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Lessons Learned from the First Swiss Pico-Satellite: SwissCube
Project Organization

- 3 years project (from phase A to D)

Diagram showing a timeline from 2006 to 2009 with phases A to E and associated activities like feasibility study, design trade-offs, preliminary design and specifications, design refinement, component tests, breadboards, system and subsystem level specifications, detailed definition, EM tests, interface specifications, EQM and Flight production, integration, and system tests, and launch and ops.
Project Organization

- More than 15 laboratories in Switzerland participated (about 150 students)
Mission Description

• Orbit
  – 720 km
  – Sunsynchronous
  – 98° inclination
  – Mean eclipse time: 35 minutes
  – Mean orbital period: 99 minutes

• Launch
  – Indian C-14 PSLV rocket
  – Planned for next month
  – Satellite will be released from a SPL (Single Pod Deployer)

• Cost
  – 400k€

• Mission objectives
  1) Education: system engineering, group work, communication skills
  2) Science: characterize variability of Airglow phenomena in intensity and altitude
  3) Technology: test optical and detector design for the development of a low-cost Earth sensor
Satellite Overview

- **Satellite size**
  - Single unit cubesat
- **Mean Power**
  - 1.5 Watt
- **Mass**
  - 823.4 grams

- **Critical functions**
  - Electrical power system
  - Antenna deployment
  - RF Beacon signal emission

- **Non critical functions**
  - Science payload operation
  - Advanced housekeeping data transmission
Science Objectives and Payload

- Characterize the airglow emission in the upper atmosphere (100 km)
  - Demonstrate the feasibility of using airglow as a basis for a low-cost Earth Sensor
  - Validate the established airglow model or bring additional information

NASA photo taken from the shuttle by the Swiss astronaut C. Nicollier

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Project Organization => Lessons learned...

• Test model philosophy (IM, STM, EQM, FM, FS)
  – The one most appropriate for the organization specific to the SwissCube project.

• A student project = no more than a few months of work...
  – Student come and then leave => creation of a system engineering team to keep the information in the project.

• Communication
  – The system engineering team interfaced with the laboratories on a weekly basis.

• Decision Power
  – The decision power resided in the systems engineering team who had all the elements in hand.

• End-of-phase reviews
  – Extremely valuable advices from the reviewers.
  – Forced the team to converge on design solutions and take system level decisions.

• Fabrication and test planning
  – The planning for fabrication and test should not be overlooked. Tests preparation also demands a significant amount of time.
  – Preparing good test procedures saved time during tests.
Electronics => Lessons learned...

• Mounting process
  – It is imperative to perform a scrupulous visual inspection after the soldering process to avoid bad solder joints and solder bridges.
  – When using conformal coating on RF components it is important to be very careful with the oscillators.

• Integration procedure
  – Think as early as possible on how subsystems and the entire system are going to be integrated.
  – Do not only think how it is going to be assembled but also how it is going to be disassembled in case of problems.
Satellite communication system => Lessons learned...

- **Thermal aspects**
  - Make a robust design so that the downlink frequency is not too influenced by the board’s temperature.
  - Use high efficiency power amplifiers, in order to decrease the power consumption and the components heating.
  - SwissCube COM board need a dedicated thermal sink path on the back side to cool down the PA.
Environmental tests => Lessons learned...

• TVC test
  – Good to learn how to operate the satellite.
  – More attention should be brought to the test equipment early in the project.
  – Staffing for the TVC test quickly became an issue. We do recommend as much as possible to keep the involvement of the key people during the stressful test campaigns.
Ground and Flight software => Lessons learned...

- Implement and test communication bus early in the project. The choice of the communication bus has enormous implications on the choice of the microcontrollers and to the flight software’s system architecture.
- **Use the same software for tests and operations.**
- **Keep in mind that all functionalities of the spacecraft need to be tested remotely and that the results should be easily seen.**
- Implement remote software update capability. Being able to update the flight software during tests without needing physical access to the spacecraft is a real need.
- Build modular ground segment software.
SwissCube Structure => Lessons learned...

- "Monoblock" approach
  - Gives the best relationship between mass and rigidity,
  - but involves a completely different way of ordering spacecraft subsystems.

- Mechanical assembly procedure
  - The assembly procedure of the satellite must be planned as earlier as possible in the mechanical design.
  - The assembly procedure must also consider the cabling aspects.
Conclusion

• This project has been an excellent educational support that promoted
  – technical skills,
  – team building,
  – initiatives,
  – responsibility

• The satellite is now ready for launch
  – Last week we were in India for the last functional tests.
  – SwissCube will be mounted on the PSLV upper stage in a few weeks
  – Launch is planned for mid-September...
Thank you for your attention...