Second Design Report

CanSat Team Icarus 6

Progress update after the first design report

1. Introduction

- The team members haven't changed since the first report: David Jonas
- Dennis Stephen Belo Alvarenga
- Emeline Buck
- László Bán
- Luca Moldovan
- Luka Takki

Since our first design report, our project has advanced a lot. Our main objective is to respond to the requirements of the primary mission imposed by the contest's regulations. Additionally, our secondary mission consists of measuring CO2 presence in the atmosphere on the ground and, once airborne, during descent as well. Moreover, for the secondary mission we will also be integrating a GPS into the CanSat in order to track it and ensure its recovery.

The most important improvement is that the communication chain is now functional: the Yagi antenna works, the base station receives the transmitted data, and the primary mission is already able to send measurements successfully. At the same time, our secondary mission is still under development and is being integrated step by step.

The purpose of this second report is to present the progress achieved since the first submission, explain how we responded to the jury feedback, and describe the next actions required before full mission validation.

To reach our goals, we have weekly in-person meetings on Fridays from 6pm to 8pm and additional hybrid meetings depending on member availabilities.

2. Project description

2.1 Mission overview

The mission overview is the same as in the last report:

Our CanSat missions can be divided in two parts:

1. Primary mission:
    - Measurement of temperature and pressure with which the altitude and the rate of fall are to be determined
2. Secondary mission:

- Capture CO_2 using descent and add a GPS module in order track to obtain the exact position of the CanSat after its descent.

The principal materials on board will be:

- 2x Raspberry Pi Pico with headers
- 2x Radio transceivers RFM69HCW
- Lithium Battery
- 5V converter and lithium battery charger
- CanSat base board for Pico
- CanSat extension board
- FPC ribbon

Electronic parts for primary mission:

- BMP280 Pressure/Temperature sensor
- TMP36 sensor

Electronic parts for secondary mission:

- SCD41 CO_2 sensor
- GPS PA1616D

2.2 Mechanical design

Parachute

The parachutes tested were two hemispherical parachutes with different dimensions. Like precised in the first report:

- The hemispherical parachute consists of six gores and a spill hole
- A first model was designed but failed because of miscalculations

For further images see appendix.

The recovery system has progressed through practical testing. We carried out drone drop tests from approximately 50 m altitude on the organized drone drop test on the 21st of March and evaluated two parachute variants. We aimed for the targeted descend duration of 4,5-5s to get a descend speed of 11m/s. We got the following results:

Test article	Drop height	Measured time	Observation
Parachute A test1	50 m	3.0 s	Parachute didn't open because the ropes weren't the exact same length
Parachute A test2	50m	5.2 s	Parachute opened instantly after the drop and the cansat took a nice descent.

Parachute B	50 m	6.5 s	Parachute opened pretty much instantly after the drop. Because of the wind the cansat landed a bit further away from its drop point.

From the following results we can find following descent speeds:

Parachute A: 9,62 m/s

Parachute B: 7,69 m/s

At the moment, the slower variant gives a gentler descent, but the faster variant corresponds better to the targeted descend speed. However, we still need to test the parachutes more since it is not enough to test a parachute only once and get an average descent speed.

3D Design

All parts were developed using the online 3D design platform Onshape, and for some more complex elements we used AI-based builders such as Zoo.dev to assist with modeling and understanding how different features would function. We considered different materials including PETG, ABS, and PLA. The current prototype is printed in PLA, but the final version that will be used for flight will be printed in PETG due to its better durability and impact resistance. We also chose a white color for the CanSat because it is more easily visible and easier to recover than darker colors such as blue or black.

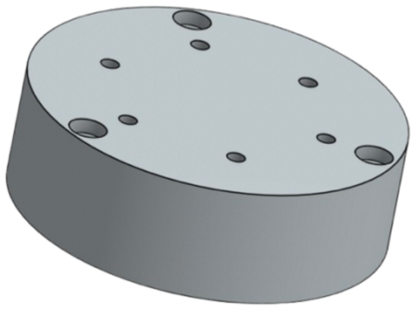
Since the first report, our structural design has gone through several iterations. Our first prototype was a very basic version made of three separate parts connected with two M3 screws using 3.2 mm holes. While this allowed us to test the overall size (66 mm diameter and around 105 mm height), it had several problems. The structure was too complex because of the three parts, the holes were too small which made assembly difficult, and there was no proper way to attach the parachute or include things like the antenna. This made the design unreliable.

Because of this, we developed a second prototype, Ikarus 2.0. This version was simplified to only two parts, which made it easier and faster to print and assemble. We also added parachute attachment holes, fixing one of the main issues from the first design. However, it still only used two screws, which meant the forces on landing were not well distributed, and overall the structure was still not strong enough.

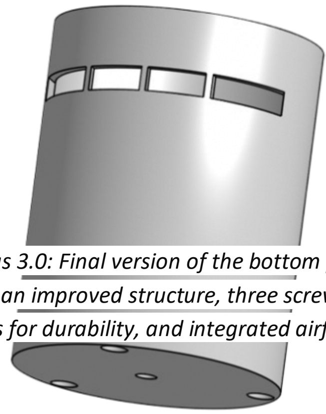
Ikarus 2.0: Structural issues including bent screws due to undersized holes, lack of vents affecting the CO2 sensor, and poor shock distribution due to the two-screw design without nut recesses.

This is why we developed our final version, Ikarus 3.0, which is a full redesign of the structure featuring :

- Wall thickness increased from 1 mm to 2 mm for much better strength
- Bottom thickness increased to 5.4 mm to absorb landing impact and support the screws
- Three M3 screws with 3.4 mm holes placed along the walls to distribute force evenly
- Nut recesses so the nuts sit inside the structure and do not move
- Added a 5 mm antenna hole at the bottom
- Added large airflow vents (60 mm × 10 mm) so the CO2 sensor can measure air properly
- Added 3 vertical ribs (1.5 mm thick) inside each vent to prevent cracking
- Increased screw hole size from 3.2 mm to 3.4 mm to account for 3D printing tolerances
- Added foam and EVA padding to absorb impact and protect components
- Two-part structure which is simpler and more reliable



Ikarus 3.0: Final version of the top part with four parachute attachments.



Ikarus 3.0: Final version of the bottom part with an improved structure, three screw holes for durability, and integrated airflow

Pictures of the 3D-printed Ikarus 3.0 parts, shown both assembled and disassembled with screws.

Overall, this version is much stronger, easier to use, and better suited for both the mechanical requirements and the mission. It can be opened in about 10 seconds and closed in around 20 seconds, while staying secure during flight and landing. Compared to the first design, the final version is significantly simpler, stronger, and more practical to assemble, while still meeting all mission requirements.

2.3 Electronic design

There was a lot of evolution in the electronic design since the first report however there are still some details about the connections of the different hardware pieces that still need to be confirmed as nothing was soldered yet because we still need to check how we will connect the secondary mission to the other components.
The electronic components were listed in the list under point 2.1 mission overview.

Primary mission and radio communication

The primary mission is now working and transmits its measurements to the ground station. The radio link has been tested together with the Yagi antenna, and the complete transmission from the CanSat to the base station with the information is operational. This is a major improvement because now we can perfect ou primary mission, but we know for sure that our system can deliver it in real time to the team on the ground.

So, to resume:

- Yagi antenna is assembled and working
- Base station receives packets sent by the CanSat
- Primary mission telemetry can already be transmitted during tests
- Current software focus is to make the mission sequence more robust, analytic with graphs and easier to debug

Further images and details can be found in the appendix.

Secondary mission status

The secondary mission is still in progress. The objective remains the measurement of CO_2 together with position by GPS for the recovery. The necessary hardware has been ordered, and software integration are being continued, but this part of the system is not yet as advanced as the primary mission. Thus, our priority is to complete the code integration and validate that the secondary mission can operate reliably. From our prediction the secondary mission should be operational alongside the primary mission before the 3rd april.

To resume:

- components CO_2 & GPS have been ordered and arrived
- CO_2 and GPS functionality are under active development
- The next step is to integrate these modules into the same mission logic as the primary mission
- Additional testing will confirm stable transmission of secondary mission data

2.4 Ground station design

The ground station is operational. The Yagi antenna is working and transmits the information correctly to the radio module. The YAGI antenna was built following instruvtions form the YAGI antenna training. The material used was:

A wooden stick

Aluminum bars

A coaxial cable

Zip ties

The antenna is working but the RSSI could be better. The contact between the coaxial cable and the dipole can be better maybe since soldering was not possible because of luminous so we had to use zips in the first place.

See appendix for images and more input.

2.5 Software design

Based on the jury feedback, we are now shifting more of our attention toward software integration. Our previous work allowed us to have a working primary mission and soon to be operational secondary mission. The next step is to combine them into one complete mission program that can initialize the system, acquire measurements, transmit them to the base station, log the data, and support recovery after landing.

To respond directly to the jury's feedback, we prepared a mission software flow diagram to help visualize the complete sequence of operations and identify where the primary mission, secondary mission, radio link, and recovery logic must interact.

We propose the following software flow diagram:

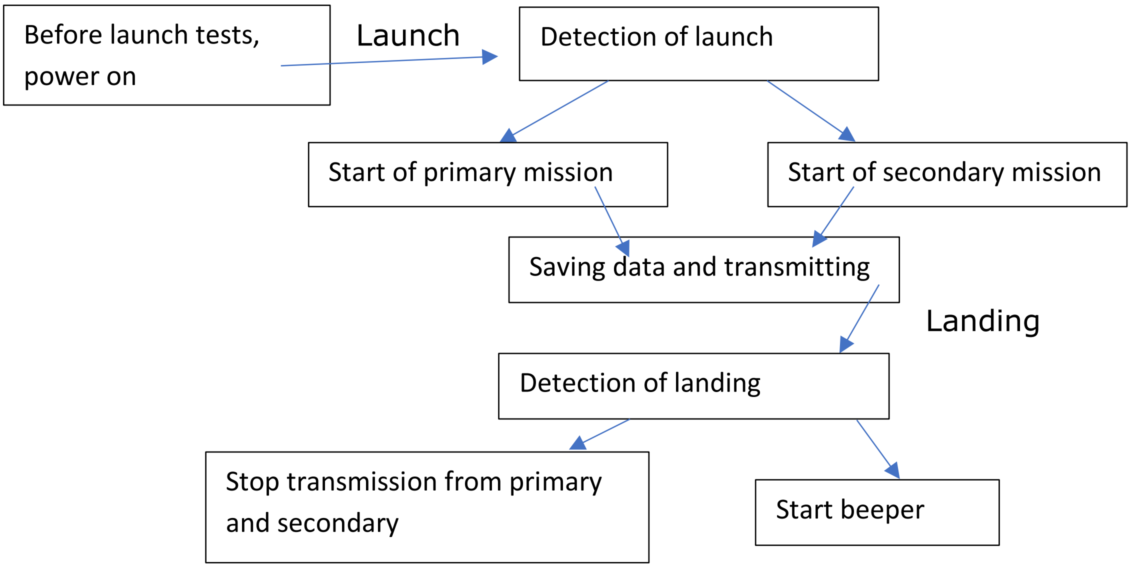


Figure 1. Proposed integrated software flow for the CanSat mission.

2.6 Recovery system

The recovery system relies on multiple elements:

- The parachute
- A GPS module to track and localise the CanSat after landing
- A buzzer (beeper) which still needs to be incorporated in the CanSat and will start beeping after landing

This system should enable us to recover our CanSat without too many troubles.

2.7 Testing

Communication tests

Communication testing confirms that the radio system and the Yagi antenna work together correctly. During the tests, the cansat was able to transmit the primary mission data to the base station.

Recovery tests

The drone drop tests provided the first experimental validation of the parachute system. These tests are important not only for meeting the recovery requirements, but also for protecting the electronics and the CO_2 sensor during descent. The measured times show that both tested parachutes keep the descent speed below 11 m/s over a 50 m drop, which is not too bad but can be improved a little.

3. Requirements

The list of requirements can be found in the appendix.:

Requirement #01 checked (our prototype is 66mm in diameter and 99mm in length)
Requirement #02 not checked (we have yet to put all electronic parts in the CanSat); 3d print weighs 43 grams
Requirement #03 checked (CanSat doesn't have any of those materials)
Requirement #04 checked (the lipo battery)
Requirement #05 planned not implemented yet
Requirement #06 beeper not checked yet; parachute has a red colour
Requirement #07 checked
Requirement #08 checked but trying to get the value closer to 11m/s
Requirement #10 checked
Requirement #11 checked (we have not exceeded the budget yet)
Requirement #12 checked (no sponsorships yet)
Requirement #13 checked
Requirement #14 checked
Requirement #15 checked

4. Overall progress

4.1 Human Resources

- David Jonas: Student in the Athénée of Luxembourg (11th Grade), responsible for parachute (Cross parachute), documentation, electronics secondary mission
- Dennis Stephen Belo Alvarenga: Student in the Athénée of Luxembourg (11th Grade), responsible for outreach and radio communication
- László Bán: Student in the Athénée of Luxembourg (11th Grade), responsible for parachute (Hemispherical parachute)
- Emeline Buck: Student in the Michel Rodange (12th Grade), responsible for programming and electronics
- Luca Moldovan: Student in the Athénée of Luxembourg (11th Grade), responsible for Radio Communication
- Luka Takki: Student in the European School of Luxembourg (11th Grade), responsible for 3D design of the CanSat

4.2 Planning

What	Wished date	Status
- do research on the CanSat - everyone gets to know their mission - maybe start working	Until 14/01	done

Primary Mission Training	14/01	Done on 14/01
- Keep working - get radio transmission to work	14-20	Done Delayed because of bug but done on 22/01
Yagi Antenna Training	21/01	Done
-Keep working - print first version of chassis	21-23/01	Done Done
First Design Report	23/01	Done
Jury feedback	6/02	Received
- finish parachute for tests - finish primary mission	Until 15/03	Done Done
- test parachutes to make sure they are ready for drop test - finish yagi antenna and test	Until 18/03	Done Delayed because of problems until the antenna was finished on the 22/03
Drone drop test	21/03	Done
Second design report	25/03	Done
Presentation to the jury	27/03	Not done yet
-finish secondary mission - finish 3d chassis and test out	03/04	In progress 20% In progress 80%
-test complet CanSat for first time	25/04	Not done yet
-test cansta again and again and again	03/05	Not done yet
Go / NoGo	5/05	
Post on social media and articles	From beginning to the end	In progress

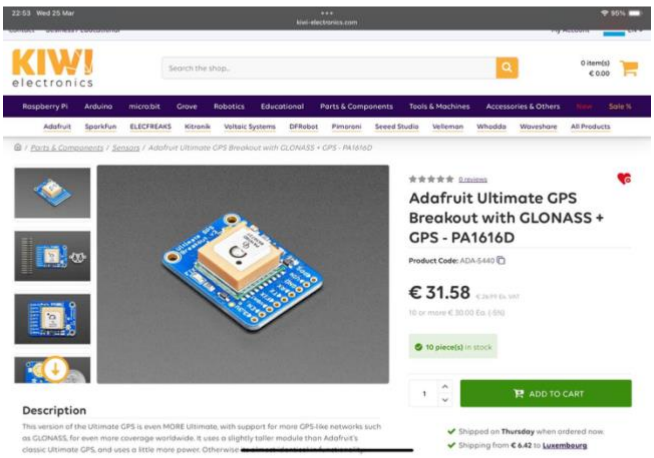
This is the overall planning. Every team member was responsible for planning their mission for it to be done when needed and it worked rather well. We tried to finish some parts like the parachute already in advance of the official tests in order to make sure it would work well. Except for some small inconvenience like the bug with the radio transmission and a problem of fonctuality with the yagi antenna most of the results were achieved in time. For the social media, we will start posting more to reach out now that we got more material to show to potential interested people.

4.3 Budget

We have bought and ordered the necessary sensor for our secondary mission. SCD41 CO2 Sensor (€64.34) from the website: Kiwi electronics. We choose this website as it is in the Netherlands which is very close to us compared to other websites. They also had good reviews on their products while websites like DFRobot had mixed reviews, and it would need to be delivered from China.

(23/01/26)

The GPS component:



Braided Nylon from Amazon; the brand's name is GanzoO.
The length of the rope is 10 meters, and it is 1 millimeter thick. Price (€5.95).
The breaking load for this GanzoO cord is approximately 60 kg according to the website.

(22/01/26)

Our 3D design was made of generic PLA and the material used was ten meters long. We made in the Makerspace in the Forum Geesseknäppchen which made this print free of charge. It took 9 hours to print the design.

We also had to buy different material for the Yagi antenna:

Wooden stick : 3,95

Aluminum sticks : 25,75

Insulated wire : 10,38

Terminal box : 2,45

Zip ties : 2,42

Sandpaper : 1,54


ART/EAN 4014529320026 3,95
1 pièce x 3,95 1
BESENSTIEL 1400X28MM
ART/EAN 4004338485504 5,15
5 pièce x 25,75 1
VA-Rundstange ø6mm 1
ART/EAN 4010311001173 2,15* 0,43
0,200 m x
1 x 0,43 0,43 1
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Aderleitung
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4.4 Outreach

We have an instagram account: icarus6_cansat where we try to post as much and as many funny and interesting videos as possible.
On top of that Luka will publish an article entitled "the story behind the Icarus 6 team's journey of building a satellite" in the European School's journal the 'Pupil's Voice'.

5. Discussion

Overall, the project has moved from concept to integration. The mechanical side remains strong, but the main progress of this report is t the primary mission and communication system working together in practice. This gives us a solid base for the final phase. We still need to:

1. Finalize the integrated mission software and improve debugging speed.
2. Complete the secondary mission integration and validate CO_2 and GPS transmission
3. Re-check the parachute area calculations with the 10% correction factor for seams and knots
4. Repeat controlled drop tests and compare the two parachute variants using representative payload conditions
5. Carry out additional full-system tests with the ground station and Yagi antenna

6. Conclusion

This second design report shows clear progress compared with our first submission. The Yagi antenna is operational, the primary mission is working, and the base station can receive transmitted data. The secondary mission is still being completed. The jury feedback helped us focus on the most important next steps: mission logic and recovery validation. With continued integration and testing, we are confident that the system will become fully mission ready.

References

https://www.esero.lu/wp-content/uploads/2023/10/CanSat-Raspberry-Pi-Pico-Workbook-EN-v11.pdf
https://www.kiwi-electronics.com/en/scd41-co2-sensor-breakout-carbon-dioxide-temperature-humidity-10905
https://wiki.mchobby.be/index.php?title=ENG-CANSAT-PICO-BELGIUM

Appendix

Parachute


Parachute B


Parachute A

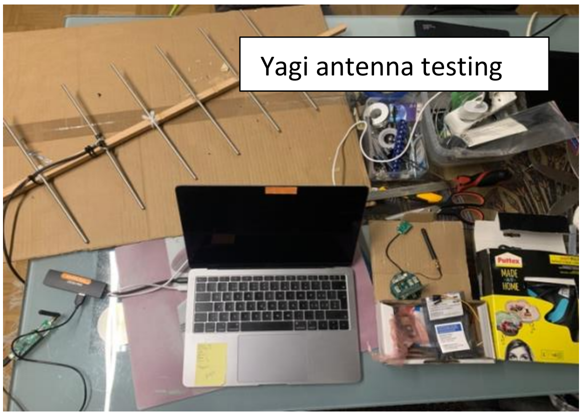
Parachute B

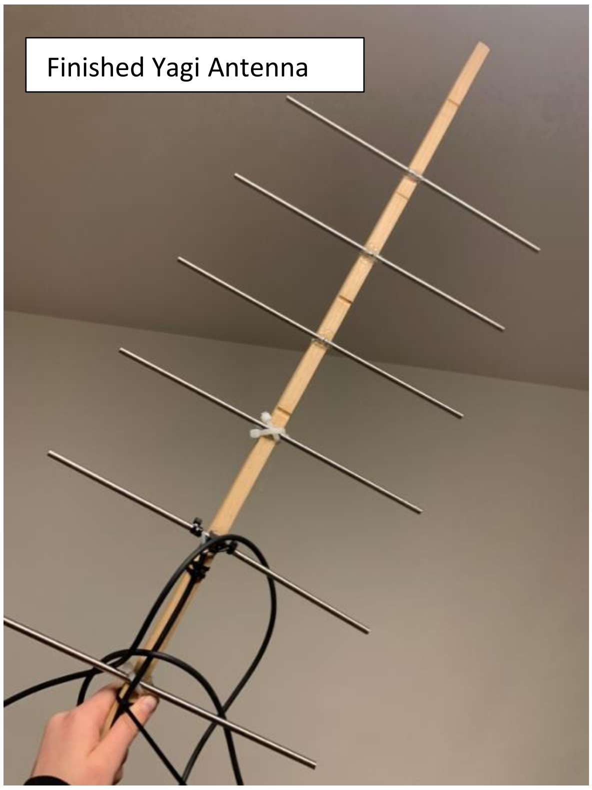

Parachute B stuck after test

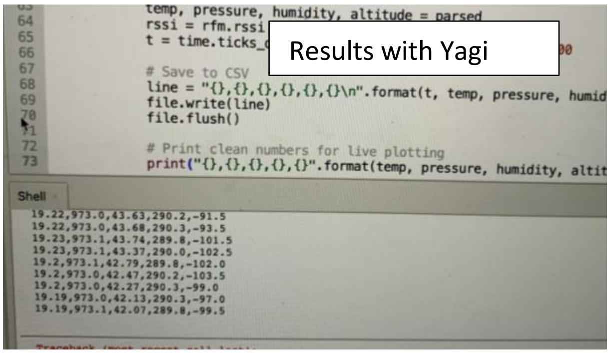

Parachute A before test 1


Parachute A test 2

Yagi antenna


Yagi antenna testing


Finished Yagi Antenna



Results with Yagi

Requirements:

Number	Requirements
#	Explanation of the requirements
Statics and dynamics	
10	The Cansat parachute must be able to withstand an deceleration of up to 5 g.
Cost	
11	The total budget of the final Cansat model should not exceed 500€, including the cost of the Cansat kit provided during the mentor's workshop. Ground stations and any related non-flying item will not be considered in the budget.
12	In the case of sponsorship, all sponsored items should be specified in the budget with the actual corresponding costs on the market.
Mission requirements	
13	The Cansat must at least measure temperature and air pressure, as described in the primary mission
14	The radio frequency must be easily modified to avoid radio communication interference with other teams. The assigned frequency must be respected by all teams during the launch campaign.
15	During the Cansat descent, the data must be transmitted both to the ground station and to the CanSat's own file storage

Mass/weight	
01	All Cansat components may not exceed the size of a standard can (**115mm in length and 66mm in diameter**). An exception can be made for radio and GPS antennas, which can be mounted outdoors. The payload area of the rocket usually has 4.5cm of additional space per Cansat available, in the axial direction of the Cansat (i.e. height), which must allow for the placement of external elements, including: parachute, equipment of fixing of the parachute and possible antennas.
02	The Cansat, including the parachute **must** weight exactly **300 grams**. If it is lighter, it **must** be loaded with weights like sand or lead.
Material restrictions	
03	The use of projectiles, fireworks or other explosive materials, as well as easily flammable and hazardous materials are not permitted.
Power supply	
04	The Cansat must have an independent power supply (e.g. battery, accumulators, solar panels, etc.). The power supply must be easily accessible in case it has to be replaced/recharged. The battery capacity must be sized so that the Cansat can be operated for at least 4 hours continuously.
05	The satellite must have an easily accessible main switch.
Recovery system	
06	The Cansat must have a recovery system, such as a parachute. It must use coloured or bright material to facilitate the recovery of the Cansat after landing.
07	The parachute must be solidly attached to the Cansat to withstand high loads.
08	The descent speed **must be 11m/s** for recovery reasons. The closer you are to that value, the higher the chances we will find your CanSat after the launch.