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# DEVELOPMENT OF A CUBESAT PICO-SATELLITE

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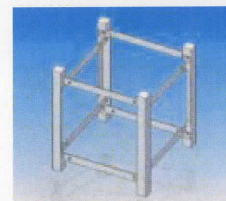
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Department of Physics

## Introduction:

The CubeSat Project was developed by California Polytechnic State University (CalPoly) and Stanford University in order to provide launch opportunities to universities previously unable to afford access to space. Today, it provides low-cost launch opportunities to students, government, and businesses. The CubeSat program is able to provide these low-cost launch opportunities by defining a common form factor and design guidelines. All satellites conforming to the regulations are able to be deployed from a standard, flight-proven deployment system called a PPOD. By adhering to the prescribed form factor and safety requirements, necessary documents and export licenses are more easily obtained. CalPoly coordinates launch opportunities and facilitates the export and licensing of completed satellites.



Picture of the PPOD deployment device, courtesy of [www.cubesat.org](http://www.cubesat.org).



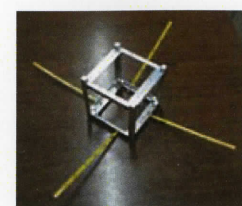
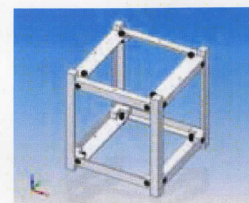
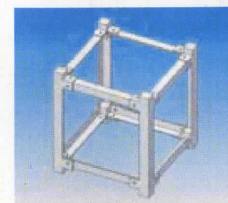
## Project Goals:

- Create a platform for future scientific missions.
  - Develop a general, adaptable satellite bus.
  - Perform a scientific experiment on orbit.
- Establish radio communication and transmit data.
- Monitor component temperature to establish a basis for future component selection.
- Minimize costs involved in satellite production.
- Provide team members with experience and learning opportunities.



## Design Specifications:

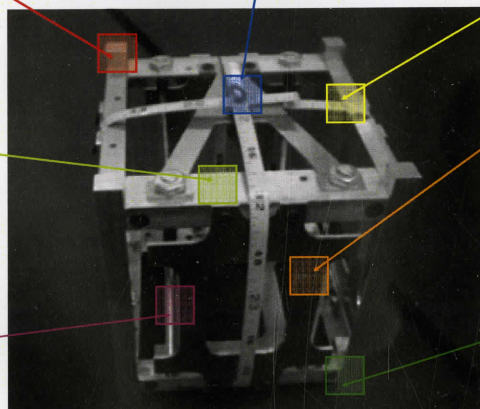
- Satellite must have a mass of less than 1 kg.
- Cube shall have a nominal side length of 100 mm.
- Center of mass must be within 2 cm of geometric center.
- Must fit within PPOD deployment device.
  - 75% of rail surface must maintain contact with PPOD guides.
  - Non-rail side areas may protrude from cube by only 6.5mm.
- No electronics may be active until after deployment from PPOD.
- Items may not be deployed from the spacecraft for 15 minutes after leaving the PPOD.



## Results:

This project was broken up into several subsystems in order to facilitate design. They are: Structural, Deployment, Power, Communications, and Software.

Students in charge of the Structural and Deployment subsystems were faced with the task of designing and producing a satellite bus that would maximize the internal volume of the craft, but still provide adequate space on the exterior of the cube to place solar arrays and provide for the deployment of antennas. The structure must also be strong and rigid to withstand launch loads and the associated vibrations.



**Rail**

- Cross members fit externally
- Wiring through posts

**Deployment**

- Glow plug/fishing wire for reliable release
- Coated antenna holes prevent shearing
- Deployment detection available

**Antenna**

- Common material: tape measure
- Slight curve aids deployment

**Cross member**

- Antenna guides stabilize antennas and protect solar cells
- Mounting points

**Solar Panel Mounting**

- Minimize mass, maximize stiffness
- Holds three cells per face

**Board Columns**

- Threaded
- Add strength
- Simple

**Separation**

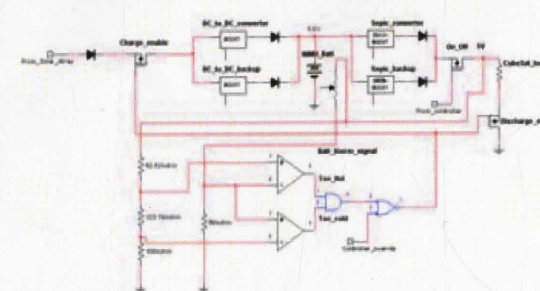
- Spring plungers
- Switches

A photograph of the CubeSat with stowed antennas. Overlays highlight innovative designs implemented on the satellite.

Students working on the electrical subsystems maintained a power budget for all the components in the satellite. A charging circuit and solar array configuration were designed to provide adequate power to necessary subsystems. A microprocessor was programmed to automate the control of the satellite. Communications systems were designed to make the satellite trackable by the Amateur Radio community. Students obtained HAM radio operating licenses and familiarized themselves with a groundstation located at the Space Dynamic Laboratory in Logan, UT.

Components	I(min)	I(max)	Duty Cycle	I(avg)	Power (@5 V)
Modem/Radio	50 mA	400 mA	6% (max) 94% (min)	71 mA	355 mW
Housekeeping	1 $\mu$ A	50 mA	6% (max) 94% (min)	3 mA	15 mW
C&DH	150 $\mu$ A	150 mA	100% at max (worst case)	150 mA	750 mW
Payload	1 $\mu$ A	250 mA	6% (max) 94% (min)	15 mA	70 mW
<b>TOTAL:</b>	<b>~51 mA</b>	<b>850 mA</b>		<b>239 mA</b>	<b>1.2 W</b>

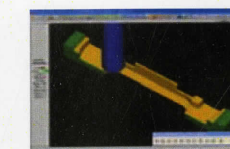
CubeSat power budget and charging circuit.



## Methodology:

In order to give team members a greater variety of career-related experiences and reduce production costs, members use the "do-it-yourself" approach to CubeSat building. A large part of the learning process is accomplished by actually designing and assembling the parts used on the satellite. Most major design improvements stem from experiences team members have acquired from experimentation and testing.

Team members get hands-on experience in the complete development process: Design, production, assembly, and testing.



Get Away Special Team members designing, producing, and assembling the Structural CubeSat subsystem.

## Conclusion:

It has been determined that the production of a small satellite able to carry out scientific experiments on orbit at a low cost is feasible. By designing and testing their own components and systems, students are able to not only gain valuable experience in their career fields, but produce CubeSats for dramatically less than traditional pico-satellites.

## Further Work:

To this point, the team has made promising progress in creating a general, low-cost CubeSat bus. The next step will be integrating a scientific payload with the bus. One potential project is making electric field measurements of the earth by deploying several long (more than two meter) booms.



Members of the Utah State University Get Away Special Team.

## Acknowledgements:

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California Polytechnic State University

