BRUSSELS' VIKINGS PARTICIPATING IN THE FIRST EUROPEAN CANSAT COMPETITION

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ABSTRACT

The demise of ESA's Straplex programme after the 2008 flight campaign in Portugal left secondary schools in Europe without flight opportunities for hands-on space education projects. Some of ESA's member states have national cansat competitions but all too often these are not targeted at secondary schools, limiting their impact on this particular age group.

This is considered extremely unfortunate, because if the decline of students engaging in the STEM faculties (Science, Technology, Engineering and Mathematics) is to be countered, it is at secondary school level that action must be undertaken, shortly before the students make a career choice. For primary school pupils, that choice is still many years away, for university students it has already been made.

1. HANDS-ON PROJECTS

Sint-Pieterscollege in Brussels has been a testbed for hands-on space education since 2004, offering students the opportunity to design and develop a wide variety of experiments ranging from passive biology to intricate dataloggers using different types of sensors. Flight opportunities for these experiments have ranged from sounding and zero-pressure balloons to zero-G planes and on one occasion even a sounding rocket.

While electronics have been at the core of this project christened SP.Ace, care was taken to offer students the opportunity to write papers and give presentations too.

However, no organised programme in Europe exists to encourage schools or students to engage in similar activities. The Straplex programme (a cooperation between ESA and the University of Porto) did for a while, but the programme's demise in 2009 ended what might have become a most innovative and promising programme for secondary schools.

2. FIRST EUROPEAN CANSAT COMPETITION

The organisation by ESA of the first European Cansat Competition is therefore to be lauded as an initiative filling a gap and meeting a definite societal need.

For this first European competition, eleven teams from different ESA member states were selected: Belgium, the Czech Republic, Denmark, Greece, Ireland, Italy, Norway, Portugal, Spain, Sweden and the UK.

3. ORIGINAL CANSAT KIT

The cansat kit that was provided to the participating teams was based on US cansat competitions and was fully capable of executing the primary mission: sending temperature and air pressure data back to the ground.

![Pratt hobbies Cansat Kit](image1)

Figure 1: The Pratt hobbies Cansat kit

However, because of the general way the kit was built up, only limited space was available for the secondary mission, as can be seen from Fig. 1.

4. SECONDARY MISSION

An ambitious ensemble of sensors was proposed for the secondary mission: a 3D accelerometer and a gps module to provide flight path information, a 3D magnetometer to determine an eventual altitude dependence of Earth's magnetic field as well as provide cansat attitude information. Furthermore a small camera was added in an attempt to capture live video during the cansat's ejection from the Intruder Rocket and during parachute descent.
5. CANSAT OVERHAUL

Because of the sheer quantity of electronics required for the secondary mission, it was decided to overhaul the cansat completely, eliminating both the basic structural elements of the cansat kit and its general buildup, keeping only the electronic components themselves but rearranging them in a far more efficient configuration in order to make the maximum of the limited space available. Hence emerged the 'stacked platform' configuration shown in Fig. 2.

Even so, new steps had to be taken to advance the students' knowhow in pcb-design, introducing double-sided boards. As our pcb's were hand-drilled, misalignment issues had to be overcome. First integration tests showed the stacked platforms to exceed the maximum allowable height by more than a centimeter. Therefore, a slit of free space was designed into one of the boards (see Fig. 3a, 3b and 3c) in order to allow the vertical breakout-board of the magnetometer to physically stick through the accelerometer board, again saving about 10% - that is 1cm - in the vertical direction.
6. TESTING

All electronics, hard- and software, were extensively tested: on the breadboard for proper functioning, then again on the flight hardware itself.

Mechanical integration tests had to be repeated several times because problems kept popping up: either the stack exceeded the maximum allowable height, or the mass penalty from using metal spacers was prohibitive, or certain pcb’s were designed so closely to specifications that they couldn't accomodate plastic spacers (that turned out to be just slightly wider than their metal counterparts).

Figure 4a&b: Mechanical integration and parachute testing. A cansat dummy was used for the latter.

Parachute tests went smoothly but were hampered by a lack of access to a sufficient height to test parachute deployment and perform terminal velocity tests under realistic conditions. This is certainly an area where significant improvements can and should be realized if a new cansat is ever developed.

Figure 5 Metal spacers were initially preferred for sturdiness, but partly replaced with plastic to save mass.

7. RESULTS

The 3D-accelerometer provided valuable and verifiable data even before the launch (Fig. 6). A first spike minutes after our cansat was inserted into the rocket’s payload bay indicated the insertion of the second cansat. Unfortunately, this caused our gps module to lose satellite lock-on (which should be taken into account by future cansat competition organisers).

Once the rocket was on the launch pad, the signals amplitude according to both pseudo-horizontal axes gave information on the rocket's tilt.

Another spike in the data indicates lift-off and powered ascent, followed by a brief period of free-fall, and parachute descent. Finally, there's another period of data after landing.

Figure 6: accelerometer data indicating the insertion of the second cansat (shortly after 100s), launch (shortly before 600s) followed by freefall and a very bumpy parachute descent phase.

The magnetometer provided useful information on cansat's attitude, yielding data that allowed to determine the period of the visually observed swinging of the cansat during parachute descent. Moreover, the instrument also recorded a shorter period 'wobbling' type of oscillation (Fig. 7 and 8).

Figure 7: The vertical axis of the 3D magnetometer confirmed the visually observed 'swinging' of the Cansat as it descended under its parachute (3s period), but also showed an additional 'wobbling' with a far shorter period (0,2s). These conclusions were supported by the data from the other axes).
Figure 8: Zooming in on the z-axis data shows the amplitude of the signal generated by the wobbling decreasing. This decline is ascribed to a hysteresis effect.

8. COMPETITION OUTCOME

While being competitive, it struck jury members and participants alike that teams were helping each other out, and that the loss of a cansat by one team was perceived as a loss by all. If space truly has the capacity to bring out the best in each of us, it worked its magic even at this minute scale.

The competition was about science, technology, guts and competence, and the UK's team 'Eclipse' certainly excelled in each of these. Coming in third was therefore not a deception but a vindication (each of the teams had been giving all they had). Of course, had we not helped out with a high performance battery, the British students wouldn't have gotten the results they did, which actually made us feel good, and certainly increased the odds of both our schools cooperating on other projects [1].

9. LESSONS LEARNT

The students from our team had clearly underestimated both the amount of preparatory work required and the amount of paperwork necessary to keep ESA informed on our progress.

While developing desktop models of the dataloggers we needed for our secondary mission was relatively straightforward, construction of the actual flight hardware and especially the full systems tests proved time-consuming. Moreover, the implementation of changes was often difficult. Designs need to take into account the possible need for changes and late access to every subsystem. Building in leds or other ways of making sure subsystems are operating correctly after power-up may help build confidence. Above all, project planning needs more attention, especially as far as testing is concerned.

10. CONCLUSIONS

Participating in a Cansat competition is a rewarding hands-on space education project that cover all topics of a space/science/technology project.

It is a challenging opportunity for youngsters and gives them a goal on which to focus their energies and abilities in an international project where they can measure their strengths against equally motivated teams from elsewhere in Europe. Both from an educational and from a European perspective, it is a very worthwhile project even if overdue.

It is to be hoped that many more Cansat competitions will follow, and even that the scope and range of hands-on projects for secondary schools will grow in the coming years.

REFERENCES