



CASE STUDY

Title

Drop your Thesis (Land 3U) – Cranfield University

Summary

Cranfield University have supported a successful application to the European Space Agency (ESA) Drop your Thesis competition. The Land 3U microgravity experiment sought to quantify the energy dissipation during touchdown on low-gravity bodies such as asteroids to explain the apparent disagreement between low energy dissipation measured during touchdowns on Philae (ESA) and Hayabusa (JAXA) and the very high energy dissipation measured by previous experiments in microgravity. The project commenced in September 2017 and will conclude in February/March 2019. The overall cost of the project (including €5000 funding received from ESA) was ~£9000.



Aims/Objectives

The Drop your Thesis competition gives University students from bachelor to PhD level the opportunity to perform scientific or technological research in microgravity conditions. Students are responsible for selecting and proposing the experiment objectives, designing the payload, integrating the components, testing, submission of ESA-standard documentation, conducting the experiment and then analysing and presenting the data. Research results can be published in papers and journals and also presented at international conferences.

What was the context / background?

The Drop your Thesis competition has been running since 2007. Selected groups of students have the opportunity to conduct their final experiment in the 146m ZARM Drop Tower in Bremen where gravity levels of $10^{-6}g$ can be achieved. Two different modes exist for the experiment, the drop mode (4.74 seconds of microgravity) and the catapult mode (9 seconds of microgravity).

How was it organised and who was involved?

This was a PhD student and academic supervisor-led curricular activity. The students group was made up of 5 MSc students from Cranfield University's 'Astronautics and Space Engineering' course and 1 PhD student. The team was supported by an academic supervisor. The project commenced in September 2017 and will conclude in February/March 2019. The process we went through to organise this was:

- PhD student proposed the project idea to the academic supervisor.
- Both academic supervisor and PhD supervisor advertised the opportunity to the MSc students.
- Interested students joined the team and helped to put together the Experiment Proposal. This was submitted to ESA in October/November.

- The team found out that they had been selected as one of the competition winners just before Christmas.
- Submission of Experiment Report versions 1-3 between March and the end of August.
- Submission of MSc thesis end of August.
- Experiment conducted in October/November.
- Feedback report submitted to ESA's Education Office within 2 weeks of experiment.
- Analysis of results added to Experiment Report and resubmitted by February/March of the following year.



Figure 1. The Land 3U team [Image credit: ESA]

What resources did you need?

Financial

- €5000 was provided by ESA once the team was selected, this was put towards travel and accommodation to the European Space and Education Centre (ESEC) in Redu, Belgium for the training as well as travel and accommodation for conducting the experiment itself. This funding can also be allocated to procuring items for the experiment, however, it was found that additional funds were necessary.
- £2000 worth of funding was acquired from the Cranfield Engineering Department.
- The students secured a £2000 sponsorship from Company X.

Facilities and Equipment

- Workshop facilities were required for building the payload to be placed in the drop tower.
- Procured items for building the payload were acquired from a variety of sources. These items were project-specific, so are not listed in detail here.

Academic support

- The levels of supervision required for the MSc students was nearer to those of a PhD.
- Recruiting MSc students to join the team early in the academic year was intensive. This work was divided between the PhD student and the academic supervisor.

Describe the activity (Max 1000 words)

The Land 3U team's experiment focused on Unpowered CubeSat Landing for Asteroids. The ZARM Drop tower was ideally suited to simulate this microgravity environment, encountered by small asteroids approximately 100m diameter. The 1U CubeSat mock-up structure mimicked a 3U landing (~3 kg) with a velocity of 100 to 200 mm/s. The velocities before and after the touchdown were recorded enabling calculation of the ratio of linear momentum loss (the coefficient of restitution, " ϵ "). These calculated values allowed the energy dissipation to be quantified.

The Drop your Thesis programme breaks down into 5 stages:

1. Project Definition and Writing of Proposal by Applicant
2. Review of the Experimental Proposal and Selection of the Winning Team
3. Experiment Preparation
4. Experiment Preparation
5. Analysis of Results

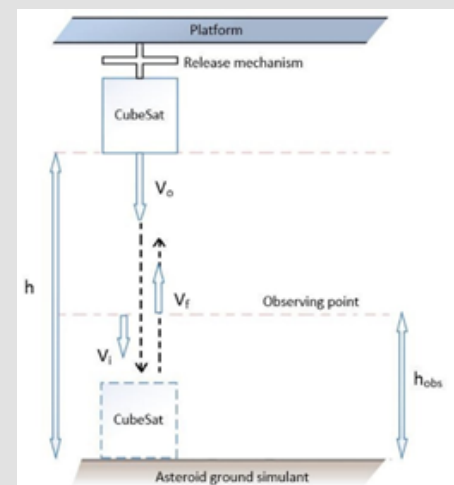


Figure 2. a) Land 3U team at ESEC [Image credit: ESA]. b) Experiment outline [Image credit: Land 3U].

1. Project Definition and Writing of Proposal by Applicant

- Applicants must identify the members of their team and find an endorsing professor/academic supervisor.
- Students expected to have an accurate plan of the intended method and set-up of their experiment as well as a sound understanding of the scientific theory underlying it, both quantitatively and qualitatively.
- Students must think carefully about which drop tower mode to choose (reading the [ZARM Drop Tower User Manual](#) is mandatory).
- Proposal focus should be on scientific/technological objectives of the project and the technical detail of the implementation of the experiment.
- Documents expected: Experiment proposal (found [here](#))
- Deadline: Autumn/Winter
- Feedback: The deadline for this document was very early in the term, therefore it was very important to assemble a team quickly and hit the ground running. The PhD student and academic supervisor were the primary drivers in kicking off the project. The project was then advertised to the MSc students who could apply internally to be on the team.

2. Review of the Experimental Proposal and Selection of the Winning Team

- Proposals evaluated by review board made up of experts from European Low Gravity Research Association (ELGRA), ZARM, ESA's Human Spaceflight and Operations Directorate and ESA's Education Office.
- Feedback: In our case, we were announced as one of the winners just before Christmas.

3. Experiment Preparation

- Selected teams will begin to build their experiment assisted by qualified professionals and their ELGRA mentor.
- Students will have to fill in some parts of the Experiment Report
 - This document serves as a reference document throughout the preparation and the execution of the experiment, as well as the final report once the programme ends.
- In some cases, it is possible for the teams to use special equipment (e.g. CCD cameras, heating/cooling devices) available from the drop tower operator. These are assessed on a case-by-case basis and may carry associated costs for the team.
- Documents expected: Experiment Report (found [here](#))
- Deadline: 3 versions must be delivered to ESA's Education Office and ZARM engineers before the campaign.
- Feedback: Students had the opportunity to attend a training course at the European Space and Education Centre (ESEC) in Redu, Belgium in late January. The first of the 3 versions of the Experiment Report was submitted in the Spring which coincided with group projects and exam preparation for the MSc students, however, most of the experiment preparation was to be submitted in August. This fitted well with the timeline of Cranfield's Masters thesis submission, which was due in August. Thus, the 5 MSc students were able to write their theses on the preparation of the experiment.

4. Education Drop Tower Campaign

- 2-week long campaign in October-November in Bremen, Germany.
- First week is dedicated to integration and ground testing of the equipment.
- Second week – team allocated 5 launch opportunities for the experiment.
- Feedback report must be submitted a few weeks after the experiment.
- Documents expected: Feedback report (provided by ESA's Education Office following the experiment).
- Deadline: November/December
- Feedback: The Drop your Thesis programme is designed for European Masters programmes that last 2 years, thus, in the case of Cranfield the MSc students conducting the experiment in October/November will have already graduated. This means that analysis of the experiment results will not be included in their thesis. For the PhD student, the timescales fit – the results will be included in the thesis.

5. Analysis of Results

- Students must analyse the results obtained during their campaign, providing the final version of the Experiment Report within 4 months of performing their experiment.
- Later, students will write a scientific paper, co-authored by the ELGRA mentor.
- Some students may be sponsored to attend international conferences to present their findings to the scientific community.
- Documents expected: Final version of the Experiment Report.
- Deadline: February/March (4 months after the campaign).
- Feedback: See comments on previous programme phase.

More detail on the programme phases of Drop your Thesis can be found [here](#).

Key Learning Points

There were some significant lessons learned:

- Ensure that students are fully aware of the commitment before signing them up – despite the programme tying into their thesis submission, there are several parts which need to be submitted before starting their thesis which might coincide with other deadlines. Make sure that the students are aware of this.
- Having a PhD student in the team was found to be very useful, particularly at the beginning during team recruitment.
- Due to student team recruitment occurring right at the beginning of the academic year, there may be a mix of ability in the team, allow for this.
- Consider leniency with the students involved in terms of deadlines on other courses to ensure that the extra-curricular demands of the programme are not hindering their progress in other topics.

Thematic Categories (tick any that apply to your case study)

Method		Topic	
Online Text and Notes	<input type="checkbox"/>	Orbits and Trajectories	<input type="checkbox"/>
Assessment Materials	<input type="checkbox"/>	Rocket Propulsion	<input type="checkbox"/>
Video and Audio Lectures	<input type="checkbox"/>	AOCS/ADCS	<input type="checkbox"/>
Lecture Slides	<input type="checkbox"/>	Payloads	<input checked="" type="checkbox"/>
Curricula	<input checked="" type="checkbox"/>	Power	<input type="checkbox"/>
Video and Audio Clips	<input type="checkbox"/>	Communications	<input type="checkbox"/>
Recommended textbooks	<input type="checkbox"/>	On Board Data Handling	<input type="checkbox"/>
Useful software	<input type="checkbox"/>	Systems	<input type="checkbox"/>
Worksheets and Projects	<input type="checkbox"/>	Mechanical	<input type="checkbox"/>
Simulations	<input type="checkbox"/>	Thermal	<input type="checkbox"/>

Tutors' Guides	<input type="checkbox"/>	Astronomy	<input type="checkbox"/>
	<input type="checkbox"/>	Earth Observation	<input type="checkbox"/>
	<input type="checkbox"/>	History of Spaceflight	<input type="checkbox"/>
	<input type="checkbox"/>	Other	<input checked="" type="checkbox"/>

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Links	http://www.land3u.com/home.html https://www.esa.int/Education/Drop_Your_Thesis/Meet_the_teams_Land3U http://www.esa.int/Education/Drop_Your_Thesis/About_Drop_Your_Thesis http://www.esa.int/Education/Drop_Your_Thesis/List_of_documents

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