Design Review – Warwick CanSat

**Contents**

[1 Introduction & Overview 3](#_Toc28879035)

[2 Understanding of the requirements 3](#_Toc28879036)

[2.1 Mission Objectives 3](#_Toc28879037)

[2.1.1 Base Requirements 4](#_Toc28879038)

[2.1.2 Standardisation of Design and Metrics 5](#_Toc28879039)

[2.1.3 Simulation of an Atmospheric Sampling System 5](#_Toc28879040)

[2.2 Team Composition 5](#_Toc28879041)

[2.3 Necessary Trades 6](#_Toc28879042)

[3 Overview of the Design, and Results from Prototyping & Testing 6](#_Toc28879043)

[3.1 First Version 6](#_Toc28879044)

[3.1.1 Physical Properties 6](#_Toc28879045)

[3.1.2 Allocation and Derivation of System & Subsystem requirements 6](#_Toc28879046)

[3.1.3 Predicted Budget for Design 6](#_Toc28879047)

[3.1.4 Results of Testing & Problems with the Design 6](#_Toc28879048)

[3.2 Current Version 6](#_Toc28879049)

[3.2.1 Physical Properties 6](#_Toc28879050)

[3.2.2 Allocation and Derivation of System & Subsystem requirements 6](#_Toc28879051)

[3.2.3 Planned Components 7](#_Toc28879052)

[4 References 8](#_Toc28879053)

# Introduction & Overview

The CanSat competition challenges teams of students to create a CanSat: a device containing all of the major subsystems found within a satellite that is no larger than a soft drink can. This device should not only safely land using a parachute, but it should also be able to gather basic data about itself and its surroundings (ESERO, 2019). This document will be structured so that each chapter aims to meet one of the requirements of the Design Review, as outlined in the CanSat Competition Mission Guide (CanSat Competition United Kingdom, 2019).

# Understanding of the requirements

## Mission Objectives

Our team aims to meet all the objectives outlined in the Mission Guide (CanSat Competition United Kingdom, 2019). Throughout this document we will be referring to each of the requirements as noted below:

|  |  |
| --- | --- |
| Number | Requirement |
| 1 | CanSat mass shall be 250 g +/- 10 g. |
| 2 | The CanSat shall fit in a cylindrical envelope with the following dimensions: 66 mm diameter x 160 mm height. |
| 3 | The CanSat should not have any sharp edges to cause it to get stuck in the rocket. |
| 4 | The rocket should not be used as part of the CanSat operation. |
| 5 | The CanSat shall deploy from the rocket payload area. |
| 6 | A Descent Control System (parachute) must be deployed immediately after release from the rocket and shall be enclosed prior to deployment. |
| 7 | The descent rate of the CanSat shall be between 5-10 m/s. |
| 8 | All electronics should be hard mounted or glued using hard adhesives. |
| 9 | The frame/structure of the CanSat shall accommodate all electronics. |
| 10 | All electronics components shall be enclosed and shielded from the environment with the exception of sensors. |
| 11 | During descent the CanSat shall collect and transmit air pressure, outside temperature, battery voltage, and GPS longitude and latitude at least once a second. |
| 12 | The CanSat shall determine altitude with respect to ground level based on pressure and temperature readings |
| 13 | Each sensor data packet shall be tagged with mission time and packet count. |
| 14 | Packet count and mission time do not reset with processor reset. |
| 15 | The sensor data packet shall meet the following structure: packet count, mission time, pressure, temperature, altitude, battery voltage, GPS longitude, GPS latitude, soft state, Bonus |
| 16 | The CanSat shall store all sensor data packets onboard. |
| 17 | The CanSat shall transmit all sensor data packets to the Ground Control Station during flight. |
| 18 | The CanSat shall include a power indicator such as an LED or buzzer, which shall indicate a successful startup and that the CanSat is operational. |
| 19 | The audio beacon is required to sound at least once a second after landing. |
| 20 | The audio beacon shall indicate if any electronics is not functioning. |
| 21 | Battery source may be alkaline or lithium. No lithium polymer or lithium ion. |
| 22 | The battery shall be easy to remove/replace in 60 seconds. |
| 23 | It shall be possible to program the microcontroller with a USB plug, without having to disassemble the CanSat in its entirety, within 60 seconds. |
| 24 | The ground station shall include one laptop computer with a minimum of two hours of battery operation and a hand-held antenna. |
| 25 | All received data packets must be displayed in real time, in SI units. |
| 26 | A box shall be used to carry all necessary tools and equipment to the launch site. |
| B1 | Include a HD Camera to video the descent in colour at a minimum of 20 fps. The video should start at apogee and be initiated by the flight software. |
| B2 | The parachute is deployed through an active mechanism. The mechanism cannot use chemicals, and those that use heat cannot be exposed to the environment. |
| B3 | An accelerometer is included to establish the location of the CanSat separate to the GPS. The final position recorded by the accelerometer should be within 20m of the GPS position of the CanSat. |

These tasks can roughly be grouped into 3 categories:

(Note: Most tasks lie within multiple groups – the lists of tasks are to help understand the categories rather than to make any solid statements about the tasks themselves)

### Base Requirements

These requirements are aimed at ensuring that the final build still meets the definition of a “CanSat”, such as restrictions to weight and size. They prevent accidental damage to the provided equipment (e.g. the rocket) and guarantee the safety of all those present, by acting as a loose “go / no go” checklist. Other requirements aim to minimise potential disruption on launch day. Requiring a certain level of accessibility to the internals of the CanSat allows teams to rapidly fix any potential issues caused by factors such transport to the venue, minimising the amount of time wasted on the day of the event.

The tasks that fit this description best are: 1; 2; 6; 7; 8; 9; 19; 21; 24

### Standardisation of Design and Metrics

In order to successfully compare each team’s submission, the CanSats should all be built to be measurable by the same metrics. Standard data structure and minimum data requirements allow for rapid comparison between each CanSat’s scientific value, whilst also simulating the demand of such data by scientists. Standardisation is also key in the rise of commercial satellite launches; the greatest strength of CubeSats is their cost-efficiency allowed by their uniformity (Wikimedia Foundation, 2019). Making this a requirement will help teams in their future work in the space industry, as this experience will likely prove invaluable in the growth of the smallsat market.

The tasks that fit this description best are: 3; 4; 5; 10; 12; 13; 14; 15; 16; 18; 20; 22; 23; 25

### Simulation of an Atmospheric Sampling System

This is what can be considered as the primary mission objective. The central function of a CanSat is to demonstrate the capabilities of cheap off-the-shelf components in the collection of scientific data. The demands the requirements make of the teams also aims to develop numerous skills that are required to work in the space industry. This is done by tasking teams with many of the same problems and design choices faced by real aerospace companies.

The tasks that fit this description best are: 11; 17; B1; B2; B3

## Team Composition

Within the Warwick Aerospace team, we have 7 team members assigned across 4 roles:

* **Software**: John Toop-Rose (Team Leader), Jack Rosenthal
  + Responsible for writing the code on the microprocessor, which ensures the CanSat completes all the required operation before, during, and post flight as well as ensuring all data is formatted correctly
* **Mechanical**: Alexander Smirnov, Aneesh Jois
  + Responsible for the physical structure designed to encase and support the electronical components, as well as ensuring the correct function of any active mechanisms
* **Systems**: Benedek Papp
  + Responsible for the integration of electronical components into the CanSat framework, as well as ensuring the smooth merger of the team’s work
* **Electronics**: Will Massey
  + Responsible for the selection and manufacture of all electronical components, ensuring that the hardware chosen is capable of all the required functions

Throughout the duration of the project team members will be able to work on any tasks available at that time. The roles assigned do not create a rigid structure, instead they aim to distribute the management of tasks based on the individual’s skills and abilities.

Due to the relatively short project duration and the fact that many of us have not undertaken such a task before, this project will follow an Agile methodology (Muslihat, 2019). Tasks and timescales will repeatedly be reassessed on a regular basis, allowing for greater collaboration within team members as well as an increased response time to unforeseen difficulties found throughout the project.

## Necessary Trades

To complete the CanSat project, numerous skills will be required.

# Overview of the Design, and Results from Prototyping & Testing

## First Version

(image of design here)

### Physical Properties

Projected dimensions, weight etc. Should show how base requirements are met

### Allocation and Derivation of System & Subsystem requirements

List which systems are designed to accomplish what objective, and how each objective that is not listed as a base requirement can be met by the design

### Predicted Budget for Design

### Results of Testing & Problems with the Design

Cover any tests and any missed requirements here (including bonus requirements). Note any problems raised by the team

## Current Version

(image of design here)

### Physical Properties

Projected dimensions, weight etc. Should show how base requirements are met

### Allocation and Derivation of System & Subsystem requirements

List which systems are designed to accomplish what objective, and how each objective that is not listed as a base requirement can be met by the design

### Planned Components

List here any features that have not been made / tested at time of writing

* Launch day checklist
* HD camera feed
* Test of radio range
* Failsafes
  + If connection is lost
  + If a component fails

# References

CanSat Competition United Kingdom. (2019, September 19). 2020 Mission Guide Document. United Kingdom.

ESERO. (2019, December 11). *CanSat*. Retrieved from ESERO: European Space Eduaction Resource Office: www.stem.org.uk/esero/cansat

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