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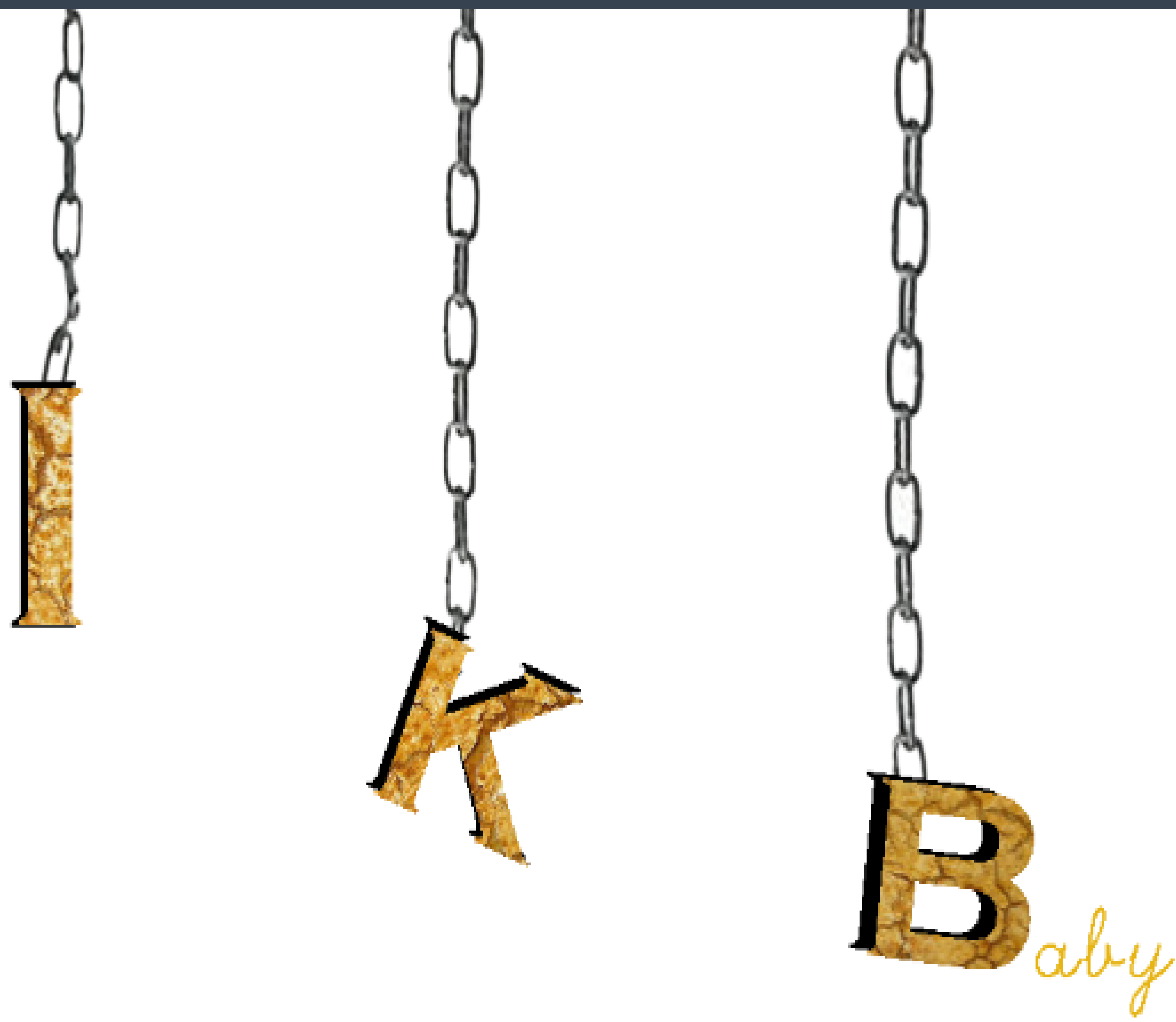
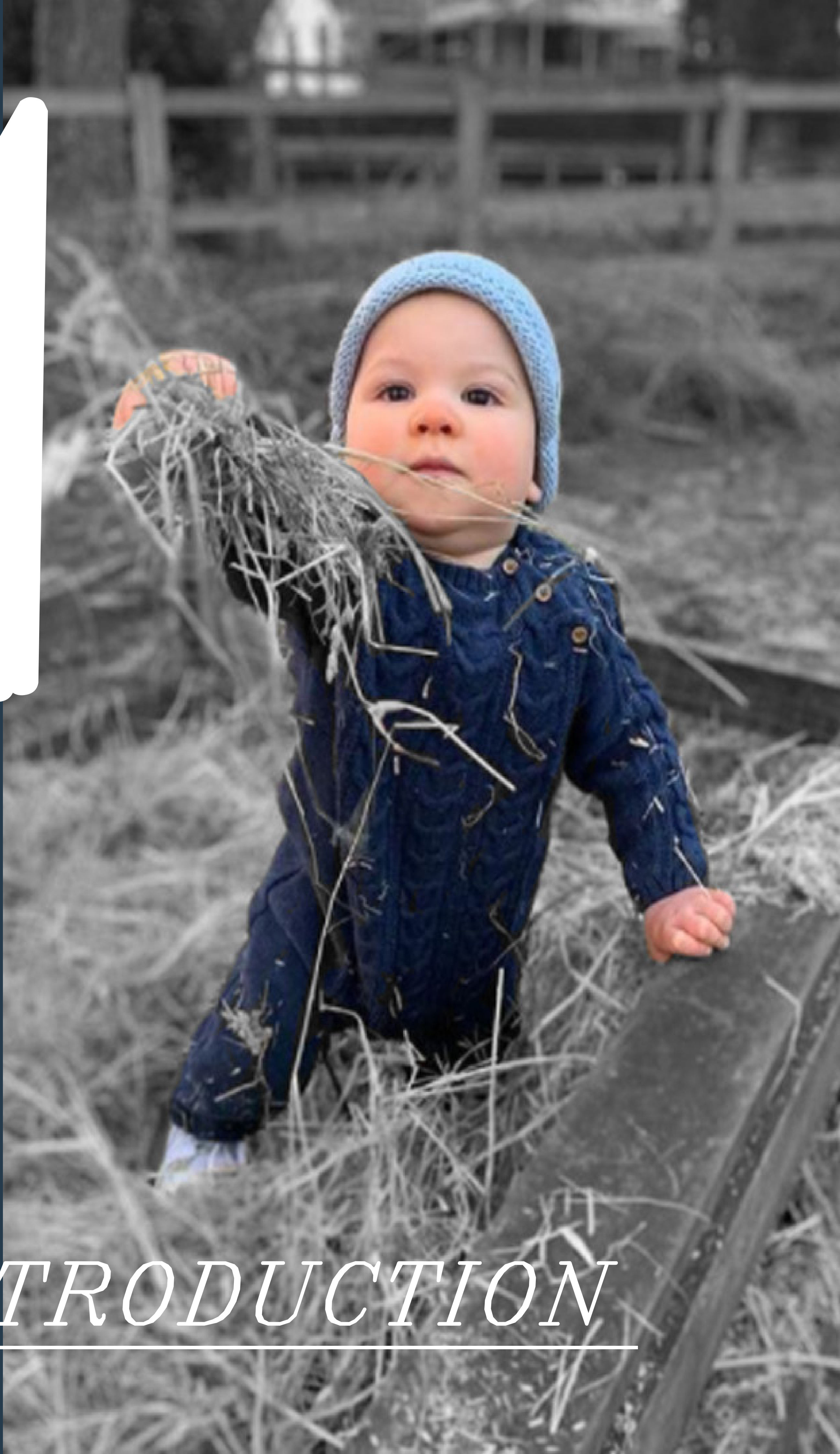


Design Proposal
Part 2

Theadora Powell

Contents

1



INTRODUCTION

RECAP OF IKB 1

BRIEF

“Design and develop an electrical product to assist with the sterilization of baby bottles, dummies and soothers with a focus on convenience, sustainability, mobility and safety”

Pio’s core identity from IKB 1 continues to influence and feature in IKB 2.

FIG 1

Key area for for development was for multiple items to be sterilisied simulate-nously.

Following feedback, I have focused on further research and analysis into the functionality of the Pio.

FEEDBACK

TUTOR

Overall a creative and engaging report with lots of ideation.

A broad range of existing products have been analysed demonstrating a good knowledge of the market. Further analysis of the products would be beneficial.

The sterilization of baby bottles is not a new requirement influenced by the pandemic, rather it is a long standing requirement driven by the fact that residue baby milk will form bacteria therefore leading to health issues.

The final design has a visual language that clearly targets the baby market and the renderings communicate the design reasonable well.

Your matrix evaluation process is helpful to understand why you have opted for your design. Comparing it to an existing product has some benefits but also weaknesses.

Area of improvement 1:

- Use the Pugh Evaluation Method in ‘Research methods for product design

Area of improvement 2:

- Start to identify the technology required and its scale. Consider how this will impact the lid’s design and model baby bottles/ other periphery in CAD in order to compare the overall scale of the steriliser

Shifting Focus

Objectives

Reconsider Pio's aesthetics to reflect Bebe's branding

Scale the Pio and its internal electronics

Develop the collapsable body

Develop a stabilised base

Provisions for prepare and end of life cycle

2 CIRCUITRY

Testing, identitfying and scaling the electronics required for the Pio

LED Schematic 1:

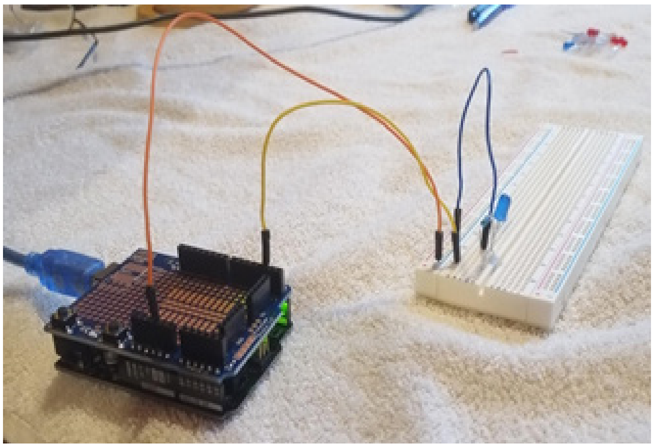


FIG 2

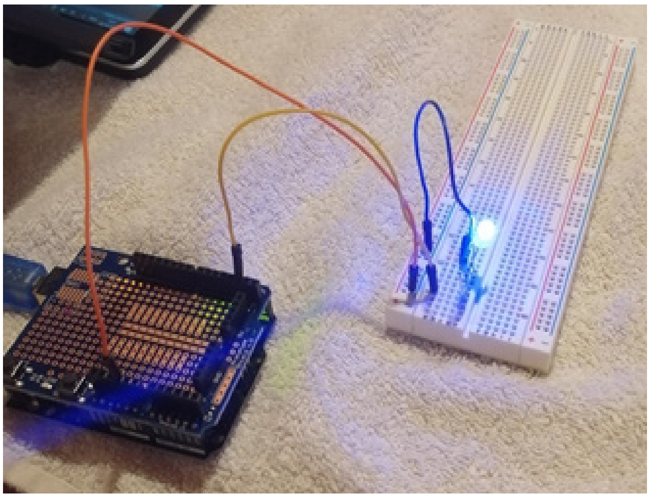


FIG 3

My first test was to set up a single LED to show the working principle. Having produced a stable light (FIG 3/4), I then had feedback when the 'Pio' was activated and started sterilising. I used Arduino to program this and to set the cycle for 10 minutes as shown in FIG 4

Next, I coded for the light to blink to alert me that the sterilising cycle had finished (FIG 5)

sketch_apr17a §

```
digitalWrite(blueLED, HIGH);    //LED on
delay(10 * 60 * 1000);          //10 minutes in ms
digitalWrite(blueLED, LOW);     //LED off
```

FIG 4

This sequence will be controlled by a button. A single press will activate.

sketch_apr14a §

```
int blueLed = 2;

void setup() {
  // put your setup code here, to run once:
  pinMode (blueLed, OUTPUT);
}

void loop() {
  // put your main code here, to run repeatedly:

  digitalWrite (blueLed, HIGH);

  delay(250);

  digitalWrite (blueLed, LOW);

  delay(250);
}
```

FIG 5

LED Schematic 2:

Next, I replicated the proposed functions by creating a fully mocked circuit to understand whether;

- The product is feasible
- The cost of production is viable

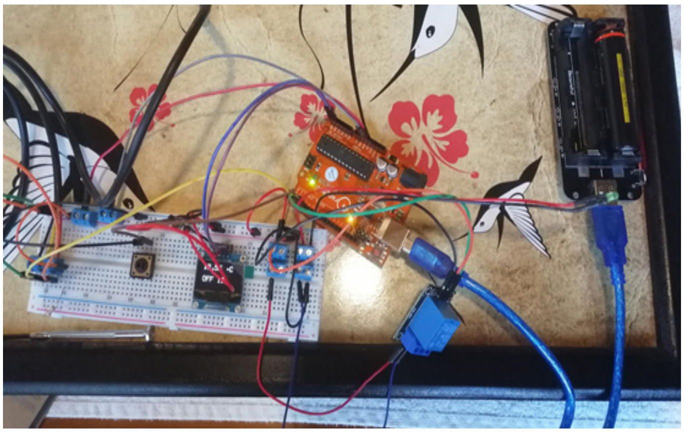


FIG 6

The full circuit includes:
(as sourced from Amazon)

- Arduino
- Relay (FL-3FF-S-Z 5VDC)
- Switch
- Lithium Battery
- 18650 Battery Shield with USB and USB-C ports
- Digital display board
- DC-DC Step-Up board
- 18 LEDs (16 white, 2 blue)

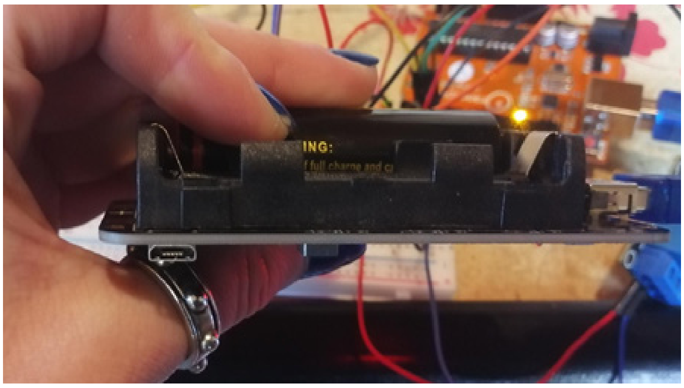


FIG 7

Additional Components:

- Push Pin Chocolate Blocks
- Male to Male Elegoo Breadboard Wires
- Clear Chocolate Blocks

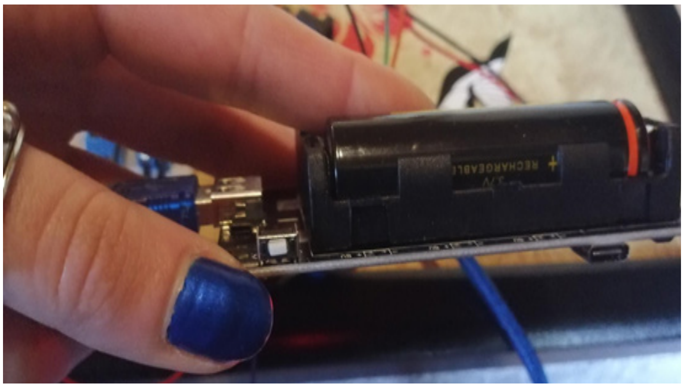


FIG 8

The dual battery shield allows for multiple charging points, for Apple and Android users.

LED Placement

FIG 9 (Standardmedia, 2021)

I used a torch to visualise how the array of LEDs might look.

I needed to ensure light would be emitted on to the interior and exterior of the baby bottle. This required 2 arrays of lights.

I based the 1st array on the diameter of a baby bottle at 2cms wider. I made my 2nd array 3mm smaller than the neck of a baby bottle. These would have to be scaled to the size of the head and body once calcu-lated

Using the principle of a clockface, I placed LEDs on the 1st array at 0 deg, 45, 90, 135, 180, etc and 1cm from the edge. Each LED being 41mm apart. When scaled for the final product the spacing when may need more LEDs.

I placed LEDs on the 2nd array at the same degrees and 1cm from the edge, bringing them closer together.

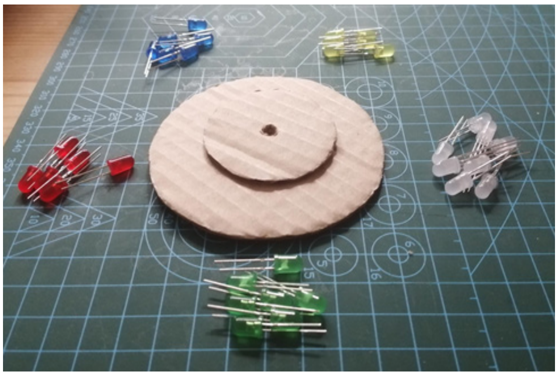


FIG 10

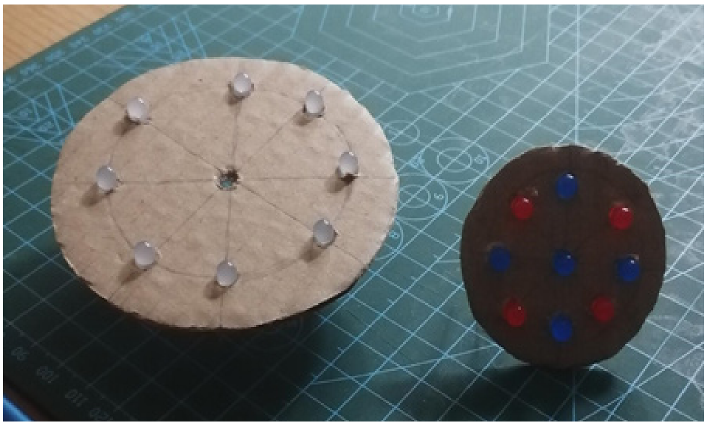


FIG 11

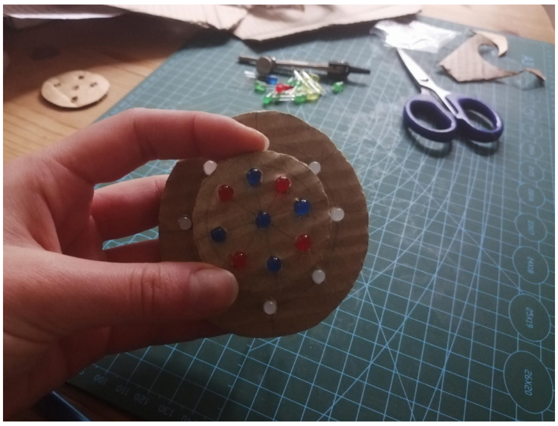


FIG 12

LED Schematic 2:

To power multiple LEDs and UV-C LEDs, a DC-DC step-up board (FIG 13) is required to control the flow of electricity between the Arduino, lithium battery and LEDs to protect the components.

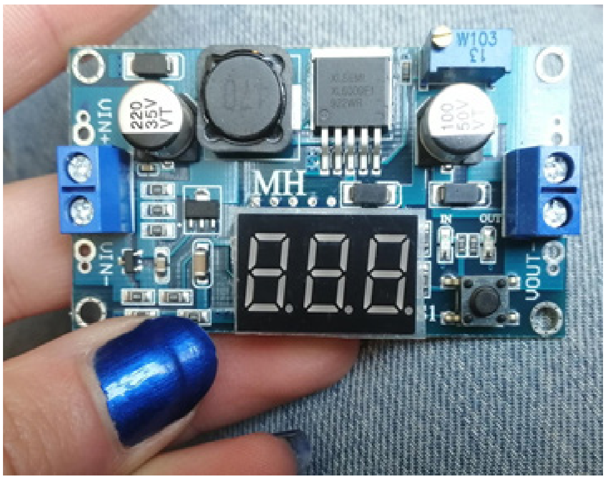


FIG 13

FIG 18/19: Stripping and bundling LEDs into sets of 8 to chocolate block.

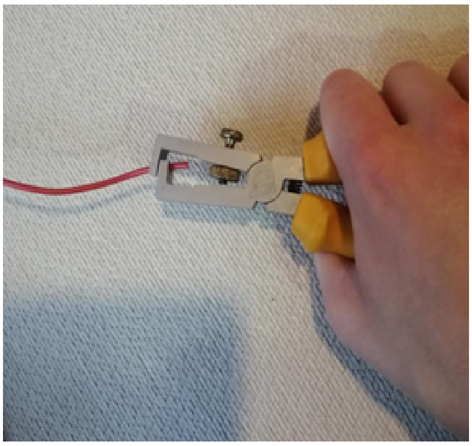


FIG 14

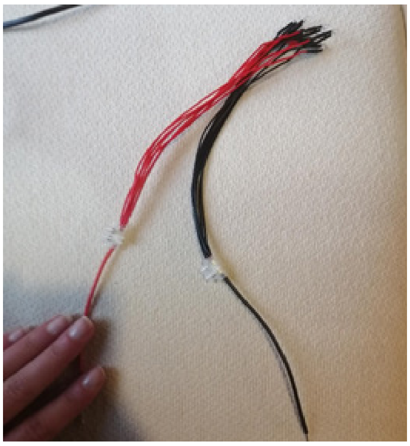


FIG 15

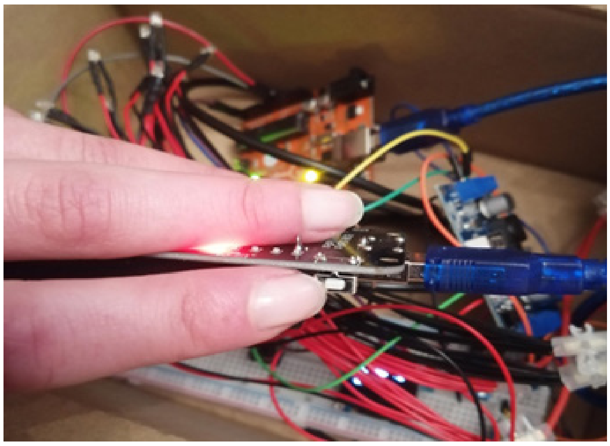


FIG 16

Pushing the mains switch on the Lithium battery pcb (FIG 16) activates the breadboard circuit making it ready to receive a command from the main switch on the breadboard.

The digital display board reads as ‘OFF’ until the switch is pressed changing to ‘ON’ (FIG 17/18) and activating the 16 ‘UV-C’ LEDs and the 2 blue indicator LEDs that signal that the device is on and sterilising.

This was a successful test that the Pio’s intended functionality would be achieved.   This would be refined for commercial mass manufacture, as researched in Appendix C

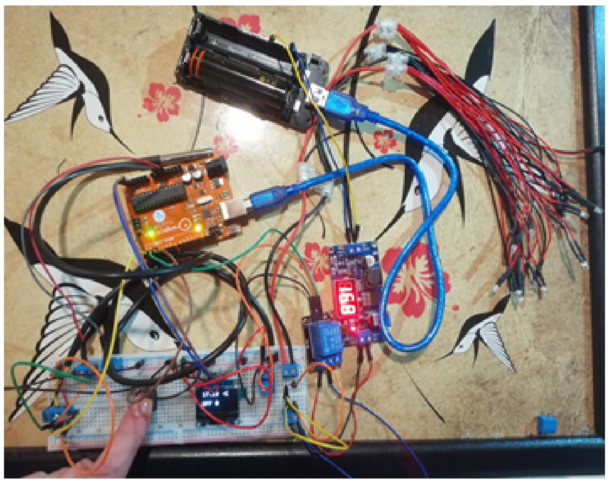


FIG 17

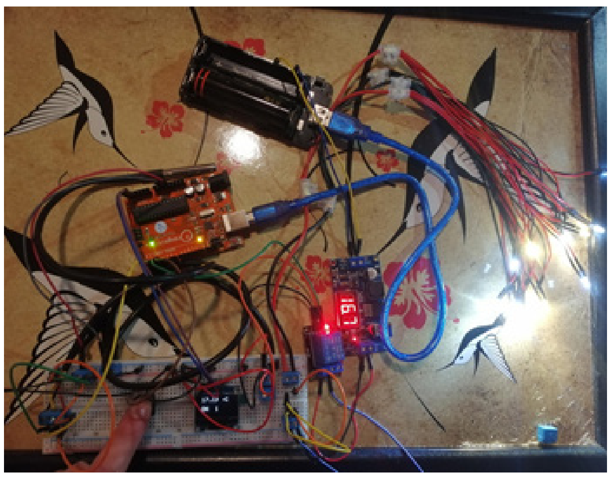
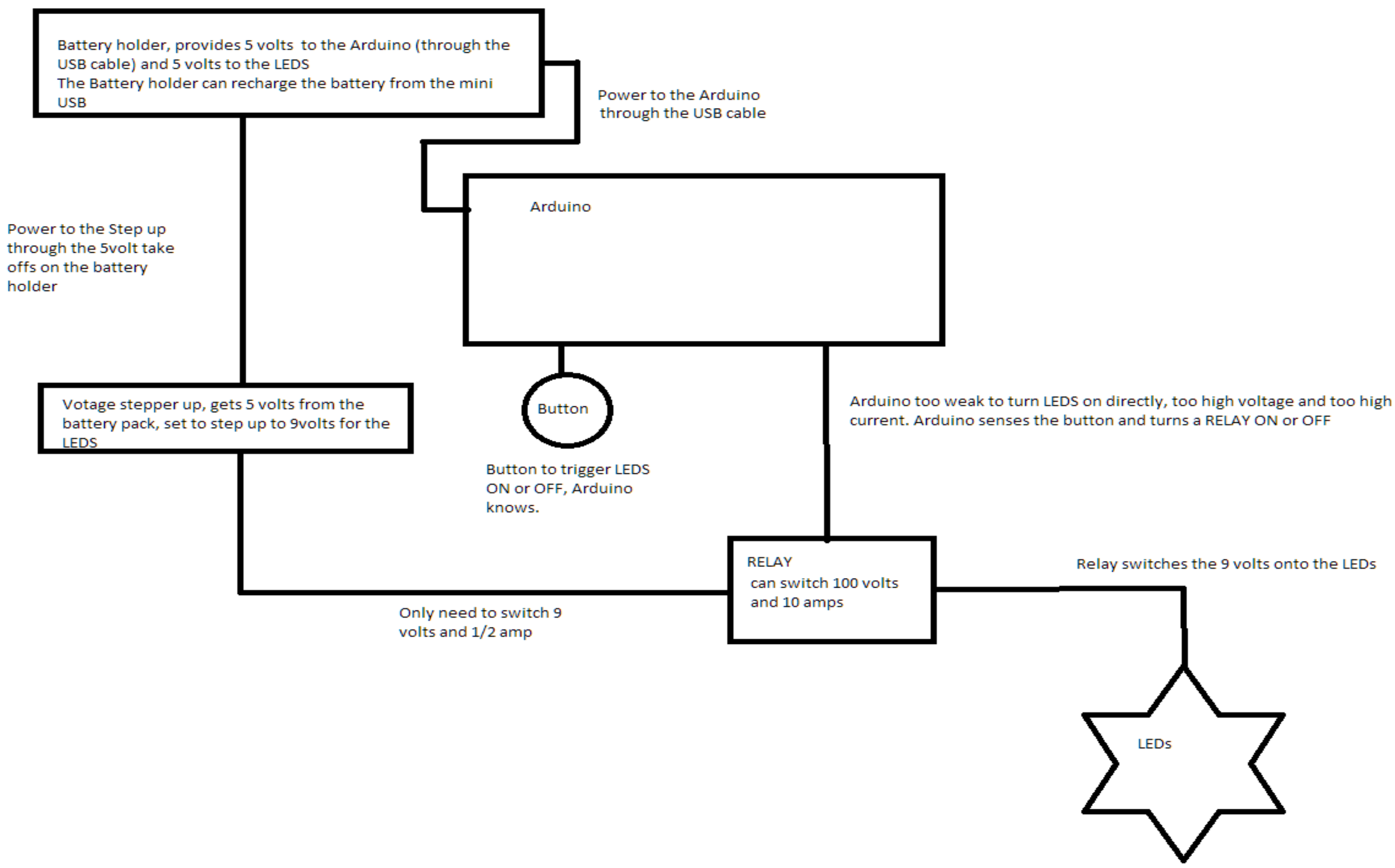


FIG 18

Block Diagram



Considerations

- When the unit has completed sterilsing how does it switch off?
- How does the user know the process is complete
- Have safety issues been considered

The purpose of these circuits was to broadly test and visualise the Pio's functionality.

However, it wasn't clear how to power off the Pio automatically as a energy and safety feature.

Therefore, I wanted to introduce a time component that carries out the sterilisation for a set time and then shuts the product down fully.

Further Research

I found a circuit online (FIG 19) that confirms the LM555 and Reed switch are applicable in a UV-C lamp circuit.

Here, the LM555 sets the duration of a cycle and in the Pio this will be modified by the choice of resistor and capacitor to increase or decrease the cycle.

When the Pio is switched the LM555 will begin counting for the stipulated period of time the UV-C lights are active and then stop.

This will reassure the user the sterilising is sufficient and ensures the maximum sterilising cycles can be achieved from a single charge.

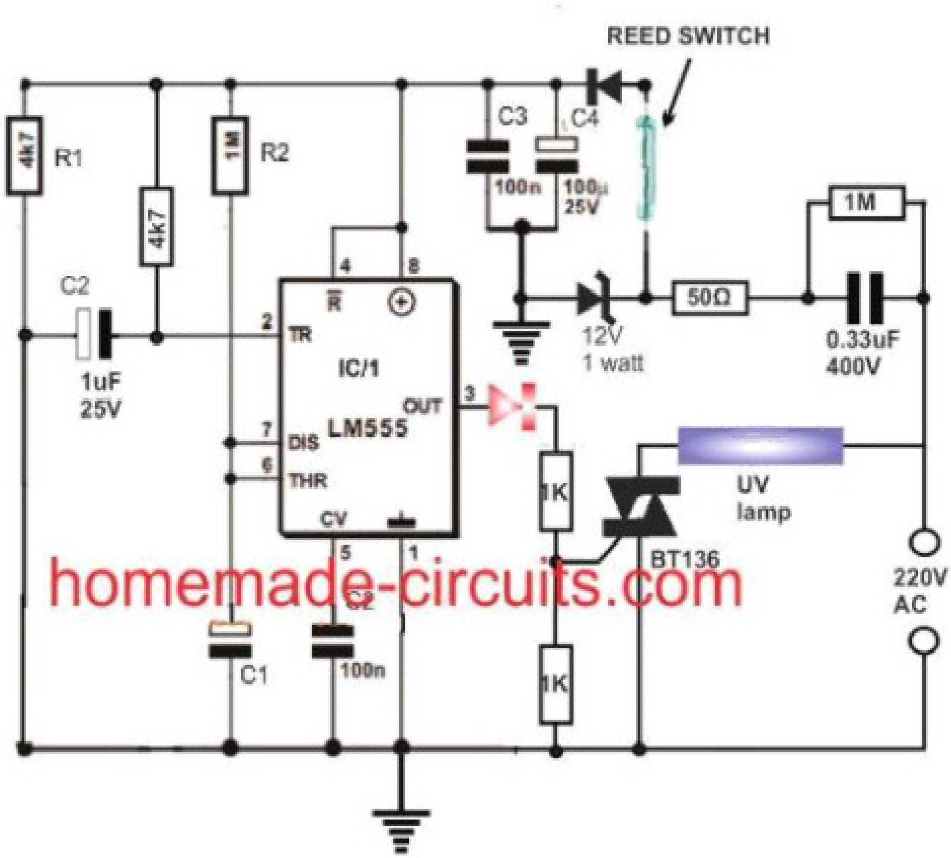


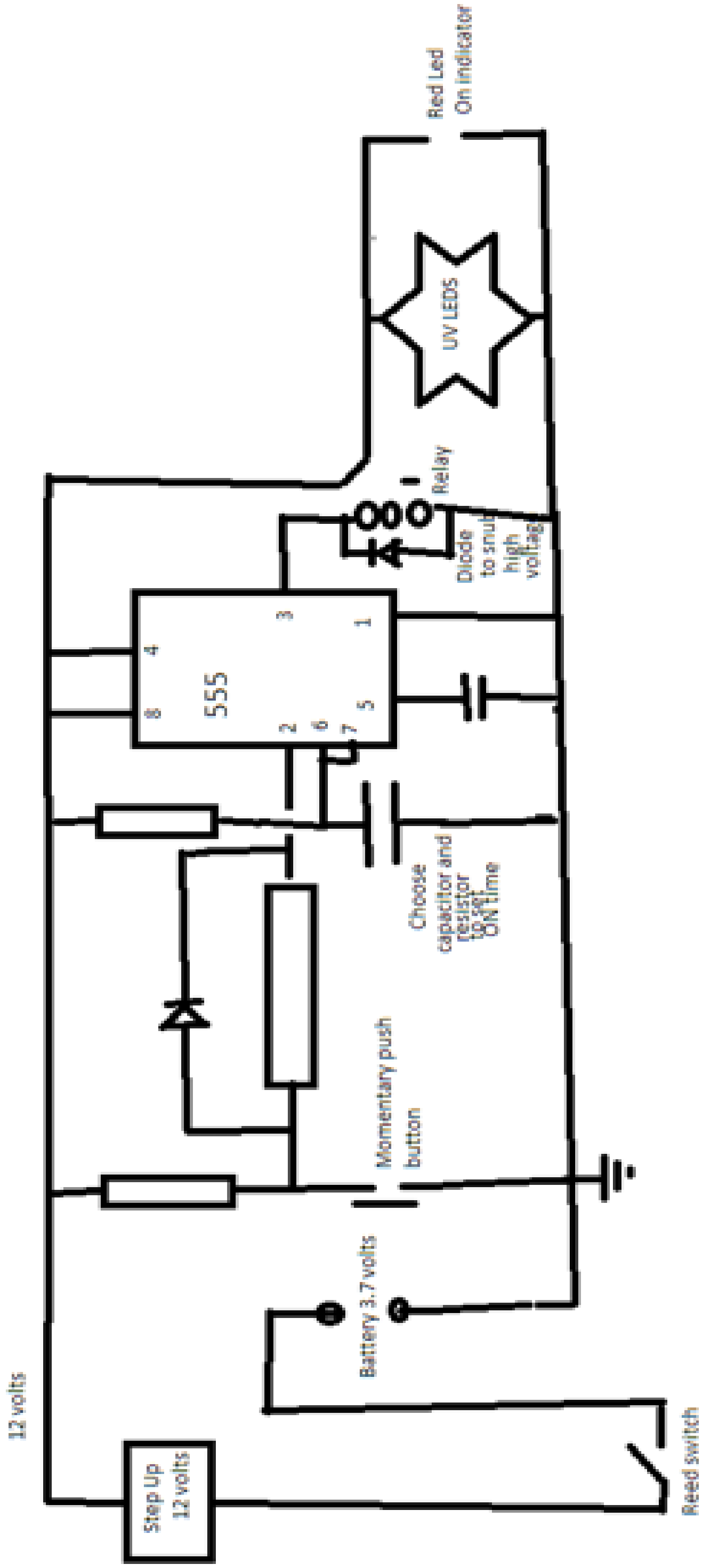
FIG 19

(Swagatam, 2020)

SAFETY ISSUES

As a separate safety feature I would add a magnet and reed switch aligned in the body and head so when the head is removed and the magnetic connection broken , the unit is completely and cannot be activated until the head is replaced.

Proposed Schematic



LED Anchorage Development

Continuing my analysis of the circular arrays from page 10, I developed a moulded cavity for the LEDs to sit in using Solidworks.

Both arrays house 8 UV-C LEDs each.

The larger circular array has a diameter of 142.42, matching the dimensions of the estimated Pio head so that the anchorage plate fits snugly inside and provides adequate support to the integral structure of the Pio's electronics.

A chamfer has been applied to make the light array fit snugly to the contours. This array is responsible for targeting surface bacteria on the exterior surface of the baby bottle.

The smaller array is directly extruded from the larger array plate. The LEDs are centralised and closer together in a span that is less than the neck diameter of most baby bottles to allow the UV-C light to strobe the internal area of the baby bottle and also sterilise any excess milk residue. These two arrays ensure total product sterilisation.

A threaded hole is located in the centre of the anchor supports to ensure the components are kept in place but this will be further explained on page 18

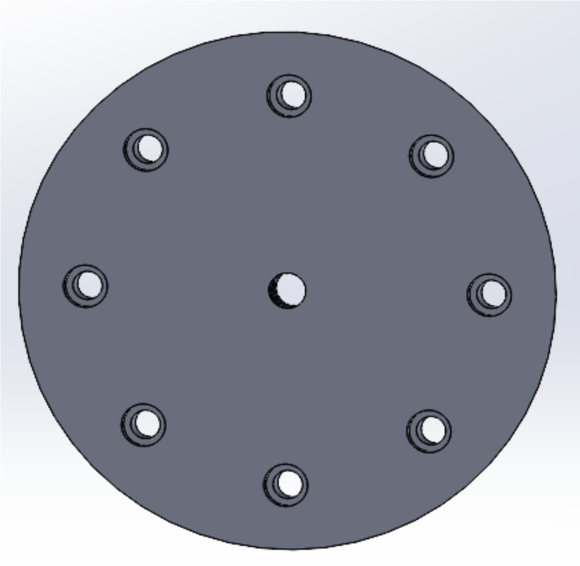


FIG 20

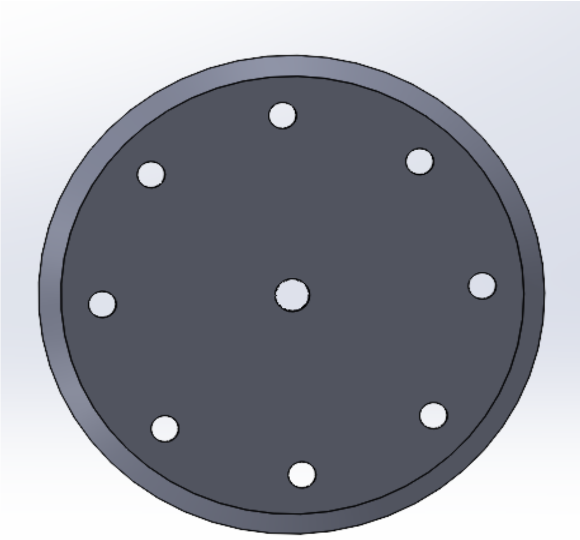


FIG 21

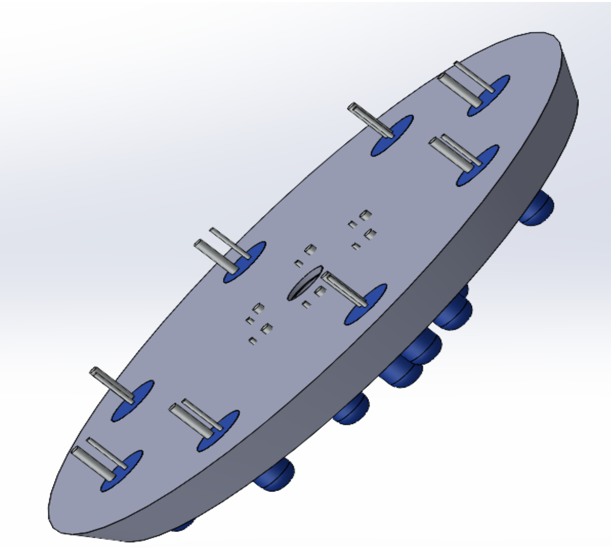


FIG 22

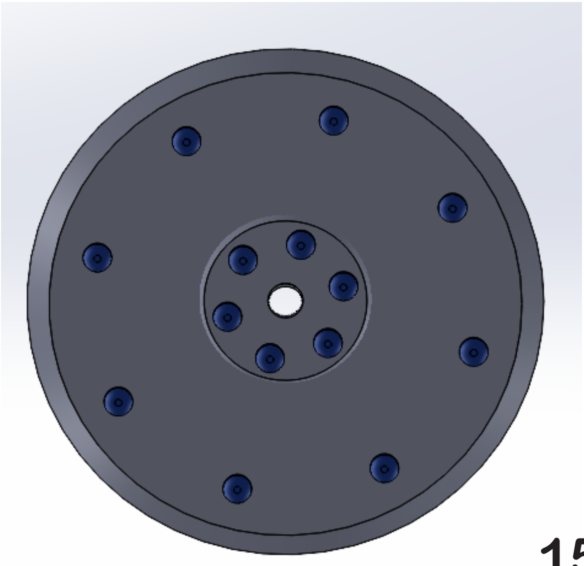
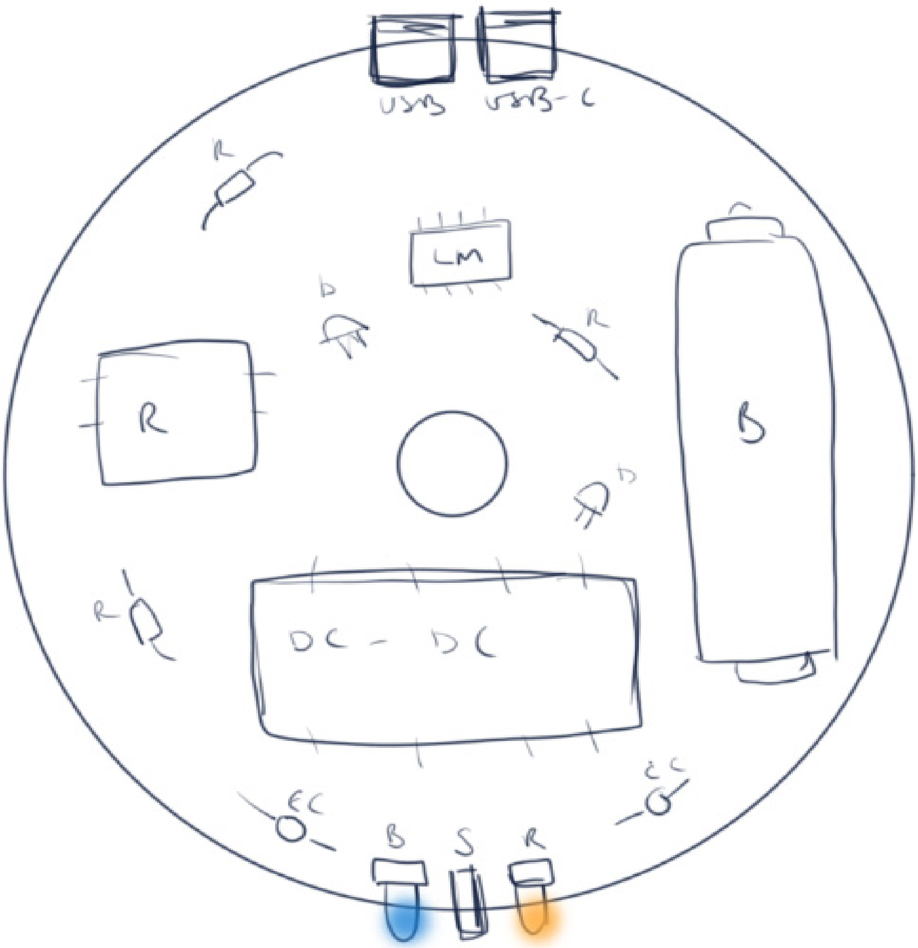


FIG 23

Pio PCB Board Design

Rough sketch of proposed custom PCB board design with all relevant components.



CAD drawn representation of the Pio PCB board to provide visual explanation.

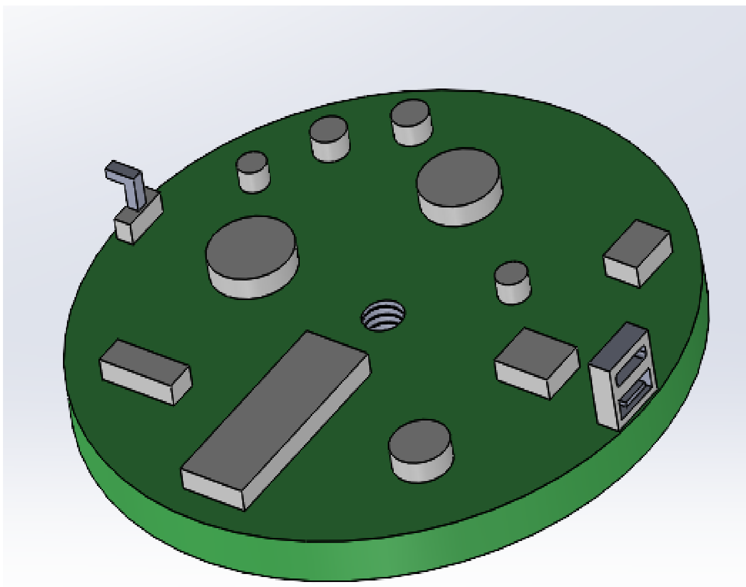


FIG 24

3 PIO HEAD

Building on the previous design from IKB1 and now having scaled and tested the technology the head size can be more accurately ascertained.

Electronics Anchorage

I added an extruded screw fixing (FIG 25) to the head to anchor the component boards in place.

The PCB board is screwed to the maximum position on the thread. To keep the PCB and LED boards separate the PCB board will have an extruded spacer so that the LED board is kept separate when wound into position. This ensures the boards are fixed at the correct point and the components align correctly with the controls and charger ports.

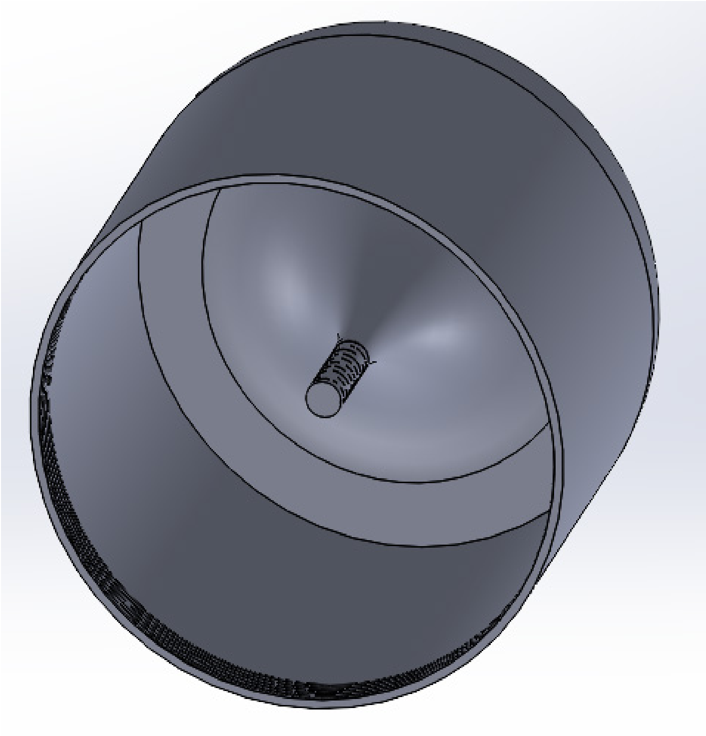


FIG 25

By extruding the screw and spacer on the PCB board, the number of manufacturing processes is reduced which impacts on cost and assembly.

This allows the unit to be easily taken apart to replace components such as the LEDs and for recycling at the end of its product life.

The process to manually disassemble the unit for after sale maintenance will be different to the automated manufacturing assembly. Due to limited space in the unit to unscrew the boards they will both have pre-cut holes into which a small bar or screwdriver can be inserted to act as a turning handle.

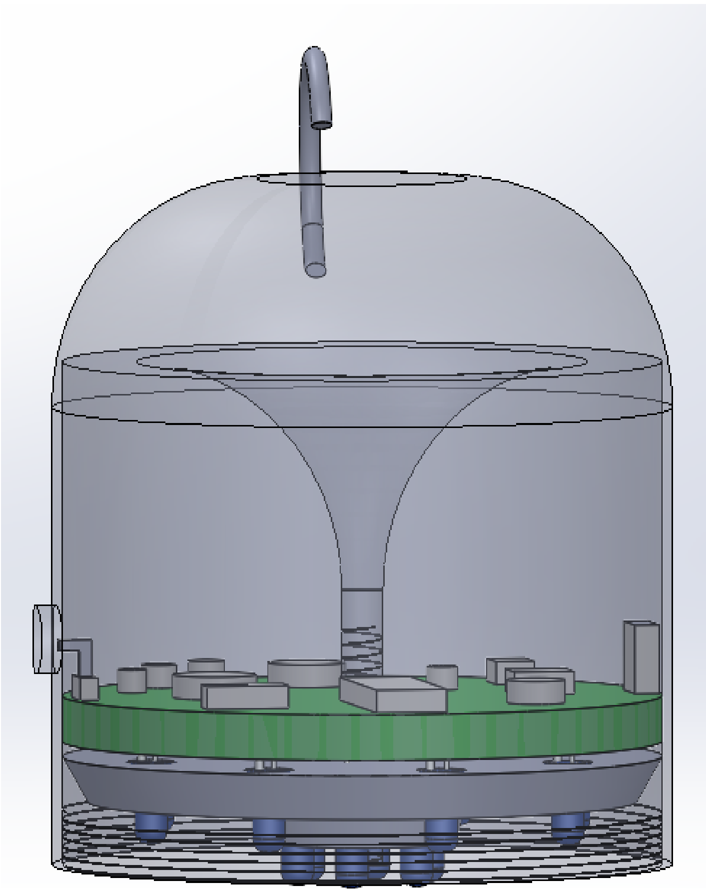


FIG 26

Charger ports

The Pio has two charger options, USB and USB-C for android and apple connections. These can be used to charge the Pio from compatible electronic devices or by using an adaptor.

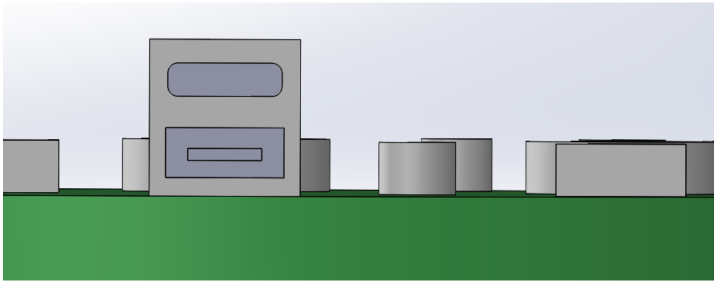


FIG 27

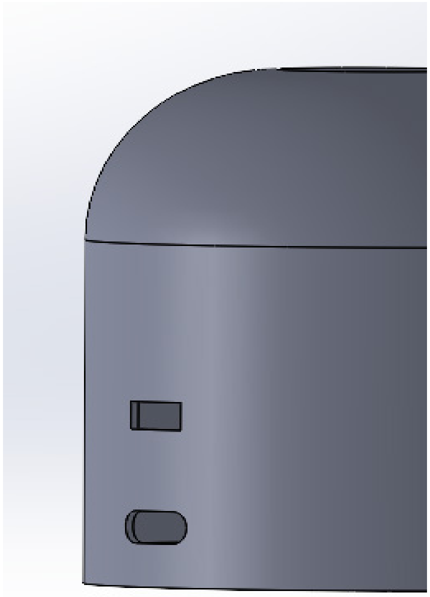


FIG 28

On Button

FIG 29/30 shows how the Pio will be activated by a single button press.

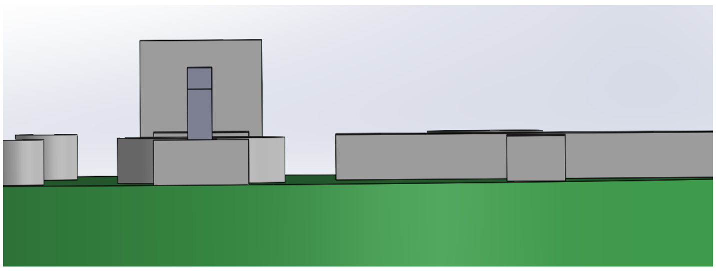


FIG 29

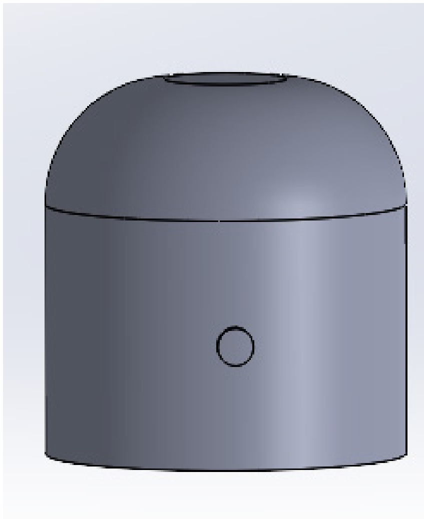


FIG 30

4 Development

Pio

Collapsable Body

STOJO

To develop the collapsible body, I analysed the structure of a Stojo as a potential template for the construction of the Bebe Pio.

STOJO ANALYSIS

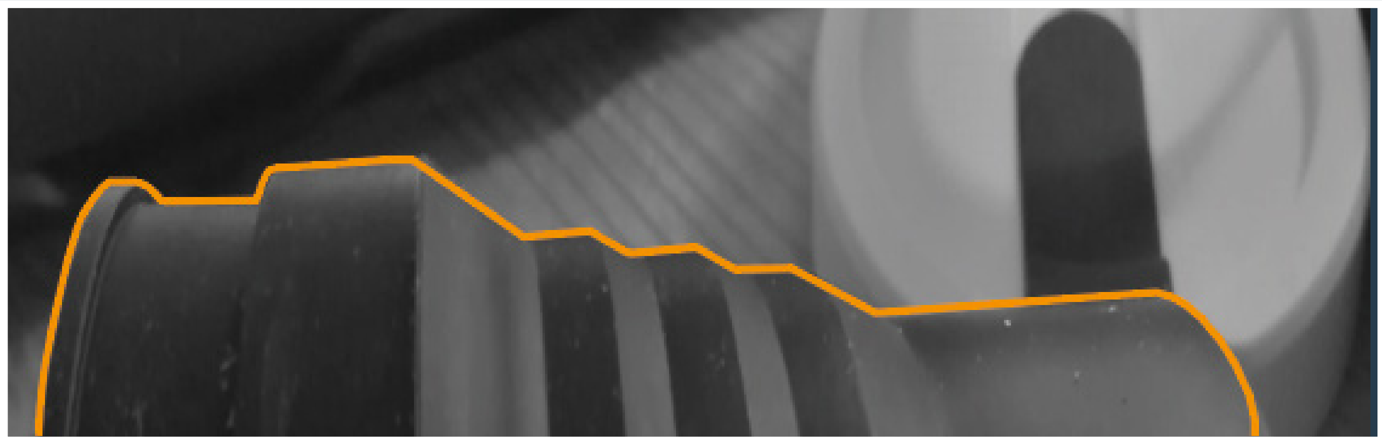


FIG 31

I stripped this down, leaving the essential form of the cup, then traced the profile measuring along each line to determine; the overall height and top and bottom diameters and the measurement of each crease in the silicone that allowed it to collapse smoothly.

I also recorded the size of the threaded plastic collar that allowed the cup to be screwed firmly to the sippy lid.

I used these as a general guide to replicating this form to scale in CAD.

FIG 32

FIG 33

The Stojo cup uses customised mouldings that allow attachments, such as the threaded collar, to be held in place.

It is not glued, the silicone cup simply expands to it's natural shape holding it securely against the plastic as shown in FIG 34

FIG 34

Any residue or debri that gets trapped between the silicone and the casing can be easily removed when disassembled.

<u>Stojo Dimensions:</u>

H = 12cm
Rim Diameter = 8.5cm
Base Diameter = 5cm
Length between each fold = 12mm
Fold measurement = 7mm
Wall Thickness = 3mm

Using the baby bottle provided by my client, I tested whether the current cup measurements could accommodate it. I found that the base of the baby bottle was too broad and I could only insert it partially (FIG 35)

FIG 35

CAD BABY BOTTLES

Taking the measurements of three typical baby bottles on the market, I replicated them in CAD to determine the dimension of the Pio.

(MAM Easy Start Self Sterilising Anti-Colic Baby Bottle, 2020)

(Tommee Tippee, 2020)

(MAM Easy Start Self Sterilising Anti-Colic Baby Bottle, 2020)

PIO: Step 1

I started by replicating the form of the Stojo cup in CAD to see how I could modify it for the Pio. To start, I drew an exaggerated profile and used the revolved boss/ base tool made it a solid 3D form.

However, it was too narrow when the bottles were inserted as shown in FIG 40 and 42. From that I needed to rethink the dimensions, to make it wider.

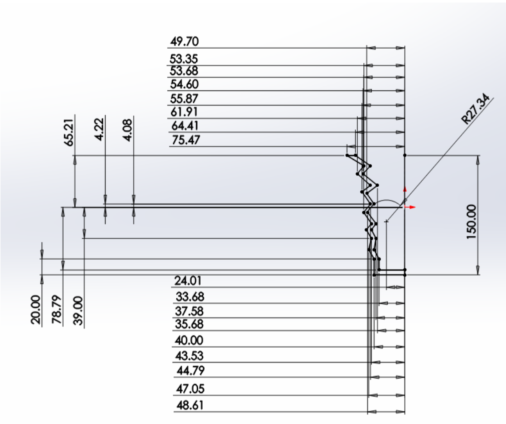


FIG 36

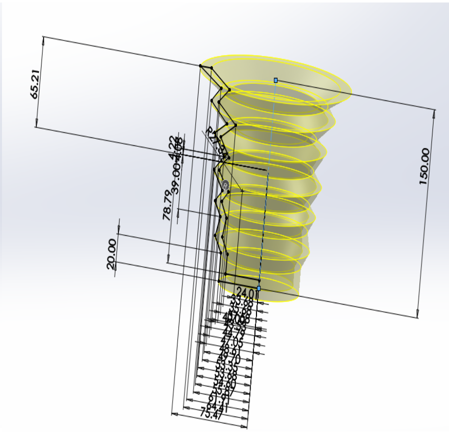


FIG 37

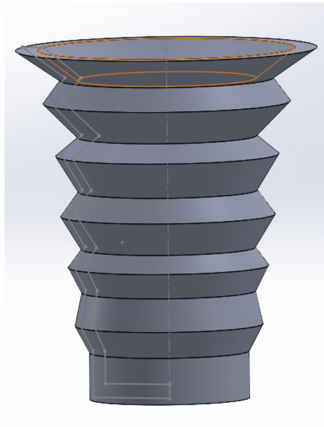


FIG 38

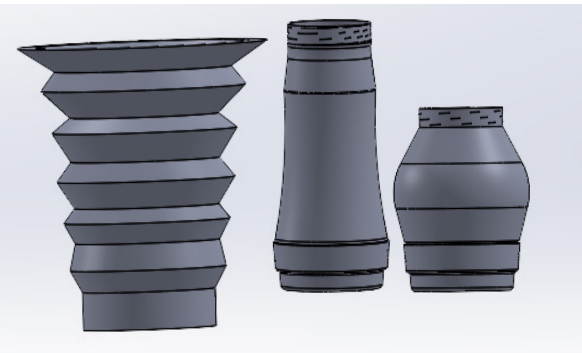


FIG 39

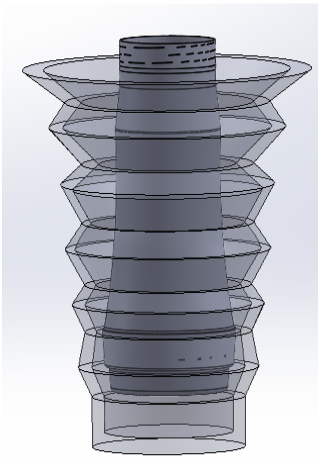


FIG 40

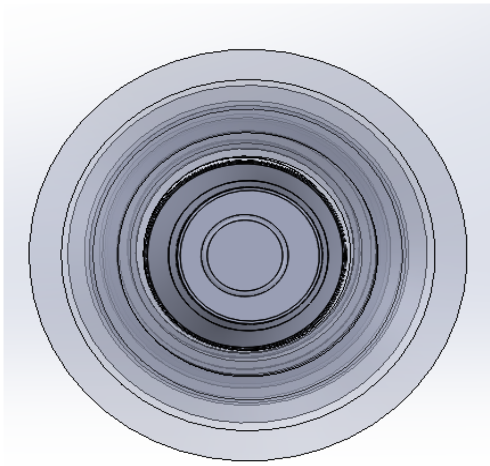


FIG 41

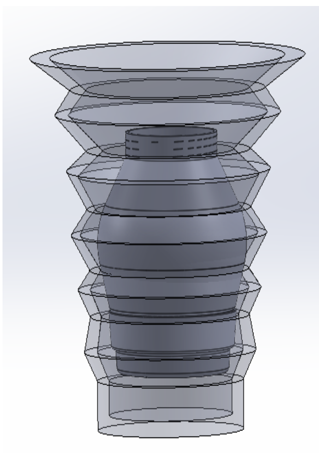


FIG 42

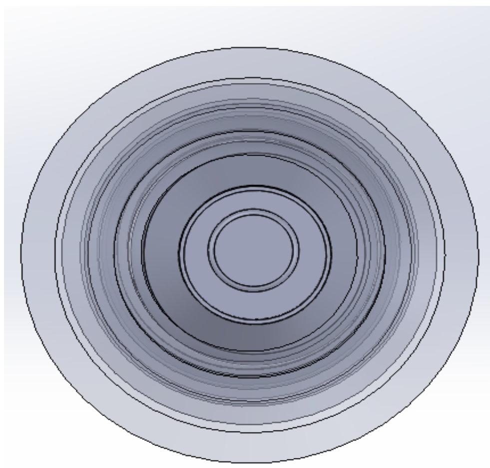


FIG 43

PIO: Step 2

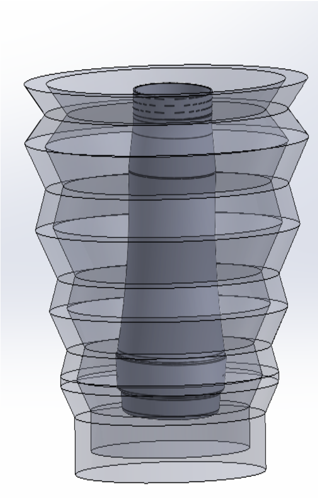


FIG 44

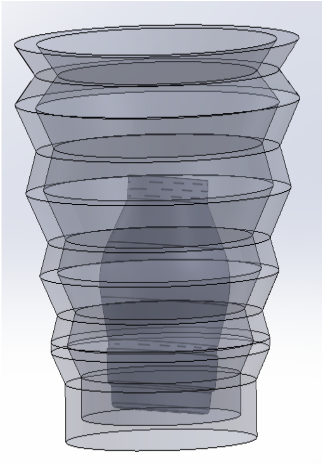


FIG 45

My second step was to reconsider the width and the overall shape for the Pio. I made the body wider but not so angled with a broader base but I found this too big overall and allowed too much movement. This could impact how well the bottles are sterilised.

My second attempt was to reverse the form in FIG 44/45 by narrowing the top and slightly widening the lower mid section. This improved stability around the neck of the bottle and allowed some bottles to insert fully but not all.

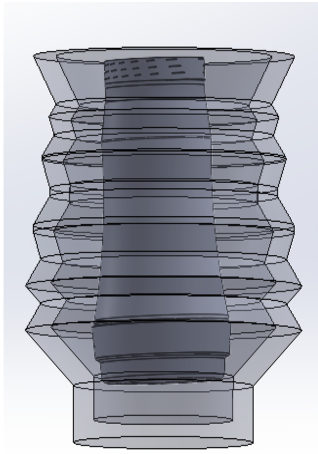


FIG 46

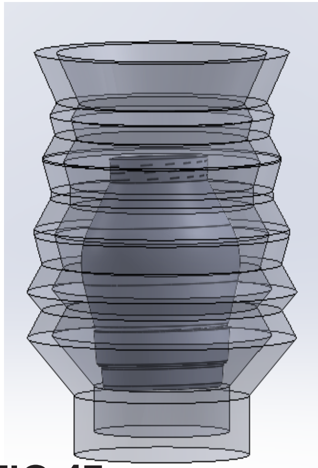


FIG 47

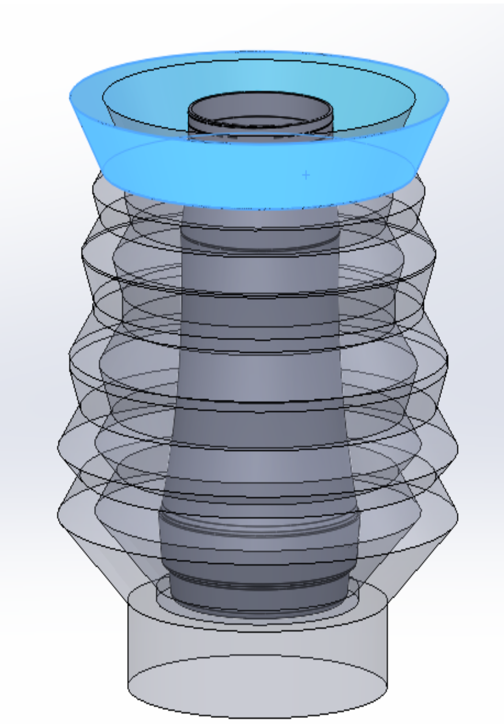


FIG 48

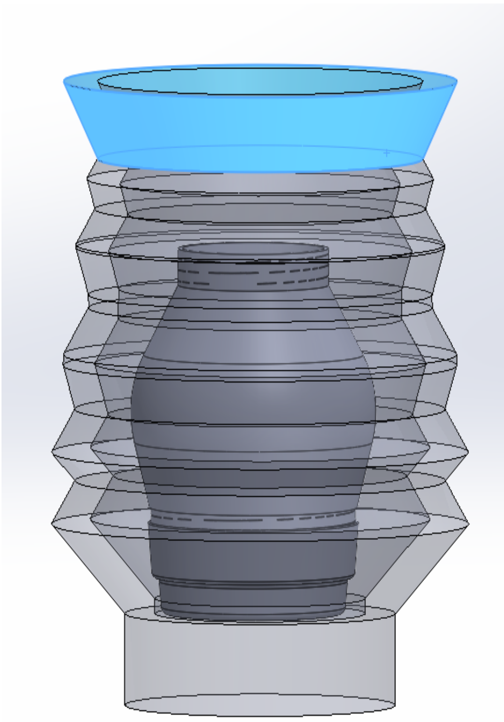


FIG 49

My third attempt, achieved the right balance at the top and base.

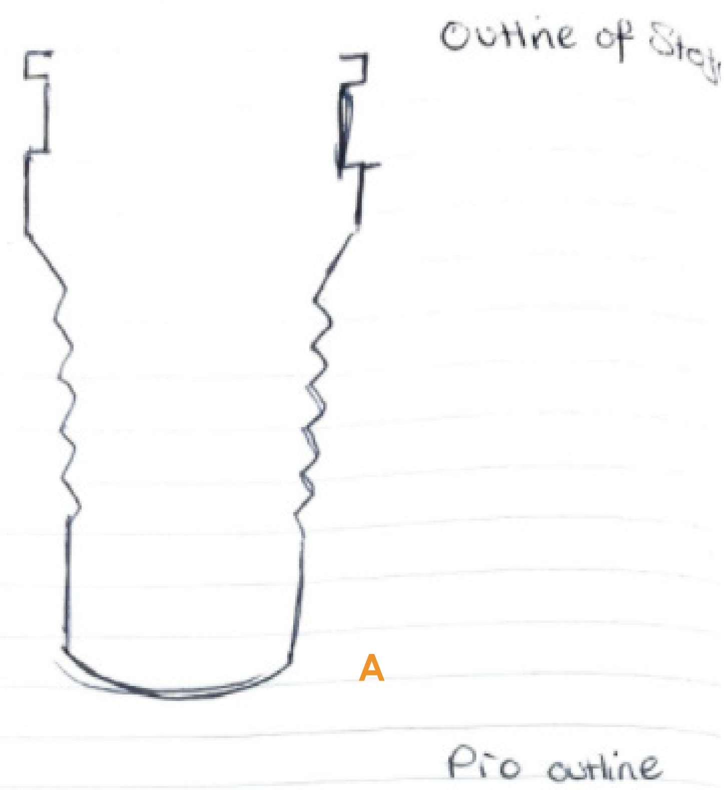
All the test bottles could fit comfortably inside with a satisfactory surrounding space.

However, this design would not collapse, so I needed to rethink the profile of the cup in Stage 3.

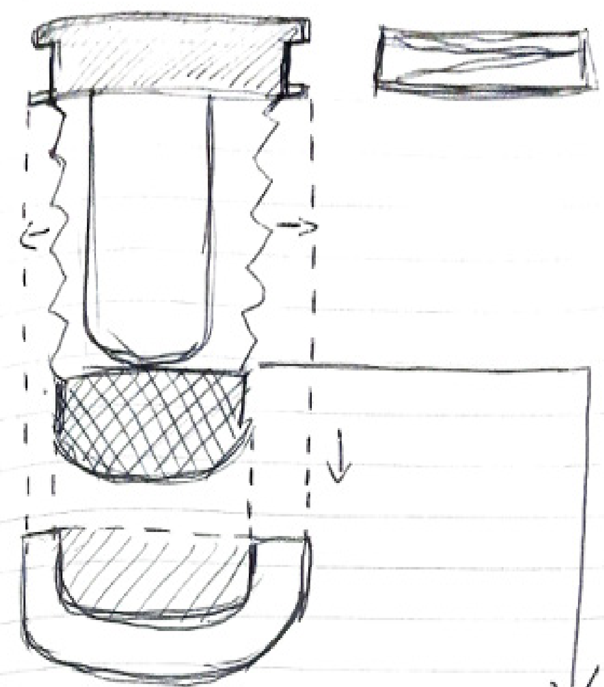
Development

I sketched alternative profiles to see how it could be made to collapse. I also had to consider how to attach the body to the Pio head. Finally, I needed to find a way to keep the body stable during the sterilisation process.

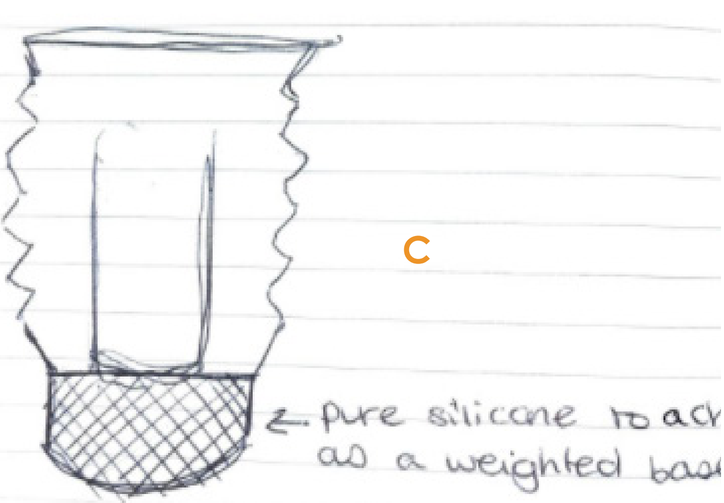
Sketch A shows a new profile for the Pio. Sketch B includes mouldings for a threaded collar. Sketches C and D show the development of a weighted base made from silicone and housed in its own compartment.



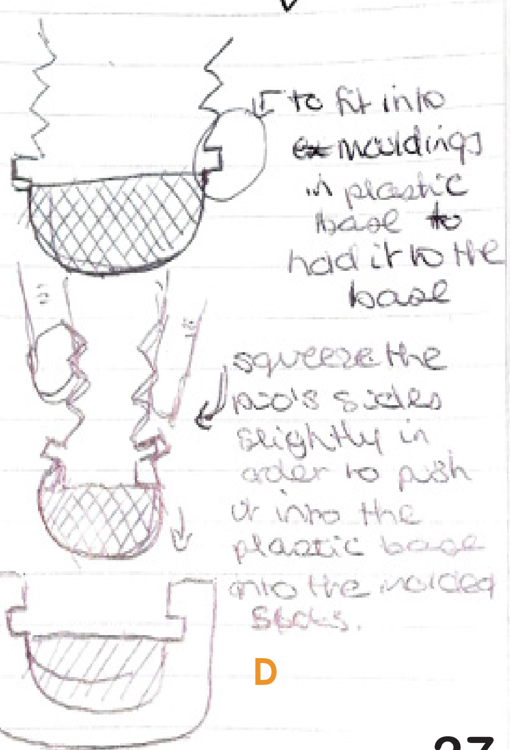
A



B



C



D

PIO: Step 3

Step 3 required careful consideration to calculate how the body could be made to collapse. My first attempt (FIG 52) was to make each folding section the same dimension. This enabled it to partially collapse like a bellows but not nest inside each other.

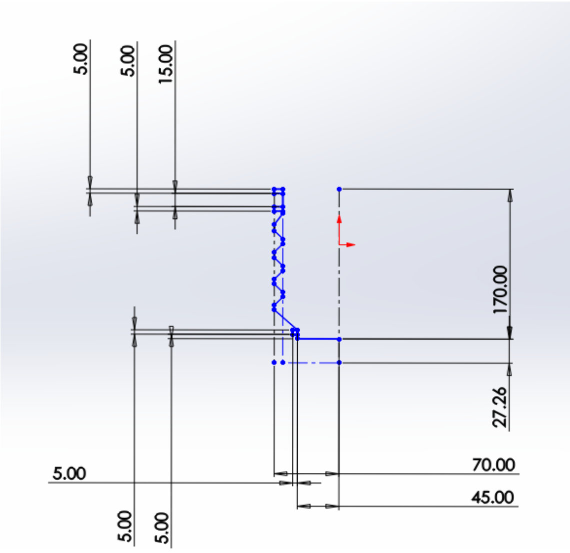


FIG 50

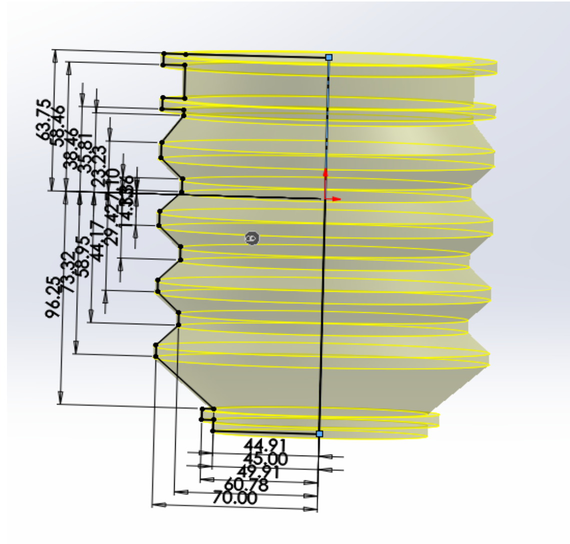


FIG 51

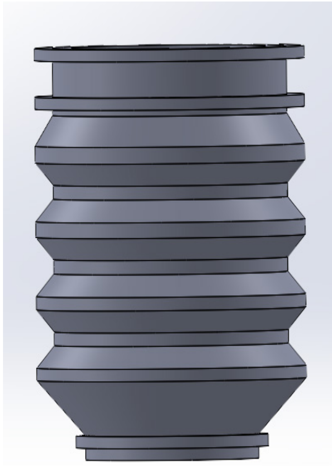


FIG 52

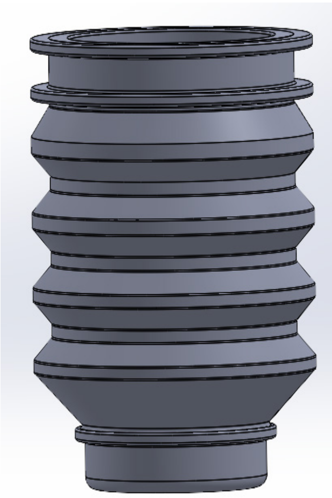


FIG 53

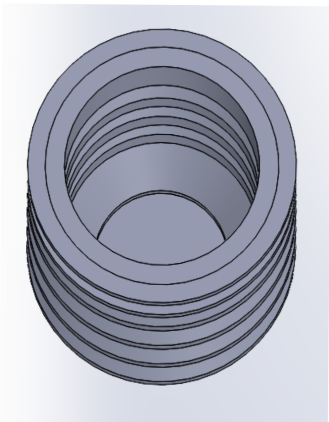


FIG 54

Using my ideations from Step 2, I incorporated a lip into the top of the body to attach a threaded plastic collar to allow the body to screw onto the Pio head.

To weight the base of the body, I mocked up a silicone extrusion which would be held in place by the addition of a housing attached to the base.

Development

I was not satisfied with how the body collapsed in FIG 52, so I used a silicone funnel to analyse a different profile and compare this with the Stojo.

The funnel's silicone was far thinner than the Stojo's which allowed for tighter bends and greater compactibility.

FIG 55

FIG 56

FIG 57

Based on this information, I produced a further CAD to test a new profile

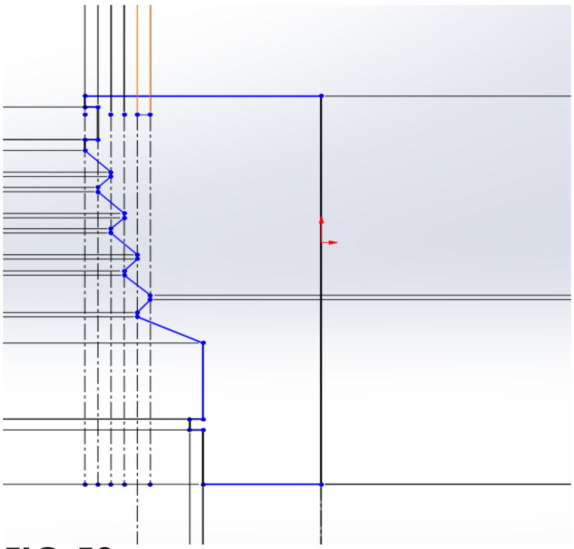


FIG 58

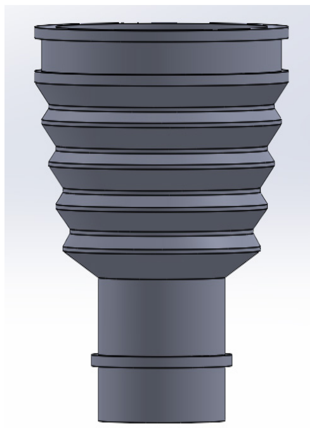


FIG 59

The measured profile of the silicone funnel

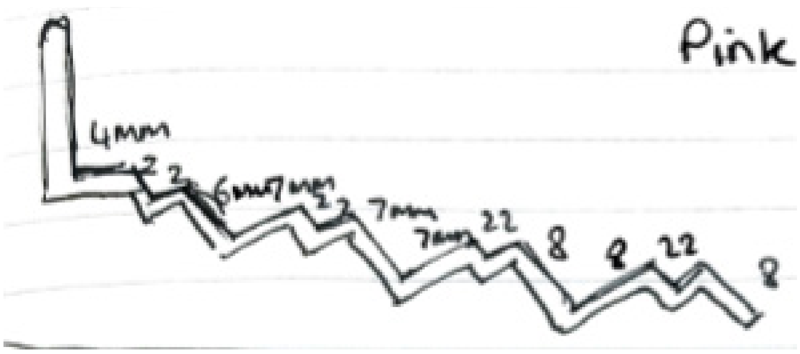


FIG 60

PIO: Step 4

Using the data from the previous steps and silicone products helped me calculate the relative distances in the bends to make the body collapse correctly.
FIG 61/62 show the final profile, with an overall height 170mm and base diameter of 90mm. Each section has a profile height of 30mm and a bend profile of 10mm to allow the sections to nest into each other.

Based on the thickness of the silicone funnel and the Stojo, I reduced the thickness from 10mm to 5mm to allow it to collapse more easily but maintain structural integrity.

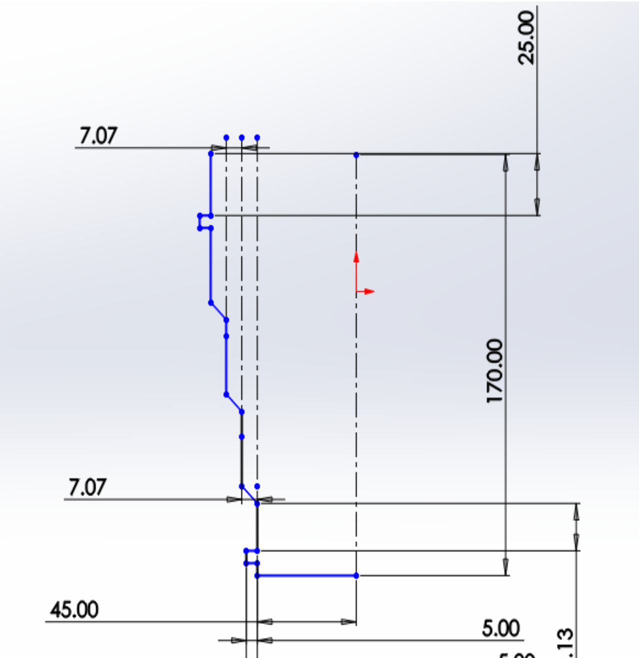


FIG 61

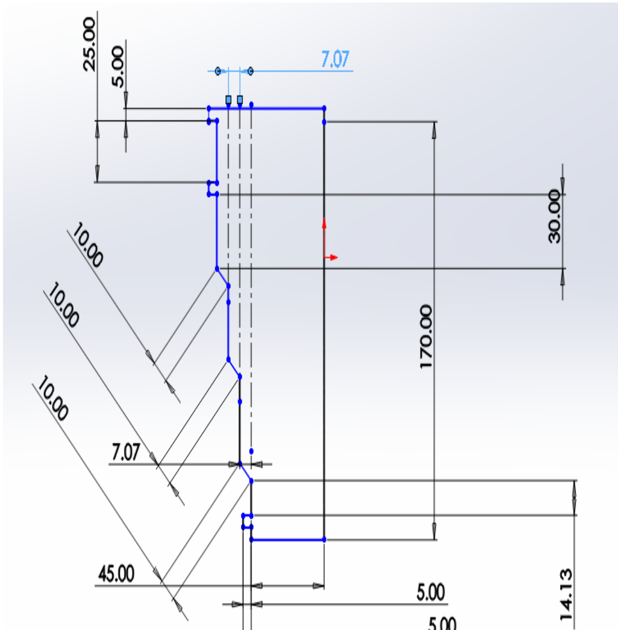


FIG 62

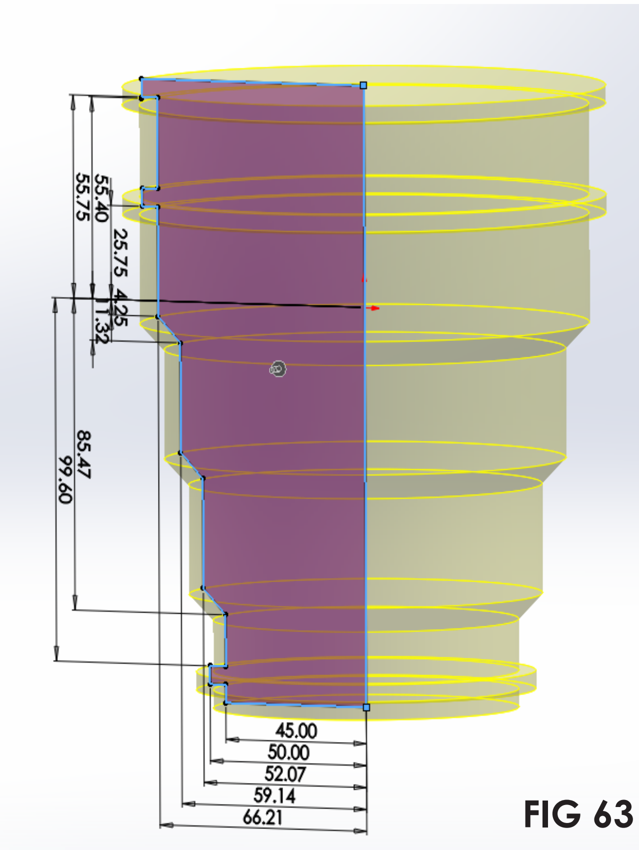


FIG 63

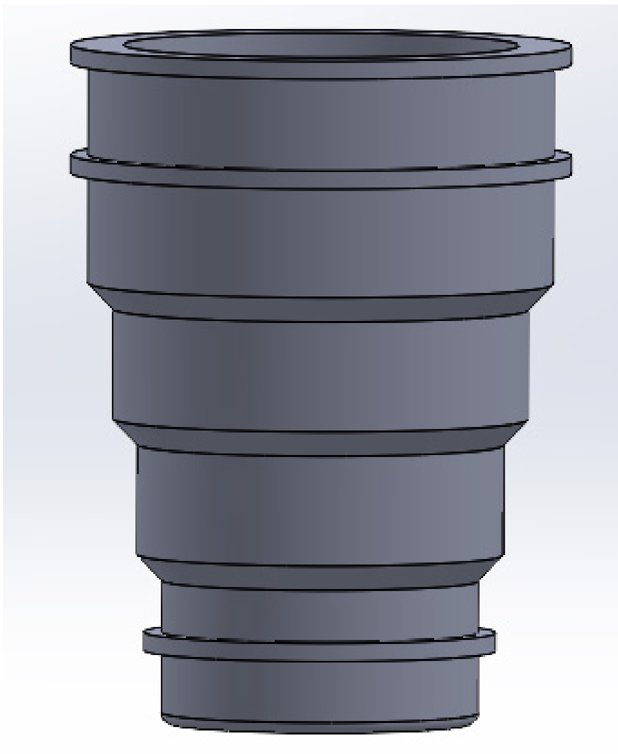


FIG 64

Collapsing The Body

Underview of the body showing profile when collapsed. All sections nest and the solid base sits centre.

I then shelled the collapsible body to a thickness of 10mm so that the walls retained enough structural strength to hold a baby bottle as well as collapse fluidly

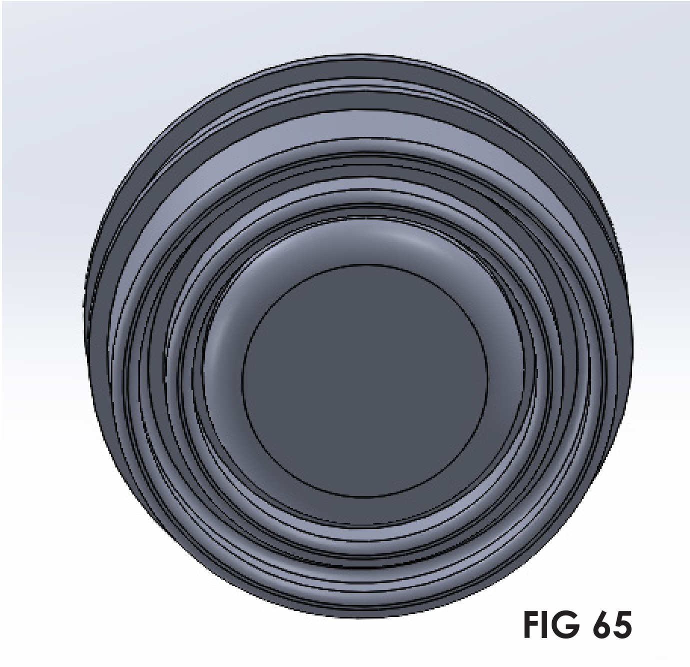


FIG 65

Screw On Collar

The collapsible body requires a collar (FIG 66) to attach the Pio head. This will be a threaded screw 12mm in depth with an override pitch of 2mm and overall 25mm in height with a circumference of 132.42mm. It will sit between the 2 silicone mouldings measuring 5mm at the top of the body (FIG 67).

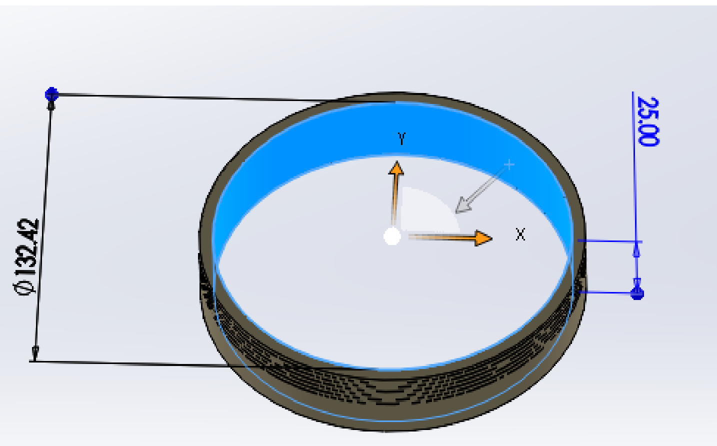


FIG 66

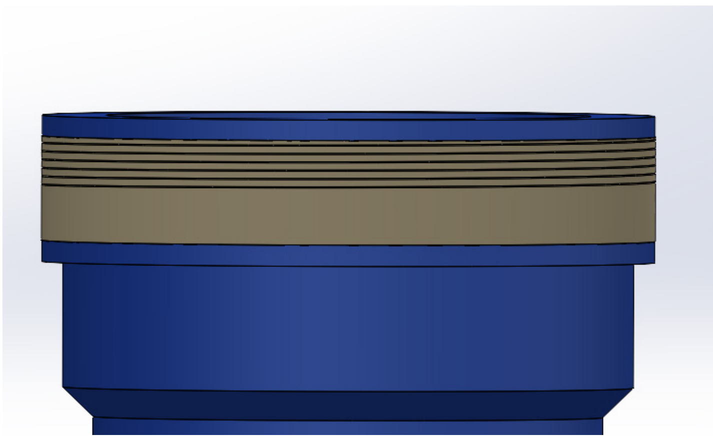


FIG 67

Body Base

To stabilise the Pio, a separate plastic base (FIG 69) will hold a silicone weight.

The body (FIG 68) attaches to this by compressing the silicone sides to make it smaller allowing it to be inserted into the base and locked behind a retaining lip when released.

By making the depth of the plastic the height of the 3rd collapsible section, the body is held in shape and has extra stability during the sterilising process.

The plastic base can be easily removed from the silicone base for cleaning by reversing the insertion process.

Pre-aesthetic views of the assembled Pio with bottle inserted.

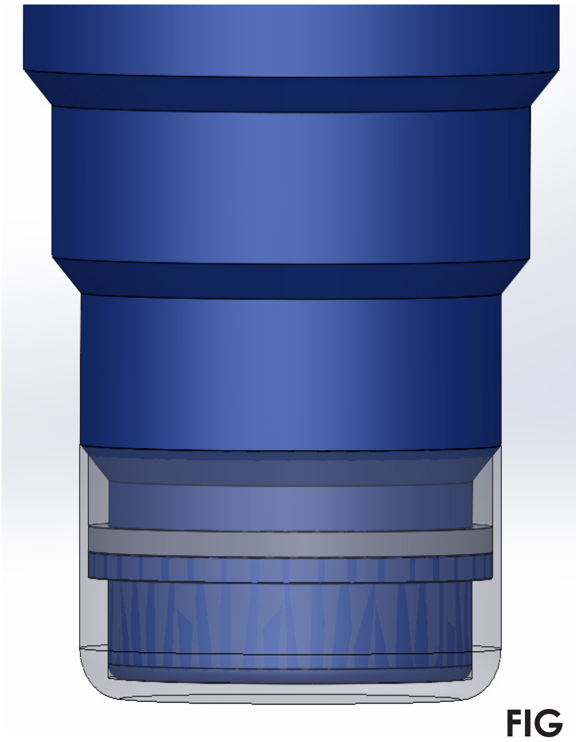


FIG 68

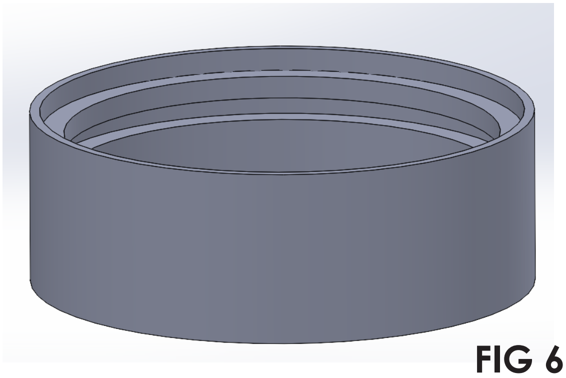


FIG 69

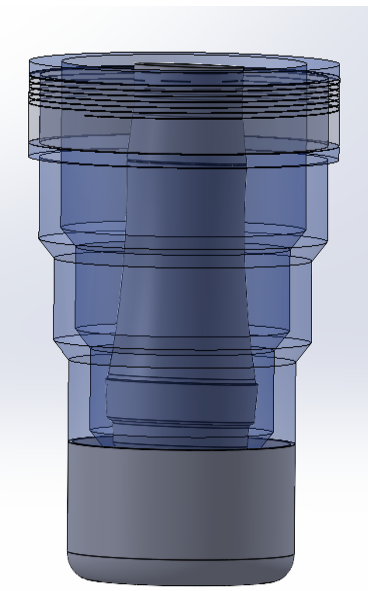


FIG 70

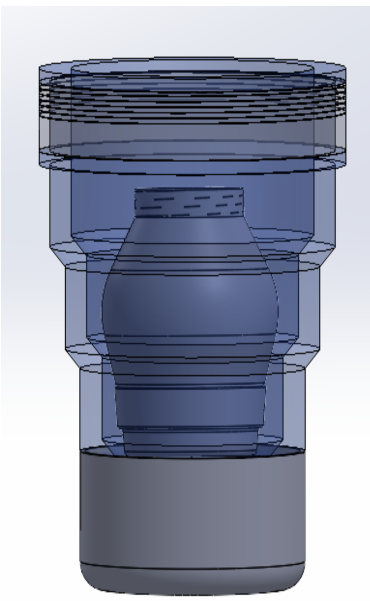


FIG 71

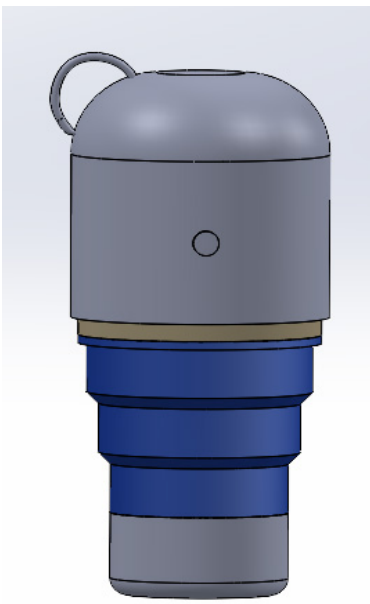


FIG 72

5 Development Pio Compartments

Compartments

I wanted the Pio to be able to sterilise a bottle and accessories.

Adding a screw on compartment will increase capacity, to sterilise multiple items.

I decided two different types of compartment were needed.

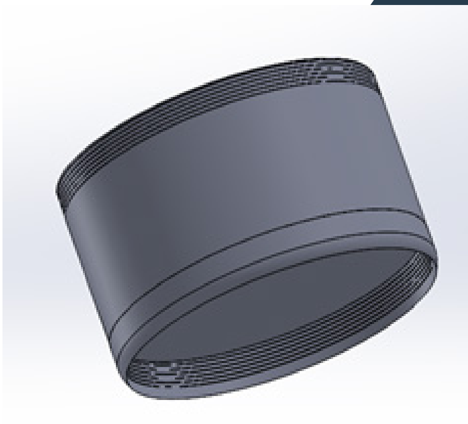


FIG 73

The first, Compartment 1, will have a transparent Quartz glass base so that the UV-C light can sterilise the contents and pass through to sterilise a bottle.

The second, Compartment 2, will be larger with a solid base that attaches to the Pio head in lieu of the collapsible body.

FIG 73/74/75, shows threaded compartments that can be attached to the top of the body and base of the Pio head..

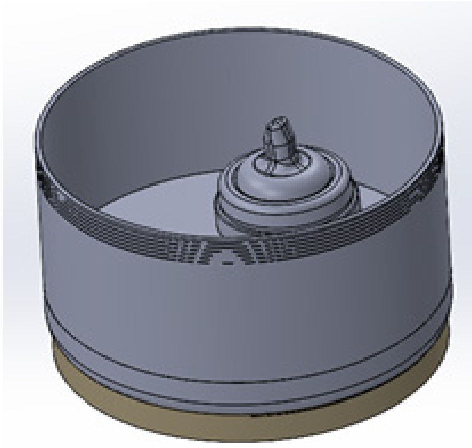


FIG 74

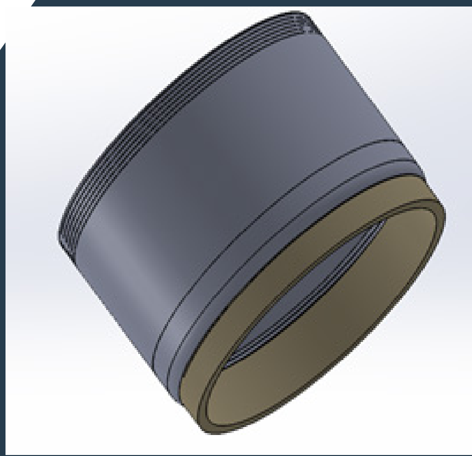
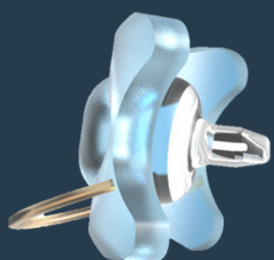


FIG 75

ACCESSORIES

I CAD drew accessories; feeding teet, a pacifier and a breast pump kit, in order to scale the Pio compartments and check the dimensions were adequate



Initial product renders demonstrate the functionality and attachment of the compartments.

Based on typical dimensions, compartment 1 will hold a pacifier and two feeding teets or one feeding teet and two pacifiers.

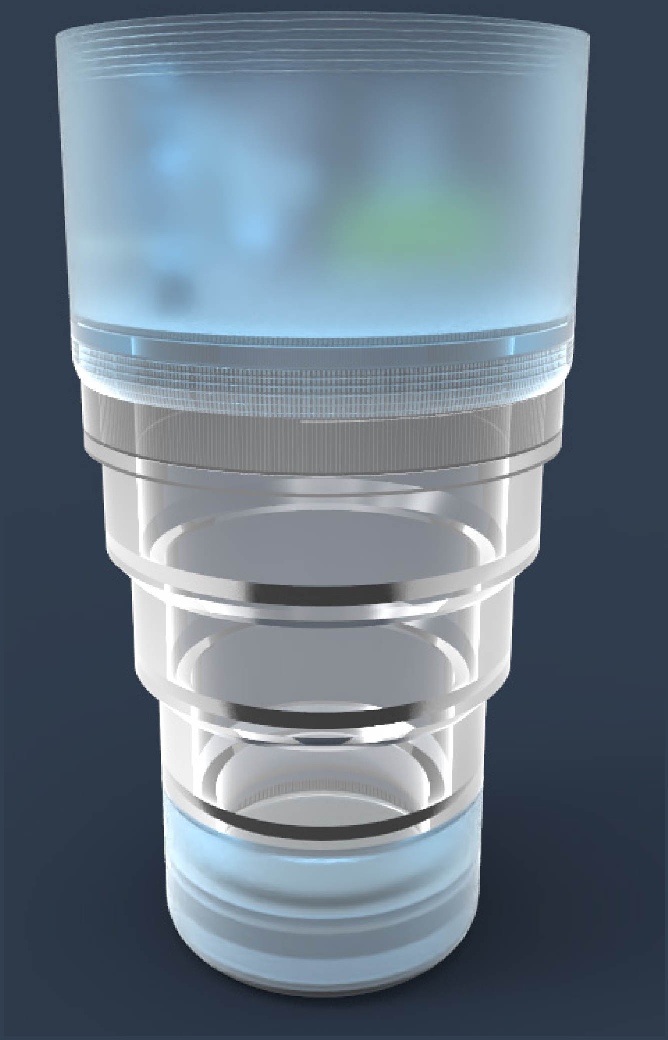


FIG 76

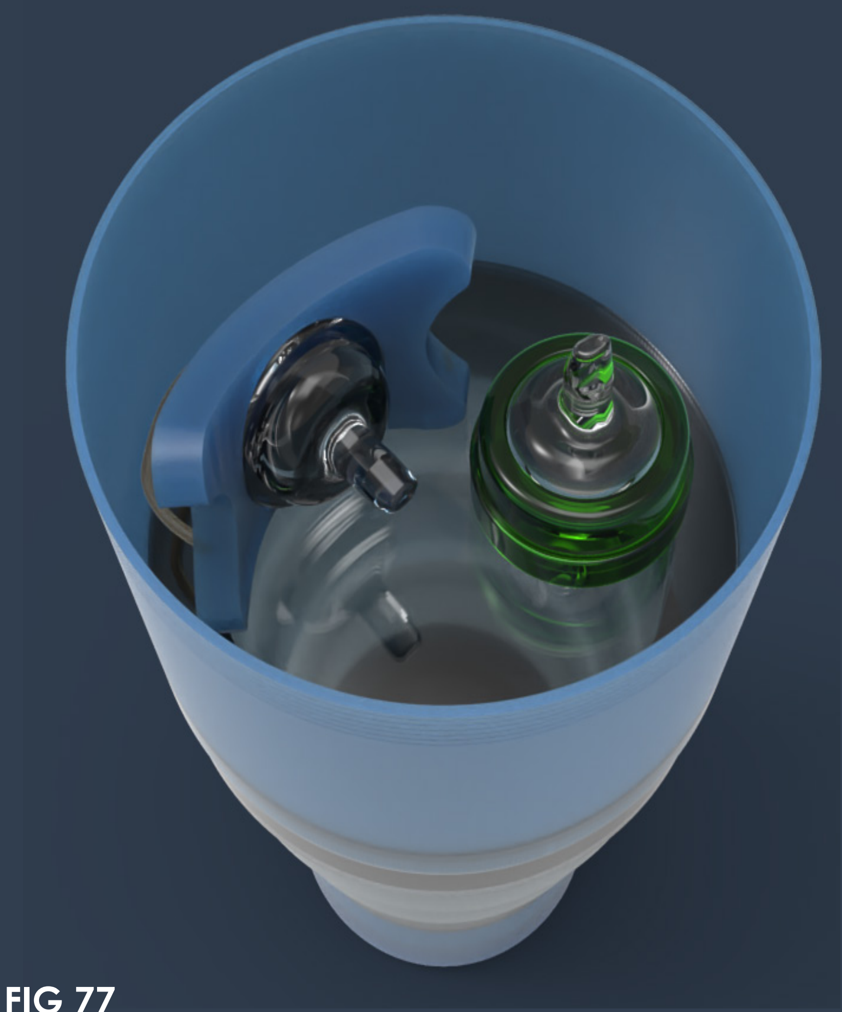


FIG 77

Compartment 2, will accommodate a pacifier, feeding teets and parts to a breast pump kit.

*Note; When assembled, a breast pump kit is much larger than the individual parts and the recommendation would be to use both compartments, keeping the larger items in the base

6 AESTHETICS

Original Head Design

FIG 78

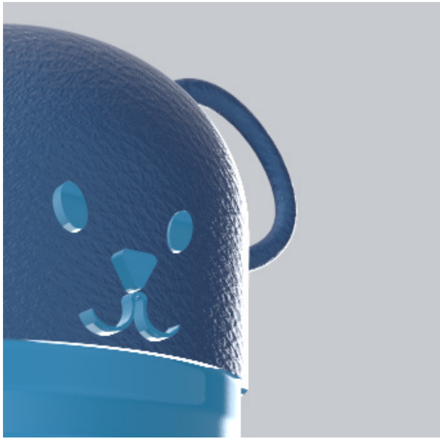


FIG 79

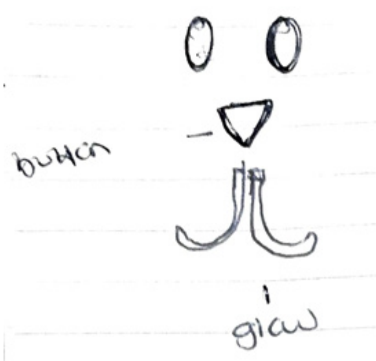
The head design originally reflected the branding of a baby product but this detracted from the sub brand focus.

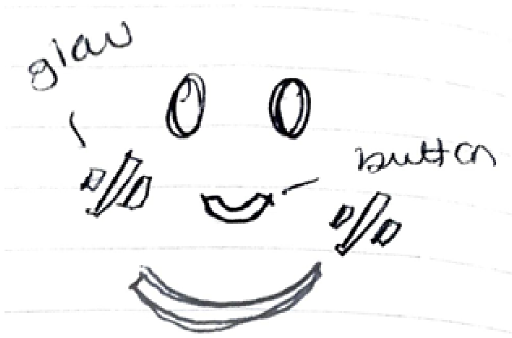
The single charger port was limiting.

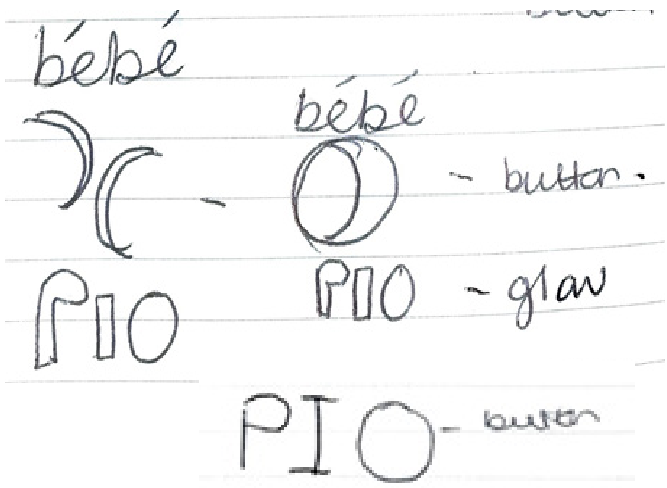
Ideation

I considered a number of designs to reflect the sub-brand's aesthetic and the baby theme.

Within these, I wanted to incorporate the device to activate the Pio and provide feedback to the user when in use.







CAD

I added my ideations in Solidworks to the Pio head. Although I initially chose a bear design for the Pio, I felt it was too close to being a product offered to the child instead of the adult and would limit future branding opportunities

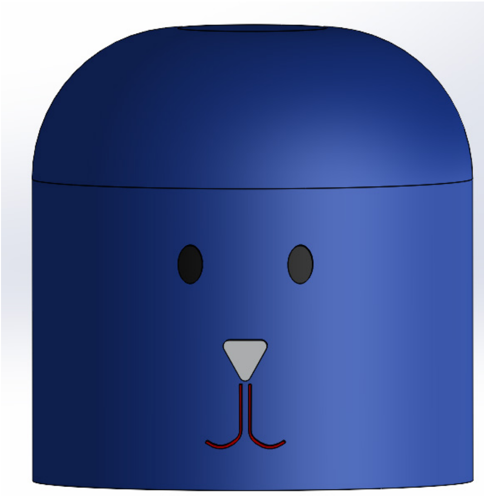


FIG 80

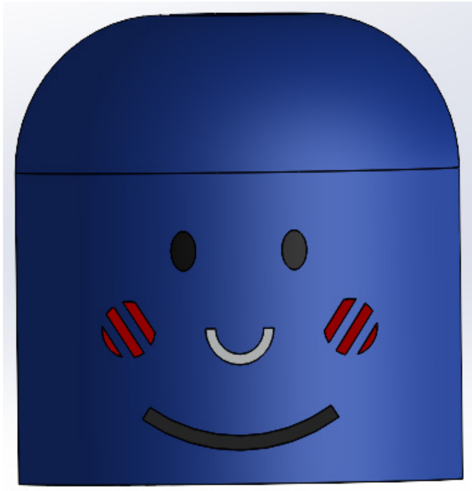


FIG 81

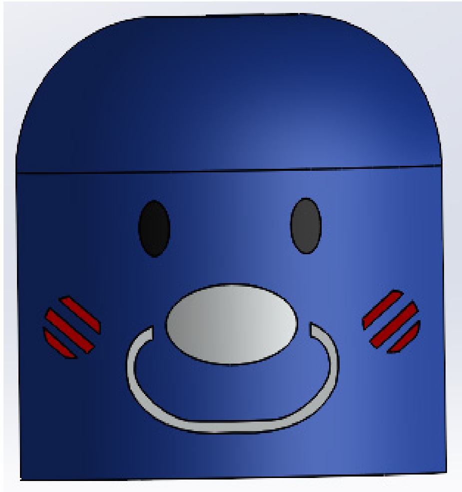


FIG 82

FIG 83

FIG 84

FIG 85

I developed some further handle designs with different thicknesses and mouldings. A double curved handle to allow the Pio to be held comfortably with two fingers and a thicker single loop to give the reassuring suggestion of strength.

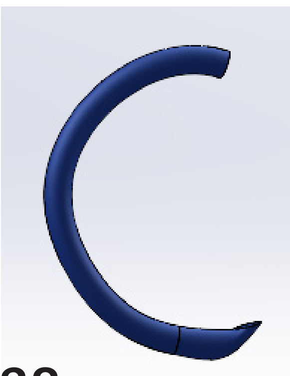


FIG 86

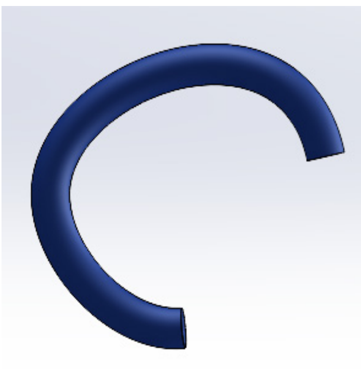


FIG 87

FIG 88

FIG 89

Client Feedback

I showed my client Zoe, from IKB 1, the aesthetics from page 44 for her preference.

She preferred the cloud motif as she felt it "evoked the feel of a baby product without being tacky or too focused on the child theme rather than the parent who would buy it".

FIG 90

Zoe prefered the streamlined handle as she felt the double loop looked awkard. She also felt it was a redundant detail as the product isn't so heavy that you would need that extra grip.

FIG 91

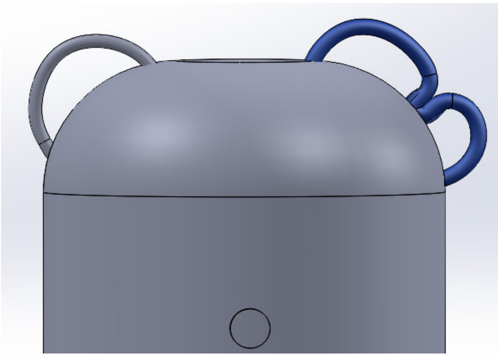


FIG 92

FIG 93

I showed her a render of the Bebe Pio. She thought that it gave the product a high end finish and looked sophisticated.

She associated the look of the product with quality and assumed from that, it would last well, be reliable and be value for money even if the cost were quite high.

FIG 94

Full Assembly

This is the full technical assembly of the Pio showing the internal structures, electronics and how it is anticipated the product will fit together including the product logo embellished on the front

The ON/OFF button will be aligned to the Bebe brand motif

The Pio head, compartments, supporting base and threaded collars will be made from soft touch HDPE.

The carry loop from synthetic hemp

The collapsable body will be made from Liquid Silicone Rubber.

Refer to Appendix C for Material research and justifications

All parts to the Pio will be injection molded

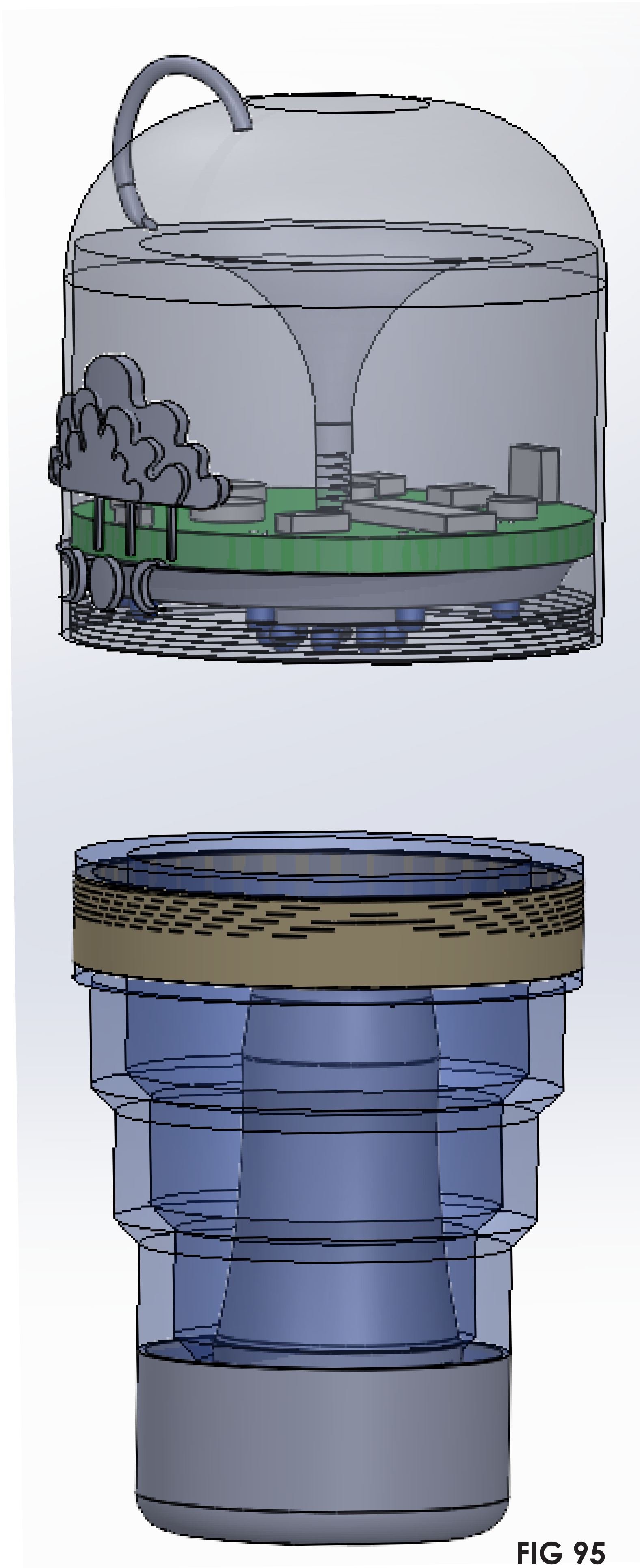
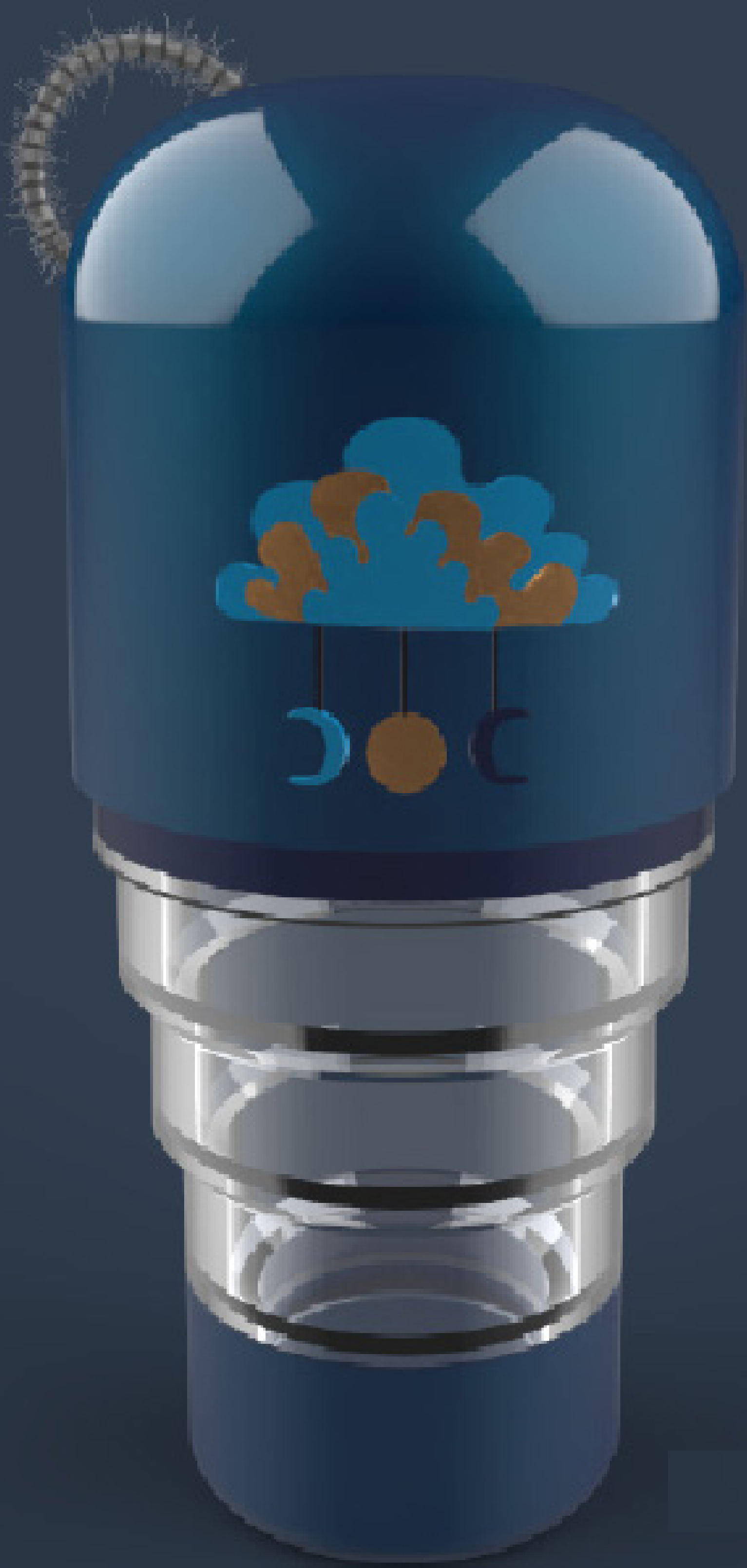


FIG 95

7 FULL ASSEMBLY RENDERED

Product View

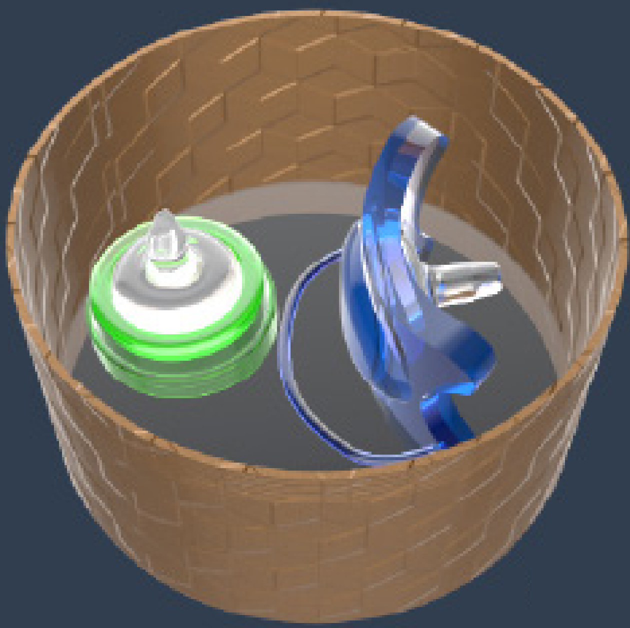


Alternative renders in Appendix A

Collapsed View

Exploded View

Compartment View



Alternative renders in Appendix A


8
PDS

Pio Specification

1) FUNCTIONALITY

- The body should be dishwasher safe.
- The head and compartments should be able to be wiped clean
- Should be stable on a level surface
- Should give user feedback
- Should sterilise 99% of all bacteria and milk residue on all surfaces
- Should have a simple ON/OFF operation
- Should shut off automatically when sterilising complete
- Sterilisation should take no more than 10 minutes.
- Should be easy to assemble
- Should accommodate different sized accessories
- Should be portable and compact
- Should accommodate a range of baby bottles on the market.

2) SIZE, WEIGHT, ERGONOMICS

- Should be lightweight
- Should weigh no more than 500g.
- Should be comfortable to hold and carry.

3) ENVIRONMENT

- Must be 100% waterproof, to protect internal electronics.
- Should be 100% recyclable and made from non toxic materials

5) AESTHETICS

- Should reflect the company's sub brand and aesthetics.
- Should appropriately reflect the target user
- Should be attractive and desirable

6) MANUFACTURE

- Should be manufactured using efficient, cost effective processes
- Mass production (batch) of 25,000 units will initially be produced.

7) CUSTOMER BASE

- Hygiene conscious consumers
- 30s to 40s middle income, but not limited to this age bracket
- Consumers who have high expectations of modern, technically designed devices

8) ELECTRICAL REQUIREMENTS

- The UV-C LEDs must have a wavelength of 266nm
- Must provide USB and USB-C charging ports
- LED arrays must be arranged so that they shine on the inside and outside of a baby bottle.
- Electronic boards to be replaceable.
- Minimum 3 operations from a single charge

9) SERVICE LIFE

- The product must be able to be disassembled for a through clean and to allow electronics to be replaced
- 2 year warranty

10) TARGET PRICE

- Cost £50-70.00
- All materials and components used should be costed for the best price

11) HUMAN FACTORS

- The user touch points should be identifiable through the use of a single colour.
- The product should not have any sharp edges
- All components should be easy to unscrew

12) PACKAGING AND DISTRIBUTION

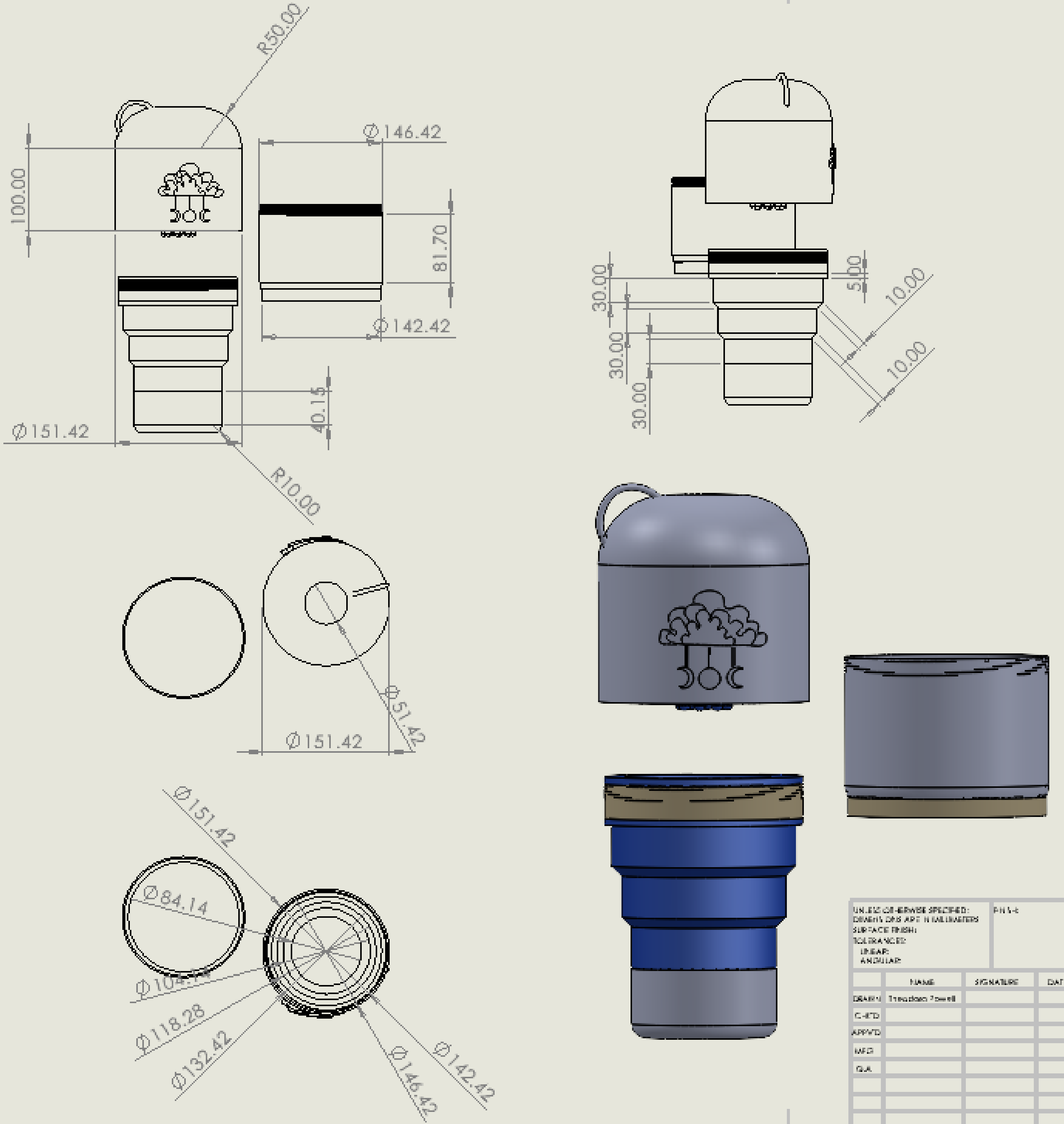
- Packaging must account for only 10% of manufacturing costs.
- Packaging must be made from recycled materials.
- The packaging should show all brand colours, the logo and the name of the product.
- The Pio should come with clear instructions on use, care and disposal

13) MATERIALS

- Materials used should be resistant to UV light.
- All materials must be appropriate to their use
- The material used should be; lightweight, inert, non-toxic, shatter-proof and moisture resist-ant
- All materials should be able to be produced in a range of colours
- The silicone used for the cup must be LFGB certified.
- The HDPE must be BPA/BPS free.
- The product must meet all of the British standards and should be awarded the CE mark.
- The materials used must have a thermal deformation of over 100 degrees.

14) PRODUCT DISPOSAL
- The product should be able to be fully disassembled for specialist recycling

9 GA DRAWING



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	collapsable cup 6 copy	Silicone Rubber	1
2	Screw Collar to Pio body	HDPE	1
4	Collar	HDPE	1
7	connector compartment 1	Soft Touch HDPE	1
8	quartz plate	Quarts Glass	1
9	connector compartment 2	HDPE	1
11	pio head	Soft Touch HDPE	1
12	EAR LOOP	Synthetic Hemp	1
13	LED PLACE 1	HDPE	1
16	pcb board	Fiberglass Resin	1
17	cloud	Soft Touch HDPE	1
21	on button	Silicone Rubber	1
22	moon	Perspex	1
23	moon 2	Perspex	1
25	screw on cap	HDPE	1

TITLE: **Bebe Pio**

MATERIAL: HDPE

A3

10

Bebe Pio

Presentation Boards

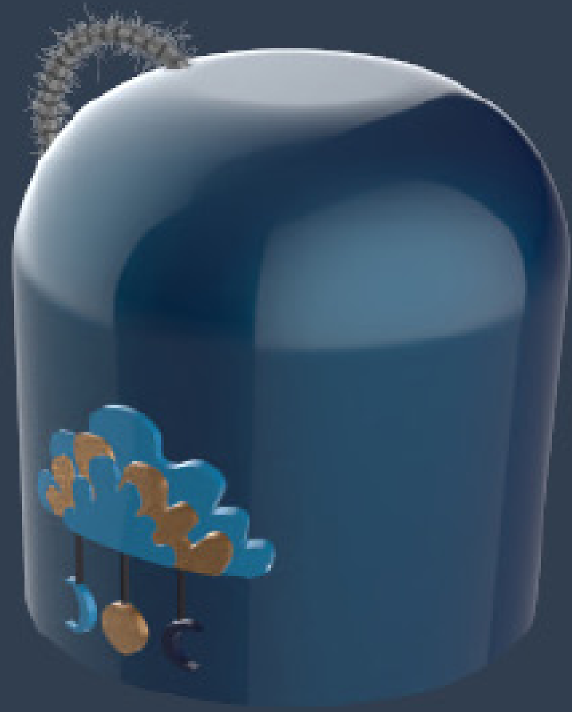
bébépio

Introducing Bebe Pio.

The Pio is an all in one complete solution to steralising baby bottles and accessories on the go. It revolutionises the portable sterilisation product market

Its sleek understated design, offers exceptional quality and performance

The Bebe Pio has two charger port options; USB and USC. This allows the device to be charged via computer or battery pack



The Pio comes with two compartments in a colour coordinated and textured finish.

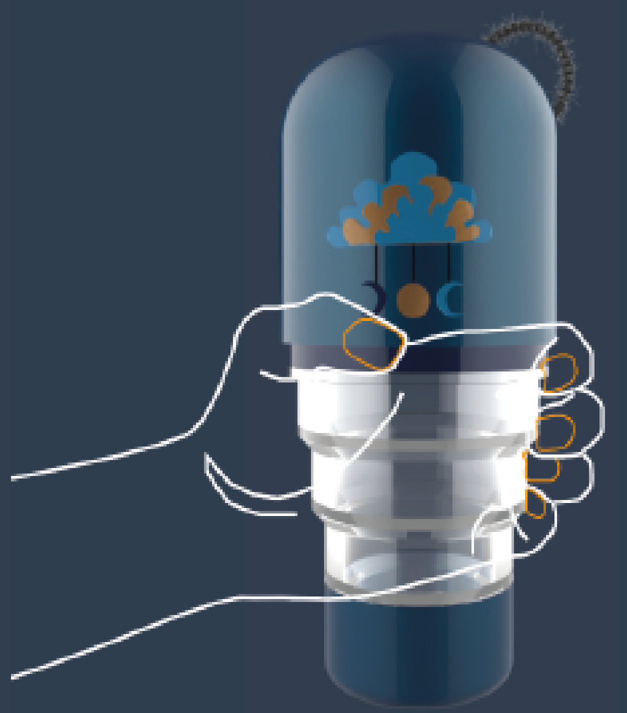
The larger gold compartment can be used alone with the Pio head to sterilise larger accessories.

The smaller compartment with a transparent base can be screwed onto the collapsable cup to sterilise smaller accessories at the same time as sterilising a bottle.

Key features:

- Kills 99% of surface bacteria inside and out
- Gets rid of all milk residue
- Compact and space saving
- Lightweight and durable
- Easy and convenient to use
- Can be used day or night - anywhere

bébépio



Introducing Bebe Pio. When expanded, it can accomodate most sizes of baby bottle. Additional compartments can be used for the simultaneous sterilisation of accessories or used as a stand alone to sterlise accessories only.

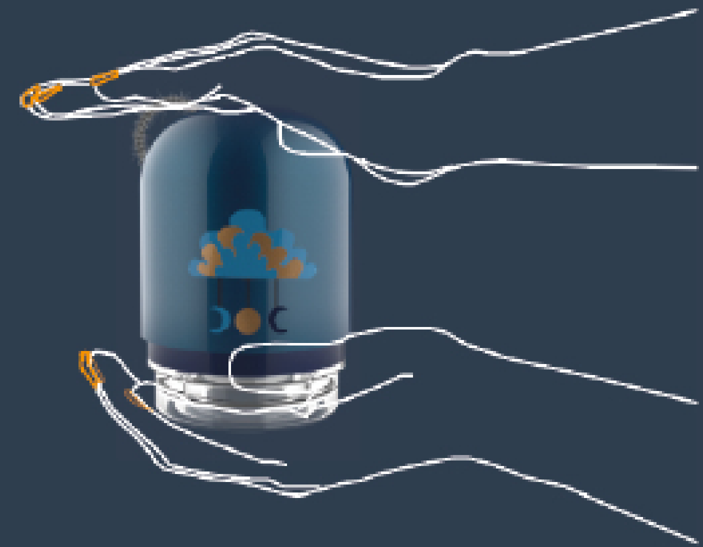
The hidden dangers you don't see such as germs, surface bacteria and milk residue can be present on your baby's bottle which if left, could be harmful. The Pio will remove these.

A simple screw top allows you to place your baby bottle into the main collapsable compartment. Two rings of UV-C LEDs ensure the baby bottle is sterilised inside and out.

A simple push button operation activates the Bebe Pio.

When in use, a blue light indicates the Pio is on and has started to sterilise.

The red light indicates when the cycle has finished and the Pio will turn off completely after 2 minutes of inactivity



Collapse your Pio and stow away for future use or attach to your stroller or changing bag for quick access.

Self-Evaluation against specification

This project has been almost entirely theoretical in concept and execution due to the lack of access to workshops and 3D modelling. I also missed having the opportunity to discuss my design ideas in more detail and explore the viability of the materials I have chosen.

In these difficult circumstances and working remotely I have tried to technically design this product to the best of my ability using materials around me as the springboard for my ideas and by sourcing specific components from Amazon to demonstrate my technical understanding.

One of the main problems I encountered during this project was figuring how to get the dimensions right and how to make the body collapse to a minimum dimension. I would have benefitted from being able to prototype this but other than that, I feel I have met the brief of a functioning product, based on the established scientific research as shown in Appendix C.

Another challenge was how to avoid product failure, particularly with a portable device. I think using threaded attachments rather than buttons or catches that wear over time, addresses an important issue.

I also wanted to think ahead to the manufacturing cost and how to limit this. Where possible, I have extruded components to reduce the number of parts in manufacture and assembly. The extruded screw in the Pio head also serves to locate and simplify access to the component boards for replacement or recycling.

I am particularly pleased to have combined practicality with a nice aesthetic. I am happy that the Pio now provides clear feedback to the user and the additional compartments offer greater flexibility.

I feel I have now addressed the issues from IKB1 and extended the functionality in keeping with the Pio and its purpose and have made the whole design more cohesive.

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Appendix A

ALTERNATIVE RENDERS STYLES: BEBE PIO

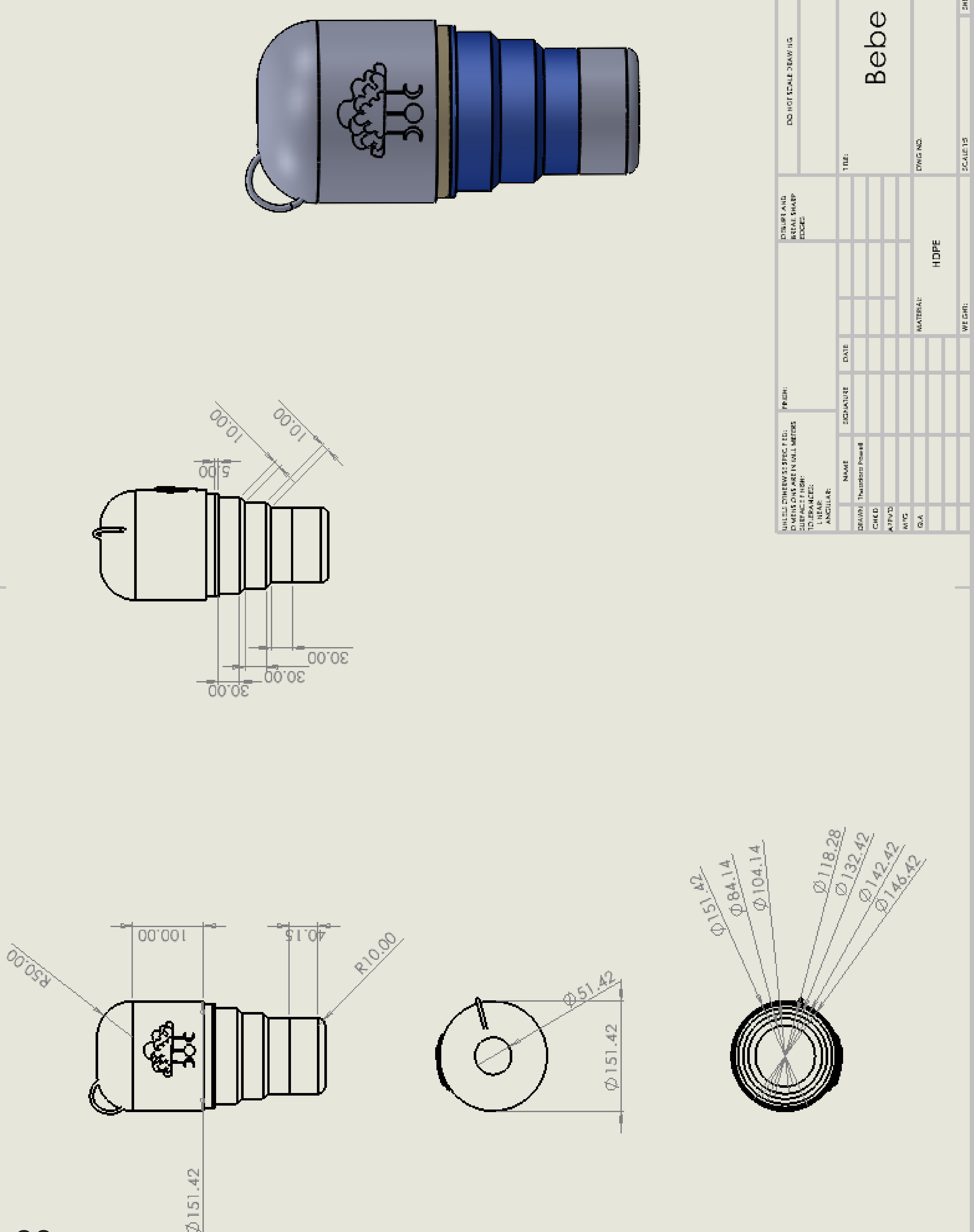
Appendix A

ALTERNATIVE RENDERS STYLES: BEBE PIO COMPARTMENTS



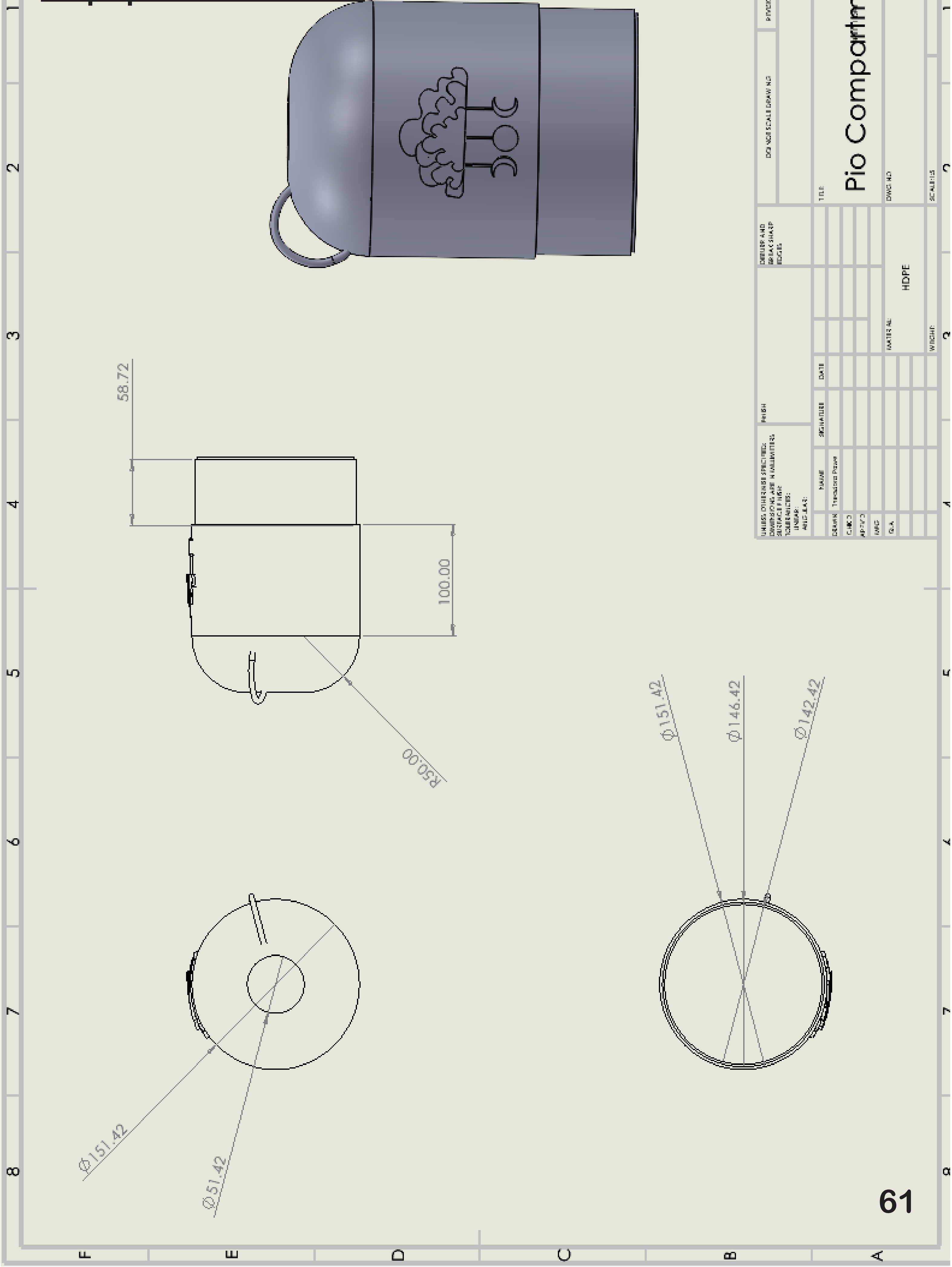



Appendix B



Bebe Pio
HDPE
A3
DO NOT SCALE DRAWING
REVISION
TITLE:
DWG NO.
MATERIAL:
WEIGHT:
SCALE:1:5
SHEET 1 OF 1
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:
FINISH:
DEBURR AND BREAK SHARP EDGES
NAME
SIGNATURE
DATE
DRAWN
CHK'D
APPV'D
MFG
Q.A
10.00
10.00
5.00
30.00
30.00
30.00
100.00
40.15
R50.00
R10.00
Ø151.42
Ø51.42
Ø151.42
Ø151.42
Ø84.14
Ø104.14
Ø118.28
Ø132.42
Ø142.42
Ø146.42

Appendix B


Pio Compartments
HDPE
A3
58.72
100.00
R50.00
Ø151.42
Ø146.42
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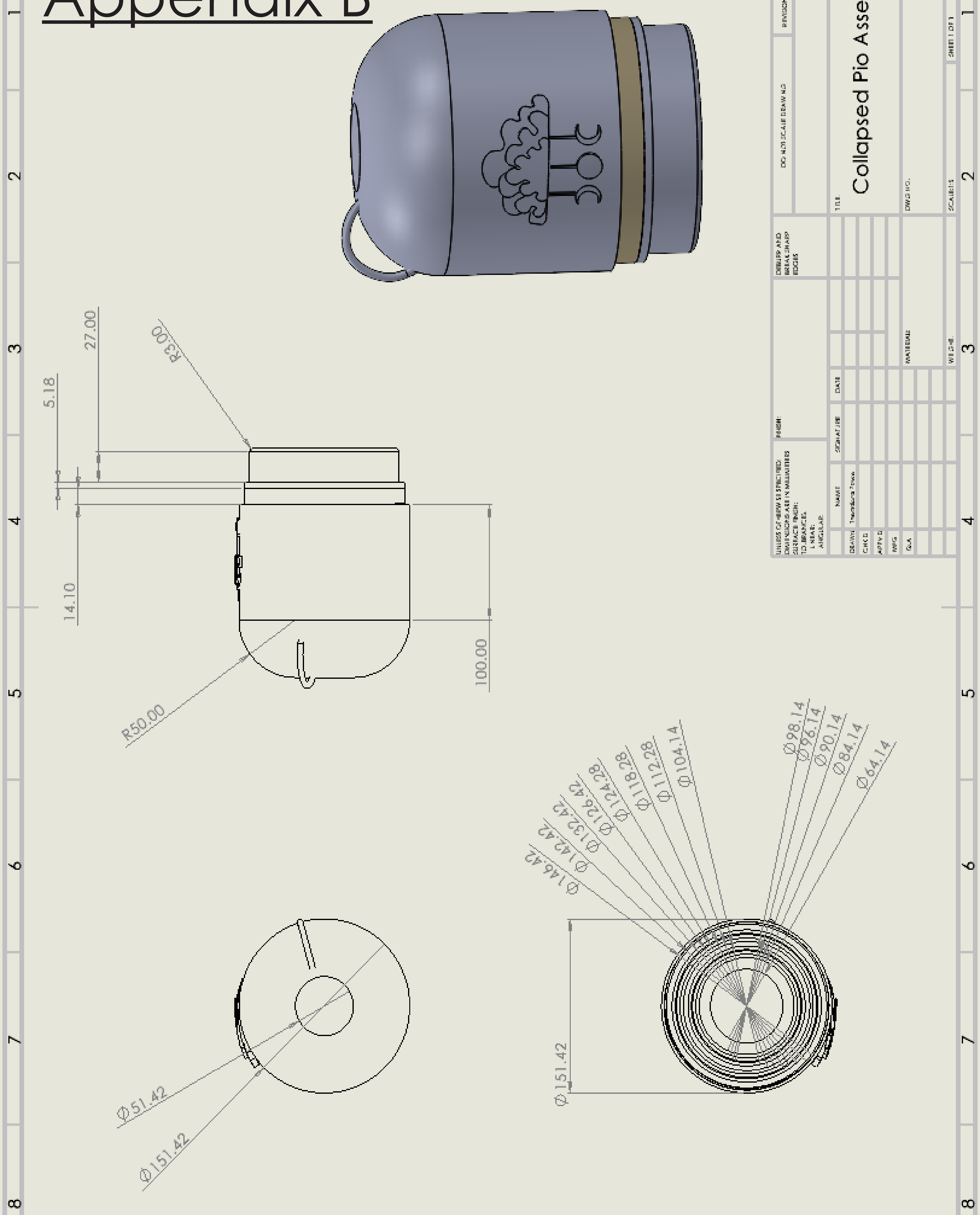
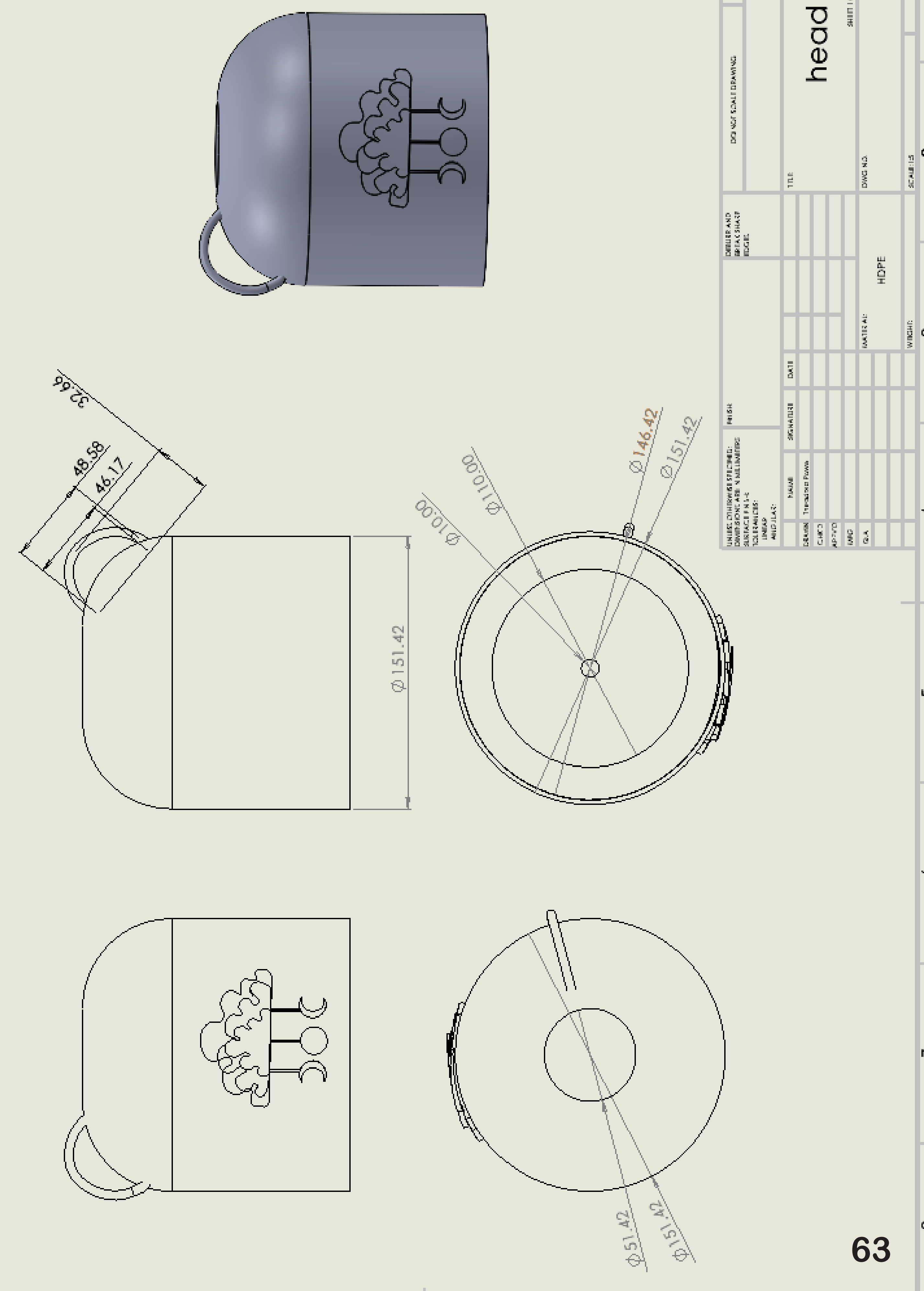
Ø151.42
Ø51.42

Appendix B


Collapsed Pio Assembly
A3
27.00
5.18
R30.00
14.10
100.00
R50.00
Ø51.42
Ø151.42
Ø151.42
Ø146.42
Ø142.42
Ø132.42
Ø126.42
Ø124.28
Ø118.28
Ø112.28
Ø104.14
Ø98.14
Ø96.14
Ø90.14
Ø84.14
Ø64.14

Appendix B


head
A3
HDPE
32.66
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Ø151.42
Ø110.00
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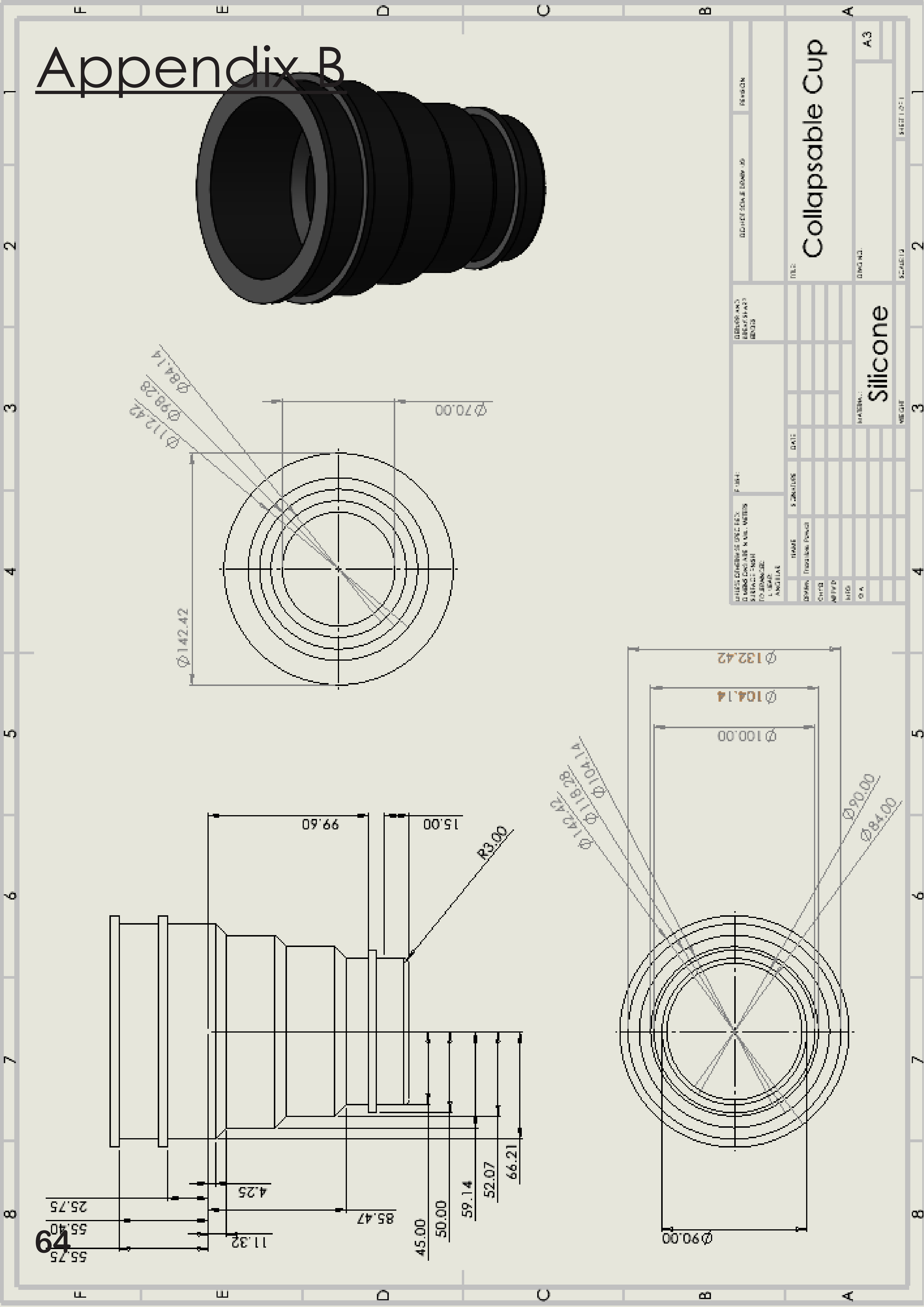
Ø151.42
Ø151.42

Appendix B



Collapsable Cup
Silicone
A3
Ø70.00
Ø84.14
Ø98.28
Ø112.42
Ø142.42
Ø132.42
Ø104.14
Ø100.00
Ø118.28
Ø90.00
Ø84.00
99.60
15.00
R3.00
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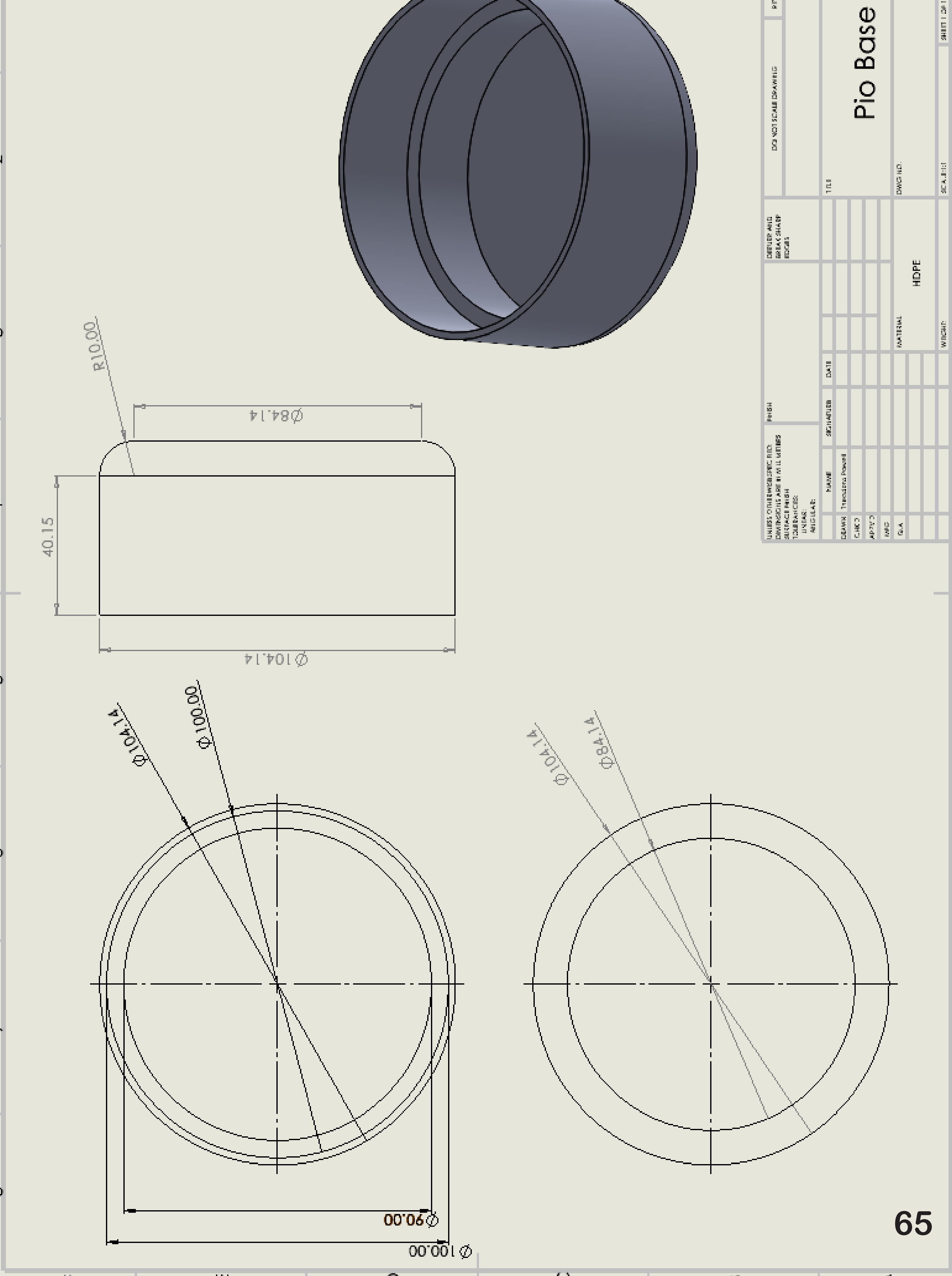
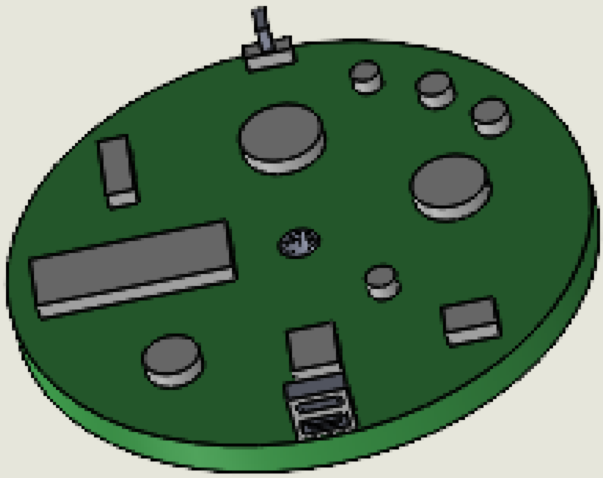
52.07
66.21

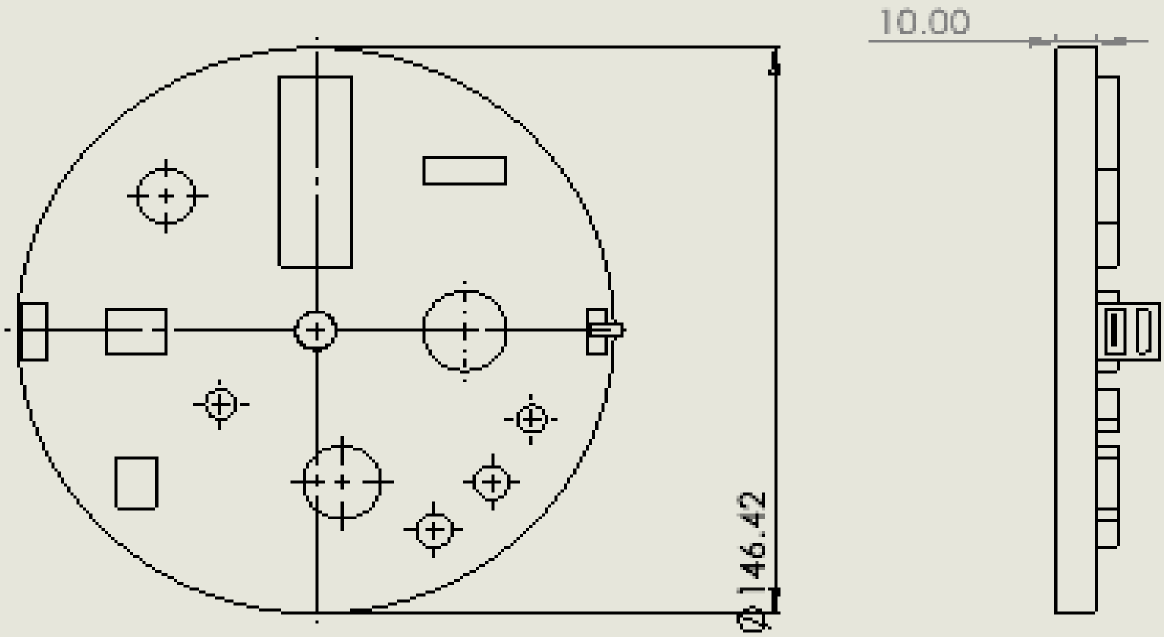
Appendix B



R10.00
Ø84.14
40.15
Ø104.14
Ø100.00
Ø90.00
Ø104.14
Ø84.14
Pio Base
HDPE
A3

Appendix B





UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:

FINISH:

DEBURR AND BREAK SHARP EDGES

DO NOT SCALE DRAWING

REVISION

	NAME	SIGNATURE	DATE
DRAWN	Theodora Powell		
CHK'D			
APPV'D			
MFG			
Q.A			

MATERIAL:

WEIGHT:

TITLE:

pcb board

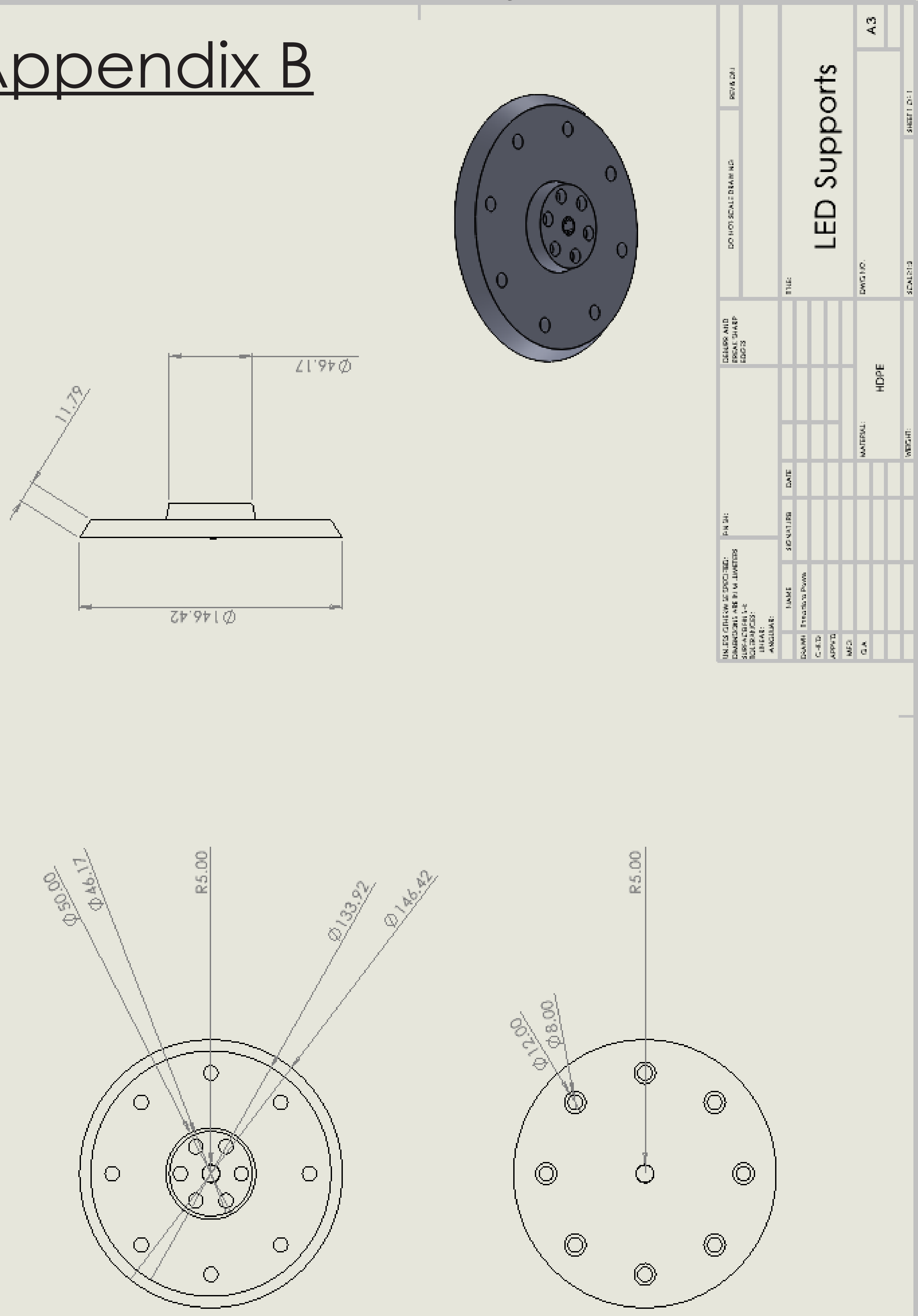
DWG NO.

A4

SCALE:1:2

SHEET 1 OF 1

Appendix B



Ø46.17
11.79
Ø146.42
R5.00
Ø50.00
Ø46.17
Ø133.92
Ø146.42
Ø12.00
Ø8.00
LED Supports
HDPE
A3

Appendix C: Research

UV-C Research

“Only UV LEDs that emit in the UV-C portion of the spectrum must be used.

This is due to the way in which the DNA and RNA molecules react to these wavelengths, rendering the pathogens sterile and unable to reproduce.” (waveform lighting, 2021).

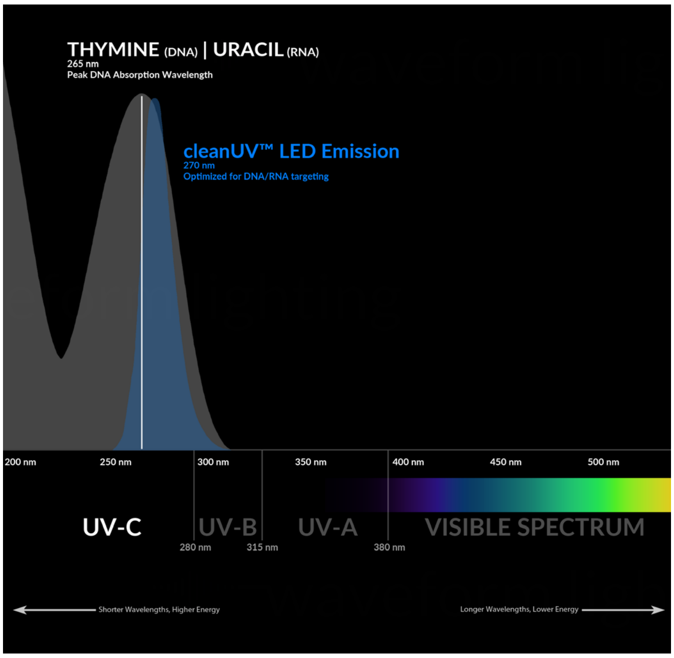


FIG 2 (waveform lighting, 2021)

Recent research has shown that UV-C is the only wavelength band that can reliably kill a range of viruses, bacterium and molds.

This is due to the fact that certain nucleic acids in the structure of DNA (FIG 3) undergo greater chemical change as they are able to absorb larger amounts of ultraviolet energy which fundamentally alter the chemical bonds of its structure and the structure of DNA itself. This change in structure prevents the pathogen from reproducing as is otherwise known as dimerization.

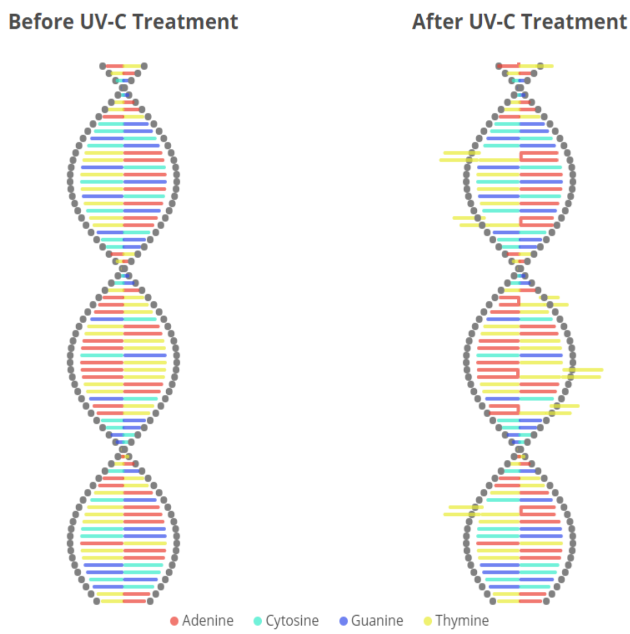


FIG 3 (waveform lighting, 2021)

“Thymine (and Uracil) have an absorption spectra that are especially sensitive at wavelengths at or near 265 nanometers. At wavelengths longer than 300 nanometers, there is almost no absorption.” (waveform lighting, 2021)

Taking into account the required UV wavelengths for sterilisation, I shall analyse this further and implement this into the Pio functionality.

Appendix C: Research

LED Technology Analysis

UVC light is a widely used sterilization technology .

Unlike their predecessor UV lamps, UV-LEDs can be configured to emit any desired wavelength. They are also very small and lend themselves to integration into small electrical devices.

They emit high intensity light as soon as they are turned on so there is no warm up time. They also contain no Mercury and yield a consistent irradiation output regardless of temperature.

UV-LEDs converges at one point. Rather than radiating in all directions, it radiates in a linear pattern and does not lose much light intensity by spreading.   This means if LED light is concentrated onto a target area it is much more effective.

Various tests have been conducted into the efficacy of UV-C LEDs (American Society for Microbiology, 2015) to destroy microbes on dairy products such as cheese to assess its suitability as an antimicrobial control intervention. These tests ran for 10 minutes at a time at a dosage of 3 mJ/cm2, killing 99.99% of all pathogens leading to a 6Log result (FIG 12). This demonstrated it was an effective process which did not affect the molecular structure or colour of the dairy,

UV-LEDs are available in various standard wavelengths, from 100 to around 280nm. My research suggested, the most effective germicidal wavelength occurs at a peak of 260 to 265 nm at which DNA absorbs UV the most, therefore achieving a higher pathogen reduction.

This suggests using a standard LED of 266 or 270nm in the Pio would be effective

Dosage required to kill viruses and bacteria:

Species	Dose (mJ/cm²)
Bacillus subtilis ATCC6633	24
Legionella pneumophila ATCC 43660	3.1
Streptococcus faecalis ATCC29212	6.6
Hepatitis A Virus	5.5
Poliovirus Type 1 LSc2ab	5.7
Escherichia coli ATCC 11229	3.5
Staphylococcus aureus ATCC25923	2.6
SARS-CoV-1 Coronavirus	0.9
SARS-CoV-2 Coronavirus	3.75

(Luminus, 2020)

FIG 11

	Number of germs remaining	Germicidal effectiveness
1 Log	100,000	90% reduction
2 Log	10,000	99% reduction
3 Log	1,000	99.9% reduction
4 Log	100	99.99% reduction
5 Log	10	99.999% reduction
6 Log	1	99.9999% reduction

FIG 12

Appendix C: Research

Components Research

UV-C LEDS

UV-C LEDs are a relatively new technology, offering significant advantages as they come in a range of wavelengths, have a long lifetime, are space efficient, lightweight, and have a very low power consumption

No more than 20mA should flow through the LED, therefore to limit current flow, it is essential to add a 250Ω resistor. UV-C LEDs need approximately 3.3V across it and 16-18mA flowing through it (Learning about Electronics, 2021).

(Tayda, 2021) **FIG 24**

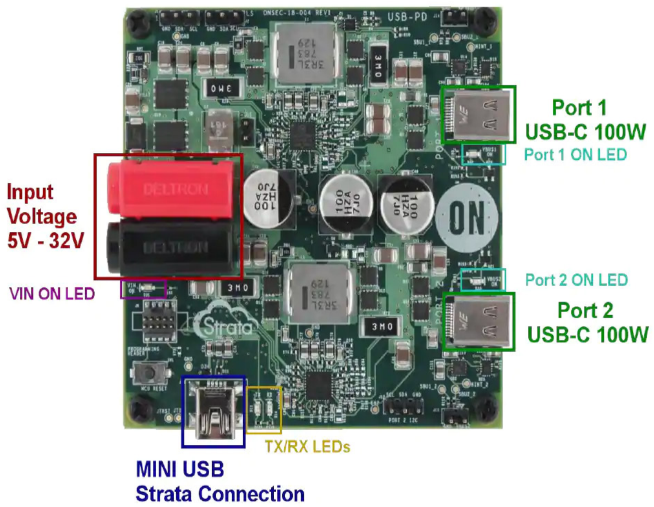


FIG 25

Transformerless Power Supply

A transformerless power supply uses a high voltage capacitor to drop the mains AC current to a lower level suitable for the connected electronic circuit without using any form of transformer or inductor.

A Zener Diode is used in conjuction to stabilise the high peak voltage which is now equal to the peak value of the mains AC (homemade circuits, 2021).

LM555

An LM555 is a highly stable device used to generate accurate time delays or oscillation. During its operation, time delay and frequency are precisely controlled by external resistors and capacitors. Additional terminals are located to reset the LM555's programmed function (Texas Instruments, 2021).

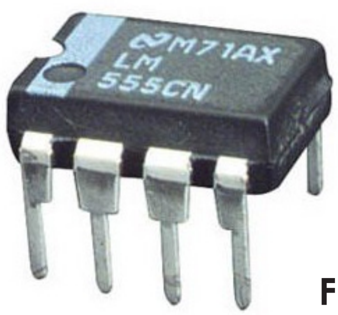


FIG 26

(Walmart, 2020)

Appendix C: Research

Component costings Analysis

COMPONENT	QUANTITY	COST
UV-C LED	16	0.08p x 16
LM555	1	0.08p x 1
Reed Switch	1	0.40p x 1
DC-DC Step up board	1	£1.00 x 1
Blue LED	1	0.20p x 1
Red LED	1	0.20p x 1
Relay (FL-3FF-S-Z 5VDC)	1	£1.40 x 1
18650 Battery Shield	1	£4.72 x 1
Lithium Battery	1	£3.50 x 1
Resistor	3	0.02p x 3
Diode	2	0.06p x 2
Ceramic Capacitor	1	0.02p x 1
Electrolytic Capacitor	1	0.03p x 1

TOTAL COST = £13.73

TOTAL No OF COMPONENTS = 31

Prices are based on a mixture of bulk sellers and online retailers. I went for a mid cost price with an estimation of £13.73 without any discounts.

My market research from IKB1 priced sterilisers between £30 and £130 depending on portability and functionality.

Following this, I would suggest a retail price between £50.00 and £70.00.

Appendix C: Research

Material Research

Soft Touch HDPE

The Pio head will be made from Soft Touch HDPE.

It is a; strong, lightweight, inert, economical, shatter-proof and moisture resistant material which can be processed and formed easily in any colour.

FIG 87 (Rtco, 2021).

The Soft Touch HDPE finish can be achieved through various curing techniques; UV curing, aluminum plating and elastic paint spray which will give the Pio a soft elastic coating and enhanced feel. This finish provides good electrical, heat and corrosion resistance.

Handles

I considered making the Pio carry loops from LDPE or Silicone for consistent material use but also considered woven materials.

Synthetic Hemp Rope

FIG 80

- UV resistant
- Won't swell or shrink when wet
- Floats in water
- Easier on the skin than natural hemp

- Rope diameter can alter slightly

Cotton Rope/Cord

FIG 81

- soft, flexible and lightweight construction
- Excellent handling qualities and knot stability
- Lends itself well to lightweight applications

- Not waterproof

Sisal Rope

FIG 82

- Resistant to sunlight
- Biodegradable
- Very affordable
- Lends itself well to craft applications
- Excellent grip

- Limited stretch

(Ropes Direct, 2021).

When comparing the three, I decided Synthetic Hemp was the best option.

Silicone Rubber

Silicone Rubber is a durable, highly-resistant elastomer to which pigments can be added to fit the design aesthetic, making it ideal for Bebe Pio's tonal shades of blue and gold. It is also highly resistant to steam sterilization and widely used in seals & gaskets for medical devices

FIG 88

(Omnexsus, 2021)

Liquid Silicone Rubber

The polymers of LSR have a lower molecular weight and therefore shorter molecular chains. This enhances flow properties making it appropriate for injection molding and extrusion processes.

Key benefits:

- Strong colour stability
- Enhanced options for part integration and allows for lightweight designs
- Excellent thermal and thermoxidative resistance, Resistance to atoxygen, ozone, sunlight and micro cracks
- Excellent processability with minimal material waste.
- Resistant to particle radiation (UV, alpha, beta and gamma rays)
- Low toxicity
- Flexible at low temperatures
- Excellent insulation properties
- Inert
- Excellent mechanical properties (high tear strength, high elongation)

(Omnexsus, 2021)

Manufacturing Processes

Injection Molding

Injection molding is the process of manufacturing highly accurate plastic components such as overcaps (spectra, 2021) and is important in the processing of LSR.

	LSR/LIM
Material Type	Thermoset
Typical Mold Temperatures	140-220°C
Typical Material Processing Temperatures	20-30°C
Typical Injection Pressures	7-35 bar
Typical Cycle	30-60 sec
Cure Time	25-55 sec

All the components of the Pio are appropriate for this process thereby streamlining manufacture and reducing costs.

FIG 89

(Omnexsus, 2021).