CAN SAT PROCESS BOOK

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BRIEF

- Showcase your design skills as part of a multidisciplinary team.
- Use a combination of collaborative research methods.
- In the group generate a list of functional design criteria and design the housing for a Can Sat module.
- Can Sat is a small scale, can sized satellite that measures, records and transmits live atmospheric readings to a ground station via radio
- Design a can sat payload equipped with a re-entry/landing system which will ensure a consistent rate of decent so that accurate readings can be taken.

RESEARCH PLAN

KNOWNS

- Needs to protect the satellite device.
- Needs to withstand impact from 50m high.
- Needs a re-entry system (parachute).
- Needs to have an attachment for the parachute to connect to the can sat module
- Timeline and milestones.

UNKNOWNS

- Dimensions of the cansat device.
- How the can sat will be lifted.
- Weight.
- Shape.
- Colour.
- Construction.
- Parachute size.
- Material.
- Volume.

REQUIREMENTS

Must have a re-entry system

Must fit all the satellite device inside

Must be able to withstand a drop from 50m high.

Must incorporate a parachute

- Aesthetically pleasing design elements like bright colours and creative graphics
- Multiple drops from 50m.
- Internal parachute deployment
- Explore the autonomous functions
- Enhanced stability and control
- Sustainability and reusability

ADDITIONAL FEATURES

RESEARCH

- Can we 3D print?

The main body is 3D printed.

- What materials can be used in the 3D printer?

unkown to us as we don’t know what material ewill be ordred

- Is the shape restricted to a can shape?

While the term Can Sat implies a can like shape the main body can have additional things on the outside.

- Should we prototype and 3D print ?

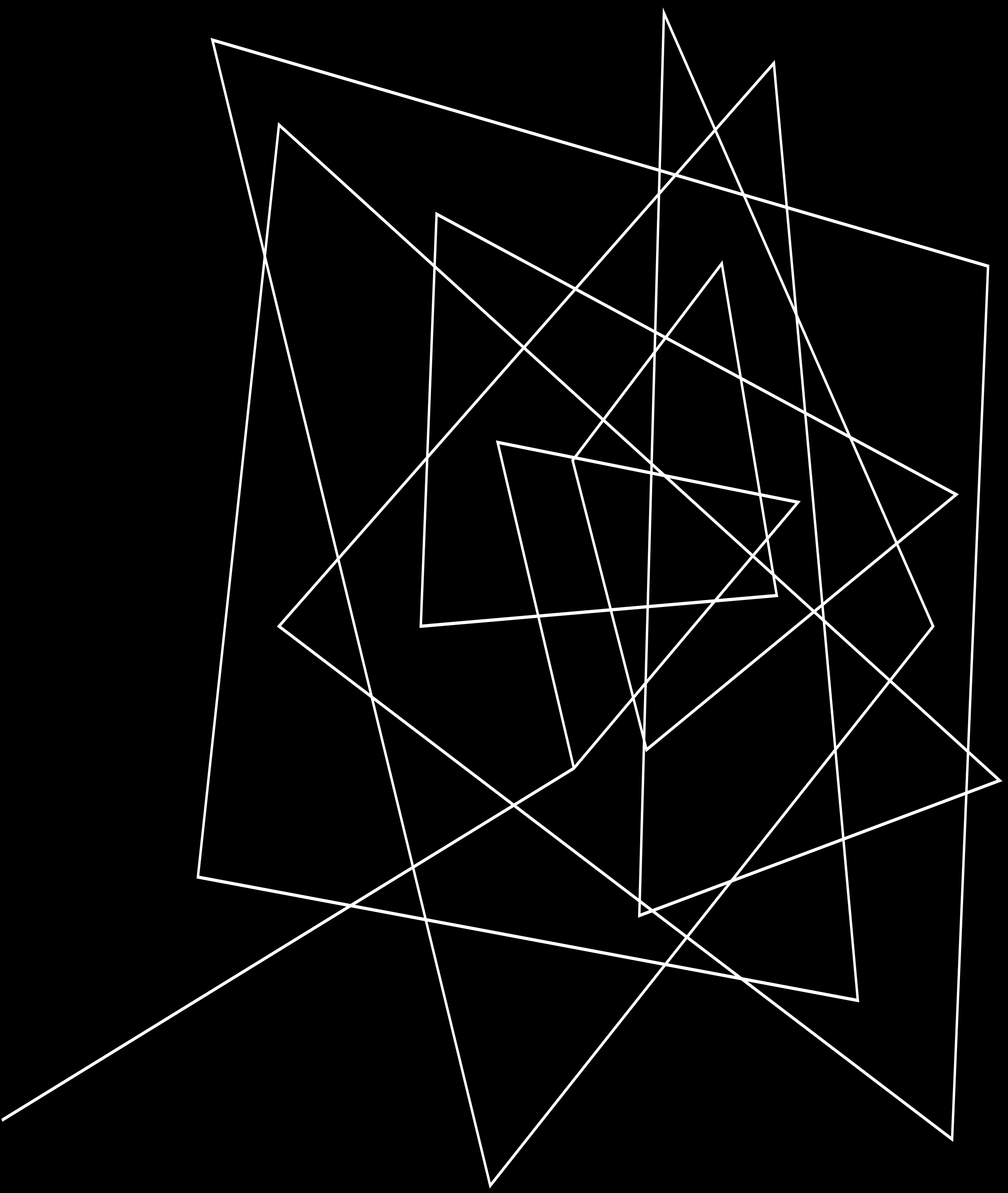
Basic prototypes must be made for test and refine the design, ensuring that it meets the objectives

- Do we have a weight limit?

No weight limit specified. It is essential to consider because can affect factors like launch altitude and parachute deployment.

- Is the parachute allowed to be outside the Can Sat?

It appears that the Parachute does not have to be deployed from inside the Can Sat, it can be attached on the outside of the body



IDEATION

IDEATION

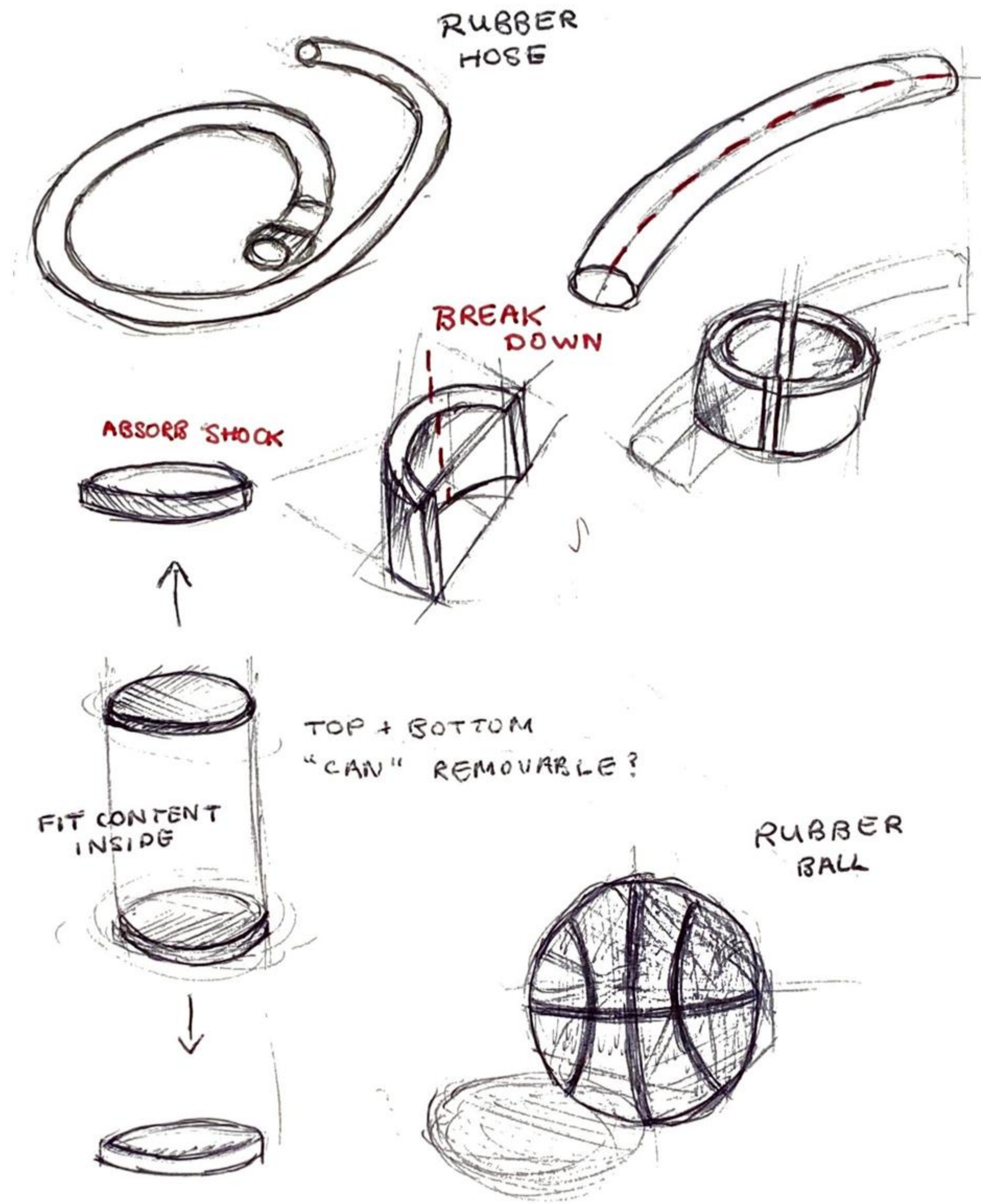
IDEAS

IDEATION SKETCHES

In considering ways to absorb the shock from the fall, rubber came into mind. Obtaining rubber in its raw form can be challenging due to its toughness, making it difficult to shape as needed.

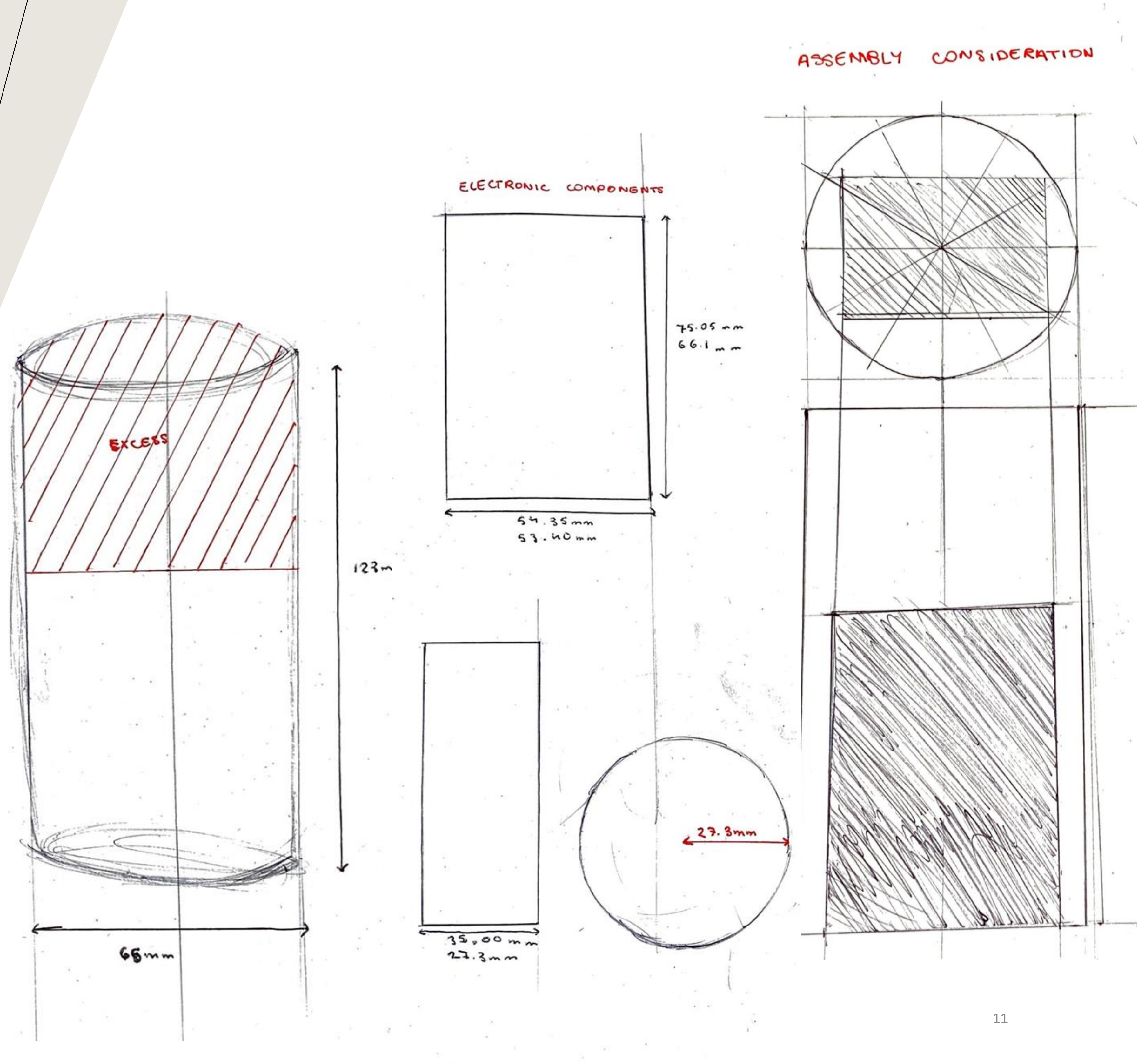
Certain things are available to use which can be broken down A rube hose gives us the ability of letting it be cut up. A rubber ball is a thin material which is bendable and can be layered if needed.

The cap would have to be definite for this project as it would have to fit in the content. The cap could be designed to be attached either from the bottom or the top, providing flexibility in assembly and disassembly.



IDEATION SKETCHES

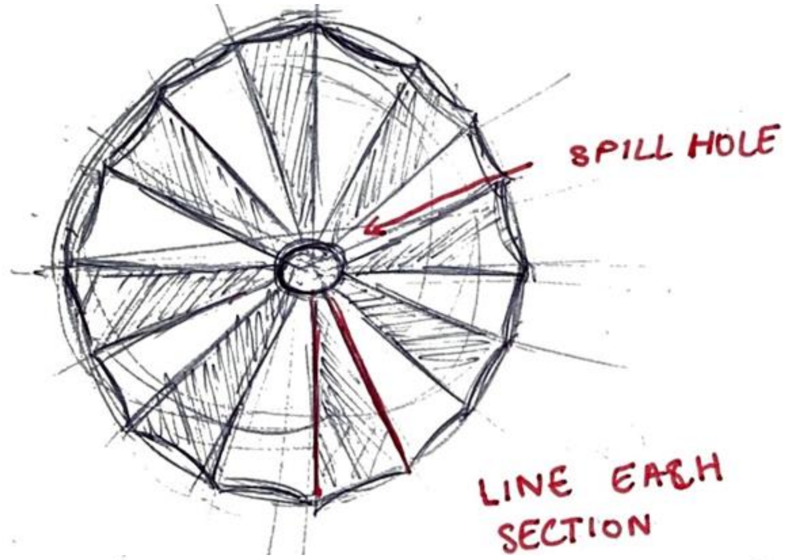
After being provided with the measurement of the content it was important to investigate the amount the electronic component would take up in a can. To do this, we looked up the dimensions of a 330ml can and calculated how much space the electronic component would occupy inside the can if it was at its maximum size. This way, we could estimate how much room we had left for supports.

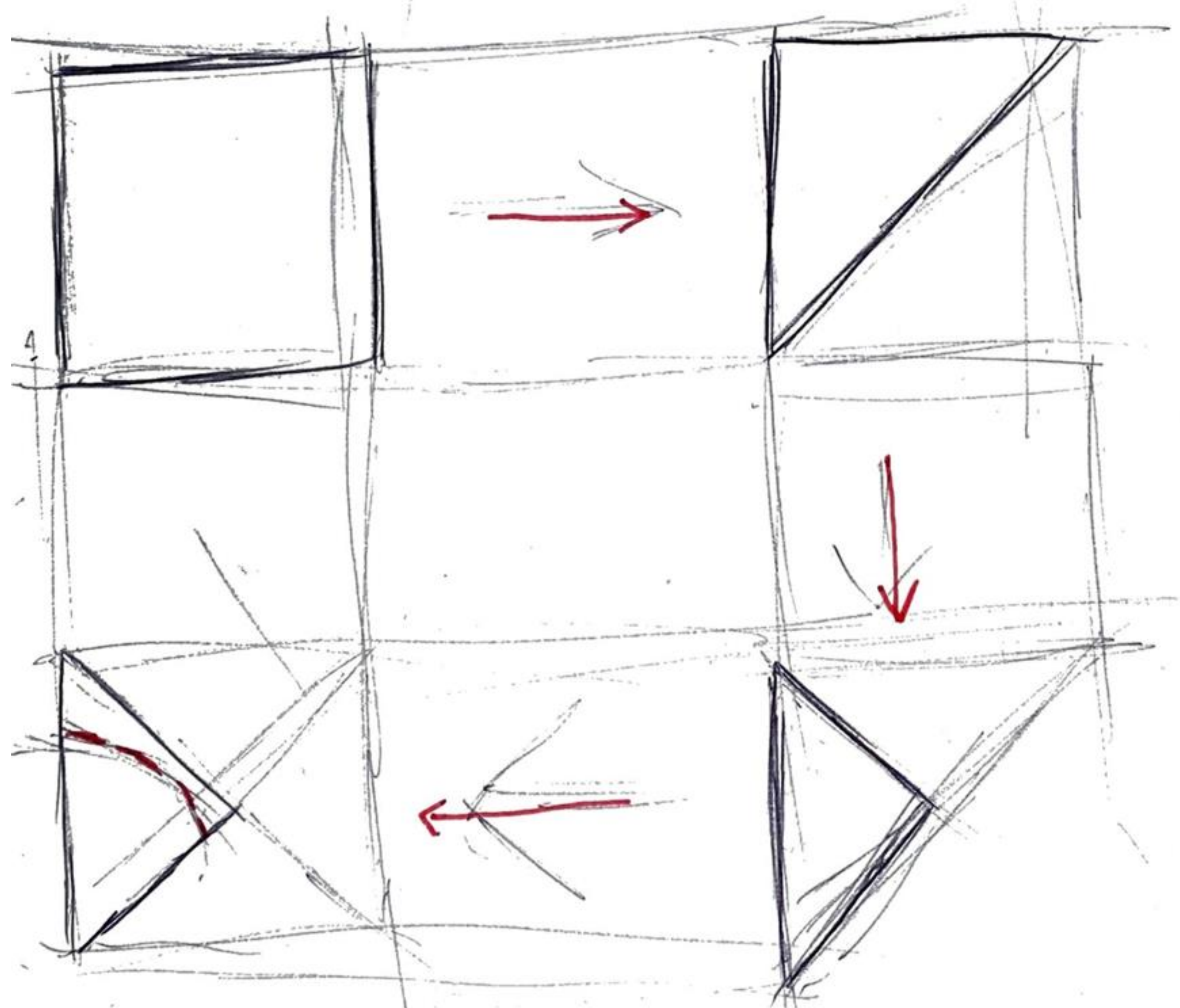


IDEATION SKETCHES

In exploring into the creation of a parachute for our project, we thoroughly examined the specifics of how the parachute functions and contributes to the effectiveness of the drop.

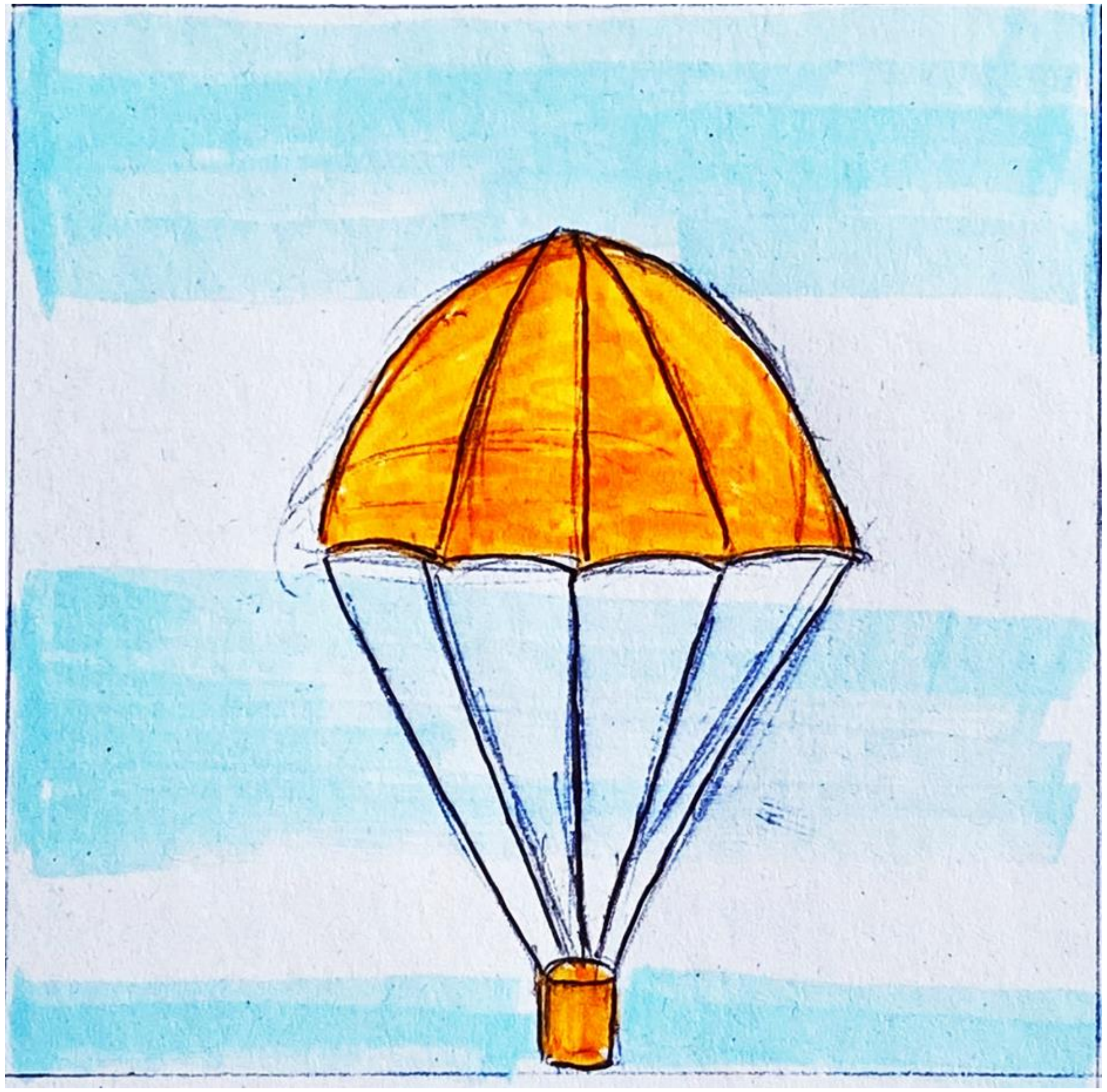
With insights gained the Master Student was able to gain our knowledge on crucial details we found important, such as the size and shape of the parachute, ensuring that it maximizes its aid during the descent. This helped with the understanding of parachutes to refine the measurements and designs.





IDEATION SKETCHES

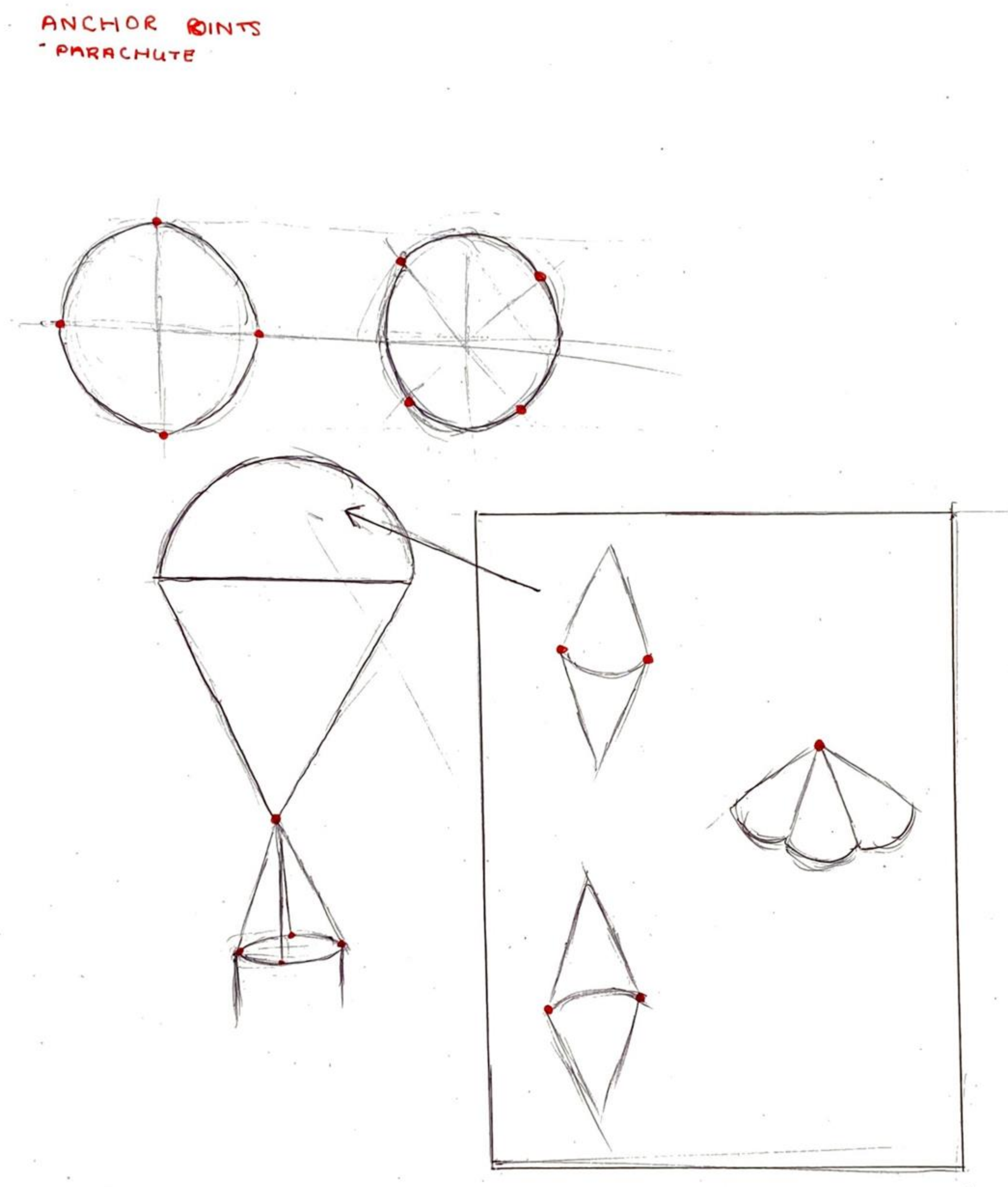
We wanted to see if adding colour to our project would make it more attractive and visible. We used a colour wheel, which shows the relationships between different colours. We held up different colours from the colour wheel to the sky and compared how they looked. We quickly found out that orange was the most striking colour against the blue sky. It also made our project look livelier and more interesting, as plain colours were too boring. We thought that using orange would make the launch more fun and make the CanSat easier to spot.



We used anchor points to mark the places where the parachute should be connected to the cylinder. Anchor points are fixed points on an object that can be used to attach other objects. By using anchor points, we could make sure that the parachute was evenly distributed around the cylinder and that it would open properly. We decided that the parachute must have four anchor points on the cylinder, one for each corner of the parachute. It did not matter what angle we chose for the anchor points, as long as they are equally spaced from each other. We could either measure and mark the anchor points manually, or already have them created with our digital model.

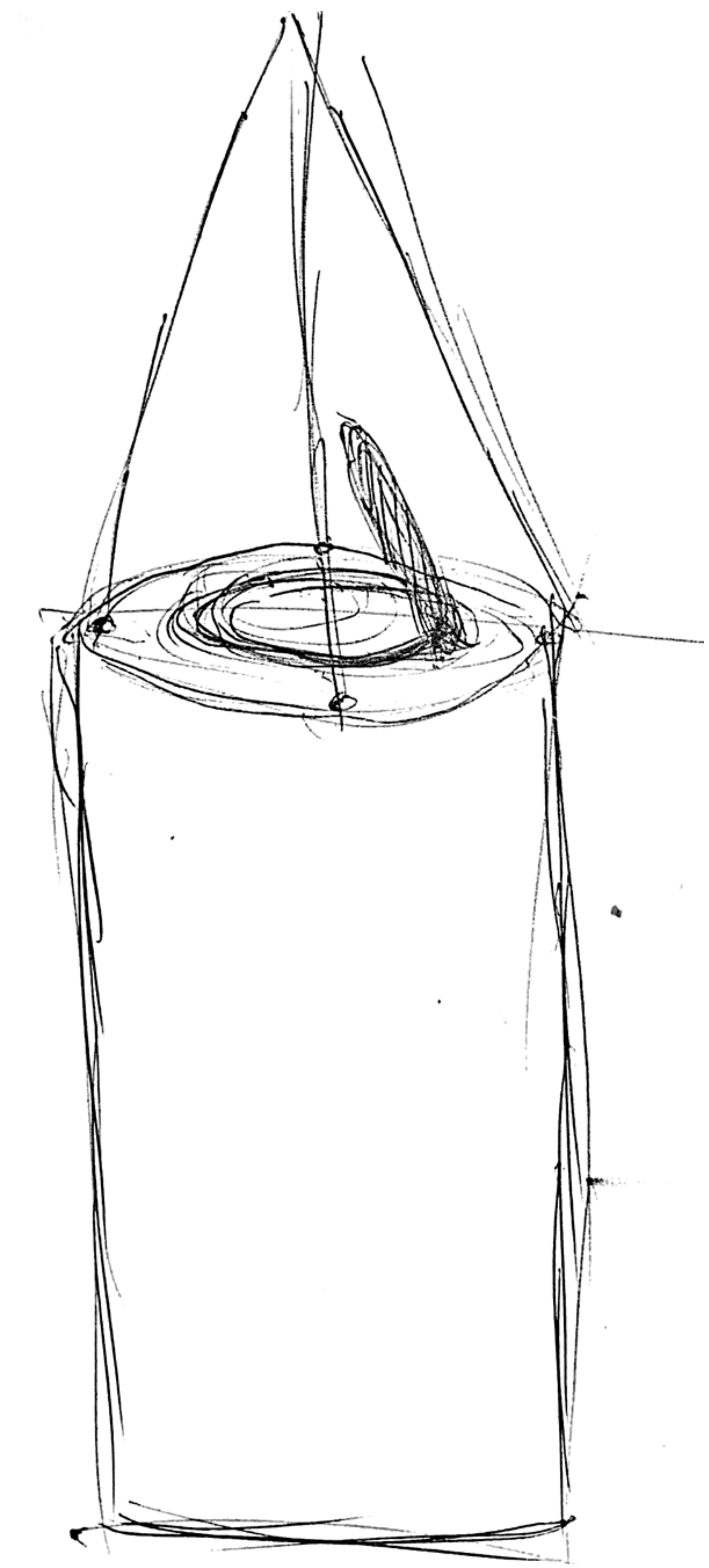
The parachute itself also had anchor points, where the strings were attached to the fabric. The parachute was made of triangular pieces of fabric, called panels, that formed the shape. Each panel had two anchor points, one at each end of the base of the triangle. The strings were tied to these anchor points and then to the anchor points on the cylinder.

IDEATION SKETCHES



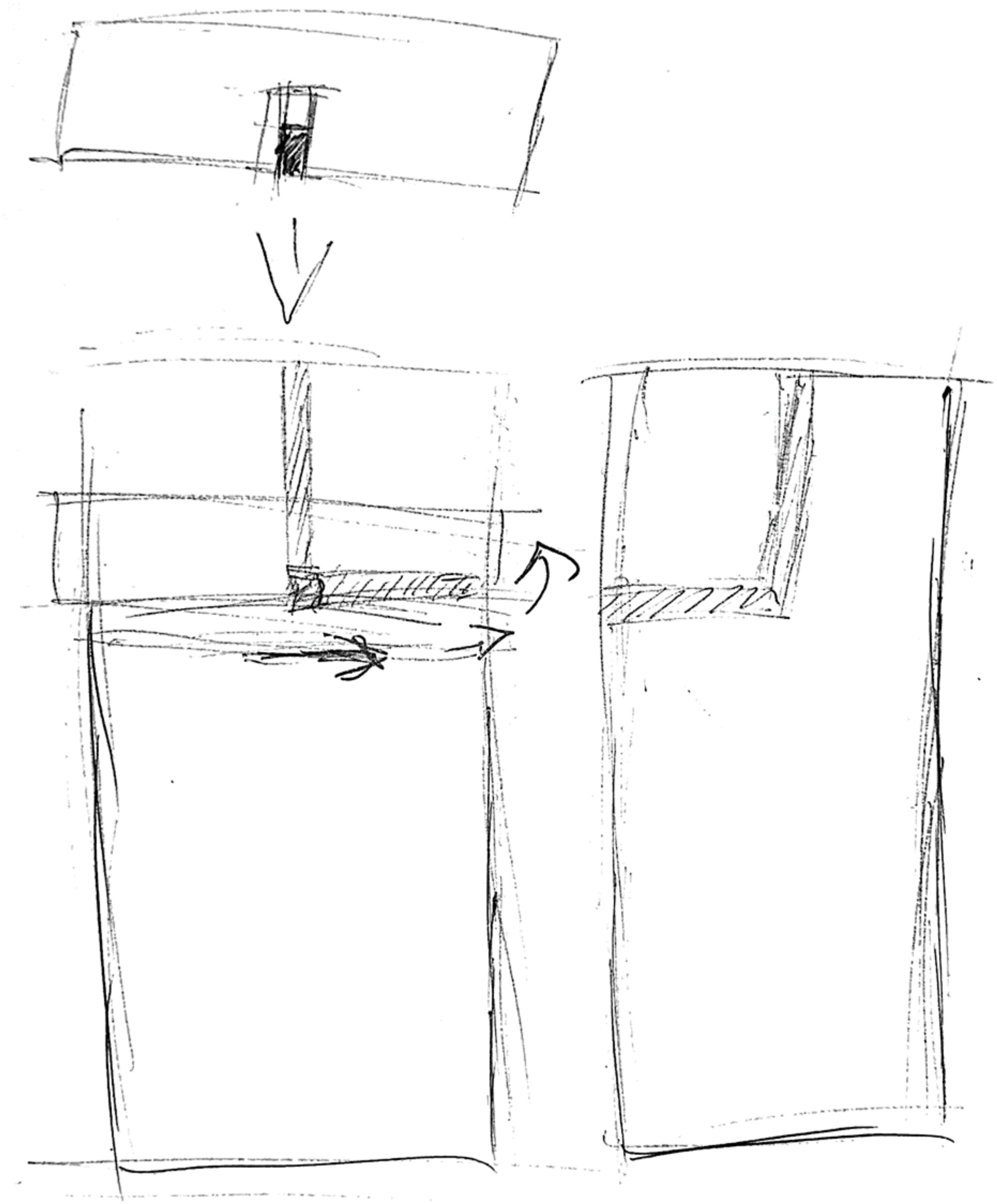
IDEATION SKETCHES

We depth into making a flip cap for the CanSat. The feature could be beneficial to keep the electronic component safe as long as the parachute will keep it vertically. However, the application would be too complex to achieve in blender, due to its need of thinner plastic need in a specific area.



IDEATION SKETCHES

By adding a simple “cube shape standing out”. It could allow the lid to slide into the groove designed for it. The grove would have to measure slightly larger. When the lid is fully inserted, it can be twisted slightly to lock it in place. This way, the lid cannot be removed unless it is twisted back to its original position. This is a simple and effective way of achieving an unmovable cap while the CanSat is launched in the air.

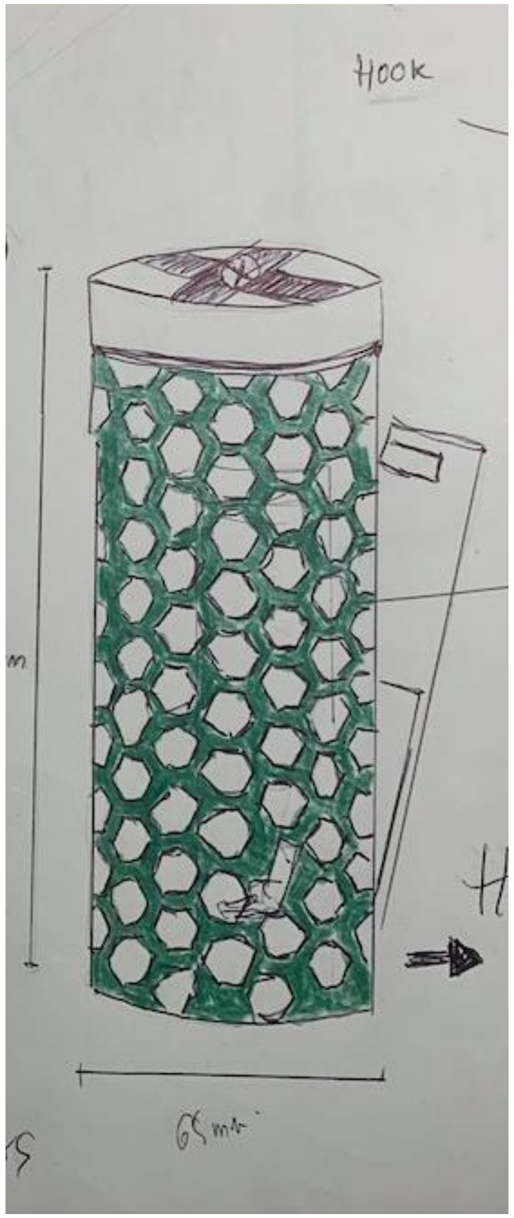


IDEA REFINEMENT

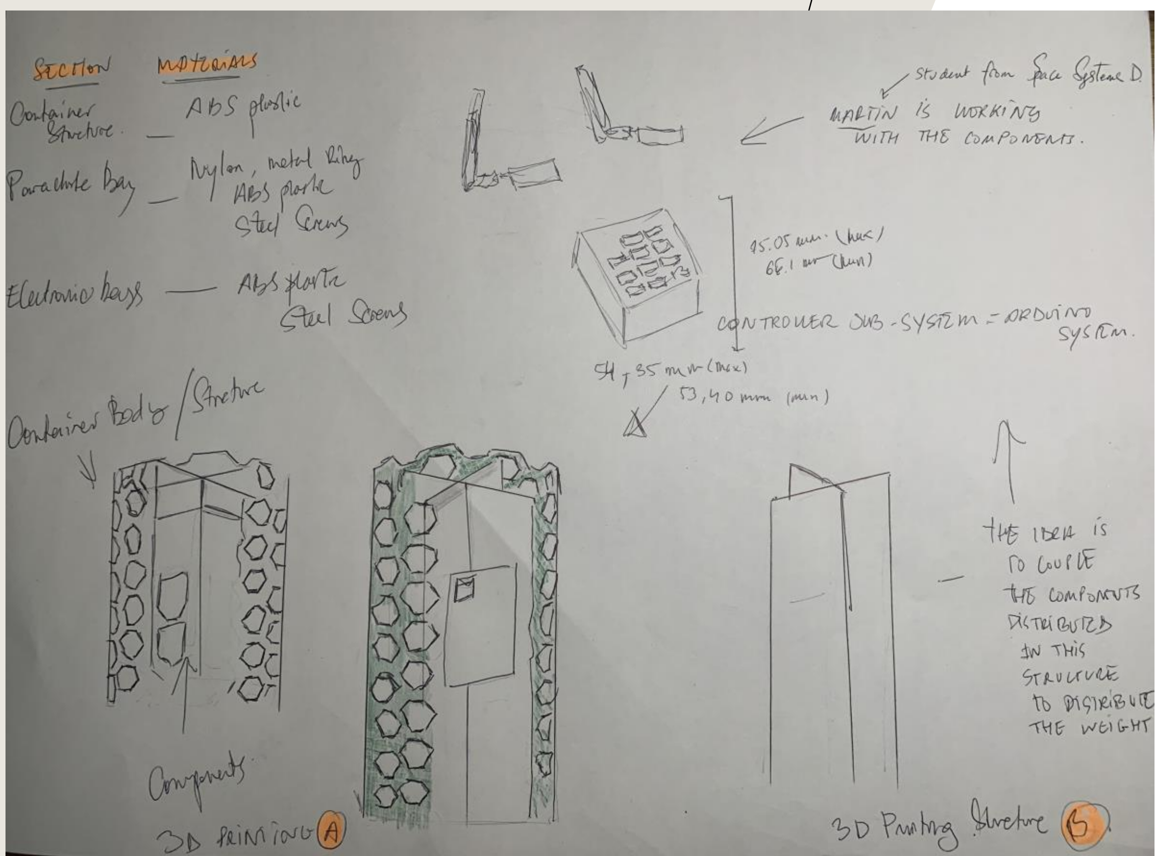
The honeycomb shapes play well with the potential for the design as it allows the construction to be lightweight while also durable. The honeycomb structure is a natural form of hexagonal geometry that has high strength-to-weight ratio. This means that it can withstand large forces without breaking or deforming, while also reducing the amount of material and weight needed.

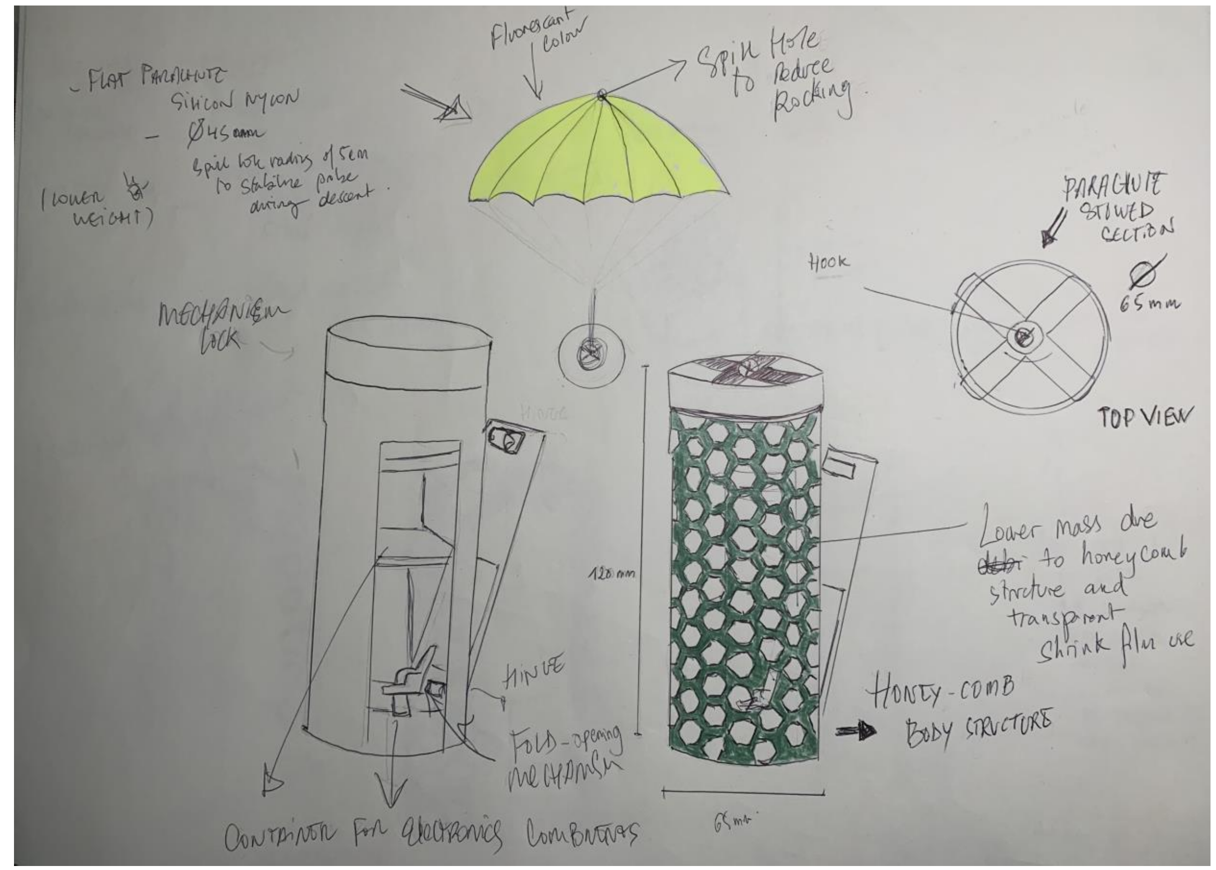
It also benefits the electronic device as it allows any components like the tracking device to stick out if needed. The honeycomb shape creates pockets of space between the hexagons that can accommodate that. This gives the design more flexibility and adaptability to fit the electronic device, regardless of its specifications.

As we wanted to make sure the electronic device would be fitted no matter what, we knew this shape would be able to satisfy this. There was no room for error. We had to ensure that the design was precise and accurate to avoid any malfunction or damage to the electronic device. We also had to consider functionality of the design. The honeycomb shape met all these criteria and proved to be an optimal choice for our design.



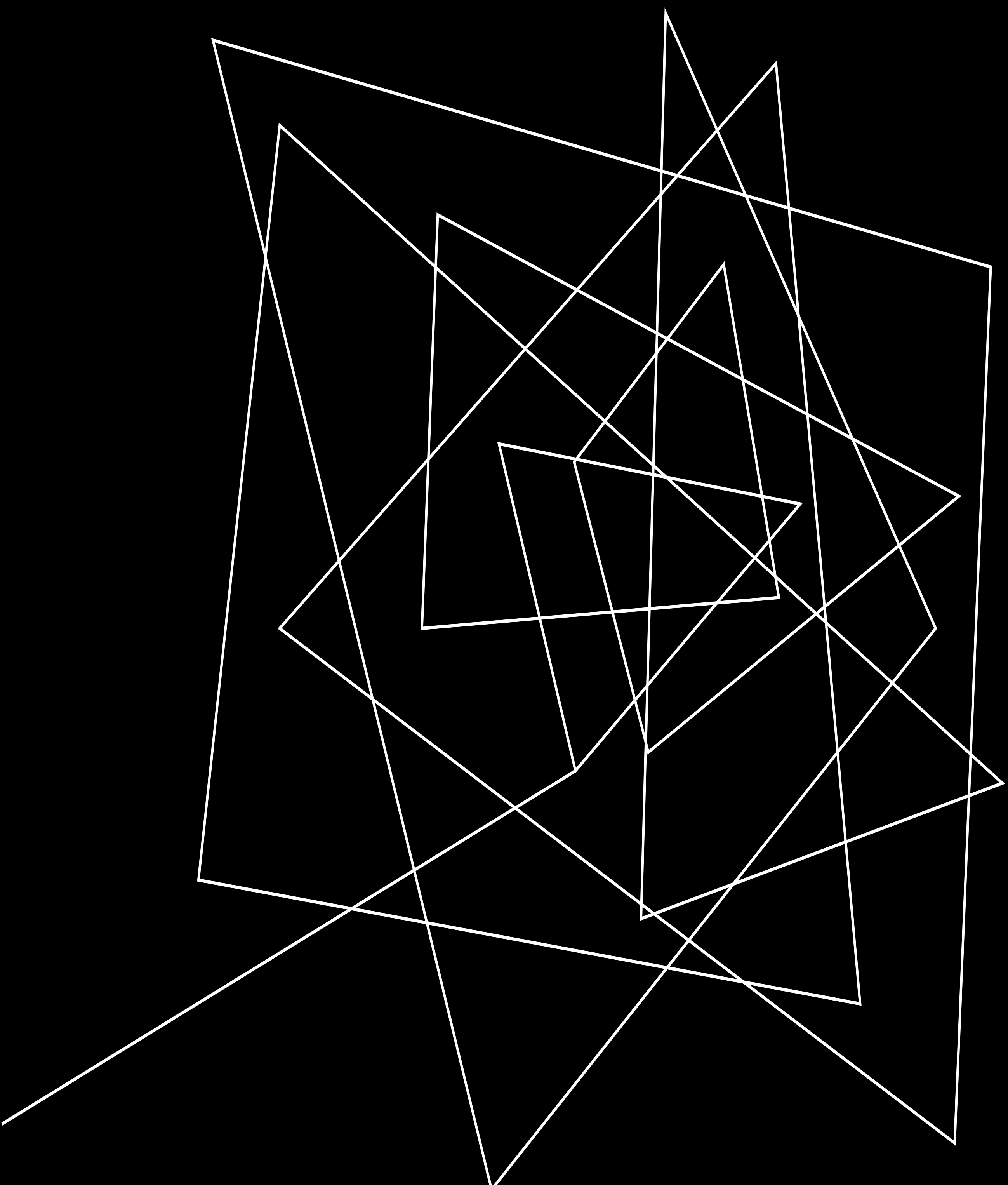
IDEATION SKETCHES





PROTOTYPE

PROTOTYPE



BLENDER PROCESS

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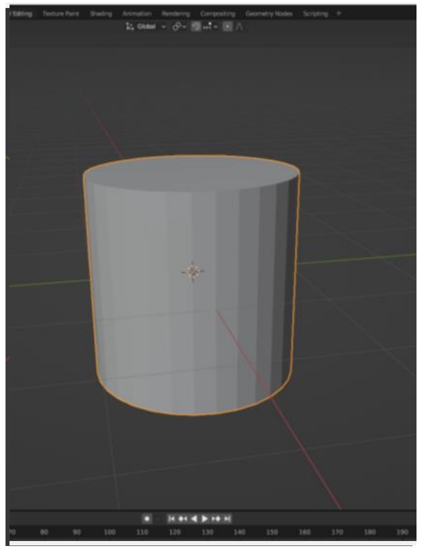
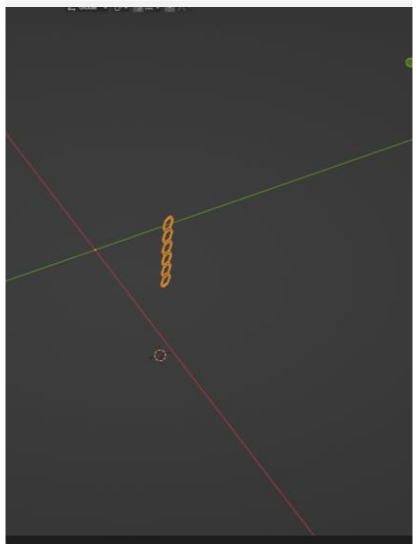


Sizing

We identified the what size the cylinder would have to be. Got the dimensions using the scaling method. We decided on a diameter of 66mm



Hexagonal Sizing

From the add-on preferences, we chose the hexagonal shapes known as honeycomb. We adjusted the dimensions of the hole in the middle of the shape to 10mm. This would allow the antena to pass through the shape.

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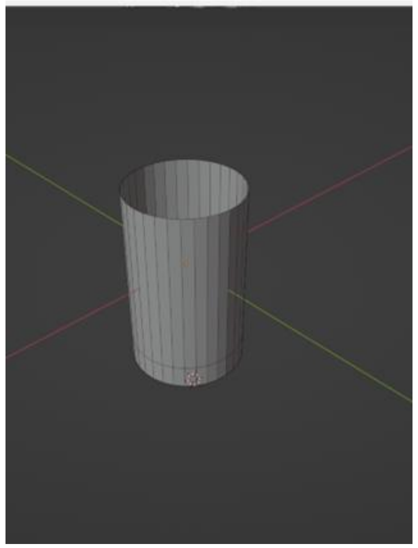
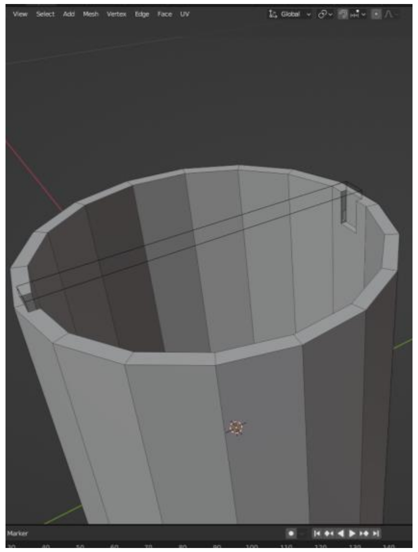


Refined shape

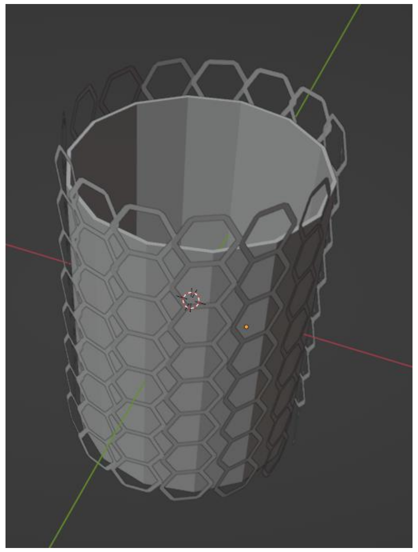
To accommodate the electronic device inside the cylinder, we made sure it was hollow. However, to avoid it being too lightweight, we added a solid area at the base of the cylinder. This would be below the hexagonal body.



Experimenting with closing mechanism.

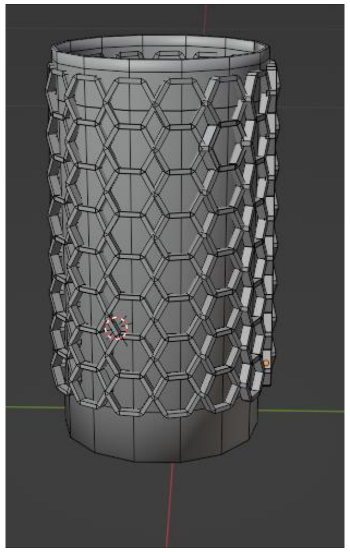
We tried one of our closing mechanisms from ideation before our original lid. This involved rotating the lid to secure it in place.

BLENDER PROCESS



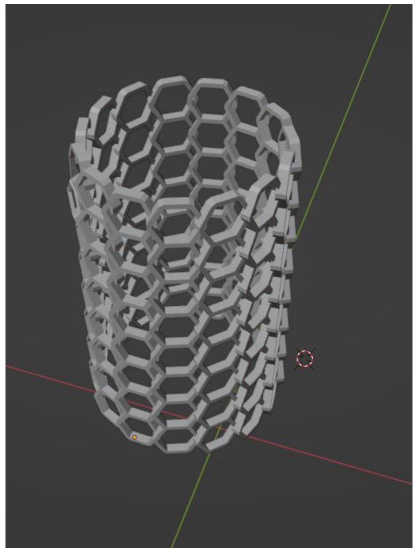
Creating a cylindrical shape with the hexagonal

To create the honeycombs, we used the cylinder as a reference and applied the “spin duplicates” tool. We adjusted the angle to 360° so that the hexagons would join at the ends and form a cylinder. We chose the number of steps based on how the hexagons looked when they were connected.



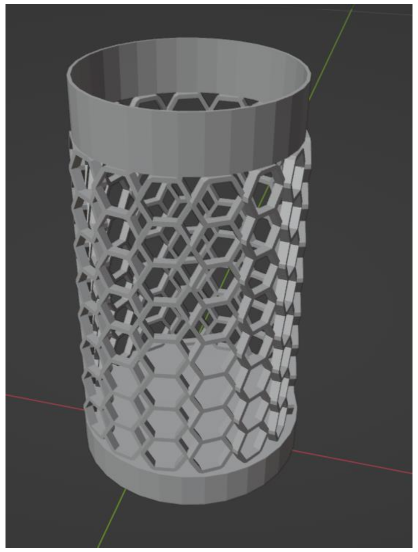
Trying to cut through with hexagons

We used the wrap tool to arrange the hexagons as we wanted. We increased their thickness. we attempted to cut the shape but failed because it was hollow inside..



Removing the cylinder

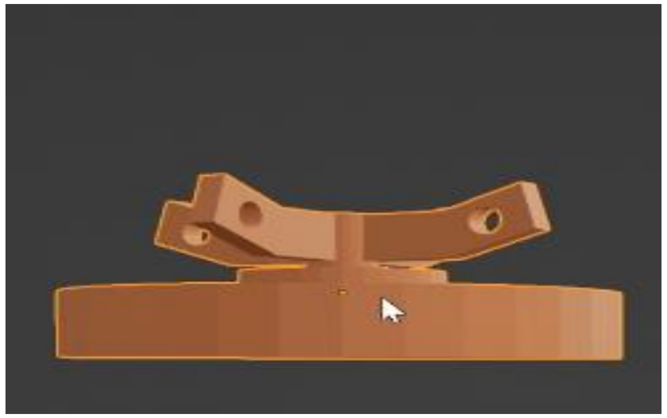
The hexagons stayed connected as we had hoped when we took out the cylinder. This meant we did not have to alter the hexagons to make them solid inside.



Finalising the body

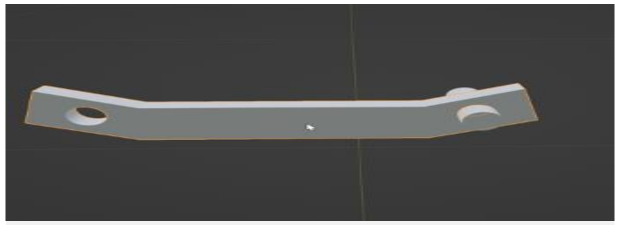
We made some minor modifications, such as adjusting the thickness. We also added a solid base, and a top part where lid would go when it would be sealed.

BLENDER PROCESS



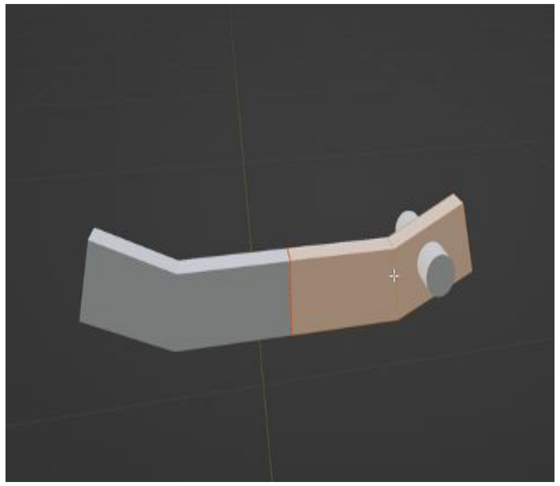
Construction of the lid

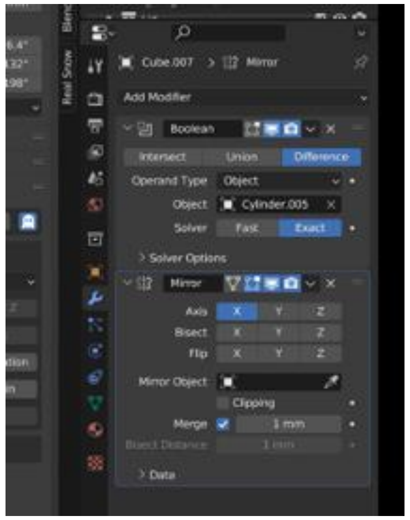
We used cylinder and cube for model this, after we used modifiers which are Boolean modifier and Mirror modifier



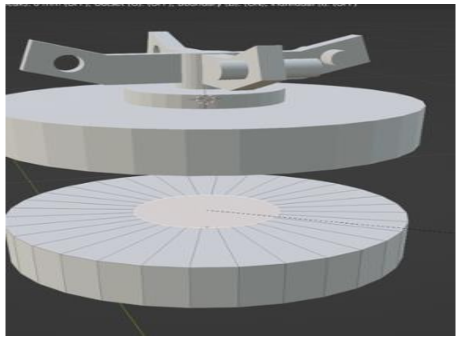
We model this box shape model using cube and Mirror modifier

Then we take cylinder and using Boolean modifier cut this hole

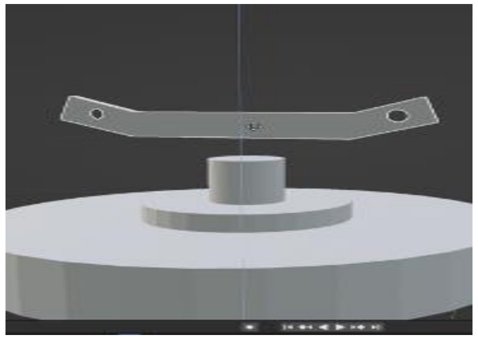


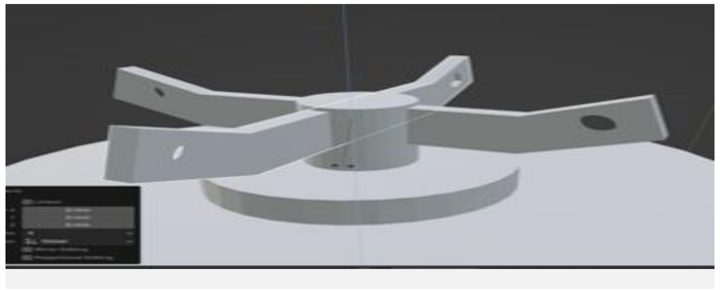


BLENDER PROCESS



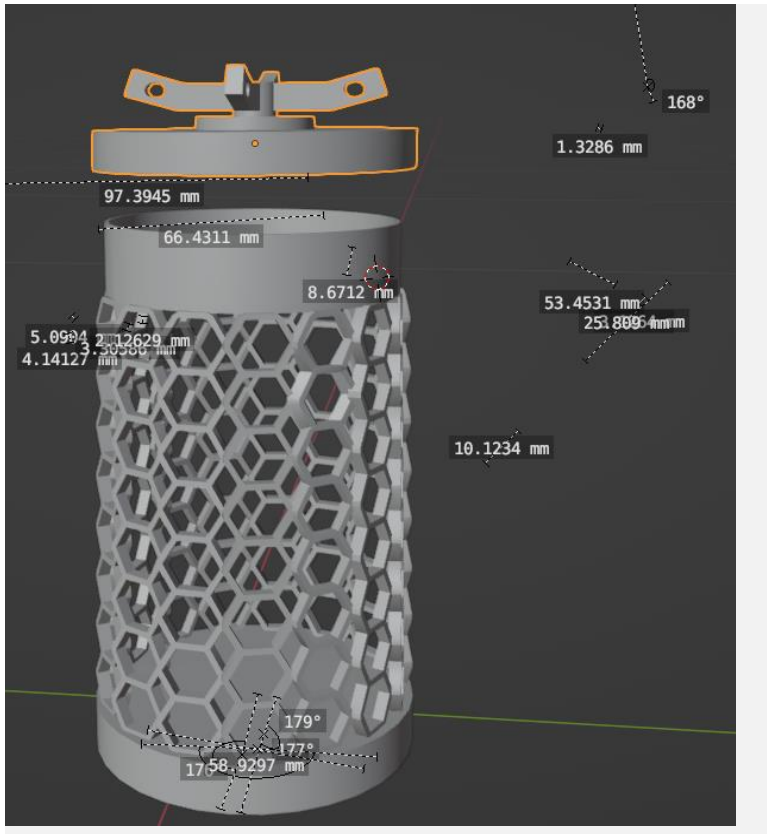
We model this cylinder shape model using cylinder and edit it to get the shape

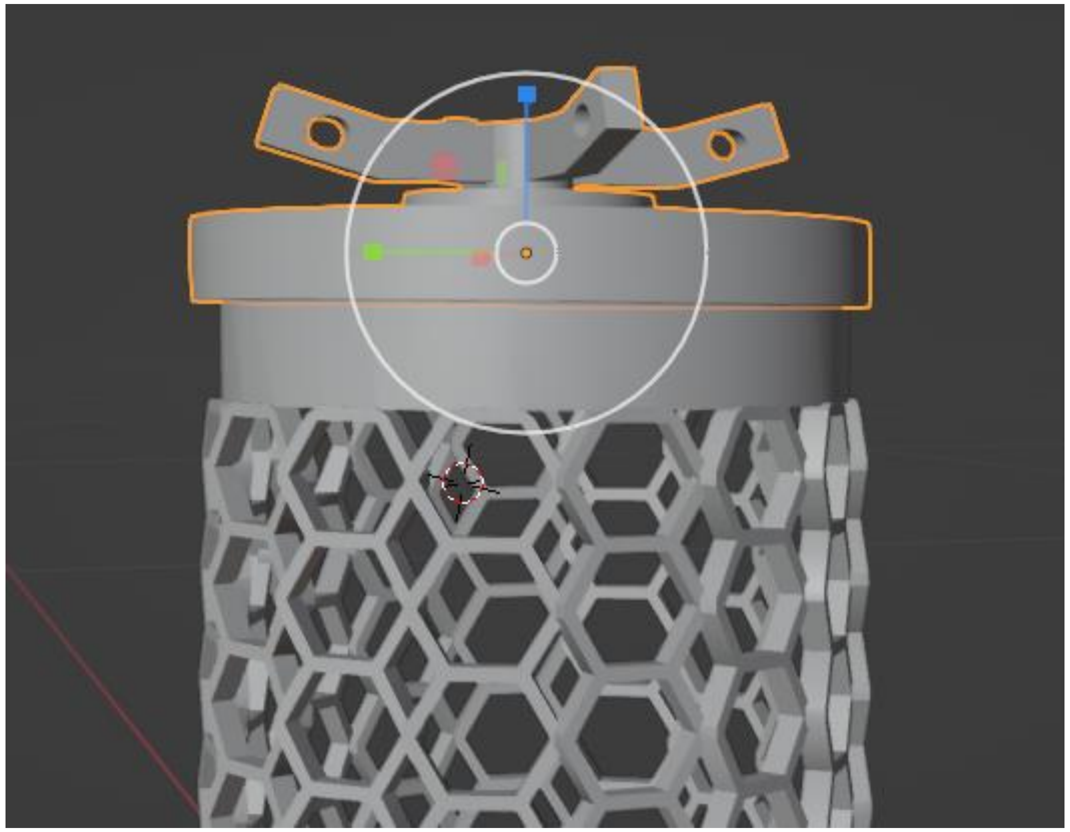




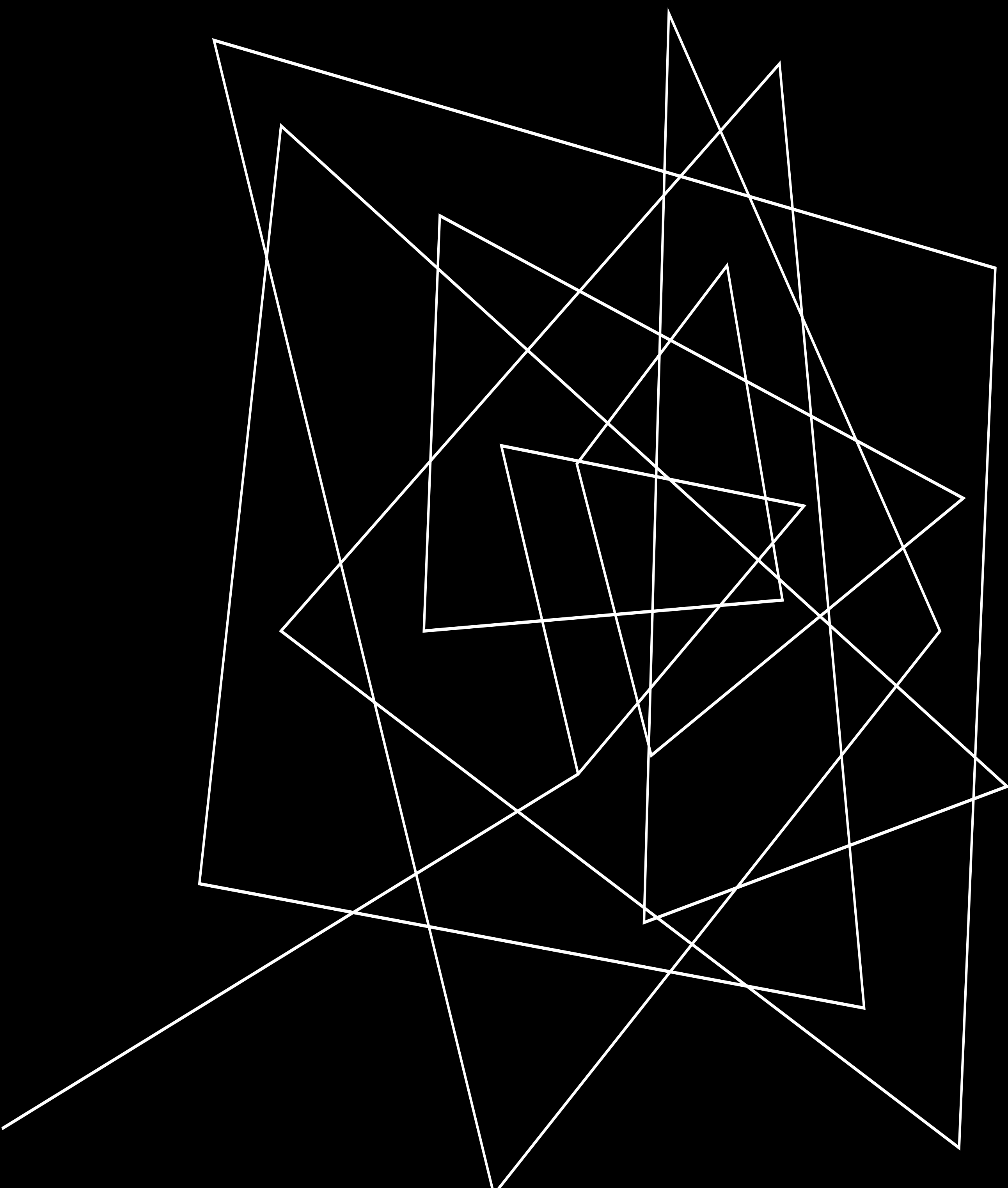
We combined this models and duplicate the box shape model and rotate it be 90 degree to get the shape of the cap.

BLENDER PROCESS





After considering various configurations for the top cover, we have designed a prototype with an increased circular diameter to ensure a secure closure through force, providing confidence that it will remain securely sealed.



FINAL CONCEPT

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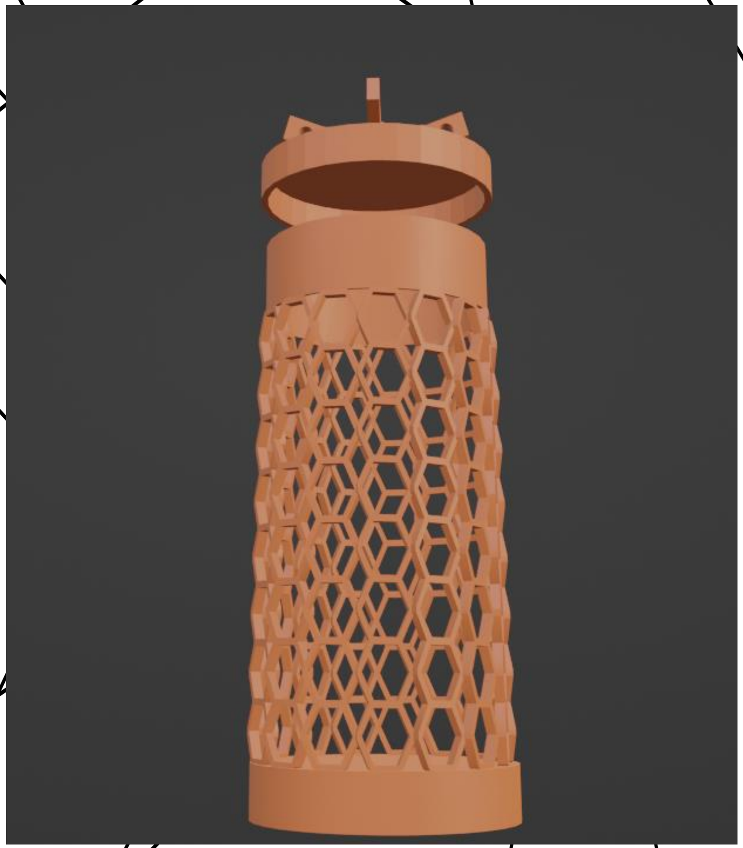
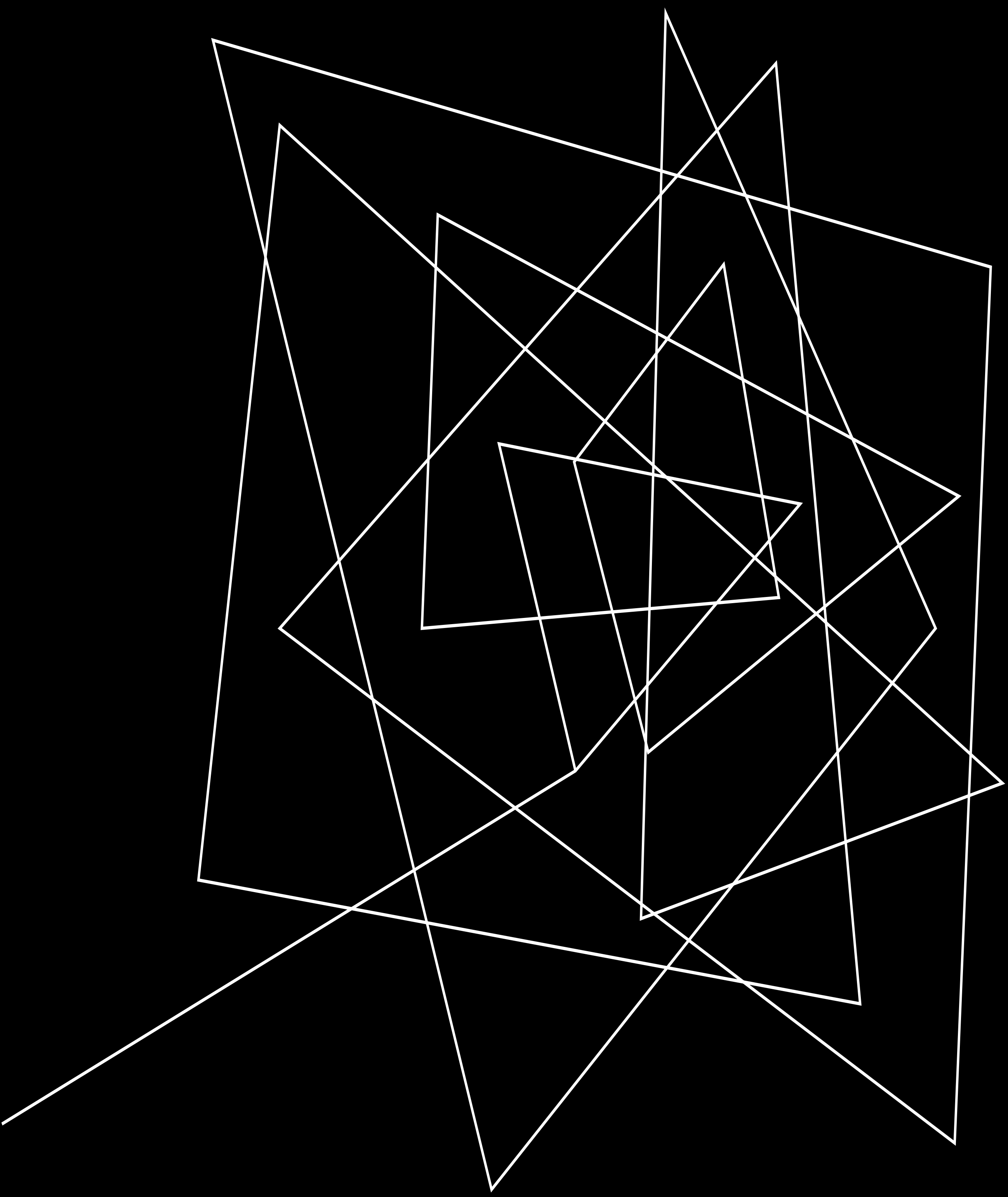


CONCLUSION



PART 2
ENGINEERING

CANSAT MISSION BRIEF

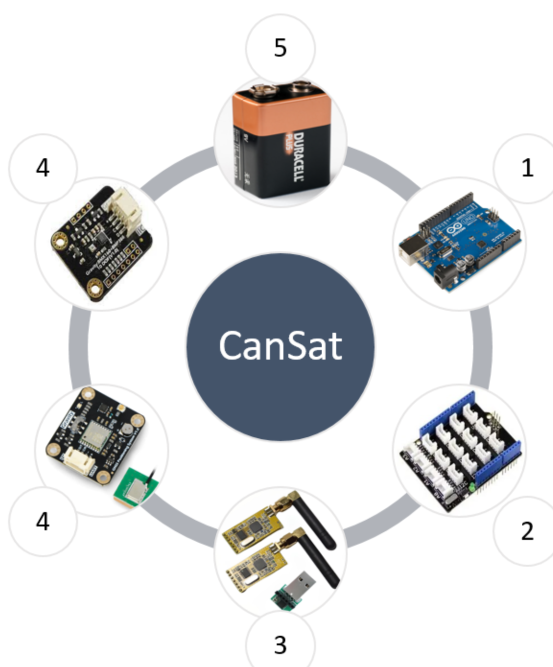
The final mission of the ME6181 - SPACE SYSTEMS DESIGN module was to design a CanSat. This project is designed to give us an introduction to different aspects required to build a functional spacecraft such as: Design, Build and all the operational aspects of a real satellite contained in a can-sized device.

Project Requirements:

- **Structure:** The first step of the project is to design a CanSat system that fits the dimensions of a standard soda can of around 330ml. This structure must be able to hold all the electrical components such as the sensors, the data transmission system as well as the power source.
- **Collect data:** The second requirement is to equip the CanSat with sensors to measure the atmospheric parameters (temperature, pressure and altitude) during its descent.
- **Transmit data:** Ensure real-time data transmission to the operator's laptop during the descent to enable live monitoring of the CanSat's performance as well as collecting the data is the third requirement of this project.
- **Re-entry system:** In order to ensure the integrity of the structural integrity of the device, the CanSat must be equipped with a re-entry system.

These requirements allowed us to delve in different aspects of aerospace engineering, project management and data analysis giving us a more practical approach to understanding the difficulties of space missions.

SYSTEM OVERVIEW



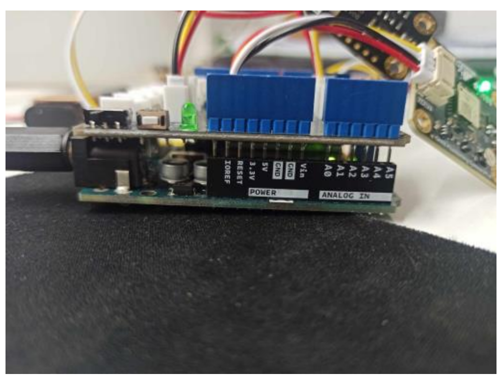
LIST OF COMPONENTS & THEIR ROLE

1. **Arduino UNO Microcontroller:** This microcontroller manages data processing and communication functions. It works as the brain of our device as it interprets sensor data, controls payload operations, and facilitates data transmission.
2. **"Daughter" Board:** This custom-designed board connects the CanSat's components to the Arduino, ensuring seamless integration and functionality of the entire system.
3. **APC220 RF Transceiver Modules (2x):** Essential for communication, these modules enable real-time data transmission between the CanSat and the operator's laptop, ensuring data monitoring and collection during the descent.
4. **Sensor Payload (BMP388 & GNSS sensors):** Includes a temperature & pressure sensor (first mission) as well as the GPS sensor required for the secondary mission. This payload is responsible for gathering data such as pressure, temperature, altitude allowing the live monitoring of the CanSat.
5. **Power System:** Powered by a 9V D-type battery, this system supplies energy to all CanSat components, ensuring sustained operations throughout the mission.

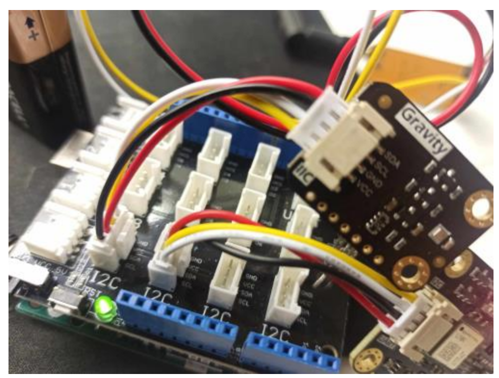
SYSTEM OVERVIEW

ASSEMBLY PHASES

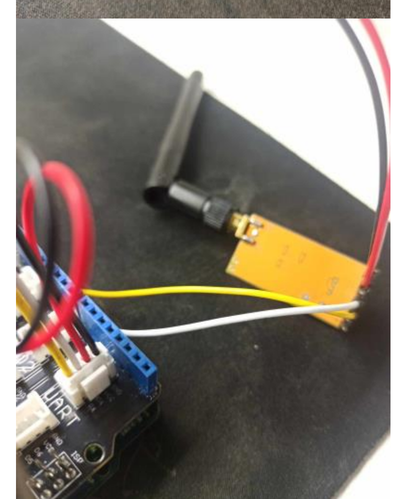
THE FIRST STEP OF THE ASSEMBLY PHASE CONSISTED OF JOINING THE ARDUINO UNO MICROCONTROLLER AND THE DAUGHTER BOARD.



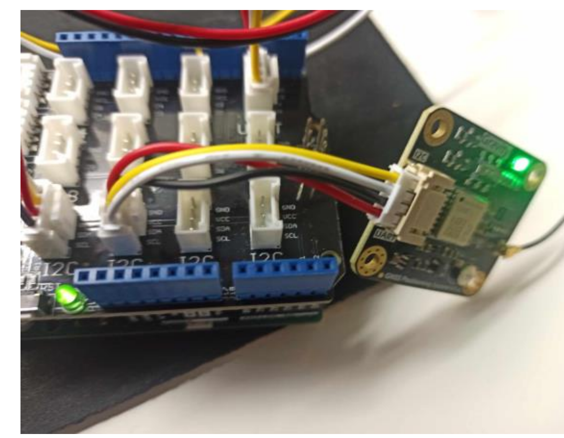
FOR THE SECOND STEP, WE HAD TO CONNECT THE BMP388 PRESSURE SENSOR TO THE DAUGHTER BOARD.



FOR THE NEXT STEP, WE HAD TO CONNECT THE BATTERY AND THE APC220 RF TRANSCEIVER MODULES TO THE DAUGHTER BOARD.



FINALLY, WE CONNECTED THE GPS SENSOR TO THE DAUGHTER BOARD.



CODING AND PRE-FLIGHT TESTS

SOFTWARE TESTS

In the development of the CanSat project, essential instrumentation and software tests included:

Sensor Initialization Test: Verification of the BMP388 sensor's communication with the Arduino, with error checks for data bus issues and chip version mismatches.

Calibration and Precision Testing: Calibration of the BMP388 for absolute pressure difference and setting to ultra-precision mode to ensure data accuracy.

Sampling Rate Test: Measurement of the BMP388's sampling period and frequency to confirm its data collection rate.

GNSS Activation and Recognition: Power-on and initialization tests for the GNSS module, ensuring it was operational and communicating correctly.

GNSS Configuration: Testing various satellite settings including GPS, BeiDou, and GLONASS for optimal positioning data.

Live Data Monitoring: Real-time data readouts for temperature, pressure, altitude, location coordinates, and velocity to monitor and verify sensor performance.

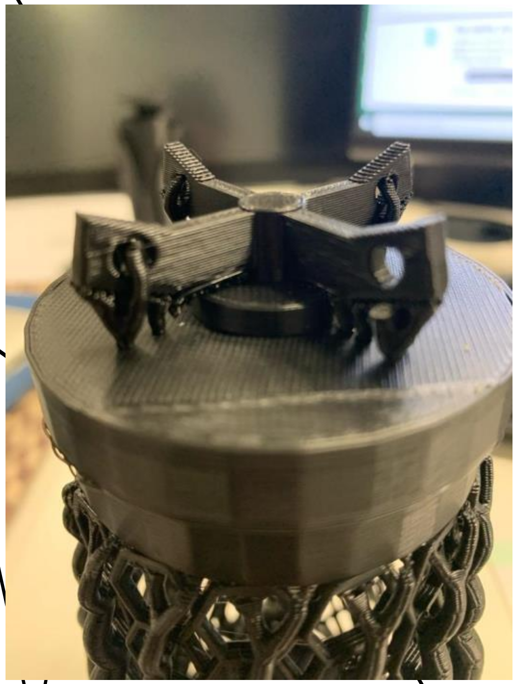
These streamlined tests were designed to confirm that both the hardware and software components of the CanSat were prepared for mission execution.

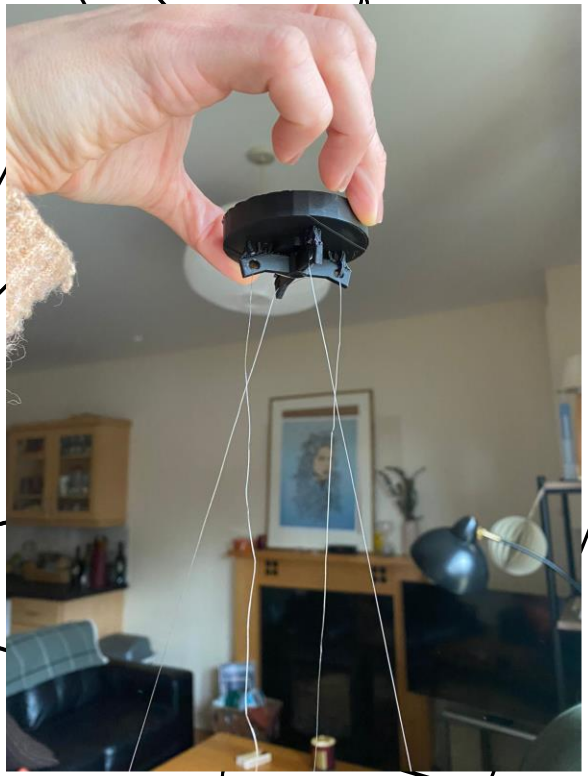
FINAL ASSEMBLY

Once all electronic components were integrated, we arranged them within the unit, positioning the sensors strategically at the upper section to avoid any interference with signal transmission. The main body's honeycomb structure was utilized to accommodate the antenna, facilitating unobstructed data exchange with the ground-based operator's laptop. While the electronics functioned properly, the CanSat's body required a redesign and reprinting to ensure all elements fit correctly due to an initial sizing complication.

Final assembly pictures

Parachute / CanSat connection





FLIGHT TEST

PARACHUTE DESIGN

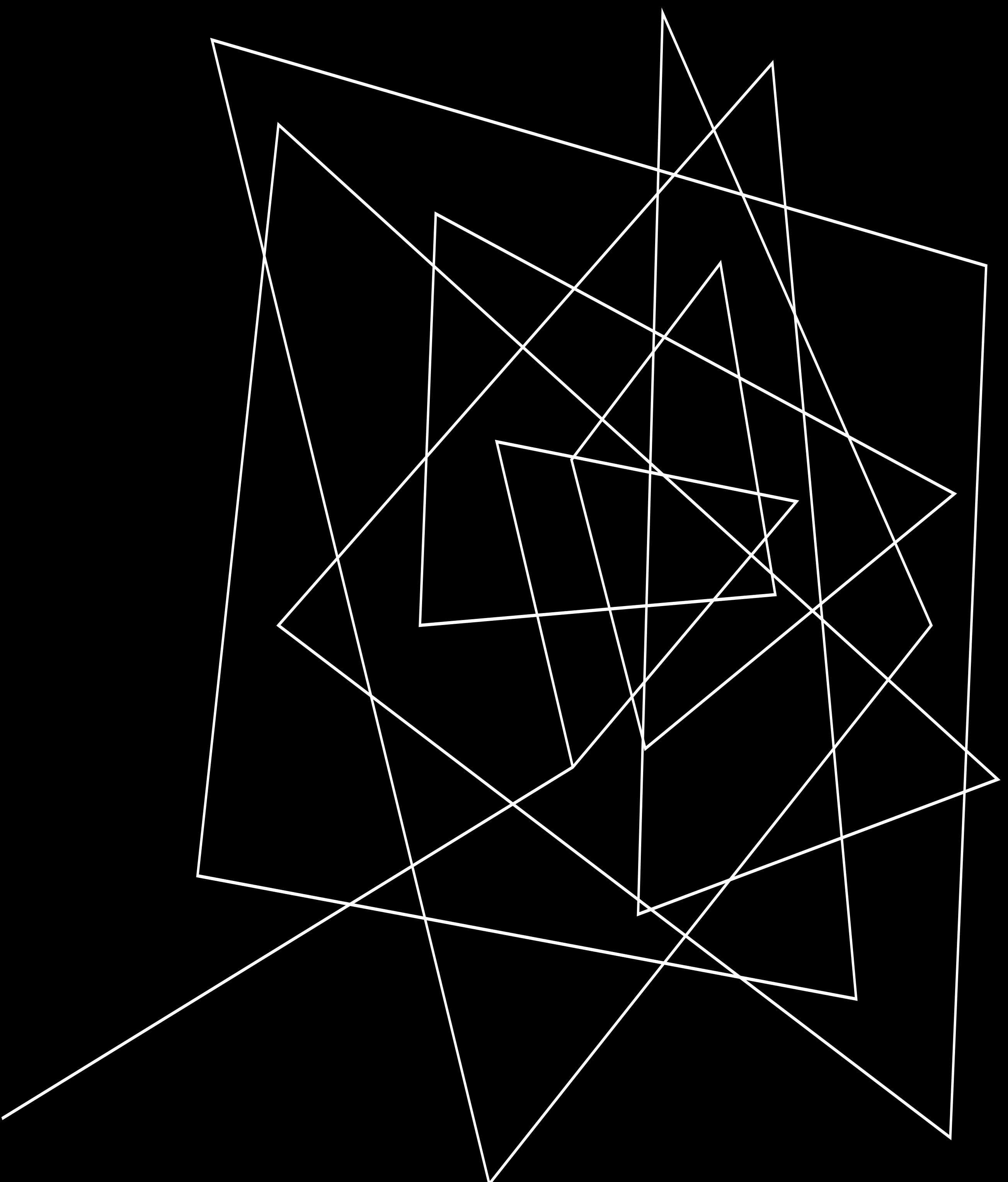
With the design team we chose to go for a square parachute, as the connection between the main body and the parachute would be easier to do.

In order to design it, here are the following data we need :

- Mass of the CanSat (m) : around 350 grams
- Descent velocity (v) : 9,5 m/s in average
- Drag coefficient (C_d) : 1,28
- Air density (ρ) : 1.255 km/m^3
- And $A = \frac{2mg}{\rho C_d v^2}$

Here we have : $A = \frac{2\times0.35\times9.81}{1.225\times1.28\times9.5^2} = 0.4825m^2$

In our case, for a square parachute to achieve the desired descent rate, the area should be of around 0.4825m².



REFLECTION

Reviewing our CanSat project, we, as a team, have found the collaborative experience with the aeronautics team truly enjoyable. Aesthetically, we are satisfied with the final result, showcasing a design that is visually appealing and reflects the collective effort and dedication invested in the project.

However, challenges arose during the printing process, particularly in relation to measurements. These challenges prompted us to invest additional time in using Blender to adjust dimensions and ensure proper fitting of components within the interior.

Regarding functionality, while we, as a team, cannot guarantee the success of the launch since we have not yet tested it, Martin meticulously reviewed and integrated all electronic components. Once integrated, he strategically positioned the sensors at the upper section to avoid interference with signal transmission. The main body's honeycomb structure is employed to accommodate the antenna, ensuring unobstructed data exchange with the ground-based operator's laptop.

In summary, despite the challenges, we, as a team, have genuinely enjoyed this project and eagerly anticipate the opportunity to test it next year.