Auraria I

Gyro-Stabilized Star Tracking System with Stereoscopic Video

Preliminary Design Review
Metropolitan State University
11/5/2015
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1.0 Mission Overview

Presenter: John Celoria
Section 1 - Mission Statement and Objectives

Mission Statement

- We will design and implement a device that operates similarly to a star tracker, and use it to target a specific star, and perform spectral analysis on the star—as well as capture true-stereoscopic footage of the space environment at apogee. Our design is the first step in developing a small scale star sensor that could be useful for smaller payloads that cannot afford or accommodate larger, more costly, and more complex star trackers.

Mission Objectives

1. Gain a heightened understanding of complex engineering problems—including designing, building, and calibrating the core components of a functional star tracking system from scratch.

2. Gather sufficient footage from the star sensor to prove the efficacy of our targeting system.

3. Gather usable footage for post processing into a stereoscopic video.
Mission Overview: Theory and Concepts

• We will be designing a gyro-stabilized star sensor that will attempt to acquire and then actively track a star.
  – This will involve establishing a pitch- and yaw-stabilized point relative to Earth from which to gather data from our target star, as well as developing a dynamic, autonomous orientation process using GPS.
• The relevant research we performed was in our involvement with RockSat-C 14/15, wherein we developed a system that analyzed the spin rate of the rocket, and spun a platform in the opposite direction, thereby counteracting the centripetal forces produced by the rocket. We were successful in that flight and will be applying what we learned about dynamic stabilization control systems to our current project, where it will be used to keep the star tracking assembly stable, as well as directly using sensor data from the stars as a targeting method for the star tracker’s fine control mechanism.
Mission Overview: Expected Results

• We expect to be able to acquire a predetermined star using GPS, track the star using a sensor-based pixel-offset-correction method—and for the stabilization system to provide $<0.1\text{Hz}$ of precession for the star tracking assembly.

• We expect to capture sufficient video footage from the cameras to work with in post-processing, where we will turn the footage into a stereoscopic video, as well as create another, separate video file highlighting infrared and ultraviolet wavelengths in false-color.
ConOps Diagram

T+70
Altitude: ~77 km
*TE-1 activates Camera and Spin Stabilization Subsystems*

T+72
Altitude: ~77 km
*Cameras begin recording; deploy*

T+198
Altitude: ~150 km
*Apogee*

T+280
Altitude: ~113 km
*TE-2 activates, signaling camera retraction; TE-2 End*

T+198
Altitude: ~150 km
*Apogee*

T+332
Altitude: ~69 km
*TE-1 End; Wallops Power Shut Off; Star Tracker Auto-Off*

T+0.1
Altitude: 1 m
*G-switch triggered; Star Tracker activated*
## ConOps Critical Events Timeline

### Auraria I ConOps Timeline

<table>
<thead>
<tr>
<th>Time (sec)</th>
<th>Event</th>
<th>Event Type</th>
<th>Dwell Time (sec)</th>
<th>Event End Time (sec)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Terrier Ignition</td>
<td>Rocket</td>
<td>-</td>
<td>0.0</td>
<td>Note: point up</td>
</tr>
<tr>
<td>0.1</td>
<td>Star Tracker activation</td>
<td>Payload</td>
<td>331.0</td>
<td>331.1</td>
<td>G-switch activation of isolated system</td>
</tr>
<tr>
<td>70.0</td>
<td>Signal for Aft Skirt deployment</td>
<td>Rocket</td>
<td>262.0</td>
<td>332.0</td>
<td>Nosecone computer controlled skirt deployment signal</td>
</tr>
<tr>
<td>70.0</td>
<td>TE-1</td>
<td>Payload</td>
<td>262.0</td>
<td>332.0</td>
<td>Activates camera system and star tracker stabilization platform, GPS will attempt to acquire signal, Arduino will delay 2.5 seconds before extending booms</td>
</tr>
<tr>
<td>72.0</td>
<td>Skirt separation</td>
<td>Rocket</td>
<td>-</td>
<td>72.0</td>
<td>Note: keep hands and arms inside vehicle</td>
</tr>
<tr>
<td>280.0</td>
<td>TE-2</td>
<td>Payload</td>
<td>1.0</td>
<td>281.0</td>
<td>This Wallops power line will be stepped down to 5V; used signal to Arduino computer to retract camera booms</td>
</tr>
<tr>
<td>300.0</td>
<td>Camera booms retracted</td>
<td>Payload</td>
<td>-</td>
<td>300.0</td>
<td>Camera booms will be retracted by this time</td>
</tr>
<tr>
<td>300.0</td>
<td>Redundant Stow Signal</td>
<td>Payload</td>
<td>32.0</td>
<td>332.0</td>
<td>Redundant looping command to retract cameras; retracts if not stowed</td>
</tr>
<tr>
<td>332.0</td>
<td>All systems off</td>
<td>Rocket</td>
<td>1.0</td>
<td>333.0</td>
<td>Note: brace for impact</td>
</tr>
</tbody>
</table>
2.0 System Overview

Presenter: Devon DeJohn
Design Overview: Science Design

- GPS module
- Star Sensor
- Blackmagic Micro Cinema Cameras
- Arduino and Raspberry Pi
GPS module

• Commercial GPS modules have restrictions in place to keep them from being used in weaponry.
  – Auto disabled if above a certain altitude
  – Auto disabled if above a certain speed
• They are also designed to work under a low G-load.
  – Testing will need to be done to ensure the modules maintain operability at high G-loading
• We have found a manufacturer that provides customer firmware that would allow the modules to work at high speed and altitude, but we are still researching the G-load aspect.
Design Overview: Science Design

Star Sensor (Star Tracker)

- We are building a dual-sensor star tracker. A miniature telescope with a 12-15° FOV will be coupled to a beam splitter which will focus the image onto both sensors.
  - The first sensor will be a 1024x1024 pixel array that will be used for targeting.
  - The second sensor will be a 1x2048 pixel line that will be used to gather spectral data.
- The tracking device itself will be mounted to a pitch- and yaw-correcting gimbal, and the gimbal assembly will be housed inside a sealed enclosure.
  - The gimbal will be controlled by two stepper motors within the assembly, acting on yaw, and pitch.
  - A Raspberry Pi will use the data from the targeting sensor to keep the star centered in the frame.
Design Overview: Science Design

Blackmagic Micro Cinema Cameras

- Our camera payload will be mounted on deployable booms.
  - We will utilize a Timer Event to activate the boom extension system.
  - This extension system will likely consist of a single horizontally mounted stepper motor drive with a geared shaft. The rotor gear will be in contact with a large geared ring that will interact with a separate gear for each camera boom.
- The cameras have an expansion port that allows us to easily access crucial functions through automation.
  - We will use an Arduino to activate and deactivate the cameras, as well as trigger recording mode.
  - Both cameras will have their own micro SD memory cards to store the footage locally.
  - Both cameras will also operate on their own individual battery packs.
Design Overview: Engineering Design

• We will be using a stacked, split-level mounting system.
  – The lower half of the payload will contain the star tracker while the upper half will contain the camera deployment system.

• The Star Tracker subsystem will be further divided into two separate housings. The lower section will contain the Spin Stabilization Subsystem motor and microcontroller. The upper section will contain the star tracker.

• The cameras will each be mounted to a rack coupled to a slide (similar to the slides for a keyboard tray).
  – We will be developing a testing method to demonstrate to Wallops the safety of a proposed extension mechanism that exceeds the 1 in/sec rule.
Conceptual Designs

• Our initial payload weight estimate is ~25 lbs.
• Estimated height of payload 10.125 inches tall.
  – The payload as it is currently designed utilizes the full payload envelope in the horizontal plane—see images following for clarification.
• We will be using Wallops supplied power lines, which will connect to both the bottom section of the payload, and the camera deployment section above.
• The payload design will incorporate four booms which will be extended and retracted via a software command, and thus will only be controllable by a flight computer. No springs, actuators, or frangibolts will be present.
10.125” tall. Bottom red plate represents horizontal payload boundary as provided by User’s Guide.
The large orange ring represents a wedge shaped gear (cross-section approximation: \[\_\_\_\ \] ). The outer edge of the ring is the diagonal part of the gear, which will contact the four gear assemblies, shown as orange cylinders.
The purple cone represents a gear that will contact the diagonal edge of the large gear ring.

The light blue bars will be the racks that the cameras will mount to. They will be toothed, and will contact the orange cylinder, which represents a flat gear which is part of the purple conical gear.
Detail of cable routing openings in Camera Extension Deck
The white rings in this image represent Teflon rings, which will mount to the red bars, and secure the Shop Vac®

The hollow space between the top teflon ring above the Shop Vac® will be used to house the Camera Extension System’s electronics, which will be mounted to the top red plate upside down.
Cable routing detail from underside of Camera Extension Deck
Detail of small incursions into the Keep Out area, as defined by Wallops in the User’s Guide.

~¼” for the two camera housings (in grey), and ~⅛” an extension rack (in blue)
Bottom of payload teflon ring detail
Teflon ring turned transparent to show bottom electronics housing detail
Detail inside bottom electronics housing. The smaller white ring represents a gear ring, which will contact the horizontally mounted motor.

The white gear ring will also serve as a fitting to keep the Shop Vac® from horizontal shifting, while the top and bottom teflon rings (from slide 26) will vertically restrain the Shop Vac®.
## Top Level Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>The camera extension system must be able to reach a fully extended span of</td>
<td><strong>Demonstration</strong></td>
<td>Camera booms will be extended to full length to verify requirements</td>
</tr>
<tr>
<td>~40” in diameter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The booms must extend to the full ~40” diameter at ~5 inches/sec</td>
<td><strong>Analysis/Test</strong></td>
<td>Criteria for the extension mechanism will be precisely calculated, and programmed accordingly</td>
</tr>
<tr>
<td>The star tracker must demonstrate the ability to track a moving target</td>
<td><strong>Test</strong></td>
<td>We will continually test the ability of our tracking software to keep an acquired target centered in the frame by tracking actual stars and physically jostling the payload</td>
</tr>
<tr>
<td>The system must survive launch environment</td>
<td><strong>Test</strong></td>
<td>We will develop and implement our own pre-Wallops testing methods in order to approximate the stability of the payload before official environmental testing in Virginia</td>
</tr>
</tbody>
</table>
Auraria-I
Functional Block Diagram

-isolated System
(No Wallops Power)

Star Tracker Subsystem
Gimbal
M1
M2
CellNav

Star Tracker Subsystem
Raspberry Pi
G-Switch
12V

Power Distribution
DC/DC 28V to 9V
GND Point

Arduino

Camera Subsystem
C1 C2 C3 C4
B1 B2 B3 B4

Stepper Motor

9V to 9V

Power Rail

Arduino

2016 PDR 28

RED - Power
GREEN - Data/Control
BLACK - Physical

TE-1 TE-2 TE-3
WALLOPS POWER AND TELEMETRY

TE-1 @ T+70 Dwell 262
TE-2 @ T+280 Dwell 1
TE-3 @ T+325 Dwell 7

According to Koehler
Timeline PDF from 2015 Flight:
T+70 = aft skirt deployment
T+332 = systems deactivation
System Overview: Description of Partnerships

- We are still putting our proposals together for Ball Aerospace, ULA, Lockheed Martin, and Coors Research.
  - The primary partnership with these corporations is to provide the MSU team with the funding needed for our project. If Ball Aerospace sponsors our project, we would be interested in utilizing any resources they may make available to us. They specialize in optics systems and our payload consists of multiple optics systems.

- We have also been in communication with Blackmagic Cameras
  - The partnership with Blackmagic will consist of the donation of the cameras that our team would like to use for our launch article.

- **ROM Weight:** 25 lbs
- **Payload Dimensions:** There are slight incursions into the Keep Out area of the payload deck; two of the camera housings extend approximately ¼” into the Keep Out area.
- **Booms:** Our design incorporates four booms that are driven by a common motor/gear assembly. We will require an extension speed greater than the 1”/sec outlined in the User Guide, and will be demonstrating to Wallops the safety and efficacy of the proposed mechanism.
- **ADC Lines:** We will not be utilizing Wallops provided telemetry.
- **Asynchronous/Parallel Use:** We will not be utilizing Wallops provided telemetry.
- **Power Lines and Timer Events:** We will be utilizing all three available Timer Events.
- **Center of Gravity Requirement:** We understand the 1x1x1 requirements and will be analyzing the CG as we work on and establish final drawings of our payload.
- **High Voltage:** We will not be using high voltage for any part of our experiment, but it is possible that we may be drawing upwards of 4A through our system. If necessary, we will provide our own power for any system with a current draw over the 3.75A rating for the polyswitch.
- **Hazardous Procedures:** N/A
- **RF:** N/A
- **Bolt Heads on bottom of deck Flush Mount:** Yes
- **US Persons for whole team:** One member of our team is not considered a US Citizen.
- **ITAR:** We will not be exporting our GPS product, and will be following international regulations closely.
• At apogee, we require the rocket to be orientated in such a way that the side of the experiment deck containing the cable channels are directed towards Earth. We want to be able to position the Star Finder system perpendicular to Earth without any possibility of the cable channel blocking our field of view.
System Overview: Special Requests

• Boom extension at a rate of five inches per second instead of one inch per second.
  – We are hoping to be able to have a maximum distance of 30-40 inches between cameras
• A small section of two of our camera’s housings extend into the ‘keep out area’ a quarter of an inch.
  – We are not sure if this is going to be a problem; however, the earlier we are able to address this issue, the earlier we can get find a solution
3.0 Subsystem Design

Presenters: Devon DeJohn, Ryan Kennedy
Subsytem Design Contents

Structures
- Star Tracker Assembly
- Star Tracker Stabilization Unit
- Camera Extension System
- Payload Reentry Protection System

Power
- Star Tracker Internal Power
- TE-1, TE-2, TE-3

Science
- Stereoscopic Video System
- Star Tracker Subsystem
- Star Tracker Subsystem Stabilization
Subsystem Design: Science

Star Tracker Subsystem
• Star Tracker
• Two-Axis Gimbal
• Internal Power
• G-switch/Timer combination
Subsystem Design: Star Tracker Subsystem Overview

The Star Tracker Subsystem will consist of two CCD arrays (1024x1024 and 1x2048) coupled with a miniature telescope. A beam splitter will be used to direct the image onto both sensors. This will be mounted to a two-axis targeting gimbal. The 1024x1024 sensor will provide targeting data to a Raspberry Pi 2 microprocessor. The Pi will then translate the data into a two-axis targeting scheme and control the two motors of the gimbal. The 1x2048 sensor will be used with a diffraction grating for spectral analysis of the targeted star. The entire subsystem will be contained in a vacuum sealed enclosure, and because the enclosure will be rotating, it will need to be isolated. As such, the Star Tracker Subsystem will be powered internally using 12V Li-Po batteries, and all wiring and electronic components will be contained within the enclosure.

The system will be activated at launch using a timed latching G-switch. Upon activation, a timer will count to 70, then the switch will close, and a new timer will count to 265 seconds, and then reopen the circuit, shutting down power to the system.
Subsystem Design: Science

Star Tracker Stabilization Unit
• Arduino
• Gyroscope (z-axis)
• GPS
• TE-1 (T+70; dwell 262)
The GPS module will try for signal acquisition as soon as the skirt is removed, and will orient the star tracker in the general direction of our first target star via the low-RPM motor. The Star Tracker Stabilization Unit will consist of a one-axis gyroscope oriented to the rocket’s Z-axis, which will measure the roll rate (if any) after despin. The gyro’s data will be translated by an Arduino microprocessor, which will control a low-RPM motor in the opposite direction as the rocket’s roll. This will provide the Star Tracker Subsystem assembly with a more stable environment from which it can acquire stars.

This system will be activated by the first of the Timer Events provided to us. TE-1 activates at T+70 (just after skirt separation signal flag). Dwell time will be 262 seconds (Wallops Experiment Shut Off @ T+332). TE-1 will be used to power on the Arduino, GPS module, and gyroscope, as well as provide power to the motor. We will use the Timer Event so as not to have the system running until it is needed, which is only for the duration of apogee, while the Star Tracker is activated.

The Arduino will have a delay of 2.5 seconds upon power-on before extending cameras (Aft skirt separation @ T+72; camera extension @ ~T+72.5)
Subsystem Design: Science

Stereoscopic Video Subsystem
• Arduino
• Stepper Motor
  – rack and pinion
• Hall effect sensor and small magnet
• TE-1 (T+70; dwell 262)
• TE-2 (T+280; dwell 1)
The Stereoscopic Video Subsystem will consist of up to four cameras mounted on telescopic racks which will be extended and retracted by a stepper motor rack and pinion assembly. The cameras will run on internal power. The stepper motor will be powered through the Timer Events, and controlled by an Arduino microcontroller also powered by the Timer Events.

TE-1 will power on the Arduino at T+70 and remain on until Wallops Power Shut Off at T+332. TE-2 will occur at T+280 with a specified dwell time of 1 second. The TE-2 power line will run through a voltage regulator and stepped down from 9V to 5V. The regulator will then feed that 5V signal into an analog pin on the Arduino set to a continuous read function. This signal will trigger the Arduino to retract the cameras, and the Arduino will move on to the next instruction.

A small magnet will be attached to the end of one camera boom. A hall effect sensor will be mounted to the payload next to it. After TE-2 triggered retraction, the Arduino will begin to read the hall effect sensor output. If the sensor’s output is low, the Arduino will run the retraction code, wait 20 seconds (to allow booms to retract), and then read the hall effect sensor again. The redundant system will have roughly 50 seconds to run, or two attempts to retract the cameras before reentry.
All commands and data handling will be carried out by three separate computers. Each computer will exclusively control its respective subsystem. No inter-system data transfer is needed.

- 2x Arduino Microcontrollers
- Raspberry Pi
Star Tracker Subsystem Logic

12V 3Ah Battery → G-Switch

Timer:
- Count: 0 to 70 → Close Circuit
- Count: 0 to 265 → Open Circuit

1024x1024 Targeting Sensor:
- Analyze Frame
- Store "A" Data
- Gimbal "Center On Object"

1x2048 Spectral Analysis Sensor:
- Analyze Frame
- Store "B" Data
- Object Centered? (YES/NO)
Camera Subsystem Logic

void setup()

- Cameras ON
- Cameras REC
- Extend Cameras
- Read analog pin 'X'
- Voltage > 0.1?
  - NO: Retract Cameras
  - YES: Delay for 30 seconds

void loop()

- TE-1 @ T+70; dwell 262 (9V)
- Magnet Attached to Boom
- Hall Effect Sensor
- Pin 'Y'
- Read analog pin 'Y'
- Voltage > 0.1?
  - YES: End Program
  - NO: Delay for 30 seconds
  - Retract Cameras
4.0 Risk Matrices

Presenter: Matthew Hevert
Risk Matrix: (Star Tracker)

ST.RSK.1: Stepper motor overcompensates for minor rotations
ST.RSK.2: Beam splitter isn’t focused to specifications
ST.RSK.3: Tracker unable to determine location of the brightest star
CAM.RSK.1: Unable to acquire the Blackmagic cameras
Solution: Use Gopros as a back up
CAM.RSK.2: The booms for the cameras won’t retract
CAM.RSK.3: The booms are damaged in launch
CAM.RSK.4: Cameras malfunction
Risk Matrix: (Miscellaneous)

MISC.RSK.1: Internal damages due to vibration
MISC.RSK.2: Grant / donation goals cannot be reached
MISC.RSK.3: Payload design exceeds budget
5.0 Test/Prototyping Plan

Presenter: Matthew Hevert
Test/Prototyping Plan - Star Tracker

- Place the arrays in the StarFinder housing and ensure beam splitter is able to focus the light properly onto each.
  - ST.RSK 2- Prisms do not focus as intended.
  - Connect to power supply and microcontroller to ensure functionality
    - This will also test the software package for the star tracker
  - Once we have a functioning model, we intend to take it into the mountains and attempt to track a star in real time.
  - ST.RSK 3- Star Tracker unable to get a lock on the star. If the system is unable to get a lock on a star, we will have to look and see if it is a programming issue or a hardware issue.
    - To determine if it is a hardware failure or a software failure we will find a dark area and have a single light 50 yards from the device and see if it is able to detect it.

- Test the Gimbal Device by rotating it around and ensuring the center stays stable.
  - Attach the star tracker to the gimbal and repeat above test
Test/Prototyping Plan - Spin Stabilization Platform

- Test the stepper motor by attaching it to a power supply and running logic to it to rotate at a low velocity
  - Connect a gyroscopic sensor to the motor and microcontroller and see if it counteracts the low rotational velocity.
  - Attach the Star Tracker to the Stabilization Platform.
  - ST.RSK 1- Stabilization platform over compensates for the low rotational velocity
    - If we are noticing that the stepper motor is getting a little rambunctious, we can go into the programming code and make adjustments to the calculations the computer makes
- Once we have a fully functioning model, we will again take it to the mountains and attempt to track a star in real time.
Test/Prototyping Plan - Camera System

- Test to ensure the 9V to 5V conversion
- Test the motor to ensure that our mechanical device rotates at the correct velocity to extend the booms at the designated speed
  - Attach the boom extensions and retest for extension speed and also that it stops when they reach their desired length
    - CAM.RSK 2- Confirm that the computer retracts the booms (spins the motor in the opposite direction) after the designated amount of time
- Once we have the cameras from Blackmagic, create a mock up that has the cameras with a 30 inch separation and ensure that we are able to capture stereoscopic images.
  - Attach the cameras to the mechanical platform and repeat the extension/retraction test
Test/Prototyping Plan - Launch Environment and Re-entry

Launch Environment
❖ Once we have a working model, we plan to partner with known contacts about setting up a vibration table test (MISC.RSK 1)
❖ We will also be testing the functionality of the G-Switch and the durability of our internal components by performing simple drop tests from various heights (CAM.RSK 3)

Reentry Protection
❖ We will test the the waterproofing of our payload by placing it in a bucket of water and checking for any leaks
❖ We will test the protective coating of our payload by placing a model in either a kiln or an oven with a temperature sensor on the inside
6.0 Project Management Plan (PMP)

Presenter: Matthew Hevert
Meetings every Monday at 5:30 PM and Wednesday at 6:00 PM.

Weekend meetings take place when Team Leads determine it necessary.

Still utilizing the ASANA program to manage the schedule and assign tasks to the Team Leads.
The $2000 earnest deposit should have been received by CU Boulder on the date that it was due.
Advisers:

**Faculty Advisor:**
Stephen Hevert
Senior Engineer for Lockheed Martin
Professor of Aerospace Technologies

**Industry Advisor:**
Craig Hassler
PhD Physicist
Retired
Has done work for NASA and DARPA
Advised on the RockSat-C project
Team Organization Chart

MSU Space Grant Director: Aaron Brown

Faculty Adviser: Stephen Hevert
Adviser: Craig Hassler

Project Manager: Matthew Hevert

Documentarian: Taryn Aichele

Mechanical Team
Lead: Ryan Kennedy
David Brown
Brian West
Amy Carl
Aaron Zapiler
Juan Rodelo-Castillo
Robert Dunn

Electrical Team
Lead: Devon DeJohn
Brian West
Robert Dunn
Ovidio Resendez
Juan Rodelo-Castillo

Programming Team
Lead: John Celoria
Jiancong Liang
Robert Dunn
Aaron Zapiler
Devon DeJohn
PMP: Latest Team Availability Matrix

<table>
<thead>
<tr>
<th>Auraria-One (Metro State University)</th>
<th>PDR RS-X Team Availability Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PLEASE USE MOUNTAIN TIME ZONE TIMES</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Oct 12-16</strong></td>
<td>Monday</td>
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<tr>
<td>7:00 AM</td>
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<td>8:00 AM</td>
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# PMP: Latest Contact Matrix

## RS-X Contact Matrix 2016  
**MSU Space Grant (Auraria-One)**

<table>
<thead>
<tr>
<th>Team Member</th>
<th>Role</th>
<th>School</th>
<th>Email Address</th>
<th>Phone Number</th>
<th>Add to Mailing List</th>
<th>Receive Texts (Y/N)</th>
<th>US Person? (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stephen Hevert</td>
<td>Faculty Advisor</td>
<td>MSU</td>
<td><a href="mailto:Heverts02@gmail.com">Heverts02@gmail.com</a></td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Craig Hassler</td>
<td>Advisor</td>
<td>CCD</td>
<td><a href="mailto:Craig.Hassler@gmail.com">Craig.Hassler@gmail.com</a></td>
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CSV file of contact matrix emails (download and then import into your email app): [link](https://drive.google.com/open?id=0B5x.wv7WzZK0c4Ypa1VvSzWpSSkU)
PMP: Worries

- Achieving maximum extension for cameras
- Conquering the software package
- Receiving funding for the project
- Ensuring that we are not over complicating our payload and keeping all possible de-scopes in mind.
The Rocket Satellite X program provides students from the Auraria Campus hands on experience within the STEM fields, as well as a fun, challenging experience to students who want to explore the possibility of pursuing a degree in science and engineering.

We are also hoping that a successful flight will incentivize collaboration between the three colleges on our campus for future projects. Our Star Tracking system is the first step in developing a celestial navigation system. Future RockSat-X payloads will build upon the success of this year's project.

With the success that we have had in past Space Grant activities, we feel confident that we will be able to produce a fully functional payload ready and thoroughly tested for flight.
PMP: Moving Forward

Moving forward into the Critical Design Review, we will be continuing to focus in on our final design. All components will now go through the final selection process and we will know our exact power consumption. We will also be able to provide the electrical layout of our payload. Our Structural Team will have detailed mechanical drawings with full dimensions including weight and estimated COG. We will continue to work on securing funding for our project and further develop our software package.