Space Universities Network
Supporting the Space Higher Education Community

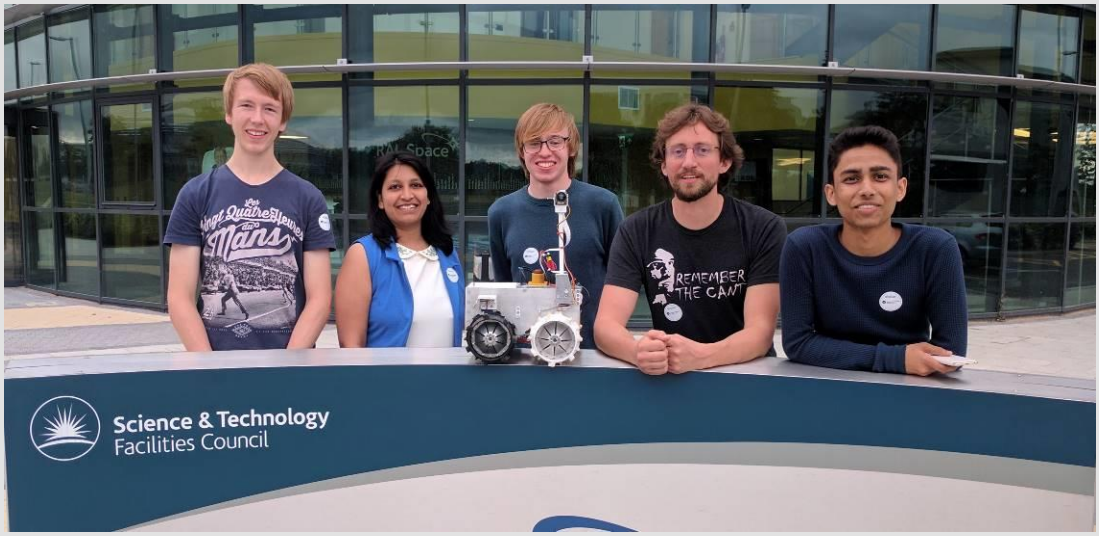
CASE STUDY

Title

UKSEDS Lunar Rover competition – University of Surrey

Summary

The University of Surrey 'Electronics and Amateur Radio Society' (EARS) sent a team to compete in the UKSEDS Lunar Rover competition to design and build a rover to achieve an objective set by the organisers. This was an extra-curricular project run by students who developed the rover over a academic year and competed in a final test day.



Surrey EARS Lunar Rover Team, Winners of the UKSEDS Lunar Rover Competition 2016-2017

Aims/Objectives

The aims of the competition were to design and build a lunar rover able to withstand tests and perform operations such as traverse over rocks, climb a 30-degree inclination slope and scoop up a dust sample. The Lunar rover needed to follow guidelines and schedule set by the competition. All subsystems of the rover, electronics, structure, drivetrain and power were to be designed and built by the team.

What was the context / background?

EARS is a large society at the University of Surrey with a keen interest in space engineering. The Space Officer for 2017, in charge of organising space related events for the year, wanted to run a challenging and interesting project that could include many of the members and be sustainable. It would offer an opportunity for members to gain valuable engineering experience and develop their team working. The project was also set up so that it could be used for outreach activities with the University of Surrey's Department of Widening Participation and Outreach (WPO).

How was it organised and who was involved?

The competition entry was student led and the team comprised: 2 Space Engineering MSc students, 2 second year Electronic Engineering students and 2 first year Electronic Engineering students. The team's activities were organised in accordance to the schedule set by UKSEDS to complete a PDR and CDR and finally the test day. The steps taken were as follows:

- Assemble team for competition entry
- Apply to enter competition
- Start designing systems
- Test designs for wheels and sample collection systems
- Complete PDR
- Integrate chosen designs together
- Complete CDR
- Complete electronics
- Compete in final test day

What resources did you need?

At an early stage, a budget of £1000 was set. Some of this was provided by UKSEDS/sponsors as part of the competition. Funding was received from the WPO on the basis that outreach activities would be completed after the competition. Some funding from EARS was obtained to be put to use for the competition with an extra amount from the Department of Electrical and Electronic Engineering at Surrey.

The main expense was the servos, which were required to withstand a vibration test. Most component orders were doubled for redundancy in testing. Prototyping, components (such as aluminium material, batteries and raspberry pi processing units) and a PCB (Printed Circuit Board) fabrication.

Facilities included a MakerSpace Facility provided by the electronic engineering department and a materials workshop. Aluminium machining was performed by the university of Surrey workshop at no cost.

Describe the activity (Max 1000 words)

UKSEDS (UK Students for the Exploration and Development of Space) in tandem with various industrial sponsors runs an annual Lunar Rover competition open to university students in the UK. The goal is to design and build a working lunar rover able to complete a set mission. The lunar rover must be designed to fulfil requirements. For 2016, the requirements were listed in Appendix D and included limiting the mass of the rover to 5kg, limiting its size to a 300mmx300mmx300mm box in addition to other communications and mechanical requirements. A particularly important requirement is for the lunar rover to be able to withstand vigorous vibration testing. This vibration testing was to test the lunar rover's ability to withstand the predicted stresses that would occur during a Falcon 9 launch. As such, The Surrey EARS Team took careful consideration in the machining of the structure in aluminium and the selection of the other components to accommodate for this. For 2016 the mission was:

To navigate into the bottom of a lunar crater, retrieve a soil sample, and return to the edge of the crater area. This consists of three components:

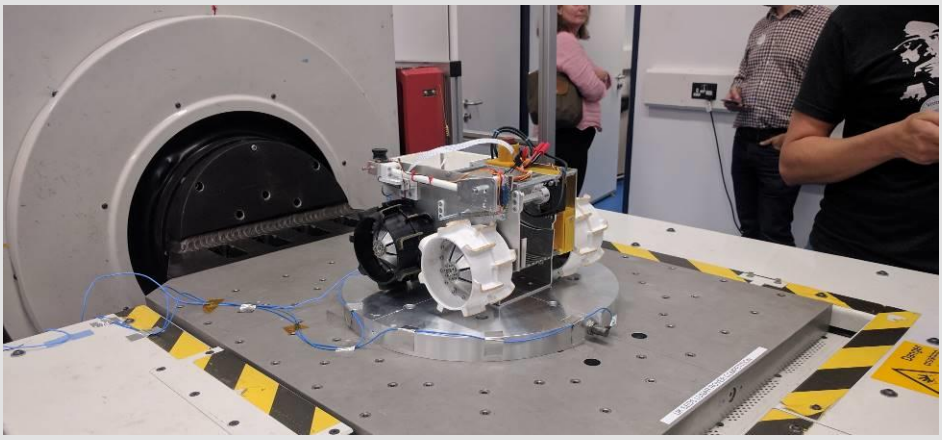
1. Entering the crater: The rover will need to move from the lip of the crater, down the slope to a designated point.

2. Retrieving a soil sample: A soil sample must be retrieved from the designated sample site within the crater.

3. Returning to the lander: The rover must then return itself with the soil sample to the starting point. The mission is complete when the rover returns to this point.

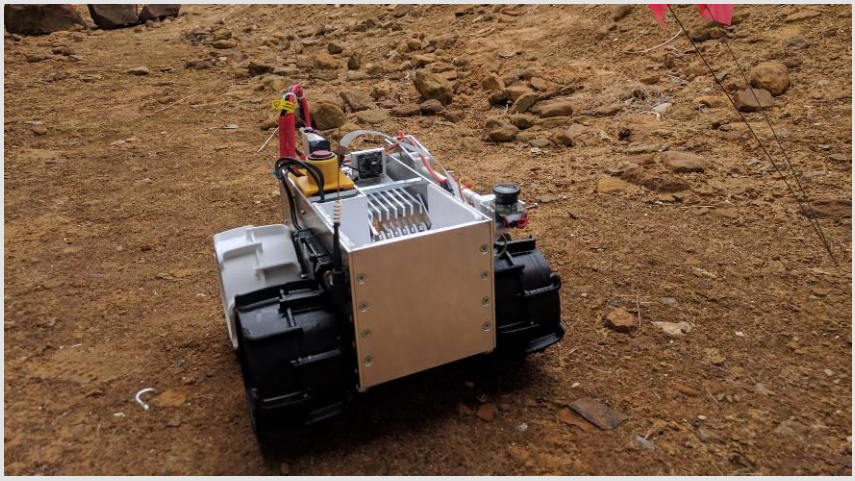
The teams must follow the guidelines and schedule for the year laid out in the requirements document which gives dates of submission of the PDR and CDR and lays out a path of action which leads from initial designs to iterations and integration to finally competition day.

The SurreyEARS team met once a week after establishing the team and also on an ad-hoc basis when more work needed to be done. They followed the guide of submitting an entry form and completing a PDR by December following this template and using the guidance and feedback to allow iteration of the designs to get lead into the CDR and allow integration of the designs together by April. The CDR followed an example given by an MIT rocket team report.



The Surrey EARS lunar rover being vibration tested

Surrey EARS passed the PDR and CDR stages allowing progression to the competition stage. This consisted of 3 scored stages: an initial attempt at completing the mission, a vibration test and a second attempt at completing the mission. The scoring system is explained in section C.7 of the requirements document. The team performed well and won the competition.



The Surrey EARS lunar rover being tested at the RALSpace Mars Yard

Key Learning Points

UKSEDS estimated a budget per team of £500. Surrey EARS felt that this needed to be increased to ensure high quality materials and components for temperature and vibration testing. The facilities used are important and having access to aluminium machining and materials workshops is critical. A suggestion by the team is that perhaps vibration testing by simulation would be more practical and allowed teams to develop their rovers out of more affordable materials such as 3D printing. Another point to consider for the future would be to find ways to keep students interested in the project throughout the year as students tend to become busy with other activities and work as well as lose interest after not keeping up with the project.

The project is mainly suited to 1st and 2nd year students due to the amount of time and effort needed for a project of this year long scale and members in later years would need to prioritise studying rather than extra-curricular activities. However, the experience and knowledge students in later years can supply to the project is very important and if UKSEDS can find a way to entice these students to take part in the project, everyone can benefit.

Thematic Categories

Method		Topic	
Online Text and Notes	☐	Orbits and Trajectories	☐
Assessment Materials	☐	Rocket Propulsion	☐
Video and Audio Lectures	☐	AOCS/ADCS	☐
Lecture Slides	☐	Payloads	☐
Curricula	☐	Power	x☐
Video and Audio Clips	☐	Communications	x☐
Recommended textbooks	☐	On Board Data Handling	☐
Useful software	☐	Systems	x☐
Worksheets and Projects	☐	Mechanical	x☐
Simulations	☐	Thermal	x☐
Tutors' Guides	☐	Astronomy	☐
	☐	Earth Observation	☐
	☐	History of Spaceflight	☐
	☐	Other	x☐

Contact Details

Name of Organisation	Surrey EARS
Contact Name	Alex Young
Email Address	ay00102@surrey.ac.uk
Links	https://robotics.ukseds.org/ https://activity.ussu.co.uk/ears

Thanks to the University of Surrey for this case study

The work to prepare the case study for SUN was funded by:

and