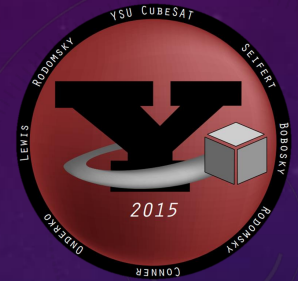# Using 3D Printing to Integrate Thermal Management into High – Altitude Flight Vehicle Structure

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Abstract

The CubeSat, a small and cost-effective satellite alternative for aerospace education and innovative prototyping, was developed by California Polytechnic University and Stanford University in 1999. This project aimed to fabricate a CubeSat using additive manufacturing processes in the structure to increase structural efficiency and thus increase available space or power for payload. The satellite will also collect data and video. Since the manifest process for rocket launch to orbit takes many years, because of this, the team chose to use a high altitude balloon for flight to the near-space environment. The vehicle used an Arduino board to record video, data, and control operations; and used 3d printed materials for the structures. All operations and parameters were tested on the ground before the balloon flight to increase confidence of operation during flight.

Objectives

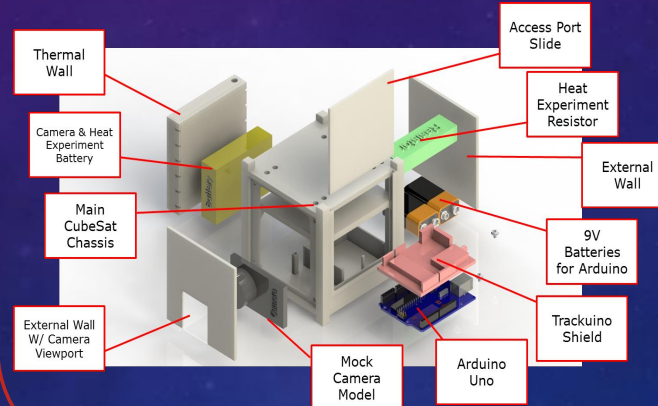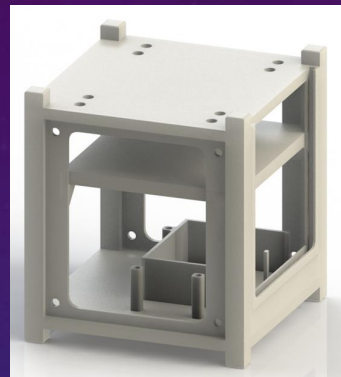Simulate CubeSat Flight using High Altitude Balloon
- Primary Objectives
  - Thermal Management Experiment
- Secondary Objectives
  - Record video and picture

Thermal Management Experiment

- The thermal management experiment tests a method of dissipating heat generated in the CubeSat
- Conducting wire will be integrated into the 3D printed plastic to transfer heat to a heat sink
- The heat sink will use paraffin wax as a phase change material to store heat and radiate the stored heat to the atmosphere
- A resistance heater will generate 6 watts of heat to be conducted to the heat sink
- The heat sink will be painted black to enhance radiation heat transfer
- The thermal experiment will be run until the heat sink reaches a maximum temperature of 65C in order to measure the useful life of the sink

Structure

Labels: Access Port Slide, Heat Experiment Resistor, External Wall, 9V Batteries for Arduino, Trackuino Shield, Thermal Wall, Camera & Heat Experiment Battery, Main CubeSat Chassis, External Wall W/ Camera Viewport, Mock Camera Model, Arduino Uno

Controls

- Data transmission using APRS amateur radio frequency
- Transmitted data packets include GPS, Temperature, and pressure data
- Secondary GPS tracker in case primary tracker fails
- Video recording using camera made for the use with Arduino with built in data storage
- Analog sensors used to gather pressure and temperature data
- On-board data storage
- GPS location can be tracked on the APRS network
- Thermal experiment triggered based on pressure readings

Future Work

- Operate at edge of space of the CubeSat using a high altitude balloon
- During flight, conduct the thermal management experiment and collect data
- Record video during flight

For Launch

- Use a 1200g High Altitude Balloon
- Helium will be used to fill balloon
- Will use a 5ft diameter parachute
- Radar Reflector will be attached to comply with FAA regulations
- 1/8in. Parachute rope will be used to secure payload

For Recovery

- Primarily location to launch: New London, Ohio
- Secondary location to launch: Tiffin, Ohio
- Data Collection was started on February 22, 2015 and continues until launch
- FAA will be notified 48 hours before launch
- Current winds and the surface map from the Weather Channel are use to collect for accurate prediction of the path and landing of CubeSat
- Weather is tracked daily to see any changes in path of the balloon and better prediction of landing

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