CanSat 2014
Post Flight Report (PFR)
Outline

Team 1174
WindCharger
June 17, 2014
Presentation Outline

1. Introduction
2. System Overview
3. Concept of Operations & Sequence of Events
4. Flight Data Analysis
5. Failure Analysis
6. Lessons Learned
**Team Organization**

- **Team Lead**
  - Evan Tingley

- **Alternate Team Lead**
  - Zachary Riffle

- **Software Lead**
  - Chris Sparks

- **Mechanical Lead**
  - Evan Unruh
  - Zachary Riffle

- **Ground Station Lead**
  - Nathanial Long

- **Electrical Lead**
  - Josh Thibaudeau
  - Chris Sparks

- **Faculty Advisor**
  - Dr. Francis Wessling

- **Ground Station**
  - Tara Sprinkle
  - Emily Kinkle
  - Zachary Riffle
## Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONOPS</td>
<td>Concept of Operations</td>
</tr>
<tr>
<td>SPI</td>
<td>Serial Peripheal Interface</td>
</tr>
<tr>
<td>I2C</td>
<td>Inter-Integrated Circuit</td>
</tr>
<tr>
<td>CDH</td>
<td>Communication and Data Handling</td>
</tr>
<tr>
<td>USART</td>
<td>Universal Synchronous/Asynchronous Receiver/Transmitter</td>
</tr>
<tr>
<td>RTC</td>
<td>Real Time Clock</td>
</tr>
<tr>
<td>GSR</td>
<td>Ground Station Radio</td>
</tr>
<tr>
<td>EPS</td>
<td>Electrical Power Subsytem</td>
</tr>
<tr>
<td>FSW</td>
<td>Flight Sofware</td>
</tr>
<tr>
<td>GCS</td>
<td>Ground Control System</td>
</tr>
<tr>
<td>CSV</td>
<td>Comma Seperated Value</td>
</tr>
</tbody>
</table>
Systems Overview
Mission Summary

- **Primary Mission**
  - Simulate a sensor payload during atmospheric entry
  - Sample atmospheric composition
  - Harvest power from the environment during descent
  - Protect sensitive egg payload

- **Secondary Mission**
  - Bonus Objective: Measure stability of descent using a 3 axis accelerometer
CanSat Overview

- Solar powered payload
- Altitude and temperature from Measurement Specialties MS5611
- Acceleration from Analog Devices ADXL345
- Radio transmission from Xbee Pro S2B
- ATXMEGA 256A3BU microcontroller
- Frontal drag device with ~45 degree sweep and 225in² frontal area
## Electrical Components Summary

<table>
<thead>
<tr>
<th>Component Description</th>
<th>Model ID</th>
<th>Cost per unit</th>
<th>Quantity</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure Sensor</td>
<td>MS5611</td>
<td>9.33</td>
<td>2</td>
<td>18.66</td>
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<tr>
<td>Accelerometer</td>
<td>ADXL345</td>
<td>7.27</td>
<td>1</td>
<td>7.27</td>
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<tr>
<td>Power Point Tracker</td>
<td>LTC3105</td>
<td>5.78</td>
<td>1</td>
<td>5.78</td>
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<tr>
<td>Solar Cell</td>
<td>TASC-2</td>
<td>2.50</td>
<td>16</td>
<td>40</td>
</tr>
<tr>
<td>5.47F Super Cap Array</td>
<td><em>custom</em></td>
<td>11.50</td>
<td>1</td>
<td>11.50</td>
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<tr>
<td>Microcontroller</td>
<td>ATXMEGA265A3BU</td>
<td>6.93</td>
<td>2</td>
<td>13.86</td>
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<tr>
<td>Wire Connections</td>
<td>Molex locking conn.</td>
<td>.25</td>
<td>20</td>
<td>5</td>
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<tr>
<td>5v to 3.3 Converter</td>
<td>LTC1763</td>
<td>4.15</td>
<td>2</td>
<td>8.30</td>
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<tr>
<td>Pcb Fab Express</td>
<td>Circuit boards</td>
<td>11.86</td>
<td>3</td>
<td>35.58</td>
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<tr>
<td>Payload Radio</td>
<td>Xbee Pro S2B</td>
<td>29</td>
<td>2</td>
<td>58</td>
</tr>
</tbody>
</table>
# Mechanical Components Summary

<table>
<thead>
<tr>
<th>Component Description</th>
<th>Material/thread</th>
<th>Cost per unit</th>
<th>Quantity</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure</td>
<td>Polycarbonate</td>
<td>~50</td>
<td>NA</td>
<td>50</td>
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<tr>
<td>Drag Device Panels</td>
<td>Ripstop nylon</td>
<td>8.78/yd</td>
<td>.5</td>
<td>4.39</td>
</tr>
<tr>
<td>Mounting Screws</td>
<td>4-40x3/8</td>
<td>9.33/50</td>
<td>12</td>
<td>2.24</td>
</tr>
<tr>
<td>Lock Nuts</td>
<td>4-40</td>
<td>2.50/100</td>
<td>4</td>
<td>0.10</td>
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<tr>
<td>Container Shell</td>
<td>Fiberglass and epoxy</td>
<td>~20</td>
<td>NA</td>
<td>20</td>
</tr>
<tr>
<td>Hinge</td>
<td>Brass</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Packing Tape</td>
<td>3.00/roll</td>
<td></td>
<td>.01</td>
<td>0.03</td>
</tr>
<tr>
<td>Springs</td>
<td>10.00/6</td>
<td></td>
<td>4</td>
<td>6.67</td>
</tr>
<tr>
<td>Total</td>
<td>Electrical + Mechanical</td>
<td></td>
<td></td>
<td>~$300</td>
</tr>
</tbody>
</table>
Physical Layout

Container:
- Electronics held in upper compartments
- Hinged opening

Payload:
- Nylon drag device
- Electronics above egg compartment
- Solar panel on top (not shown)
Concept of Operations and Sequence of Events
Concept of Operations

Launch - 0m

Apogee

Approx. 700m

Separation

500m

Landing
Comparison of Planned and actual Sequence of Events

**Arrive at field**
- Planned 0800
- Actual 0825

**Setup Table**
- Planned 0800
- Actual 0825

**Team Check In**
- Planned 1030
- Actual 1200

**Setup Ground Station**
- Planned 0900
- Actual 0930
Comparison of Planned and Actual Sequence of Events

- **CanSat Turn in**
  - Planned - 1100
  - Actual - 1200

- **Lunch**
  - Planned - 1200
  - Actual - 1230

- **Launch CanSat**
  - Planned - 1630 group (Pad 5)
  - Actual - 1645

- **Recovery**
  - Planned – Following Launch
  - Actual – 1652
Flight Data Analysis
Payload Separation Altitude

- **Planned-500 meters**
- **Actual- approximately 440m**

**Reasons for error:**
- Set base pressure early in the day, air pressure increased throughout the day (high pressure system moved in)
- Payload power on time (charging a cap)
Descent Rate Before Separation

- No data available, all container packets are from ascent
Payload Descent Rate

- **Planned**: 9 m/s
- **Actual**: 12 m/s
- **Reasons for error:**
  - Greater payload mass and less drag area than original design

![Altitude vs Time Graph]

\[ y = -12.831x + 441.29 \]
Container Telemetry

- Only two Container packets received.
- Data was from ascent, so no descent rate data is available.

<table>
<thead>
<tr>
<th>Mission Time (s)</th>
<th>Altitude (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2103</td>
<td>491.7704</td>
</tr>
<tr>
<td>2104</td>
<td>509.6134</td>
</tr>
</tbody>
</table>
Payload Telemetry

Temperature
- Fairly Stable
- Sensor located under radio, may explain increase

Voltage
- Very Stable
- Indicates solar panels functioned correctly

Temperature

\[ y = 0.0114x + 34.03 \]
\[ R^2 = 0.8903 \]

Power Source Voltage

\[ y = 0.0008x + 3.6474 \]
\[ R^2 = 0.1896 \]
Packet Count

- Transmittal rate of 1Hz
- 14 Packets total

Packet Count

Mission Time (s)

Packet Count

Presenter: CanSat 2014 PFR: Team 1174 (1174 WindCharger)
Selectable Objective Data: 3-axis Accelerometer

Flight Stabilization

Acceleration (g) vs. Mission time (s)

- X-Acc
- Y-Acc
- Z-Acc

Presenter:
CanSat 2014 PFR: Team 1174 (1174 WindCharger)
Failure Analysis
Failure Analysis

• **What Failed:**
  – GCS original antenna range failure on flight day
  – Did not save container packets in final flight code
  – Container radio after separation from rocket

• **How it Failed:**
  – Range testing not done on an appropriate environment. Results assumed good enough
  – Code was not included in final build
  – Combination of antenna choice and pointing of nulls outside the gain lobe during descent

• **How to Fix it:**
  – Better testing before the competition would solve almost all of our issues from flight day.
Lessons Learned
Lessons Learned

• What worked
  – Team collaboration
  – Flight code pieces
  – Last minute time management
  – Shared equipment/resources
    • Most club hardware was interchangeable

• What failed miserably
  – Weekly Status Meetings
    • Needed more structure and forethought in Agenda
  – Team defined Subsystem requirement definitions and checks
Thank You

- Adam Bower, Matt Rodencal, Jordan Teats, Trey McFerrin, Chuck Dunn, Steve Collins, John Alcorn, and Ethan Hopping
- STI Electronics, Radio Bro, ASGC, and UAH