Final Report

CanSat: A landing Soda Can

26/04/2023 _ Report V1.0.0

ACKNOWLEDGEMENT

The team wants to express its gratitude to people who contributed to the achievements of the first semester's objectives.

We want to thank **Mr. CHABROL**, our customer, for its advice all along the semester.

We want to thank **Mr. KAZEMI**, for his answers to our questions, and his advice about electronic components.

We want to thank **Mr. OTHMANI**, for his answers to our questions, and his advice on the mechanics of the CanSat.

We sincerely appreciate the time and effort in sharing **Mr. KOMURIAN's** knowledge and experience with the Agile methodology. His guidance has been incredibly helpful, and we are grateful for the valuable advice he has provided.

We would like to thank **ICAM S-E**, for the availability of materials and equipment, and for placing orders for components.

Finally, we want to thank all members of the team, for their regular work all along the semester and their contribution to the writing of this report.

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GLOSSARY

CanSat: Mini satellite of the Size of a soda can

Apex: the string between the center of the parachute to the CanSat

Planet Sciences: Planète Sciences is a non-profit organization founded in France in 1962. Its mission is to promote science and technology among young people by organizing educational activities, workshops, and summer camps. The organization operates across Europe and aims to encourage children and teenagers to discover and engage with science and technology through hands-on experimentation and educational programs. Planète Sciences is supported by a network of volunteers, teachers, scientists, and researchers, and collaborates with various institutions, including universities, schools, museums, and companies. The organization also organizes science events and competitions, such as the CanSat competition, to challenge young people and foster their interest in science and technology.

I. Introduction

1. Context challenges and objectives of the project

This project was embarked upon with the aim of learning about **project management** and **challenging** ourselves with **technical** tasks. A mini satellite with a proportional shape of a soda can, capable of achieving scientific and technical missions, was designed, and built as part of this project. This competition, known as CanSat, was created by Planète Sciences, and supported by the European Space Agency, and was attracted students from all over Europe. **Valuable experience** in project management, team collaboration, and technical problem-solving was gained through this project, which will serve well in future endeavors.

S	SPECIFIC The specific goals of the CanSat project are as follows : control the descent of the CanSat to land at a specific point, deploy a structure from the CanSat, and perform an air analysis. In order to achieve these goals, we have defined milestones and deliverables. Each objective given by the customer has been transformed into principal user stories in the Product Backlog, which have then been split into more specific sub user stories. This organization of the goals allows us to divide the large project into smaller, specific tasks, making it easier to track progress and manage the project.
M	MEASURABLE Data on the progress of each task and user story in the CanSat project must be gathered in order to measure its advancement. This data will be stores in the KANBAN where each task is associated with one or more people and can have 3 states : To do, doing or done. The access and the modification of this KANBAN by the project team is allowed at any time. Five sprint completions were chosen as milestones for measuring the progress of the CanSat project. Theses milestones provide the opportunity for progress tracking and the ability to make adjustments to the project plan during the academic year. Prior to reaching the final stage, the project will be presented to the customer during the sprint demo. The burndown chart and timeline will also be used to track progress towards the final goal.
A	ATTAINABLE To ensure the feasibility of the CanSat objectives, careful planning and analysis of necessary ressources, skills, and time fot the completion of each task and user story will be undertaken by the team. Clear roles and responsibilities for each team member have been established, and the necessary skills and ressources have been provided to enable effective task completion. Potential barriers or challenges that may arise have also been identified by the team and strategies for their overcoming have been developed through a risk analysis. Regular communication with experts and consideration of their advice in the decision-making process will also be maintained by the team to ensure the achievable nature of our goals.
R	RELEVANT The objectives of the CanSat project, includingthe control of descent, deployment of a structure, and performance of an air analysis, are relevant beacause they contribute to the overall goal and are necessary for the success of the project. These objectives involve careful planning, precise exécution, and the collection of data on various factors and atmospheric conditions.
T	TIMELY We will regularly check in on progress using the tools mentionned above throughout the academic year to ensure that we are meeting our goals in a timely manner.

Figure 1 : SMART Description of the project

2. Agile Methodology

During our project, the **Agile methodology** was employed to help manage and structure our work. A short **sprint** was worked on by us, with each sprint lasting around **two months**. At the beginning of each sprint, a planning meeting was held to discuss the tasks that needed to be completed and how they planned to be accomplished. The tasks were then worked on throughout the sprint, with **weekly stand-up meetings** held to discuss progress and identify any issues that needed to be addressed. At the end of each sprint, a **review meeting** was held to demonstrate the work done and receive feedback from the client. This iterative approach allowed **flexibility and adaptation** to changes as they arose, ensuring the delivery of a high-quality product within the allocated time and resources. Overall, the use of the Agile methodology was a **valuable experience** for our team, as it allowed efficient and effective teamwork.

3. Presentation of stakeholders

This project connects different **stakeholders** which impact or be affected by it. A great understanding about expectations and interests of each stakeholder is essential for a good project management.

⇨ The customer

For this project our client is **Mr. CHABROL**, research director and head of the Energy Department at ICAM Strasbourg-Europe. He has already accompanied teams in several CanSat projects. Mr. CHABROL has **high expectations** for the performance of the CanSat team and wants that all goals are met efficiently.

⇨ Other stakeholders

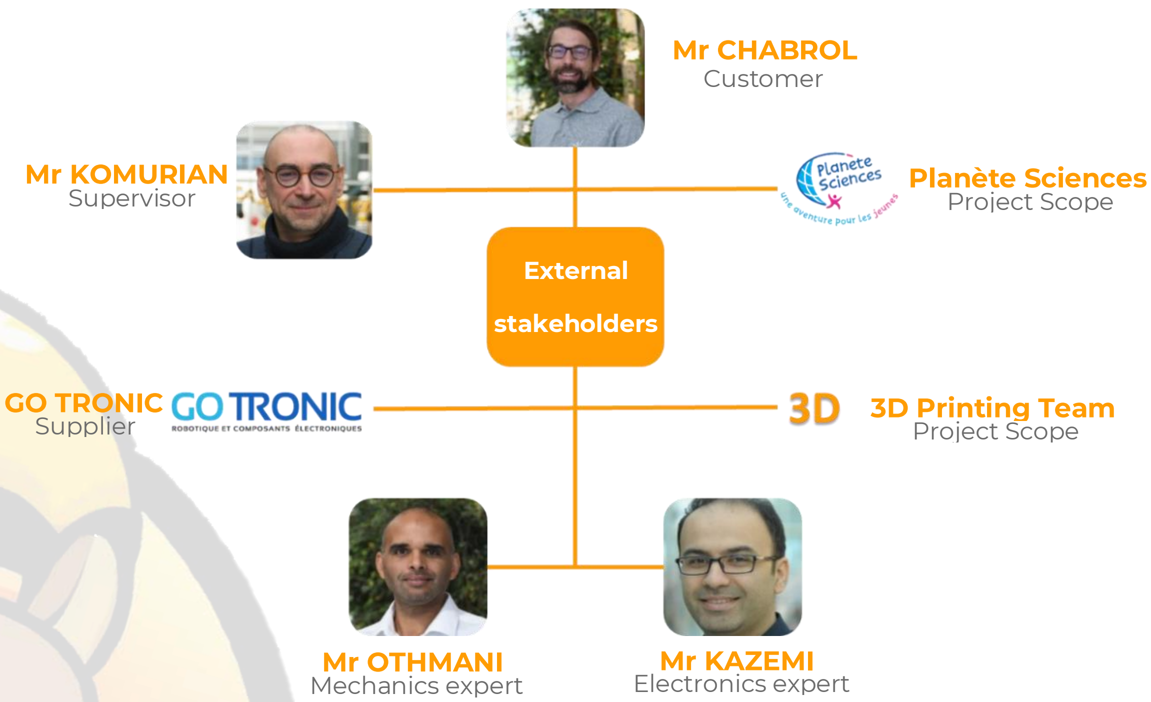


Figure 2 : Stakeholders of the project

4. Presentation of the team

⇨ Team members

Our team consisted of Grégoire TROESTLER as the Product Owner, Romain DE GUIO as the Scrum Master, and Matthieu GORISSE, Maxime SALAS, Manon LEBOEUF, Paul BOUSQIER, and Fabio URSI as the Development Team.

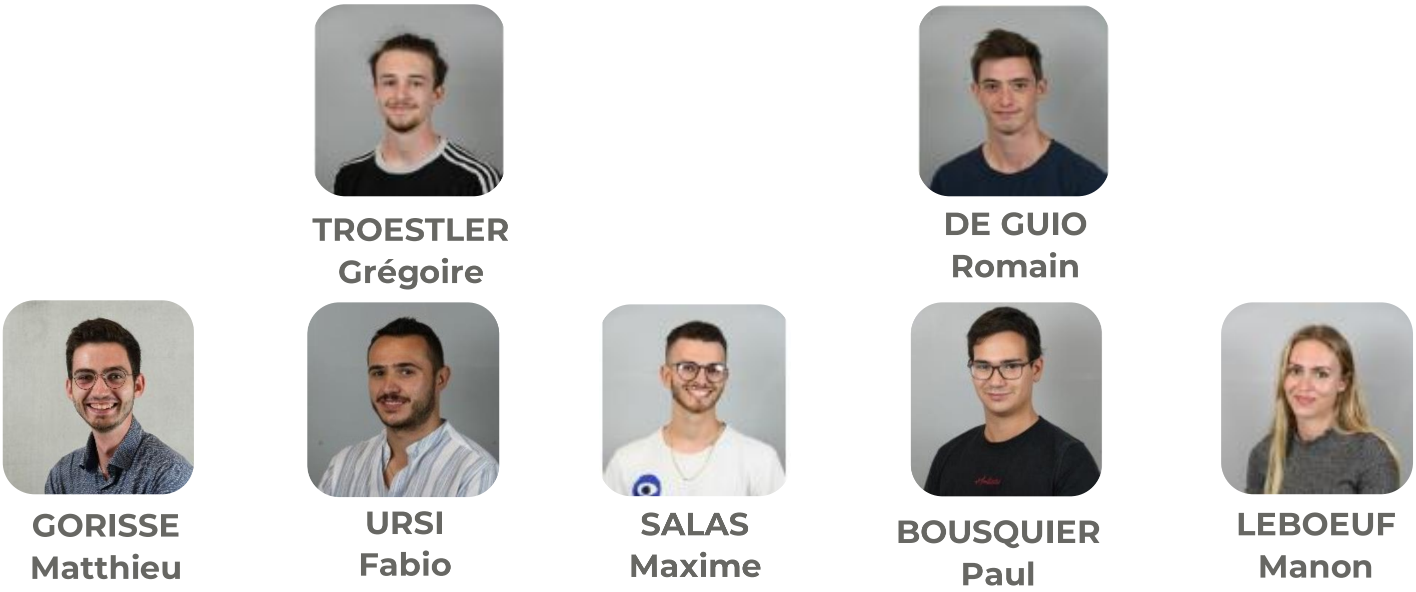


Figure 3 : Team members

Table 1 : Organization of the team

DIVISION	MEMBERS
Electronic & DATA	TROESTLER Grégoire, GORISSE Matthieu, BOUSQUIER Paul
Conception & paraglider	DE GUIO Romain, URSI Fabio
Deployment	LEBOEUF Manon, SALAS Maxime

II. State of the art

Doing a **state-of-the-art** review is an important step in the technical project process as it allows to understand what has **already been done** in a particular field and identify **gaps** or **opportunities** for further research or development. It also helps to understand the **current limitations** of the technology and identify potential challenges that you may face during your project. In addition, a state-of-the-art review can help to identify potential collaborators or research groups that may be working on similar problems or approaches.

It is a crucial step in the design and development of a technical project because it ensures that the project is **viable** and that it meets the **needs** and **requirements** of the context in which it takes place.

Throughout this report, "State of the art" boxes are included to explain the origin of the CanSat conception.

III. Design of the CanSat

1. Key steps of the choice of the design

➪ *Step 1: Choice of the Main Mission*

The first step of our project was to choose the **main mission** that would be undertaken by our CanSat. **Two options** were available: either the descent of the CanSat **during its free fall** could be controlled, or it could be controlled **after it had landed** on the ground. After careful consideration and analysis, the decision was made to focus on the **first option**. In making this decision, a **decision matrix** was used that considered various factors, such as technical feasibility, level of difficulty, and the potential scientific and educational value of each option. By using this matrix, an informed decision was made and the main mission that was believed to best meet the goals of the project was selected. This critical first step set the stage for the rest of the work and helped focus efforts on a clear objective.

Table 2 : Decision matrix, main mission

Control Trajectory	During Descent	On Ground
Space Management	++	--
Control of Movement	-	+
Simplicity of development	+	-
Overall team motivation	++	--

⇨ *Step 2: Choice of the Secondary Mission*

After the main mission was selected, the next step was to choose a ***secondary mission*** *for the CanSat.* ***Two options*** *were available:* ***an auxiliary structure*** *could be deployed during the descent, or a* ***QR code*** *could be scanned during the fall. Once again, a* ***decision matrix*** *was used to consider various factors, such as creativity, technical feasibility, level of difficulty, and the potential scientific and educational value of each option. After careful analysis, the decision was made to focus on the first option and to deploy an auxiliary structure during the descent. It was believed that this mission would be more challenging and would provide greater scientific and educational value than scanning a QR code. This decision was critical, as it helped to define the scope of the project and ensured that efforts were focused on meaningful objectives.*

Table 3 : Decision matrix, secondary mission

Secondary Mission	Deploy a Structure	Scan a QR code
Creativity	+++	---
Simplicity of development	+	-
Technical Challenge	=	=
Numerical Challenge	---	+++
Overall team motivation	+++	---

⇨ *Step 3: Choice of the Optional Mission*

An **additional mission** could be added to our CanSat as part of the project. After careful consideration, it was decided to **analyze the evolution of air properties** during the fall. This mission was **not mandatory**, but it was believed that it would **provide valuable scientific data** that could be used to better understand the behavior of the atmosphere during the fall of an object. By analyzing the air properties, insights into the temperature, humidity, pressure, and other environmental factors that could affect the trajectory of the CanSat were hoped to be gained. This optional mission added an additional layer of complexity to the project, but it was felt that **it was worth** pursuing to gather valuable data and gain a deeper understanding of the scientific principles at play during the experiment.

Table 4 : Decision matrix, optional mission

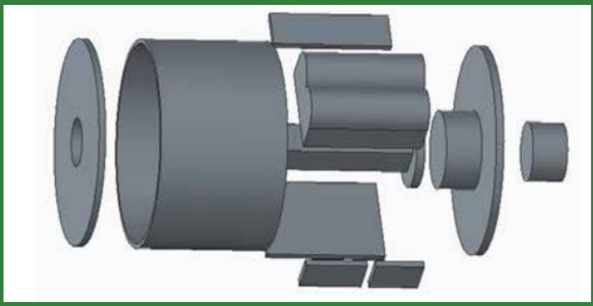
Advantages	Drawbacks
Easy to implement	Less Space in the CanSat available
Green Aspect	Not In Real Time
Added Technical Challenge	Low Precision for the difference in altitude

⇨ *Step 4: Choice of design for component integration*

STATE OF THE ART:

To produce all parts the **Team JawaCan** used an FDM 3D printer with ABS plastic as the material of choice. The CanSat is composed of **four distinct mechanical modules**, each designed to be modular:

- The lower lip includes the electromagnet and features holes to enable IR communication. It is also connected to the upper lip.
- The central structure houses the wiring and ensures mechanical pressure on the shelf.



JawaCan Group CanSat Internal Structure

Figure 4 : Choice of design

After choosing the main, secondary, and optional missions, the next step was to decide on the **design for component integration**. Two options were available: to keep the CanSat as a **single unit** or to **split it into two parts**. After analyzing the pros and cons of each option using a **decision matrix**, it was decided **to split the CanSat** into two parts. Although this design choice reduced the overall strength and flexibility of the materials, it dramatically increased **the ease of component integration**. By splitting the CanSat into two parts, installation and configuration of the various sensors, communication devices, and other components needed for the mission were made easier. This design choice was critical, as it allowed the streamlining of the development process and ensured that the project could be completed on time and within budget.

Table 5 : Decision matrix, choice of design

Split the CanSat?	Yes	No
Components Easy to Integrate in the design	-	+
Components Easy to Install / Uninstall	++	--
Resistivity	-	+
Space Saving	++	--
Material Flexibility	-	+

⇨ *Step 5: Choice of design to control the trajectory.*

STATE OF THE ART:

Opale Paramodels is a company specialized in the field of paragliders. The company designs a multitude of products, among which is a **miniature paraglider** technology capable of remote control. The method of operation involves the **connection** of the **halyards** of the paraglider **to servomotors**, which are strategically placed within the body of a figurine. The trajectory and speed of the miniature paraglider can be controlled by the user using a **remote control**.

To gain a deeper understanding of the product and to evaluate it in relation to a CanSat project, the following data may be considered:

Wingspan flat: 283cm

Flat surface: $1.6m^2$

Lines: Aramid 25 / 50daN spliced / DFL 70

Textiles: Nylon Ultra-light 10/20D 27/32gr

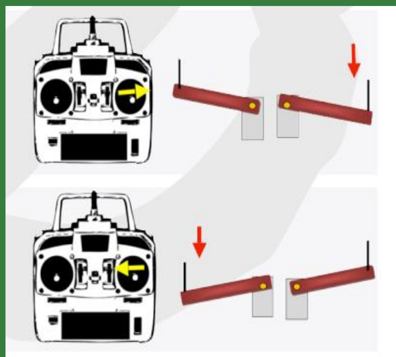


Figure 5 : Choice of design to control trajectory

After deciding on the mission objectives and component design, the next step was to choose a **trajectory control design**. It was ultimately decided to control the trajectory of the CanSat using **an extendable arm** attached to the apex of the paraglider and controlled by a **servo motor**. The specific details of this design are explained in [a following part](). This design choice allowed for adjustment of the angle and position of the CanSat during its descent, providing greater control over its trajectory and better steering towards the desired GPS coordinates. Although this design added additional complexity to the project, it was considered critical in achieving the mission objectives and ensuring the success of the CanSat.

Table 6 : Decision matrix, trajectory control and deployment

Advantages	Drawbacks
Provides greater control over the CanSat trajectory during descent	Adds additional complexity to the design
Allows for adjustments to the angle and position of the CanSat	Requires a servo motor and extendable arm, which can add weight and size to the CanSat
Helps to guide the CanSat towards the desired GPS coordinates	Can be difficult to program and calibrate for precise control

⇨ *Step 6: Choice of the design for the secondary mission*

STATE OF THE ART:

The 2019 CanSat competition was won by the **Copernic team**, a group of students from ECAM Strasbourg-Europe. The team's main mission involved opening a door while the CanSat was in mid-air. The door was **held closed by a rod**, which was secured to the CanSat's parachute. To release the rod and open the door, a **rubber band** was attached to the door and placed under tension. When the parachute was deployed, the rod followed its movement and was

After considering several possible solutions, it was decided that **a door system** would be incorporated into the CanSat. This system would open during flight, **releasing a compressed structure** during descent. The idea for this system was inspired by the winning CanSat Copernic 2019 project. Equipped with a tension system using a spring and an elastic, the CanSat releases the structure once the parachute is pulled, thanks to the rod connected to it. This design choice was critical, as it provided a simple and effective solution for deploying the auxiliary structure during descent and ensuring the success of our mission.

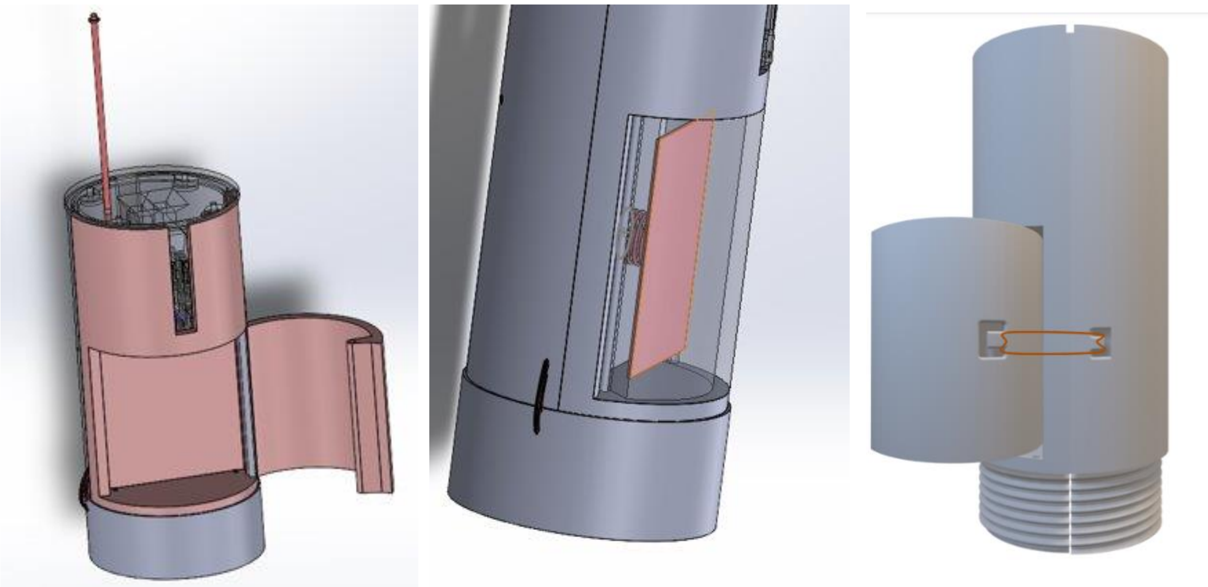


Figure 6 : Conception of door system

⇨ *Step 7: Choice of the structure for the secondary mission*

STATE OF THE ART :

Several Options were available to us:

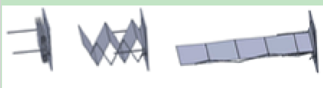
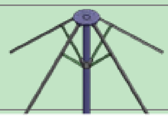
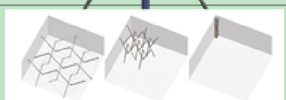
Deployment system		Mechanism
Folding accordion		Spring effect. Carpenter's joint shaped for self-locking.
Umbrella mechanism		Deploying the structure around a cylindrical support by sliding a hollow join over it.
Tensegrity structure		Assemblies of compressed bars and tensioned cables. Difficult to manipulate and fold.
"2-seconds-tent" technology		Roll bar system and springs. The deployment might be « violent » for the CanSat.

Figure 7 : Choice of structure

After deciding on the deployment mode for the secondary mission, the next step was to choose **the structure that would be deployed**. Ultimately, a piece of fabric with a mass was chosen, which would become **a mini CanSat with a mini parachute**. This design choice met the requirements of the secondary mission while **minimizing the impact on the main mission objectives**. Deploying a separate mini CanSat allowed avoiding interfering with the trajectory of the main CanSat, ensuring that it reached its target location with minimal disruption. Additionally, this design choice facilitated testing the deployment system in a **controlled and predictable way**, giving greater confidence in its effectiveness and reliability. The mini CanSat could also be opened to **add or remove weight as desired** to modify the descent speed of the structure.

Figure 8 : Mini CanSat for secondary mission

The kangaroo in the **final team logo** is directly inspired by this idea of having a CanSat and a mini-CanSat inside.

Figure 9 : Team logo

⇨ *Step 8: Choice of the parachute design*

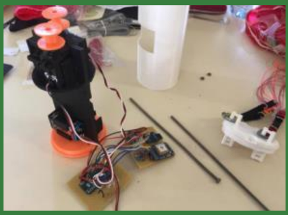
STATE OF THE ART Candiver Team:

The Team **Candiver** was tasked with controlling the trajectory of their CanSat during the descent to land in a specific area. To achieve this, they designed a **paraglider-shaped parachute** for improved maneuverability, which was guided by two motors mounted on a 3D-printed part that wound the parachute line and pulled on the sail's end. Additionally, they implemented a quick deployment feature by folding the parachute in an **accordion-style manner**. However, the team faced some challenges during their testing phase. They discovered that the parachute was too large, and on one occasion, a hanger got caught on the parachute and caused it to **rotate**, affecting the trajectory control.

Tired attached to the folded parachute.

Parachute with tangled lines.

Unfolded parachute attached to the Tired.



The internal components of the Tired

STATE OF THE ART Phoenix Mission:

The **Team Phoenix Mission** involved designing and releasing a cross-shaped parachute for their CanSat. They calculated the necessary area of the parachute using **an equation** that considers the balance between **weight** and **drag force**. To improve ground mobility, they decided to **drop the parachute** after the CanSat had landed, which was achieved using a servomotor. To accomplish this, all the parachute's ropes were gathered into a small ring that could slide along a **metal hook**. Before the servo motor was activated, the ring was held in place by the metal hook, and once the servo motor had rotated to the appropriate position, the ring was released, allowing the CanSat to begin moving.

Figure 1 : Real parachute in the shape of a cross.

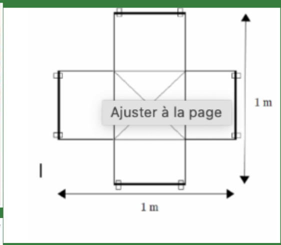


Figure 1 : Model of the parachute in the shape of a cross.

Figure 1 : Parachute release system.

$$S = \frac{2 \times m \times g}{\rho \times Cx \times V^2}$$

With S surface of the parachute, m mass of the parachute, g gravity, ρ density of the air, Cx coefficient of friction, V targeted speed limit

Figure 1 : Surface of the parachute.

After several **parachute designs** were evaluated, including round-shaped, elliptical, NASA wing-shaped, and paraglider-shaped, a decision was made to use a **round-shaped parachute** for the CanSat. This design was chosen based on a **decision matrix** that evaluated several factors, including stability, controllability, and ease of deployment. It was believed that a round-shaped parachute would provide the best balance of these factors and would be **the most suitable design** for the specific application. The characteristics of the different parachute designs evaluated are compared in the following table:

Table 7 : Decision matrix, parachute design

Parachute Design	Stability	Controllability	Ease of Deployment	Ease of horizontal speed
Round-shaped	High	Moderate	Easy	Difficult
Elliptical	Moderate	High	Moderate	Moderate
NASA wing-shaped	High	Low	Difficult	Easy
Paraglider-shaped	Low	High	Difficult	Easy

Based on our evaluation, it was felt that the round-shaped parachute provided the best overall performance for the project, with a high level of stability, moderate controllability, and ease of deployment.

IV. Realization of the paraglider:

After considering several possible solutions and testing them, it was decided to use **a round-shaped** parachute to slow down and direct the CanSat. Here is a summary of the tests conducted on the three paragliders.

Table 8 : Presentation of our three paragliders

<u>1^{st} **Paraglider**: round shaped</u> The CanSat is slowed down, but it doesn't travel a great distance.	
<u>2^{nd} **Paraglider**: oval shaped</u> The CanSat is slowed down, but not as much as with the previous one. It travels a greater distance, but the paraglider experiences some issues when inflating itself.	
<u>3^{rd} **Paraglider:** round shaped reworked</u> It has a greater surface than the parachute 1. The string has different length to direct the CanSat. This 3^{rd} paraglider slows down the system while directing it and there are no deployment issues due to the shape of the parachute.	

The 3^{rd} parachute has a round shaped design with **3 layers of apex**. There is 2 layers of apex to helps to direct the air towards the upper end of the parachute canopy, which assists in fully opening the parachute and ensuring a safe descent. As shown below.

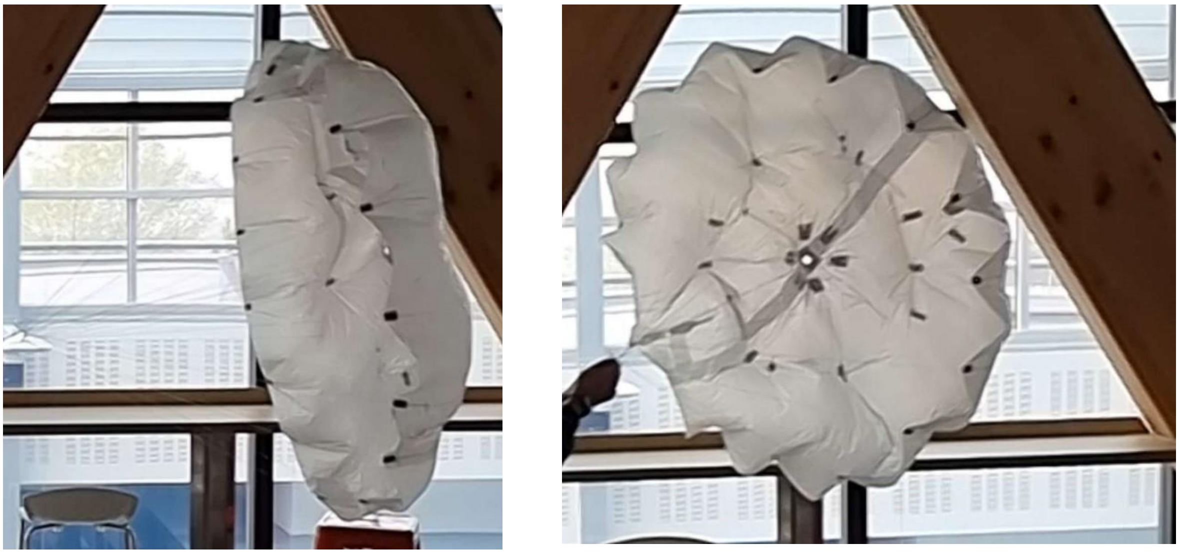


Figure 10 : Inflated paraglider

The parachute is made of nylon 0.45mm and strings. The parachute is folded in a hexagonal shape.

Here are the **steps** to build the parachute.

- Cut the nylon to get triangle of 77cm (x2)
- Join the 2 parts of nylon the get a single round shaped piece.
- Put a 16 piece of tape at the extremity of the parachute to attach the string at these areas.
- Put 12 piece of tape in circle in 2 different radius to place the apex.
- Link all the rope of the left side together.
- Link all the rope of the right side together.

Photo of the manufacturing process

V. Implementation of the trajectory control system

STATE OF THE ART:

An interview was conducted with two students from Planète Sciences: **Peter and Alexandre**, who had already undertaken a similar project. They shared their **knowledge of the logic used in a trajectory control** program during descent. They advised us to adopt an **"all or nothing" approach**, as they had found it to be an effective method. The concept involves calculating the angle of the CanSat relative to its predicted position. The greater the angle, the more the servomotor will have to pull the halyard, which will cause the CanSat to change in the opposite direction. Conversely, if the angle is low, the servomotor will pull the halyard to a minimum. To reinforce this logic, it was suggested to define limit angles, beyond which the program would activate.

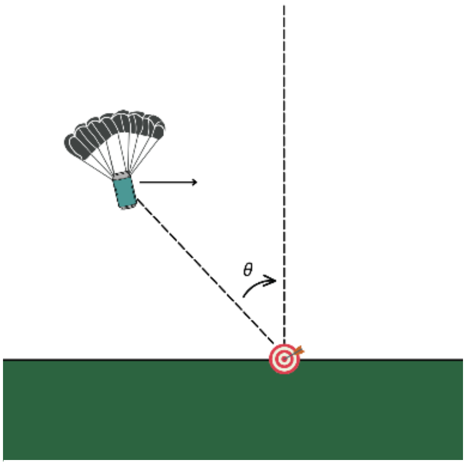


Figure 11 : Scheme of trajectory

1. Description of the control system used.

The trajectory of the CanSat is controlled by the **Arduino Nano**, which uses **GPS** coordinates and the **orientation** of the CanSat to control a **servomotor** that will incline the parachute. This motor rotates either clockwise or counterclockwise and rotate a lever that is connected to the halyard of the parachute. This system ensures that the CanSat lands in **a desired location**.

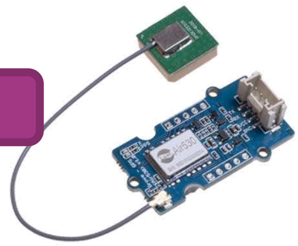
⇨ *Program algorithm*

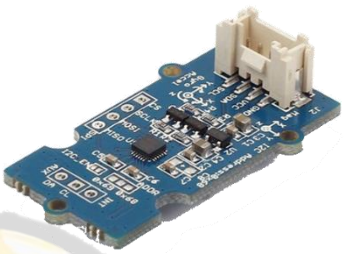
During the descent, the trajectory of the CanSat is controlled by an **Arduino program** that considers several parameters:

- The GPS coordinate of the Target
- The GPS coordinate of the CanSat
- The orientation of the CanSat
- The vertical and horizontal speed

The GPS coordinates of the target are obtained on the day of the competition, while the GPS coordinates of the CanSat are obtained using a GPS module sensor. The orientation of the CanSat is determined using a **compass module**, and the instantaneous speed of the CanSat is measured using an **accelerometer**.

Module GPS (Grove 109020022)



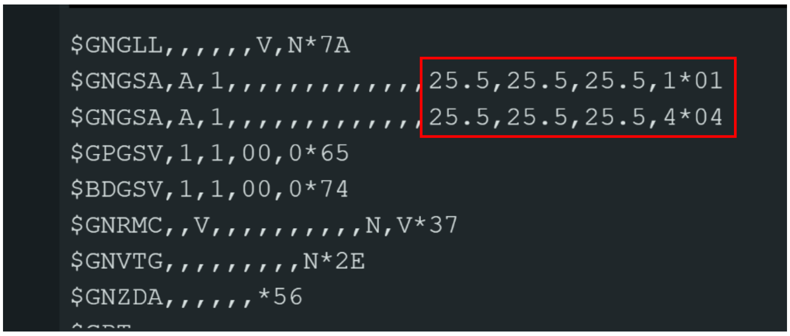


Accelerometer, gyroscope, and compass module (Module 9 DoF MPU9250 Grove 101020080)

Using this information, the program calculates a **vector line** from the CanSat's position to the target, and then determines **the angle** between the CanSat's orientation and this line. The servomotor is then activated in the appropriate direction to modify the trajectory of the CanSat.

Once the CanSat is aligned with the target, **phase 2** begins. The goal of this phase is to keep the CanSat aligned with the target.

The program uses the principle of **hysteresis** to determine when to rotate the servomotor right or left. The rotation of the servomotor is only changed when the orientation crosses two hysteresis lines.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$GPGSV,1,1,00,0*65
$BDGSV,1,1,00,0*74
$GNRMC,,V,,,,,,,,,,,N,V*37
$GNVTG,,,,,,,,,N*2E
$GNZDA,,,,,,*56
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In phase 3, the CanSat reaches **the target point**, and the program is stopped. The program has been designed to ensure that the trajectory of the CanSat is accurately controlled during the descent, and that it reaches the target point with a high degree of precision.

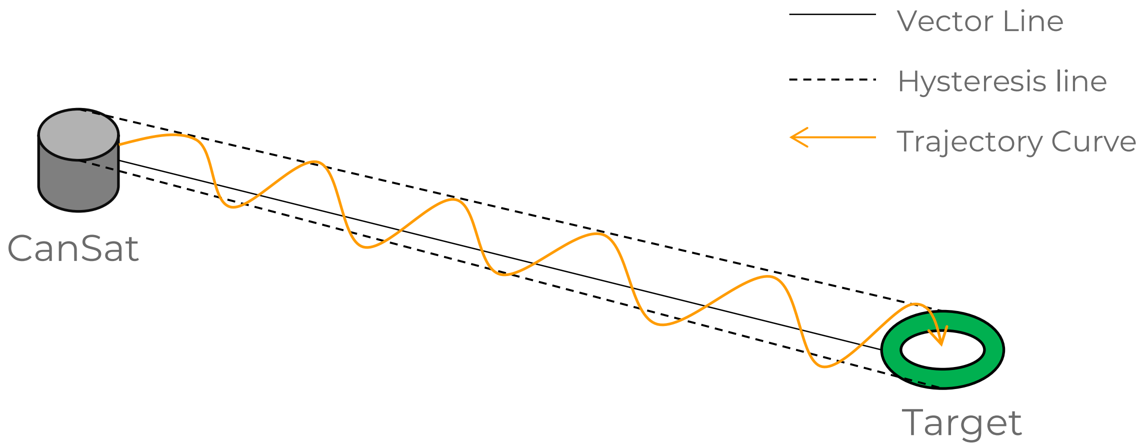


Figure 12 : Scheme of algorithm result

⇨ *Sensor Calibration*

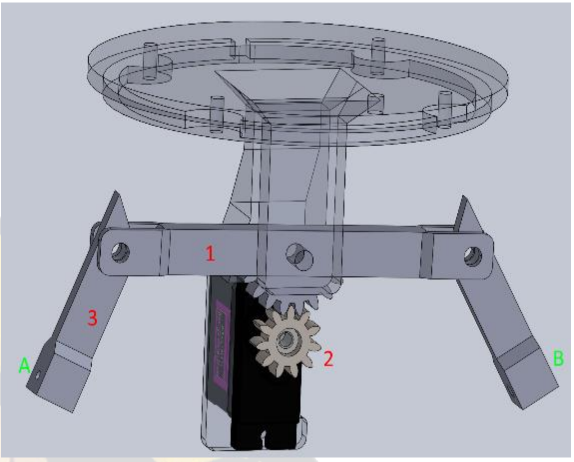
To obtain **meaningful results**, it was first necessary for our sensor to be **calibrated**. A calibration curve was used to map the output of the sensor to the actual physical quantities it was measuring. The sensor was tested in a controlled environment, and the readings for different known values of the physical quantity were recorded. These values were then plotted on a graph to generate the calibration curve. Through this process, it is ensured that the data collected during the upcoming flight accurately reflect the physical conditions that will be measured.

⇨ *Transmission between the servomotor and the halyard*

As said previously, it was decided to use only 1 arm.

The maximum angle of rotation of the transmission arm is enabled by a **half gear**. **Better control** over the trajectory was achieved by **increasing the distance** between the points where the apexes are attached, despite the maximum diameter of the CanSat being 8 cm.

An **extension** was added on the arm that could be folded or retracted to comply with regulations. When the parachute is inflated, the cable is stretched, causing the extension to be aligned with the bar.



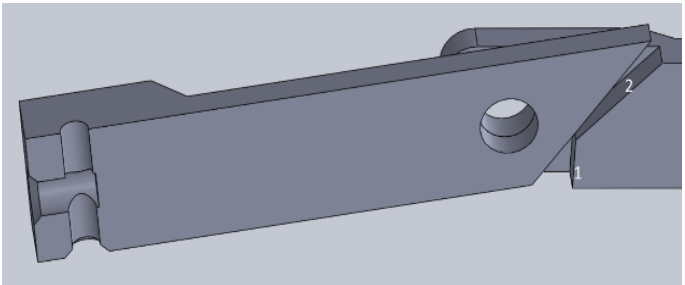


Figure 13 : Arm system for paraglider

2. Results of the tests carried out to validate the system.

The GPS module was first used to figure out the CanSat's position and calibrate it. Simultaneously, data from the accelerometer and compass were gathered to determine the CanSat's angle. Finally, these two programs were combined into one that decides whether to pull the halyards more to the left or right.

Picture of the group going outside to initialize the GPS and run calibration tests.

Video of the final program in action.

VI. Deployment system

The purpose of the CanSat secondary mission is to deploy a structure on the ground, either during descent or directly after landing.

1. Description

The deployment system is composed of a **mini CanSat** attached to a **mini parachute**, which is released from the CanSat upon launch. (Cf: *Choice of the structure for the secondary mission*)

2. First Tests

The structure was tested by the team and deemed successful. The door of the CanSat was released when the parachute was deployed, which was triggered by the attached metallic bar. The structure was effectively ejected with the help of the internal spring and external elastic. As anticipated, it deployed far away from the CanSat to avoid any interference with the parachute. Nonetheless, to guarantee consistent deployment during every launch, a standardized folding method was required for the parachute inside the CanSat. After testing multiple options, a circular folding technique around the mini CanSat was selected, which further improved the deployment process.

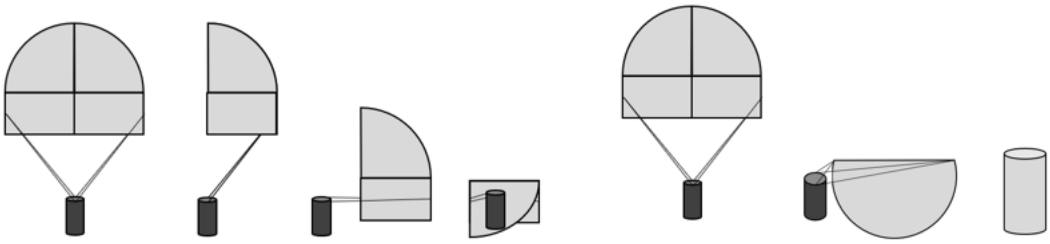


Figure 14 : Paraglider folding

Table 9 : Decision matrix, folding method

Folding Method	Angular Fold	Circular Fold
Deployment	Hard	Easy
Probability of wire entanglement	Low	Medium
Size	Small	Medium

VII. Analysis of air characteristics

The optional mission is to perform an air analysis and involve **collecting data** on various atmospheric conditions and stocking this data on the **Flash Memory** of the Arduino Nano (32 Ko). Thus, two different components were used: a **pressure sensor** and a two in one **temperature/humidity sensor**.

1. Component choice

Based on the matrix decision, the BMP280 is the most suitable **pressure** sensor. The BMP280 was chosen as the top pick due to its combination of cost-effectiveness, **versatility**, and **compact size**. This grove wired sensor is also well documented.

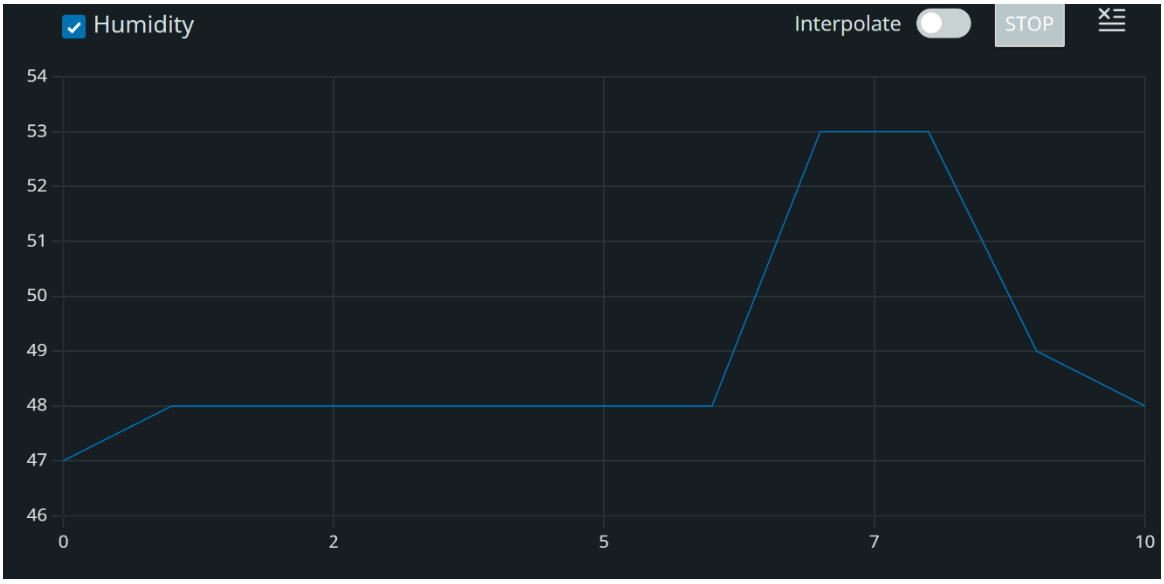
Barometer Sensor (BMP280)

To collect **temperature** & **humidity** related data, the DHT11 sensor was the best option among the three different one, as shown in the matrix decision. This decision was based on three factors: **volume** occupied by the sensor, **cost**, and **accuracy**.

Temperature & Humidity Sensor (DHT11)

2. Results

DHT11 TEST: Humidity & temperature sensor




```
Humidity: 48.00 %        Temperature: 18.60 *C
Humidity: 48.00 %        Temperature: 18.60 *C
Humidity: 48.00 %        Temperature: 18.60 *C
Humidity: 48.00 %        Temperature: 18.60 *C
Humidity: 48.00 %        Temperature: 18.50 *C
Humidity: 53.00 %        Temperature: 18.50 *C
Humidity: 53.00 %        Temperature: 18.80 *C
```

Figure 15 : Sensors data display

VIII. Resolution approach

1. Teams work methodology – Agile Scrum methodology.

Teamwork is an essential element of any technical project, as it allows individuals with different skills and expertise to collaborate and work together towards a common goal. By working as a team, members can share their **knowledge** and **skills**, divide tasks, and provide support and encouragement to each other. This can help to ensure that the project is completed efficiently and effectively and can also foster a sense of **community** and cooperation among team members.

⇨ *Agile methodology*

As presented before, the **Agile methodology** was employed to help manage and structure our work. It was a valuable experience for the team.

⇨ *Burndown charts*

The **burndown chart** has been used as an indicator of **progress** for the CanSat project. This graphical representation shows the amount of work remaining to be completed, providing a **clear visual** of the project's progress towards completion. The burndown chart is an effective tool for tracking **the status of tasks** and user stories, allowing to know if the team is late or not. By utilizing the burndown chart, a **global vision** of the progress of the project is obtained, and where issues and delays were encountered is seen, but overall, the project was on advanced.

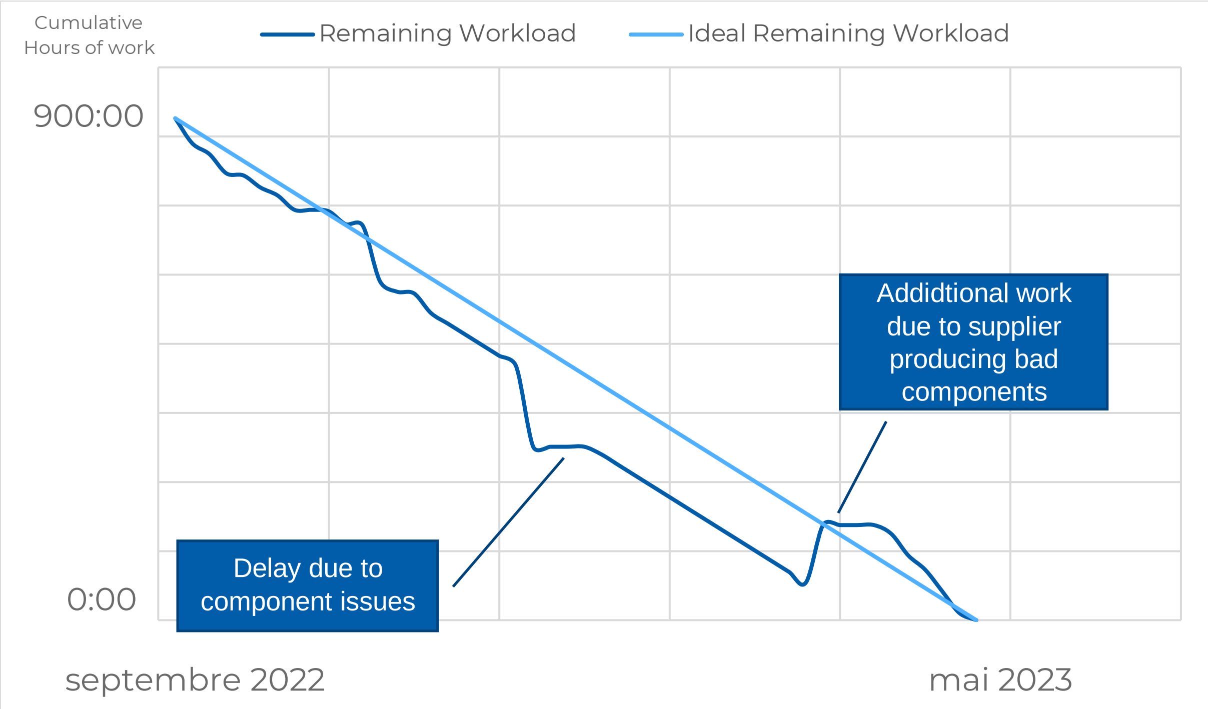


Figure 16 : Burndown chart

⇨ *Backlog*

The product **backlog** has been utilized as a key component of the CanSat project's **management**. The work that needs to be completed to achieve the project's **objectives** is represented by this list of **user stories** and tasks. The product backlog is constantly **evolving** and prioritized by the team. Challenges and issues can be identified and addressed as they arise by using the product backlog, ensuring that the team is always working towards the most important and pressing tasks. This approach allows necessary adjustments to be made to the project plan in a timely and efficient manner, enabling the team to **adapt** to change.

The complete Backlog can be found on the SharePoint.

⇨ *Planning*

The overall **planning** of the CanSat project was closely linked to a problem-solving methodology. The academic year is split in **5 milestones**. Each milestone is defined in our **Sprint Date Table**.

By carefully analyzing the time needed to complete each task and planning for **key dates** (such as ideal dates to place orders), we were able to identify and predict problems as they arose. For each sprint, user stories that will be worked on during the sprint are selected and added to the **KANBAN board**. Additional tasks, if necessary, are defined and added to the board. The Scrum board is consequently taking the form of the KANBAN board throughout the sprint.

Notes were kept of what was achieved in each session and what needed to be achieved next time. By following this planning approach, the challenges of the CanSat project were effectively addressed, and progress was made towards achieving the project's goals.

⇨ *Budget*

The budget requires some attention to be respected. The current state of the budget has been recorded in an Excel spreadsheet, listing all expenses. Good management of financial resources is important for the success of a project.

Table 10 : Budget table

Budget		
Name	**Costs**	**Remaining**
1st order	84,7 €	215,3 €
1st 3D printing	4,5 €	210,9 €
2nd order	61,7 €	149,2 €
2nd 3D printing	9,0 €	140,2 €
3rd 3D printing	10,3 €	129,9 €
3rd order	15,2 €	114,7 €
Merchandising Costs	50,0 €	64,7 €
Total	**235,3 €**	**64,7 €**

Budget-wise, we were **comfortable** because money was saved by making the parachute **ourselves**, which enabled us to invest in **merchandising**.

Backlog Overview

Backlog PT CANSAT #4

/	USER STORY	Task	Who ?	wants…	so that… / to	Task Needed	Priority	When it end ?	Sprint related	Status
Missions	US1	1.	The customer	the cansat to land at a maximal speed	it lands safely and without damage.		1	17 avril 2023	Sprint 5	Done
Missions	US12	12.	The customer	that the CanSat can determine air characteristics	we can have information about the air.		2	17 avril 2023	Sprint 5	Done
Missions	US2	2.	The customer	a control system	the cansat trajectory can be controlled		1	17 avril 2023	Sprint 5	Done
Missions	US3	3.	The customer	a deployement system	a structure is deployed on the floor		1	17 avril 2023	Sprint 5	Done
Organization	US4	4.	The organisation	that the team respect the C'space planning	the organisation can follow the advancement of the project.		1	17 avril 2023	Sprint 5	Done
Organization	US5	5.	The customer	all the deliverables of the project	the customer can follow and control the advancement of the project.		1	26 avril 2023	Each Sprint	Done
Organization	US6	6.	The team	to implement an agile method	work as efficiently as possible while being close to the customer needs.		2	26 avril 2023	Each Sprint	Done
Organization	US7	7.	The customer	our CanSat to follow the rules of the competition	it may compete.		1	17 avril 2023	Sprint 5	Done
Integration	US8	8.	The customer	our components and captors to be well integrated to our CanSat	our CanSat respect the dimensionning authorized.		1	17 avril 2023	Sprint 5	Done
Integration	US9	9.	The customer	our CanSat to respect a certain dimensionning	to feat the Balloon.		1	6 mars 2023	Sprint 4	Done
DD&RS	US10	9.1	The customer	our components and captors to be removable	they can be reused in other projects.		3	17 avril 2023	Sprint 5	Done
DD&RS	US11	9.2.	The customer	our CanSat can do more than one drop	it respect DD&RS.		3	17 avril 2023	Sprint 5	Done

IX. Test of the landing of the CanSat

1. Description of the implementation of the test

Tests were conducted in **batches of 10** under **continuous development conditions**, enabling any issues to be identified quickly and adjustments to be made as necessary. For example, the design of the parachute was refined using the test results, resulting in a more effective solution. Regular testing throughout the development process allowed **early identification of any issues** and ensured that the final product **met all requirements**. Detailed records of each test were kept, including any issues encountered and the steps taken to address them. This documentation will be valuable in future projects, as experiences can be referenced to inform decisions and avoid repeating any mistakes.

2. Evaluation of the performances of the last CanSat

Overall, we believe that the CanSat project was a success, as we were able to achieve our main objectives and accomplish the required missions. Although the tests we performed on the ground are not entirely representative of the actual conditions of the competition, we are confident in the stability, safety, and durability of our CanSat. We were able to control its descent and steer it towards the target with precision. Additionally, we successfully deployed the secondary mission and collected valuable data from the optional mission. The split design for component integration proved to be efficient and allowed for easy access and assembly. After improving the initial design, the parachute performed well during the actual mission. Overall, we are satisfied with the performance of our CanSat and the skills we developed throughout the project.

X. Merchandising

The team decided to create a **logo** for the CanSat project to strengthen its **identity**. The logo was designed considering the uniqueness of our project, which involves a CanSat containing a mini CanSat symbolized by a **kangaroo** and its joey.

This logo will be used on various materials, such as the CanSat itself, packaging, t-shirts, parachute, and stickers to distribute. We chose a consistent approach to ensure recognition of the logo across all these materials.

Figure 17 : T-Shirt and stickers design

XI. Conclusions and perspectives

1. Summary of the objectives achieved.

CanSat-ypique has successfully passed all the tests and meets the regulations set forth in the CanSat competition rules. For example, the total mass of CanSat-ypique is 650g, which is well below the maximum mass limit of 1kg specified in rule number 5. Additionally, the base volume of CanSat-ypique matches the base volume quoted in rule number 6. As per rule 15, the main power switch of CanSat-ypique is easily accessible from outside the CanSat. You can find all the checkable rules in the annex.

During this second semester, the team managed to stay on schedule, made **good progress** to complete the different needs and objectives of the project.

However, this period was a path full of pitfalls. The team had to manage different problems with the assembly, tests, and general organization. **Solving** these problems allowed the team to **improve** its ability to react, adapt and implement solutions to bring the project to a **successful conclusion**.

2. Ideas for improvement for future similar projects

During the whole time of the project, the team managed problem and **find solutions**. From these difficulties, the team was able to **improve** and will be able to improve in its future projects.

First, several areas for improvement have been identified for the team to consider for their future **AGILE management** projects.

Communication and collaboration can be strengthened by providing clear communication channels and regular meetings.

Planning can be improved by establishing a clear project plan with realistic milestones. **Quality** can be enhanced by implementing high standards and utilizing automation tools for testing. The team can be encouraged to self-organize, allowing for more **autonomy and creativity**. In addition, feedback and retrospectives can be used to foster a culture of **continuous learning** and improvement.

Secondly, in terms of **environmental** improvements for future projects, several measures could be taken. The team thought that the materials used in the project could be carefully selected to ensure they have **minimal impact** on the environment. For instance, using **recycled** materials or materials that are easily **biodegradable** could be prioritized. In addition, the CanSat's payload could be designed to collect environmental data such as **air quality**, which could be used for research and analysis purposes. This data could help in making informed decisions about the environment, and ultimately lead to the implementation of more environmentally friendly policies. Additionally, efforts could be made to minimize the **carbon footprint** of the launch process by using **renewable energy** sources or using more efficient rocket engines. Finally, once the CanSat completes its mission, it should be retrieved and recycled or disposed of in an **environmentally friendly** way. These measures could help to ensure that future projects are more environmentally conscious and sustainable.

XII. Annexes

Reference List

Functional analysis

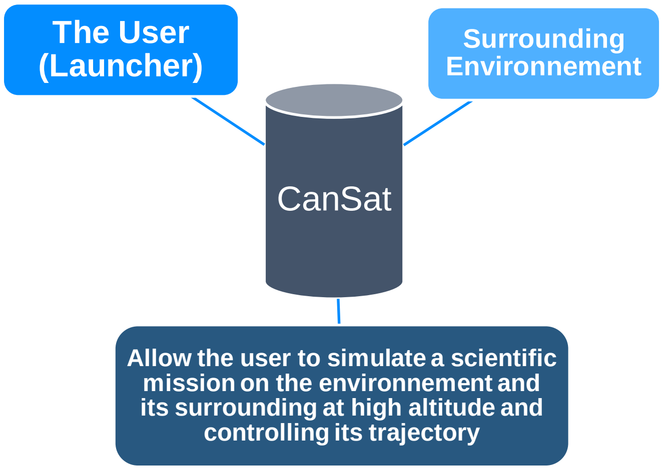


Figure 18 : Horned Beast Diagram

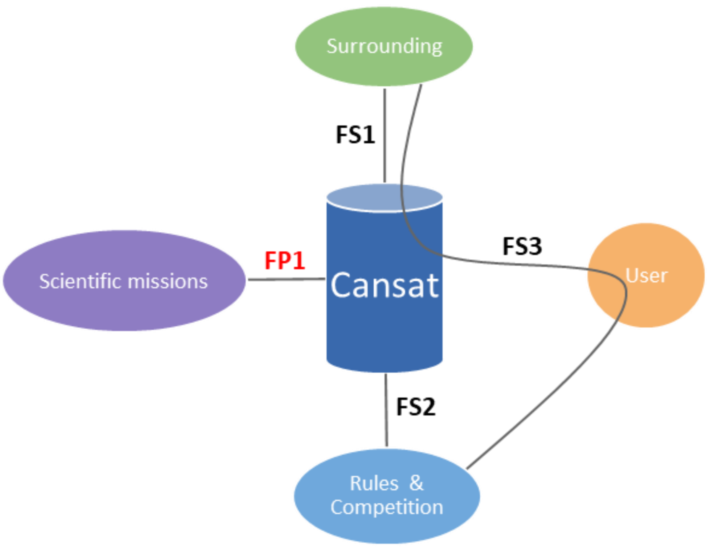


Figure 19 : Octopus Diagram

Table 11 : Functions Specification Table

Functions ID	Description
FP1	The CanSat simulate a microsatellite capable of carrying out scientific missions.
FS1	The Cansat must be able to retrieve information from its surrounding.
FS2	The CanSat respect the rules of the competition.
FS3	The CanSat must have a modern and creative design.
FS4	The CanSat is able to store all the components.
FS5	The CanSat is able to be link to the balloon.
FS6	Respect DD&RS label.
FS7	The Cansat can be launched multiple time

User story Table

Table 12 : User story table

User Story Table

Epic	US ID	Story	End Date
Missions	US4	The customer wants the cansat to land at a maximal speed so that it lands safely and without damage.	Sprint 5
	US12	The customer wants a control system so that the cansat trajectory can be controlled.	Sprint 5
	US12	The customer wants a depolyement system so that a structure is deployed on the floor.	Sprint 5
	US12	The customer wants that the CanSat can determine air characteristics so that we can have information about the air.	Sprint 5
Organisation	US2	The organisation wants that the team respect the C'space planning so that the organisation can follow the advancement of the project.	Each Sprint
	US5	The customer wants all the deliverables of the project so that he can follow and control the advancement of the project.	Each Sprint
	US9	The customer wants that the team to apply an agile method so that the client is regularly involved in the project.	Each Sprint
	US2	The customer wants our CanSat to follow the rules of the competition so that it may concurr.	Each Sprint
Integraton	US2	The customer wants our components and captors to be well integrated to our CanSat so that our CanSat respect the dimensionning authorized.	Sprint 5
	US2	The customer wants our CanSat to respect a certain dimensionning to feat the Balloon.	Sprint 5
DD&RS	US2	The customer wants our components and captors to be removable so that they can be reused in other projects.	Sprint 5
	US2	The customer wants our CanSat can do more than one drop so that it respect DD&RS.	Sprint 5

Planning

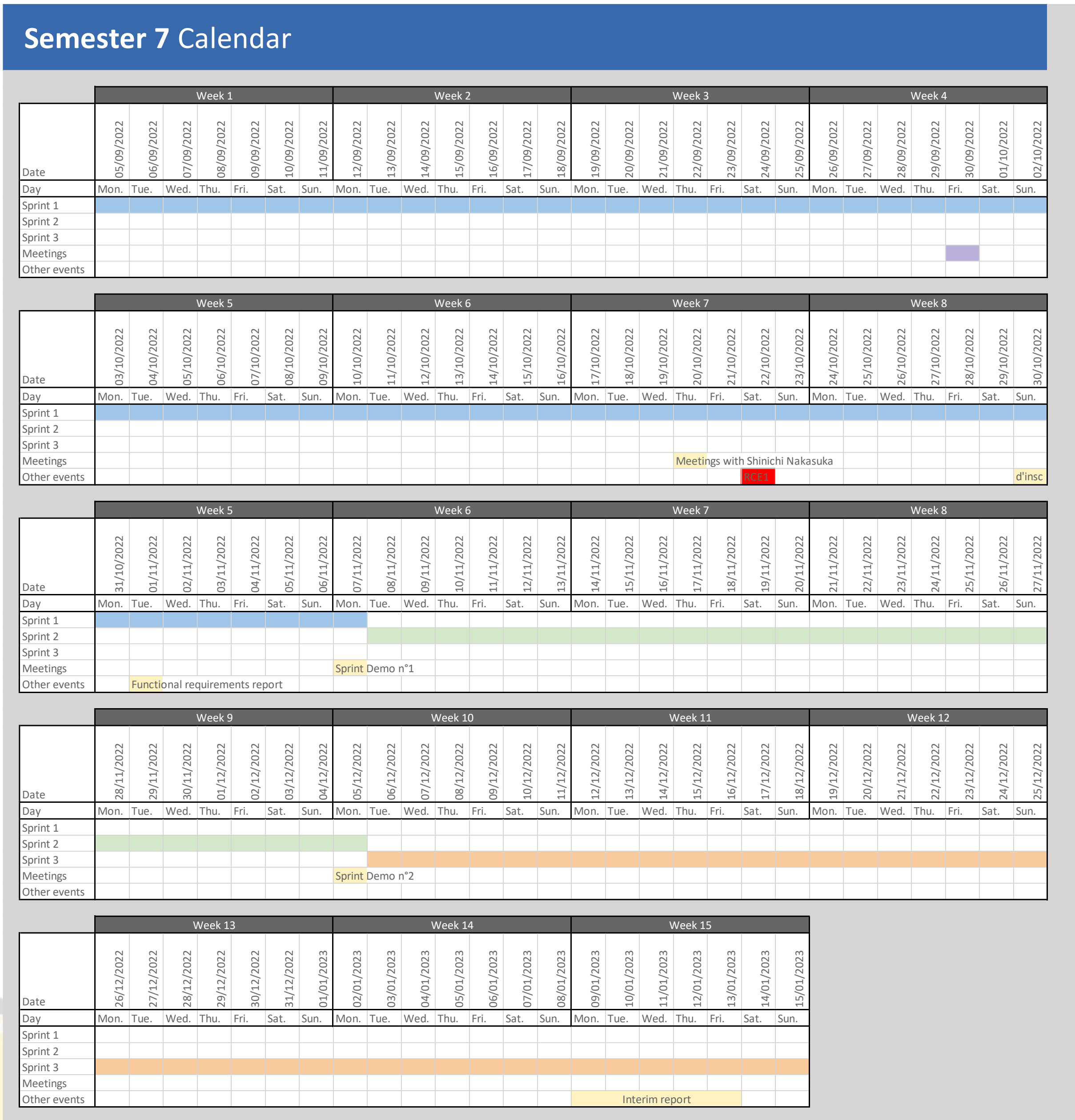


Figure 20 : Semester 7 Calendar

Semester 8 Calendar

	Week 16							Week 17							Week 18							Week 19						
Date	16/01/2023	17/01/2023	18/01/2023	19/01/2023	20/01/2023	21/01/2023	22/01/2023	23/01/2023	24/01/2023	25/01/2023	26/01/2023	27/01/2023	28/01/2023	29/01/2023	30/01/2023	31/01/2023	01/02/2023	02/02/2023	03/02/2023	04/02/2023	05/02/2023	06/02/2023	07/02/2023	08/02/2023	09/02/2023	10/02/2023	11/02/2023	12/02/2023
Day	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
Sprint 4																												
Sprint 5																												
Meetings								Sprint Demo																				
Other events												RCE2																

	Week 20							Week 21							Week 22							Week 23						
Date	13/02/2023	14/02/2023	15/02/2023	16/02/2023	17/02/2023	18/02/2023	19/02/2023	20/02/2023	21/02/2023	22/02/2023	23/02/2023	24/02/2023	25/02/2023	26/02/2023	27/02/2023	28/02/2023	01/03/2023	02/03/2023	03/03/2023	04/03/2023	05/03/2023	06/03/2023	07/03/2023	08/03/2023	09/03/2023	10/03/2023	11/03/2023	12/03/2023
Day	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
Sprint 4																												
Sprint 5																												
Meetings																						Sprint Demo						
Other events																												

	Week 24							Week 25							Week 26							Week 27						
Date	13/03/2023	14/03/2023	15/03/2023	16/03/2023	17/03/2023	18/03/2023	19/03/2023	20/03/2023	21/03/2023	22/03/2023	23/03/2023	24/03/2023	25/03/2023	26/03/2023	27/03/2023	28/03/2023	29/03/2023	30/03/2023	31/03/2023	01/04/2023	02/04/2023	03/04/2023	04/04/2023	05/04/2023	06/04/2023	07/04/2023	08/04/2023	09/04/2023
Day	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
Sprint 4																												
Sprint 5																												
Meetings																												
Other events																												

	Week 28							Week 29							Week 30							Week 31						
Date	10/04/2023	11/04/2023	12/04/2023	13/04/2023	14/04/2023	15/04/2023	16/04/2023	17/04/2023	18/04/2023	19/04/2023	20/04/2023	21/04/2023	22/04/2023	23/04/2023	24/04/2023	25/04/2023	26/04/2023	27/04/2023	28/04/2023	29/04/2023	30/04/2023	01/05/2023	02/05/2023	03/05/2023	04/05/2023	05/05/2023	06/05/2023	07/05/2023
Day	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
Sprint 4																												
Sprint 5																												
Meetings								Sprint Demo																				
Other events															Acceptance report & Final report								Defense					

	Week 32							Week 33							Week 34							Week 35						
Date	08/05/2023	09/05/2023	10/05/2023	11/05/2023	12/05/2023	13/05/2023	14/05/2023	15/05/2023	16/05/2023	17/05/2023	18/05/2023	19/05/2023	20/05/2023	21/05/2023	22/05/2023	23/05/2023	24/05/2023	25/05/2023	26/05/2023	27/05/2023	28/05/2023	29/05/2023	30/05/2023	31/05/2023	01/06/2023	02/06/2023	03/06/2023	04/06/2023
Day	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
Other events																												

	Week 36							Week 37							Week 38							Week 39						
Date	05/06/2023	06/06/2023	07/06/2023	08/06/2023	09/06/2023	10/06/2023	11/06/2023	12/06/2023	13/06/2023	14/06/2023	15/06/2023	16/06/2023	17/06/2023	18/06/2023	19/06/2023	20/06/2023	21/06/2023	22/06/2023	23/06/2023	24/06/2023	25/06/2023	26/06/2023	27/06/2023	28/06/2023	29/06/2023	30/06/2023	01/07/2023	02/07/2023
Day	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
Other events						RCE3																						

	Week 40							Week 41							Week 42							Week 43						
Date	03/07/2023	04/07/2023	05/07/2023	06/07/2023	07/07/2023	08/07/2023	09/07/2023	10/07/2023	11/07/2023	12/07/2023	13/07/2023	14/07/2023	15/07/2023	16/07/2023	17/07/2023	18/07/2023	19/07/2023	20/07/2023	21/07/2023	22/07/2023	23/07/2023	24/07/2023	25/07/2023	26/07/2023	27/07/2023	28/07/2023	29/07/2023	30/07/2023
Day	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
Other events																												

	Week 41							Week 42							Week 43							Week 44						
Date	31/07/2023	01/08/2023	02/08/2023	03/08/2023	04/08/2023	05/08/2023	06/08/2023	07/08/2023	08/08/2023	09/08/2023	10/08/2023	11/08/2023	12/08/2023	13/08/2023	14/08/2023	15/08/2023	16/08/2023	17/08/2023	18/08/2023	19/08/2023	20/08/2023	21/08/2023	22/08/2023	23/08/2023	24/08/2023	25/08/2023	26/08/2023	27/08/2023
Day	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
Other events																												

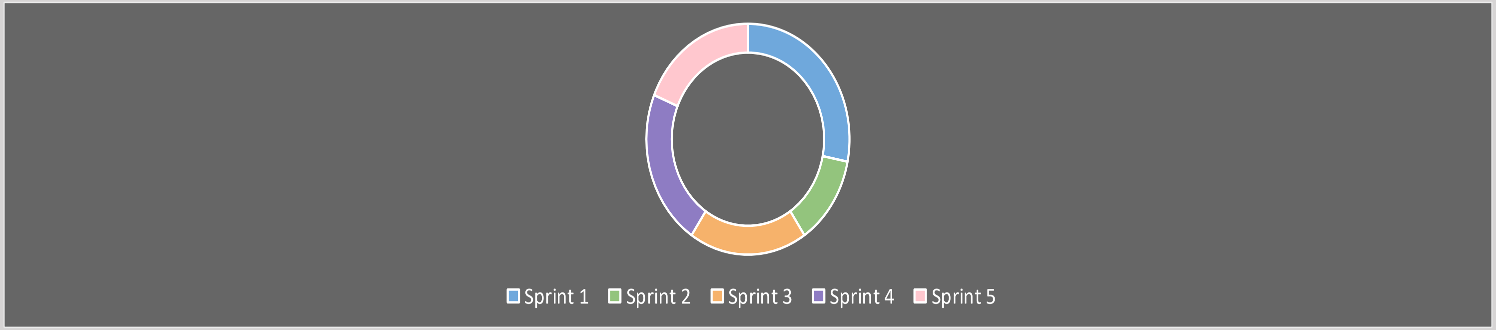
	Week 45						
Date	28/08/2023	29/08/2023	30/08/2023	31/08/2023	01/09/2023	02/09/2023	03/09/2023
Day	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
Other events	RCE			Envoi des rapports de projets			

Figure 21 : Semester 8 Calendar

Table 13 : Sprint Table

Sprint Table

Date	Sprint	Name	Numbers of Weeks
7 novembre 2022	**Sprint 1**	Choice of mission, associated hardware and software and first design of the Cansat	9
5 décembre 2022	**Sprint 2**	Final selection of the components and wiring plan and final design of the CanSat.	4
22 janvier 2023	**Sprint 3**	The components have been ordered and are tested on a breadboard.	6
6 mars 2023	**Sprint 4**	First prototype of the CanSat with the mechanical and electrical parts.	7
17 avril 2023	**Sprint 5**	The body is fitted with the components and is ready for the first tests.	6



KANBAN

TO DO	Who ?	IN PROGRESS	DONE
	Maxime, Manon		A first design of the parachute
	Manon,Romain,Matthieu		The team wants to know the consumption, the volume, the precision of the GPS, the captors, the software and hardware needed.
	Manon		A first design of a surface deployement system
	Grégoire, Matthieu		at least 2 people from the team to go to the RCE1
	Team		to have a functionnal specifications of the project
	Manon		Requirements list
	Mattieu		Goals ans deliverables
	Grégoire		Organisation and Team
	Maxime		State of the art on this subject
	Romain		Report of the meeting
	Mattieu		Compte rendu RCE1
	Team		to find out what has been done in the past
	Team		to understand the project's challenge
	Grégoire, Romain		a Green Plan
	Grégoire		to complete the security form frequently
	Grégoire, Romain, Matthieu		an organised workspace
	Grégoire		a KANBAN
	Team		to define sprint
	Grégoire		a summary of each week
	Grégoire		a calendar
	Grégoire		Organising the workspace

Figure 22 : KANBAN Board sprint 1

KANBAN

TO DO	Who ?	IN PROGRESS	DONE
	Maxime		A final design of the parachute
	Maxime		Design of the deployment of the parachute (chaussette)
	Maxime	Explain how to detect the descent (jack wire) + wireplan	
	Romain		the final decision concerning the consumption, the volume, the precision of the GPS and the captor and the software and
	Romain		List of all the component/material needed for the control of the trajectory control system
	Grégoire,Romain		wireplan of the trajectory control system
	Matthieu		to know how to control a parachute trajectory [to change position and rotation of the CanSat while beeing in air]
	Manon, Matthieu		A final design of the deployment system
	Romain, Manon		the final decision concerning the software
	Romain, Manon		List of all the component/material needed for the deployment system
	Romain		a final design of the captor system for the air analysis (with consumption, ...)
	Romain		List of all the component/material needed for the captor system for the air analysis
	Grégoire,Romain		wire plan of the captor system for the air analysis
	Grégoire, Romain		an organised workspace
	Grégoire		a summary of each week
	Grégoire		a summary of the key project dates
	Grégoire	a document of every component to be ordered	
	Grégoire		add the user story material
	Romain		Take a meeting with the technical expert
	Matthieu		Final design of the consat on solidworks

Figure 23 : KANBAN Board sprint 2

KANBAN

TO DO	Who ?	IN PROGRESS	DONE
	Grégoire, Romain		Make the purchase order
	Manon, Matthieu		Ending of the Solidworks
	Matthieu		Ending of the Trajectory Control Program
	Romain		Design of the paraglider V1
	Tous		Interim report
	Matthieu, Romain		Start printing 3D parts
	Romain		Getting started with components
	Grégoire		Update budget
	Romain	Make an appointment with an expert	
	Manon	Test the deployment structure	
	The team	Assemble all 3D parts	
	The team		Paragliding drop test

Figure 24 : KANBAN Board sprint 3

KANBAN

TO DO		IN PROGRESS	DONE
	Who ?		
	The Team		**We want that our CanSat respect a certain dimmensionning**
	Romain		**Build a new and improved glider**
	Matthieu, Romain		**A first test of the sensors**
	Grégoire, Matthieu		**to configure and test the GPS sensor with the compass in order to know the orientation of the CanSat**
	Grégoire		**to do a second order**
	Manon, Maxime	**build the plate of the secondary mission**	
	Matthieu, Romain		**Operating the pressure / temperature sensor**
	Grégoire, Fabio		**Targeting and extracting GPS values**
	Romain	**Add the new parachute to the CanSat**	
	Mattieu, Grégoire	**link the servomotor to the steering computer program**	
	Paul		**Battery choice and battery integration**
	Romain		**Make an appointment with an expert**
	Manon		**Test the deployement structure**
	The Team		**Assemble all 3D parts**

Figure 25 : KANBAN Board sprint 4

KANBAN

TO DO	Who ?	IN PROGRESS	DONE
	Romain, Paul		The parachute has to be add at the cansat
	Grégoire, Matthieu	To know the GPS position of the CanSat	
	Fabio, Matthieu		To implement the component on the CanSat
	Grégoire, Matthieu, Fabio	To change position and rotation of the CanSat while beeing in air	
	Grégoire, Matthieu, Fabio		To control our parachute orientation with servomotors
	Manon, Maxime	A second test with the deployment system well integrated in the cansat	
	Manon, Maxime, Paul		Make the mini-CanSat that will be propelled
	Romain		Start 3D printing
	The Team		Write the report
	Manon, Fabio	Make the poster	
	Manon, Maxime		build the plate of the secondary mission
	Matthieu, Grégoire		link the servomotor to the steering computer program

Figure 26 : KANBAN Board sprint 5

Budget

Table 14 : Budget Table

Name	Costs	Remaining
1st order	84,7 €	215,3 €
1st 3D printing	4,5 €	210,9 €
2nd order	61,7 €	149,2 €
2nd 3D printing	9,0 €	140,2 €
3rd 3D printing	10,3 €	129,9 €
3rd order	15,2 €	114,7 €
Total	**185,3 €**	**114,7 €**

Total Budget Remaining: 114,7€

Table 15 : Decision matrix for trajectory control

1 servomotor + 1 bar	4	16	5	25	3	9	4	8	50
2 servomotors + 2 leverage arms	3	12	2	10	2	6	2	4	28
2 servomotor + 2 pulleys	3	12	3	15	2	6	2	4	33

Table 16 : Decision matrix for deployment system

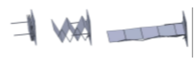
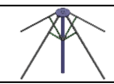
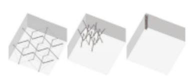
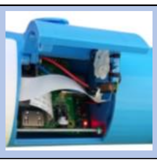
Criteria		Deployment size capacity		Simplicity		Space-Saving		Safety of the CanSat		Weighted total
		2		5		3		4		
Folding accordion		2	4	3	15	4	12	4	16	47
Umbrella mechanism		4	8	4	20	4	12	3	12	52
Tensegrity structure		4	8	1	5	2	6	3	12	31
"2-seconds-tent" technology		5	10	4	20	3	9	1	4	43
Mechanical door-opening + Compressed structure		5	10	5	25	4	12	3	12	59

Photo of the manufacturing

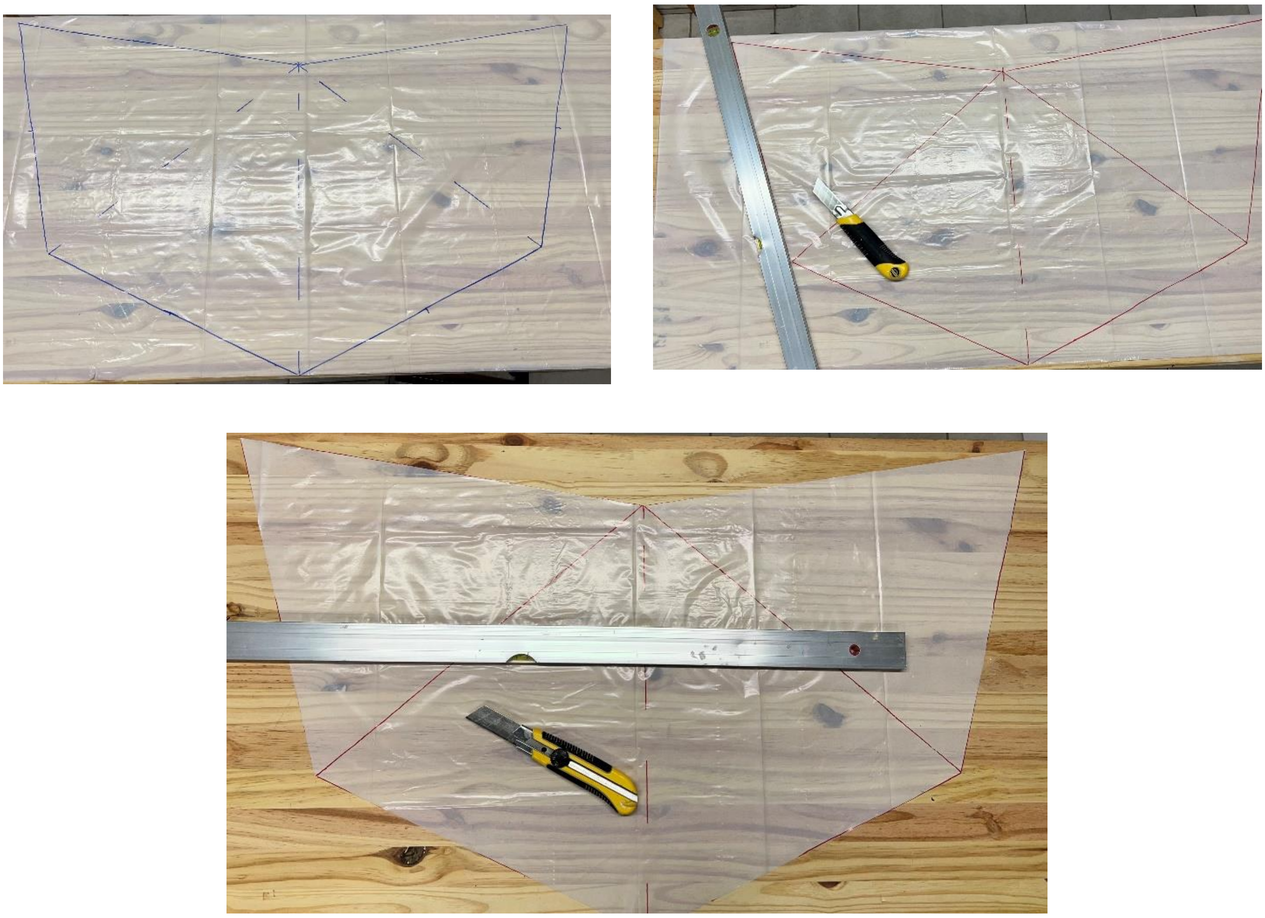


Figure 27 : Manufacturing of paraglider

Components and associated decision matrices

Table 17 : Components table

TOTAL			9		73.70 €			133			1464
Title	Function	Name	use	Justification	Price	Link	Dimension (mm)	poids (g)	Tension (V)	amperage	puiss (mW)
capteur temp et pression	TEMP / PRESSURE	Capteur de pression et de t° Grove 101020192	1	GROVE	9.50 €	Capteur de pression et de t° Grove 101020192 Seeed Studio - Capteurs de pression | GO	40 x 20 x 8 mm	3	3,3 à 5 Vcc	600 µA	3
Capteur humidity	humidity / temp	Humidity sensor DHT11	1	module grove	6.30 €	https://www.gotronic.fr/art-capteur-d-humi	40 x 20 x 11 mm	5	3,3 à 5 Vcc	2,1 mA	10.5
Micro controleur	Flight computing	arduino nano	1	cheaper	17.80 €	https://www.gotronic.fr/art-carte-compatibl	45 x 18 x 18 mm	5	X	X	X
cable servo / grove	cable		1		1.20 €	Câble Grove --> 2 servos Seeed Studio - Connectique et accessoires | GO	20 mm	3	X	X	X
Servomoteur	Contrôle de la trajectoire/ déplacement Course :	Prop B : Servomoteur DF9GMS	1	Cheaper, smaller, but small couple : Couple : 1,3 kg.cm/0.15 Nm à 4,8 Vcc	7.90 €	https://www.gotronic.fr/art-servomoteur-dms-mg90-32266.htm	22,9 x 12,2 x 32,5 mm	12	4,8 à 6 Vcc	300 mA à 4,8 Vcc	1440
GPS	gps pour contrôle trajectoire	Module GPS Grove 109020022	1	lot of documentation. Module Grove Base Shield needed	13.70 €	https://www.gotronic.fr/art-module-gps-grove-109020022-31996.htm	40 x 20 mm	10	X	X	X
accelerometer / compass	compass, accelerometer, gyroscope	Module 9 DoF MPU9250 Grove 101020080	1	2 in 1 (gyro not used)	14.20 €	Module 9 DoF MPU9250 Grove 101020080 Seeed Studio -	40 x 20 x 7 mm	10	3,3 à 5 Vcc	2,1 mA	10.5
module grove	connection	Module Grove Base Shield 103030000	1	needed but too big / cheap / common	3.10 €	https://www.gotronic.fr/art-shield-grove-nano-103100124	45 x 41 x 11 mm	25	X	X	X
battery	power the sytem	Varta - Pile 9V rechargeable	1	9v / 200mAh		https://www.amazon.fr/Varta-Pile-recharg	17.5 x 48.5 x 26.5 mm	60	X	X	X
Nylon canvas	parachute	B09ZYHY5LC	1	tear-proof and durable	11,4€	1_2?crid=Q9FCKQEGHSNS&keywords=tiss	100 * 152 * 1	79g	X	X	X
Nylon rope	attaching the parachute	B07JB9Y1C2	1	tear-proof and durable tensile resistance 192kg	30,89	pf_rd_p=c0fd4374-336f-410a-bbb1-ba298317999b&pf_rd	11.8 x 11.8 x 9.6 cm;	580 g	X	X	X

Sensors decision matrices

Table 18 : Decision matrices for components

	criteria	small vol		cost		documented		total weight
micro controller		5		3		4		
	arduino	4	20	3	9	2	8	37
	arduino uno	2	10	4	12	2	8	30
	raspberry PI 3	1	5	1	3	1	4	12

	criteria	small vol		cost		multi usage		total weight
accelerometer		5		3		4		
	MMA8452Q	2	10	2	6	2	8	24
	MPU9250 101020080	3	15	1	3	3	12	30
			0		0		0	0

	criteria	small vol		cost		multi sensor		total weight
pressure sensor		4		3		4		
	BMP280	3	12	3	9	3	12	33
	BMP280 SEN0372	2	8	2	6	1	4	18
	BME280 VMA335	3	12	1	3	3	12	27

	criteria	small vol		cost		precision		total weight
humidity sensor		4		3		2		
	ADA2652	1	4	1	3	1	4	11
	DHT11	3	12	4	12	2	4	28
	SEN-DHT22	2	8	2	6	3	12	26

	criteria	small vol		cost		weight		total weight
servo moteur		5		3		4		
	S07NF	1	4	3	9	2	8	21
	MG90-180	4	16	4	12	4	16	44
	FS5115M	2	8	1	3	3	12	23

	criteria	small vol		cost		grove		total weight
compass		5		3		4		
	S07NF	1	4	3	9	0	0	13
	MG90-180	4	16	4	12	1	4	32
	FS5115M	2	8	1	3	0	0	11

Latest printed CanSat with latest parachute (26/04/2023)

Figure 28 : Last test of CanSat

Project security

Self-assessment of potential risks and plan to reduce them

Project name: IcamSat Project_2_Group_10_Cansat_Team#4	*Author of the self-assessment: TROESTLER Grégoire*
Members of the team: *Manon LEBOEUF* *Romain DE GUIO* *Matthieu GORISSE* *Maxime SALAS* *Grégoire TROESTLER* *Fabio USRI* *Paul BOUSQUIER*	

Risks	Initial eval.: 12/10/22			Eval. 2: 13/01/23			Eval. 3:			Eval 4:			Action ref.
	E	F	S	E	F	S	E	F	S	E	F	S	
1. Risk caused by a physical activity (Injury, disease, infection, risk of musculoskeletal, ...) - Manipulation of heavy load - Manipulation of load with inappropriate postures (overhanging, ...) - Manipulation of products that can generate injuries (Cutting tools, glass, shards, ...) - ...	0	0	+	0	0	+	0	0	+				
2. Risks of injuries on floor-level (Fall, brutal clashes, ...) - Slippery ground due to use of products that can spread on the floor - Congested area - Narrow pass or along dangerous area - ...	0	0	+	0	0	+	0	0	+				
3. Risks due to internal traffic (Injured by a vehicle, ...) - No separation between the traffic pass and people track (drones, karting, forklift, ...) - Risks of failures or erratic's behavior from a vehicle (Typically prototypes or vehicles in test, ...) - ...	0	0	+	0	0	+	0	0	+				
4. Risk of fails from heights (Drop down of a box, Fall of operators from heights, ...) - Works on inclined areas (steps, ...) - Works at height (stepladder, ladder, scaffold, ...) - Works with makeshift tools (Chair, tools, ...) - ...	+	0	+	+	+	+	+	0	+				

Project security

Self-assessment of potential risks and plan to reduce them

Risks	Initial eval.: 12/10/22			Eval. 2: 13/01/23			Eval. 3:			Eval 4:			**Action ref.**
	E	F	S	E	F	S	E	F	S	E	F	S	
5. Risks due to mechanical manipulations (Applied to load, resources or engines, …) - Instability of manutention resources - Instability of load - Use of unsuitable or defective manutention resources - …	0	0	+	0	0	+	0	0	+				
6. Risks during travel (Traffic accident, …) - Uncertain quality of maintenance of the vehicle - Drive disturbed by the smartphone or other sources of distraction - Stress generated by the traffic, an urgency, an issue - …	0	0	++	0	0	++	0	0	++				
7. Risks on resources (Injuries caused by a mechanical system, …) - Action on a part of a material in movement (forwarding body, …) - Projection of fluids (gas, liquid under pressure, …) or raw materials (metal filings, chips, dust, …) - No consignment or insufficient consignment of a machine or an equipment on which there is a maintenance operation - …	+	0	0	+	0	0	+	0	0				
8. Risks due to electricity - Contact with an electrical conductor or a metal object under voltage - …	+	0	+	+	0	+	+	0	+				
9. Risks due to collapse or objects failing (Boxes, row materials, storage, …) - Storage of heavy products in heights - Stacking of products improperly restrained - Jobs don on several levels of floor with risk of interaction between each other (Waterfall, …) - …	0	0	+	0	0	+	0	0	+				
10. Risk due to noises (discomfort, communication disturbed, …) - Important and discomfort background noises (Frequency, rhythm, …) - …	+	+	+	+	+	+	+	+	+				
11. Risks due to fire or explosions - Storage and use of dangerous products (Tag information) - Mix of incompatible products - Generation of an explosive atmosphere (expansion of a dangerous gas, fermentation, spray can, …) - …	0	0	++	0	0	++	0	0	++				

Project security

Self-assessment of potential risks and plan to reduce them

Risks	Initial eval.: 12/10/22			Eval. 2: 13/01/23			Eval. 3: ……			Eval 4: ……			Action ref.
	E	F	S	E	F	S	E	F	S	E	F	S	
12. Risks due to biological agents (infection, allergies, microorganism intoxication) - Working with contaminating products (waste, used water, out-of-date products, spray can, medical waste, …) - …	0	0	+	0	0	+	0	0	+				
13. Risk due to products, emissions and wastes (infection, intoxication, inhalation, …) - Use of products with a danger symbol - Exposure to smoke (welding, …), toxic vapors (varnish, solvent, …) or dusts (cutting, milling, polishing, …) - …	0	0	++	0	0	++	0	0	++				
14. Risks due to lighting - Tired, stressed due to an insufficient lighting - Barriers masked due to lake of brightness of the lights (fall, lashes, …) - …	0	0	+	0	0	+	0	0	+				
15. Risks due to thermal environment (hot or cold) - Risk to be burnt on contact (hot or cold) - …	0	0	+	0	0	+	0	0	+				
16. Psychosocial risks - Stress environment (long time to work in a day, …), internal (harassment, …) or external (pressures from customers, conflicts, …) violence - …	0	0	++	0	0	++	0	0	++				
17. Risks due to radiations - Dangerous risks on health by radiation coming from equipment (radiography, …) or raw materials (nota: symptoms can appear a long time after for radiations) - …	0	0	++	0	0	++	0	0	++				
18. Other risks (Precise them)													

Project security

Self-assessment of potential risks and plan to reduce them

Ref.	Description of the potential action	How to verify application	Delay to apply	Applied and efficient
10	Change of workplace	Survey the team to find out their satisfaction	Instantaneously	Yes

Table 19 : Rules of CanSat

CanSat Specification (Rules)	Cansatypique
05- Maximum mass of 1kg	650g
06- Base volume of 80mm diameter and 200mm height (exception of the parachute)	Matches the maximum diameter and height
07- Elements deployed beyond the base volume and at the exit of the release only	Check
11- Maximum voltage difference limited to 30 V	4 AAA batteries, limited to 6V
15- Main power switch accessible from outside the CanSat	Check
16- Descent speed between 2m/s and 15m/s	Speed estimated at 2.2m/s

Liste de contrôle d'un rapport avant remise

(à compléter et à remettre avec le rapport)

NOM : .... Prénom : .... Promo : ………..

Nature du rapport (Projet libre, PT, PRD, stage …) : ………………………..

Titre du rapport: .... Date ou version du document : ………………........

Fiche à compléter et à remettre avec tout rapport. Toute ligne doit recevoir une coche.

Thèmes et critères de contrôle		**OK**	**Sans objet**
Page de garde			
	Présence du titre du rapport plus brève description si nécessaire		
	Présence du logo client du rapport		
	Présence du logo ECAM		
	Nom de l'auteur		
	Date et version du document		
Pages préliminaires			
	Remerciements (sur une seule page recto)		
	Sommaire (début sur une page recto)		
	Liste (optionnelle) des figures + tableaux (début sur une page recto)		
	Liste des abréviations (début sur une page recto)		
Corps du rapport			
	Introduction sur une page recto		
	Développement avec chapitres et sous chapitres numérotés		
	Les chapitres débutent sur une page recto		
	La conclusion numérotée débute sur une page recto		
	La conclusion montre en quoi les objectifs sont atteints (ou non …)		
Annexes			
	Liste des références (début sur une page recto)		
	Chaque annexe est numérotée et débute sur une page recto		

Liste de contrôle d'un rapport avant remise –V2020

Liste de contrôle d'un rapport avant remise

(à compléter et à remettre avec le rapport)

Thèmes et critères de contrôle		OK	Sans objet
Sur toutes les pages sauf page de garde			
	Rappel du titre du rapport, pagination et date/version en haut ou bas de page		
	Les textes sont justifiés		
	Les sous-paragraphes et listes sont en retrait		
	Les paragraphes sont séparés des uns des autres par une interligne majorée		
	La mise en valeur d'un texte est faite par une mise en italique ou une taille de caractère distinctive (et non par un soulignement)		
	Le vocabulaire utilisé est adapté au rapport – il n'y a pas de mot familier (ex : *manip* au lieu de *manipulation* ou *essai*)		
	Les phrases sont courtes, la ponctuation facilite la lecture et la compréhension.		
	Les figures sont identifiées par un numéro et par un titre positionné **en dessous** de celles-ci		
	Les tableaux sont identifiés par un numéro et par un titre positionné **au-dessus** de ceux-ci		
	Le présent de l'indicatif est le temps privilégié		
	Le rapport est rédigé à la troisième personne voire au mode passif pour éviter les "on" (ex : *l'expérience est réalisée...* au lieu de *on réalise l'expérience...*) et l'emploi de la première personne (*nous avons fait l'expérience …*)		
	Le texte est analysé au correcteur orthographique et les fautes d'orthographe détectées ont été corrigées		
	Les pages blanches sont tramées par un "Cette page est laissée blanche intentionnellement"		
	Le rapport a été relu par un tiers		
Fourniture du rapport			
	Pour les rapports et annexes au format numérique, les fichiers sont nommés conformément aux consignes données (ex : *ECAMXX Rapport de stage Gilbert Mayer version 4*)		
	Pour les rapports et annexes au format numérique, au moins une version est fournie au format PDF		
	Chaque fichier PDF a été ouvert et la qualité de la mise en page a été vérifiée		

Liste de contrôle d'un rapport avant remise –V2020