NNU RS-X 2016
Conceptual Design Review

Northwest Nazarene University
Mitch Kamstra, Braden Grim, Jameson Krueger
10/13/15
CoDR Presentation Content

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  – Mission Statement
  – Mission Objectives
  – Theory and Concepts
  – Concept of Operations
  – Expected Results

• Section 2: Design Overview
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  – Engineering Design
  – Functional Block Diagram
  – Payload Layout (sketches)
  – RockSat-X User’s Guide Compliance
CoDR Presentation Contents

• Section 3: Management
  – Team Organization
  – Schedule
  – Budget
  – Mentors (Faculty, industry)
  – Risks/Worries
  – Contact and Availability Matrices

• Section 4: Conclusions
Mission Overview: Mission Statement

- The 2016 Northwest Nazarene University RockSat-X team will test flexible sensors in a space environment and return to earth safely. The test will be communicating sensor data via RFID technology while being extended away from the payload and into space. The test will determine the feasibility of use of passive RFID tags as a power and communication source for such sensors, showing the RF power received over a variable distance, and it will prove the robustness of flexible electronics for use in a space environment. The test will be completed by re-sealing the test platform and returning it to earth safely.
Mission Overview: Mission Objectives

Overview

- Test flexible Analog-to-Digital Converter and other flexible sensors on on-board payload
- Communicate from payload to extended boom via RFID technology
  - Power an RFID tag and sensor with RF from payload
  - Flexible 915MHz antenna
  - Cell Phone interface
- Extend boom with test into space
  - Equipped with sensors and camera
- Obtain video of test on payload and test on boom

Minimum Success criteria

- Extend/retract boom
- RFID reader receive ID from extended RFID tag
- Video
Mission Overview: Theory and Concepts

• Testing flexible electronics on RockSat-X and RockSat-C has been something NNU has had experience with for over 4 years and has built a lasting industry partner, American Semiconductor Inc., for the NNU students.

• Proving the durability of these flexible electronics through launch and during exposure to the harsh environment of space has paved the way for an increase in complexity of flexible devices and tests.

• These experiments have included: static testing in a with a mechanical, sealing door, dynamic testing with mechanical flexing of the devices, and deployment of the devices from the payload and rocket.
Mission Operations

Altitude

- **t ≈ 1.2 min**
  - Altitude: 75 km
  - **Skirt Deployment**

- **t = 0.6 min**
  - Altitude: 60 km
  - Begin storing RFID data, cameras on

- **End of Orion Burn**
  - t ≈ 0.6 min
  - Altitude: 52 km

- **t ≈ 1.3 min**
  - Altitude: 95 km
  - **Deploy Boom**

- **t ≈ 0.6 min**
  - Altitude: 95 km
  - **Begin data collection (inertial measurement unit)**

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

- **t ≈ 2.8 min**
  - Altitude: 95 km
  - **Bring Boom in**

- **t ≈ 4.0 min**
  - Altitude: 95 km
  - **Begin storing RFID data, cameras on**

- **t ≈ 4.5 min**
  - Altitude: 75 km
  - **Chute Deploys**

- **t ≈ 5.5 min**
  - Altitude: 52 km
  - **All systems off**

- **t ≈ 15 min**
  - **Splash Down**

- **t ≈ 3 min**
  - Altitude: 60 km
  - Begin storing RFID data, cameras on

- **t ≈ 4.5 min**
  - Altitude: 60 km
  - **Bring Boom in**

- **t ≈ 4.5 min**
  - Altitude: 75 km
  - **Chute Deploys**

- **t ≈ 5.5 min**
  - Altitude: 75 km
  - **All systems off**

- **t ≈ 15 min**
  - **Splash Down**
Mission Overview: Expected Results

• Collect launch/reentry data (G forces, pressure as it varies with height, temperature upon reentry)
• Characterize RFID performance as it varies over distance (power transmitted vs power received back)
• Compare FleX-ADC results with a proven ADC
• Capture boom deployment on video
Design Overview: Science Design

- Collect launch and reentry data using gyroscope, accelerometer, magnetometer, pressure and temperature sensors
- Boom with RFID tag and FleX-ADC will deploy
- Video will record boom deployment
- Cell phone with RFID reader will transmit power/record data to/from RFID tag
Design Overview: Engineering Design

• Flexible boom unravels
  – Easy stowage
  – Capable of mounting flexible electronics
  – Deployed via stepper motor
• Structure: Aluminum case housing mission critical electronics
• Power System: power regulation
  – Over-current protection
  – Under voltage protection
  – Fault detection
  – Regulation
• On-board Computer: Master of all sensor devices
  – TI MSP430 μController (CCS software)
  – Slave devices include IMU, FleX-ADC, Cell Phone, GoPro
• Reusing GoPro, FleX-ADC from previous years

http://www.roccor.com/products/seam-lock/
Functional Block Diagram
Design Overview: Payload Layout
Design Overview: RockSat-X User’s Guide Compliance

- Rough Order of Magnitude (ROM) weight estimate 15lb
- Estimate on payload dimensions (will it fit in the payload space?) Yes, >12 in diameter, >5.13 in. height
- Deployables/booms? Yes
- How many ADC lines? TBD, ~5
- Asynchronous/Parallel use? TBD
  - Do you understand the format? Yes
- Power lines and timer events use? Yes, TBD
- CG requirement
  - Do you understand the requirement Yes
- Are you utilizing high voltage? No
- Hazardous Procedures? No
- RF? Yes
- Bolt heads on bottom of deck flush mount? Yes
- US Persons for whole team? Yes
Management

- Team organization chart
- Preliminary schedule for the semester
- Monetary budget
- Team mentors
- Contact Matrix
- Team Availability (MDT) Matrix
Team Organizational Chart

Advisors:
Dr. Dan Lawrence
Dr. Stephen Parke

Team Leaders:
Braden Grim
Mitch Kamstra
Jameson Krueger

Mechanical Team:
Braden Grim
Jameson Krueger
(Additional Recruitment)

Team Communication:
Jameson Krueger

Electrical Team:
Mitch Kamstra
Caleb Wolf
(Additional Recruitment)
## Preliminary Schedule

<table>
<thead>
<tr>
<th>Date Range</th>
<th>Event Description</th>
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<tbody>
<tr>
<td>10/13/15</td>
<td>CoDR</td>
</tr>
<tr>
<td>10/21/15</td>
<td>ASI Meeting/Establish requirements</td>
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<tr>
<td>10/21/15 – 11/20/15</td>
<td>Begin Mechanical and Electrical Design</td>
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<tr>
<td>November</td>
<td>PDR</td>
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<tr>
<td>December</td>
<td>Refine Design</td>
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<tr>
<td>December</td>
<td>Begin ASI Electronics Interfacing</td>
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<tr>
<td>December</td>
<td>Prepare for CDR</td>
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<tr>
<td>January</td>
<td>Begin manufacturing</td>
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# Approximate Budget

## NNU RockSAT-X 2016 Team Budget

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<th>Total Cost:</th>
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<th>Funding</th>
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### Hardware:

- **Controller**: $50
- **Camera(s)**: $400
- **Electronics**: $500

### Materials:

- **Aluminum**: $300
- **Machine tools**: $300

### Other

- **Miscellaneous**: $300
- **PCB material**: $100
- **Daily Food**: $40.00

### RockSAT Fees

- **Deposit**: $2,000.00
- **Sharing Payload Cost**: $14,000.00

### Funding

- **ISGC (Travel)**: $14,360.00
- **NNU (Launch/supplies)**: $8,450.00
- **ASI and Partner (launch)**: $7,500.00

## Travel

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### Video Production

- **Quantity**: 4
- **Cost**: $2,600.00

### Other

- **Miscellaneous**: $300
- **PCB material**: $100
- **Vehicle Rental**: $800.00

## Single Trip Total

- **Cost**: $7,180.00

## Two Trip Total

- **Cost**: $14,360.00
Team Mentors

• American Semiconductor
  – Partner Company (unknown as of now)
  – More involvement

• Faculty
  – Dr. Dan Lawrence
  – Dr. Stephen Parke
# Contact Matrix

**Team Name/School Here:** Northwest Nazarene University

## Fall 2016 RS-X Contact Matrix

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
<th>Day Phone</th>
<th>Cell Phone</th>
<th>Receive Texts?</th>
<th>Email</th>
<th>Citizenship</th>
<th>OK to Add to Mailing List?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advisor</td>
<td>Dan Lawrence</td>
<td>(208) 608-0534</td>
<td>(208) 608-0534</td>
<td>Yes</td>
<td><a href="mailto:mdlawrence@nnu.edu">mdlawrence@nnu.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Advisor</td>
<td>Stephen Parke</td>
<td>(208) 697-2318</td>
<td>(208) 697-2318</td>
<td>Yes</td>
<td><a href="mailto:sparke@nnu.edu">sparke@nnu.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Team Member</td>
<td>Jameson Krueger</td>
<td>(208) 602-5279</td>
<td>(208) 602-5279</td>
<td>Yes</td>
<td><a href="mailto:jkrueger@nnu.edu">jkrueger@nnu.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
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<tr>
<td>Team Member</td>
<td>Braden Grim</td>
<td>(208) 899-3897</td>
<td>(208) 899-3897</td>
<td>Yes</td>
<td><a href="mailto:bgrim@nnu.edu">bgrim@nnu.edu</a></td>
<td>U.S.</td>
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<tr>
<td>Team Member</td>
<td>Mitch Kamstra</td>
<td>(509) 879-8465</td>
<td>(509) 879-8465</td>
<td>Yes</td>
<td><a href="mailto:mkamstra@nnu.edu">mkamstra@nnu.edu</a></td>
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### Team Availability Matrix

#### Team Name/School Here: NNU

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Risks/Worries:

• Pressing Issues
  – Robust Power Supply
  – RFID – approval
  – Feasibility of video transmission
  – Deployment (Boom or Deployable?)
Conclusion

- Mission will continue tests of FleX electronics
- Incorporate additional business partners
- Add RFID element to experiment
- Demonstrate usefulness of flexible electronics

Next steps for PDR
- Begin design process with ASI involvement
  - Meet with representatives
- Begin SolidWorks design
- Consolidate FleX ADC experiment PCB