CANSAT

- Laura Scannell 22340866
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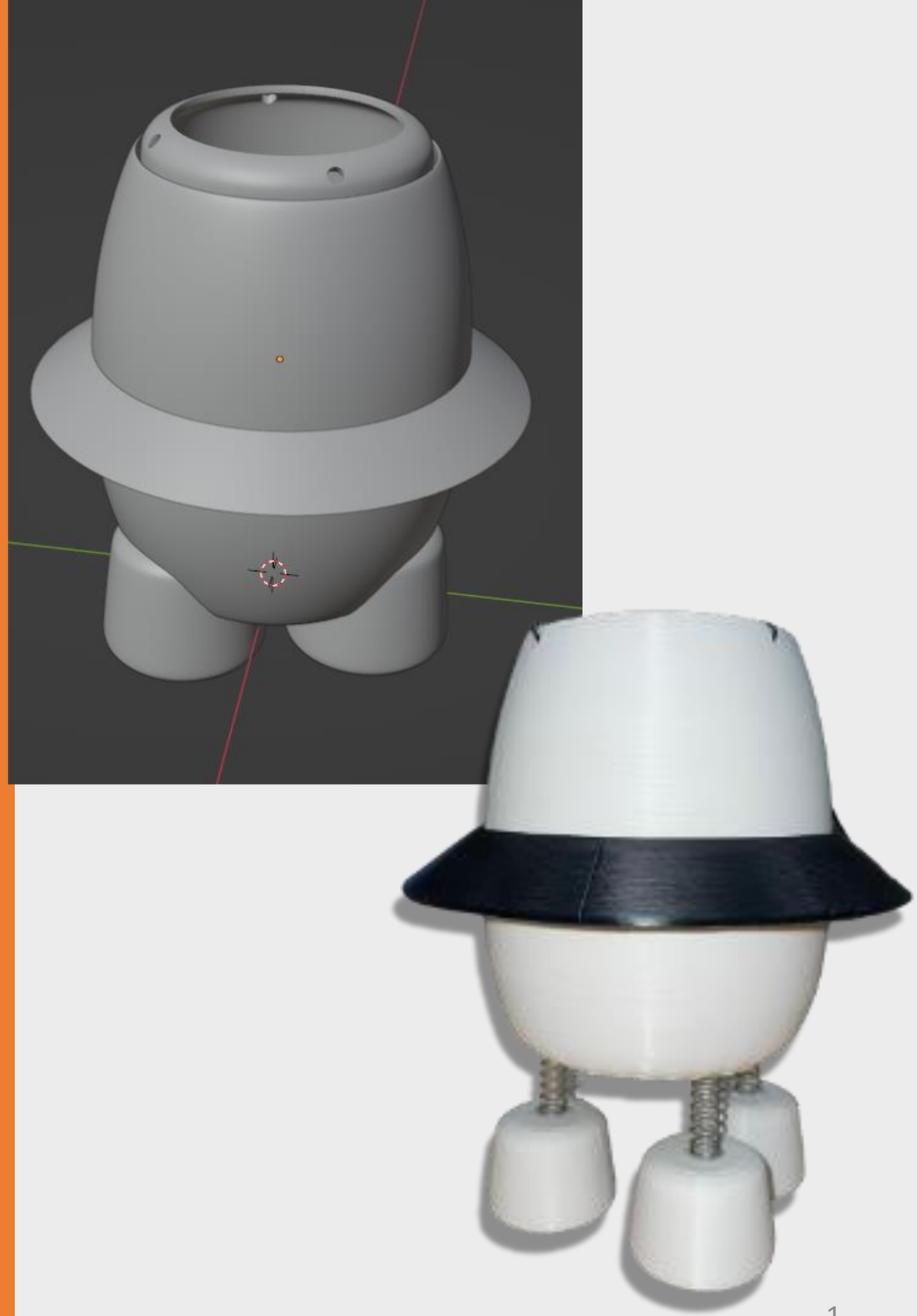


Table of Contents

Design Guide

Knowns

- Withstand 50m fall+ survive

-Have dimensions of a can

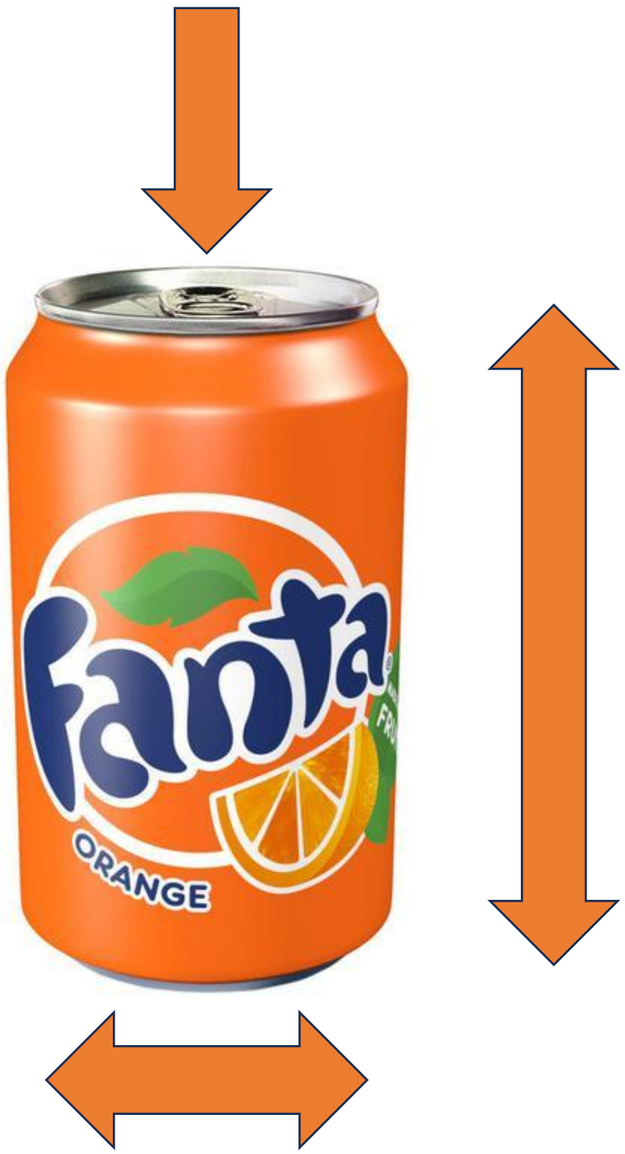
- Hollow inside to encase the satellite system.

- Protect the satellite system from breaking

Unknowns

- Weight
- volume
- Colour
- Parachute size
- Exact satellite components

Can Dimensions



Height: 115mm

Capacity: 330ml

Diameter: 66mm

Thickness: 0.02cm

Needs

- Parachute
- Protective casing
- Latch to attach parachute
- Be able to be modelled on Blender
- Reusable
- Within the dimensions of a can
- Holds the satellite

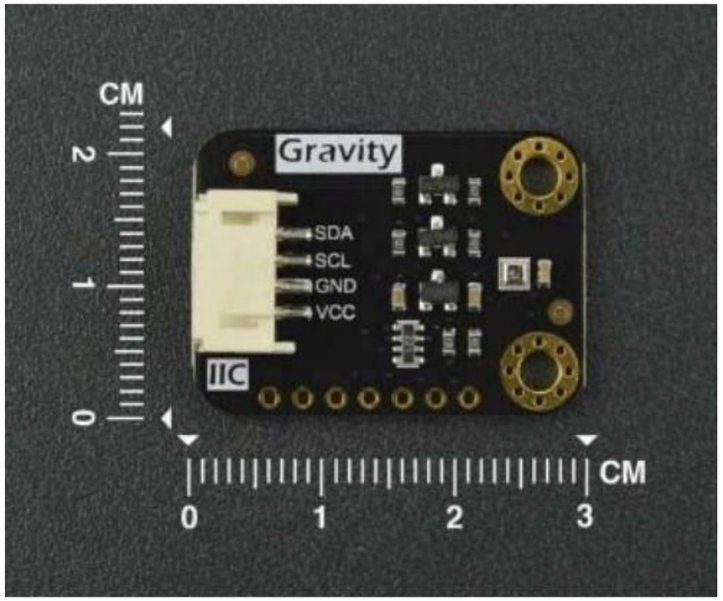
Wants

- Aesthetic design
- Padding
- Removable satellite
- Open and closable casing

Electrical Components

Main Components - Dimensions

Pressure Sensor



Data Transceiver

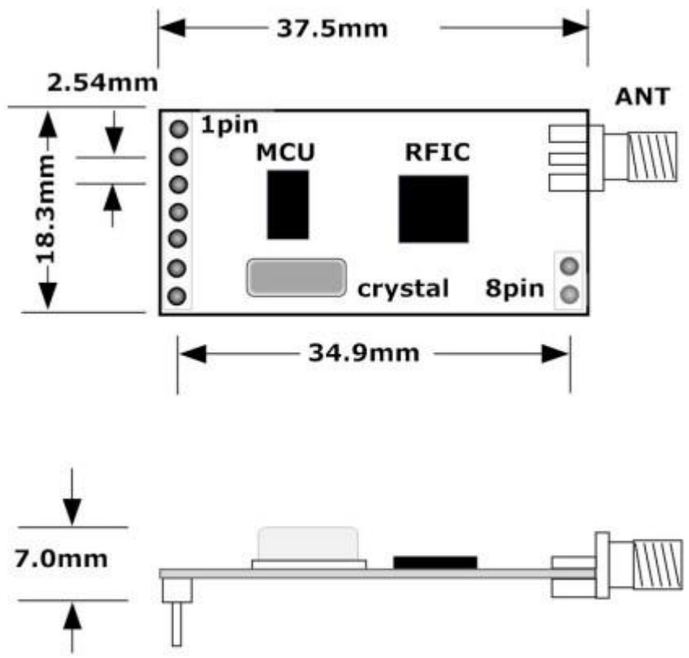
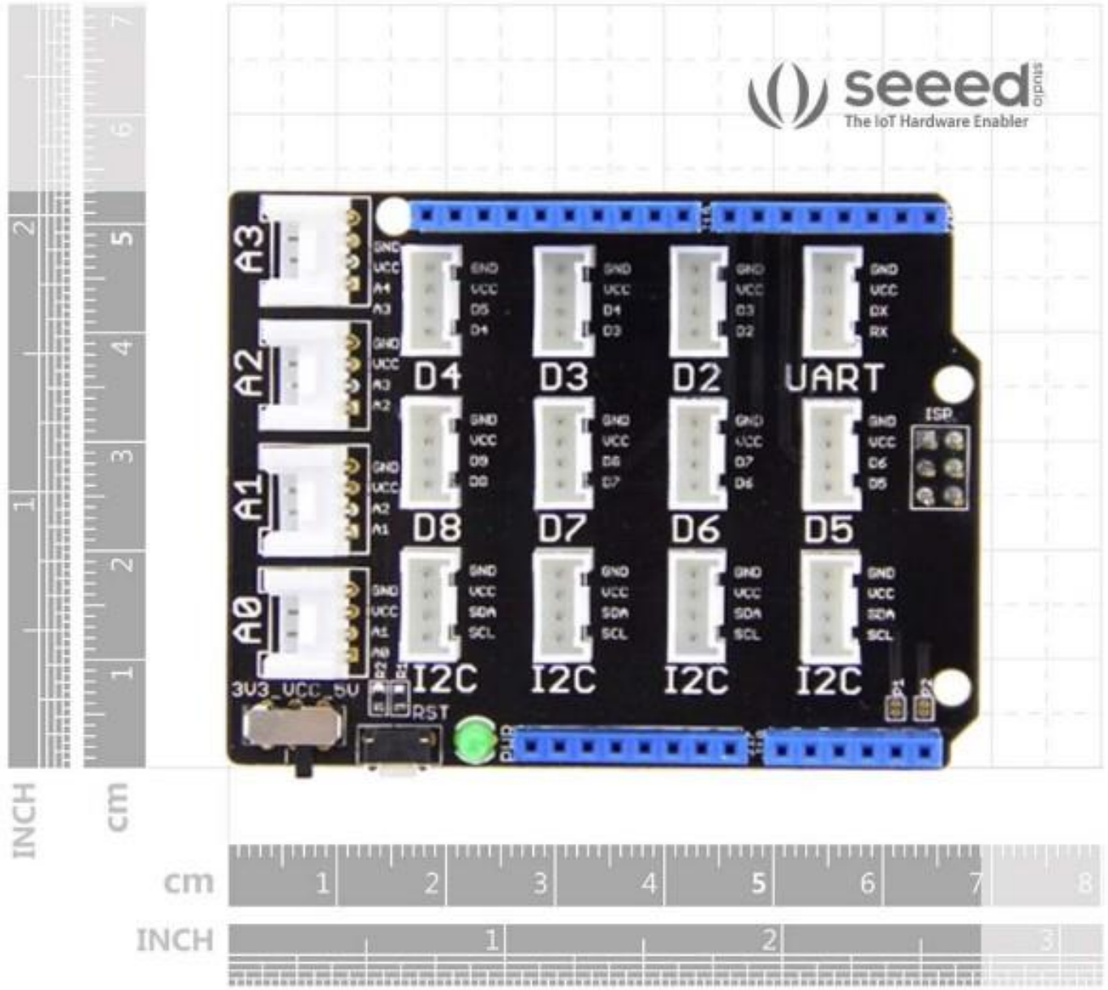


Figure 1: Size of Module

Arduino Uno

Length	68.6 mm
Width	53.4 mm
Weight	25 g

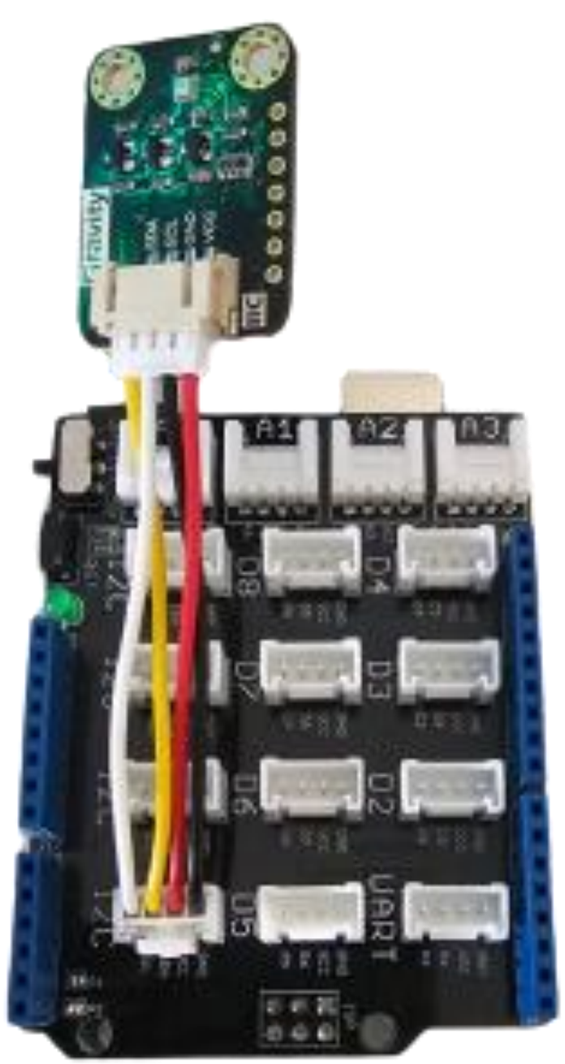
Grove Shield



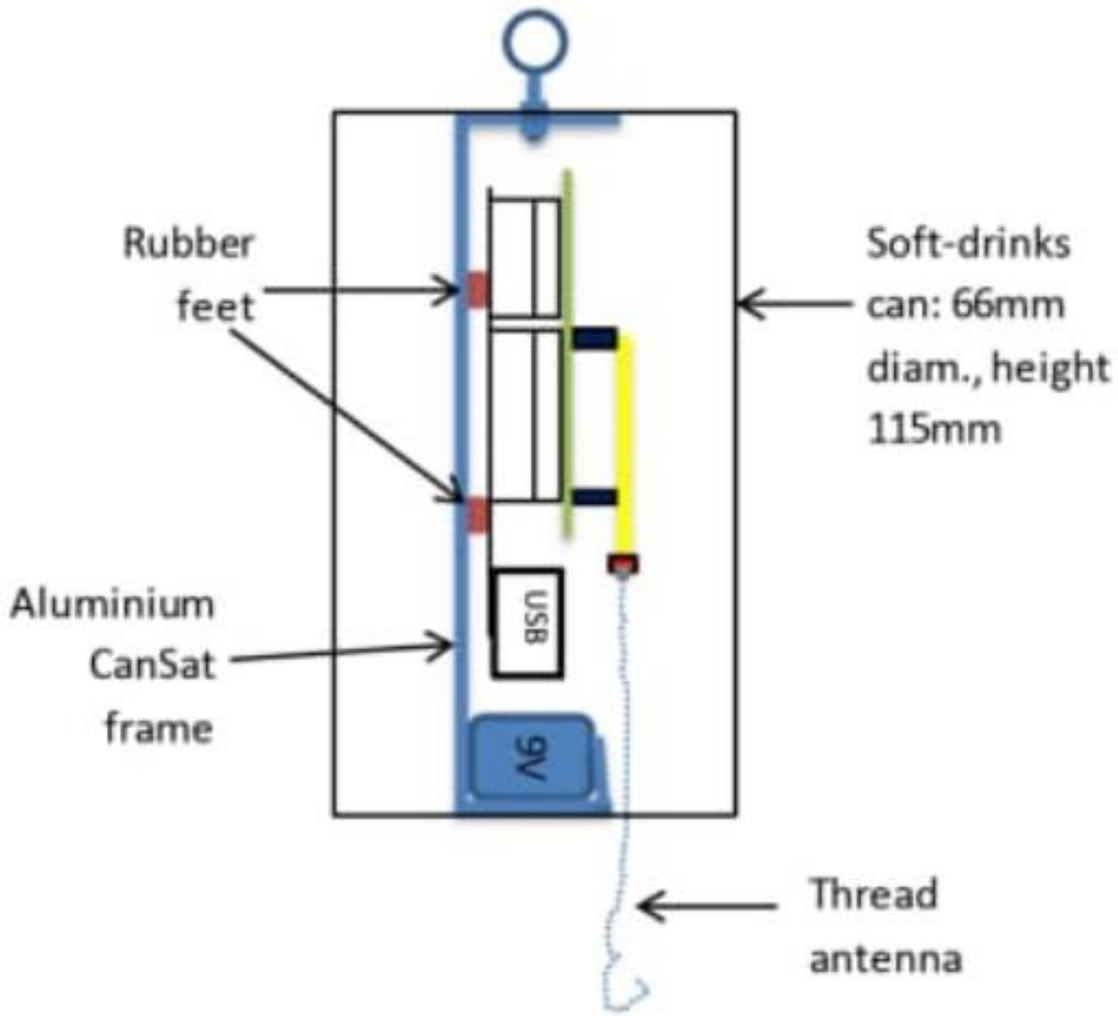
Possible Fit

53mm

74mm



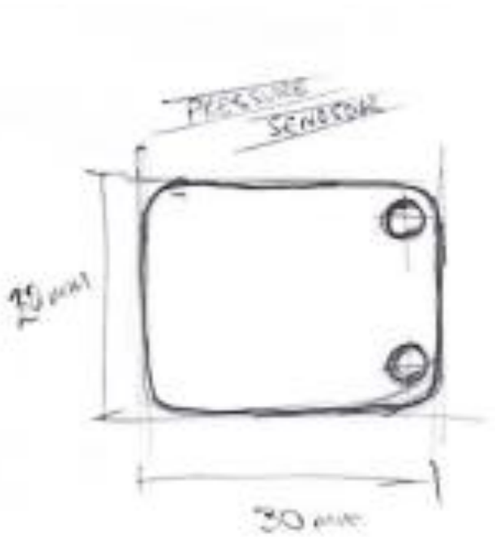
28mm

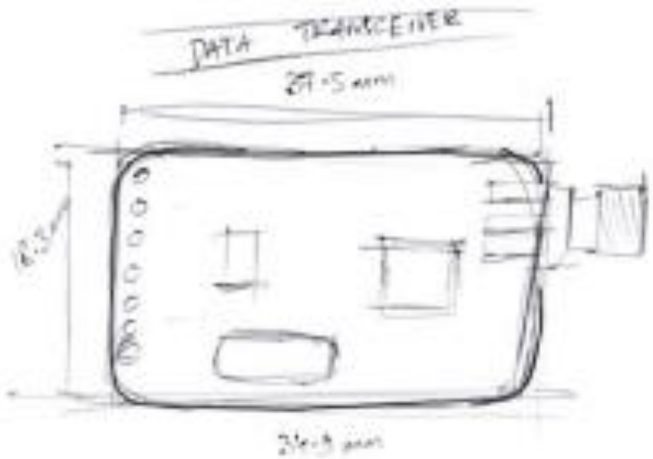


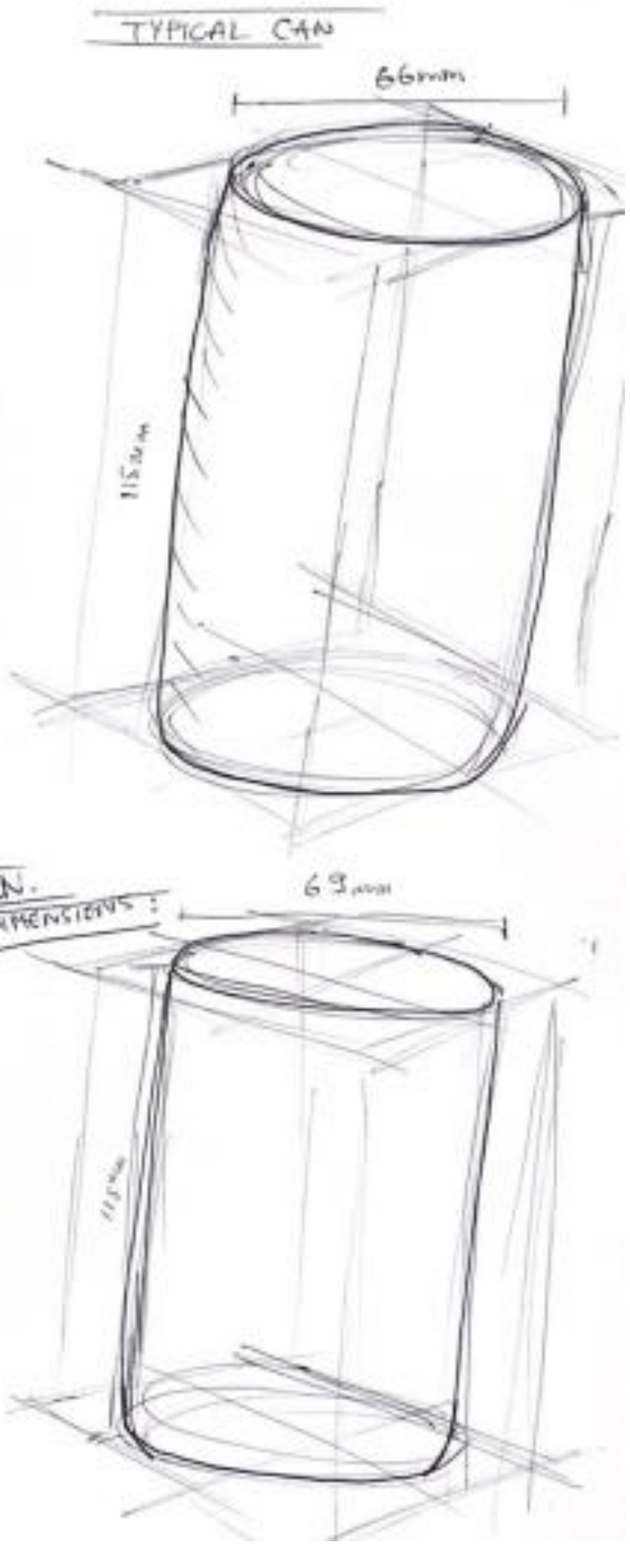
When communicating with our master student we were informed of the dimensions and all electrical components that were to go into our project.

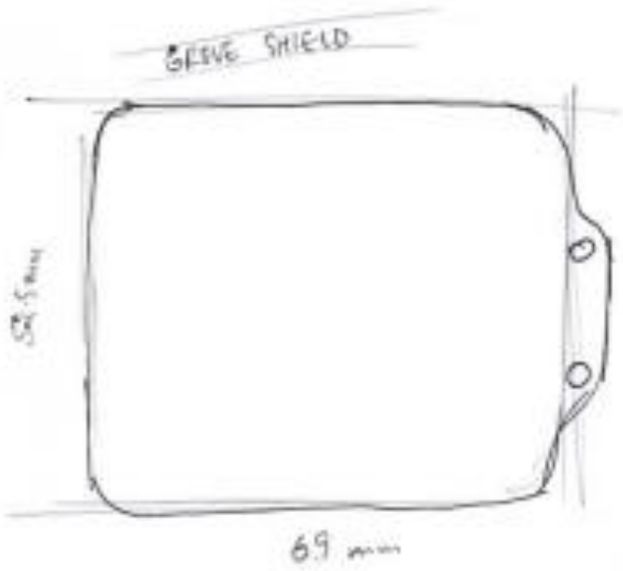
Ideation

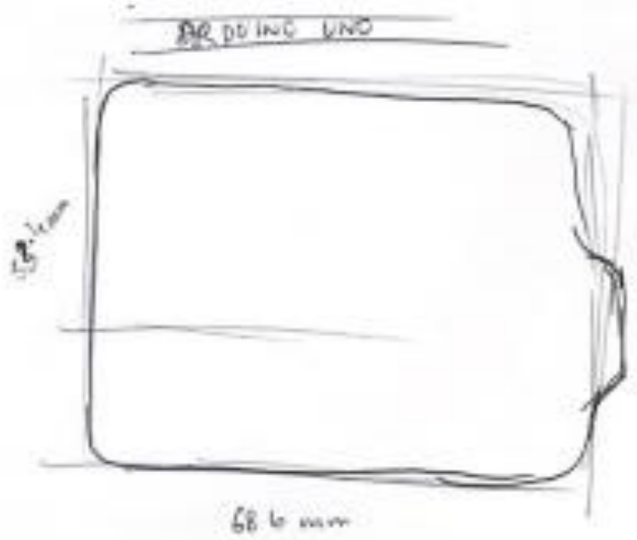
Ideation



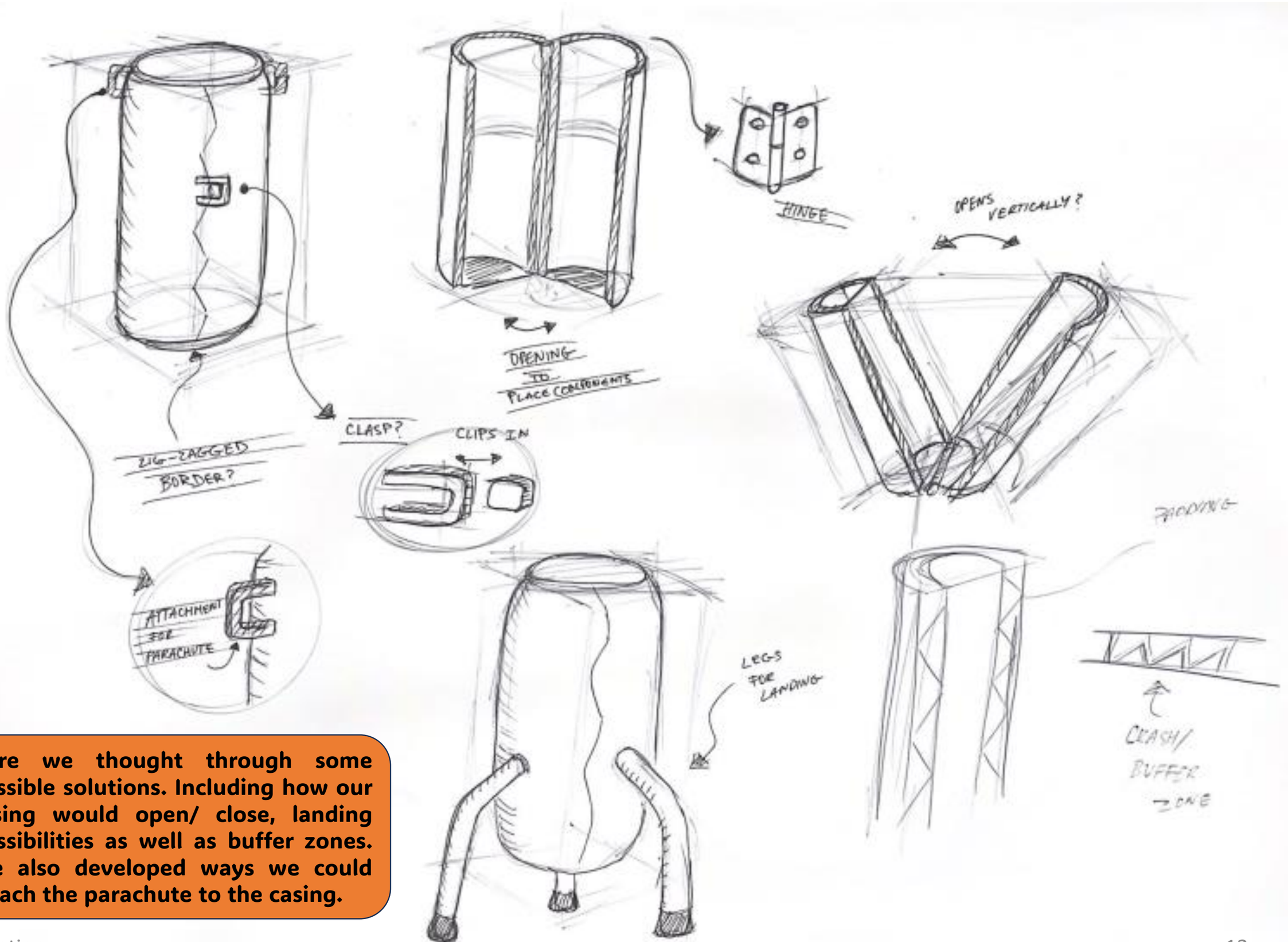








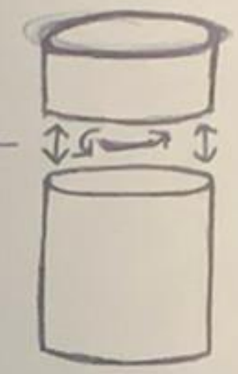
We began ideation by sketching out the basic shapes of our components and of the can to reference for dimensions.



Here we thought through some possible solutions. Including how our casing would open/ close, landing possibilities as well as buffer zones. We also developed ways we could attach the parachute to the casing.

FLAP

OPENING FROM THE FRONT



TWIST

TOP

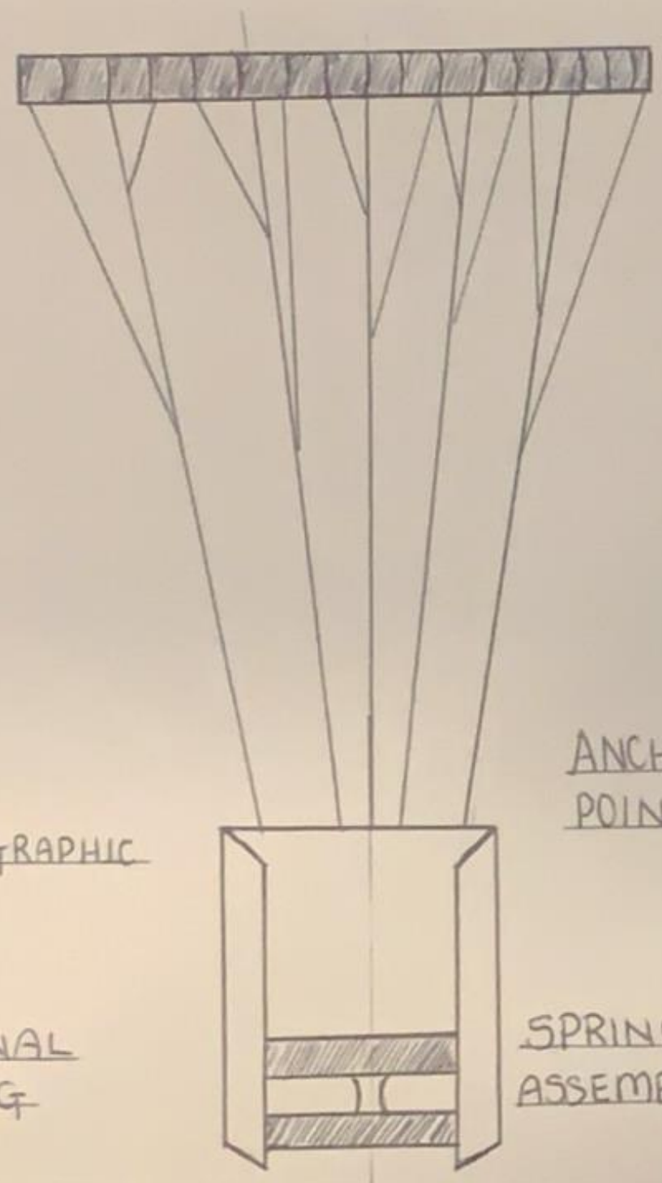
BOTTOM

ACCESSIBLE SATELLITE

WEIGHTED BASE
ensures landing on heavier side

LEGS

LAURA SCANNELL

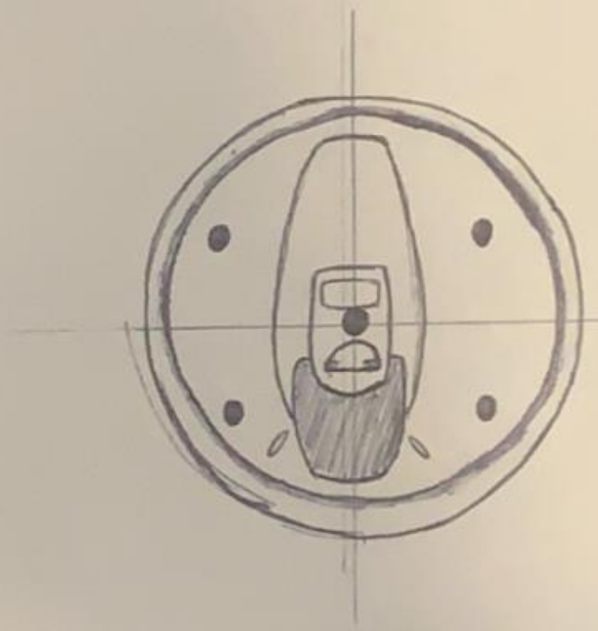


ORTHOGRAPHIC

ANCHOR POINTS

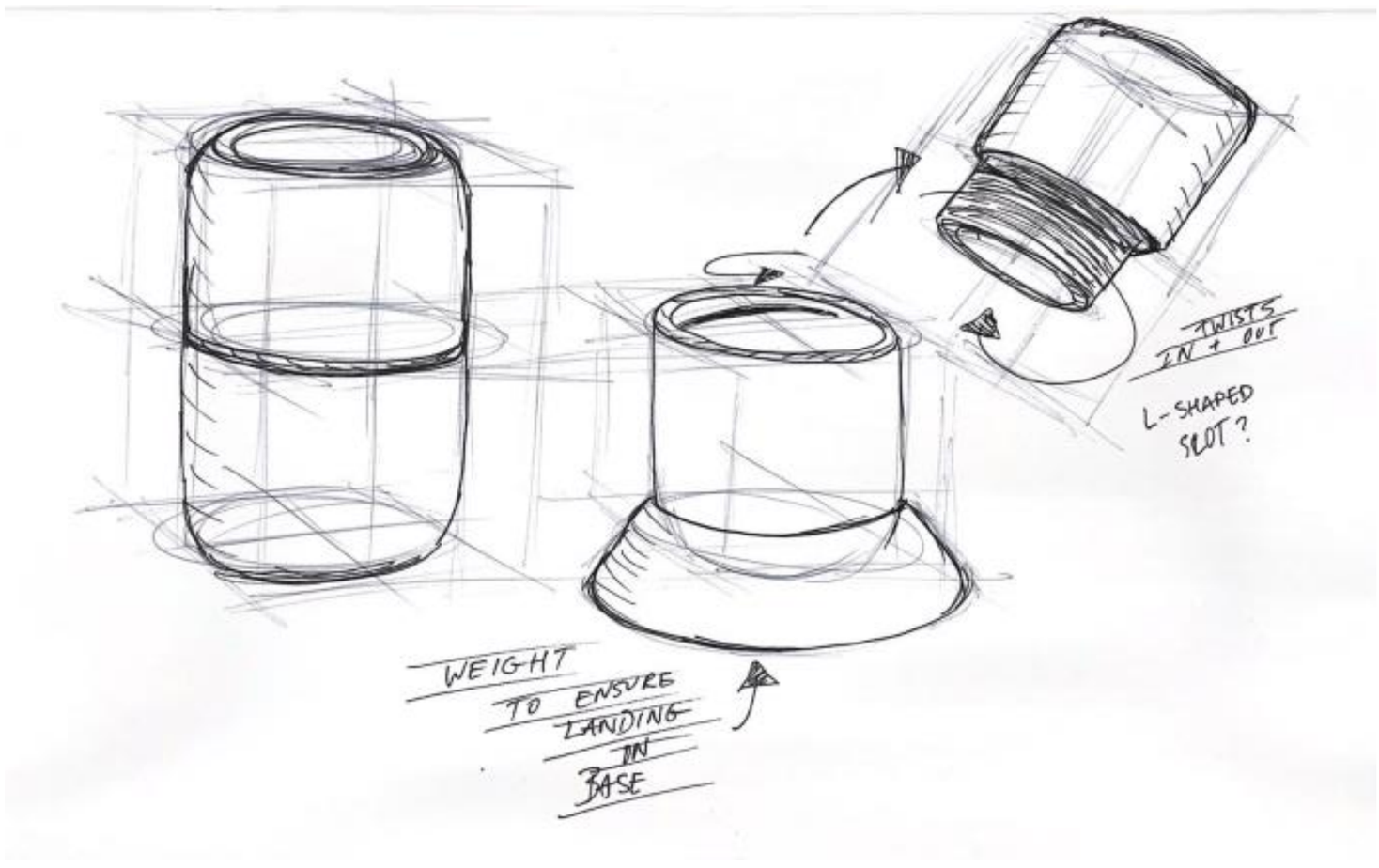
INTERNAL PADDING

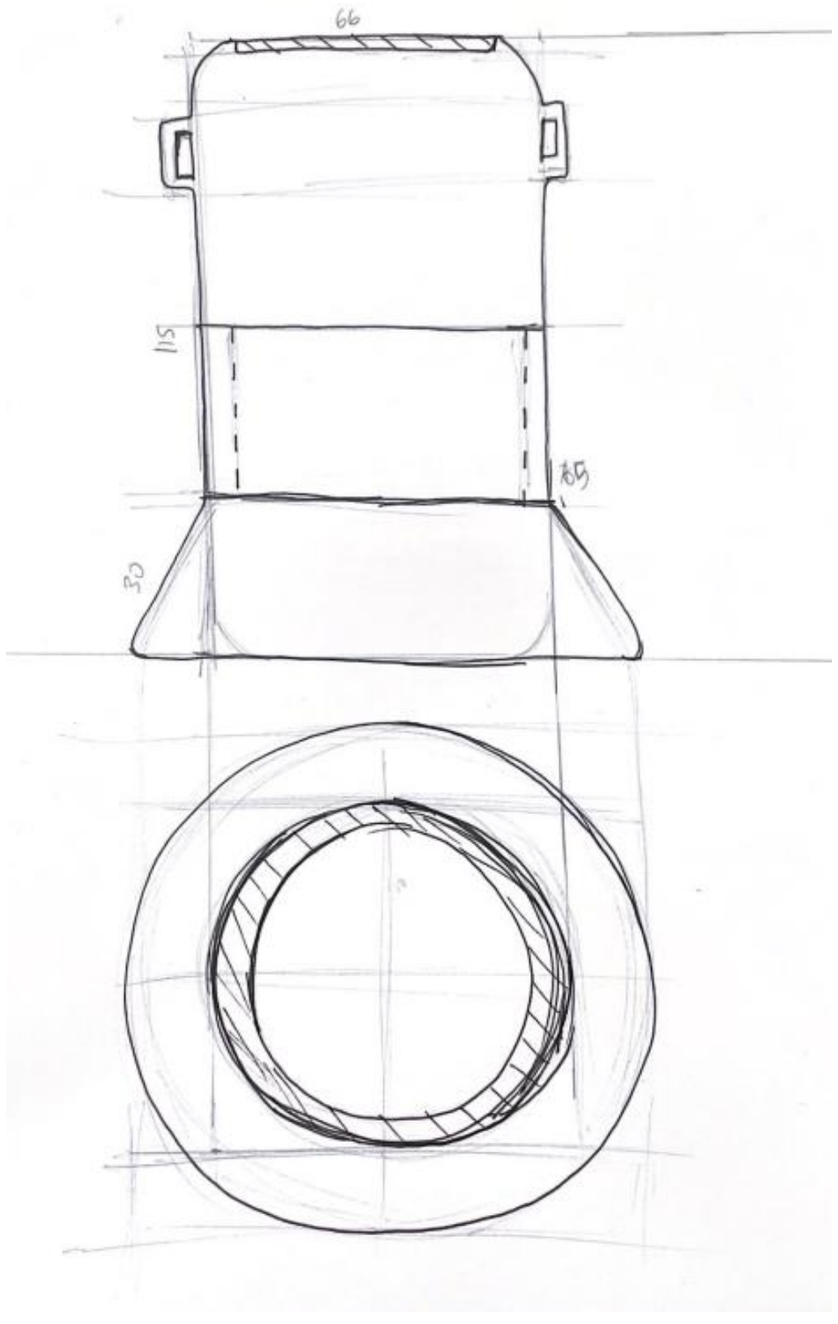
SPRING ASSEMBLY



PLAN VIEW OF CAN

Chosen Design

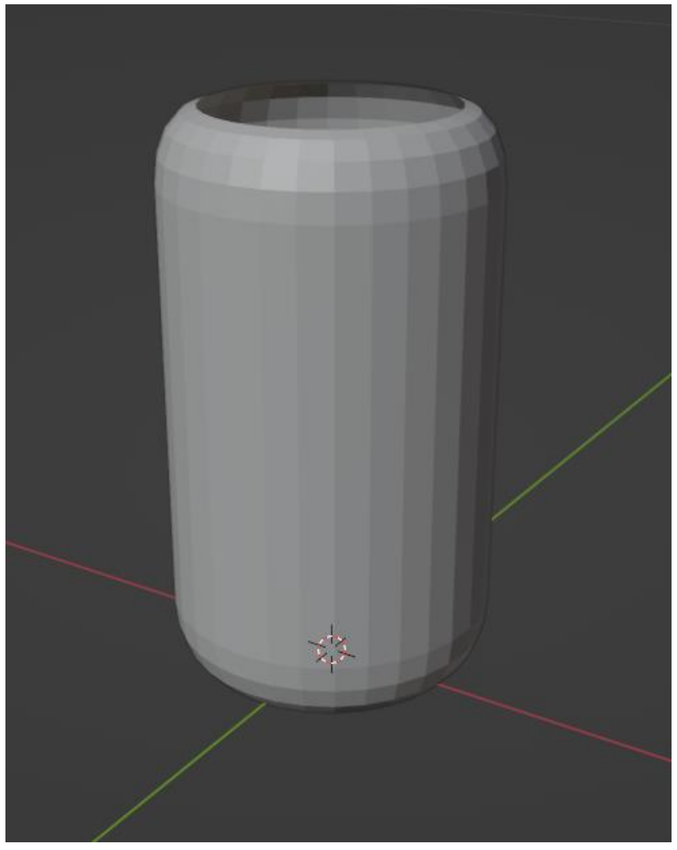


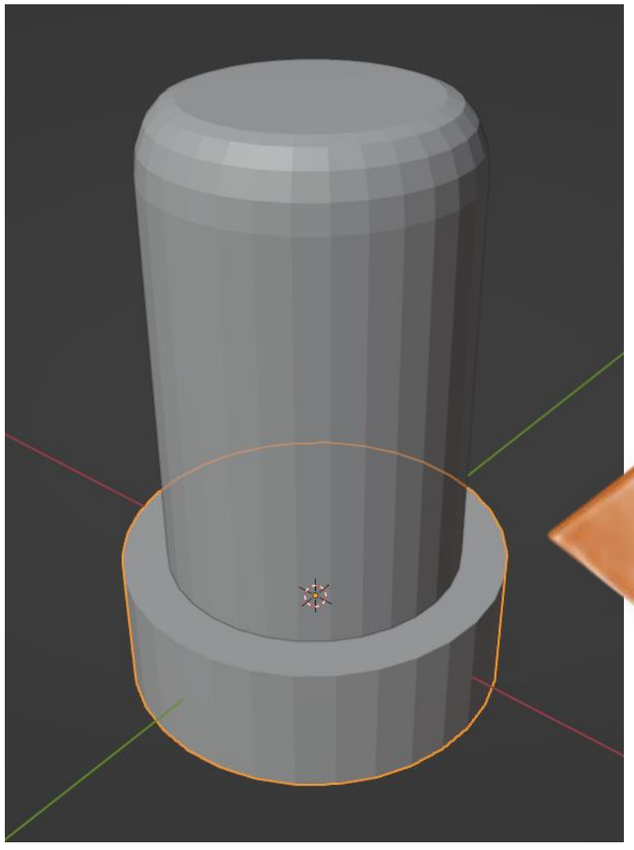


We chose to model a simple but practical design that would twist open for the components to sit into. We decided to attach 2 latches at either side of the casing as anchor points for the parachute. However, this was subject to change.

3D Modelling

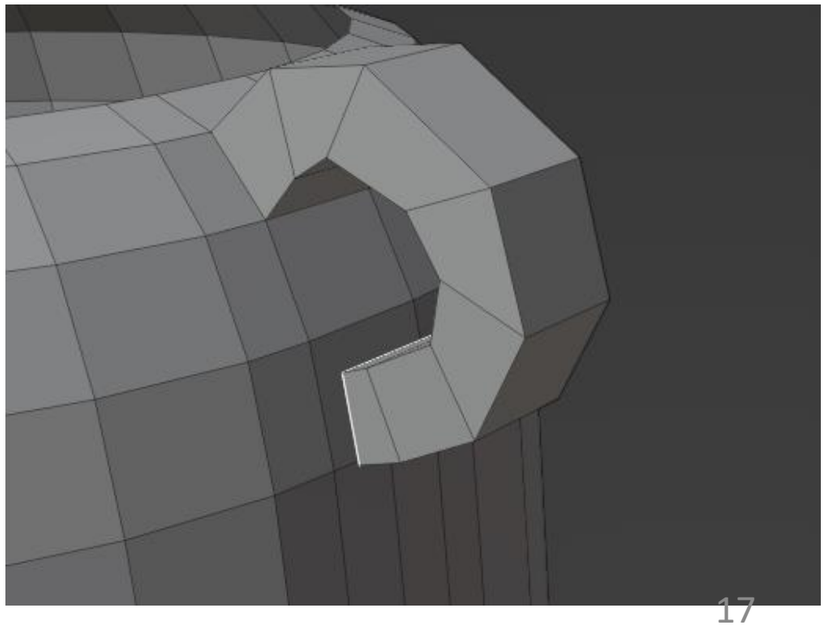
Basic Shape + Form





We began making the basic cylindrical shape with the skirt.

Anchor Points



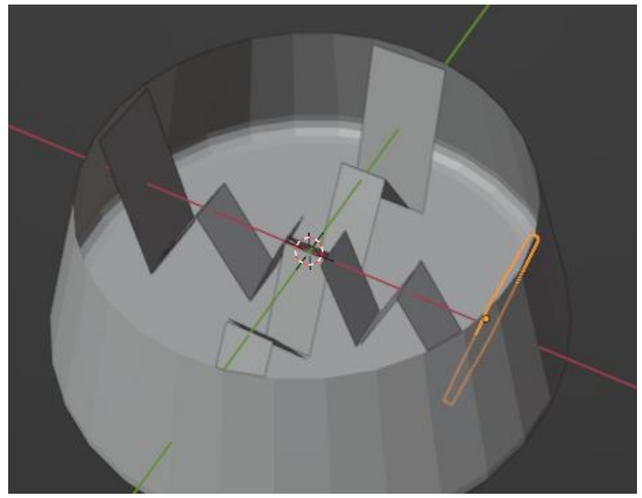
To create the handles, we used a mixture of the extrude, scale and rotate along the axis functions. Then to connect the two faces and finish the loop, we selected both faces that we wanted to join and pressed 'F' to add a face between the two.

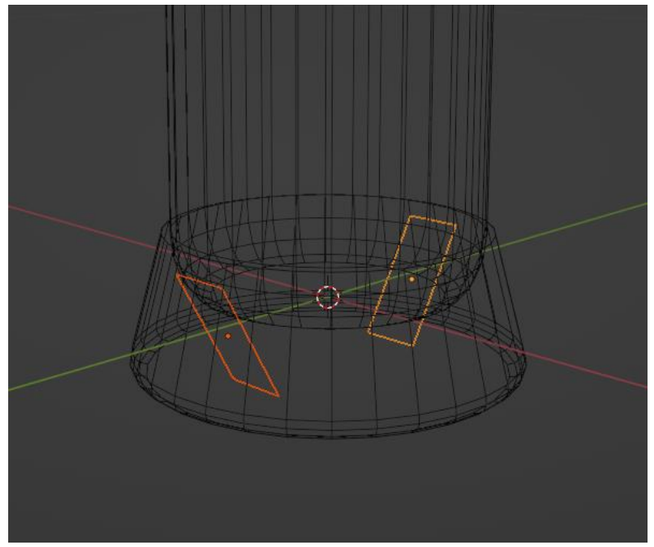
Landing Base

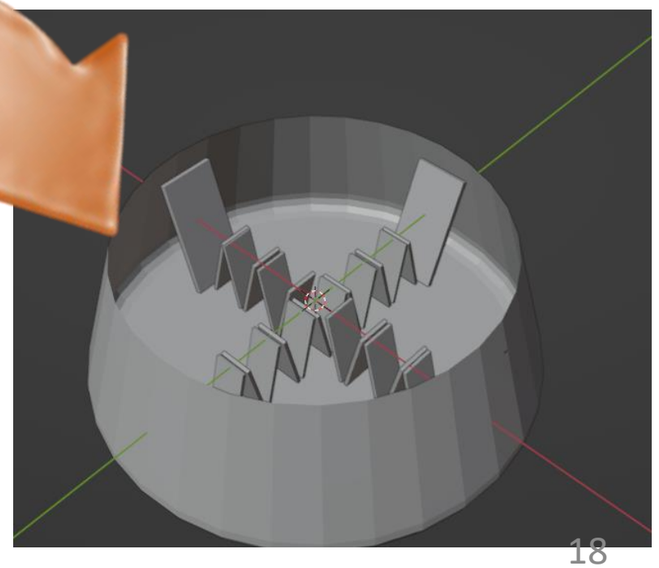
- **When considering a landing base/ skirt for the capsule, we thought that supports would be needed internally**

- **The zigzag pattern we used offered even support for the satellite above it.**

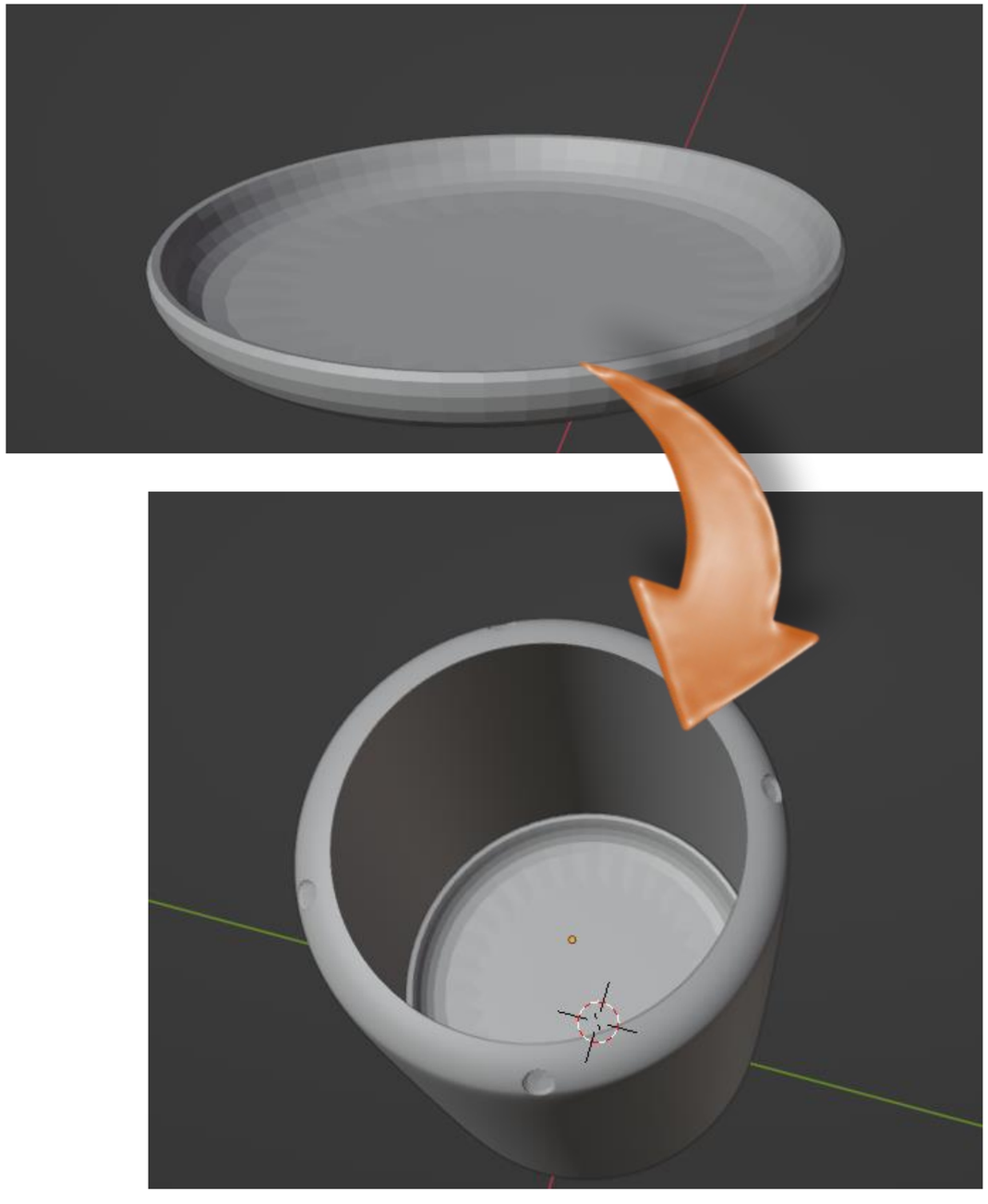
- **We used the solidify modifier to add some thickness the these supports**





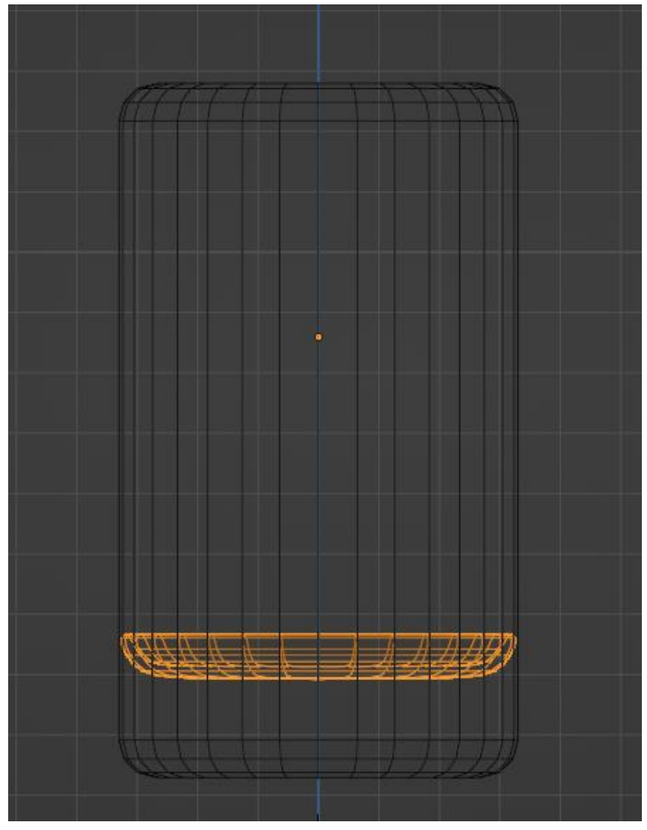


Landing Base Plate



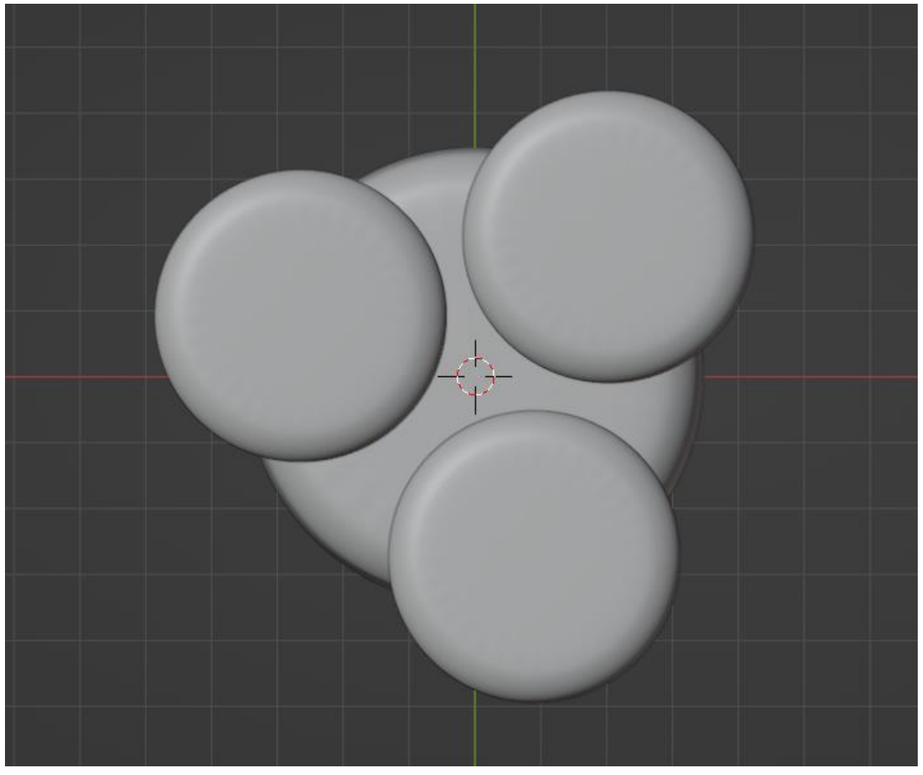
- **The landing base plate was used instead of the zig zag landing base because it was easier to construct and wouldn't need as many supports.**

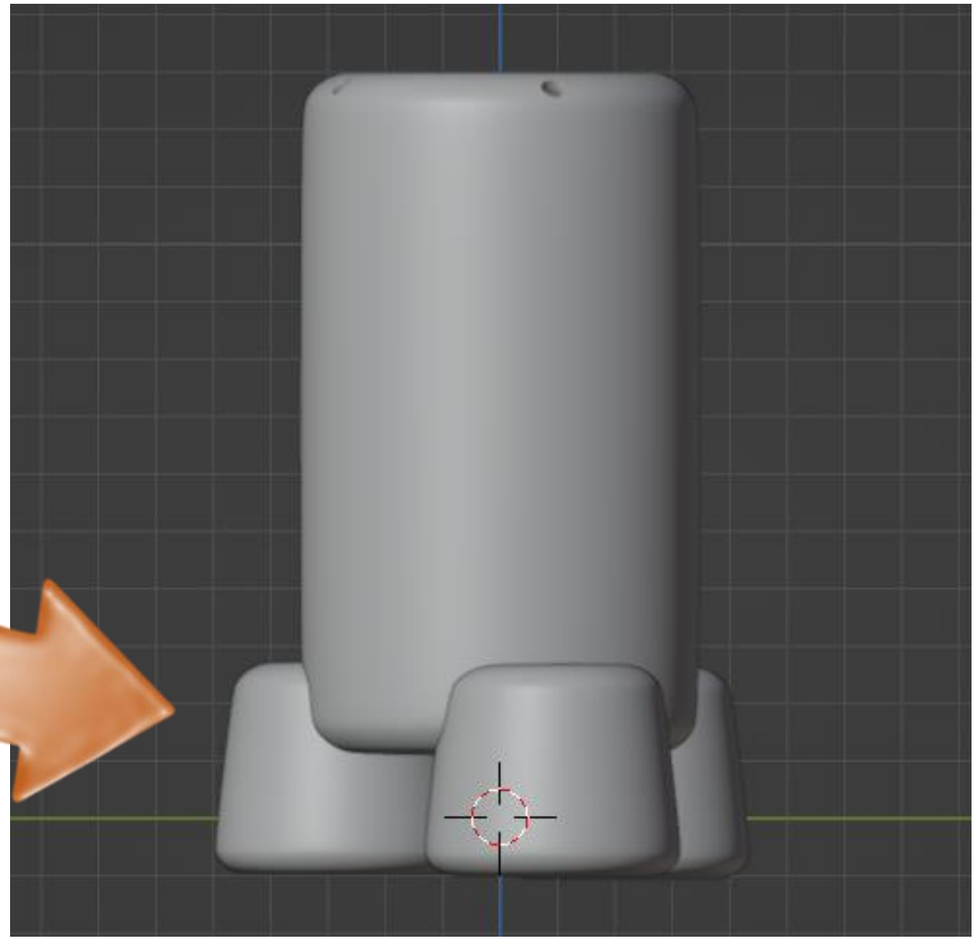
- **We allowed a hollow gap at the base to absorb some of the shock, if any, from the landing**

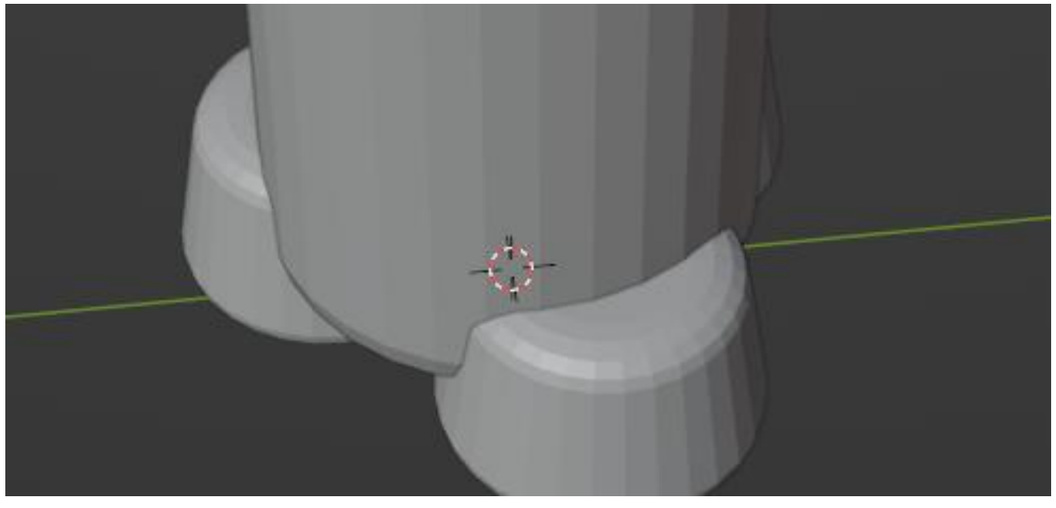


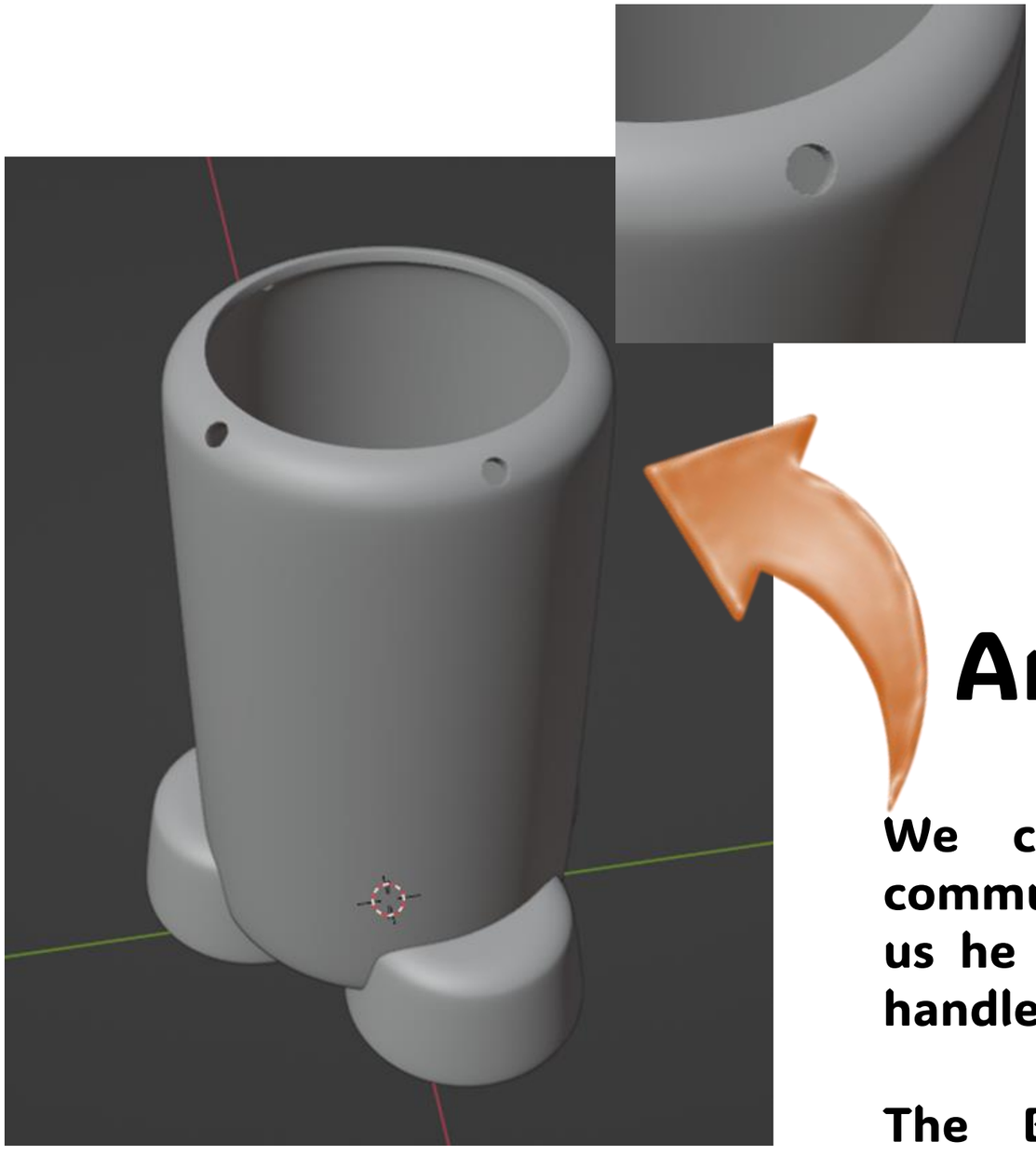
Base redesign

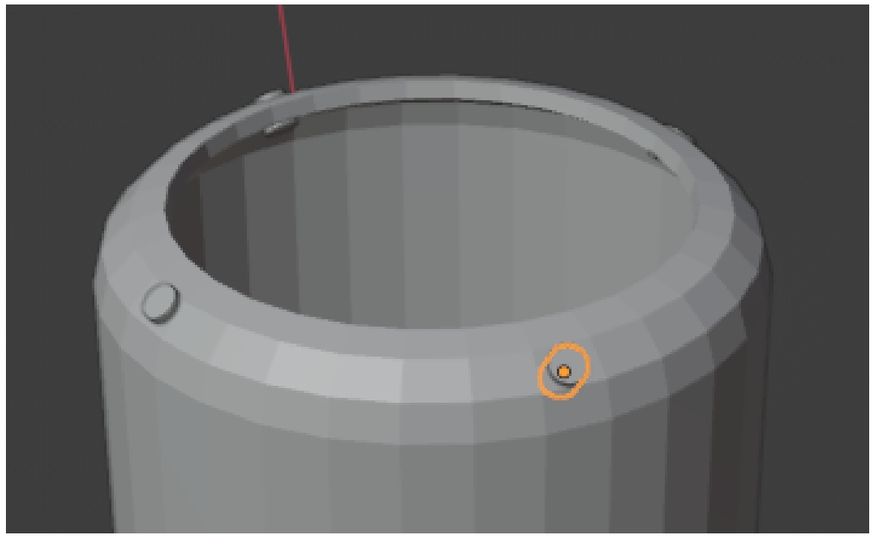
We decided to add three individual bases to the capsule to have a wider base for it to fall on. We added cylinders and scaled them down small enough to add them onto the main cylinder.









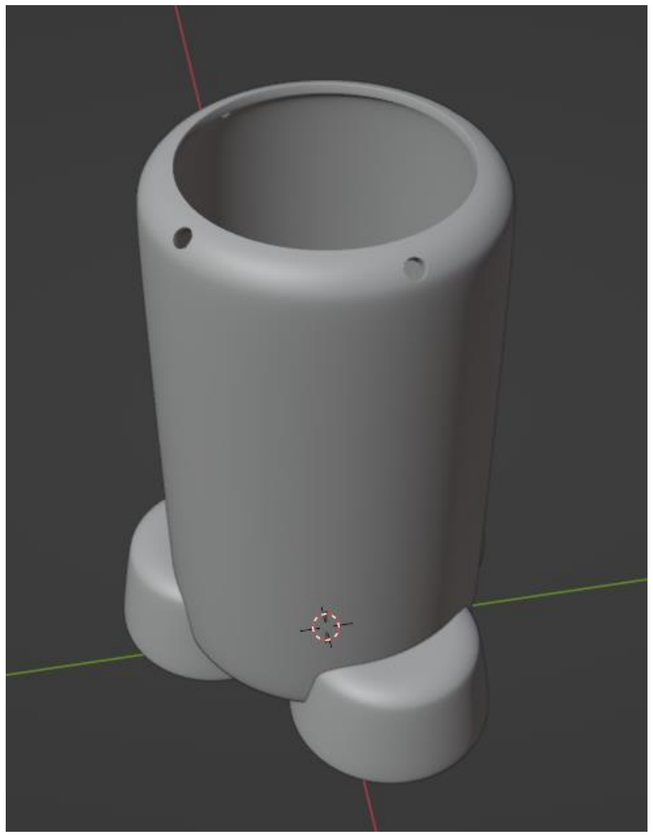


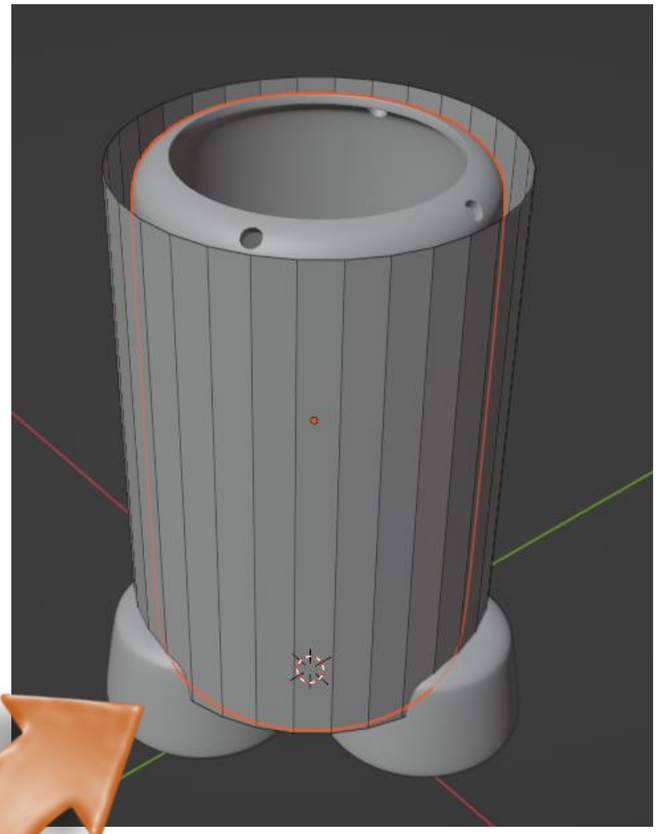
Anchor Point redesign

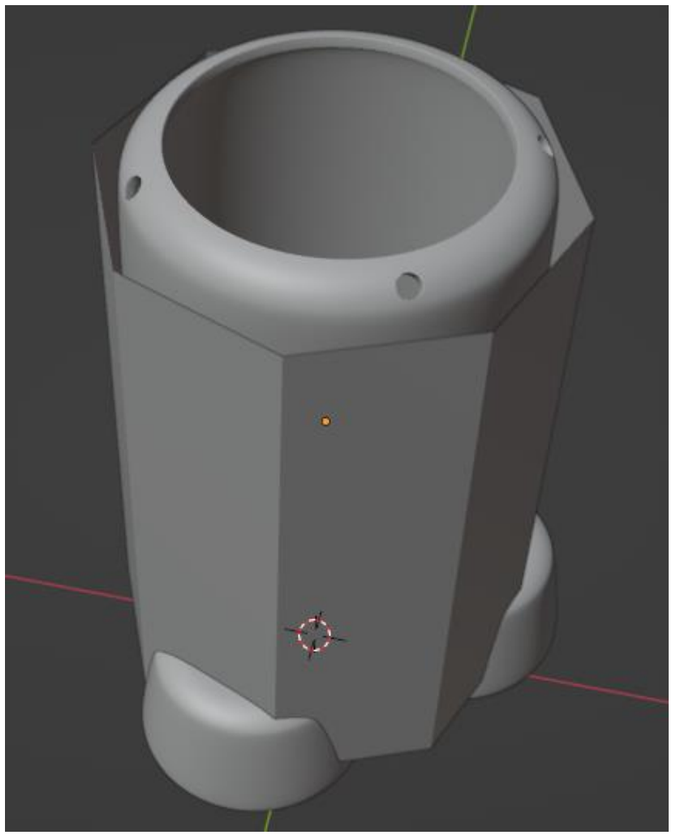
We changed latches to holes. When we communicated with our master student, he told us he would prefer to have holes instead of a handle.

The Boolean modifier was then used to implement the holes into the main cylindrical capsule

Outer Casing





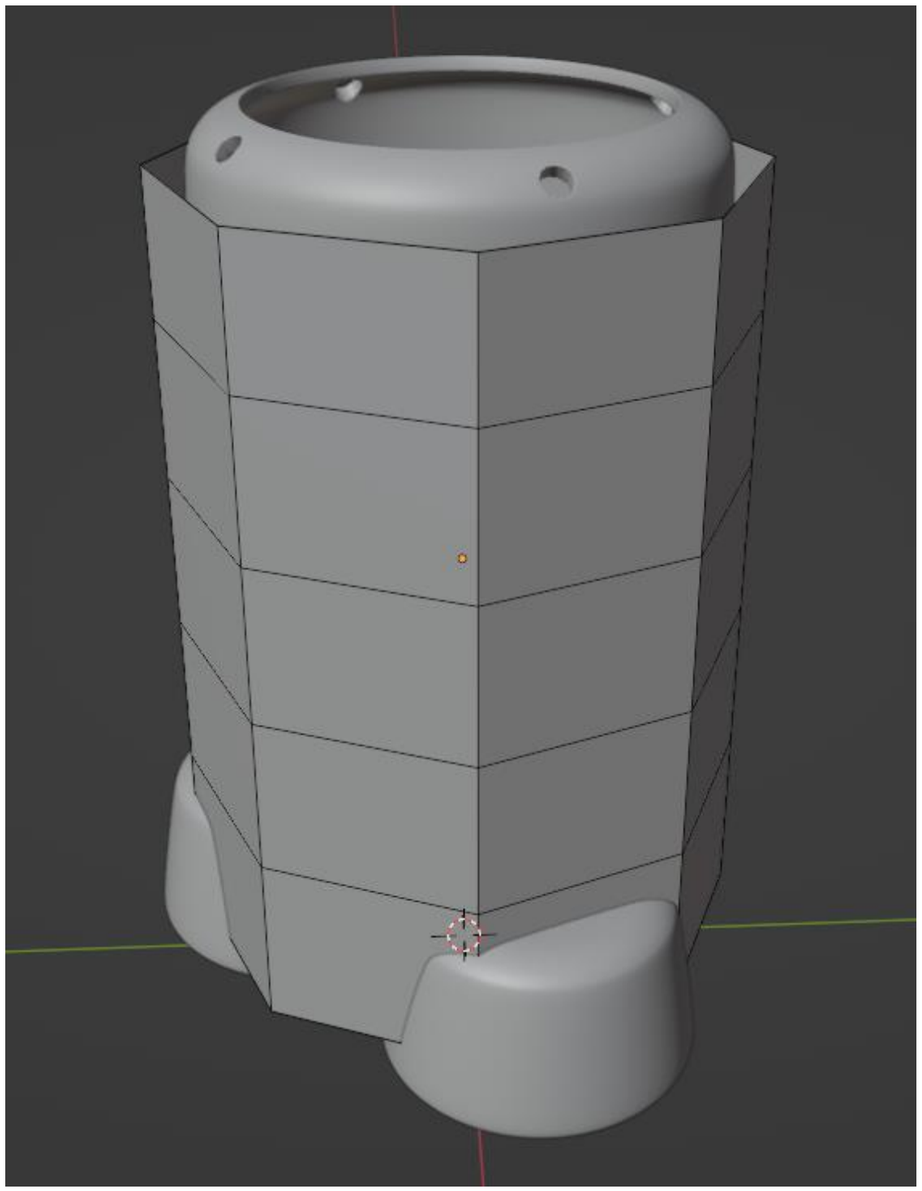


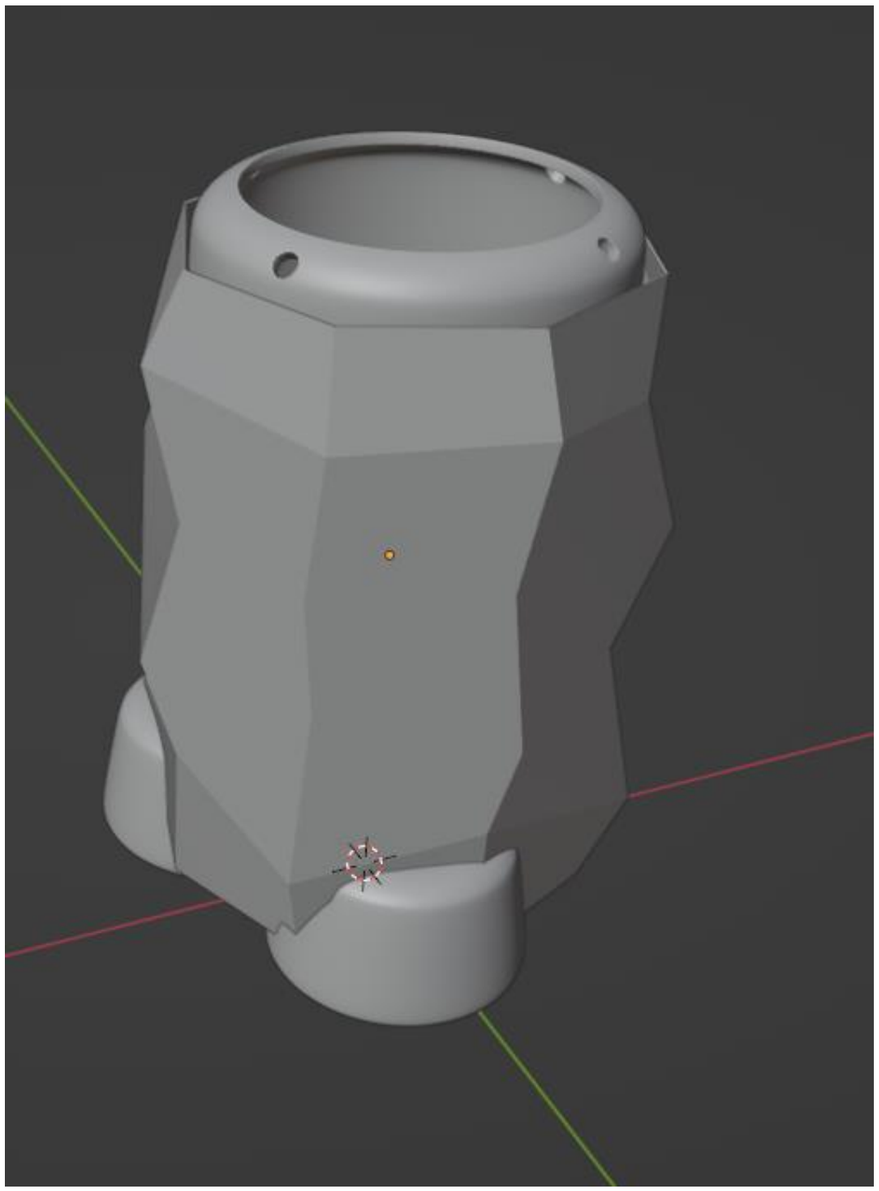
We decided we should have an outer casing for further protection of the electrical components.

When talking to our master student we decided to move away from the twisting cylinder idea and simply have the components slide into the casing rather than twist. This avoided complications with 3-D printing and added a further layer of protection

We tried a few different shapes like an octagon, adding curvatures to the octagon and cylindrical.

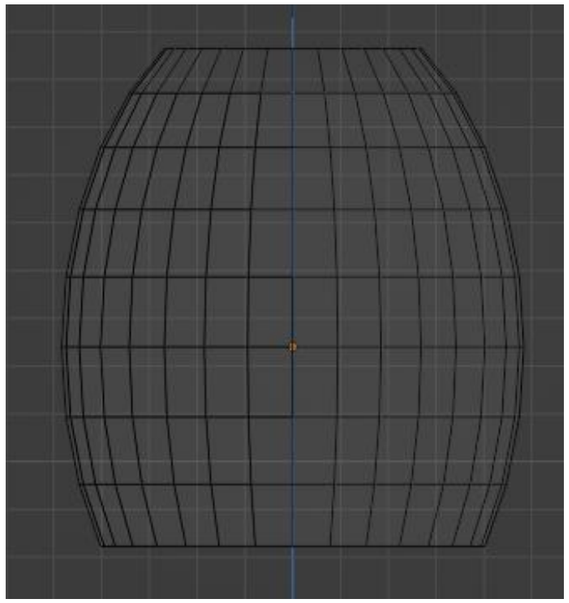
More Outer Casing Designs

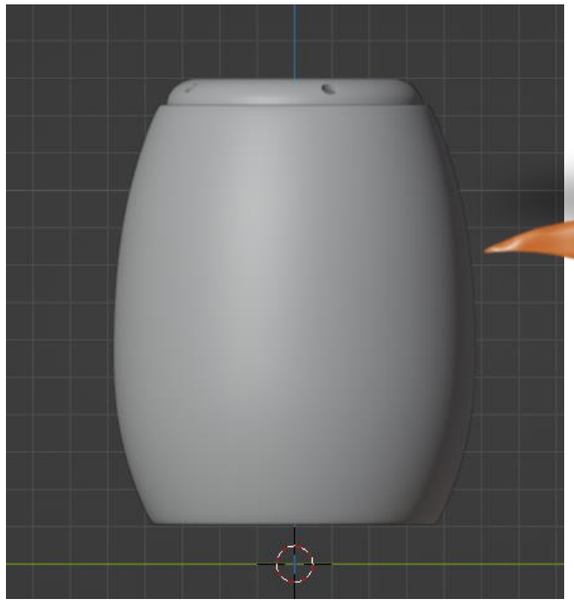


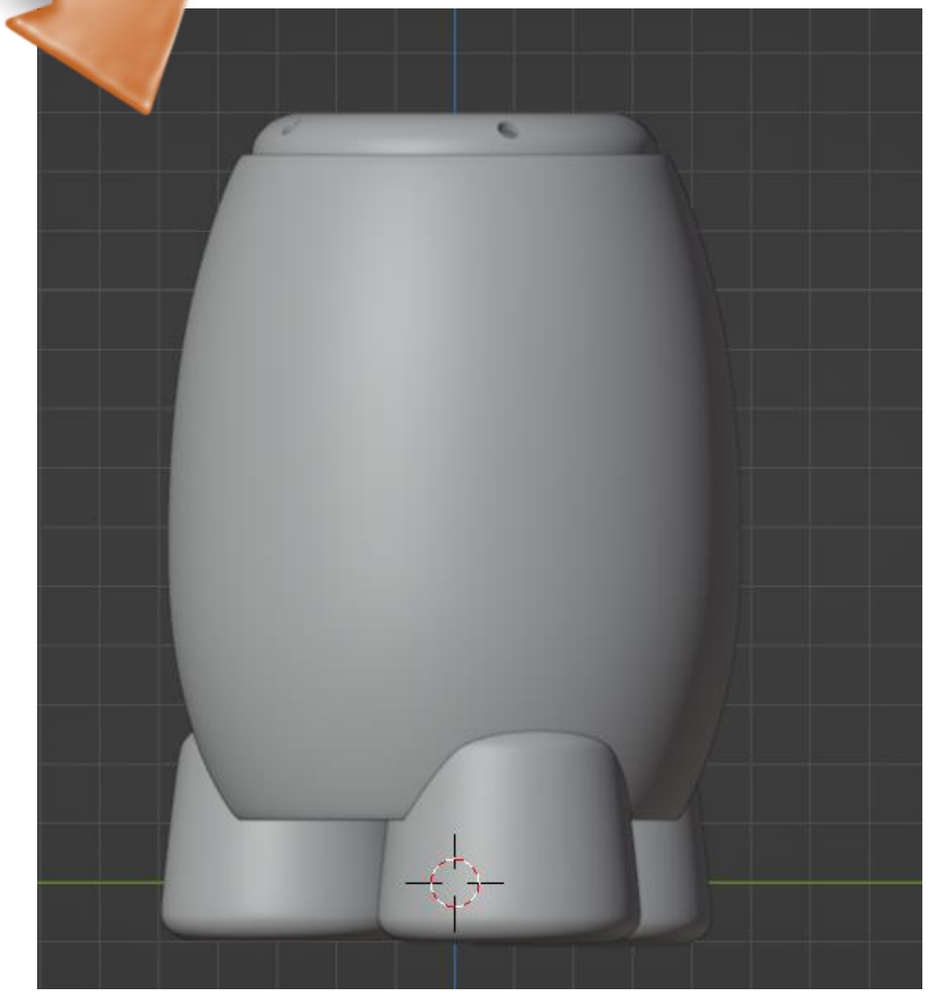


We wanted to make it functional and practical and have protection of the satellite be the main interest.

Chosen Outer Casing



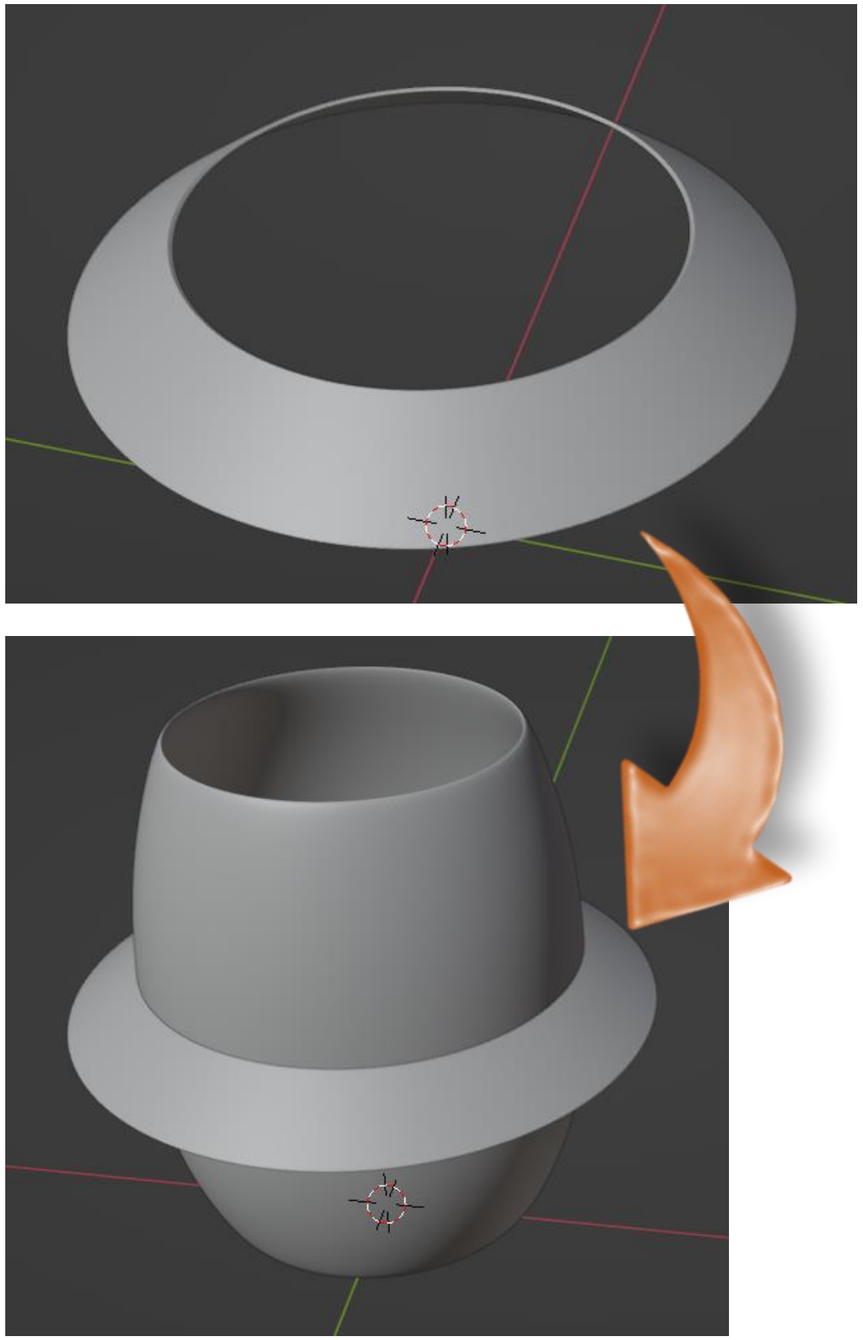




- **Ultimately, we decided to go for the shape seen above. We scaled a sphere up and removed the top and base. Using a mixture of extrusion and scaling the faces to achieve the casing around the cylinder.**

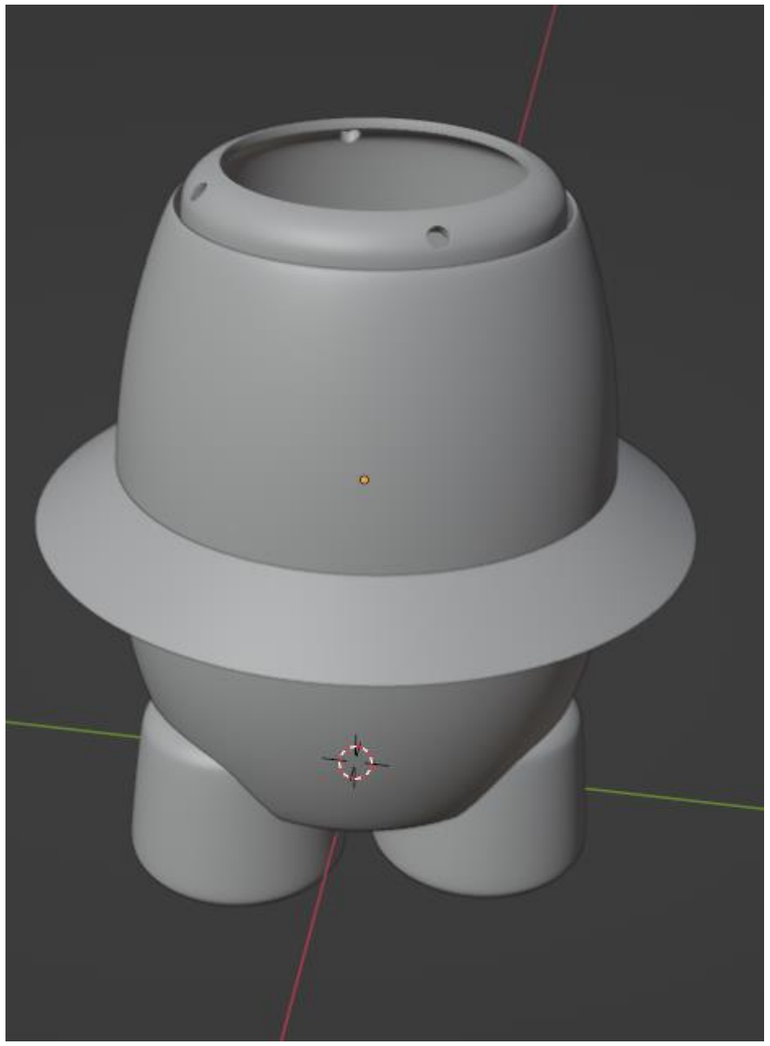
- **We added the shade smooth effect and used the solidify modifier to give it some mass**

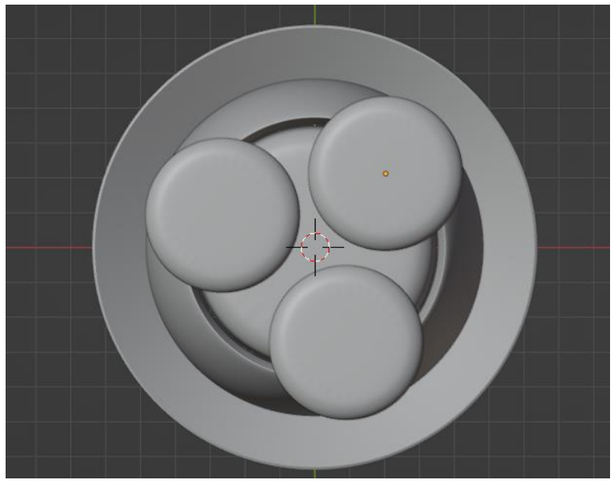
Wing Design

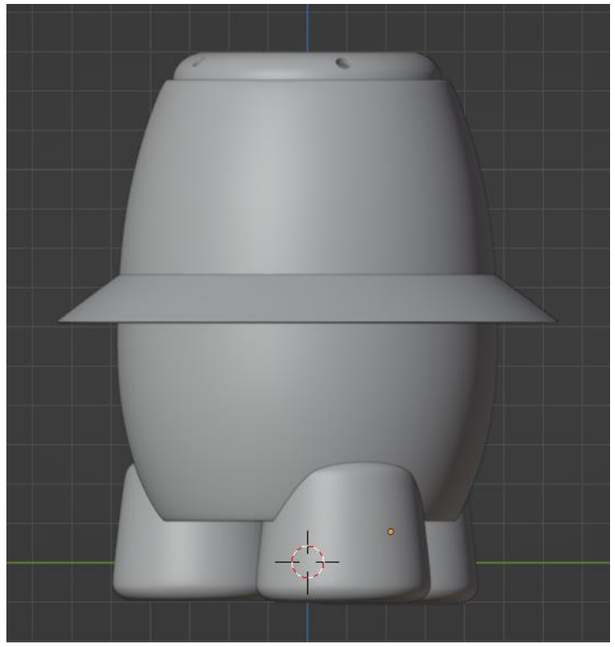


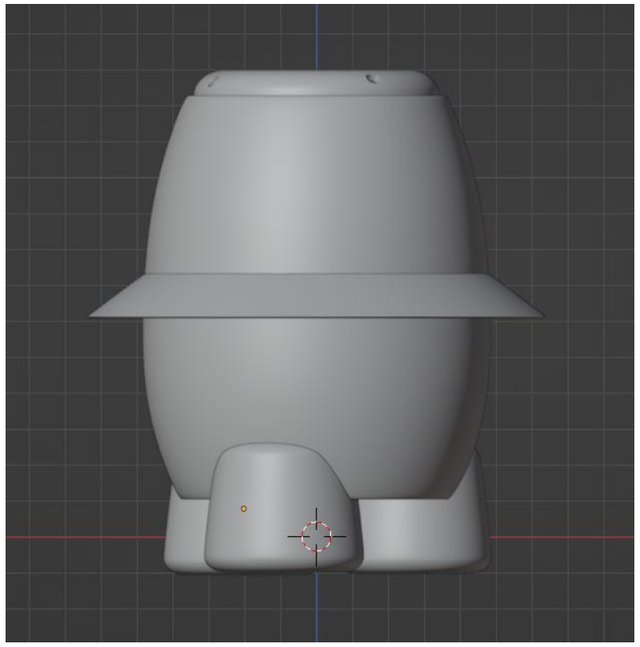
- We wanted to add a wing or wings to contribute to the slowing down of the capsule. The wing would catch air.
- To make this we scaled down a cylinder on the Z axis. We removed the top and bottom faces and added a ring using Command + r and added that horizontally around the cylinder. Using the scaling button, we scaled up faces and edges to create this 360 degree ring
- Once again, we added thickness using the solidify modifier and smoothed it using ‘shade smooth’.

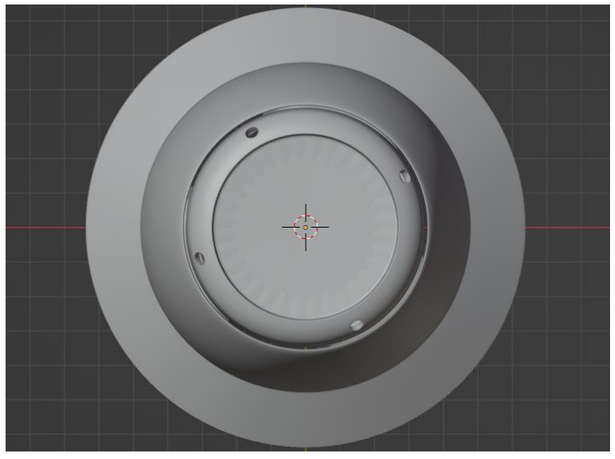
Final Blender Model











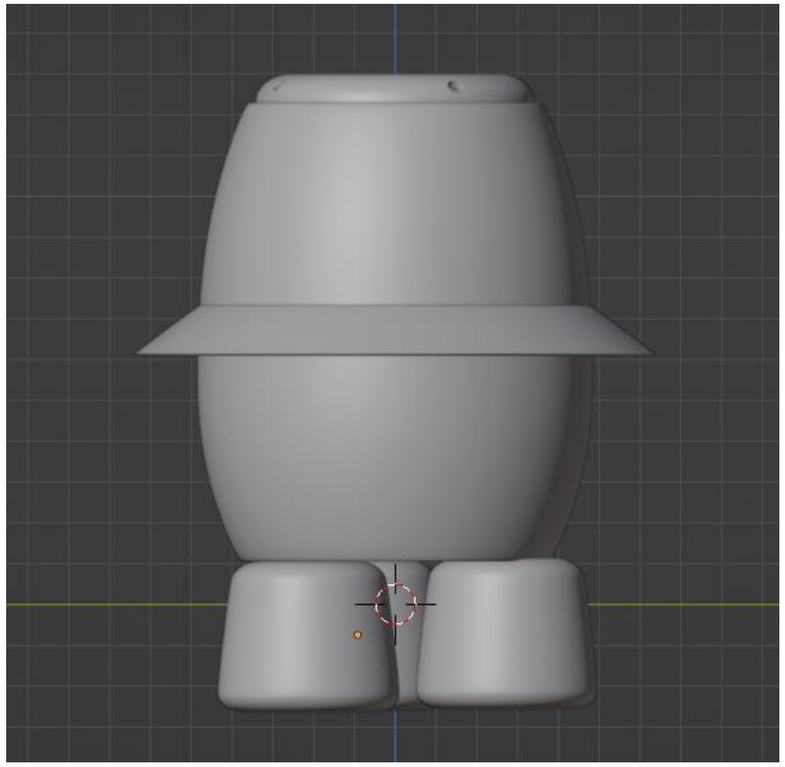
Final Blender Model

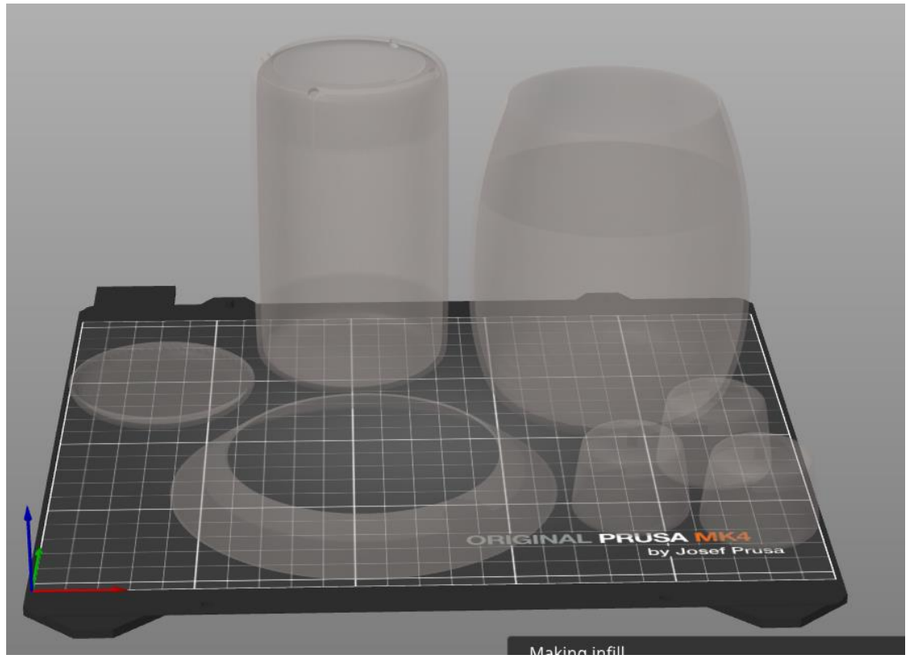
The final design consists of:

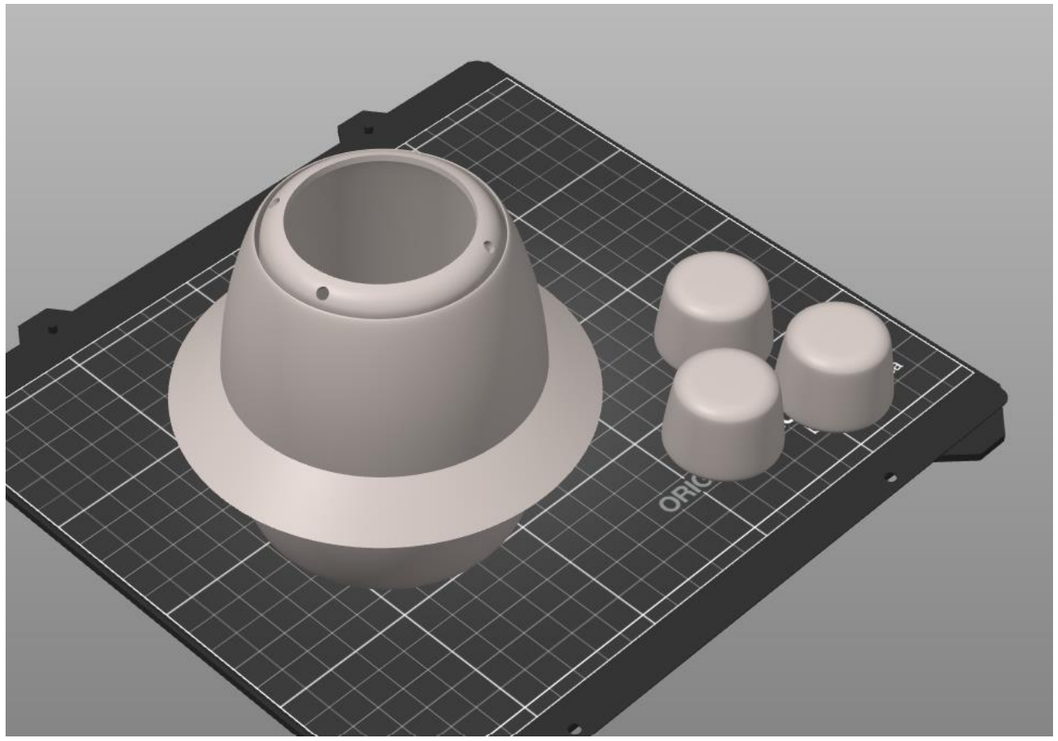
1. **An internal cylinder with the dimensions of a can**
2. **An outer casting adding extra protection**
3. **4 holes in the internal cylinder for the parachute to connect to**
4. **3 legs at the base to take some of the shock from the landing**
5. **An internal disc for the components to sit into**
6. **A 360-degree wing around the outer body**

3D Printing

Slicing



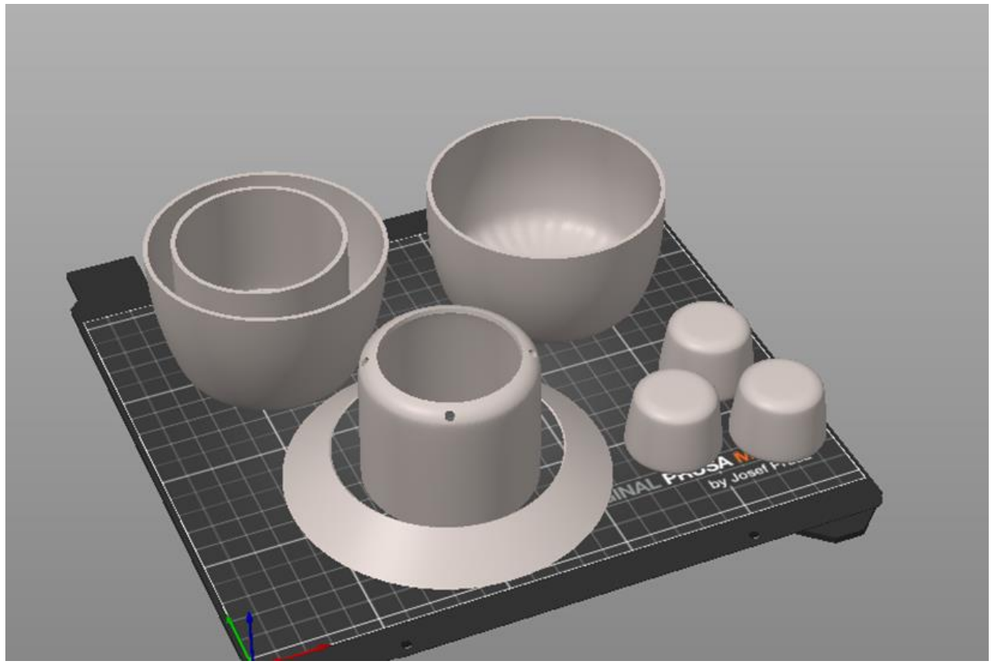


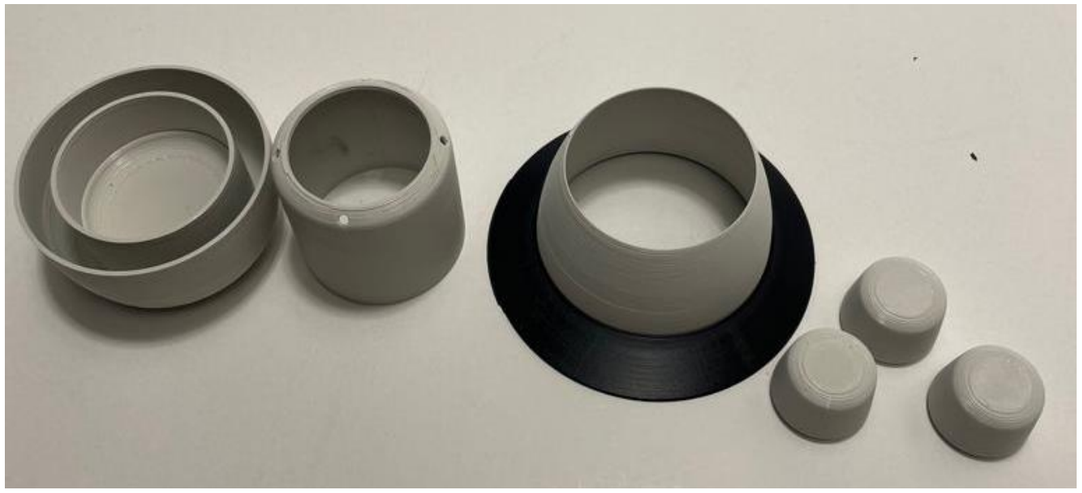


We imported the blender file as an STL into Prusa slicer. We had to scale the component down so that it would work in the specific 3-D printer that our university has.

After slicing we downloaded the g-code.

Printing





The capsule was printed in 7 different parts:

- **The lower half of the outer and inner cylinders**
- **The upper half of the casing**
- **The upper half of the inner cylinder**
- **The 360 wing**
- **The 3 separate bases**

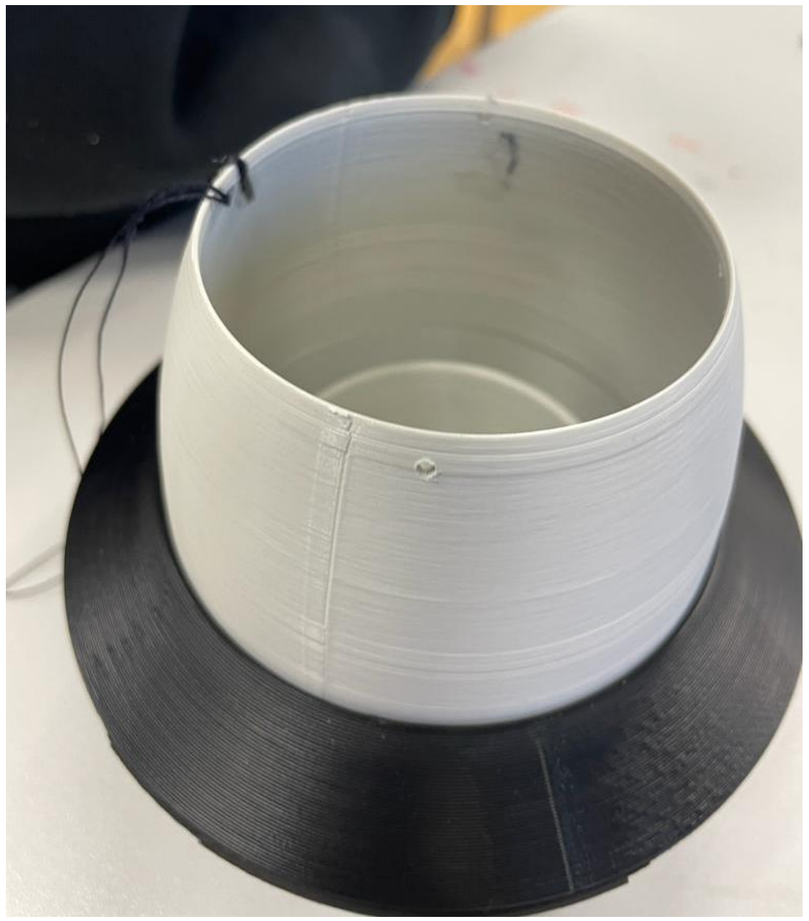
Assembly

Gluing Outer Casing and Wing

- **We used super glue to glue the top and the bottom half together. The wing was a snug fit on the outer casting so we didn't think that glue was necessary.**

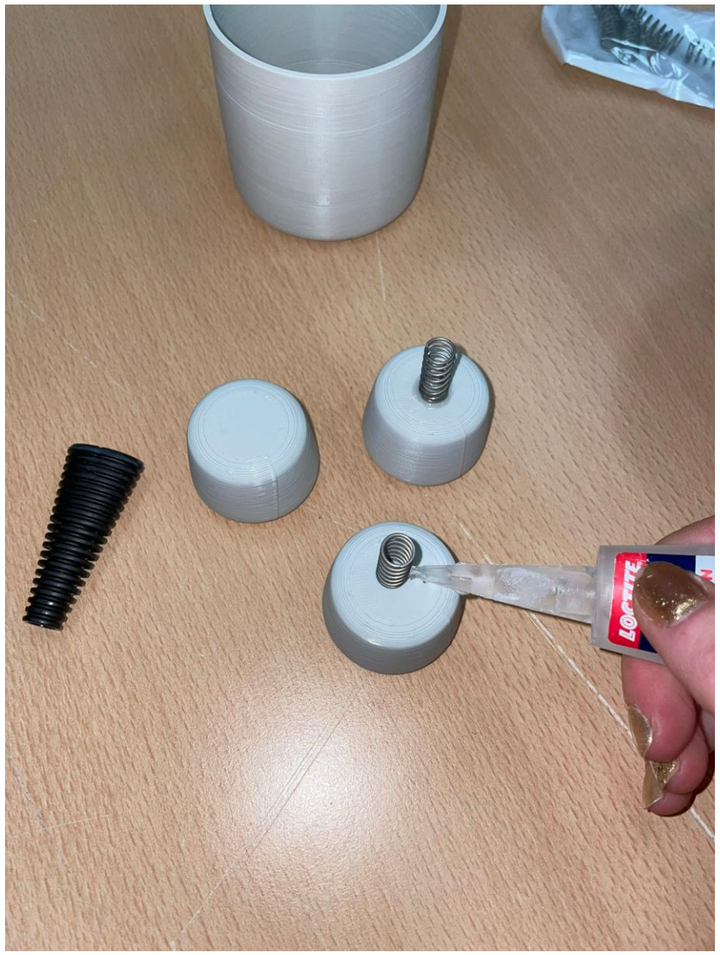
- **After a test run, we decided to also superglue the wing as with impact it fell off.**

Attaching Parachute



We met up with our master student about a week before launch to finalize the whole project. He brought the parachute that he made himself. We drilled holes into the exterior as we decided not to glue the upper half of the inner cylinder. For this, we used a hand drill. To attach the parachute, we used a mixture of knots and superglue to secure it in place

Attaching Springs



We aimed to enhance the landing experience by incorporating springs into the base, providing a cushioning effect. This innovative approach suspends the capsule in the air, effectively minimizing the impact of a potential crash landing. We glued the springs on using super glue.

Testing

Test Drop

Roughly a week before the launch day, the three of us got together and decided to test the durability of our capsule with a test fall. We went to the second floor of the foundation building and dropped it.

https://youtube.com/shorts/Evt0wLnI7XM?feature=share

Reflection

Overall, we learned a lot from this project. Firstly, we improved on our communication skills as this project involved communicating not only with course mates but with a "customer" of sort in a different course. We also feel our time management has improved as we had to find time to work together as a team.

In terms of blender skills, this project thought us how easy it is to create many iterations and redesign through 3D modelling. We understand how rapid prototyping helps generate many ideas as we started out with one idea and moved away to a different concept for a variety of reasons.

We also learned more about 3D printing and how to use prusa-slicer. We now have a greater understanding of how to slice and ensure objects are ready for printing.

ME6181/PD4063 CanSat Group Project
Part 2 – ME6181

James O’Connell (19249632)

Table of Contents (Part 2 – ME6181)

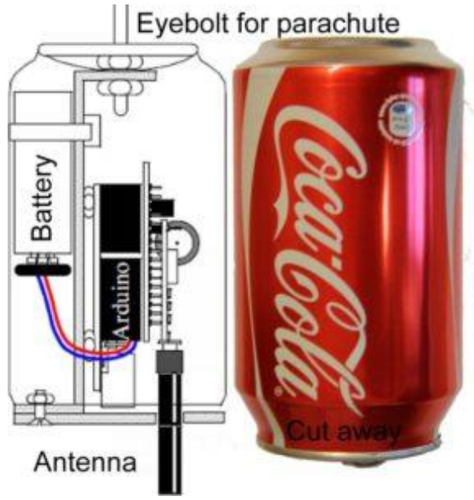
CanSat Mission Brief

A CanSat is a simulation of a real satellite, contained within the volume of a 330ml soft-drinks can

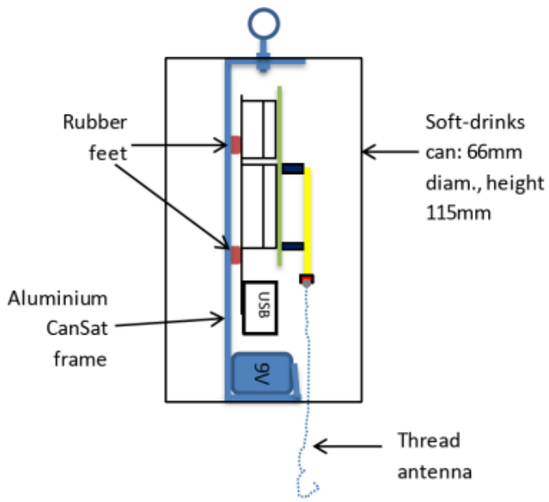
Primary Mission – remotely measure temperature and pressure and transmit data back to the ground station

Secondary Mission – chosen by the team - examples include: telemetry data, telecommand, landing system and control mechanism

The CanSat must also have a re-entry system to allow safe landing after launch with a descent velocity between two and five meters per second



Source – Andoya Space



Source – CanSat User Manual 2019

ME6181 Deliverables

Deliverable 1 – Pressure Sensor Demonstration – Week 6

Deliverable 2 – Radio Transceiver Demonstration – Week 9

Deliverable 3 – CanSat Flight Test – Week 13

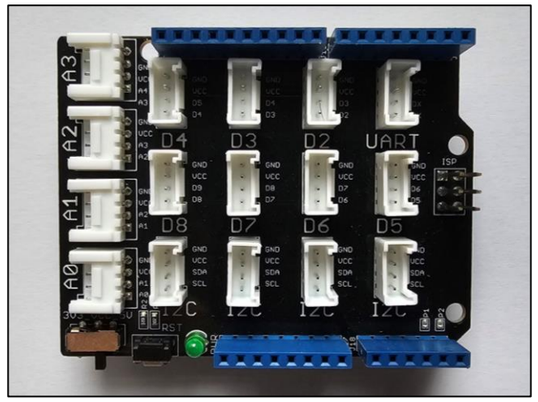
Deliverable 4 – Final Group Process Book – Week 13

Systems Overview - Components

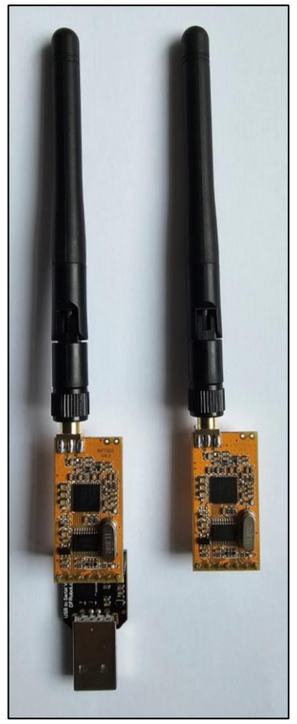
Component List:

- Arduino Uno Microcontroller – x1
- Grove Base Shield – x1
- APC220 Radio Module – x2
- BMP388 Barometric Pressure Sensor – x1
- GNSS Positioning Module – x1
- 9V Battery
- 9V to Barrel Jack Adapter
- Grove Universal 4Pin – x2
- Grove-4pin Female Jumper Conversion Cable

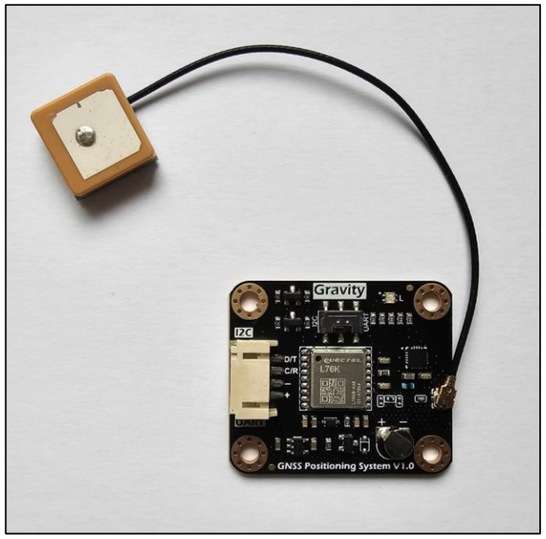
Arduino Uno



Base Shield



Radio Modules



GNSS Module

9V Battery + Adapter

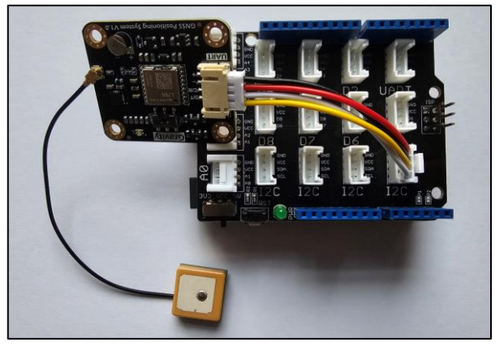
Pressure Sensor

Systems Overview - Assembly

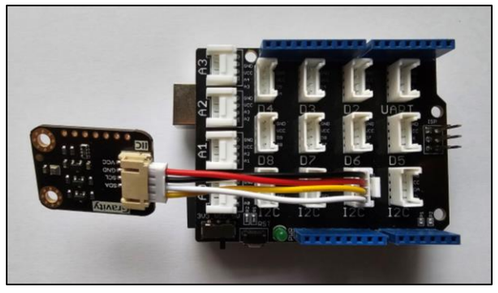
Pressure Sensor – The pressure sensor connects to the board via an I2C connector. Minor modifications were required on the cable. The SDA and SCL cables connecting to the sensor needed to be swapped and the GND and VCC cables connecting to the board needed to be swapped. The pressure sensor provides temperature, pressure and altitude data.

GNSS Module – The GNSS module also connects to the board via an I2C connector. The cable had to be modified the same way as the pressure sensor cable was. The GNSS module provides the latitude and longitude value of the CanSat and is the secondary mission sensor

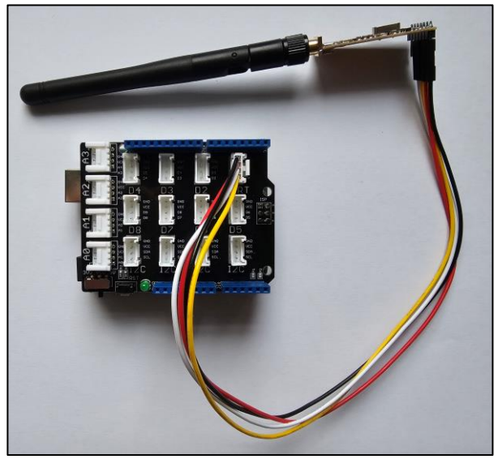
APC220 Radio Module – The radio module connects to the board via the UART port and transmits the data from the CanSat. The second module connects to a laptop via a USB port to receive the data.



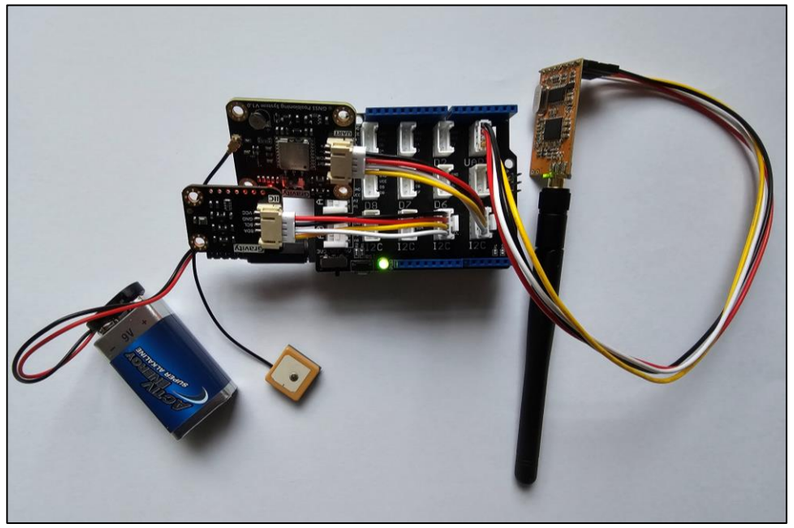
Pressure Sensor



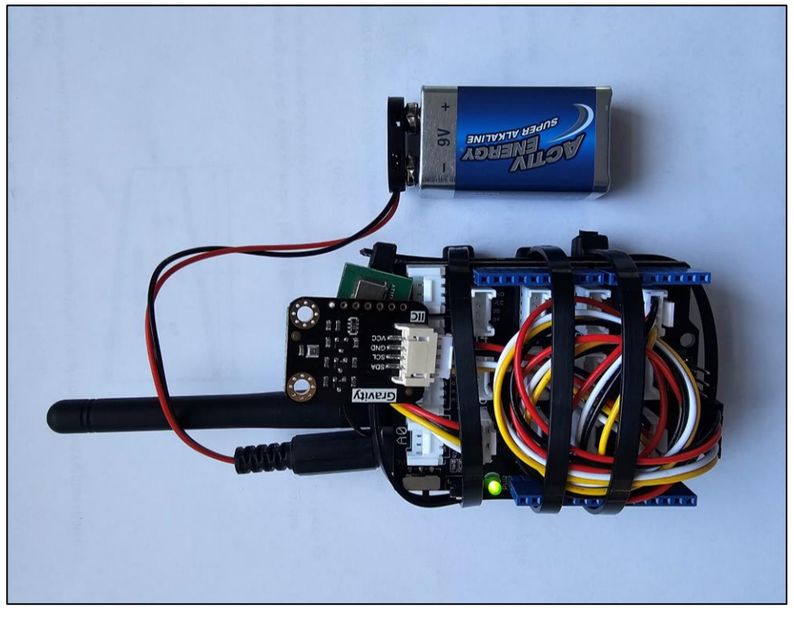
GNSS Module



APC220 Radio Module



All Components Assembled



Components secured together

All components were assembled as illustrated. As the components are not connected to a computer, power is instead provided by a 9V battery

To secure all the components together and create an overall smaller profile, zip ties were used. Three zip ties were wrapped width ways across the board to secure the pressure sensor, GNSS module and the cables. The antenna was fed up through the gap between the Arduino board and shield and is held in place by another zip tie.

Coding and Pre-Flight Tests

Overview

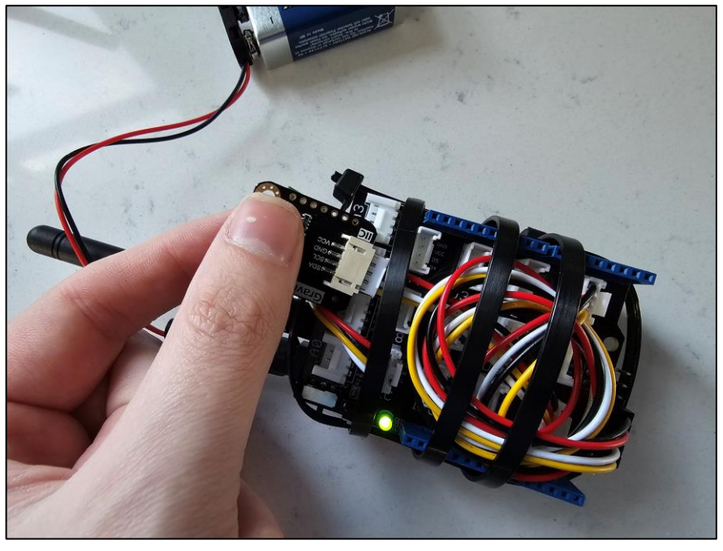
Arduino IDE was used to code the Arduino board and sensors. Each component was coded separately and tested individually. Once all components were working as intended, all the code was consolidated into a single file. The code for the components was taken from the DFRobot Wiki.

Pressure Sensor

The code for the pressure sensor was acquired from the DFRobot Wiki. The code only required slight tweaking and the installation of a library, An approximate altitude of 10m was used for Limerick. To test the sensor heat was applied and an increase in temperature was observed. Similarly, when the sensor was raised and lowered a change in altitude was observed.

GNSS Module

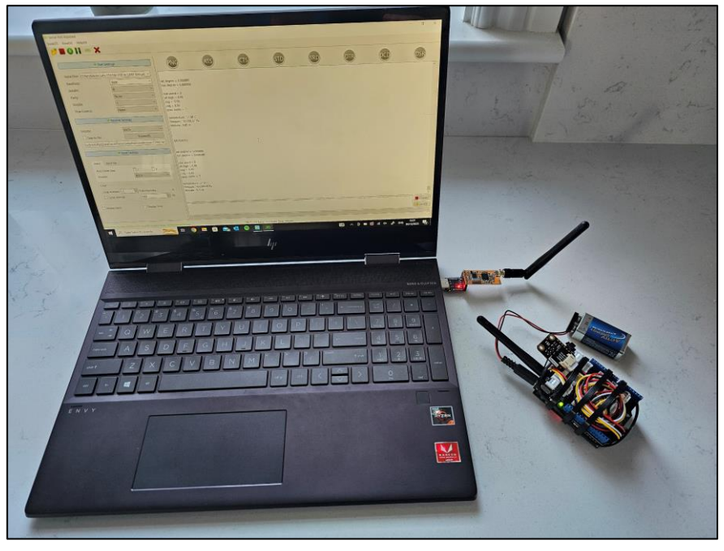
Again, the code for the GNSS module was acquired from the DFRobot Wiki. The code did not need to be altered for it to function, it only required a library to be installed. When initially powered up, the LED on the GNSS shines red which indicates it does not have a signal. The module needs to be left close to a window or outside and away from other electronics to catch a signal. To test the module the latitude and longitude co-ordinates displayed were entered into google maps which gave the correct location.



Testing Pressure Sensor

APC220 Radio Module

The radio module did not need any specific code to function. Instead, it required a few setup steps. First a driver for the USB-TTL converter needed to be installed on the computer/laptop. Next the modules were both configured using RF-magic. Once the modules were configured, data could be transmitted. Serial Port Assistant was used to display the data being received from the CanSat. To test the modules, the Arduino board was powered with a battery and the data was displayed on the computer



Testing Data Transmission

Parachute Design and Manufacturing

Parachute Design

The parachute area was calculated using the equation below. A hexagon shape was chosen due to its relative ease of manufacture and reasonable drag coefficient of 0.75. The mass of the CanSat was estimated to be approximately 350g for use in the equation. As per the brief a descent rate between 2m/s and 5m/s is required. A descent rate of 4m/s was selected as a slower speed results in an excessively large parachute. The area of the parachute corresponds to a hexagon with sides of 450mm, an area of 0.5261m^2. A 100mm diameter spill hole was also incorporated into the design resulting in a final area of 0.5182m^2.

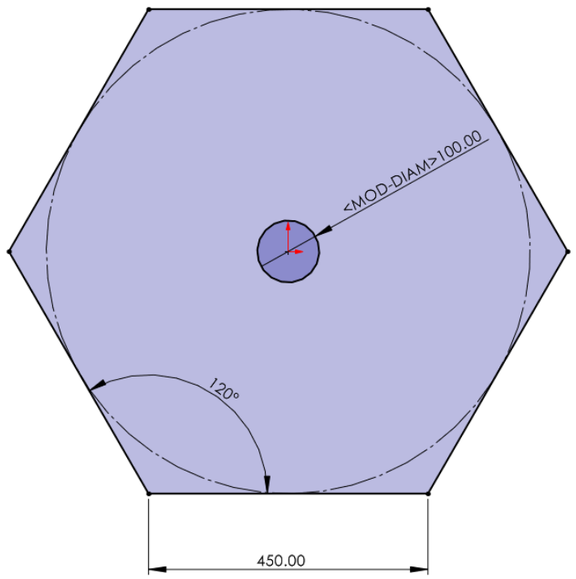
Parachute Area Equation

$$A = \frac{2mg}{C_d \rho v^2}$$

Parachute Manufacturing

The parachute was fabricated using a bin bag along with electrical tape. The area of the parachute was marked out using the electrical tape and cut. An 800mm length of nylon thread was attached to each side of the hexagon to connect the parachute to the CanSat module. There are four anchor points on the CanSat module to allow for easy attachment of the parachute.

Parachute Dimensions



Parachute Attached to CanSat Module

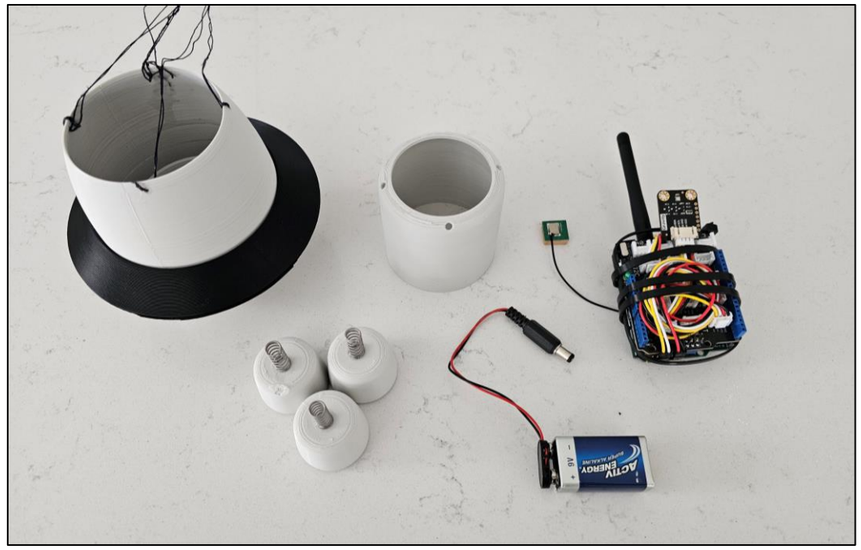
Parachute Attachment Points

Final Assembly

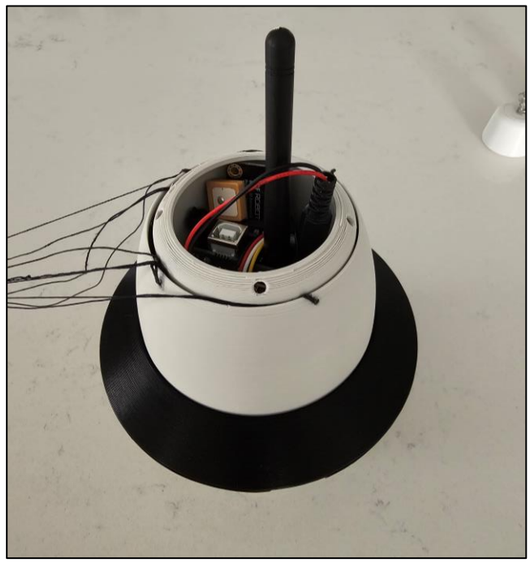
Overview

The final assembly of the CanSat module consists of four main parts: the outer shell, inner shell, legs and sensor module. There are two shells to comply with the brief. The inner shell is the volume of a 330ml soft drink can and is where the sensor module sits. The outer shell allows for other design elements to be added. The three legs each have springs which will absorb some of impact when the CanSat hits the ground after launch, protecting the sensors. Foam was also placed below the sensors for the same purpose.

Assembly Components



Final Assembly



Inner Shell

Final Assembly Side View

Assembly

Superglue was used to fasten the upper and lower halves of the shells. The threads from the parachute were tied into the anchor points and further secured with superglue. The inner shell is not permanently fastened to allow the removal of the sensor module should an issue arise.

Testing

Following the final assembly several tests were carried out to ensure all was in working order. First the parachute was tested to check its deployment and descent rate. The sensors were removed for this and a dummy weight was placed inside instead. The parachute deployed as intended and descended at an appropriate rate. After this the sensors were tested to make sure each was working and that data was being transmitted successfully. There was no issues encountered with the sensors and the data was received on the computer.