Mission Overview

Cian A. Branco
Mission Overview – Mission Statement

Mission statement:

Monarch-3 seeks to cap-off all lessons learned from the prior two years through successful pressure data gathering at the rocket boundary layer and transmission from above Wallops to ODU in Norfolk.
Monarch-3 Mission Objective

• Objectives: Measure atmospheric pressure within the boundary layer of the rocket during flight; store this data aboard the rocket; and transmit the pressure data as well as data from onboard accelerometers through a special-port mounted antenna to our ground station at ODU.

• Three primary areas of development:
  - Mechanical
  - Electrical/Electronic
  - Radio
System Requirements-Mechanical

- Pressure sensor suite must be low profile and cover the entire range of expected pressures during flight.
- Need an in-can structure to support the instrumentation in-flight.
- Must design special port to accommodate antenna hardware, pressure sensors, and data processor.
System Requirements - Electrical/Electronic

• System must operate for a minimum of one hour to ensure full flight operations
• System must sample at a rate acceptable to the science objective
• System must be capable of withstanding the launch environment
System Requirements - Radio

- Radio must be capable of reaching the ODU ground station at maximum range
- Radio must be capable of downlinking a significant subset of the flight data
- Radio must operate within flight conditions
Mission Overview: Theory and Concepts

• Rocket Boundary Layers
  - Research on-going

• Radio and electronics:
  - Will use the two prior year’s designs (and lessons learned) as much as possible to minimize development time.

• Results:
  - Data stored aboard matches data transmitted
  - Packets detected at ODU and our portable ground station
ODU ConOps, “Monarch-3” *In Progress*

- **t = 0 min**
  - G switch triggered
  - All systems on
  - Begin data collection

- **Apogee**
  - t ≈ 2.8 min
  - Altitude: ≈115 km

- **End of Orion Burn – Spin Rate Largest**
  - t ≈ 0.6 min
  - Altitude: 52 km

- **High Tumble Rate**
  - t ≈ 4.0 min
  - Altitude: 95 km

- **Low N2, Low spin**
  - t ≈ 5.5 min
  - Chute Deploys

- **Karman line: Atmospheric pressure at effective zero**
  - t ≈ 2.4 min
  - Altitude: 100 km

- **Low N2, Low spin**
  - t ≈ 5.5 min
  - Chute Deploys

- **t ≈ 15 min**
  - Splash Down

- **Atmospheric pressure at effective zero**
  - t ≈ 2.4 min
  - Altitude: 100 km
Mission Overview: Expected Results

**Mechanical:**
- Pressure distribution as a function of altitude and velocity.
- Pressure can be compared to expected values for turbulent, supersonic boundary layers.
- Internal structures and supports are intact.

**Electrical/Radio**
- Data aboard rocket matches data transmitted to ground station and ODU; Radio works as designed.
System Overview

Cian A. Branco
System Block Diagram

- 9DOF board
- High-DPS
- High-G
- Internal sensors
- SD Card
- Teensy
- SmXrone
- Radio
- G-Switch
- Battery bank
- Wallops Trigger
System design - Physical Model

- Batteries
- Sensor circuit
- Main Processor/Storage
- Power circuit
- G-Switch
- Radio
RockSat Compliance

• Mass
  – We can easily fit within mass budget, based on our design from last year being fairly under mass.
• Volume
  – Volume is a similar situation, we have a similar layout and plate count from last year.
• Early Activation
  – Early activation is a still under consideration.
• Special Request
  – A special port is required for our radio transmission.
  – Set-up like last year will be fine
Design Overview: Shared Can Logistics

We have no preference in orientation, and await our assignment for a partner.
Subsystem Design
Mechanical

Cian A. Branco
Subsystem Design Section
Material Choice

- Makrolon is the material of choice for the plates due to its optimum strength and material characteristics, especially the non conductive nature.

- Mounts will be constructed from sheet aluminum as they were last year.
Risks

- **Risk 1**: Physical failure of joints
  - Rigorous physical testing will be performed early

- **Risk 2**: Machine shop failures could cause plate and other manufacturing errors
  - Purchase an excess of consumable construction material
What about the pressure sensors?

- Will be able to down-select once we know our budget contribution from ODU
- Likely not a large expense; all options currently considered easily fit within the port
Subsystem Design
Circuit Board

Connor Huffine & Jason Harris
Subsystem Design Section

- Similar to last year’s flight package, using same parts as they were satisfactory.
- Circuit redesigned to accommodate new port design and lack of smart phone
- Power system will be using last year’s design, as it worked well.
Block diagram
Trade Studies

• All parts for the sensors and power circuit are being chosen for their proven effectiveness and familiarity from last year.
• Any part changes will be considered if other solutions present themselves.
• It’s better to stick with a part we know and have working code for than to shift to a new part without major advantages, especially given that the part we used prior was effective.
Risks

- Risk 1: Circuit fails in flight
  - We need to make sure it is properly assembled and laid out prior to late stage testing.

- Risk 2: Circuit is non-functional
  - Design review should be made by multiple team members to spot bad connection layouts faster.
Subsystem Design
Radio

Jason Harris & Connor Huffine
Subsystem Design Section

- Radio must easily broadcast packets at acceptable rate and fidelity
- Proven ability to talk to ODU ground station is a must
- Current options are cannibalized Baofeng or dedicated board.
Radio Functionality

- Coprocessor (Teensy) collects sensor data
- Stores it to the SD card
- Creates a packet of data
- Creates a modulated signal to feed to the radio.
- Radio broadcasts through antenna
Risks

• Risk 1: Radio cannot send data
  – Extensive testing schedule will mitigate this.

• Risk 2: Code could fail during flight, leaving half the payload dead in the air.
  – See above.
Test/Prototyping Plan
Prototyping Section

• Port
  – Overall concept nailed down
  – Need to verify with pressure sensors

• Radio
  – Less “Prototype”, more “new implementation”
Prototyping Plan

**Risk/Concern**
- Radio: Concern about new implementation
- Port: Physical space and data downlink

**Action**
- Verify radio operation with antenna design
- Trade space involving volume of sensors, number of sensors, and available data capacity
Project Management

Cian A. Branco
## Management: Preliminary Budget

<table>
<thead>
<tr>
<th>Expected Cost:</th>
</tr>
</thead>
<tbody>
<tr>
<td>½ RockSat-C canister</td>
</tr>
<tr>
<td>Payload hardware</td>
</tr>
<tr>
<td>Lodging:</td>
</tr>
<tr>
<td>2 rooms x 7 nights @ $150 per night</td>
</tr>
<tr>
<td>Meals:</td>
</tr>
<tr>
<td>7 nights x 4 team members @ $20 per meal</td>
</tr>
<tr>
<td><strong>GROSS COST</strong></td>
</tr>
<tr>
<td>VSGC EXPECTED CONTRIBUTION</td>
</tr>
<tr>
<td><strong>TOTAL REQUESTED- ODU</strong></td>
</tr>
</tbody>
</table>
Risks and Worries

• Radio is critical point for half of our goals; risk will be mitigated with thorough testing.

• Pressure sensors will need to be robust enough to survive launch stresses.
Conclusion

• Objective: Acquire, store, and transmit pressure and other sensor data from RockSat-C in-flight.

• Plan for where you will take your design from here?
  – Majority of design heavy lifting is done due to plan recycling
  – Pushing towards quick assembly for extensive testing in the spring