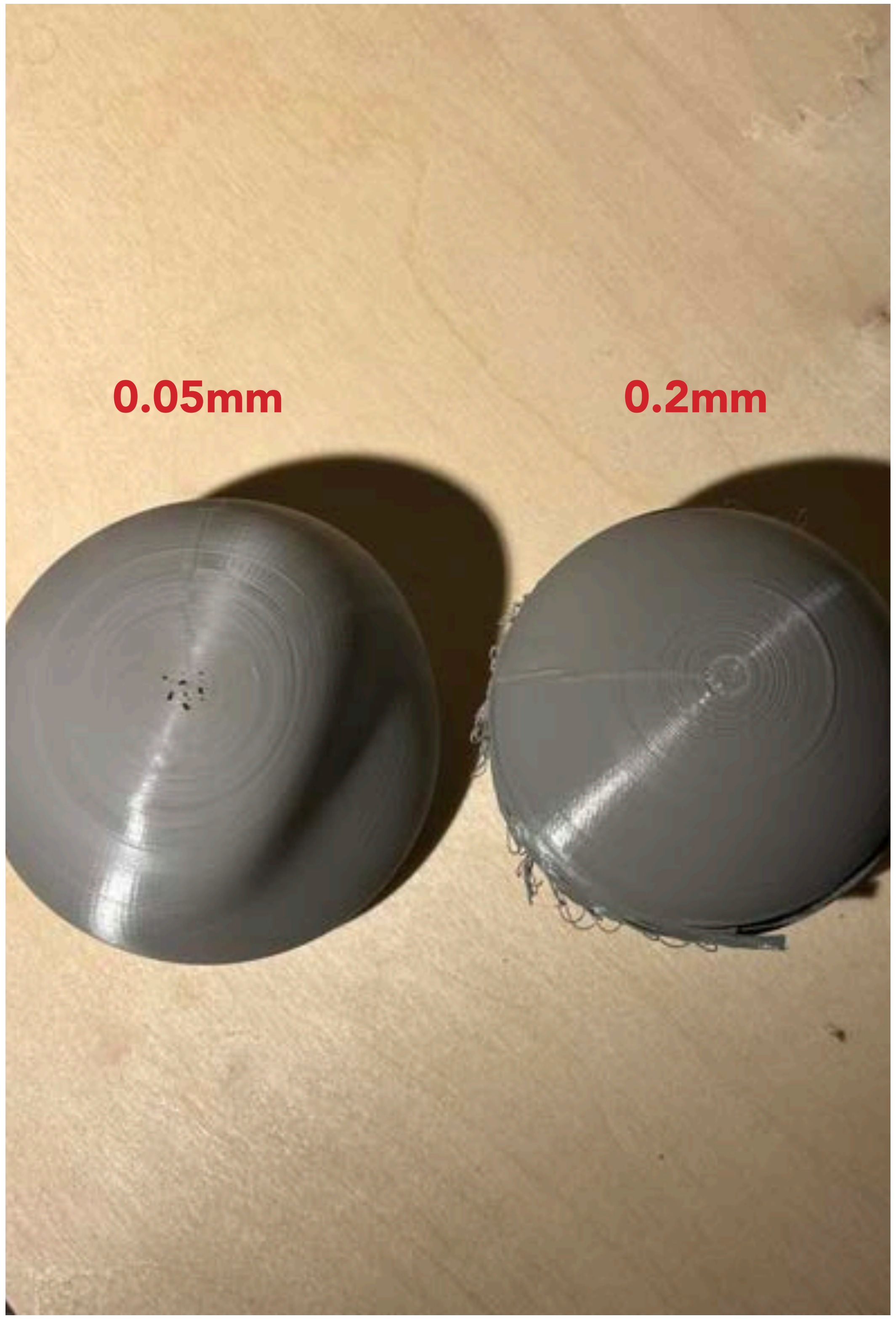
Accuracy.

This is a photo from a website I found that explains how to 3D print spheres. It explains how different accuracy settings affect the way the sphere is printed and how it looks when it is finished. I have been using 0.2mm, as this is the default setting. I would like to explore what happens when I use 0.05mm to see if it makes a difference and how it effects my print



Testing.

Here I experimented with increasing the accuracy of the printer. For all my samples so far, I have been using an accuracy of 0.2mm, however for this sample I used 0.05mm. The idea behind this was to reduce the raised bumbs around the top of spherical shapes. Whilst this worked, it didnt affect the overall appearance that much, added lots more time onto the print and left some holes in the top. The photo on the right compares the top of the sphere at 0.05mm and 0.2mm. The difference is minimal and not worth the extra printing time. Furthermore the raised bits of the 0.2mm are slight imperfections which can represent the process that has been used, so aren't neccessarily a negative.



Bulb Types.

INCANDESCENT

+ Cheap
+ Wide range of sizes and voltages
+ Emit light in all directions
- Gradually being replaced by LED lights
- Less than 10% of energy used is light. The rest is wasted as heat
- Don't last very long before needing to be replaced

COMPACT FLUORESCENT

+ Use 75% less energy than incandescent bulbs
+ Last 7-10 times longer
+ Spirals give off light in all directions
- Delay to reach full brightness
- Most aren't dimmable
- Contains mercury, making it difficult to dispose of

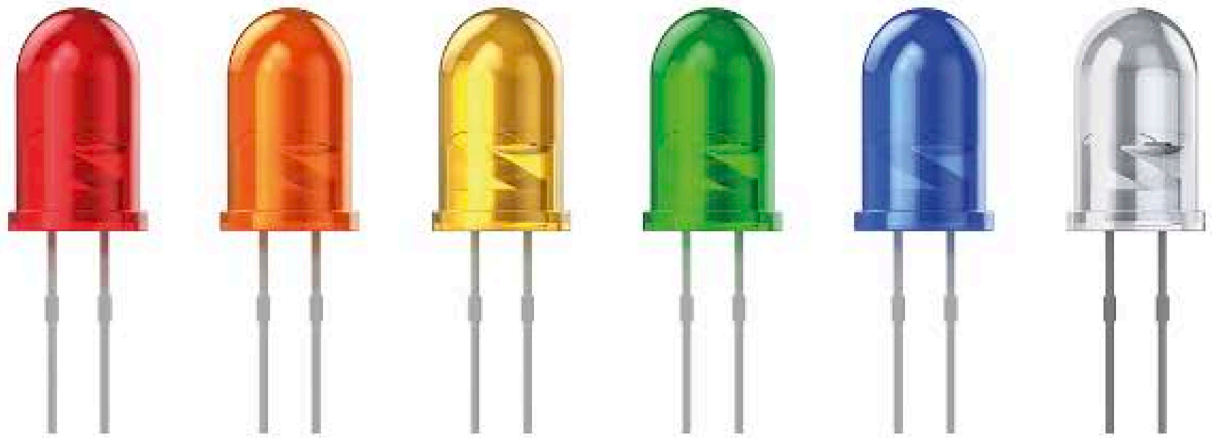
HALOGEN

+ Incandescent bulbs that use 25-30% less energy
+ Meets new energy-efficiency standards
+ Instantly produce light
+ Dimmable
- More expensive
- Don't last that long

Bulb Types.

LEDs

+ Use much less energy
+ Available in any colour
+ Very long lifespan
+ Produce more light than incandescent
+ Instant brightness
+ Not affected by turning off and on repeatedly
- More expensive
- Some can't emit light in all directions



METAL HALIDE

+ 3-5 times more efficient than incandescent
+ Much higher quality light
- Long time to warm up
- Use mercury, so difficult to dispose of
- UV radiation

Testing.

Here I have tested the shape with a light bulb inside. I used a warm white LED filament bulb that provides all round light in all directions. I was pleased with the tone, but I think it glows too much through the slit and not enough out the bottom. Perhaps a spotlight would be better.

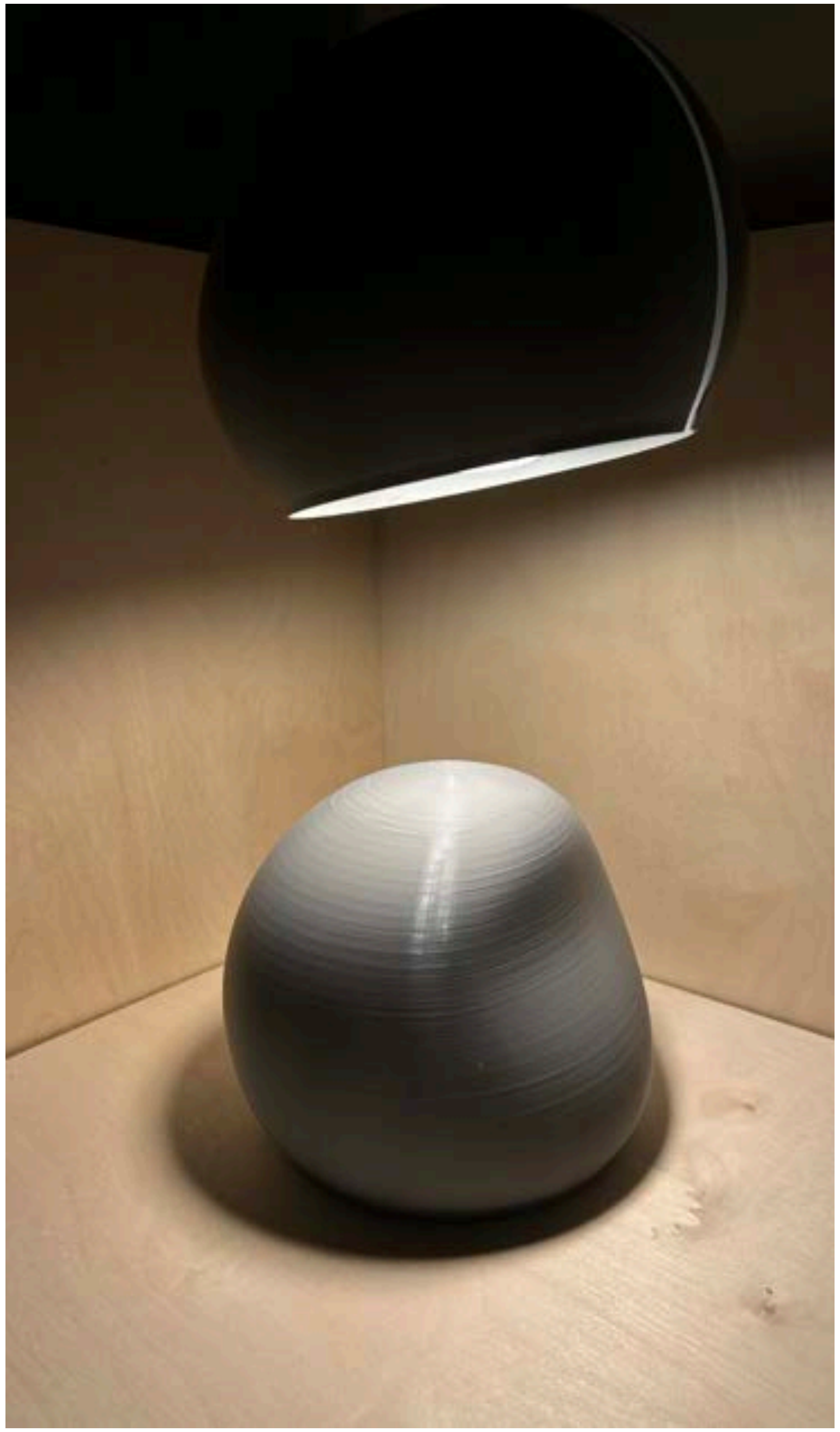


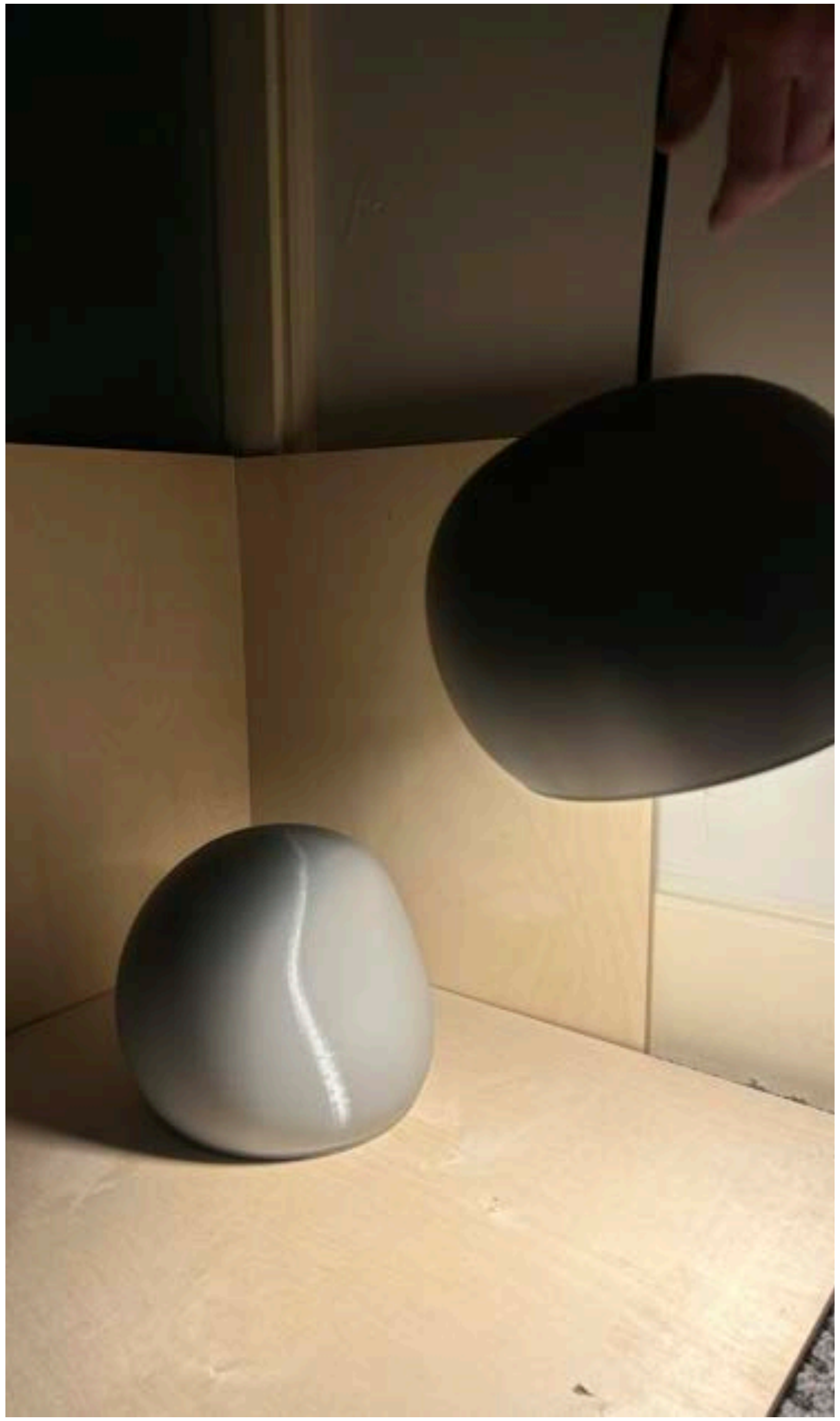
Testing.

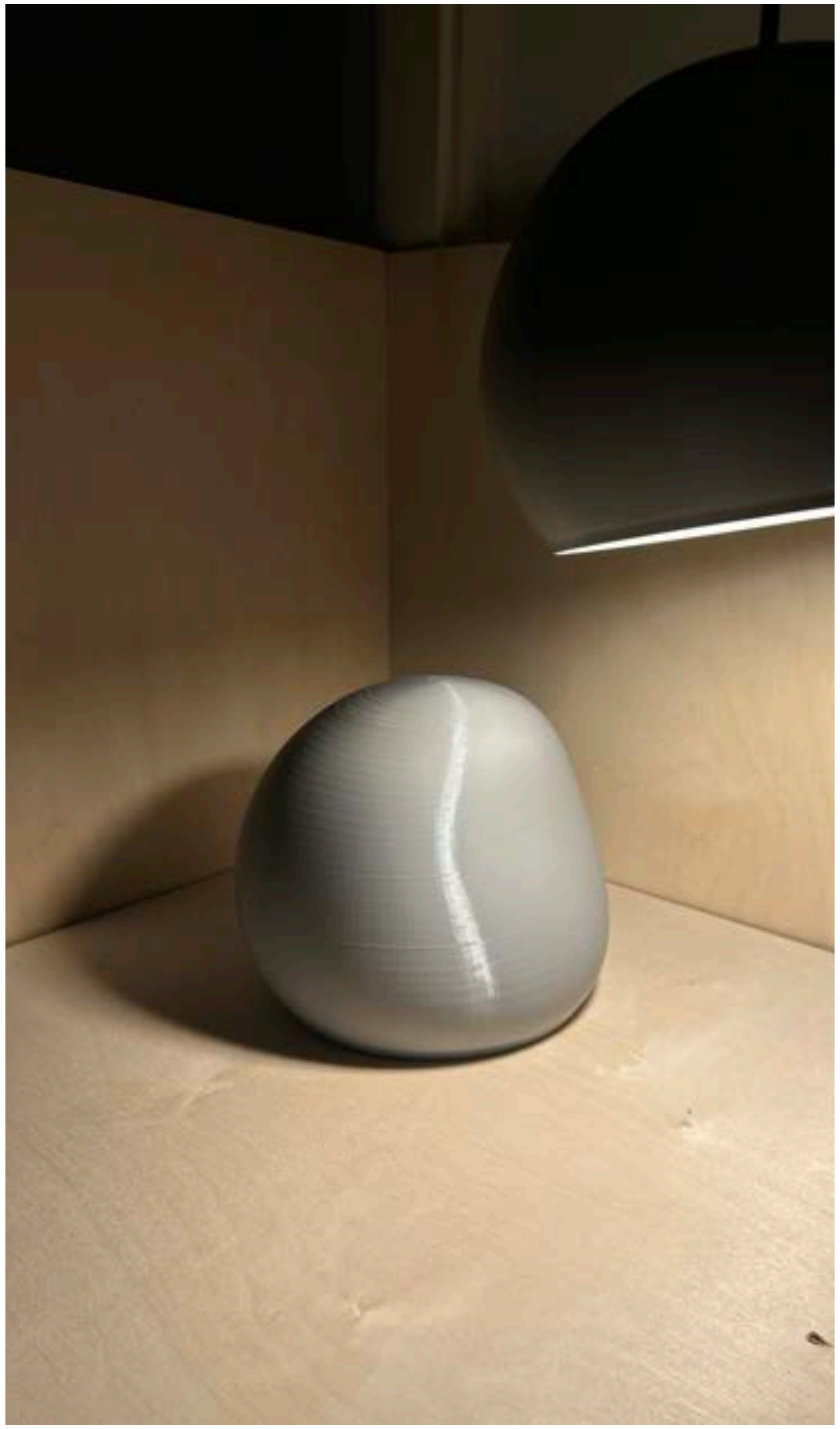
Here I tested the shape with a warm white spotlight. I found the light to be much better, more dramatic and directed, which suits my design better. It also still glows nicely through the slit, but just not as prominently.

Testing.

Here I have tested the spotlight bulb shining on another sphere. This represents how my design will currently work. I tested how the light reflects off the shape and was pleased with the outcome. The directed light creates nice shadows and contrasts between dark and light.

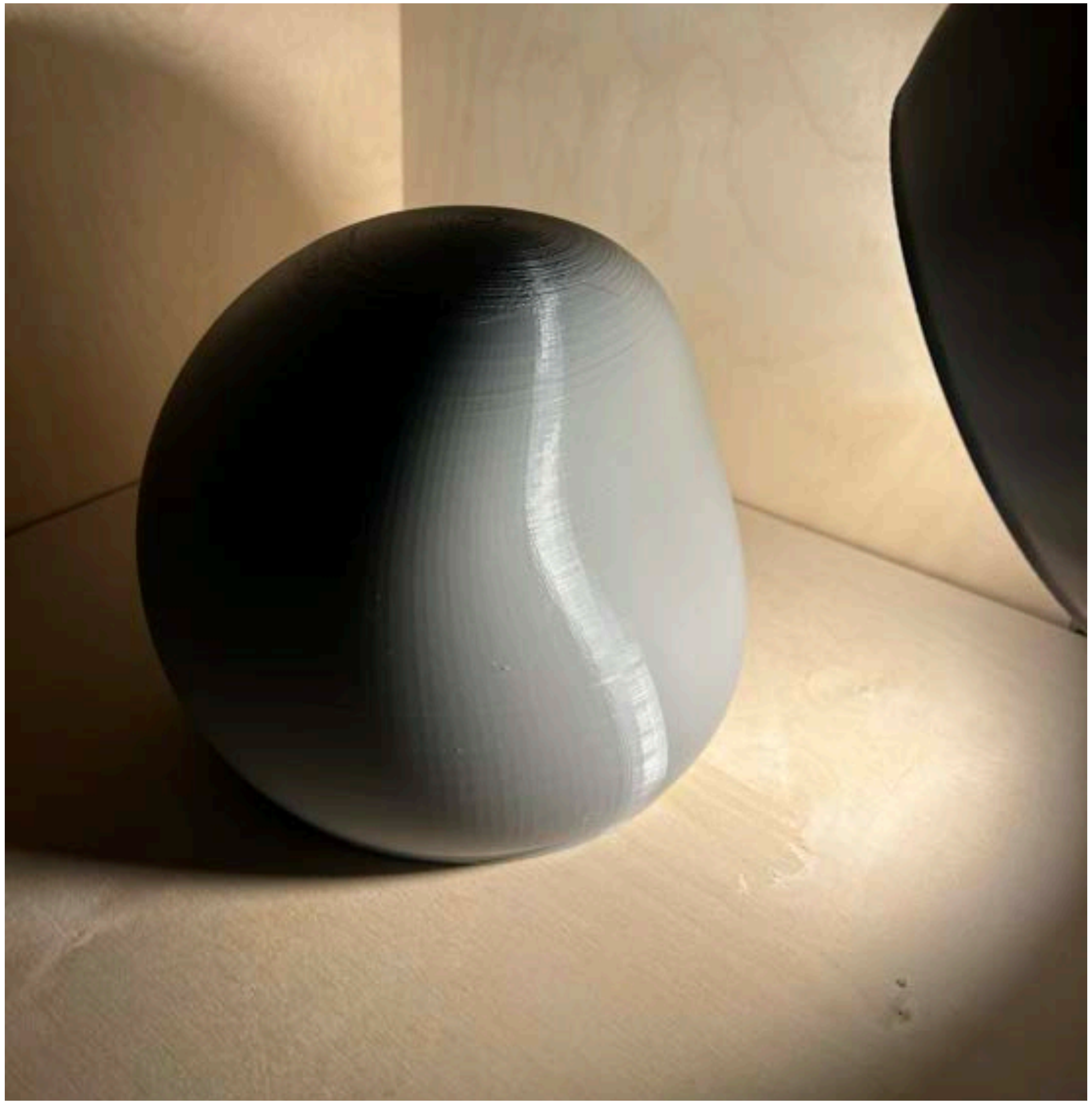






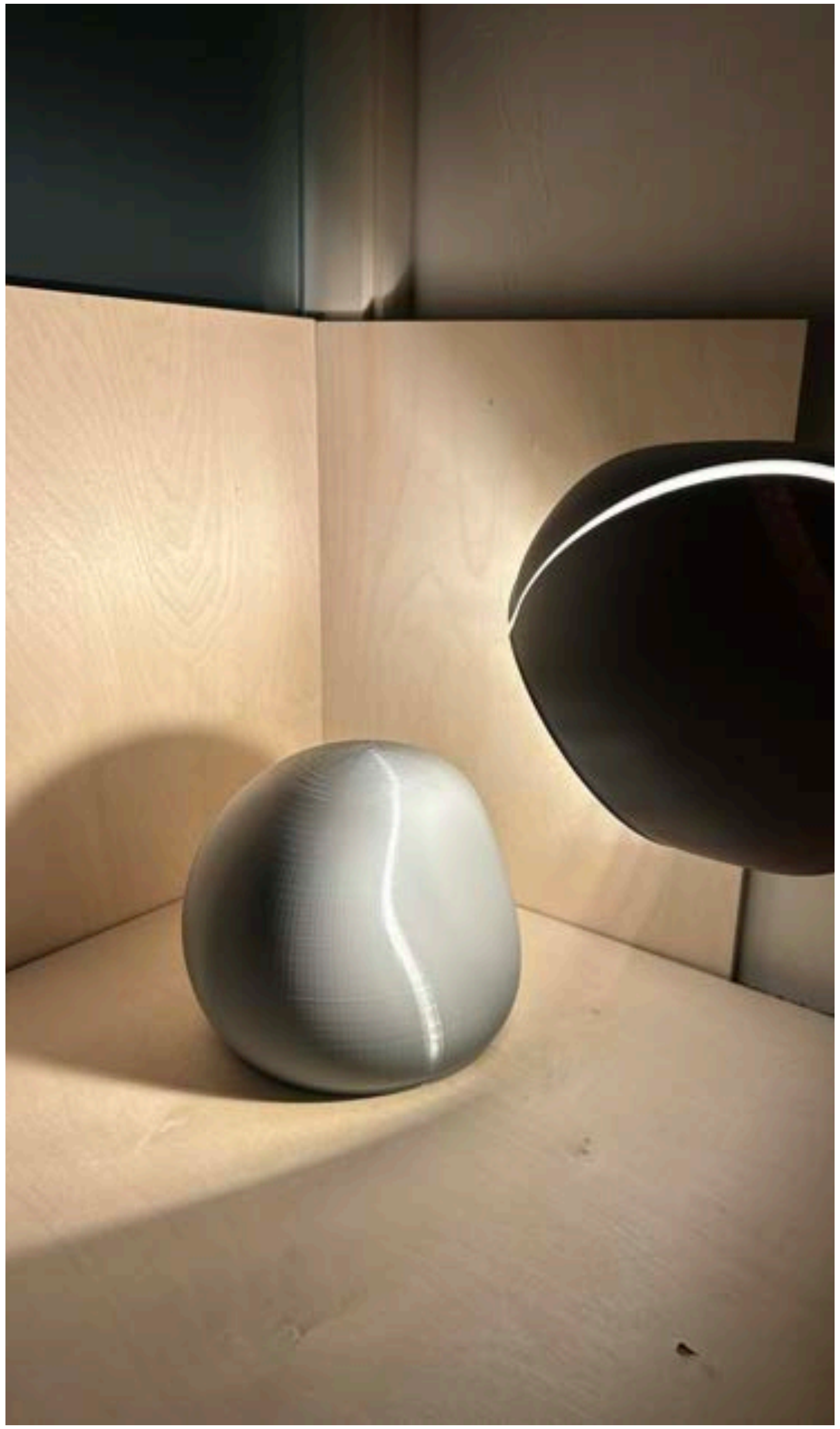
Testing.

This is a close up of how the spotlight bulb reflects off of the other squashed sphere. When up close, the light is very directed, illuminating the surface it shines on, creating beautiful beams of light. In contrast, it leave the back of the shape in complete shadow, creating an eclipse effect. This is an idea I would like to carry forward into my design.



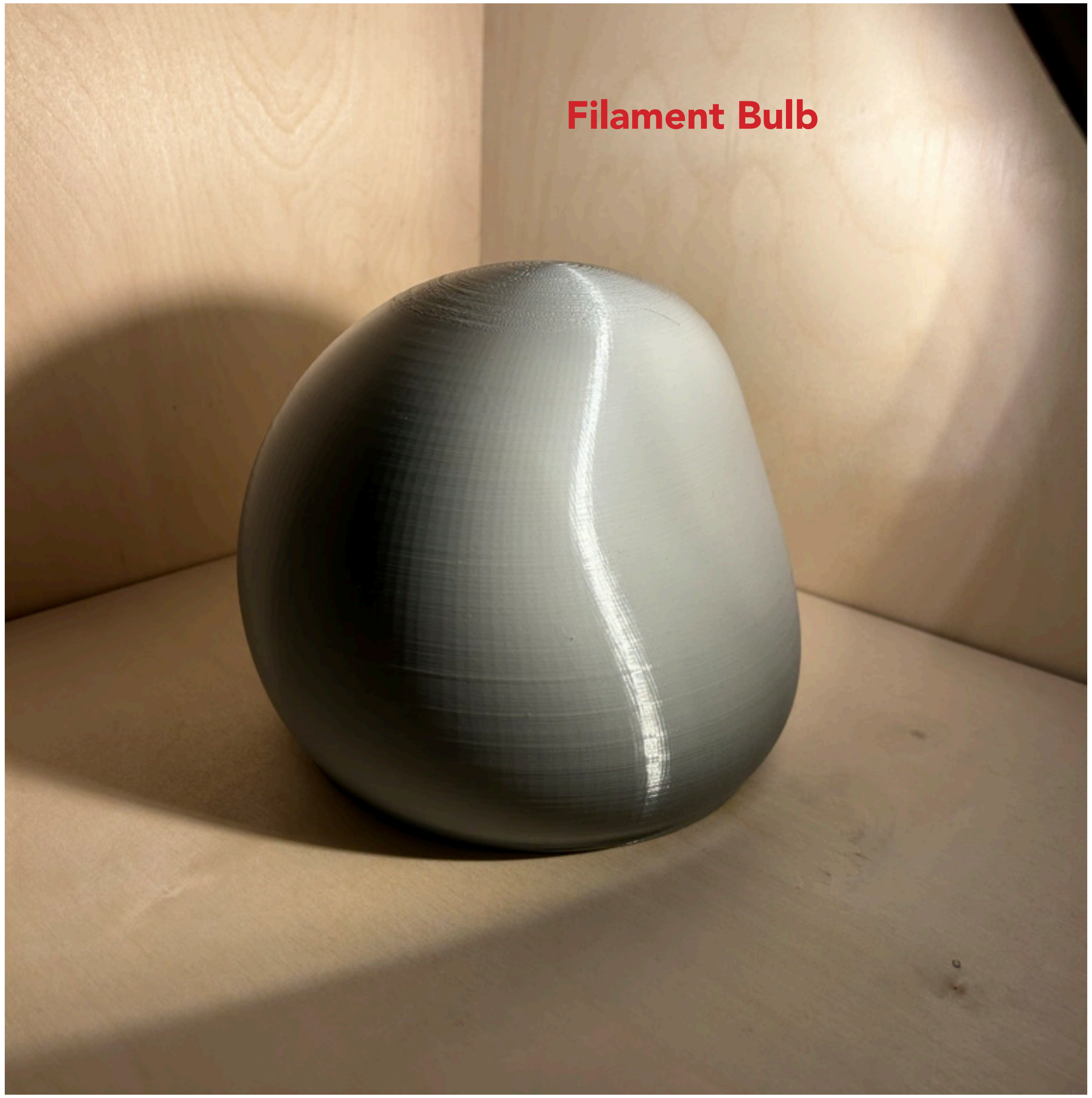
Testing.

This is the regular filament bulb that creates more of an all round glow. I found that the light is less directed and dramatic and doesn't create the same level of contrast as the spotlight. However, the glow through the slit does add another element to the design.



Testing.

This shows a close up of the spotlight bulb vs the filament bulb side by side. The spotlight creates a much more dramatic contrasted light, which I prefer and suits my design better. Therefore from these tests I have decided to use a spotlight going forward.



Faults.

These are some faults with this design. The first fault is that the light fitting slips through the slit and doesn't stay still. This is due to there being no secure fitting to lock it in place. Perhaps if I cut a circle out the top of the slit, it would sit in the circle and be hled in place better. The second fault is that when angled, it would fall through the gap in the shade. Therefore for the angled spheres, the hole/gap for the light fitting would need to be more in the side of the shape than the top to hold it in place more securely.

Time Management.

In Week 9 I spent the entire week attempting to print a large shape in the algae. I had previously had success printing smaller shapes, but found the printer was becoming clogged every time I tried to do larger prints. Whilst I didn't manage to achieve all the tasks I set out to do this week, due to constant printing failures, I feel it was very valuable to my design process, as I learnt a lot more about the material and the process of 3D printing. However, next week I need to catch up a bit on the design and light fitting, as I have now fallen slightly behind due to the issues with the material.

Week 9

13.03.23

To Do List

- Test different colour LEDs ✗
- Print big squashed sphere in algae ✓
- Develop design ✓
- Research pages ✓
- Look more into fittings ✗

To Attend

Monday – Studio : 9-5 ✓

Tuesday – Work from home ✓

Wednesday – Lectures : 10-12 ✓

Thursday – Studio : 9-5 ✓

Friday – Thesis tutorial : 12 - 12:30 ✓

CAD : 2 - 3:30 ✓

Tutorial – Fiona

How will the sphere be suspended at an angle?

Does it need to be weighted to hold sphere in place?

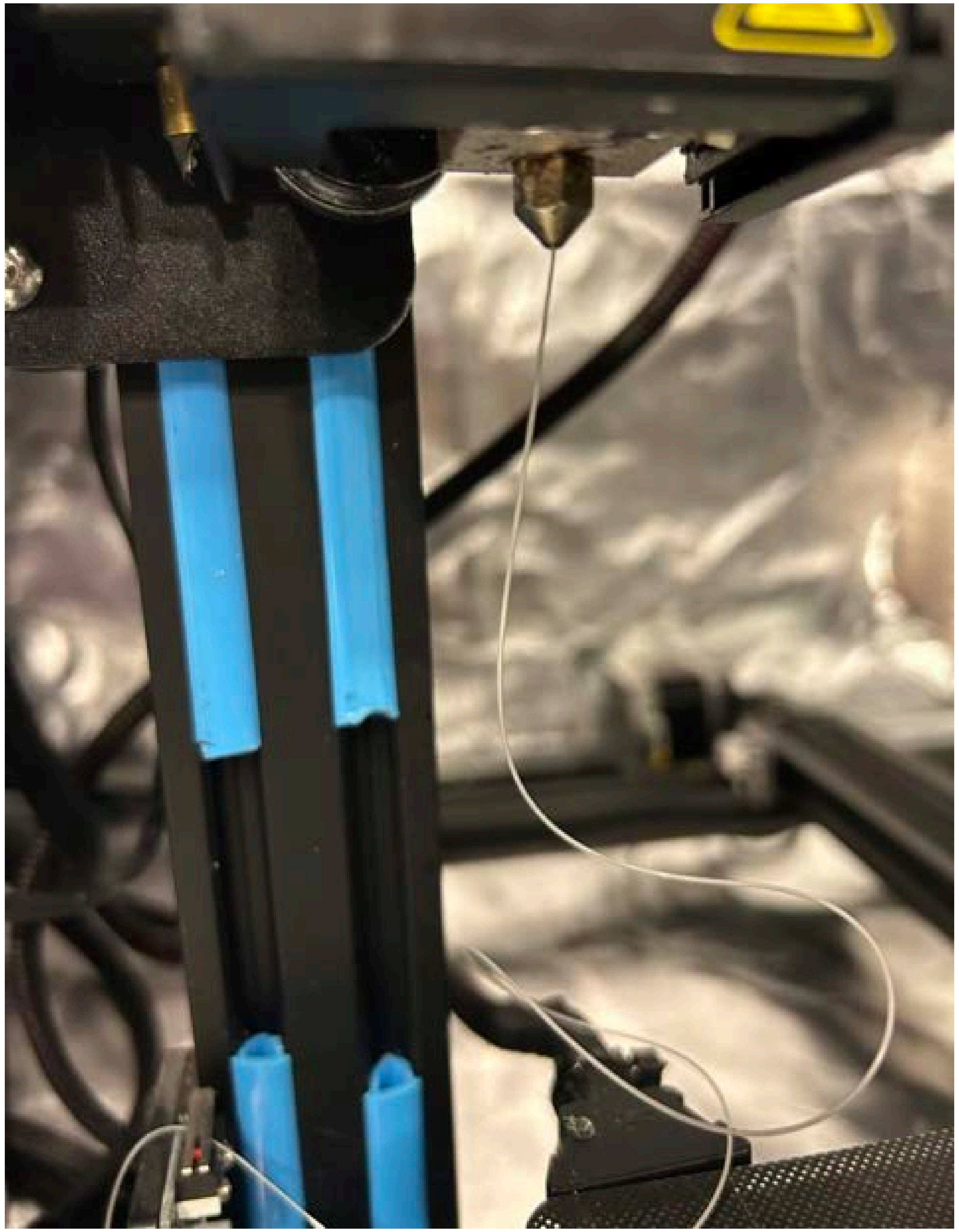
What tone of light will I use?

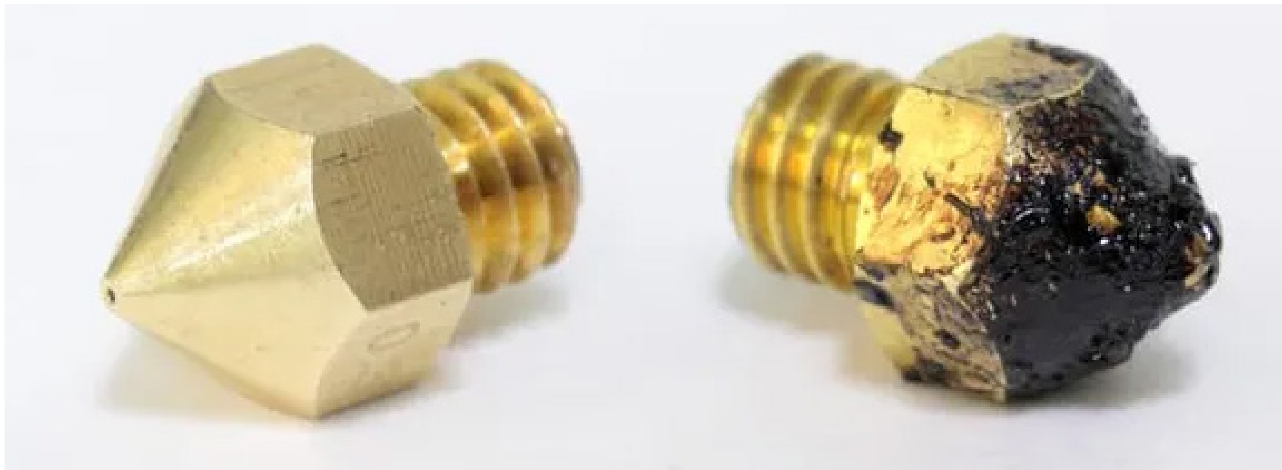
What type of light fitting?

Print lots of different slits + fittings in the same sphere to test how it will be held

Failures.

After printing the large squashed spheres using regular PLA, I decided to to print them using the algae-based filament. However, I faced some problems when printing with the material on larger prints. I found that the nozzle of the printer was becoming coated in black gunk and stopping the filament from extruding, meaning the print would stop part way through and the part would only be partially completed. I needed to experiment with different printer settings to try and get the algae filament to print properly. I suspected that the temperature may be too high, causing the filament to burn and coat the nozzle.





Failures.

This was my first attempt at printing a large squashed sphere using the algae filament. It stopped printint at around half way through the print, due to the nozzle becoming clogged. These are the settings I printed with:

Temperature: 190 degrees
Printer: Creality printer in 350
Printer size: 300x300mm
Nozzle: Regular 0.4mm

I suspected that either the temperature was too high causing the printer to become clogged, or there was an issue with the particular printer I was using. It was frustrating, as the part that printed looked beautiful and came out much better than regular PLA.

Failures.

This was my second attempt at printing a large squashed sphere using the algae filament. It stopped printint at around 1/5th of the way through the print, due to the nozzle becoming clogged. These are the settings I printed with:

Temperature: 190 degrees
Printer: A different Creality printer in 350
Printer size: 300x300mm
Nozzle: Regular 0.4mm

Here I used a different printer, but unfortunately the result was the same and even less of the shape printed. This indicated that it was more likely an issue with the temperature rather than the particular printer.

Failures.

This was my third attempt at printing a large squashed sphere using the algae filament. It stopped printing after just a couple of hours, due to the nozzle becoming clogged. These are the settings I printed with:

Temperature: 185 degrees
Printer: Large printer in 351
Printer size: 400x400mm
Nozzle: Regular 0.4mm

I lowered the temperature for this print and used the larger printer in 351, as I had been told they were more accurate. However, the result was even worse, as the nozzle became clogged quicker and due to the lower temperature, it did not stick to the bed properly either. This was concerning, as it seemed like neither changing the temperature or the printer could fix the issues I was having.

Failures.

This was my fourth attempt at printing a large squashed sphere using the algae filament. It stopped printing after a few hours, due to the nozzle becoming clogged. These are the settings I printed with:

Temperature: 190 degrees lowered to 185 after the first few layers
Printer: Creality printer in 351
Printer size: 300x300mm
Nozzle: Spider nozzle with Lubricant 0.4mm

After talking to Chris Forbes about the situation, he recommended that I use the printer with the newest model of nozzle + a lubricant to help the filament flow. He also recommended that I reduce the temperature after the first few layers had been printed, so that it was properly stuck to the bed, but would cool down after printing. Unfortunately this failed again and the nozzle still became clogged.

Suggestions.

How Can I Fix These Printing Issues?

I spoke to Chris Forbes and Luke Siena regarding the issues I was facing with the material and they gave me a number of suggestions to try to get more successful prints.

1. Lower the temperature (this resulted in the material not sticking to the bed and the print failing)

2. Lower the temperature after the first few layers have printed (this led to the nozzle still becoming clogged)

3. Use the printer with the new nozzle (didn't have any effect and still became clogged)

4. Print at a faster speed with the new nozzle (unable to do this option, as the nozzle blocked, becoming unusable)

5. Use lubricant in the nozzle (had no effect and nozzle still clogged)

6. Use a bigger nozzle (will try next)

7. Print the piece in small sections and glue it together (not really a valid option)

Throughout the previous tests, I had tried pretty much all of these suggestions with no successful results.

My last resort was to use a bigger nozzle, which would hopefully be less likely to clog. I will this next.

Printing the piece in smaller parts and gluing it together is a possibility, however this would be extremely time consuming and have messy results. The other issue with this option is that the printer fails at random, so it is impossible to work out how small to print the pieces in, meaning this option is not really a possibility.

Due to the printers repeatedly becoming clogged after use with the algae-based filament, I have been told that if the larger nozzle does not work, I will not be able to continue using the 3D printers with this material.

Failures.

Here I tried my last resort of printing with a larger nozzle. This photo shows what happened on my first attempt. These are the settings I used:

Temperature: 190 degrees
Printer: Large Creality printer in 351
Printer size: 400x400mm
Nozzle: 1mm

After repeated failures, I tried using the bigger nozzle. I was surprised at how thick the filament was coming out the nozzle. It is over double the thickness of the regular nozzle and was much harder when being extruded. This caused a number of problems, such as the filament not sticking to the bed and also not detaching from the nozzle properly, leading to the filament being dragged around and pulling off the bed. In order to fix this it took a few hours of playing around with different settings to try and make the filament stick to the bed.

Alterations.

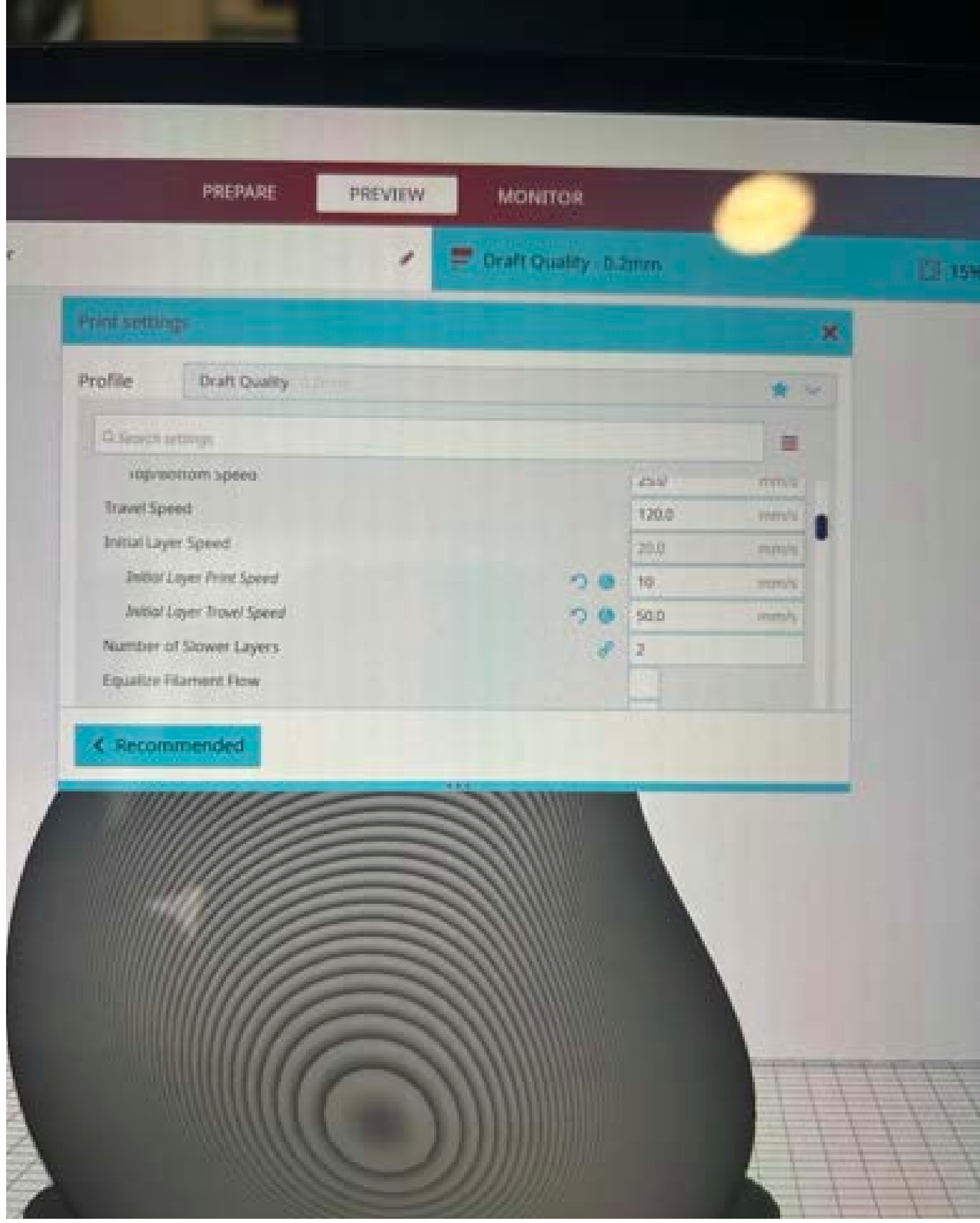
I spent hours experimenting with different settings and slightly altering the printer to try and get the large nozzle to extrude the filament neatly and stick to the bed. Here are some of the settings I changed:

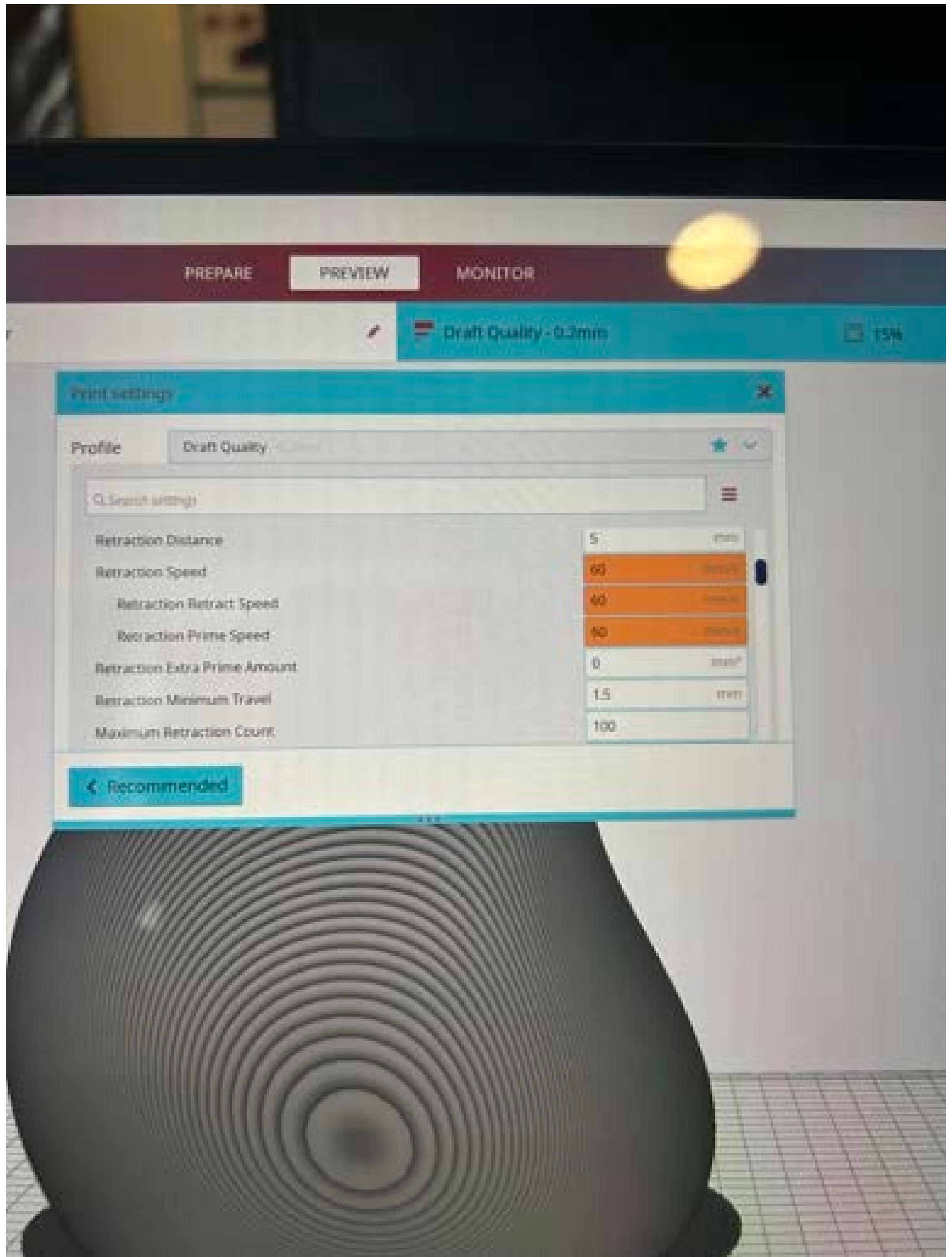
Temperature - I increased the temperature from 190 to 210 degrees, as despite the fact that higher temperatures clogged the smaller nozzles, the thicker filament meant it require more heat to extrude properly. This improved how well the filament extruded and stuck to the bed, but did not completely fix it and was still lifting.

Retraction - I slightly increased the retraction to pull the filament higher up into the nozzle when moving, stopping it dragging across the bed

Nozzle height - I put the nozzle closer to the bed so that it pushed the filament down onto the bed and didn't let it lift off. This helped massively. After the first few layers were print-ed, I then increased the nozzle heigh to allow it to print normally.

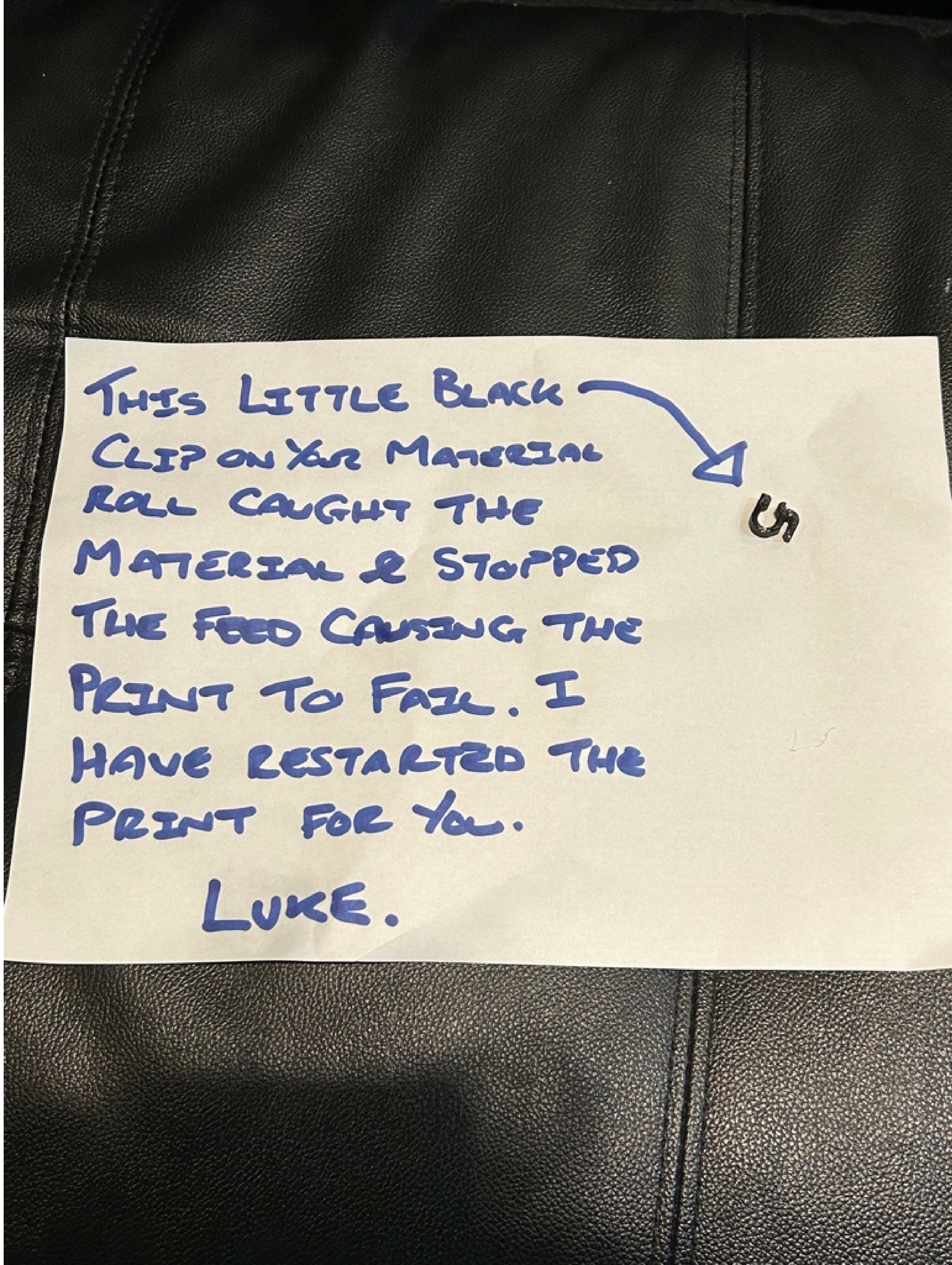
Printing speed - I found that the printer was dragging filament around, as it was moving too quickly, not giving it enough time to settle on the bed. I reduced the speed for the first 4 layers to allow a proper foundation to print and then increased the sppeed to normal, once the rest of the shape started printing.





Failures.

After doing all of the alterations shown on the previous page, I put another print on, it started printing very well with no blockages, however, when I returned to collect my print, I had been left this not explaining that the filament had become caught on a clip on the roll, preventing it from extruding and stopping the print. Therefore the print only got around half way through. Whilst this was frustrating, it was also a good thing, as the part that printed was done to a high standard and did not cause the nozzle to block/burn. It suggested that the settings I was using would work for the larger print.



Success.

Finally, after over a week of failed prints and experimenting with settings, I managed to get a successful print of the full sized squashed sphere. It also printed without blocking the nozzle at all, even after a 12 hour long print. This is brilliant, as it seems I have now worked out the best settings to print successfully with the algae-based PLA

Temperature: 210 degrees

Printer: Large Creality printer in 351

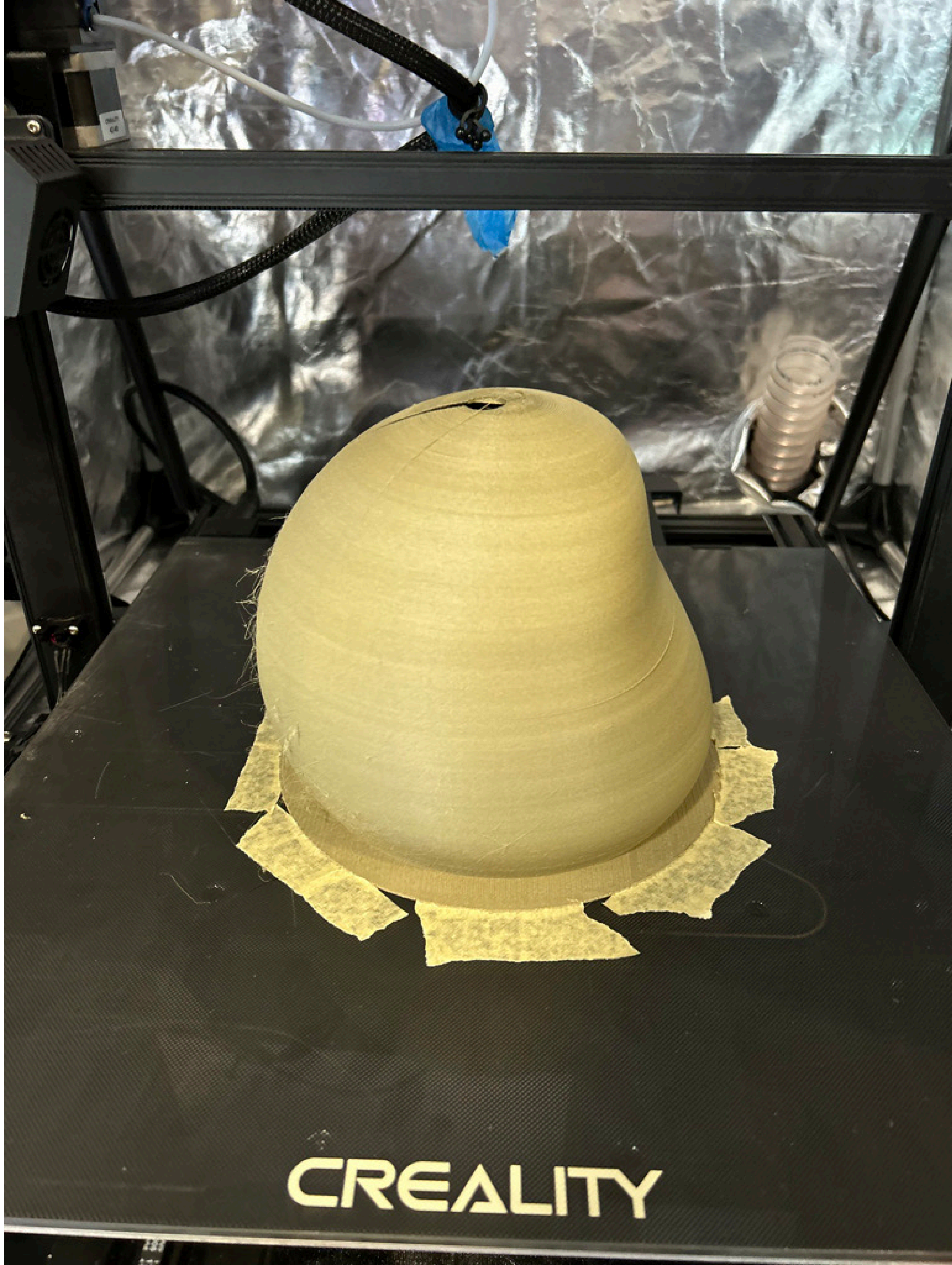
Printer size: 400x400mm

Nozzle: 1mm

Retraction: 60mm

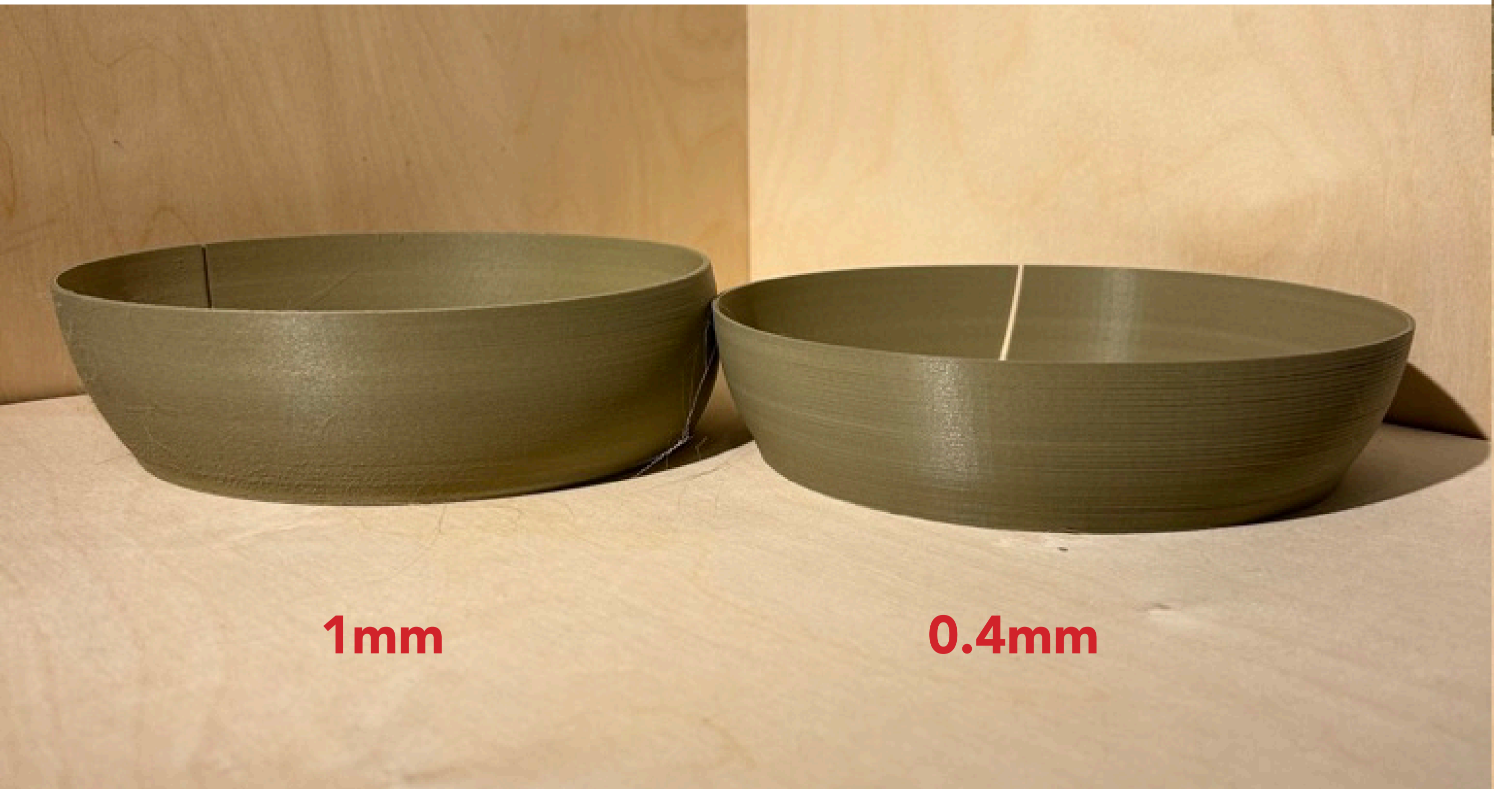
Speed: Low initial speed, regular speed after first 4 layers

Nozzle height: 0.1mm for first layer, 0.2mm for remainder of print



Differences.

One of the worries of printing with a bigger nozzle, was that it may be less accurate and a worse finish. This shows the difference in the finish of the 1mm nozzle on the left, compared to the 0.4mm nozzle on the right. I was very pleased with the outcome, as the finish was barely different at all, just a tiny bit more rough and matte. Additionally, this slightly rougher finish makes the material look more natural, better representing where it has come from.

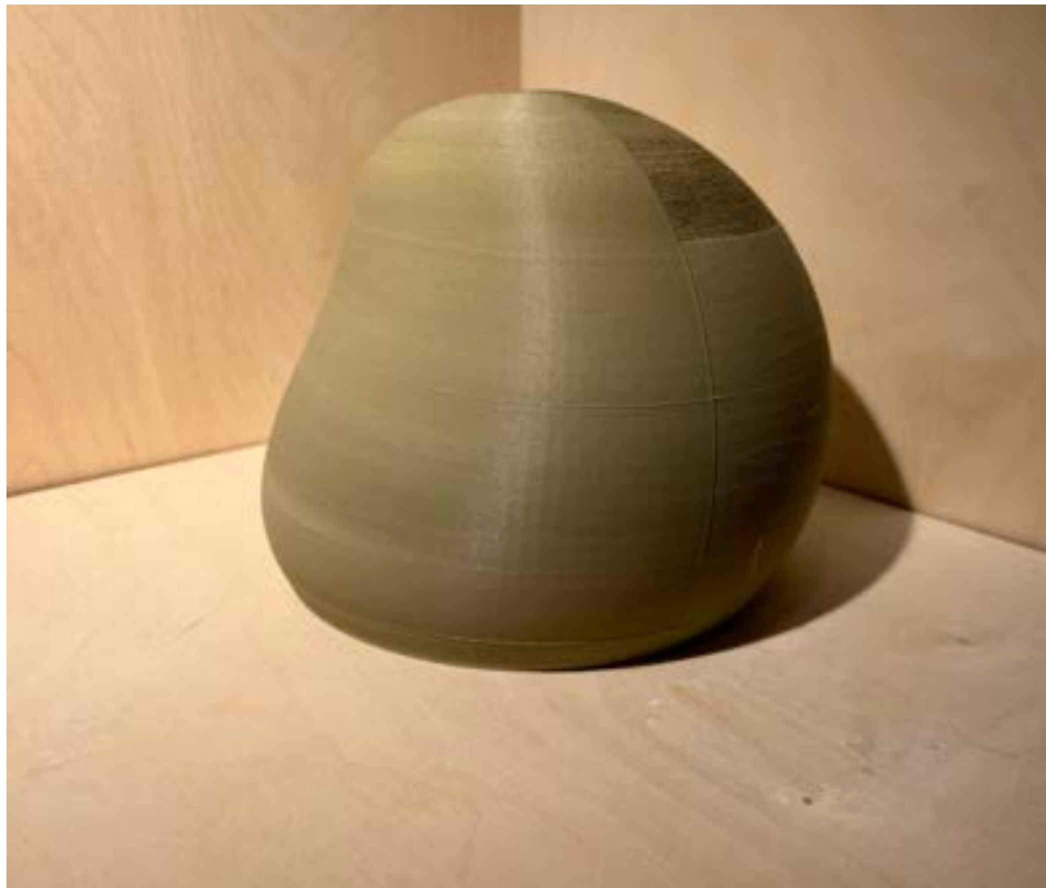


Differences.

This is the raft that is printed as the first few layers to support the spherical shape. As you can see in the photo, there is a drastic difference in line thickness between the two. However, this difference is hardly noticeable in the spherical shape, which is perfect for my design, as the finish of the material was one of its best features and I was worried that the thicker nozzle may ruin that.

Outcome.

This is the outcome of the successfully printed squashed sphere in algae. I was very pleased with the way it looked, subtly reflects the light and looks beautiful by itself. I also loved the way the colour is different throughout and fades between light and dark. After identifying the slit in the last print was far too large, I made the slit in the shade smaller and more curved, so that it conforms to the shape of the sphere and doesn't look so roughly cut out. Finally, I made a whole in the top of the sphere to allow the light fitting to go through.

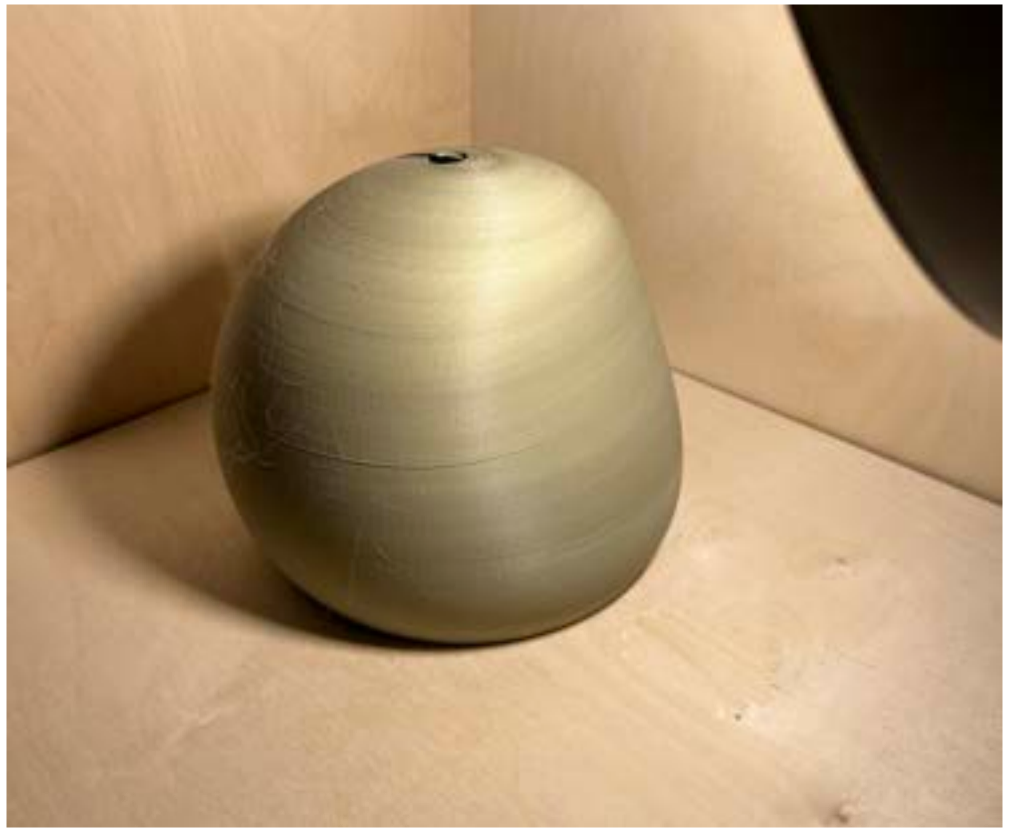


Imperfections.

There were some slight imperfections in the print, however I believe these further highlight where the material has come from and the process that has been used to manufacture the shape. For example, there is some feathery string on the shape, but this pulls off easily without leaving any marks. Additionally, there are some sections which are slightly more rough and dark and some more prominent lines, but again I believe this adds to the natural aesthetic.

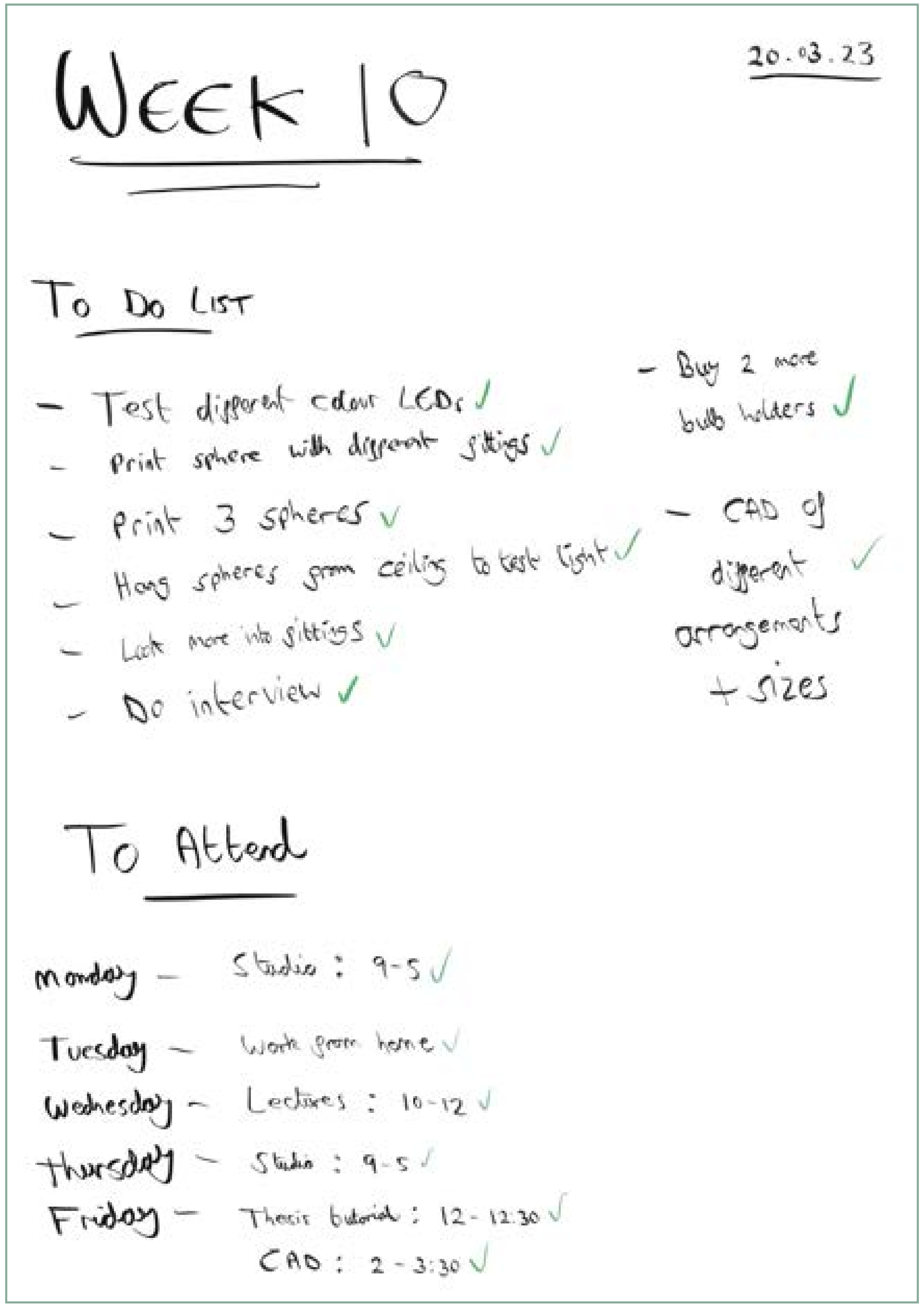
Testing.

Here I have tested the spotlight bulb shining on the algae sphere. This represents how my design will currently work. I tested how the light reflects off the shape and was pleased with the outcome. The light creates nice shadows and contrasts between dark and light. It also highlights different colours in the material and looks much better than regular PLA.



Time Management.

I was very pleased with what I got completed in Week 10. This was definitely the most productive week so far and I got loads of work done and ticked everything off of my weekly to do list. I also successfully printed 2 more shades, which proves that the settings I changed on the printer now work consistently with the algae material, which was a worry in the previous week. I need to try and keep this level of work up for the remaining few weeks.



Week 10

20.03.23

To Do List

- Test different colour LEDs ✓
- Print sphere with different settings ✓
- Print 3 spheres ✓
- Hang spheres from ceiling to test light ✓
- Look more into fittings ✓
- Do interview ✓
- Buy 2 more bulb holders ✓
- CAD of different arrangements + sizes ✓

To Attend

Monday – Studio : 9-5 ✓
Tuesday – Work from home ✓
Wednesday – Lectures : 10-12 ✓
Thursday – Studio : 9-5 ✓
Friday – Thesis tutorial : 12-12:30 ✓
CAD : 2-3:30 ✓

Tutorial - Rob

How will they be angled

will you stare up into it

How deliberate will the differences in material be?

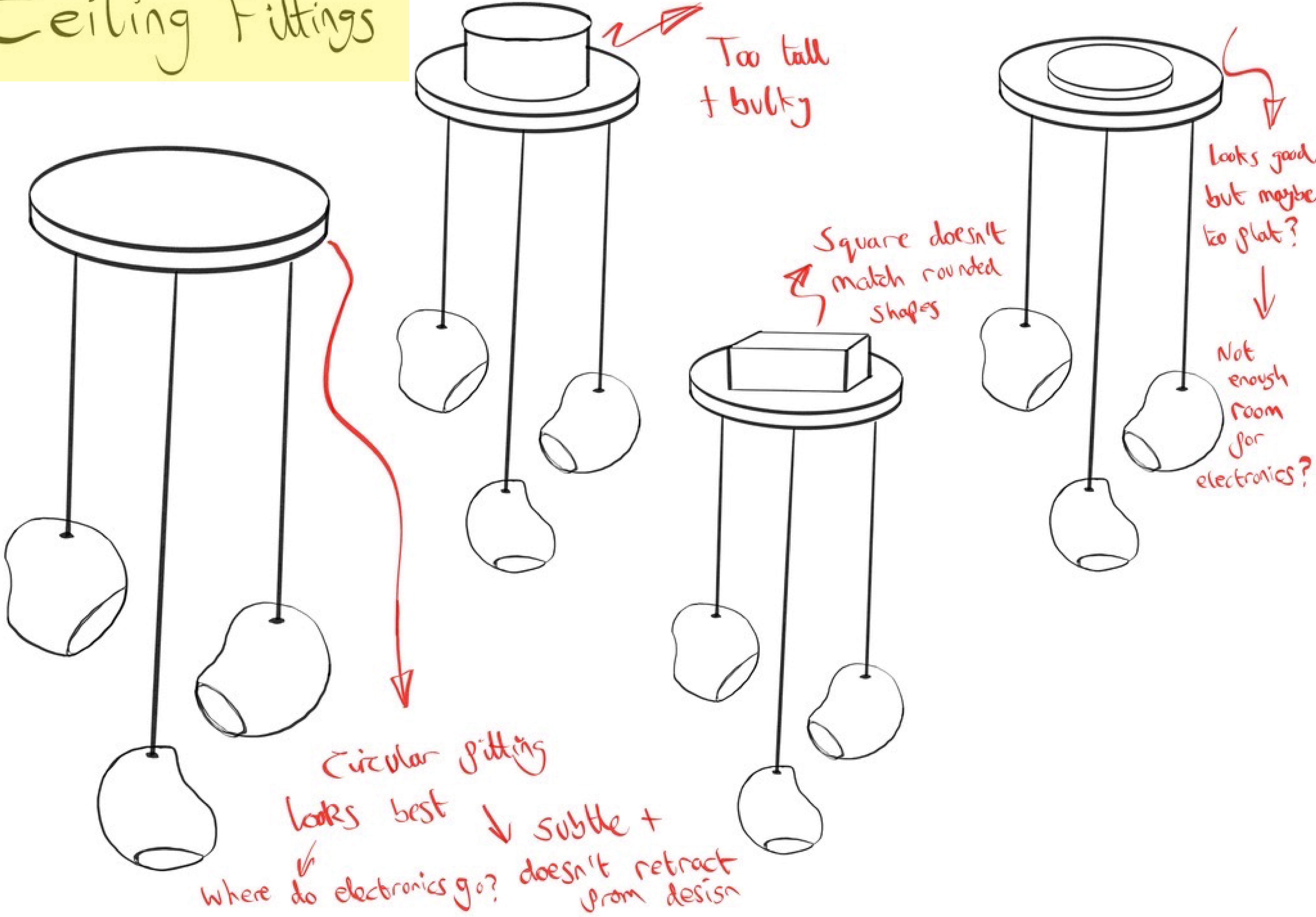
Work out tolerances

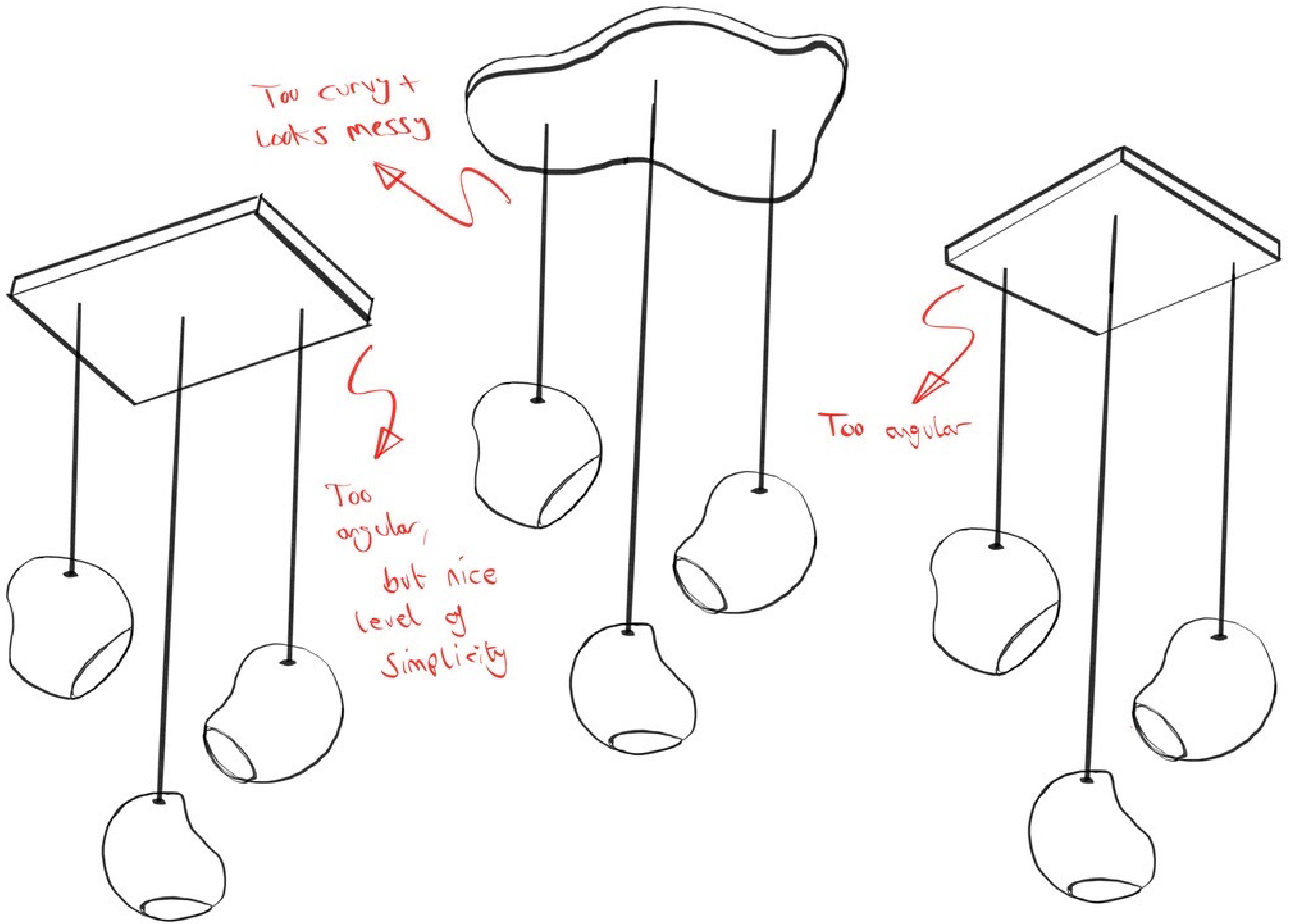
what is an acceptable imperfection

Create a sphere with lots of different holes to see what position is best

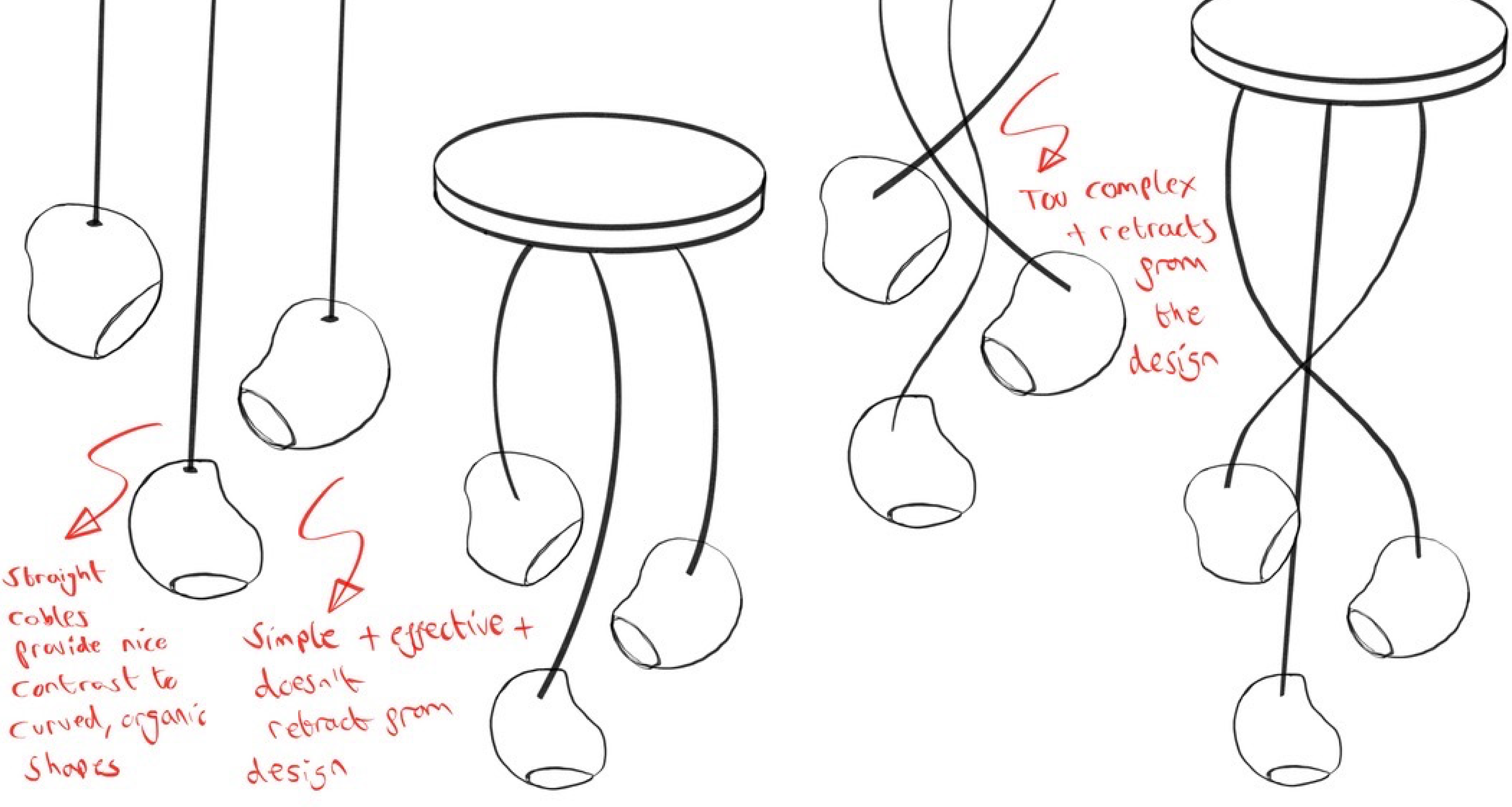
Create a rig to put the lights up the lights up at a height

Ceiling Fittings



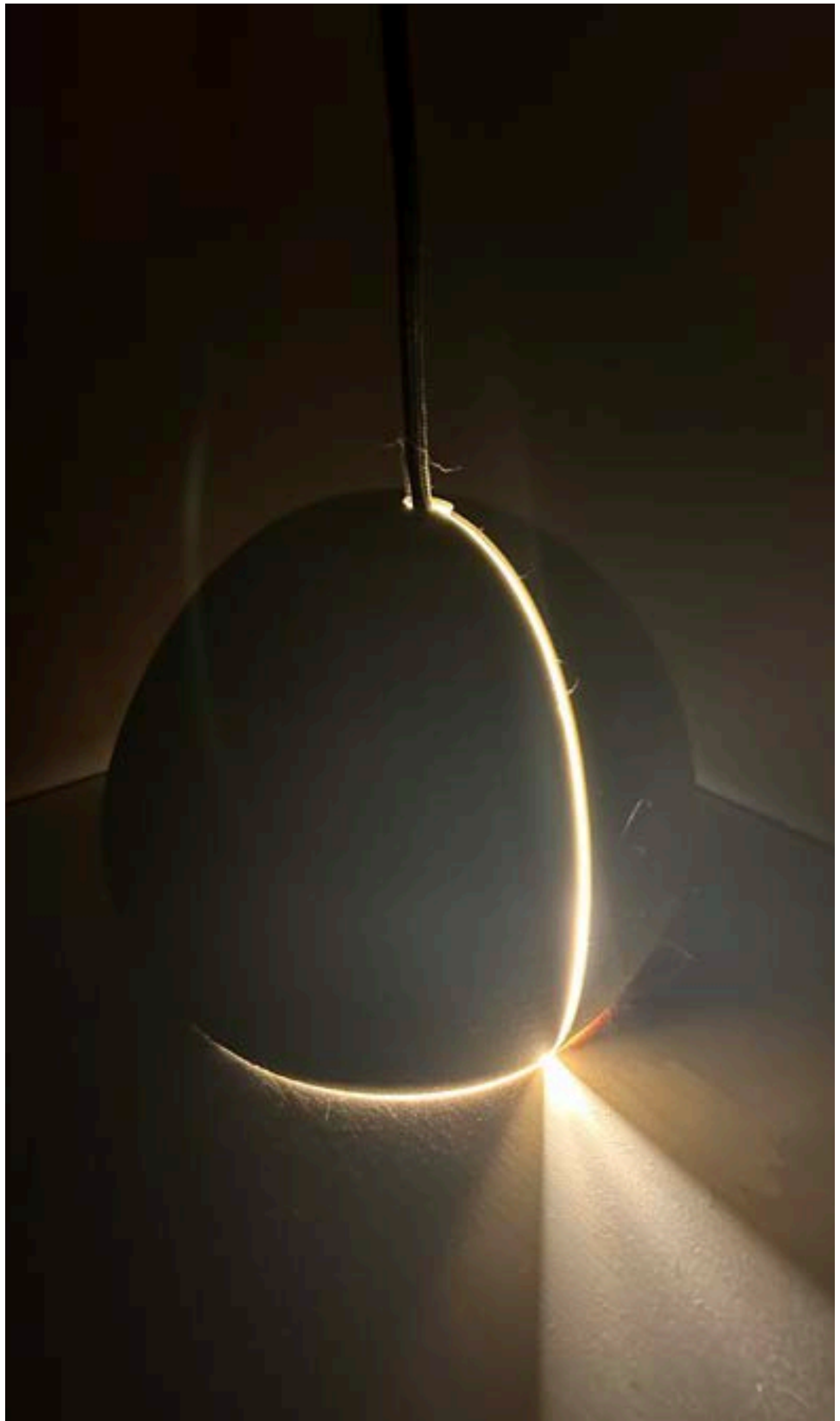

Too curvy +
looks messy
Too
angular,
but nice
level of
simplicity
Too angular

Cable Arrangements



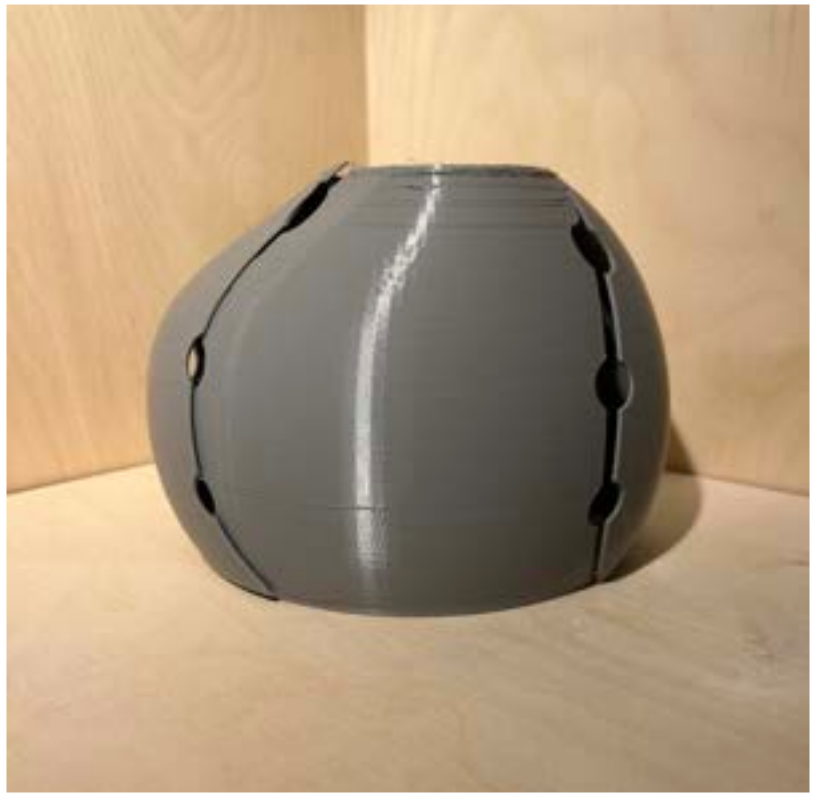
Testing.

Here I have tested the spotlight bulb inside the algae sphere. This represents how my design will currently work. I tested how the light looks inside the shape and was pleased with the outcome. The glow from the inside through the slit looks so much better than the larger split in the previous model. I also like the way it curves. Finally, the light fitting fits perfectly through the shade and holds it securely in place



Samples.

Here I printed a shape with lots of different holes cut out. This was to allow me to test the light fitting in various places all over the curves of the sphere to see if it can be held securely at different angles. Seeing as my design requires them to be angled towards each other, this was an important test, as I needed to understand if it required more support on the inside to hold the sphere in place on the fitting.



Testing.

Here I have tested the spotlight bulb shining on the algae sphere. This represents how my design will currently work. I tested how the light reflects off the shape and was pleased with the outcome. The light creates nice shadows and contrasts between dark and light. It also highlights different colours in the material and looks much better than regular PLA.

Testing.

Here I tested how my light could potentially look when hanging from the ceiling. I didn't have 3 shades printed in the algae yet, so I used other samples just to see the overall look. This is not the layout I will have them in, as I don't like the diagonal arrangement of the shades, however it gave me an understanding of how they hang and how far apart they need to be to shine nicely onto each other. I was very pleased with how the bottom 2 shades look when the spotlight bulb is shining on them, illuminating one side and leaving the other in shadow, which is exactly the effect I was going for. I wasn't pleased with how thick the cables were and how they didn't hang straight and were curvy/bent. I will need to change the cable for the real thing.

Testing.

This is another view of the lights hanging from the ceiling. The glow from the bottom of the middle sphere looks nice when looking from underneath. I was also impressed by how much of the room was illuminated by the light. Every single other light in the house was off when this photo was taken, with the only source of light coming from this, but it]illuninated the entire room well, with just 3 LED spotlight bulbs.

Lighting Types.

Here I researched the different types of lighting and their features. My light will be an ambient light. This is because it will be hanging from the ceiling and providing an overall glow in a room. It will also be one of the main features in a room, rather than something that blends into the background.

AMBIENT

- Provides overall glow in a room
- Sets tone for a space
- Creates enough light to see clearly
- Usually created using overhead fixtures like recessed pot lights, track lights, chandeliers and other ceiling lamps, or stand alone fixtures like floor and table lamps.

ACCENT

- Creates a focal point
- Adds to ambient light
- Draws attention to a feature such as furniture/piece of art
- Usually acheived through track and recessed lighting or wall mounted fixtures

TASK

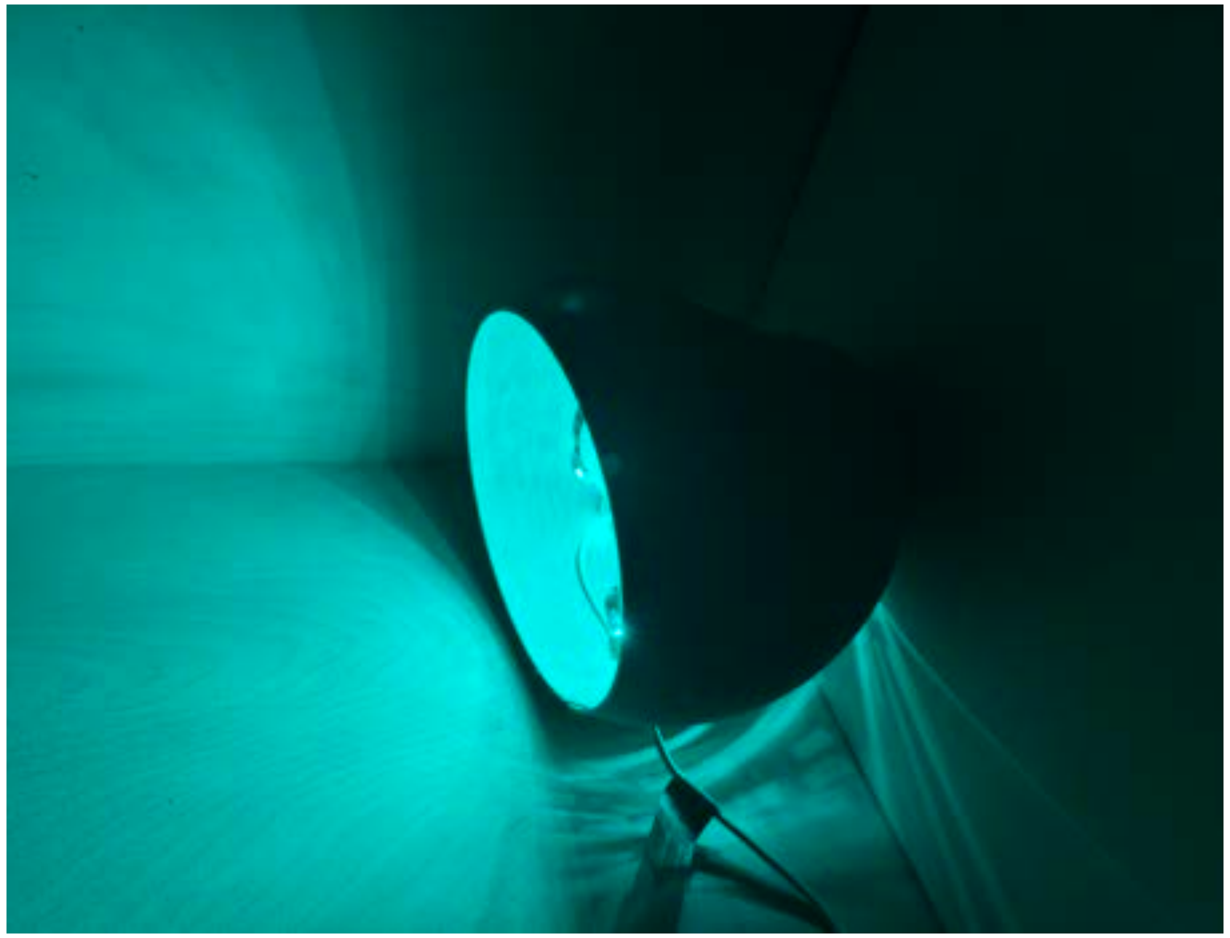
- To help accomplish a task
- Localised light
- Allows you to adjust it for a work space/chosen area to suit you
- Bright enough to prevent eye strain and complete tasks such as reading, writing etc
- Desk lamps, task lamps, overhead lighting

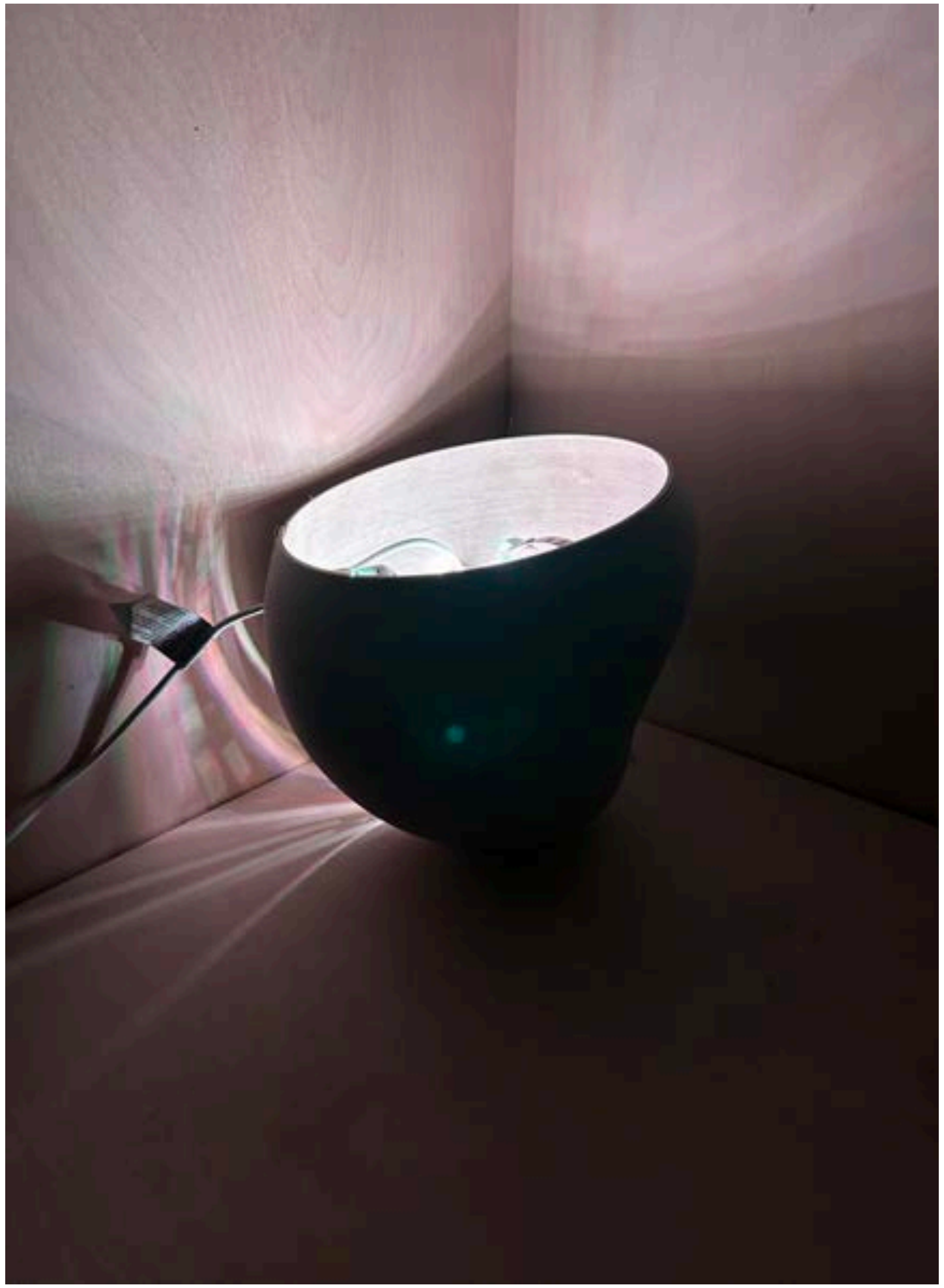
Testing.

To test which tones of light would look best with the green shade, I used colour changing LEDs to see how different colours affect the appearance of the light. I was already pretty certain that warm white would be the best, from the other testing I had done earlier in the project using spotlight vs filament bulbs, however it was worth trying to see if a colour changing bulb might be a nice addition.

Testing.

This shows the algae shade with LEDs inside and various different colour coming from an LED strip bunched up inside. The results were pretty much as expected and it didn't look good in any of the colours. It completely dominates the shade, hiding its natural colour and producing an artificial one instead. Therefore, I will not be using a colour changing bulb.





Testing.

This shows the algae shade with LEDs inside shining onto the exterior of another algae shade. As you can see, it doesn't reflect at all and leaves the shade looking dull. It also completely disguises the beautiful natural colouring. Finally, using strips of LEDs rather than a spotlight bulb creates a much less directed light, which doesn't give the contrast of shadows and light, which I liked in previous tests.

Psychology.

The Psychological Impact Of Light And Colour

From this research, it makes sense to use a warm white bulb in my pendant light. I have tested various colours and shades of light in previous pages and decided that the warm white also suited the natural green colour of the lampshade better.

Light can improve or disrupt our sleep, overall wellbeing and mood. Psychologically, light can decrease depression scores and even increase cognitive performance such as reaction time and activation.

BRIGHTNESS

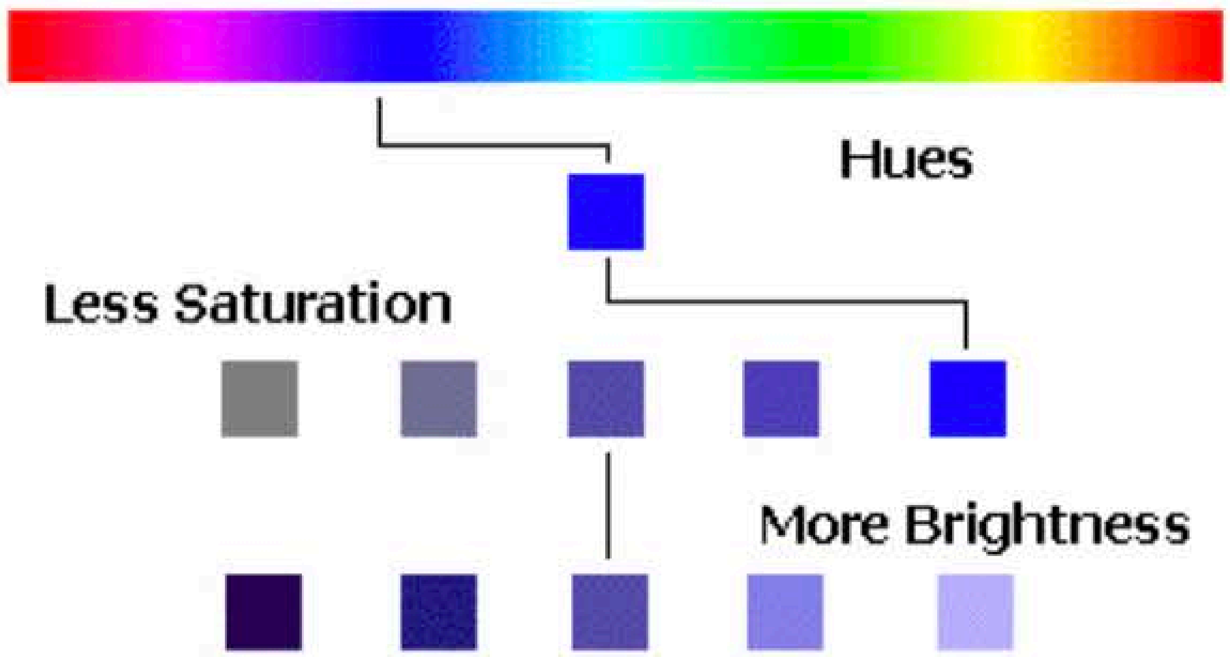
- Brighter light can intensify emotions
- Lower light can keep emotions more steady
- People make more rational decisions and become more agreeable in low lighting

SATURATION

- This means the intensity of colour
- More saturated can have amplifying effects on emotions
- Duller, more muted colours can dampen emotion

HUE

- A colour or shade of light
- Natural light improves happiness
- Blue/white light makes us more energetic and can disrupt sleep if seen close to bed time, as it surpresses melatonin levels
- Red/amber light in the evening can improve mental health, as it increases the release of melatonin, which improves sleep



Interior.

Interior.




Interior.

Interior.

Over the previous pages I have created some moodboards of the kind of interiors my design could fit into. These aesthetics suit my product and are what I have based its appearance on.

Some of the common features of interiors that my design will fit into are:

- Natural colours
- Neutral colours
- Green
- Wood
- Metal - bronze, copper, silver, gold, brass
- Bringing nature into the home
- Modern

Art & Design Movements.

My project has taken inspiration from 2 different art & design movements - Art Nouveau and Relaxed minimalism.

Art Nouveau began in the 1890s and was a movement that lasted for around 20 years. It is characterised by:

- **Organic lines and shapes**
- **Asymmetrical forms**
- **Curves**
- **Plant-like features**

All of these above characteristics are featured in my design and are things I have considered in the aesthetics of my product. However, Art Nouveau can be quite bold, harsh and elaborate, which is not something I neccessarily wanted to replicate in my design, therefore I also took inspiration from another design movement.

Relaxed Minimalism is a modern take on minimalism that involves combining an uncluttered lifestyle with a few more elaborate items. This is characterised by:

- **Simplicity**
- **Clean lines**
- **Light**
- **No clutter**

I wanted my design to be a good balance of both of these movements, which provided me with inspiration.

Art Nouveau.

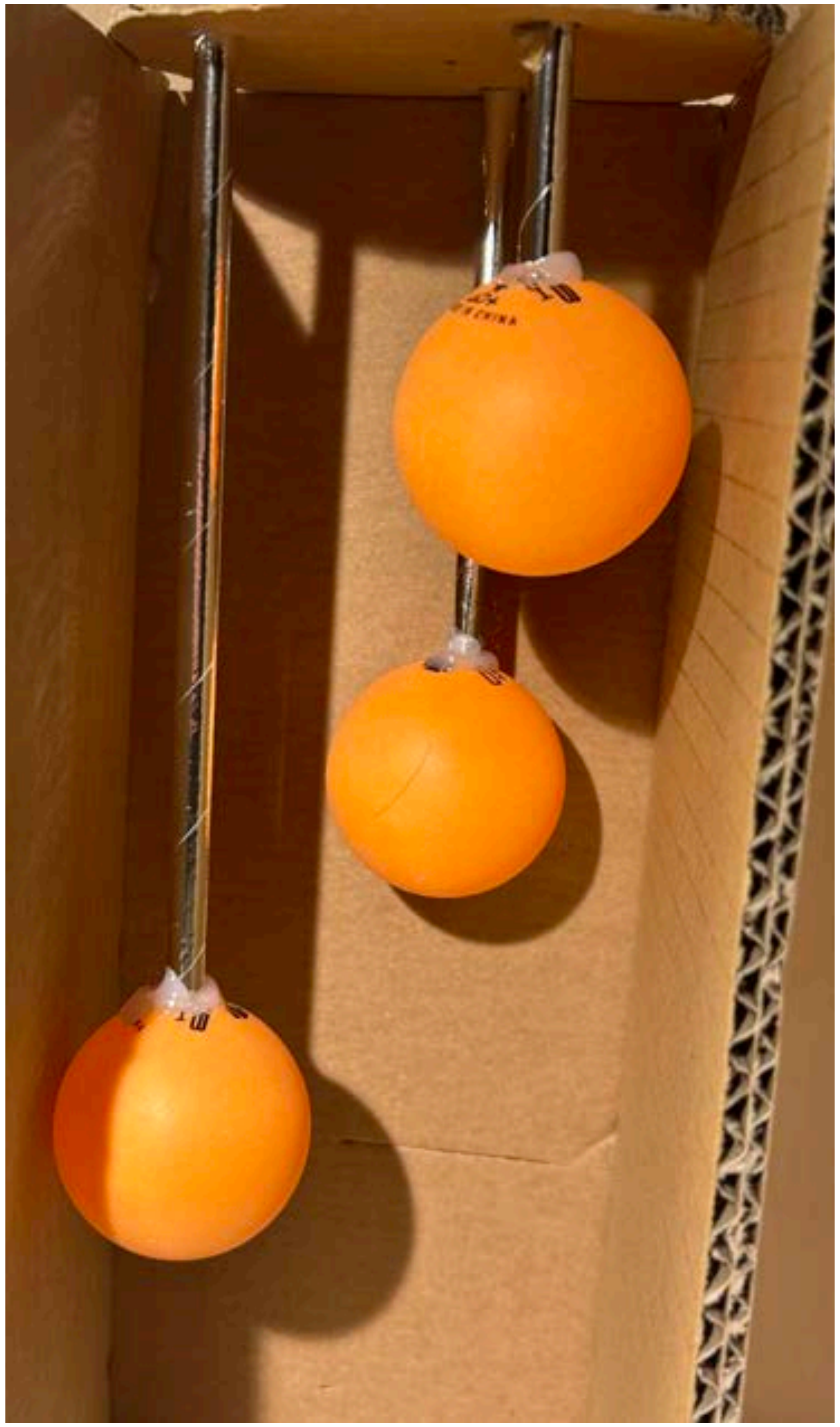
Relaxed Minimalism.

Testing.

Here I used ping pong balls and straws to hang 3 spheres from a makeshift ceiling. I wanted to test different arrangements of how they hang. I believe the best arrangement is the one on the left, with the triangular shape at different heights. This is the standard layout for a 3 point ceiling rose, so also makes sense to use this.

Testing.

Here are some more models testing arrangements of the shades. I don't like these as much, as they look uneven and also the idea behind my product is that they are angled to shine light onto each other, but these arrangements wouldn't allow that.



Testing.

This is my second squashed sphere shape. For this I put the hole in the top off centre, so that when hanging from the ceiling, it hangs at an angle, allowing it to point towards another light. I also made the slit even more wavy, conforming to the shape of the sphere. Whilst this shape is similar to the first sphere, there are differences, meaning that they don't look identical, but it is clear they are part of a set.

Testing.

This is the third squashed sphere shape. It is quite a lot different from the other two and I am not fully convinced whether I will use it or not. I do like the way it looks so different from various angles/ sides, but I'm not sure if it looks too different from the others. Again, I put the hole in the top off to the side to allow it to hang at an angle.

Testing.

This is my three shapes side by side. I think the look great as a set and I love the way they catch the light in the first photo. However, I do think that the shape shown on the previous page may be slightly too different and not quite spherical enough. I may change this shape, but first I will test out how it looks when hanging from the ceiling.

Testing.

Here I hung my three shades through the stairs. This is a good test place, as they can hang from a perfect height. Initially this is the arrangement I hung them in, but I found that they were too far apart from each other and the arrangement looked untidy. I also found that the light was not directed towards each shade enough.

Testing.

Here I moved the shades much closer to each other. This looked better, but still looked uneven, as they were too close in height, but too far in depth, as the lowest sphere was much further forward than the rest. Again, I felt this looked messy and they needed to be more evenly spaced.

Testing.

Here the lights were a good distance apart. They were evenly spaced and close enough to have directed light create shadows on the spheres, but not too close. I love the way the light creates and eclipse effect on the outside of the sphere, which is exactly the effect I was trying to acheive.

Testing.

This is a close up of one of the shades hanging from the ceiling. As you can see, the fact the the other spheres are positioned to shine against the surface of each other, it creates this effect. Part of the shade is illuminated, with beams of light conforming to the shape of the sphere, whereas the other part is left in complete shadow, giving the appearance of an eclipse, which further accentuates the curves of the sphere.

Testing.

This is a photo of when the lights inside the shade are off and daylight is coming into the house. Earlier in the project, I identified that I wanted the light to look beautiful on and off and I think this achieves that, as the daylight still creates nice reflections off the spheres and accentuates the curves. Additionally, you can see on the wall behind that shadows of the spheres are created, which is a nice effect, as they clearly show the shape of the spheres.

CAD Sizing.

Currently all of my shades are the same size, however I am debating potentially having different size ones. Here I created some variations of sizing arrangements on CAD to see if there was any that I liked. I am not sure if I want to change the sizes or not, as it is difficult to tell from these photos, so perhaps I will make models. The reason I haven't just printed a large one is that it will use up a huge amount of filament and take a few days to print, which could be a waste of time and money.

CAD Sizing.

Here are some more sizing arrangements. I quite like the left one, where the sizes get bigger as they go down, however it is still difficult to tell without seeing it in 3D, so I need to either print a larger one or maybe paper mache one.

Ceiling Fitting.

My product is a pendant light that hangs from the ceililng. Due to there being 3 separate shades and bulbs, my light requires a 3-way ceiling fitting. This is an example of a 3 way ceiling rose for pendant lights.

The standard sizing for a 3 way ceiling rose is 120mm diameter. However, when hanging my lights through the stairs, I found that this was far too small and the shades bumped into each other and could not be arranged in the desired layout.

The standard layout is a trianguar formation of fittings inside the cirlce. This suits my light perfectly, as this is how I will be arranging my pendant lights.

The next size up is 200mm diameter. There is a chance this could still be too small, however, I will make a model of a 200mm diameter ceiling rose to test with my product. It would be perfect if this size fitted, as it would mean I could use a standard component for the ceiling fitting.

Testing.

Here I made a 200mm diameter ceiling rose from cardboard to hang my lights through. They hung in the desired arrangement at the correct distances. Therefore I am able to use the 200mm standard ceiling rose for my light. However, it was tight and so there is not much room for movement. If I make one of the spheres larger, it probably would not fit, so I would need a different ceiling fitting.

Time Management.

In Week 11, I spread my time out over lots of different tasks, as there was not one particular larger task that needed completing. Overall I was pleased with everything I managed to complete this week and I also managed to get a good amount of CAD done, which is one of my weaknesses. This will allow me to spend more time on the presentation towards the end of the project, which I didn't leave enough time for in my previous project. I don't want to make that mistake again.

WEEK 11

27.03.23

To Do List

- Write up interview analysis ✗
- Do some of thesis ✓
- Keyshot of different colour + material fittings ✓
- Research pages ✓
- Order light fittings ✓
- Re print 1st sphere ✓
- Print new shape to compare to shape I'm unsure about ✓
- Print huge one in regular PLA ✓

To Attend

Monday – Studio: 9-5 ✓

Tuesday – Work from home ✓

Wednesday – Lectures: 10-12 ✓

Thursday – Studio: 9-5 ✓

Friday – Thesis tutorial: 12-12:30 ✓
CAD: 2-3:30 ✓

Tutorial - Alex

Fitting shouldn't be really shiny - too much contrast with matte material

Don't do different sized ones

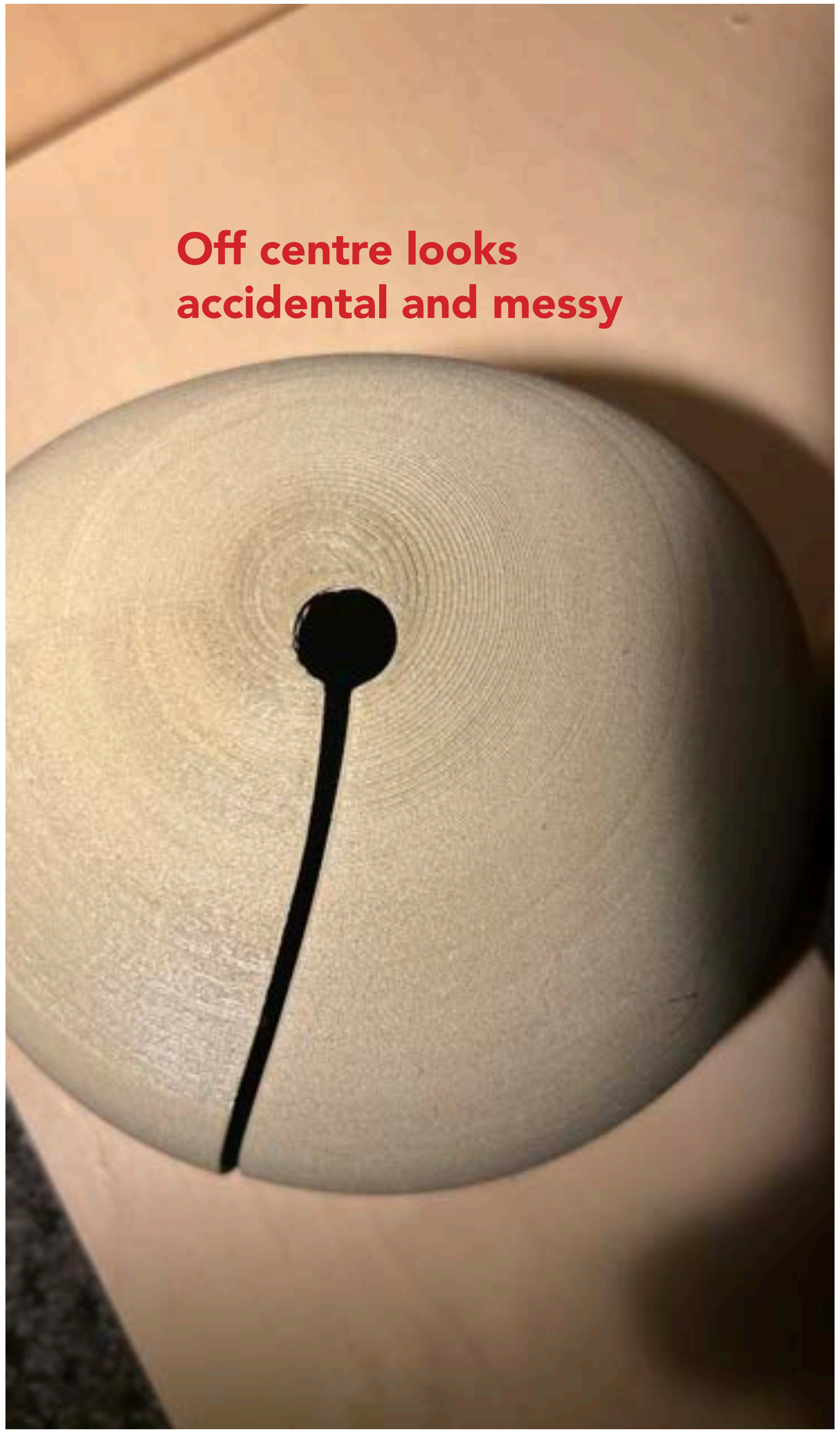
Light should be the focal point, not the fitting

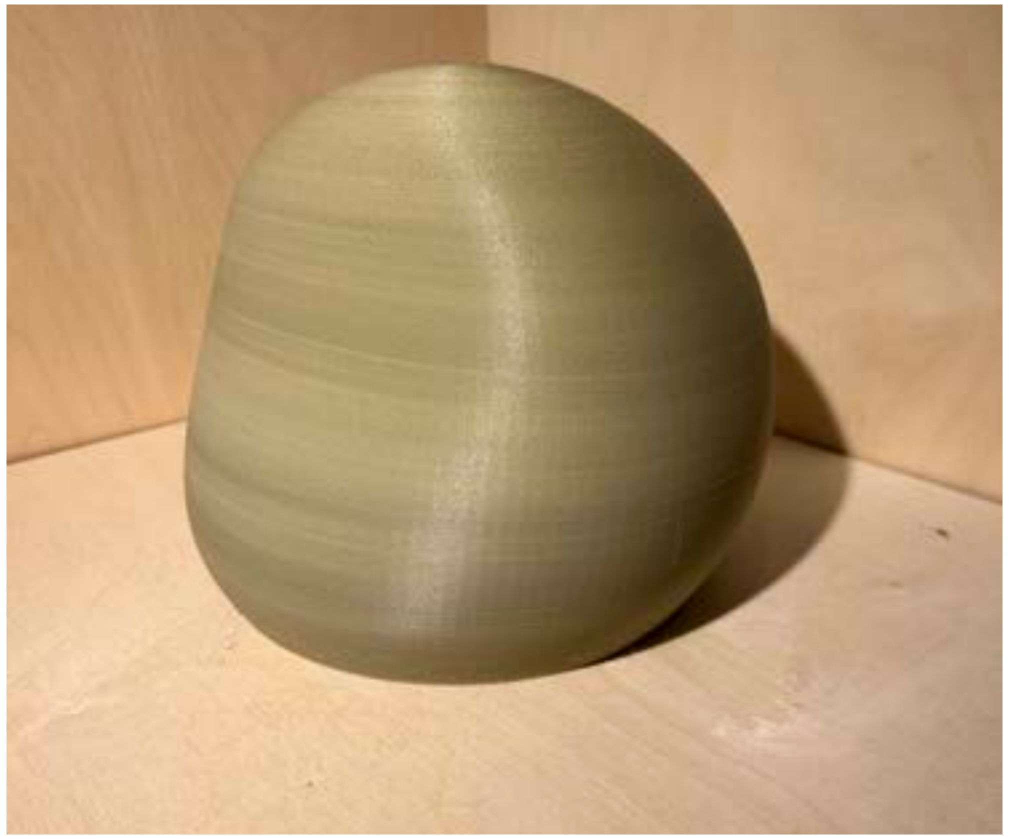
Fitting should be black to blend in with cable

They are already varied shapes, so different sizes could result in them not looking part of a set

Adjustments.

This shows a slight adjustment I made to my design to address some of the imperfections. As you can see in the photos, initially the hole in the top of the sphere was slightly off centre. This, unlike the other shapes that hang at an angle, was not intentional, so needed changing. I reprinted the shape with the hole more central to correct this.





Adjustments.

After identifying that I wasn't keen on one of the shapes, I printed a new shape, that was slightly more spherical than the last one. I prefer this shape, as it fits in better with the rest and looks part of a set. In my opinion and others, the old shape looked too different to the rest.

Adjustments.

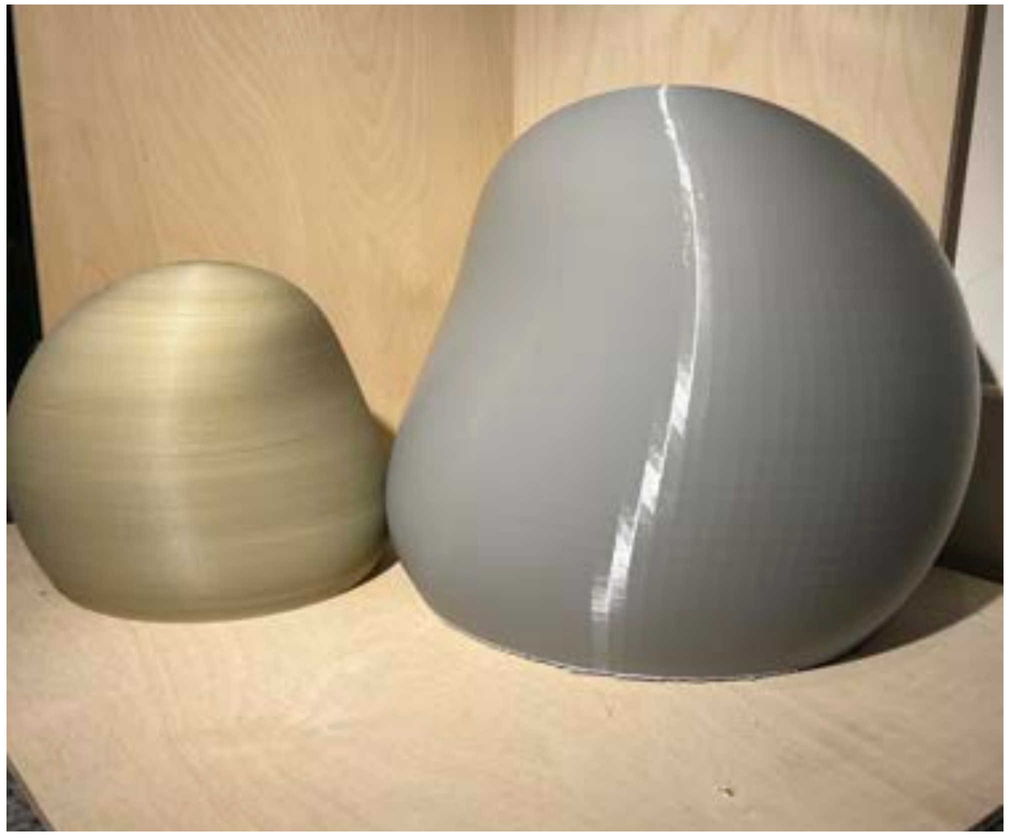
This shows the new improved shape hanging. It deliberately hangs at an angle, so that it will be able to direct light towards another shade. I believe it is squashed enough to look different, but not too different so that it looks like the odd one out.

Adjustments.

This shows the new shape next to the old shape. The new shape is on the left and the old on the right. I believe the new shape is better, as it looks more spherical and I did not like the point at the top of the old shape. I will remove the old one from the set of 3 and replace it with the new one.

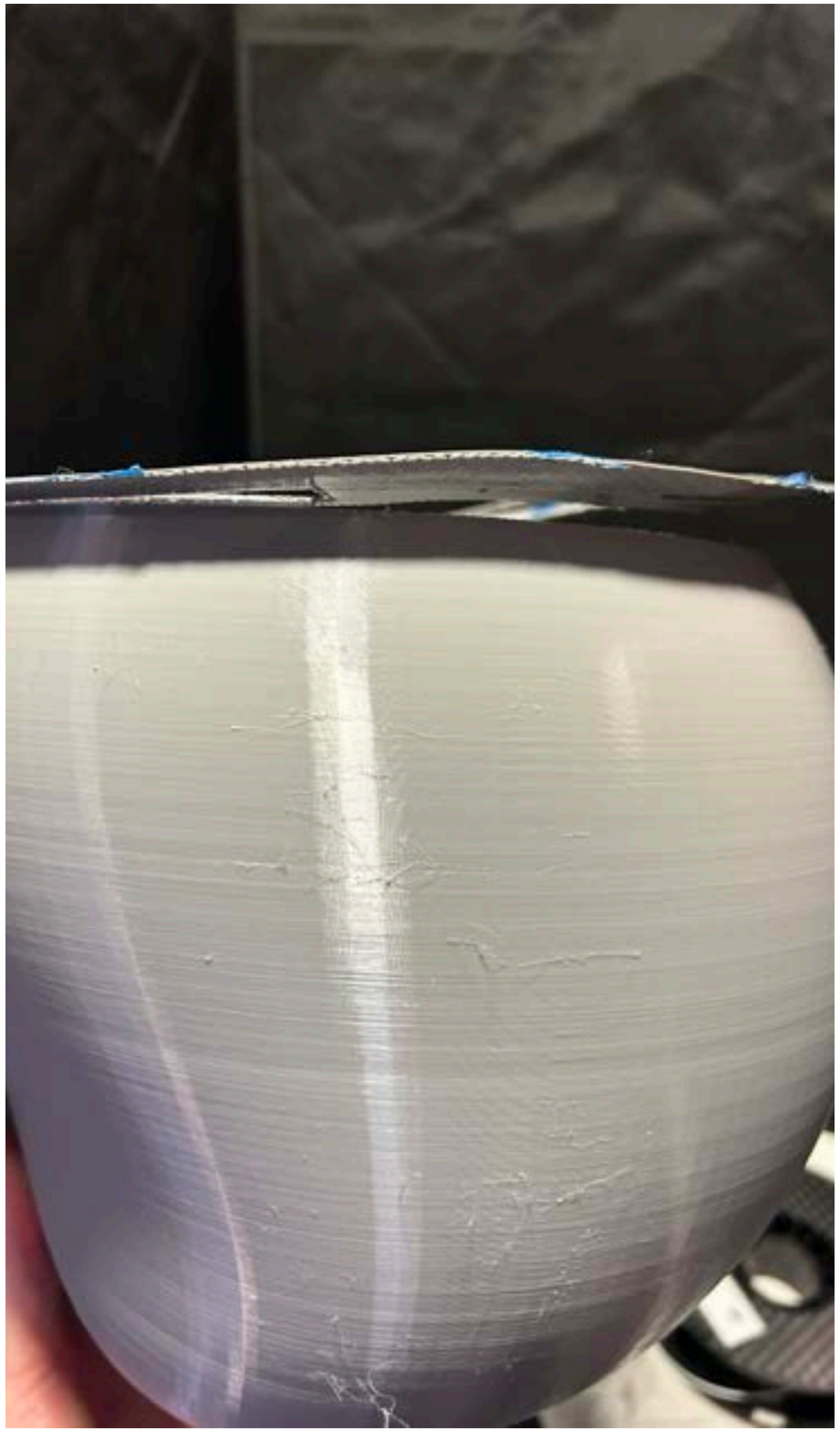
Testing.

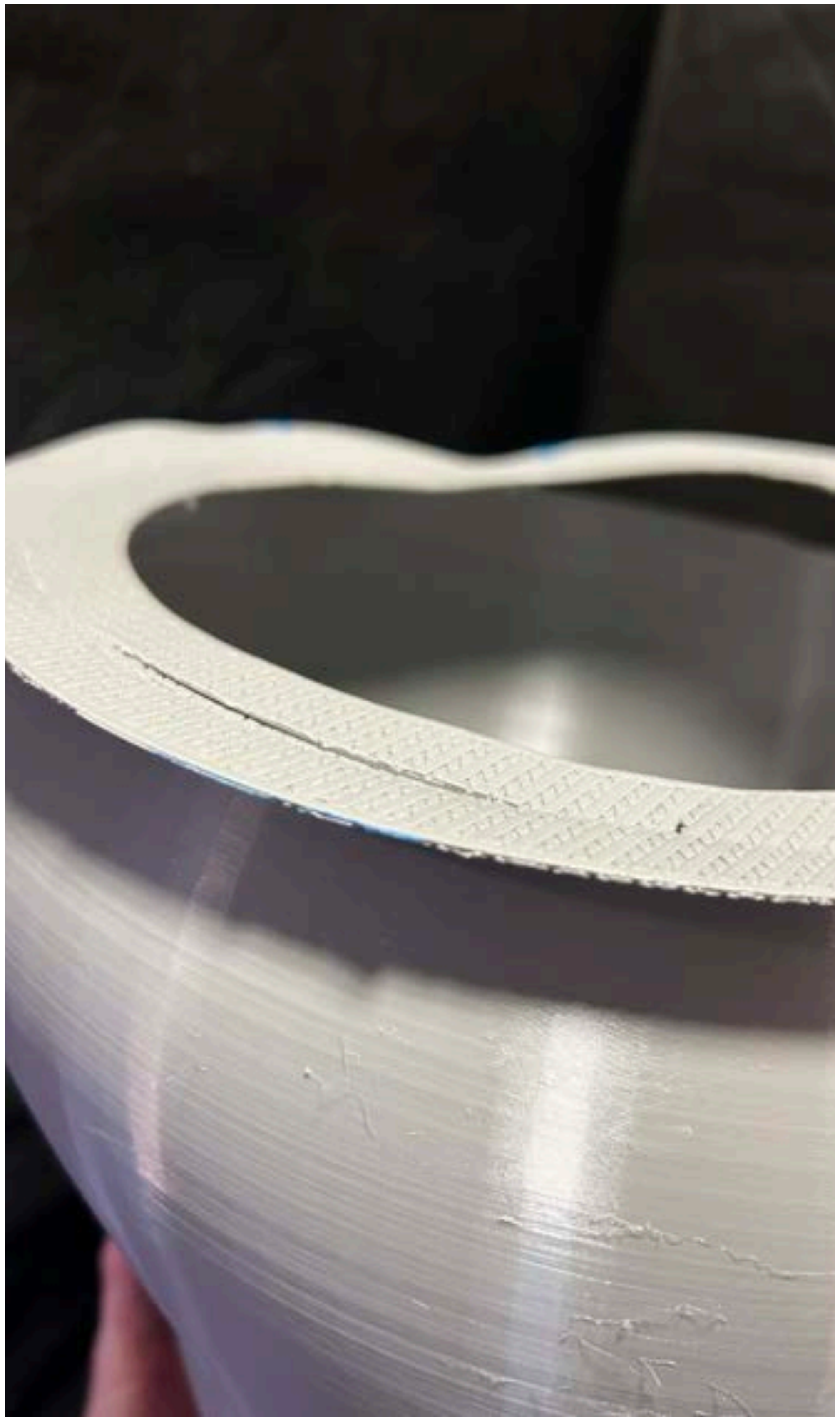
Here I printed a much larger sphere to test how it would look and if the printer would be capable of printing something of this size. It took 2 days but printed fairly well, except for a small imperfection on the back. You can see the bigger size compared to the smaller size. I believe in a very large room, the bigger size could work, hoever it is much more practical to use the smaller size. Additionally, the larger sphere loses some of its smoothness due to the size and the squashed curve doesn't look as fluid. Therefore I will continue with the small spheres, but perhaps suggest it could be available in different sizes for the customer

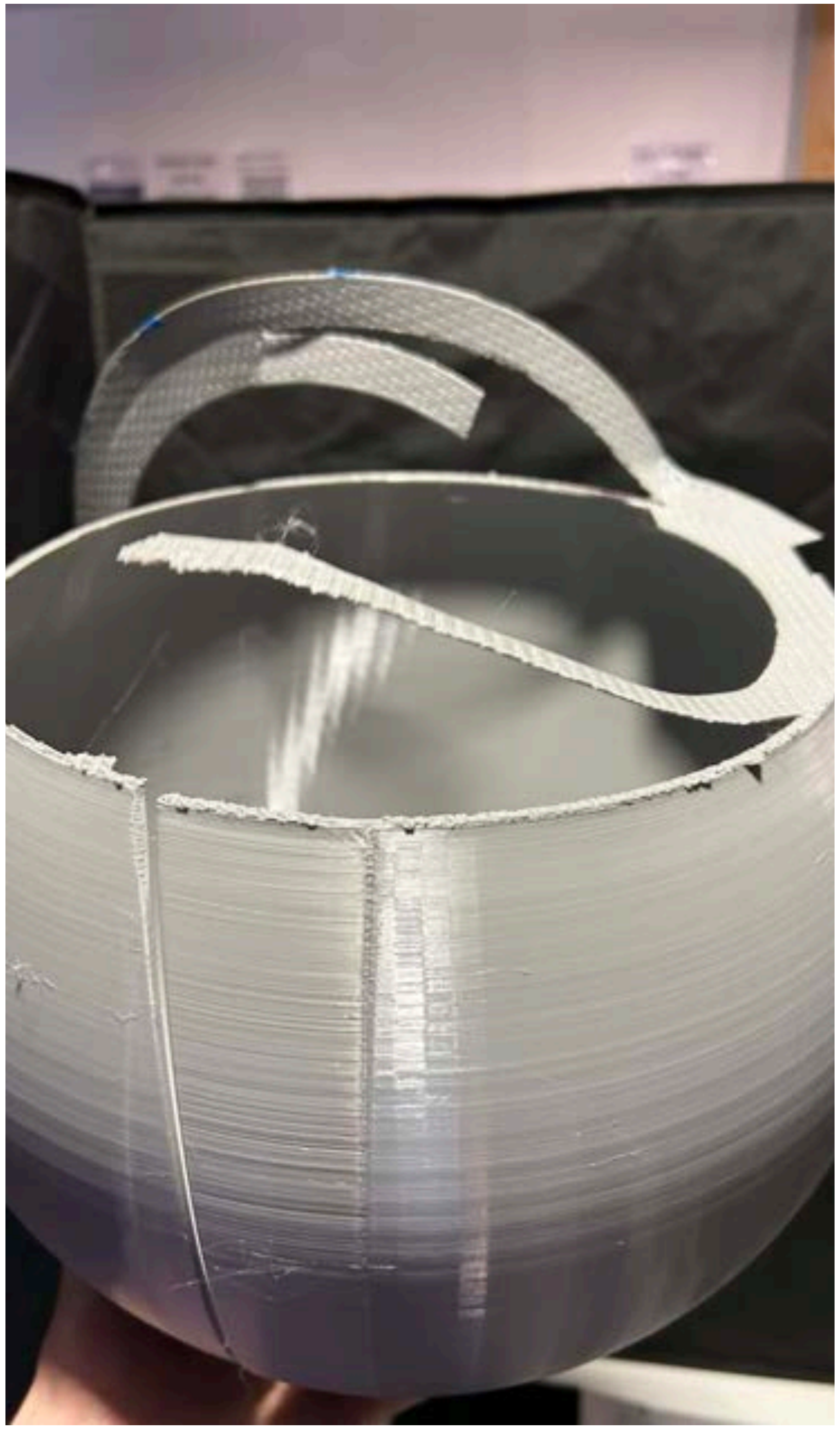


Testing.

This shows the large sphere after printing. Due to the increased size, the raft at the bottom of the sphere was so much more difficult to remove. It also split and left some very sharp edges. This is only a minor problem and can easily be fixed, but overall I think it loses some of its silky appearance when printed on this scale.







Brushed Black

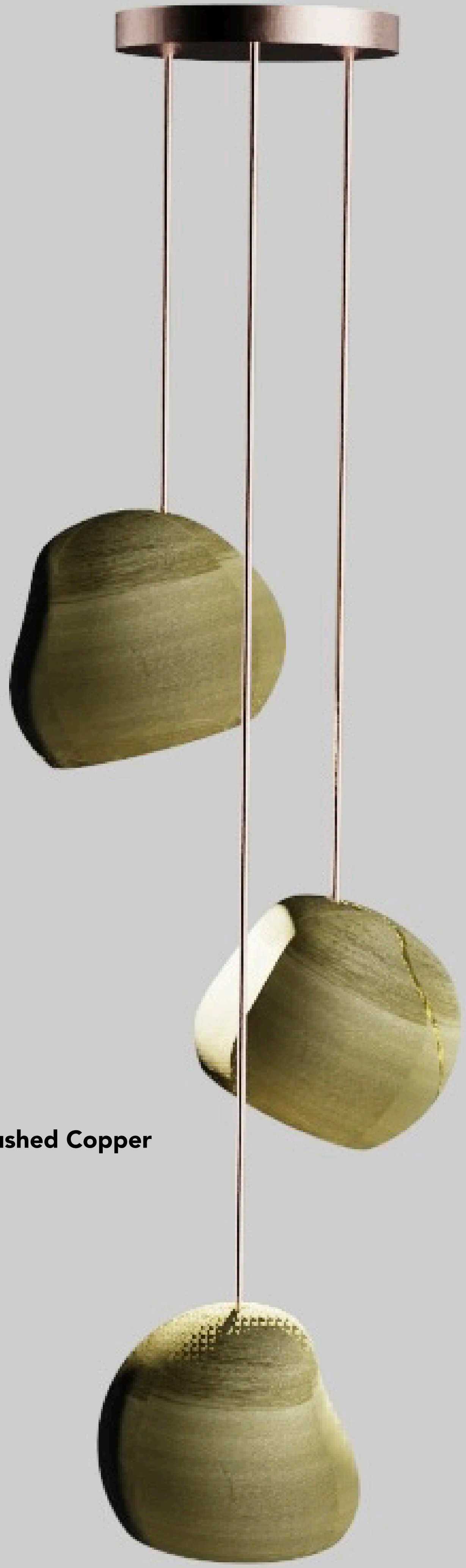
Matte White

Here I used Keyshot to test what metal ceiling roses with different finishes would look like. I modelled the ceiling rose on the one I have ordered for my light, so that all the dimensions are accurate.

The finish I have decided to go with is a brushed black metal. I have chosen this, as I don't believe the fitting should be shiny, due to the spheres being matte. Additionally, the spheres should be the focal point of the design, as the light is supposed to advertise the material and the 3D printing process. Therefore, the light fitting should be subtle and recede. This gave me a choice of either black or white, but I believe white looks to plasticy and black suits the material better.

Finishes.

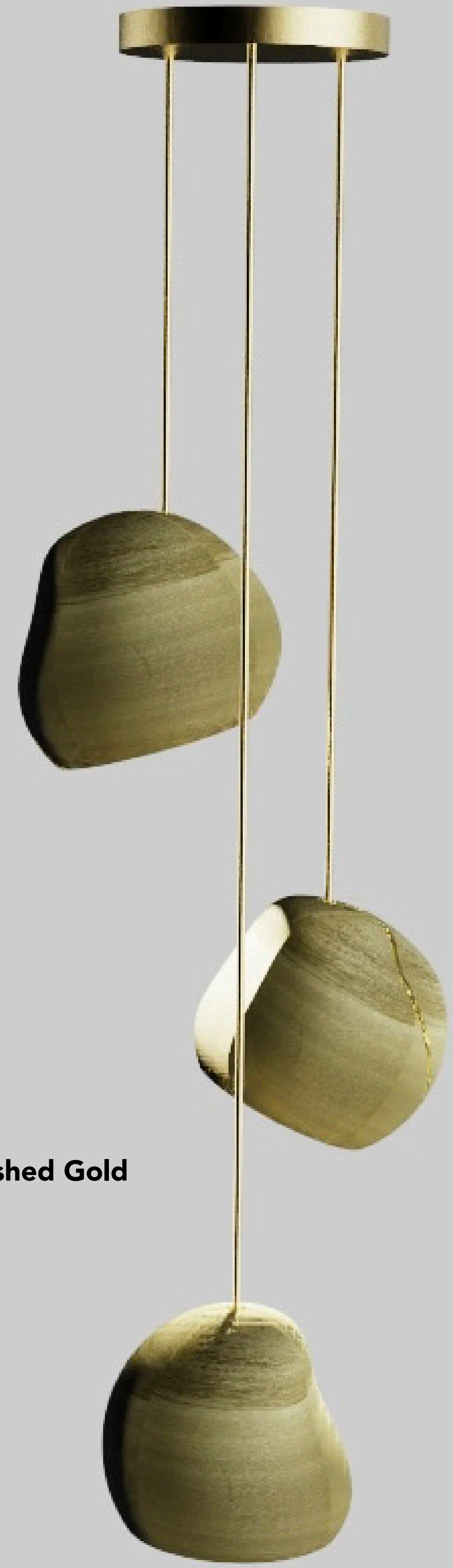
Polished Bronze



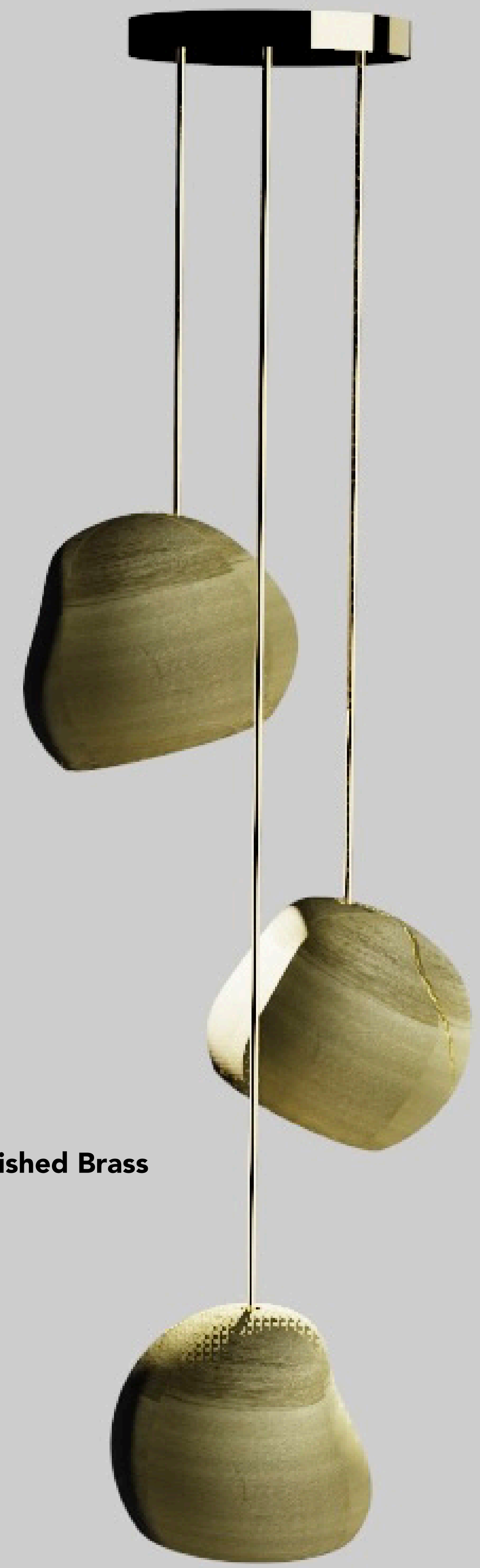
Brushed Copper

Here I tested some more finishes. Whilst I do like the other finishes, I think that the colours potentially retract from the rest of the light, unlike the black which recedes into the background and is less noticeable. However, potentially the ceiling rose could be available in different finishes for the customer to choose from.

Chrome



Brushed Gold



Polished Brass

These are the final finishes I tested. I quite liked the chrome/silver finish, as although it is shiny, it is quite subtle compared to the bolder colours. However, I still believe the black is most suited to the design and that is what I will be going forward with.

Renders.

The following pages are the first renders of my final design for the pendant light. Seeing as CAD is normally one of my weaknesses, I was fairly pleased with how they turned out. I believe they communicate the design well and the material looks realistic and accurate to how it looks in person. I have shown the light in various states, such as on, off, in darkness, in daylight and some examples of the light in situ.

Time Management.

In Week 12, whilst it may look as if I didn't complete a large quantity of work, it was actually a very productive week. I had quite a lot of catching up on annotating and organising my process document, all of which I completed during this week. Additionally, I took my light home and successfully wired it into the 3 way light fitting, which was a big task for me, as I had never done something like this before. Finally, I connected it into my ceiling at home and took some nice photos on Sunday, which I will upload into my process document over the remaining weeks. Overall, I was pleased with what I achieved this week, even though my process document doesn't appear to have progressed much since the previous week.

Week 12

03.04.23

To Do List

- Start designing range ✗ – Convert idea into floor / wall / desk light
- process doc ✓
- Email Notpla ✓
- Order cable ✓
- wire light ✓

To Attend

Home – Wednesday - Tuesday } Easter Holiday

Wiring.

In order to test out my light, I had to wire the cables into the ceiling rose. This involved a few steps. Firstly, the bulb holders I was using were connected to a plug and switch, so the wire needed cutting, stripping back and threaded through the 3 way ceiling rose. I then wired this into an existing ceiling fitting in my dining room at home, so that I could hang it up and take photos. Although it was fairly simple to do, wiring and electronics is something I have never done before, so it was interesting to learn a new skill and better understand how it works.

Wiring.

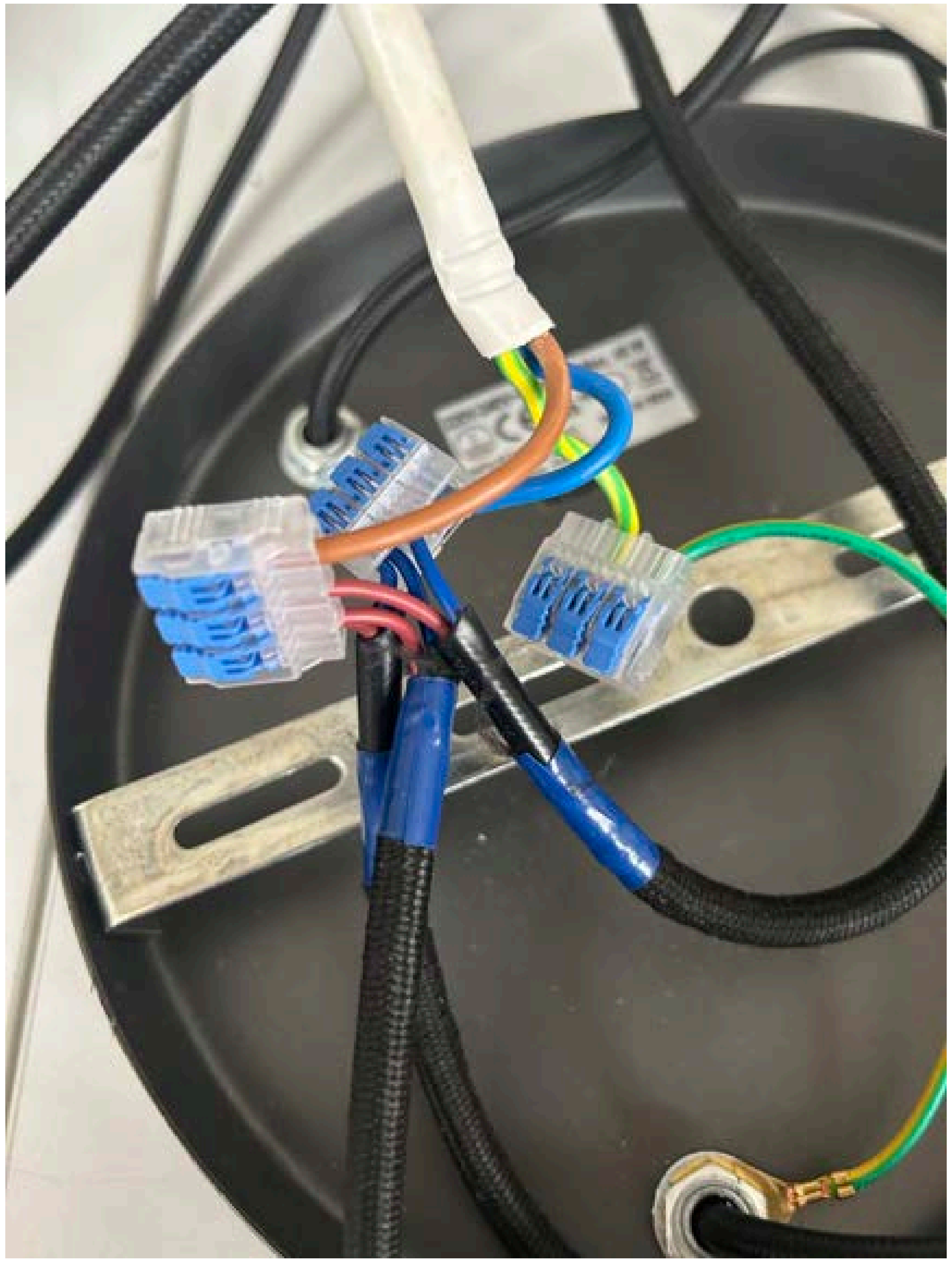
Next I attached the wiring into the rose and then screwed the 3 way ceiling rose into the ceiling. The great thing about this ceiling rose is that the extra wire can sit inside it, so I did not have to cut the wire to the perfect hanging length. This also means that the hanging length can be adjusted, simply by unscrewing part of the fitting.

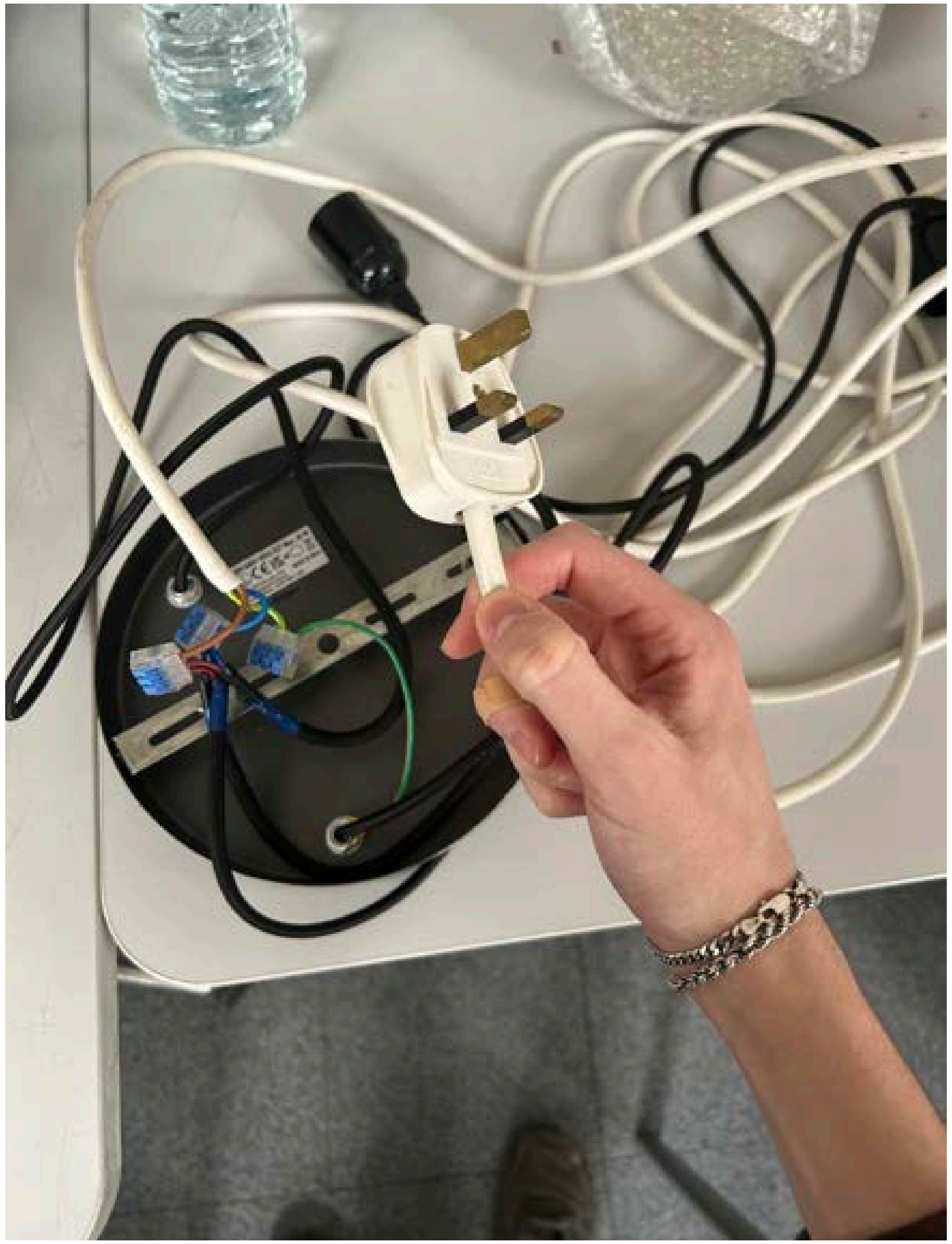
Changes?.

Here I experimented with a slight adjustment to the design. I thought it could perhaps improve the aesthetics of the design if the slit opened up towards the bottom and wasn't an even width all the way along. I placed a small piece of plastic to act as a spacer, just to test the appearance. Whilst I quite liked the new look with the widening slit, it made me question the practicality of it. Either I could use a spacer to hold the slit open, or I could reprint the spheres with a widening split. However, both of these options offer problems. Firstly a spacer would interupt the way the light glows from the slit and could look messy. Secondly, if I printed the spheres with a wider slit, they would lose some structure and the gap would naturally close itself, meaning the slit wouldn't be a different size all the way down and would look the same as it did before, but weaker and with less structure. Therefore I have decided to keep the slits as they are.




Wiring Into Plug.





After connecting the light into my ceiling at home to take photos, I unwired it and rewired it into a long plug. This is due to the fact that when I present my product at the degree show and in my presentation, I won't be able to wire it into a ceiling, so will need to hang it from a rig and plug it into a socket nearby. To wire into the plug, had to connect all 3 leads from the hanging shades and connect them together using the small plastic junctions/cable terminals. These joined the 3 wires together along with the wires inside the plug

Time Management.

In Week 13, I completed the full design of my range, which I was very pleased with. It took a lot less time than initially expected, but I think this was due to the fact that I had developed my original desing so muc, it was then just a case of transferring the concept over into different types of light. I managed my time well this week and achieved mostly everything I set out to do. Ideally I would liked to have completed more of my conclusions pages, so that I could spend the entirety of the final week on the presentation, however I still have the time to do these.

WEEK 13

10.04.23

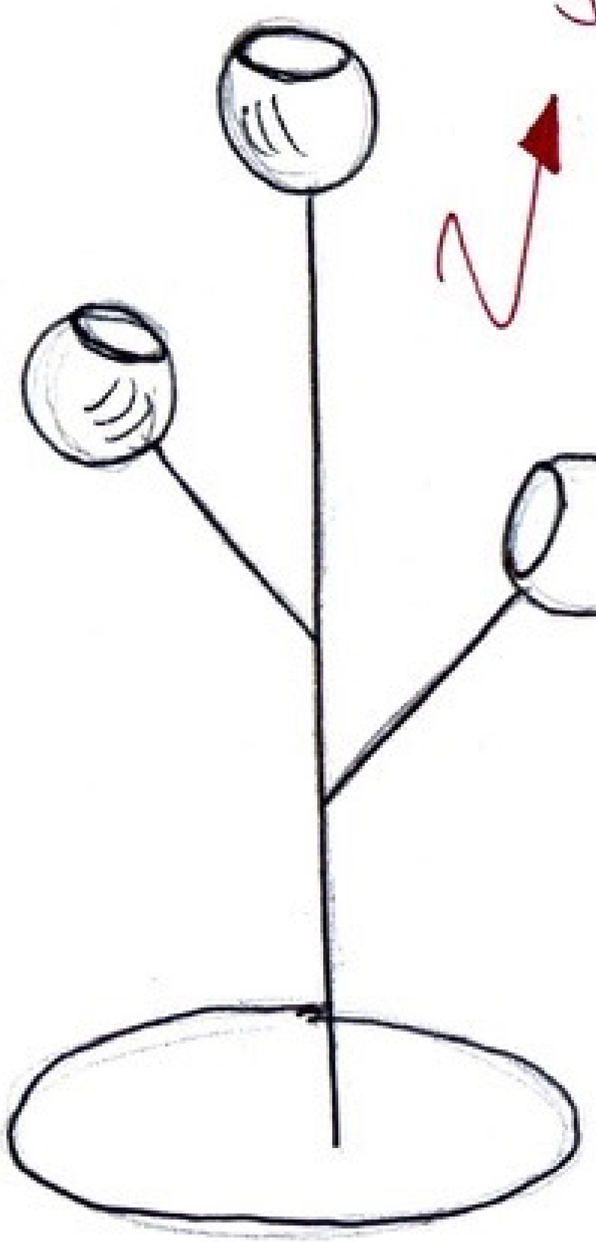
To Do List

- Start designing range – Convert idea into floor / wall / desk light ✓
- Upload photos of light at home ✓
- Castings ✓
- Conclusion Pages ✗
- Interview pages ✓

To Attend

Back in Notts – Tuesday } Easter Holiday

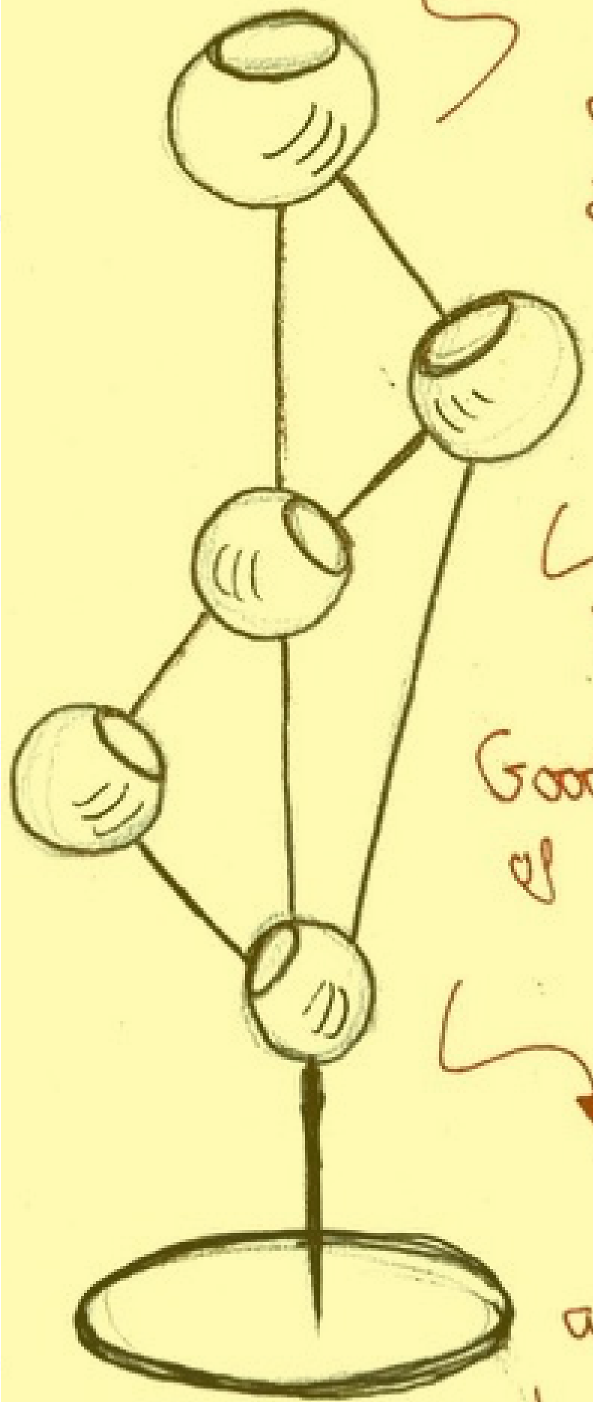
Range Design.



Just 3 spheres looks too bare

Stand too large for such small spheres

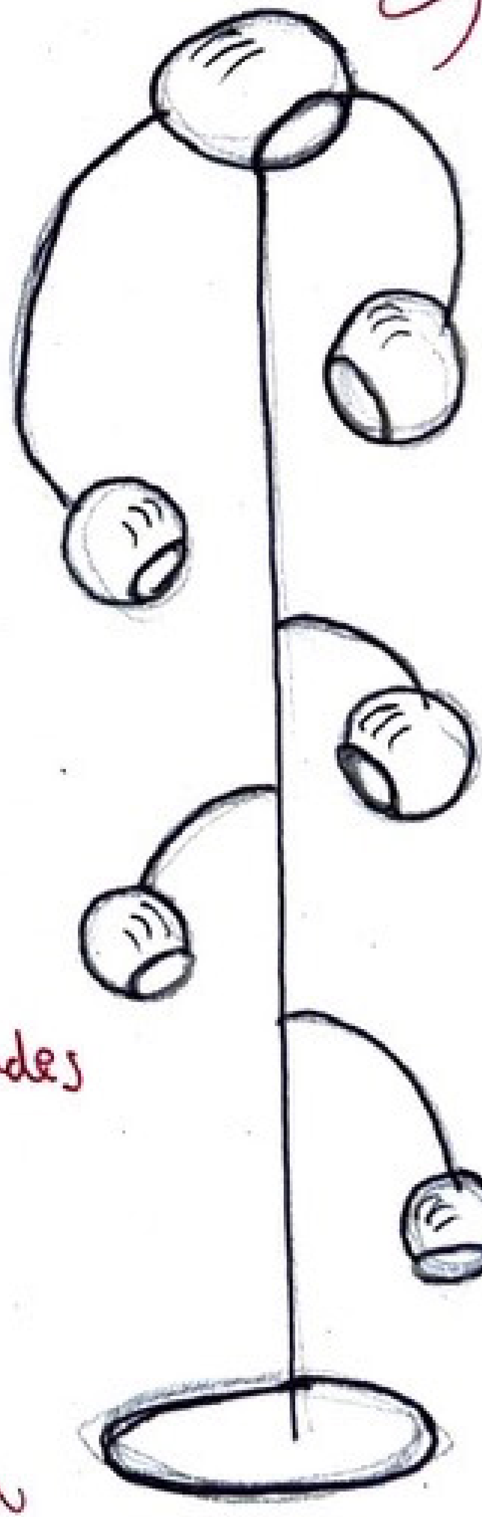
Shades are angled to shine onto exterior of each other



Reflects other design, but in reverse

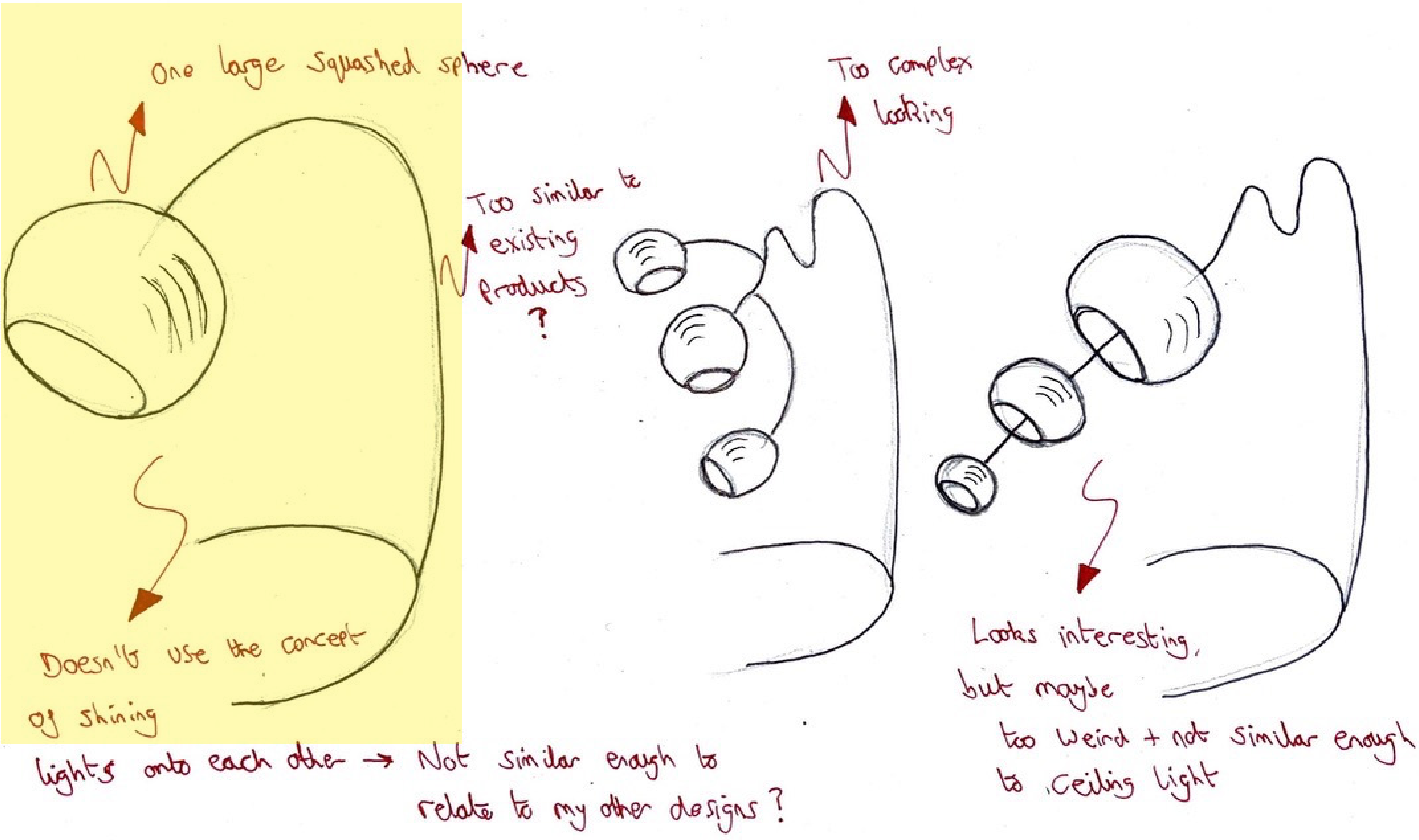
Good ratio of stand : shades

I like the asymmetrical layout → Reflects the asymmetry of squashed spheres



Too tall + looks lanky

Range Design.

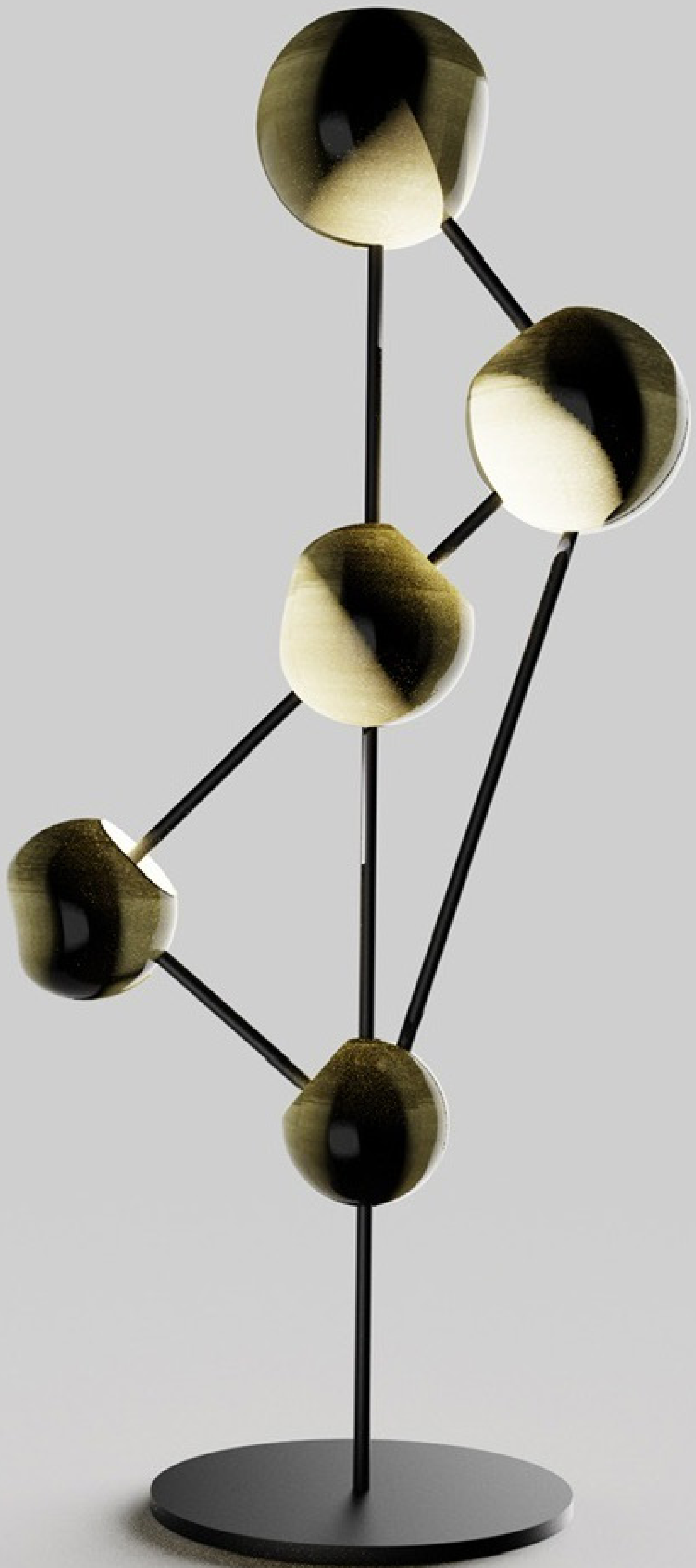


Floor Lamp.

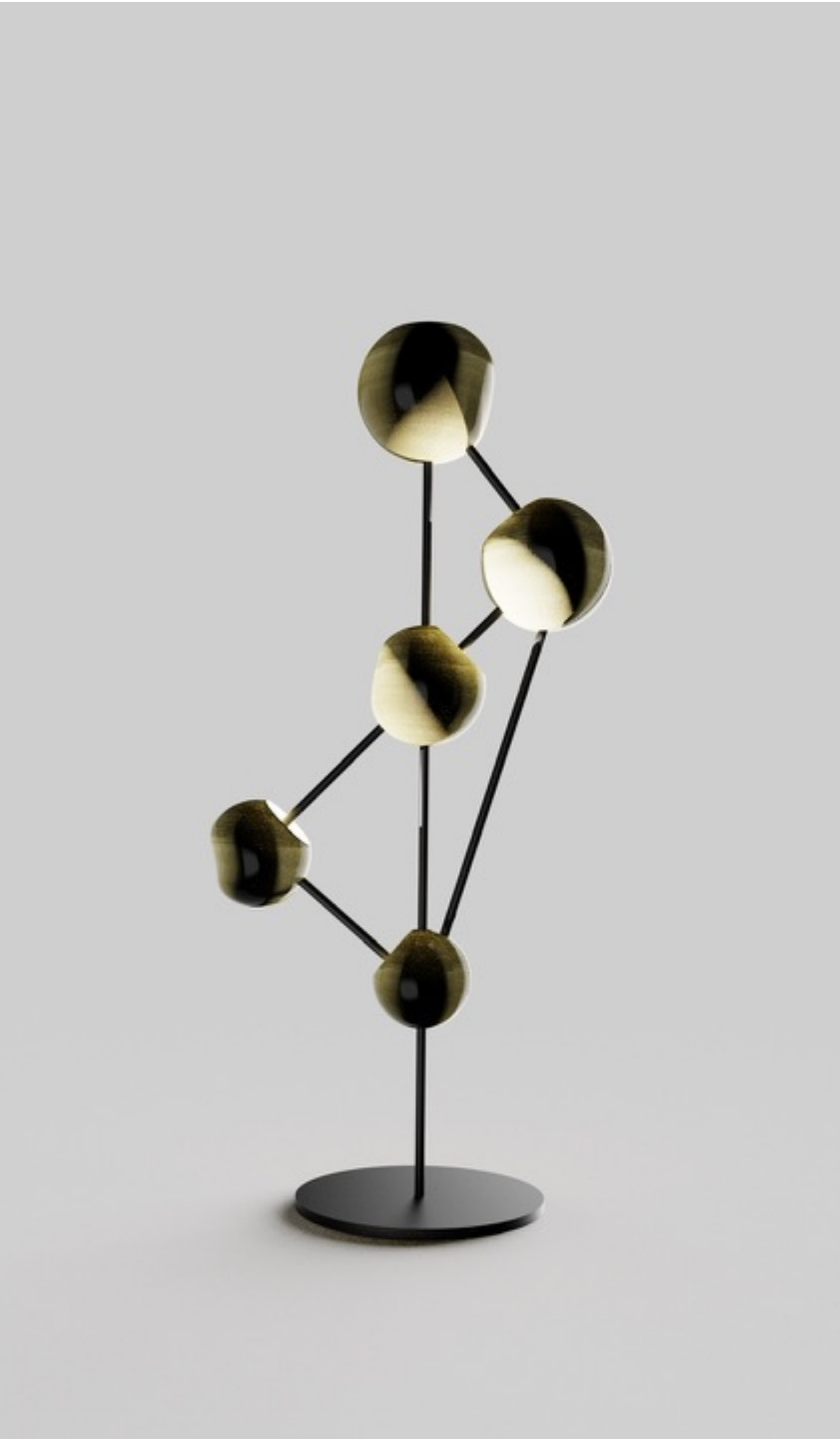
At the beginning of the project, I stated that I wanted to design a range. Whilst I have left it quite late to design this, I still wanted to include some CAD renders of potential avenues for a range of algae-based lighting. These designs are not fully developed, but purely suggestions of how my original design could be converted into both a floor lamp and desk lamp.

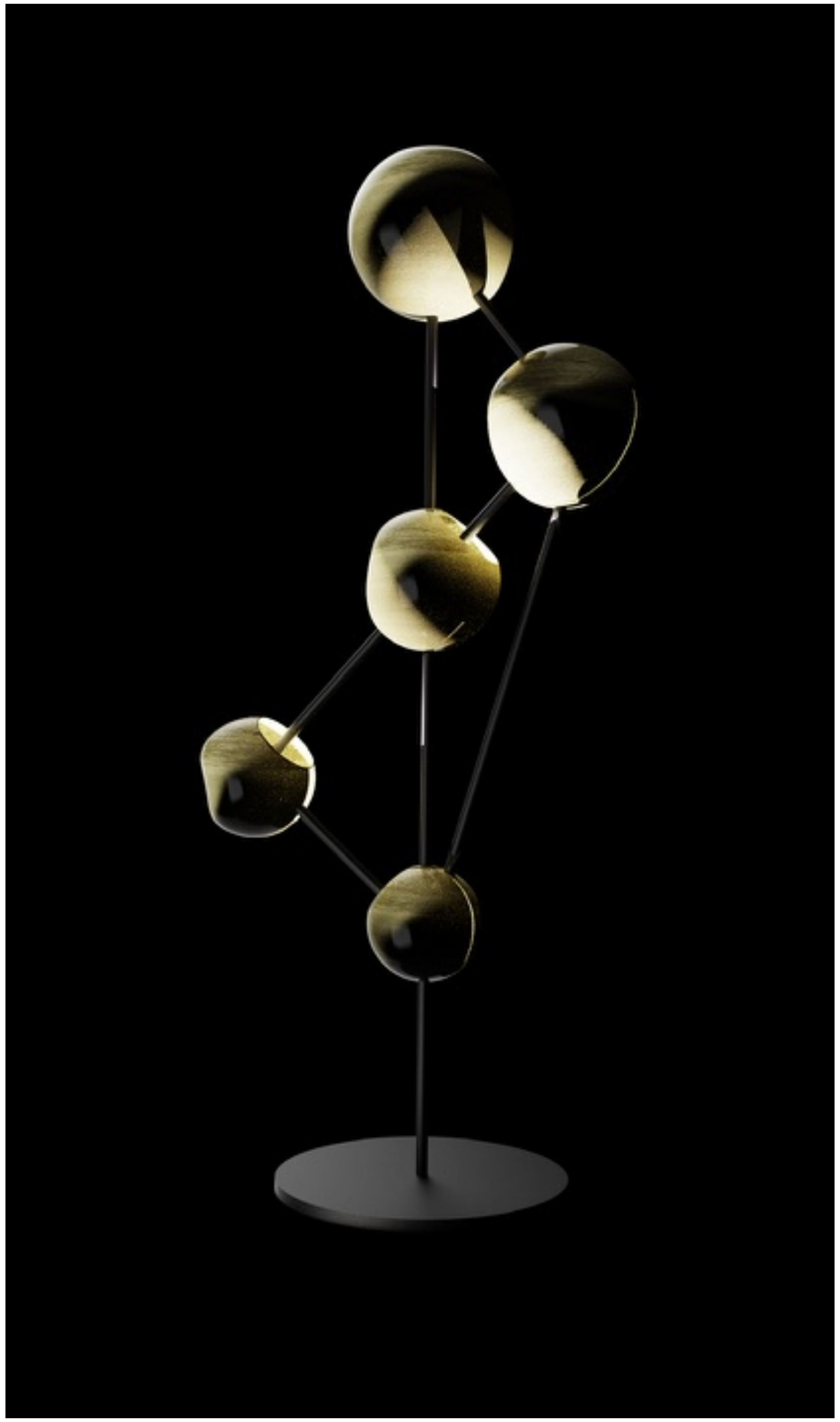
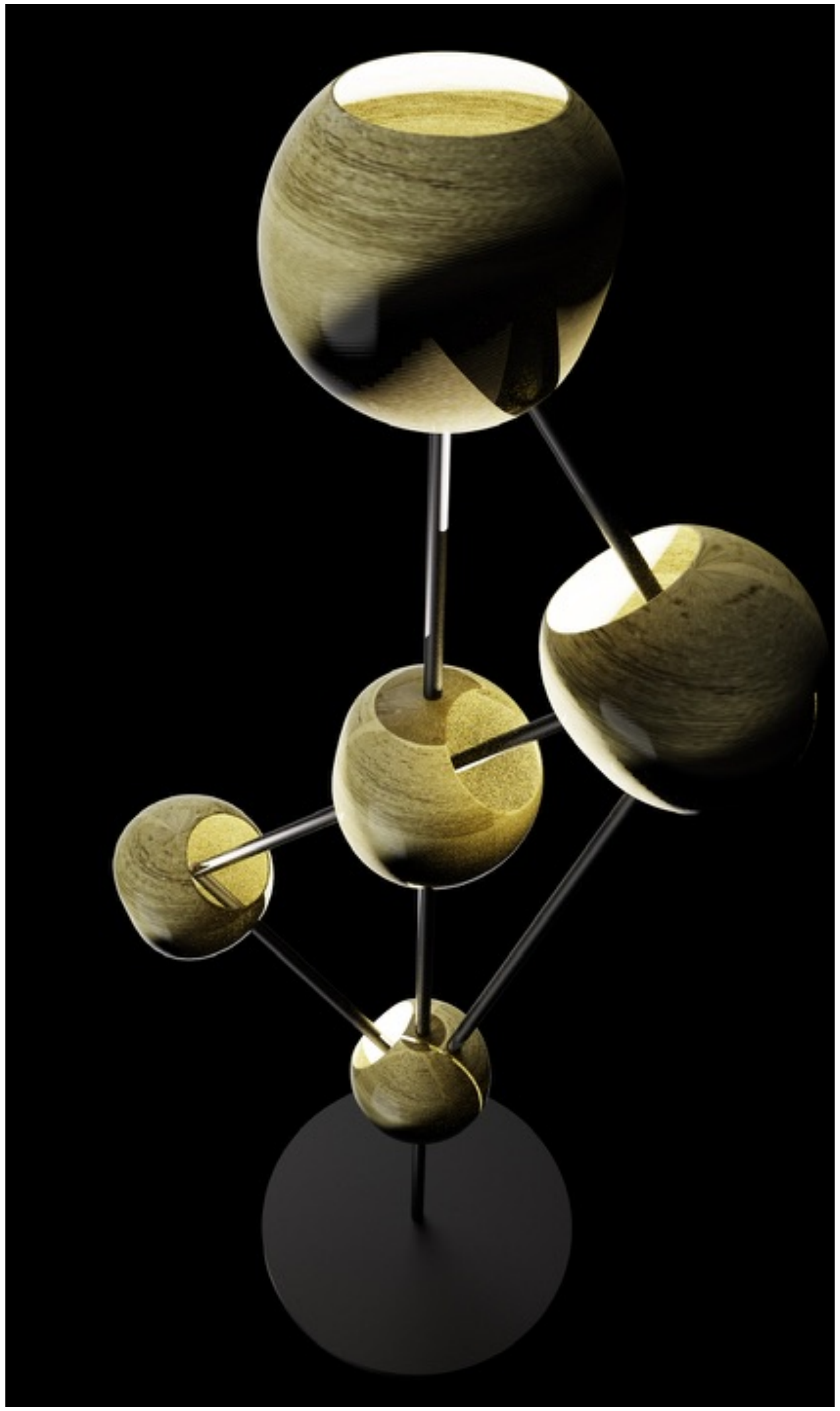
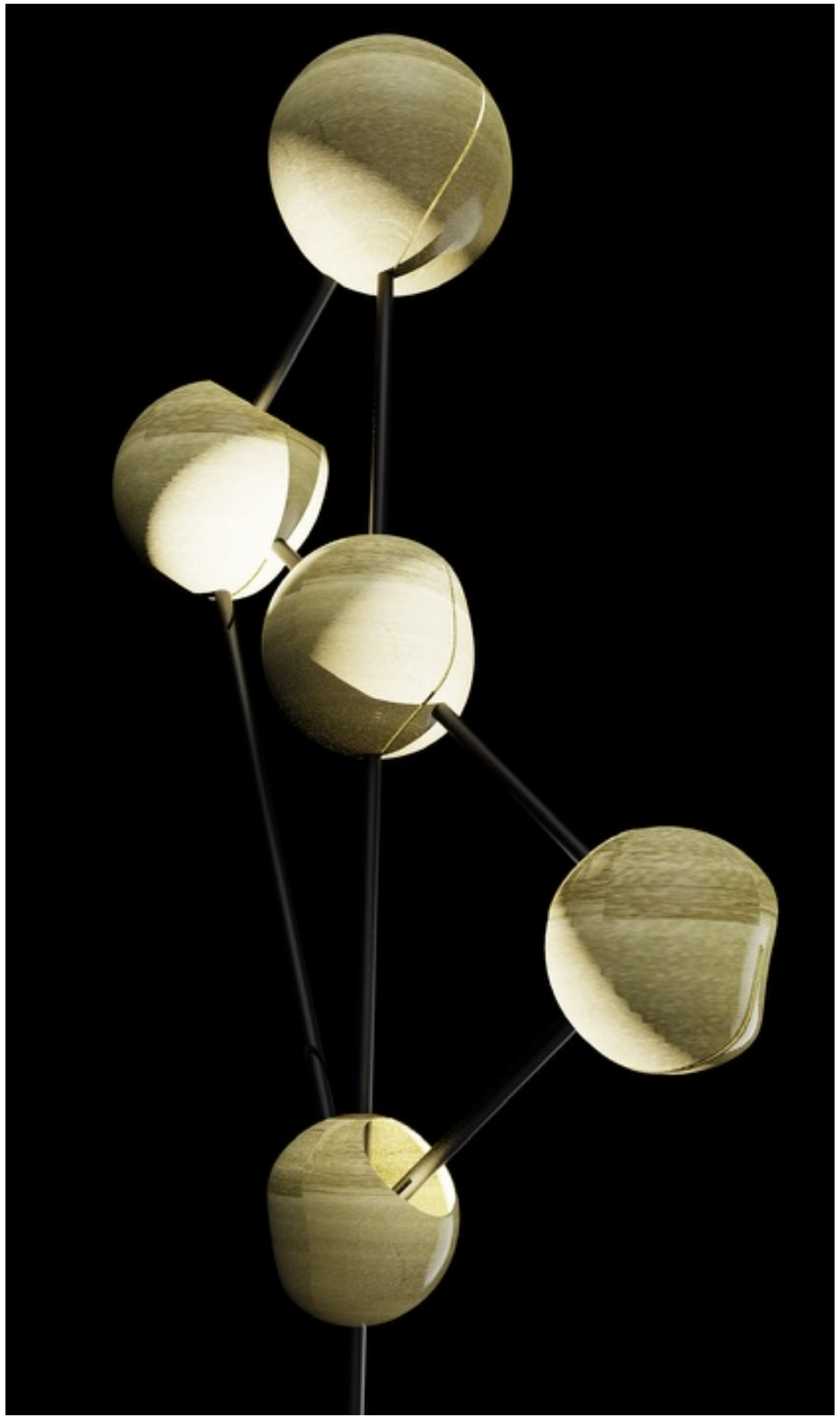
Here is an example of a potential floor lamp. As you can see, the concept of the lights shining onto the exterior of each shade is carried over from the main design. Each shade is connected via metal poles, with wiring inside. They each contain a spotlight bulb and are angled towards each other to shine light onto the surface of each sphere.

The idea of squashed spheres to represent the cell structure of algae has also been carried over from the main design, along with the slits to allow light out.



Floor Lamp.



Floor Lamp.

Desk Lamp.

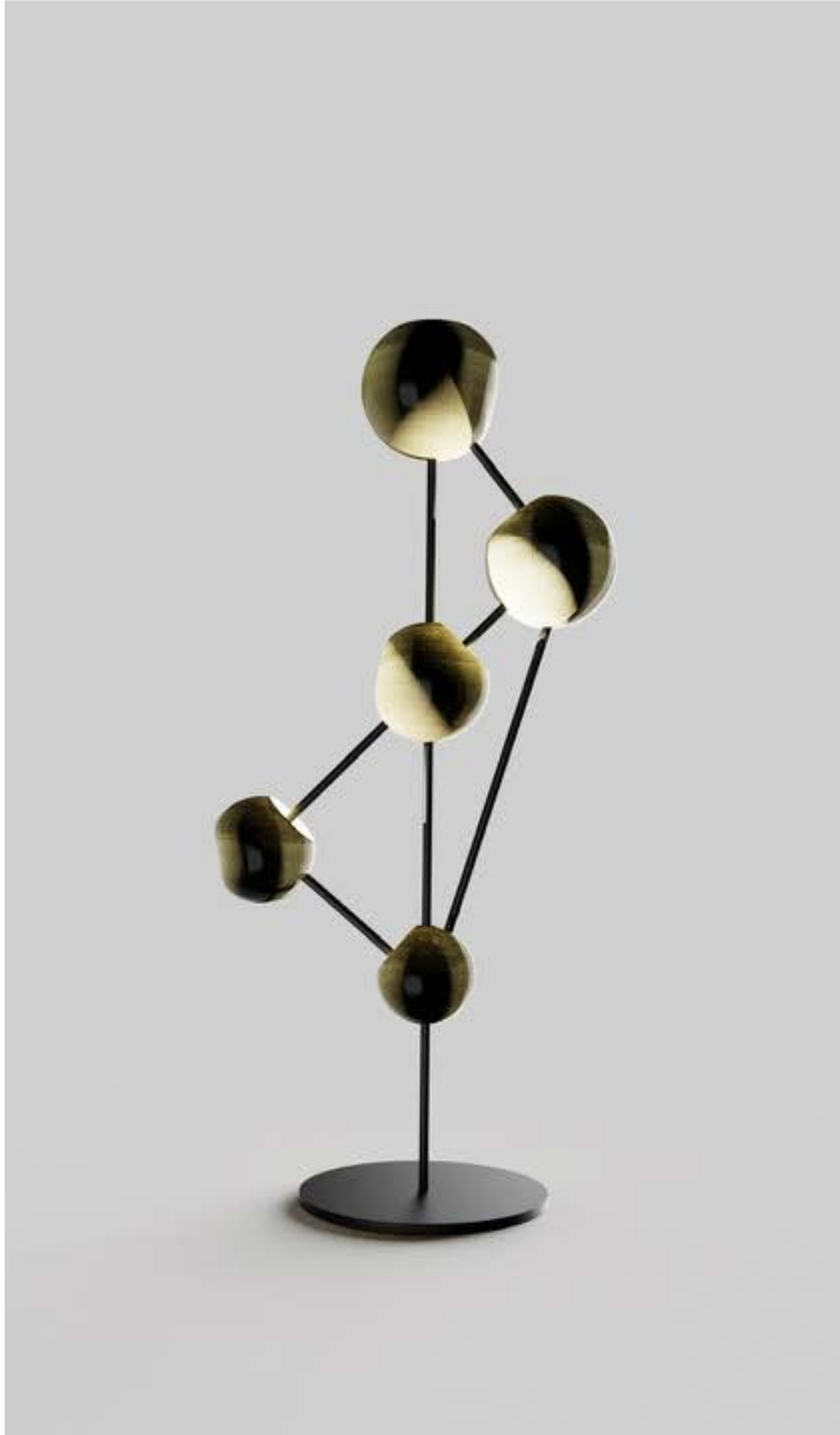
This is my design of a desk lamp for my range of 3D printed algae-based lighting. I kept this design very simple and selected just one of the spheres to act as a shade. This shape sphere was my personal favourite and also everyone else I showed the spheres to said this was the best shape.

Whilst this design doesn't carry over the concept of light shining onto the exterior of the shades, this idea would not have been effective for a desk light, as you need a direct source of light for task lighting, which this design provides. It still fits in with the other designs, by using the squashed spherical shapes to represent the cell structure of the algae. Additionally the curved, bent stem matches with the smooth curves of the shade.



Desk Lamp.

Desk Lamp.



Full Range.

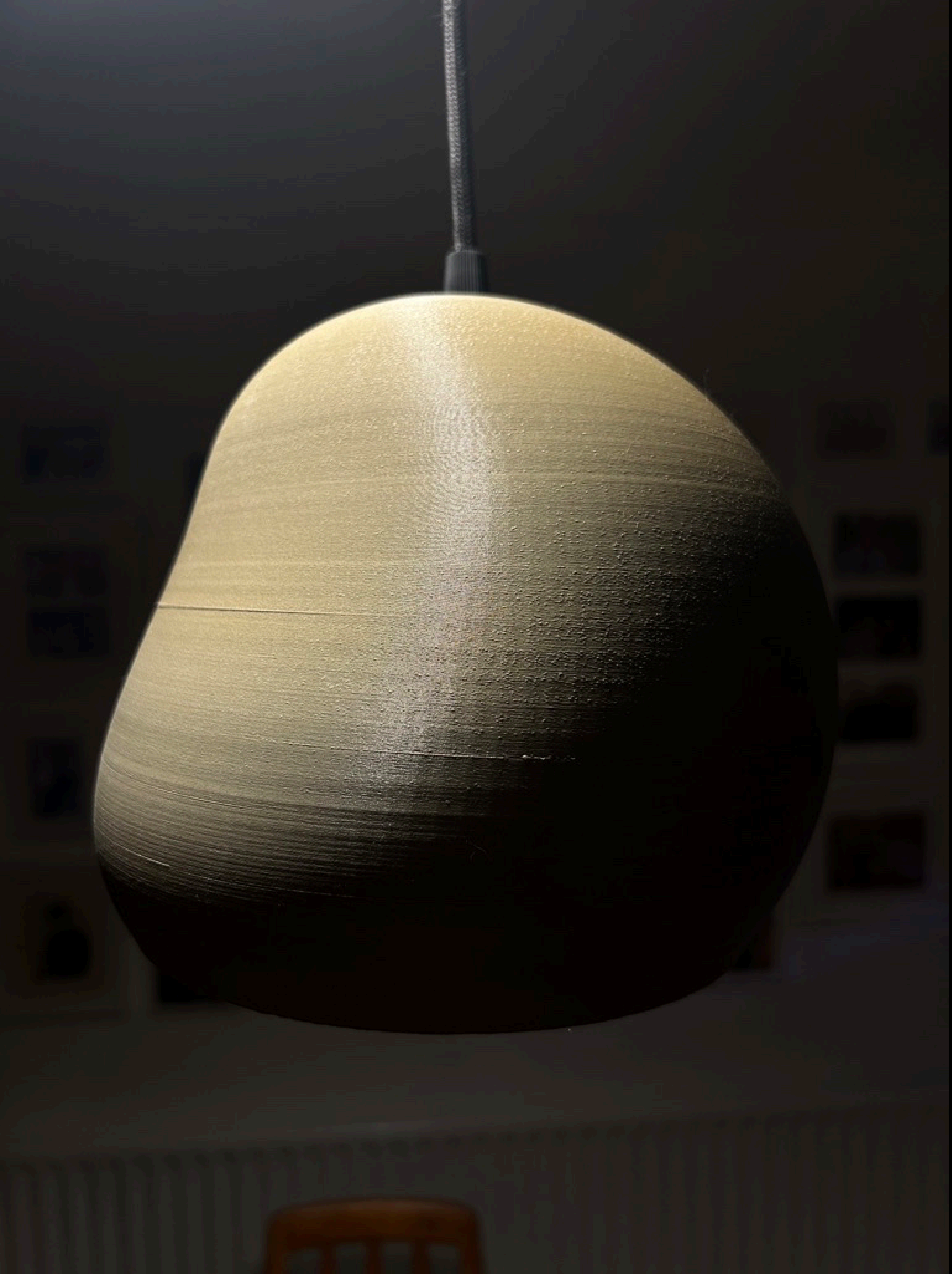
Final Design Photos.

Photos.

Photos.

Photos.

Photos.



Photos.

Photos.

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Photos.

Photos.




The light switch I used at home was dimmable, so this shows the varying levels of light as it dims. I love the way the shadows on the surface of the lights become more prominent as it darkens.

Studio Shots.

Studio.

Studio.

Studio.

Studio.

Studio.

Studio.

Costing.
Personal

Here I calculated how much it would take for me to personally design and make 1 light. I considered material and part costs, along with the time it would take for me to operate the 3D printers (starting and stopping prints etc) and the processing. I also included a designing fee at minimum wage. This is a very rough estimate of the cost. I actually spent a lot more on materials throughout the project for various tests, models and experiments, however this has not been included in the costing. This just shows the cost of one light. Additionally, the designer fee would only be a one off fee.

MATERIALS:

Algae-Based PLA - £40 per kg - 675g needed **= £27** (Each shade requires around 225g of filament)
Metal Ceiling Rose - Standard Component **= £12** (I purchased this rather than making it. Would be much cheaper to make)
Cable = £10
Bulbs = £15
Plug = £2
Choc Block = £1.50
Total Cost = £67.50

MANUFACTURE:

Designing - 10 Weeks at minimum wage (£9.18 per hour for 21-22 year olds) **= £3672**
Putting 3D prints on/taking them off - 2hrs = **£18.36**
Light Sanding - 30 mins **= £4.59**
Wiring - 1hr **= £9.18**
Total Cost = £3704.13

Total cost for me to make and design 1 light = £3771.63

Costing.
Industry

<u>**MATERIALS:**</u>

Algae-Based PLA - £40 per kg - 675g needed **= £27** (Each shade requires around 225g of filament)
Aluminium Ceiling Rose - £0.55 per kg **= £1.10**
Cable - £70 per 100m **= £2.10**
Bulbs - £2 per bulb **= £6**
Choc Block = £0.80
Total Cost = £37

MANUFACTURE:

Running 3D Printer - 36hrs at £0.28 per hour in energy cost = **£10.08**

(some unskilled workers earn as little as £0.30 per hour. This has been calculated for a worker on £2 per hour)

Light Sanding - 10 mins **= £0.33**
Manufacturing Ceiling Rose = £2
Wiring - 30 mins **= £1**
Total Cost = £13.41

Total cost for 1 light to be made in industry = £50.41
Wholesale price = Manufacture + 50% = £50.41 + 50% = £75.61
UK Retailers mark up between x2.2-2.7 = £75.61 x 2.2 = £166.35

Here I calculated the cost of making my product in inudstry. Again this is very rough, as I don't know the exact cost of running machines etc, however I researched average pricing of running a 3D printer and concluded with this price. The material costs are quite high here, as I could not find any wholesale pricing for the algae-based PLA, so I worked out the pricing using the price that it is sold for. It would likely be a lot cheaper than this if I was to source it directly, therefore this cost is probably far too high. I worked out it should cost around £50 to manufacture and therefore sell for around £166.

However, I believe this is slightly too high due to the material cost and therfore I will price my light at around £120

FINAL COST = £120

Costing.

Justification

I have priced my light at £120. Whilst this intially may seem relatively cheap for the type of product that it is, there are a number of reasons for this lower cost.

1. The material is relatively cheap compared to other materials used in lighting, such as metal, glass etc.

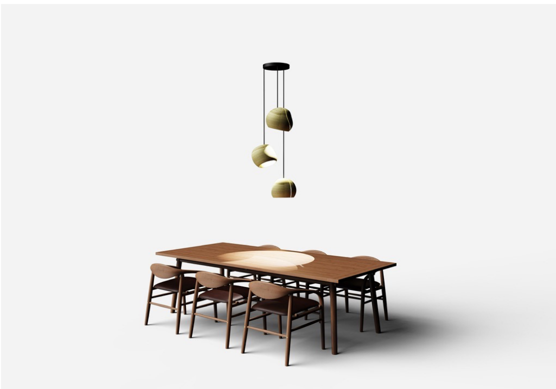
2. The processing of the material is very cheap. Running a 3D printer isn't as expensive as other machines traditionally used in industry. Algae-based PLA also prints at a lower temperature than regular 3D printing plastic, making it more energy efficient and therefore less costly. Glass and metal require extremely high temperatures to process

3. 3D printing eliminates transport costs. Using 3D printing means that it can be done anywhere in the world and doesn't have to be made in China in order to make it cheap. This means that the product can be printed locally, hugely reducing the need for big shipping and transport costs.

4. I don't want to price people out of a sustainable product. Lots of sustainable designer products are often more expensive than their unsustainable counterparts. Therefore people of lower income may not always be able to afford to make sustainable product choices. I want this product to be affordable to the majority, to allow people of all different levels of income to make sustainable choices and enjoy a designer product. A product made from algae is a talking point and will get people talking about the material and therefore sustainability. If its affordable, it will appear in more homes, encouraging more conversations on sustainability.

Marketing.

The following pages show some marketing of my product. I have chosen the shop I would like to sell my product in and suggested the reasons why. I have also added my photo onto some website screenshots to show how it could look on the market.



Sam Bird Smith

Phyto

Hanging pendant light made from 3D printed algae-based bioplastic

£120.00

2 year guarantee included

Free standard delivery

View delivery options

View product description

Colour: Black

Copper Black Silver Gold

Quantity — 1 +

Colour: Black

£120.00

Standard UK delivery within 10 days

Add to your basket

Spring Offers Now On | Up to 20% Off Our New Collections

BARKER AND STONEHOUSE

Shop Explore

Sofas Chairs Tables Bedroom Garden Storage Accessories Shop by Room Brands New In Clearance

Home > Accessories > Lighting > Ceiling Lights

Ceiling Lights

Bring light to any room with our collection of beautiful ceiling lights, from contemporary copper and metal to traditional and elegant glass, crystal, and more. Find the perfect match for your home... >

Colour | Stock Status | Item Status | Material | Brand | More Filters | 88 Products | Sort by

Marketing.

I would like my product to be sold at Barket and Stonehouse. The reasons for this are:

- The market position is similar to where I want my product to sit - not too expensive, but not too cheap either

- They are an environmentally conscious company

- They have recently been certified as carbon neutral

- Plant a tree for every delivery

- Sustainable stores

- Eco-friendly transport for deliveries

This shows that the company has sustainability at the core of its values. My product is made from sustainable materials and so would fit well within the company and I want it to be sold somewhere that is environmentally conscious.

Marketing.

Another reason I would like my product to be sold at Barker and Stonehouse is due to the fact that they stock a 'Conscious Collection'. This collection consists of a number of environmentally friendly furniture items. These range from reclaimed furniture to 100% recyclable sofas and products made from recycled plastic. This shows that they are open to selling sustainable products made from unconventional materials and thereforemy product would fit perfectly into this collection.

Marketing.

Whilst I would like my product to be sold at Barker and Stonehouse, I would still like it to have its own identity. This is the logo I have designed for my product. The overall shape is a squashed circle, to represent the shape of my light and also the cell structure of algae. The background also consists of green clusters, again to represent what algae looks like under a microscope. Finally the name sits in the middle in white writing.

BARKER AND STONEHOUSE

x

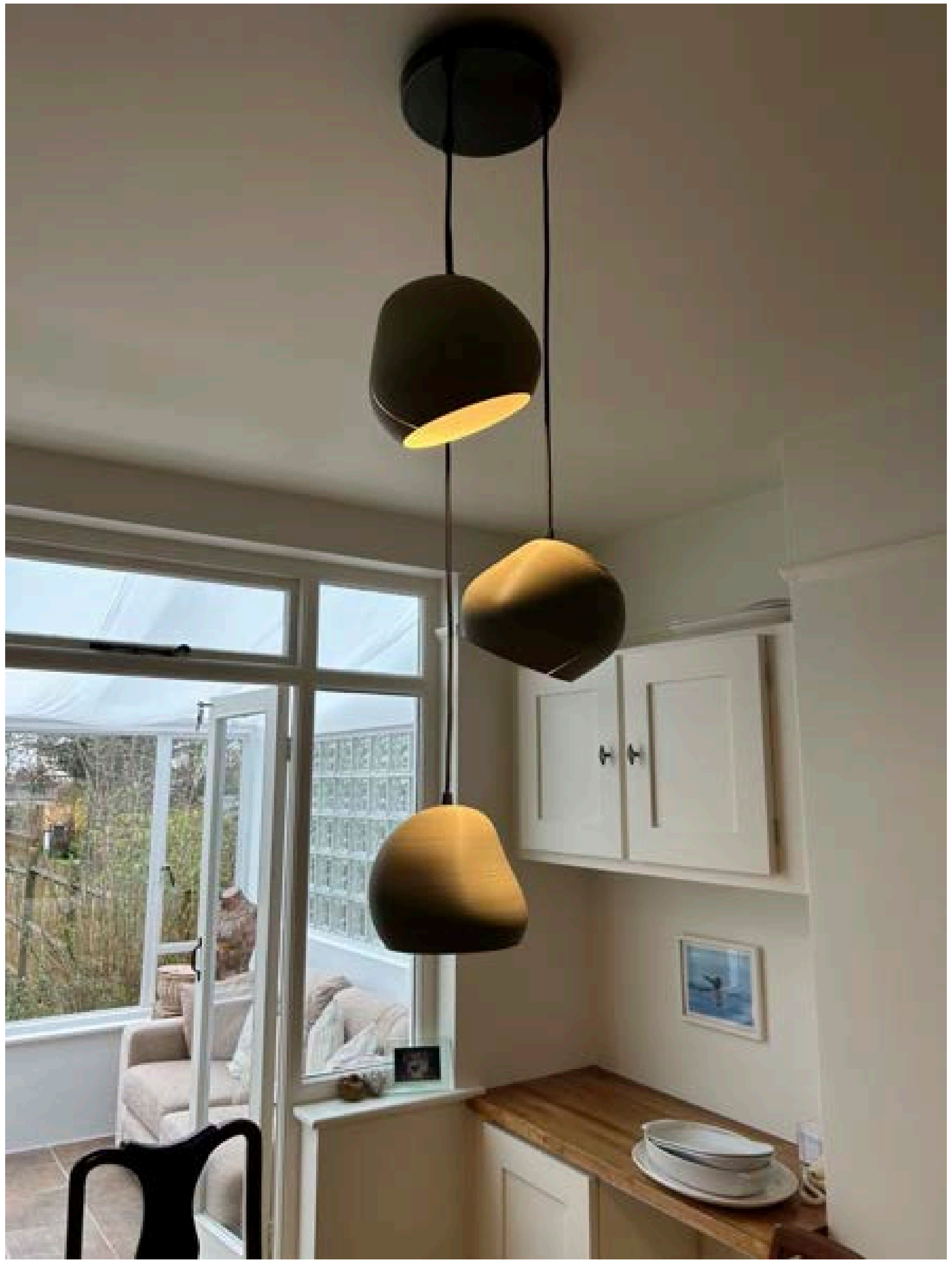
Phyto

Final Design Explained.

This is Phyto.
Phyto is a hanging pendant light, made from 3D printed algae-based bioplastic. This is a more sustainable alternative compared to synthetic plastic and even other bioplastics, such as regular PLA used in 3D printing.

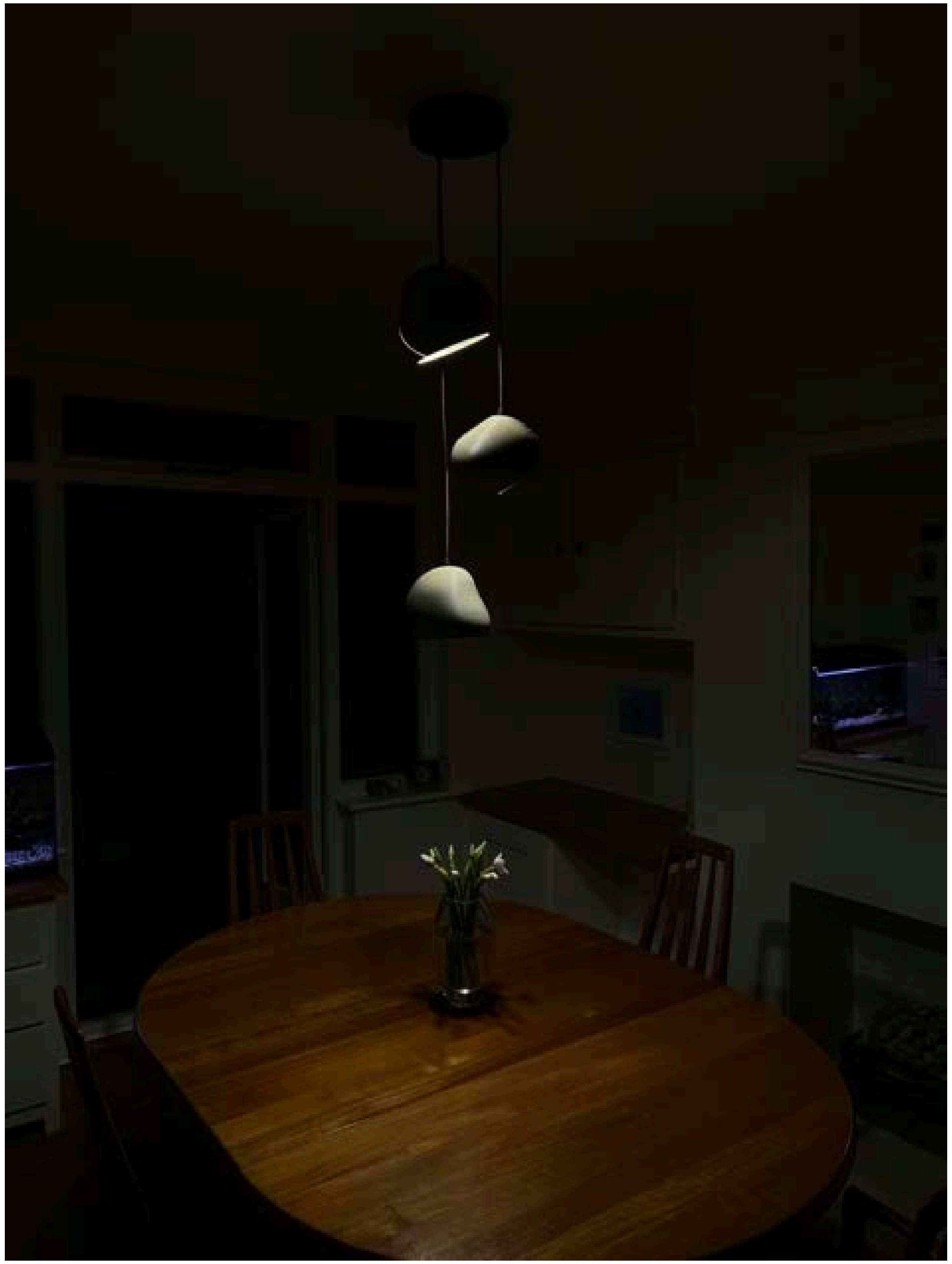
The shapes of the light are inspired by the appearance of algae under a microscope to pay homage to the origin of the material. The squashed spheres represent the cell structure of types of microalgae, which appear in slightly uneven circular clusters. The uneven forms lend themselves perfectly to 3D printed and would be difficult to achieve through other manufacturing methods, justifying the use of 3D printing. The natural colouring of the shades also helps to demonstrate where the material has come from.

I chose the name Phyto, as it is a shortening of the word ‘Phytoplankton’, which is a general term for microalgae - the algae which has been used in this material.



Final Design Explained.

The shades have been printed so that the hole in the top which the light fitting sits in, is off to one side. This means that the shades sit at an angle when hanging. They are angled towards each other, so that the spotlight bulb inside shines directly onto the curved surface of the closest shade. The material reflects the light nicely and creates lines which conform to the shape of the curved surface, accentuating the curve.



Due to the fact that a spotlight bulb is used rather than a regular bulb, the light source is far more narrow and directed. This results in the surface which the light is directed onto being completely illuminated, and the opposite side being completely in shadow. This creates an eclipse effect, as seen in this photo.

Final Design Explained.

Each sphere also has a curved slit cut out from the opposite side to the side that is illuminated. The split conforms to the curved surface of the sphere and breaks up the part that is in shadow. It adds a warm glow and allows small amount of light to escape. The slit also allows the shades to be taken on and off by sliding the hanging wire through the gap, therefore the shades are easy to replace, adjust the angle and replace the bulb.

Final Design Explained.

Phyto is also available as a range. This consists of a ceiling light, desk lamp and floor light and has the potential to be developed further. This could be wall lights and other variations of the existing 3 lights in the range. The most important thing is that the shapes and materials are consistent throughout the range. For lights with multiple shades, the concept of the shades being angled to shine onto each other should also be carried over.

Design Evolution.

This photo shows every single 3D print I completed for this project from start to finish. It begins in the front left corner, with the 1st print attempt and ends in the back right corner, with my final printed design. It also includes most of the failed prints I experienced. Seeing them like this shows clearly how the design evolved from the samples at the beginning, to the uniquely shaped end product. It also shows all the testing I did throughout the project.

Evolution.

Evolution.

Evaluation

Final Design Analysis.

PROS:

- Illuminates the room very well

- Creates a warm glow

- Pays homage to algae

- Justifies use of 3D printing

- Aesthetically pleasing forms and colours

- Would suit a wide range of interiors

CONS:

- There are imperfections on the surface of the shades. Whilst this is a good thing, as it shows how the product has been made and that the material is experimental, it would have been good to work out what level imperfections are acceptable.

- The hanging wires aren't completely straight

- The wires are a little thick and I would ideally like them to be thinner

How Does My Product Meet The Brief?

Sam Bird Smith

Self-Directed Project - BA Furniture and Product

This is a photo of the brief I made for myself at the start of the project. At the bottom of the page is my reframed brief I created later in the project. I believe my product has fulfilled the brief in the following ways:

- The light pays homage to the origin material, through the forms which represent the cell structure of algae and the cluster of spheres
- The unusual forms justify the use of 3D printing, as they would be difficult and expensive to create through other manufacturing methods
- I suggested ways in which the light could be developed into a range
- I explored in depth the environmental impacts of plastic, bioplastics, algae and 3D printing and through this research justified why I am using this material and process

Areas I could've considered in more detail:

- The light fitting/ceiling rose - the material for this wasn't explored in much detail, however this is due to the fact that I wanted the light to be the main feature, not the connection. I also used a universal connection meaning people could theoretically wire the light into any fitting they have at home.
- The wiring - I used wiring which I believe could be nicer looking, straighter and thinner
- Perhaps I could've calculated the carbon footprint of my light and compared it to similar products, however this would've been very difficult to achieve

Design a pendant ceiling light to be made from 3D printed algae-based PLA. The light should justify the use of 3D printing as a manufacturing method and also pay homage to the origin of the material.

Brief.

3D-PRINTED ALGAE LIGHTING.

"A new bioplastic made from algae could replace oil-based plastic completely according to its inventors, potentially turning the manufacturing industry from a source of CO2 into a destroyer of the greenhouse gas."

"Dutch designers Eric Klarenbeek and Maartje Dros have developed a bioplastic made from algae. In the lab, the duo cultivate the living algae, which they then dry and process into a material that can be used to 3D print objects."

https://inhabitat.com/new-3d-printed-algae-could-revolutionize-the-way-we-make-things/

Research and explore the potential of algae-based bioplastics and how they can be used within the manufacturing method of 3D printing, as an ecological alternative to unsustainable materials used in the lighting design industry.

Consider the differences between algae-based bioplastics and regular plastics, analyse the current impacts of 3D printing and its future potential, appraise algae as a natural organism and its other uses.

How Does My Product Meet My Values?.

On the right is a screenshot of my value hierarchy that I created earlier in the project. It shows my values in order of importance. I believe my product meets my values in the following ways:

Honest - The design highlights the fact that it has been 3D printed using an experimental material. The lines from 3D printing are visible, however this adds to the aesthetic and texture of the surface. Additionally, there are imperfections, caused by the manufacturing process. These are on display and not hidden, adding to the honesty of the design.

Tribute - The light pays homage to the origin material, through the forms of the shades, which represent the cell structure of algae. Additiionally, the natural colouring also indicates what the material is made from.

Inducing - My project should hopefully induce conversations on sustainability. The light is a unique colour and shape and made from algae, which is an extremely unusual and interesting material, which will almost certainly create conversation surrounding the material and its origin and therefore sustainability. Furthermore, the low cost of the product means that it will be affordable for a large majority of people of different levels of income. This means that it will be more widely available and therefore more likely to appear in a larger number of homes, meaning more people will be talking about it.

Does It Meet My Specifications?

1. The use of 3D printing is justified through the choice of unusual, asymmetrical, spherical shapes which would be very difficult or expensive to achieve through other manufacturing methods.

2. It pays homage to the material by representing what algae looks like under a microscope through the forms used and the natural colouring.

3. It acts as an ambient light, as I have tested it as the main light in my dining room above a table and it successfully illuminated the whole room.

4. The spotlight bulbs I have used create a warm light, so it illuminates the room with a comforting warm light, rather than a cold, clinical blue-white light.

5. The light is affordable at just £120, making it available to a wider market range.

6. The shades of the lights are the focal point, as I made sure to pick an inconspicuous ceiling rose and hanging wires, so as not to draw away from the 3D printed algae shades.

Specifications.

1. Justify the use of 3D printing - shape of the light should be difficult to make through any other manufacturing method and lend itself to 3D printing.

2. Pay homage to the material - the light should act almost as a tribute to the material, by representing algae in some way.

3. Ambient light - my light should be an ambient light that hangs in the centre of a room, or above a table.

4. Warm light - the bulb should be a warm white colour, not a blue-white.

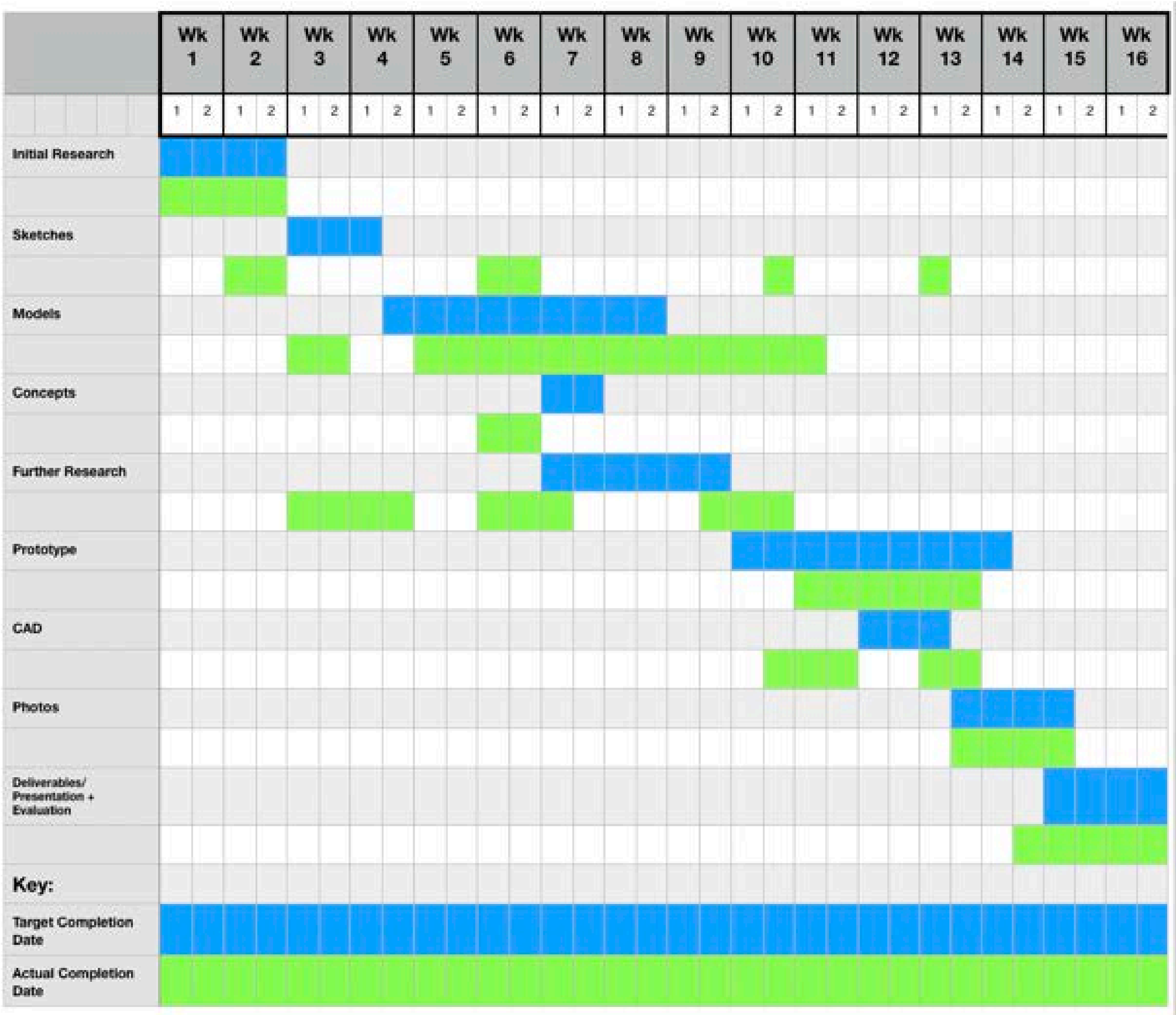
5. Affordable - shouldn't be too expensive, due to the cheap material being used and to make it available to peopel of all levels of income.

6. Shade should be the focal point - I want the shade of the light to be the focal point, therefore the cables and ceiling rose should not be too elaborate, so as not to retract from the design.

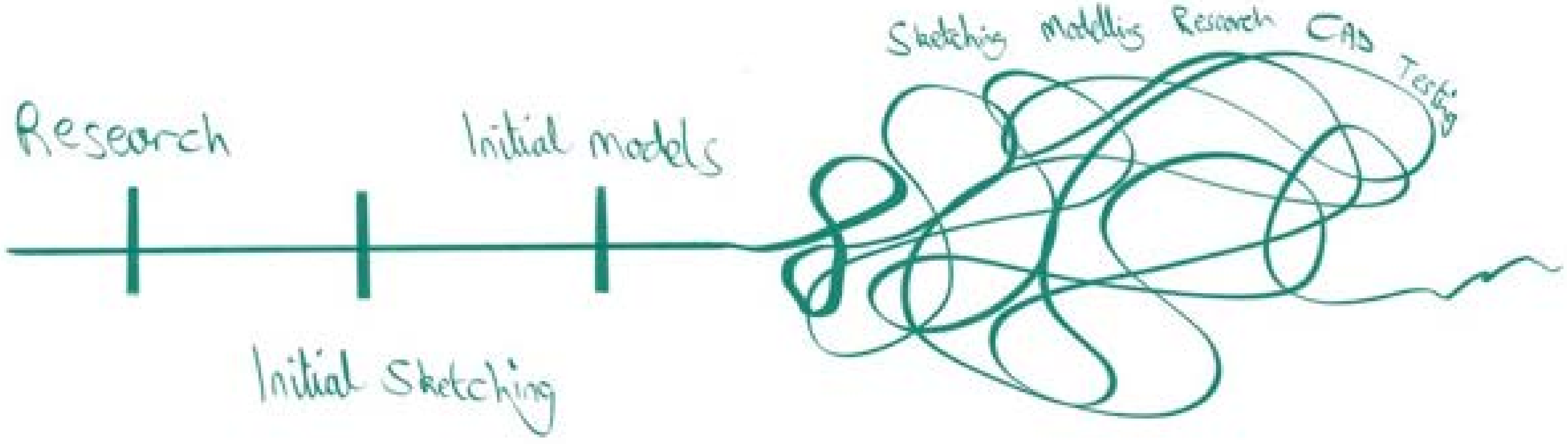
Time Management Reflection.

Overall I am pleased with the way I managed my time throughout this project. It was a significant improvement from the previous project and probably the best use of time management I have shown since the beginning of University. I created a Gantt Chart at the beginning of the project, which helped structure my overall time management. However, the most important aspect of my time management was the weekly ‘To Do Lists’, which I found incredibly helpful for breaking down the huge quantity of work that needed to be completed for this project into smaller, much more manageable sections.

The photo on the right shows my completed Gantt Chart for this project. The green squares show when I actually completed the tasks, compared to the blue, which show when I predicted I would complete them. Overall I think it was a fairly accurate prediction and I stuck to it pretty closely. It was only a rough guide and I found that I was making models/3D prints constantly throughout the project, so that extended for a lot longer than planned. Additionally, I returned to sketching a research at varying points as the project progressed, which explains why there are gaps in the green squares. Most importantly I left myself enough time for the evaluation and deliverables/presentation, something which I failed to do on the previous project.



Design Process Analysis.



This is my own personal design process. I created it at the beginning of the year to showcase the way in which I usually approach projects. I stuck pretty closely to my design process for this project, more so than I have on previous projects. I believe this is due to the fact that I managed my time better than before and structured my weeks with weekly time plans and to do lists. Whilst I am very pleased with the way I approached the project, sometimes I think the beginning of my process can be a little rigid. I always start with research, however sometime maybe I could experiment with making models earlier in the process.

If I Had More Time.

- Develop the range more - Whilst I am pleased with the designs for my full range, if I had more time I would like to have developed the designs properly and explored how they would function. Currently they are more aesthetic focused designs and I didn't consider too much how the wiring would work etc. Additionally I would have loved to make the floor lamp, as it would've meant I could spend more time in the workshop, which I missed out on for this project.

- Different wiring - The cables I have to hang my light probably aren't the nicest looking and could definitely be improved. Ideally I would like to change the cable to a thinner, straighter one, as the current cable doesn't hang perfectly straight and looks a bit chunky. Potentially I could've explored using a thinner, twisted/braided cable, as I believe this would've suited the design. However, it would've been quite time consuming to have to rewire the whole light and remove the current cable from the bulb holders etc and I decided to use my time elsewhere

- Widening slits - As I identified in a previous page, I quite liked the idea of the slits widening towards the bottom. This would've been difficult to achieve, as the wider the slit, the more structure of the shade would be lost, causing it to move around and close the slit more. However, I think I could've worked out a way to hold the slit open towards the bottom using some kind of hidden attachment. This is something I would like to have explored given more time.

- Manufacture my own filament - Something I would love to have done with this project is to manufacture my own algae-based bioplastic filament that could be 3D printed. However, this would've been extremely time consuming, as I would've had to test so many combinations of ingredients to get a suitable material. It would require a filament maker machine which costs thousands of pounds and finally it would require a 3D printer which could cope with testing different materials. The printers at University can not do that and would get blocked and potentially break. They became clogged repeatedly with the material I was using which was industry standard, so if I used my own that I had made they would most definitely break.

Conclusion.

WHAT I HAVE LEARNT:

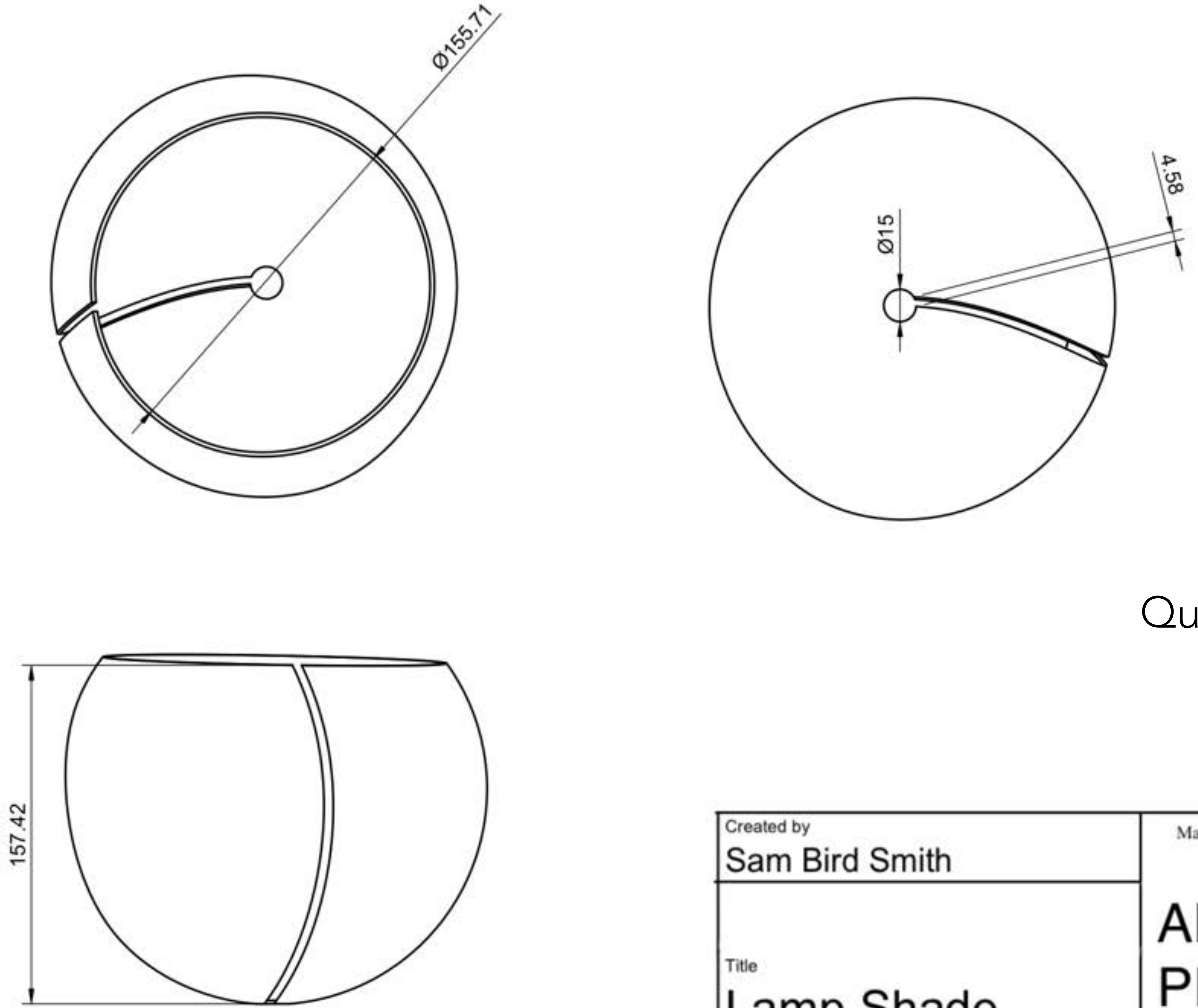
- Let the process decide the outcome - In the past, I have completed projects where I try and work out what the final product will look like before the project really begins. For this project, I let the design process lead the project and decide the outcome. I think this is clear to see through the development of my design from intial sketches to the final prototype.

- The importance of experimentation - At the beginning of this project, I 3D printed some samples of random shapes using the algae-based PLA. At first, I just printed these to test if the material could print properly and what it felt and looked like, however by being more playful with the samples and using the shapes in alternative ways, it led to the development of an idea.

WHAT WOULD I DO DIFFERENTLY:

- Understand the technical side better - I think if I understood the electronics side of the light better, I could've experimented more with different fittings and wiring/cables. Seeing as I hadn't had any experience with wiring before, it took some time to do and I needed help from others. It also meant that I put off wiring the light until later in the project, as I knew I couldn't do it myself, which almost acted as a mental block.

Tech Pack.



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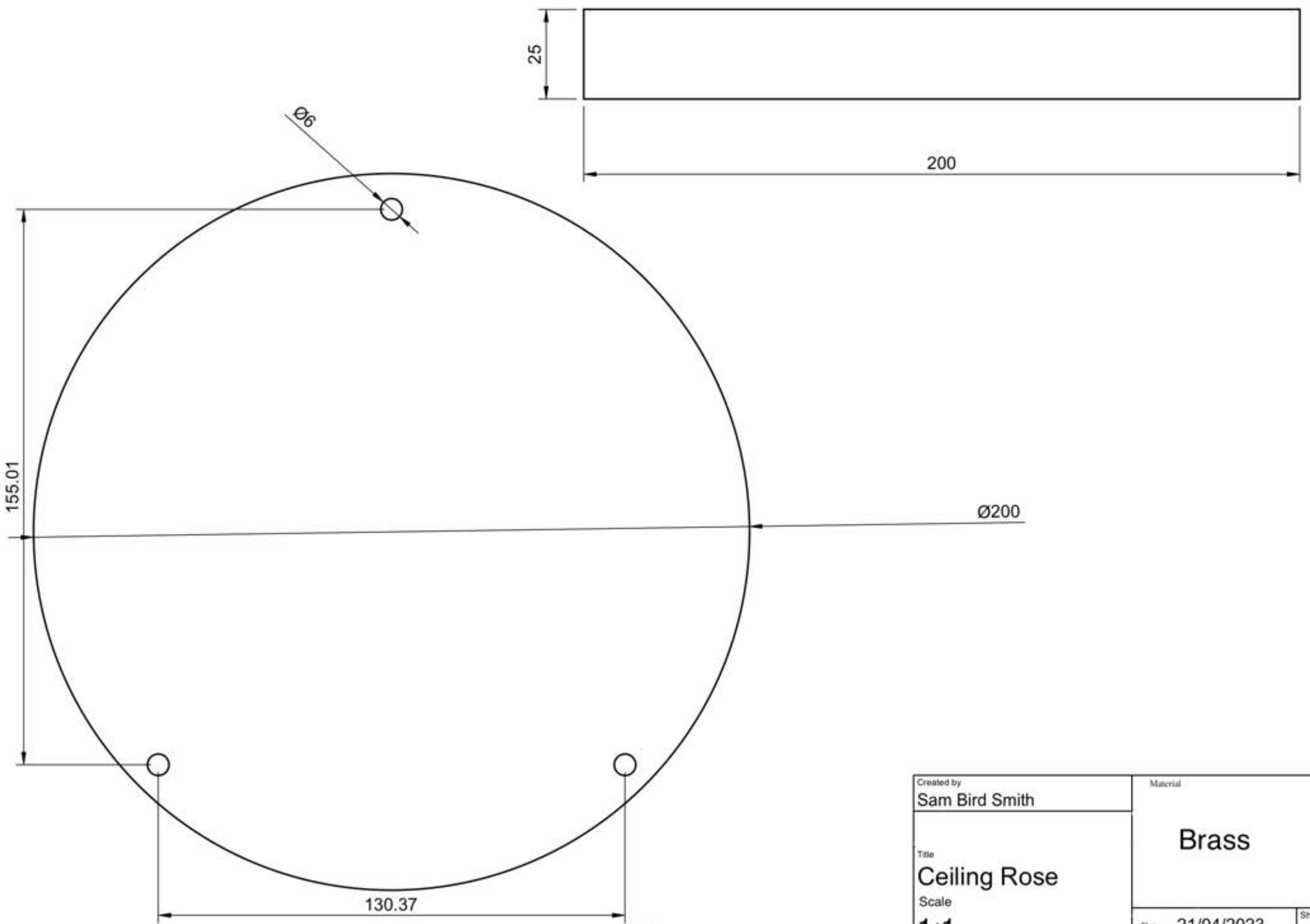
Scale 1:2	Date 21/04/2023 — Sheet 1/2



Created by
Sam Bird Smith

Material
Brass

Title
Ceiling Rose

Scale
1:1

Date 21/04/2023

Sheet 2/2

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