CanSat 2013
Post Flight Review (PFR)

Team #1012
“Ironhide”
## Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>CNC</td>
<td>Computer Numerical Control</td>
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<tr>
<td>CONOP</td>
<td>Concept of Operations</td>
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<tr>
<td>GPS</td>
<td>Global Positioning System</td>
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<td>JTAG</td>
<td>Joint Test Action Group</td>
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<tr>
<td>MCU</td>
<td>Microcontroller Unit</td>
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<tr>
<td>PCB</td>
<td>Printed Circuit Board</td>
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<tr>
<td>PFR</td>
<td>Post Flight Review</td>
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<tr>
<td>SD</td>
<td>Secure Digital</td>
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<tr>
<td>SOE</td>
<td>Sequence of Events</td>
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Presentation Outline

• Systems Overview 6
• Concept of Operations and Sequence of Events 13
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Team Organization

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Josh Thibaudeau
Fabrication
Freshman, Aerospace Eng.

Masaaki Suzuki
Descent Control
Freshman, Aerospace Eng.
Not Present: Glenn Scott Nesbitt II, Evan Tingley
SYSTEMS OVERVIEW
Mission Summary

• **Primary Objectives**
  – Land egg Intact
  – Transmit telemetry throughout flight
    • Pressure altitude
    • GPS altitude, position, time, and number of satellites tracked
    • Temperature
    • Battery Voltage
    • Flight State
  – Ground station
    • Receive and save telemetry
    • Graph in real time

• **Secondary Objective**
  – Record acceleration profile during ground impact
• CanSat
  – Payload
    • Houses and lands science payload (egg) and avionics
    • Descends under control of conical drag device
  – Container
    • Contains and protects payload during ascent, ejection, and initial descent
    • Descends under control of parasheet at 20+-1 m/s
Physical Layout - Payload

- Drag Device
- Top PCB
- Bottom PCB
- Antenna
- Egg Cylinder
- Power Switch
Physical Layout - Container

Hooks
Buzzer and Battery
Parasheet
Hinge
Top Bulkhead
Fiberglass Shroud
Components Summary - Electronics

**Bottom Board**
- Voltage Regulator
- Hotwire
- Radio
- Antenna
- Hotwire Control

**Top Board**
- JTAG
- Power LED
- Serial
- Accelerometer
- SD
- GPS
- MCU

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Components Summary – Flight Software

• Following sensors were pooled for data continuously, and tested in flight configuration:
  – GPS
  – Pressure (translates to Altitude)
  – Temperature
  – Battery Voltage

• Separation
  – Flight state machine
  – Pressure altitude
CONCEPT OF OPERATIONS & SEQUENCE OF EVENTS
Planned CONOP

- Ascent
  - CanSat (Payload within Container)
  - Parasheet
  - Container
  - Conical Drag Device
  - Payload

- Launch

- 670m, CanSat/Rocket Separation

- 20 m/s Initial Descent

- 400m, Payload/Container Separation

- Landing

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Actual CONOPs

- Same as planned
Planned SOE

- Power up
- Integration into Rocket
- Telemetry start by command
- Flight to apogee then descent to 400m
- Separation by hotwire burn
- Landing
- Measurement of ground impact acceleration
- Continued telemetry
- Power down
Actual SOE

- Power up
- Integration into Rocket
  - Telemetry start by command
- Flight to apogee then descent to 400m
- Separation by hotwire burn
- Landing
- Measurement of ground impact acceleration
  - Continued telemetry
- Power down
FLIGHT DATA ANALYSIS
• No data is available
• The SD card and radios were offline
FAILURE ANALYSIS
## Failure analysis

<table>
<thead>
<tr>
<th>Issues</th>
<th>Root Cause</th>
<th>Corrective Actions</th>
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</thead>
<tbody>
<tr>
<td>Radio Range</td>
<td>Undetermined. Details on next slide</td>
<td>See next slide</td>
</tr>
<tr>
<td>SD Card</td>
<td>Though individually implemented and tested successfully, wasn’t integrated properly. Unused during flight</td>
<td>Ensure timely component integration with integration testing.</td>
</tr>
<tr>
<td>Accelerometer</td>
<td>Time constraint. Not able to work with and test sensor data</td>
<td>Manage timeline and meet deadlines as they approach</td>
</tr>
<tr>
<td>Not launched on time</td>
<td>All of the issues mentioned above, particularly Xbee (telemetry) issue</td>
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Failure Analysis – Xbee radios

• **Failure: Lack of radio range**
  – Good communications when close
  – Loss of all packets at distances greater than 20 feet

• **Possible Causes**
  – Xbee modem difference between payload and ground station
  – Incorrect configuration
  – Bad antenna connection

• **Corrective Action**
  – Range testing in flight configuration, well in advance of demonstration flight
    • Software was successful when tested on development boards
LESSONS LEARNED
Successes and Failures

• Successes
  – Pressure sensing
  – Flight state machine and decision process
  – Separation by hotwire
  – Full deployment of conical drag device (payload)
  – Stable Descent
  – Robust electrical power
  – Structural sturdiness
  – Correct mass

• Failures
  – Egg protection
    • Broken Egg
  – Communications
    • Lack of range
  – Impact acceleration measurement
  – Launch timeliness
Conclusions

• High value of extensive testing in flight configuration
  – Drag Device
    • Early conical drag devices were unsuccessful when tested during a rocket launch.
    • After resulting modifications, successful deployment and stable descent.
  – Pressure Sensor, Flight State Machine, and Hotwire
    • Vacuum chamber tested in flight configuration
    • Worked flawlessly
  – Communications
    • Untested in flight configuration
    •Failed at flight distances
• Technical knowledge gained from subsystem development
  – CNC machining
  – Circuit board layout
  – Embedded system operation
    • Hardware and software perspectives
  – Design and fabrication of reliable descent control systems
• Teamwork skills gained on a multidisciplinary team