NNU RS-X 2016
Subsystem Testing Review (STR)

Northwest Nazarene University
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2/16/16
Presentation Outline

• Section 1: Mission Overview
• Section 2: Final Design Description
• Section 3: Hardware Procurement Status
• Section 4: Subsystem Testing Results
• Section 5: Plan for ISTR
• Section 6: Plan for FMSR
• Section 7: User Guide Compliance
• Section 8: Project Management Update
1.0 Mission Overview

All
• The NNU RockSat-X team will test the feasibility of flexible electronics in the harsh environment of space.
Mission Overview: Minimum Success Criteria

– Receive at least one temperature value from RFID tag
– Capture video footage of boom deployment
– Gather analog data using FleX ADC
Mission Overview: Comprehensive Success Criteria

– Fully extend boom with attached RFID tag
– Collect both temperature and TX power via passive RFID tag
  • Measure power variation over deployed distance
– Capture video of full deployment
– Collect all analog data using FleX ADC, store it in OBC, and compare with internal ADC of MCU
– Return components undamaged
ConOps

Altitude

- **t ≈ 75 sec**
  - Altitude: 95 km
  - *Deploy Boom*

- **t ≈ 70 sec**
  - Altitude: 75 km
  - *Skirt Deployment*

- **t ≈ 0.6 min**
  - Altitude: 60 km
  - *Begin storing RFID data*

- **t ≈ 5 sec**
  - Initiate motor timers
  - Activate Cameras
  - Boot Phone

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

- **t ≈ 280 sec**
  - *TE-2 Activate Bring Boom in*

- **t ≈ 330**
  - Altitude: 75 km
  - *All systems off*

- **t ≈ 5.5 min**
  - *Chute Deploys*

- **t ≈ 0.6 min**
  - Altitude: 60 km
  - *Begin storing RFID data*

- **t ≈ -180 sec**
  - *Begin data collection (inertial measurement unit)*

- **t ≈ 15 min**
  - *Splash Down*
## Concept of Operations

<table>
<thead>
<tr>
<th>Event</th>
<th>Time On</th>
<th>Dwell</th>
<th>Event Description</th>
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<tbody>
<tr>
<td>GSE 2</td>
<td>T-180 sec</td>
<td>Flight</td>
<td>Initiate OBC, begin collecting ADC data</td>
</tr>
<tr>
<td>TE-2</td>
<td>T+5 sec</td>
<td>Flight</td>
<td>Boot smart phone, activate cameras and motor timers</td>
</tr>
<tr>
<td>TE-3</td>
<td>T+280 sec</td>
<td>Flight</td>
<td>Activate boom retraction, drawer seal</td>
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</table>
Experiment Order

UHCC: University of Hawaii Community Colleges
UNL: University of Nebraska Lincoln
CTU: Capitol Technology University
NNU: Northwest Nazarene University
VT: Virginia Tech
CC: Carthage College
MSU: Metro State University
UPR: University of Puerto Rico
2.0 Final Design Description

All
System Changes Since CDR

- Changed to Samsung Smartphone
- GoPro Hero3
  - Software control of Session not possible
- Trying different motors and drivers
  - Changing motors has minimal impact
Functional Block Diagram

Motor and Camera control

- GoPro 1
  - SD Memory
  - Li-ion Battery
- GoPro 2
  - SD Memory
  - Li-ion Battery

Power Regulator

- 28V
- 12V
- 9V
- 3.3V

FleX ADC Experiment

- ATMEGA328P
- SD Memory
- Analog Accelerometer

RFID Experiment

- Smart Phone
  - SD Memory
  - Li-ion Battery
- RFID Reader
  - Li-ion Battery

RFID Tag

- Temperature Sensor
- Microcontroller
Mechanical Design:

Top View

24 in
Mechanical Design:

Side Views
Mechanical Design:

Side Views
Mechanical Design:

Isometric 1
Mechanical Design:

Isometric 2
Mechanical Design:

Isometric 3
Mechanical Design:

Isometric 4
Mechanical Design:

- Gearmotor
- Lead screw
- RFID tag
- Teflon nut
- GoPro
- Stepper motor
Mechanical Design:

- RFID tag
- RFID reader
## Detailed Weight Budget

<table>
<thead>
<tr>
<th>Part</th>
<th>Weight (lbs)</th>
</tr>
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<tr>
<td>Arete Pop</td>
<td>0.078</td>
</tr>
<tr>
<td>Gear motor</td>
<td>0.023</td>
</tr>
<tr>
<td>Stepper motor</td>
<td>0.44</td>
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<tr>
<td>Smartphone</td>
<td>0.31</td>
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<tr>
<td>GoPro</td>
<td>0.36</td>
</tr>
<tr>
<td>Deck</td>
<td>3.425</td>
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<tr>
<td>Electronic Box</td>
<td>2.7</td>
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<tr>
<td>Drawer w/ Lid</td>
<td>5.86</td>
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<tr>
<td>Boom</td>
<td>0.075</td>
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<tr>
<td>PCB</td>
<td>0.35</td>
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<tr>
<td>Bolts/Wires/Etc</td>
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<td><strong>Total</strong></td>
<td><strong>14.621</strong></td>
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### Materials List:

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<tr>
<th>Description</th>
<th>part</th>
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<tr>
<td>RFID</td>
<td>RFID Tag</td>
<td>PakSense</td>
</tr>
<tr>
<td>Arete Pop RFID Reader</td>
<td>A100-U</td>
<td>Phychips</td>
</tr>
<tr>
<td>Li-ion, 360mAh Battery (built in)</td>
<td>Arete Battery</td>
<td>Phychips</td>
</tr>
<tr>
<td>3.5mm, TRRS audio cable</td>
<td>TRRS Audio Cable</td>
<td>FosPower</td>
</tr>
<tr>
<td>4GB SD memory card</td>
<td>SD Card</td>
<td>SanDisc</td>
</tr>
<tr>
<td>Micro USB cable for power</td>
<td>USB cable</td>
<td></td>
</tr>
<tr>
<td>Smart Phone</td>
<td>Samsung Droid Charge</td>
<td>Samsung SDI</td>
</tr>
<tr>
<td>3.7V Li-ion, 5.92Wh Battery (built in)</td>
<td>SAMINTBATSS</td>
<td>Samsung SDI</td>
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<tr>
<td>FLEX ADC</td>
<td>Flexible ADC</td>
<td>American Semiconductor</td>
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<tr>
<td>Microcontroller</td>
<td>ATmega328P</td>
<td>Atmel</td>
</tr>
<tr>
<td>3-axis, analog accelerometer</td>
<td>adxl377</td>
<td>Analog Devices</td>
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<td>4GB SD memory card</td>
<td>SD Card</td>
<td>SanDisc</td>
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<td>DRAWER/ELECTRONICS BOX</td>
<td>6061 Aluminum</td>
<td>Electronics box</td>
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<td>6061 Aluminum</td>
<td>Drawer box</td>
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<td>6061 Aluminum</td>
<td>Drawer</td>
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<td>Microcontroller</td>
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<td>Atmel</td>
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<tr>
<td>DC Motor</td>
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<tr>
<td>Stepper Motor</td>
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<td>Not chosen yet</td>
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<tr>
<td>Motor driver (DC), H-Bridge</td>
<td>sn754410</td>
<td>Texas Instruments</td>
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<td>Motor Controller (stepper)</td>
<td>Depends on motor</td>
<td>Depends on motor</td>
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<td>GoPro, 1440p48</td>
<td>Hero 3 Black</td>
<td>GoPro</td>
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<td>Li-ion, 1050mAh Battery (built in)</td>
<td>GoPro Battery</td>
<td>GoPro</td>
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<td>Bi-Directional Logic Level Converter</td>
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<td>SparkFun</td>
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<td>7V max Optoisolator</td>
<td>6N138</td>
<td>Lite-On inc.</td>
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<td>(2) 5V Switching Regulator</td>
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<td>2.5V Linear Regulator</td>
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<tr>
<td>DC/DC CONVERTER 12V 50W</td>
<td>PQA50-D24-S12-D</td>
<td>CUI inc.</td>
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<td>Various resistors and capacitors</td>
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Hazardous Mechanical Items:

- Deployable boom
  - Deploys at .27 in/s
  - Deployment length is 24 in from edge of box
Electrical Schematics – Arduino 2
Electrical Schematics – EPS
# Updated Power Budget

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Voltage (V)</th>
<th>Max Current (A)</th>
<th>Start Time (min)</th>
<th>Time On (min)</th>
<th>Watts</th>
<th>Ah</th>
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<tr>
<td>ATMEGA 328P</td>
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<td>-3</td>
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<td>0.01</td>
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<td>-3</td>
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<td>FleX ADC</td>
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<td>0.01</td>
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<td>8.5</td>
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<td>DC Motor</td>
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<td>1.2</td>
<td>1</td>
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<td>Stepper Motor</td>
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<td>2.40</td>
<td>0.00</td>
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<td>-3</td>
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<td>0.03</td>
<td>0.00</td>
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<tr>
<td>Micro SD Breakout</td>
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<td>-3</td>
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<td><strong>Total</strong></td>
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<td><strong>9.96</strong></td>
<td><strong>1.00</strong></td>
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<tr>
<td>Total Power Capacity</td>
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<td>Over/Under</td>
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<td><strong># of Flights Margin</strong></td>
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### Pin Assignments: Power

#### Power

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<thead>
<tr>
<th>Pin</th>
<th>Function</th>
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<tr>
<td>1</td>
<td>GSE 1</td>
<td>CTU</td>
</tr>
<tr>
<td>2</td>
<td>Timer Event Redundant (TE-RA)</td>
<td>CTU</td>
</tr>
<tr>
<td>3</td>
<td>Timer Event Redundant (TE-RB)</td>
<td>CTU</td>
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<tr>
<td>4</td>
<td>Timer Event 1 (TE-1)</td>
<td>CTU</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>CTU</td>
</tr>
<tr>
<td>6</td>
<td>GND</td>
<td>CTU</td>
</tr>
<tr>
<td>7</td>
<td>GND</td>
<td>CTU</td>
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<td>8</td>
<td>GND</td>
<td>CTU</td>
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<tr>
<td>9</td>
<td>GSE 2</td>
<td>NNU</td>
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<td>10</td>
<td>Timer Event 2 (TE-2)</td>
<td>NNU</td>
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<td>11</td>
<td>Timer Event 3 (TE-3)</td>
<td>NNU</td>
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<tr>
<td>12</td>
<td>GND</td>
<td>NNU</td>
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<tr>
<td>13</td>
<td>GND</td>
<td>NNU</td>
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<tr>
<td>14</td>
<td>GND</td>
<td>NNU</td>
</tr>
<tr>
<td>15</td>
<td>GND</td>
<td>NNU</td>
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## Pin Assignments: Telemetry

<table>
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<tr>
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<th>School</th>
<th>Pin</th>
<th>Function</th>
<th>School</th>
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<tr>
<td>1</td>
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<td>20</td>
<td>Parallel Bit 7</td>
<td>CTU</td>
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<td>2</td>
<td>Analog 2</td>
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<td>3</td>
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<td>NNU</td>
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<td>4</td>
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<td>8</td>
<td>Analog 8</td>
<td>NNU</td>
<td>27</td>
<td>Parallel Bit 14</td>
<td>NNU</td>
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<td>9</td>
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<td>NNU</td>
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<td>10</td>
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<td>NNU</td>
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<td>11</td>
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<td>30</td>
<td>Parallel Read Strobe</td>
<td>CTU/NNU</td>
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<tr>
<td>12</td>
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<td>CTU</td>
<td>31</td>
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<td>13</td>
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<td>RS-232 Data (TP1)</td>
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<td>CTU</td>
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<td>RS-232 GND (TP2)</td>
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<td>15</td>
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<td>17</td>
<td>N/C</td>
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<td>19</td>
<td>Ground</td>
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</tr>
</tbody>
</table>
Hazardous Electrical Items:

- RF Transmission
System Overview: Description of Partnerships

- **American Semiconductor**
  - Financial support
  - Electrical design and troubleshoot assistance

- **PakSense**
  - Partner with ASI in RFID design
  - Potential extra financial support
  - Dependent on upcoming demo
De-Scopes and Off-Ramps

• Possibly eliminate one GoPro
  – Dependent on weight and space
Special Requests

• NNU has no Special Requests for Wallops
3.0 Hardware Procurement Status

All
Mechanical Elements

• Materials in house:
  • Lead Screw
  • Teflon (lead nut)
  • Aluminum for small pieces
  • Gasket Material
  • Miscellaneous materials

• To be ordered:
  • Large Aluminum Stock
  • GoPro Lens
Electrical Elements

• Components arrived:
  – Accelerometer
  – Arduinos
  – ADC (rigid)
  – Logic level converter
  – SD breakout
  – Power Regulators (minus 12V)
  – Optoisolators
  – Motors and drivers
  – Samsung Smartphone
  – RFID reader and tags

• Components to be ordered
  – Motors (still testing various)
  – PCB
  – 12V regulator
Software Elements

• Completed code:
  – ADC control code
    • Includes SD storage, reading of accelerometer, and comparison to Arduino ADC
    • Does not include telemetry downlink
  – Motor control
    • Stepper and DC
    • Not yet integrated with mission timeline
  – Samsung smartphone control
    • Includes automatic boot up and opening of RFID app
    • Does not include data storage
4.0 Subsystem Testing Results

All
FleX ADC

• See Arduino Schematics in Electrical Design
• Most of the ADC experiment has been breadboarded
  – Missing Telemetry element
• Schematic design finished
• Next step is PCB design
FleX ADC
FleX ADC

• Results of test are successful
  – ADC produces reading of accelerometer voltage
  – Saved to SD card

New Data Set
179, 179, 178, 684, 680, 681
179, 179, 179, 684, 680, 681
179, 179, 178, 685, 680, 681
179, 179, 179, 684, 681, 681
179, 179, 179, 684, 680, 681
179, 179, 179, 684, 680, 681
179, 179, 179, 684, 680, 681
179, 179, 179, 685, 680, 681
179, 179, 179, 684, 680, 681
179, 179, 179, 684, 680, 681
179, 179, 178, 684, 680, 681
See provided schematics
EPS

• 5V and 2.5V regulators tested
  – No heat generated
• Optoisolators tested
  – Logic signals generated
  – No overheating
• 12V supply not yet tested
  – Ordered, will arrive soon
• PCB will incorporate all components
EPS

• Initial EPS breadboard shown below
• 12V supply to 5V and 2.5V output
OBC (motor/GoPro control)

See provided schematics
OBC (motor/GoPro control)

- Stepper and DC motor control prototyped
- Only by individual motor, not yet integrated
- GoPro session can’t be controlled by software (can only hack it)
- Replaced with Hero 3 in design
- Possibly use both as backup
OBC (motor/GoPro control)
OBC (motor/GoPro control)

- Successful software control of motors
- Changing motors and style for better performance
- Will incorporate switch into DC motor control
RFID Experiment (model)

- Micro USB for power to Samsung
- Gold plated, shielded TRRS stereo audio/video cable for Arete Pop to Samsung

Extended from drawer into space

Housed inside static Electronics box

Power on timer

Extended from rocket in dynamic drawer
1. Power up and boot from power connected – **ACHIEVED**
2. RFID app begin reading from power up – **ACHIEVED**
3. Read Power from RFID tag – **ACHIEVED**
4. Read temperature from RFID tag – **ACHIEVED**
5. Display both power and temperature – **NOT YET ACHIEVED**
6. Save data read from RFID tag – **NOT YET ACHIEVED**
7. RFID app close and phone power down at timer – **ACHIEVED**
RFID Experiment (tests)

- Boot up time
- Measured tag-to-reader distance in lab
RFID Experiment (test results)

- Smart phone boot time: 57.5s - 59.5s
- Reader-to-Tag distance

<table>
<thead>
<tr>
<th>Trial</th>
<th>Time (s)</th>
</tr>
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<tr>
<td>1</td>
<td>57.83</td>
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<td>9</td>
<td>59.47</td>
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<tr>
<td>10</td>
<td>58.07</td>
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</tbody>
</table>

Average: 58.34
Minimum: 57.53
Maximum: 59.47
Structure (model)
Structure (status)

• Quick Status
  – Drawer fits in box
  – Rotated RFID reader 90°
  – Change to Hero3
  – New stepper motor

• NOT FINAL
  – Need to check tolerances
Structure (tests)

- 3D printed prototypes
Structure (results)

- Tolerances good:
  - Drawer guides
  - Boom mechanism
- Adjust tolerances for:
  - RFID reader
  - GoPro
- Waiting for new stepper motor
5.0 Plan for Integrated Subsystem Testing Review (ISTR)

All
Plan for ISTR

• Subsystems to be integrated:
  – EPS/FleX ADC, OBC (motor control), RFID
  – This should be relatively simple
  – Will include first PCB revisions

• Challenges will be with integrating mechanical design
  – Demos with 3D printed versions will happen soon
  – Machining schedule will take quite some time
  – Planning to have main mechanical components machined by late March
6.0 Plan for Full Mission Simulation Review (FMSR)

All
Mechanical Testing

• Test dynamic seal in water

• Test drawer
  – Add limit switches to drawer to shut power off when completely open/closed

• Test boom mechanism with RFID tag attached
  – Will test boom going straight down (tape measure can’t support tag when fully deployed in gravity)

• Tests will be performed beginning of April
Electrical Testing

• Will inhibit GoPro function (not yet incorporated into design)
• Inhibit RFID?
• Need to test RFID next to metal surface
• When PCB’s arrive, test all control through mission timeline
  – Very close to this
• Incorporate FleX ADC when available
• GoPro internally powered
Software Testing

- Software testing dependent on electrical manufacture
  - PCB and motor arrival
- Software control of electrical GoPro inhibit
- EPS independent of software (minus optoisolators)
- Software control of RFID Experiment underway
System Level Testing

- System level testing dependent on machining schedule
  - Late march target for majority of machined components

- FleX ADC experiment only needs power through mission timeline (continuous)
  - Independent of motor/GoPro control

- Should be able to integrate all electrical components by mid-late March (PCB’s included)
7.0 User Guide Compliance

All
### User Guide Compliance: Summary

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Status/Reason (if needed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center of gravity in 1&quot; plane of plate?</td>
<td>YES, X: 0.61 in, Y: .78 in, Z: 1.50 in</td>
</tr>
<tr>
<td>Weight 30.0+/- 1.0 (15.0 +/- 0.5) lbs?</td>
<td>YES, 15 lbs with ballast</td>
</tr>
<tr>
<td>Max Height &lt; 10.75” (5.13”)</td>
<td>YES</td>
</tr>
<tr>
<td>Bottom of deck has flush mount hardware?</td>
<td>YES, 4.74 in from deck</td>
</tr>
<tr>
<td>Within Keep-Out Zone</td>
<td>YES</td>
</tr>
<tr>
<td>Using &lt; 10 A/D Lines</td>
<td>Using 5 lines</td>
</tr>
<tr>
<td>Using/Understand Parallel Line</td>
<td>YES, 8 lines</td>
</tr>
<tr>
<td>Using/Understand Asynchronous Line</td>
<td>YES if Available</td>
</tr>
<tr>
<td>Using X GSE Line(s)</td>
<td>YES, GSE 1</td>
</tr>
<tr>
<td>Using X Non-Redundant PWR Lines (TE-1, TE-2, TE-3)</td>
<td>YES, TE-1 and TE-2</td>
</tr>
<tr>
<td>Using X Redundant Power Lines (TE-R)</td>
<td>NO</td>
</tr>
<tr>
<td>Using &lt; 1 Ah</td>
<td>YES, 0.06</td>
</tr>
<tr>
<td>Using &lt;= 28 V</td>
<td>YES</td>
</tr>
<tr>
<td>Using RF (If yes, list frequency and TX Power)</td>
<td>YES, 915 MHz @ 360 miliwatt TX power</td>
</tr>
<tr>
<td>Using deployable?</td>
<td>YES, but speed is under 1 inch per second</td>
</tr>
<tr>
<td>Whole team consists of US Persons</td>
<td>YES</td>
</tr>
<tr>
<td>Using ITAR and/or Export Controlled hardware</td>
<td>NO</td>
</tr>
</tbody>
</table>
8.0 Project Management Update

All
Team Organizational Chart

Advisors:
Dr. Dan Lawrence
Dr. Stephen Parke

Team Leaders:
Braden Grim
Mitch Kamstra
Jameson Krueger

Mechanical Team:
Braden Grim
Jameson Krueger
Tyler Hestand

Team Communication:
Jameson Krueger

Electrical Team:
Mitch Kamstra
Caleb Wolf
# Approximate Budget

## NNU RockSAT-X 2016 Team Budget

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost Minus Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cost:</td>
<td>Shared Deck: $30,310.00</td>
</tr>
</tbody>
</table>

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

#### Travel
- **Flight BOI-DCA** $650.00
  - **Quantity** 4
  - **Cost** $2,600.00

- **10 day Hotel** $89.00
  - **Quantity** 2
  - **Cost** $1,780.00

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

### Other
- **Miscellaneous** $300
- **PCB material** $100
- **Daily Food** $40.00
- **People** 5
- **Days** 10

### Miscellaneous
- **Vehicle Rental**
  - **Large SUV** $800.00

### 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 PakSense (launch)** $7,500.00

### Total Costs
- **Single Trip Total** $7,180.00
- **Two Trip Total** $14,360.00

---

**Note:** All costs are approximate and subject to change.
Team Picture
<table>
<thead>
<tr>
<th>Date Accomplished</th>
<th>System to be tested/Designed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/20/16</td>
<td>Demo for ASI</td>
</tr>
<tr>
<td>2/28/16</td>
<td>Fully Breadboard motor control</td>
</tr>
<tr>
<td>3/2/16</td>
<td>All PCB’s ordered (1st rev)</td>
</tr>
<tr>
<td>3/2/16</td>
<td>Machine lead screw assembly for testing</td>
</tr>
<tr>
<td>3/12/16</td>
<td>Integrate PCB’s (EPS, OBC (motor/GoPro control), ADC, RFID</td>
</tr>
<tr>
<td>March</td>
<td>ISTR</td>
</tr>
<tr>
<td>4/1/16</td>
<td>Begin integrating mechanical assembly with electrical</td>
</tr>
<tr>
<td>4/21/16</td>
<td>Senior design final presentation (final assembly required)</td>
</tr>
<tr>
<td>May - June</td>
<td>Testing and fine tuning of experiment before Wallops Integration</td>
</tr>
</tbody>
</table>
## Contact Matrix

### 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>
</tr>
<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>
<td>Yes</td>
</tr>
<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>
<td>U.S.</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Worries and Concerns

• Machining Schedule
  – Slower process than electrical manufacture

• Few last minute changes to EPS
  – Power smartphone from TE-2
  – Independent of OBC
Conclusion

• RFID Inhibit?
• Questions?