THE FIRST EUROPEAN CANSAT COMPETITION FOR HIGH SCHOOL STUDENTS

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ABSTRACT

This paper is about the first European CanSat Competition for high school students. The competition, which were organised by the European Space Agency (ESA) in collaboration with the Norwegian Centre for Space Education (NAROM) and the Norwegian Space Centre (NSC), took place on August 15th to 19th, 2010. Ten teams consisting of high school students (aged 16+) from ESA Member States were selected to have their CanSat launched from Andøya Rocket Range (ARR). The European CanSat Competition is part of ESA's initiative to inspire young people to follow a career in science or engineering, with a view to ensuring the availability of a highly qualified workforce for the space industry of the future. The Competition offered a unique experience by enabling students to carry out a full space project lifecycle, as well as encouraging interaction between teams from many different countries.

1. BACKGROUND

The CanSat concept was first introduced in the late 1990s by the American professor Robert Twiggs. It provides an affordable way to introduce students to the many challenges in building a satellite. Students design and build a small electronic payload that can fit inside a soda can. The CanSat is launched and ejected from a rocket or a balloon. By the use of a parachute, the CanSat slowly descends back to earth performing its mission while transmitting telemetry. In recent years, CanSat activity in Europe has been growing. These contests have proven to be an effective, practical and low-cost way to inspire students. In 2010 there were four national competitions in Europe: in The Netherlands, Spain, France and Norway. ESA hopes to encourage many more such activities on a national and regional level. Further information about these competitions can be found by visiting www.cansat.eu.

The initiative for a European CanSat Competition was taken by ESA by following a workshop for all countries, which currently had some kind of CanSat activity in progress. The main goal for the workshop was to foster more collaboration for CanSat activities in Europe, and to brainstorm joint actions that could be supported by ESA's Education Office.

The Norwegian Centre for Space-related Education (NAROM) sent a proposal for hosting a European CanSat competition based on their experience from the Norwegian competition in 2009 [1],[2]. ESA selected Norway's proposal for the first European CanSat Competition, and a call for proposals to schools was posted on the ESA web site at the beginning of January 2010. From a total of 33 proposals, 11 proposals from 11 countries were selected to attend an introductory teacher's workshop at the European Space Research and technology centre (ESTEC).

2. TEACHER WORKSHOP

An introductory workshop for the teachers was held on 12-13 February at ESTEC, the ESA's technical centre in the Netherlands. With the assistance of experts from NAROM, the teachers learned all the basic steps to build a CanSat and how to accomplish the primary mission objectives. A teacher guided by NAROM staff is shown in Fig 1.

Figure 1. Teacher guided by NAROM staff at teacher workshop

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ESA provided all the teachers with a free CanSat starter kit, as shown in Fig. 2, to kick-start the work at the schools.

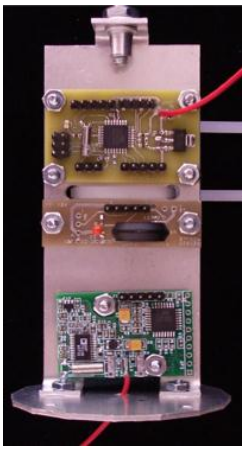

Figure 2. CanSat kit from Pratt Hobbies

The CanSat starter kit can be ordered from the Pratt Hobbies website and comes with three prefabricated printed circuit boards; a processor board, a sensor board and a transmitter board. The sensor board has two analogues sensors, one pressure sensor and one temperature sensor. The primary mission in the competition was to use data from these sensors to calculate the altitude of the CanSat. The kit also contained an aluminium mounting plate and a parachute.

The kit provides a platform for the pupils to start building from. It is fairly easy to add components to this kit and also to program the processor board to handle data from them. Furthermore the transmission frequency can be adjusted in the program, enabling telemetry from several CanSats simultaneously.

NAROM instructors gave the teachers an introduction to the kit and, made sure all teachers got their kit up and running. NAROM also handed out documentation in the form of a CanSat book, explaining some of the basics principals in CanSat design.

In addition, the teachers had the opportunity to tour part of the site, including the satellite testing facilities and the Space Expo.

3. WORK AT SCHOOLS

The teachers took their CanSat starter kit and documentation back to their school and got their students started on the CanSat mission. During the preparations at the schools, the teachers had the opportunity to contact experts from NAROM through ESA for help and feedback.

ESA also set up an online forum, where participants and coordinators at ESA and NAROM could post questions, answers and information. This was a very helpful tool that eased the workload on the competition staff, as the participants often found the solution to their question by reading other posts. In many cases questions were answered by the participants themselves, without any involvement from CanSat staff.

A website, www.cansat.eu was designed by ESA to post information about the programme, such as competition rules and a calendar with important events and milestones. The website also includes information about all ten teams and links to the national competitions in Europe. This site is intended to evolve so that it serves as a central point of reference for information on all CanSat activities and competitions taking place in European countries.

Many of the teams also created their own websites and blogs to post information about their projects. Social media tools, such as Facebook.com were also used as a form of outreach and for communication among the participants. Several videos were posted on YouTube by the teams themselves, showing pre-flight tests and other events from the work at the schools.

4. THE COMPETITION

The actual CanSat competition was held on 16th to 19th of August at Andøya Rocket Range (ARR) as shown in Fig. 3.

Figure 3. Andøya Rocket Range

ARR located 2 degrees north of the Arctic Circle on the Norwegian island of Andøya, is a premier launch facility for sounding rockets and balloons. The competition was arranged in collaboration between ESA, NAROM and the Norwegian Space Centre.

The European CanSat competition started with an Opening Ceremony featuring addresses from the Director of NAROM, Managing Director of ARR and the Head of ESA's International Relations Department as seen in Fig. 4.

Figure 4. Opening ceremony

On the first day of the competition each team had the opportunity to convince the jury that their CanSat was the best trough a 10-minute presentation explaining their CanSat mission and objective. Fig 5. shows the Italian Tassoni team doing their presentation.

Figure 5. The Italian team presenting the Tassoni mission

The jury consisted of representatives from ESA, NAROM, the Norwegian Space Centre and the International Astronautical Federation.

The rest of the day was used to carry out the final preparation and technical inspection of the CanSats as shown in Fig. 6.

Figure 6. Final preparation of the CanSats

All CanSats had to go through a technical inspection to obtain a launch permit from NAROM staff. Some teams stayed up all night to finalise their CanSat for launch the next day.

The second day started with a pre-flight meeting where all teams and involved range personnel gave a short status report. After the pre-flight meeting everyone was transported to Skarsteinsdalen, a former military camp where the CanSats were to be launched with a rocket to an altitude of about 1 km.

As a launch vehicle for the CanSats a commercially available amateur rocket kit, called *The Intruder*, is used. This kit was ordered from Rebel Space, a specialized dealership in the Netherlands. The rocket diameter provides just enough inside space to fit a CanSat. However the rocket was lengthened to accommodate two of them. The layout of the modified rocket can be seen in Fig. 7.

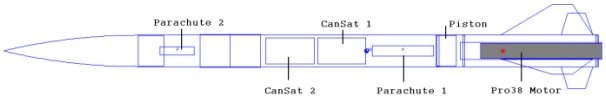

Figure 7. The layout of the Intruder Rocket used to launch two CanSats to an altitude of 1 kilometre

The CanSats are ejected by a basic method, widely used in model rocketry. An ejection charge of black powder in the top end of the motor is set to go off 13 seconds after ignition. The charge produces pressure, pushing a piston forward freeing the CanSats from the rocket as the nose cone pops of. The rockets are powered using the Pro 38 4 grain motors from Cesaroni. Pro 38 motors are sold as reloadable kits, and the rockets can easily be reloaded after each flight. The rocket is safe to handle before the motor is installed, allowing the students to put their own CanSat in

the rocket. Professionals handle the explosives, and install the rocket on the launch pad.

Normally only one recovery parachute is used in this rocket, which is attached to both the aft of the rocket and the nosecone. However, because the CanSats precisely fit in the tube, the connection line could have endangered the deployment. The choice was therefore made to equip the nosecone with a separate parachute, eliminating the need for the connection line. The rockets are sold as kits with the CanSat modifications ready for assembly. Table 1 provides more information on the basic dimensions and performance of the rocket.

Weight:	3 kg
Length:	1.5 m
Fin Span:	232 mm
Body Diameter:	79.4 mm
Propellant weight:	280 grams
Maximum acceleration:	Vertical (y): 107 m/s2 Horizontal (x): 0.7 m/s2
Maximum velocity:	Vertical (y): 544 km/h, Horizontal (x): 13 km/h,
Maximum altitude:	940 m

Table 1. The dimensions and performance of the Intruder Rocket based on simulation.

Two CanSats were prepared and placed in each rocket as shown in Fig 8.

Figure 8. A CanSat being placed inside the Intruder Rocket

Range personnel released a meteorological balloon to measure the wind speed up to 1 km. These wind data were used to set the final launcher settings before the first rocket launch. The countdown procedure started at T-20 minutes as soon as the first rocket containing the Norwegian and Swedish teams was inserted. One of the launches is shown in Fig. 9.

Figure 9: A launch of the Intruder rocket with CanSat inside

A total of five rockets wit 10 CanSats were launched. The CanSats, the rocket body and the nose cone came down on separate parachutes each time. On the ground students were prepared with their ground station, consisting of a computer, a radio receiver and a Yagi antenna. The students downloaded telemetry data in real-time from the descending CanSats, as seen in Fig. 10.

Figure 10. The Greek team receiving telemetry from their CanSat

A light breeze on launch the launch day made some of the CanSats drift up to 1 km from the launch site. Fortunately eight of the ten CanSats were found by NAROM staff and handed back to the teams. The rest of the day, was used by the teams to prepare for the final presentation of their results.

Before the final presentation a post-flight meeting was held. All stations gave a briefing on how the launch of the CanSats went. Overall the launch operation went very smooth and was considered a success. After the final

presentations from each of the teams, the students had a guided tour of Andøya Rocket Range.

5. COMPETITION PRIZE CEREMONY

The jury evaluated the teams on the educational value of their project, their technical achievement, team value and outreach. The top three teams were selected and given a gold, a silver and a bronze CanSat trophy. All three teams also received a SkyScout planetarium and a telescope for their schools.

The seven remaining teams were all awarded certificates for the areas where they had shown extraordinary skills or effort. The objective of the gold-winning Team Eclipse from the UK, as shown in Fig. 11, was to produce a wind profile by combined use of GPS, accelerometer and compass data.

Figure 11. The winning team from UK

Sadly the GPS lost its satellite connection when the CanSat was mounted inside the rocket, and did not manage to lock its position before landing. Nevertheless the team solved this problem by deriving a wind profile from the accelerometer and the compass, using advanced data handling.

The silver award winners, team Truailliú from Ireland, used photo transistors and optical fibres to analyse the atmospheric absorption spectrum in order to determine the density of air pollution. Third place went to The Brussels' Vikings from Belgium. The team had a very technically advanced CanSat with several circuit boards of their own design. The small can contained a camera, a 3D magnetometer, a 3D accelerometer and a GPS module.

6. SOCIAL ACTIVITIES

Besides the CanSat competition there was the possibility to carry out some social activities. Andøya Rocket Range lies on a very nice beach, although the sea never gets close to a comfortable temperature for bathing. However once the students heard that they would receive a diploma for taking a swim in the Arctic Ocean, the temperature of the sea did not stop them from taking a swim.

The closure of the competition ended with a social barbeque evening. Some of the students stayed one extra day to go on a whale safari from the town of Andenes.

7. EVALUATION

At the end of the competition the students filled in an evaluation form prepared by NAROM. Based on the evaluation, the students generally were very satisfied with the competition. On the overall evaluation the score was 3.7 on a scale from one to four, with four being the highest score. Comments from the evaluation form shows the students appreciated the CanSat competition;

"It was a once in a lifetime experience. I really enjoyed staying here for the duration of the competition. The landscape is beautiful and the competition in itself was very interesting."

"Everyone worked together; we were like a big team. I'm very happy to be here with all the other teams from all the different countries."

The CanSat project provided students with a wide range of hands-on benefits. They gained a wealth of knowledge and skills throughout the process, which included CanSat design, integration, testing, launch, data analysis and presentation of results. Other practical benefits include knowledge of soldering, programming, technical design, team work and making presentations.

8. LESSONS LEARNED

The first European CanSat Competition has been a success in many ways. All involved parties have gained valuable experience so that the next competition can be even better.

The Pratt Hobbies starter kit worked well for this competition, although delivery time from the US can be quite long. Now that CanSat activity in Europe is expanding, it would be better to have a European supplier. ESA is now working on designing such a kit, which would

make it much easier for the CanSat activities to grow in Europe.

The forum by ESA was a great way for the participants to communicate and solve their own problems. For the next competition the online forum and website should be up and running from the beginning lightening the workload on the organisers.

As for the launch campaign it would be a good idea for all the CanSats to have a sort of GPS tracking system or radio beacon. This way, they would be much easier to locate in a terrain of dense vegetation.

9. The 2nd European CanSat Competition

The CanSat project provided students with a wide range of hands-on benefits. They gained a wealth of knowledge and skills throughout the process, which included CanSat design, integration, testing, launch, data analysis and presentation of results. Other practical benefits include knowledge of soldering, programming, technical design, teamwork and making presentations.

Based on the great output the first European CanSat competition ESA has now called for proposals for a second competition. A maximum of 12 proposals will be picked out early autumn this year. The tutors of the twelve teams will be invited to a teacher workshop at ESTEC early December.

Also for the 2012 competition NAROM will have the honour of hosting the Competition Launch Campaign at Andøya. This time the Launch Campaign will be in the spring time, starting April 23.

10. REFERENCE

1. Vandeberg R. and Wang T., *Norwegian CanSat Competition Pilot* European rocket and Balloon Programmes and Related Research, Bad Reichenhall, Germany, 2009.
2. Nylund A. and Antonsen J., *CanSat –General introduction and educational advantages,* European rocket and Balloon Programmes and Related Research, Visby, Sweden, 2007.