Lil G’s
Conceptual Design Review

Community Colleges of Colorado
ACC, RRCC

Caleb Christenson, Nathan Clapp, Mac Grove, Faatasina Liufau, Tiffany Lovett, Spencer Madison, Segev Morgan, Onterrio Morris, Santana Padilla, Cid Quezada, Marieke Spiegleman, Jared Stroud, Shannon Walters-Dorchak

10/18/19
Slide Assignments:
1-6: Santana
7-13: Nathan
14-17: Santana
18-28: Cid
29-30: Nathan
31-46: Marieke/Spencer

Nathan Clapp, 10/24/2019
PDR Presentation Content

- **Section 1: Mission Overview**
  - Mission Statement
  - Mission Objectives
  - Theory and Concepts
  - Concept of Operations
  - Expected Results
  - Case Study Design (Bio)
  - Theory and Concepts (Bio)
  - Expected Results (Bio)
PDR Presentation Content

- **Section 2: Design Overview**
  - Science Design
  - Initial Ideas
  - Payload Layout
  - Engineering Design
  - Functional Block Diagram
  - Payload Layout (sketches)
  - RockSat-X User’s Guide Compliance
PDR Presentation Contents

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

- **Section 4: Conclusions**
  - PDR objectives
  - Our next overall goals
  - Final Thoughts
  - Questions for us
Mission Overview

Presenters: Nathan Clapp, Santana Padilla
Mission Overview: Mission Statement

Create a virtual reality camera assembly that fits into a payload, so 360° video of a rocket outside of the Earth’s atmosphere can be obtained.

Assess the effects of microgravity and radiation exposure on the bacterial species *Serratia marcescens*, as a secondary experiment.
Mission Overview: Mission Statement

- Mission Statement:
  - Create an innovative camera assembly to capture virtual reality footage of a space mission.

- We may, as secondary goals:
  - Record VR image data for use in a machine learning program.
  - Include an enclosed radiation study of a dry microorganism, *Serratia marcescens*. 
Mission Overview: Mission Statement

• Data Usage:
  ○ Video/image data will be used for NASA research and outreach efforts, and may be used by RRCC/ACC students to test a neural network.

• Why this mission should fly on a rocket:
  ○ Virtual reality video of space would provide significant material for fostering enthusiasm in space exploration.
  ○ Our design, if proven effective, may provide cost-effective options to future VR-focused missions.
Mission Overview: Mission Objectives

- **Mission Objectives:**
  - Interface the VR camera with a data storage system.
  - Program the payload to extend and retract one or more camera arms.
  - Collect data from the camera system during timed events.
  - Ensure that data is redundantly stored.
  - Expose a microorganism to a microgravity environment and radiation.
Mission Overview: Mission Objectives

- **Second Level Success Criteria:**
  - Recover at least one full copy of the virtual reality video footage.

- **Minimum Success Criteria:**
  - Recover part of the virtual reality video footage.
  - Recover microbial samples for case study.
Mission Overview: Theory and Concepts

- **Design of 360-Degree Camera System:**
  - **Goal:** Design a 360° camera assembly that extends as far out as possible towards Nadir (or other direction, as specified) to record during missions.
Mission Overview: Theory and Concepts

- **Past research:**
  - VR and 360-degree cameras have been used in space before, mostly in and around the ISS.
  - NASA is working on a VR payload with similar parameters but hasn’t flown their experiment yet.
Mission Overview: Theory and Concepts

- Planetary Images Analysis Using Machine Learning:
  - **Goal**: Build a machine learning program that can do a rudimentary planetary survey by performing image analysis from images taken from space.
      - Potentially add other data types and sources to enhance planetary analysis.
  - **Concept**: Machine learning has been used in space exploration missions. The closest use to our application is atmospheric analysis.
Mission Overview: Expected Results

- **Recording and Storing 360-Degree Footage:**
  - **Primary:**
    - The recording state of the 360-degree camera(s) will have been timed appropriately for the various stages of the flight.
    - The boom arm(s) will be extended and contracted accordingly.
  - **Secondary:**
    - Data from the mission will be analyzed to assess the accuracy in both our data collection, and the neural network.
Mission Overview: Case Study Design

- **Case Study Design for *Serratia marcescens* Samples:**
  - **3 Case Study Missions:** We will compare RockSat-X data with DemoSat Fall 2019 and Spring 2020 mission data.
  - **Data Comparison:** We will study the data in comparison to controls, Earth-based specimens, and other recent studies on this organism.
Mission Overview: Theory and Concepts

- **Radiation Case Study of *Serratia marcescens***:
  - **Goal**: Compare how radiation exposure and microgravity affects *S. marcescens* post flight, specifically nitrogen degradation and colony color variations.
  - **Theory**: Microorganisms exhibit enhanced metabolic processes and virulence in microgravity environments.
  - **Applications**: The study of organism behavior in space environments is useful to future space exploration, health science and astronauts, and planetary ecological protections.
Mission Overview: Expected Results

- Expected Results and Examinable Properties of *Serratia marcescens* Sample:
  - Focal Properties: We will gain data on cell survival and metabolism. We will culture the specimens to analyze nitrogen degradation rates, colony color, and growth using formation size and count.

  - Radiation Concept: White colonies of *S. marcescens* are noted for high survival rates in extreme radiation rich environments. It will be interesting to see if this also has a preservation affect in post-flight cultures.
Design Overview

**Presenter:** Cid Quezada
Design Overview: Science Design

- **Instrumentation**: camera, raspberry pi, motors, boom arm, and monitoring/data sensors

- **Concept**: The boom arm will extend away from the main payload, allowing VR footage to be taken of the rocket and other payloads.
Design Overview: Initial Ideas

Arm Concepts Rocket

1) Linear Actuator + Arm Combo

Electrical Box Linear Actuator

Notes
- If linear actuator is split for 2 cameras, length of it's extension reduces by half
- Smaller camera would allow more structural strength

Extension Arm 5 inch

Camera
Design Overview: Initial Ideas

1B) Double linear Actuator

- Gear
- Linear actuators
- Camera

- Motor setup is up to debate
Design Overview: Initial Ideas

- Using rotation of the rocket, the shelf would eventually extrude.
- Motor with cable would retract extender when needed.
- Concept 2: bat with linear actuator attached to each slider.
Design Overview: Payload Layout

Example Payload Layout:

- Mechanical Pivot Arm
- 360 VR Camera
- Electrical Components
- Data Storage
- Arm/Camera Setup
- Bio Exp
- Sensor
Design Overview: Payload Layout

Potential Mechanical Arm Extensions (one option will be used):
- Telescoping (mechanics)
- Linear Actuator
- Mechanical Pivot Arm


Design Overview: Payload Layout

Data Storage
Linear Actuator
Camera
Extending Arm
Electrical Box

Fully extended actuator and arm
Design Overview: Payload Layout

Dovetail joint extender
Camera

Electrical Box
Data Storage
Design Overview: Engineering Design

- **Current Designs**: Servo Arm & Linear Actuator

- Include one or more linear actuator(s) to extend an arm-mounted camera from the rocket.

- Thermally insulative protection for camera and electronics.

- **Dependencies**: Linear actuators, motors
Design Overview: Engineering Design

- **Current Designs**: Dovetail sliders

- Uses centripetal force of rocket to extend sliders

- Use a motor and cable to slow down and prevent sliders from exiting too soon

- Thermally insulative protection for camera and electronics.

- **Dependencies**: Motor and centripetal force
Design Overview: Engineering Design

- **Command and Data Handling, Software:**
  - Our main computer, likely a Raspberry Pi 3, will run a lightweight Linux operating system, such as DietPi.
  - The main computer will be tasked with running command scripts as rocket events are signalled.
  - Our flight event code will be written in a compiled language, likely C++ or Swift.
  - Code for video/sensor data collection and storage will likely be written in Python.
Functional Block Diagram

- Rocket Power
- Power Detector
- Voltage Converter
- Boom/Motor
- Radiation Sensor (Secondary Experiment)
- Alternate Power Source
- VR Camera
- SD Card
- Main Computer

RED = Power
GREEN = Data
Management

*Presenter:* Spencer
## Tentative Schedule

### October 2019
- **10/25/19** Conceptual Design Review (CoDR)
- **10/28/19-11/1/19** Design Electronics system and purchase parts

### November 2019
- **11/4/19 - 11/8/19** Start Prototyping and testing
- **11/11/19 - 11/15/19** Week of Preliminary Design Review (PDR)
- **11/18/19 - 11/22/19** Continue to develop prototype
- **11/25/19 - 11/29/19** Have a complete working prototype system.

### December 2019
- **12/2/19 - 12/6/19** Extra Testing time
- **12/9/19 - 12/13/19** Week of Critical Design Review (CDR)
- **12/23/19 - 1/5/20** Winter Break

### January 2020
- **1/8/20** Final Selection
- **1/9/20 - 1/31/19** Finish subsystems
Tentative Schedule

February 2020

2/1/20 - 2/9/20 Finish Testing Subsystems
2/10/20 - 2/14/20 Subsystem Testing Review (STR)
2/17/20 - 2/21/20 Begin Integration Testing

March 2020

3/16/20 - 3/20/20 Integrated Subsystem Testing Review (ISTR)

April 2020

4/6/20 - 4/10/20 Full Mission Simulation
4/27/20 - 5/1/20 Full Mission Simulation Review (FMSR)

May 2020

5/25/20 - 5/29/20 Prepare for Integration Readiness Review (IRR)
Tentative Schedule

June 2020

06/01/20 Last day for adjustments/revisions in design
06/01/20 Integration Readiness Review (IRR)
06/15/20 - 06/20/20 Integration Testing Week

July 2020

07/20/20 Before Flight Procedure (BFP)
07/27/20 Launch Readiness Review (LRR)
GSE Checkouts
Payload Integration and Sequencing GPS Roll-Out and Vibration Testing Spin and Balance Testing
Moment of Inertia Testing

August 2020

08/03/20-08/12/20 Launch
GSE Checkouts
Payload Integration and Sequence Testing
Wallops Integration
Tour of WFF
Launch and Recovery
08/14/20 - 08/31/20 Rough Draft Of Final Report

September 2020

09/15/20 Second draft for report
09/30/20 Final Report Due
Team Structure

**Team Management:**
Spencer Madison

**Mechanical:**
Meeting Time/Location Sunday 3:00 PM Starbucks, Jewell and Wadsworth
**Team Leads:** Sina Liufau and Cid Quezada
Team Members: Caleb Christenson, Shannon Walters-Dorchak, Onterrio Morris, and Jared Stroud

**Electrical:**
Meeting Time/Location Sunday 3:00 PM Starbucks, Jewell and Wadsworth
**Team Leads:** Caleb Christenson and Marieke Spiegleman
Team Members: Sina Liufau, Santana Padilla, and Cid Quezada

**Software/Programing:**
Meeting Time/Location(s) Mondays 6:00 PM RRCC Room 2670, ACC M3020
**Team Leads:** Nathan Clapp and Segev Morgan
Team Members: Mac Grove, Tiffany Lovett, Onterrio Morris, and Marieke Spiegleman

**Biology/Experiments:**
Meeting Time/Location Thursdays 3:00-4:00 PM RRCC Idea Lab
**Team Leads:** Tiffany Lovett and Santana Padilla
Team Members: Mac Grove, and Shannon Walters-Dorchak
Management (Budget)

Labor:

- **Option 1:**
  Hourly (Colorado minimum wage, $11.20/hr, 10 hrs/week): $61,152

- **Option 2:**
  $1000 Stipend each semester for each student (Fall, Spring, Summer): $39,000

- **Option 3:**
  $500 Stipend each semester for each student (Fall, Spring, Summer): $19,500
Management (Budget Continued...)

Travel: ($1750 per trip, per person, Not including Costs of Advisor Travel)

- **Airfare**: ($500-$600)
- **Per Diem**: ($50 a day, $61 is the national average)
- **Lodging**: ($25 a night at Wallops)
- **Spring Break Trip**: (3 people)
  - $5,250 (5 days)
- **June Trip**: (6 people)
  - $10,500 (10 days)
- **Launch Trip**: (13 people)
  - $22,750 (10 days)
Management (Budget Continued...)

Hardware: Total with 2 Cameras 1: $7,725 2: $8,505  3: $9,605

- Camera:
  ○ Option 1: Insta360 Air $120/camera
  ○ Option 2: Insta360 OneX $450/camera
  ○ Option 3: RICOH THETA Z1 $1000/camera

- Boom Arm: $1000/per arm
- Microprocessor: (Raspberry Pi): $55/unit
- Motor(s) for Arm: $200/motor
- Power System: $150
- Circuitry: $200
- Thermal/ Waterproof Enclosure: $300
- Extra Parts Budget: $2,000
Management (Budget Continued...)

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<td>Option 3:</td>
<td>$61,152</td>
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<td>$9,605</td>
<td>$109,257</td>
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</table>

Range: $60,475-$109,257
## Management Contact Matrix

### Lil G’s (Arapahoe Community College, Red Rocks Community College)

<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>Add to mailing list?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronics Team Lead</td>
<td>Caleb Christenson</td>
<td>303-815-9714</td>
<td>303-815-9714</td>
<td>Yes</td>
<td><a href="mailto:cchristenson2@student.cccs.edu">cchristenson2@student.cccs.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Electronical Team Lead</td>
<td>Marieke Speigleman</td>
<td>303-913-9155</td>
<td>303-913-9155</td>
<td>Yes</td>
<td><a href="mailto:marielke.speigleman@gmail.com">marielke.speigleman@gmail.com</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Software Team Lead</td>
<td>Nathan Clapp</td>
<td>303-263-0845</td>
<td>303-263-0845</td>
<td>Yes</td>
<td><a href="mailto:gnathanq20@gmail.com">gnathanq20@gmail.com</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Software Team Lead</td>
<td>Segev Morgan</td>
<td>720-480-9248</td>
<td>720-480-9248</td>
<td>Yes</td>
<td><a href="mailto:segev.morgan@gmail.com">segev.morgan@gmail.com</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Biology/Experiments Team Lead</td>
<td>Tiffany Lovett</td>
<td>913-709-4265</td>
<td>913-709-4265</td>
<td>Yes</td>
<td><a href="mailto:tlovettt5@student.cccs.edu">tlovettt5@student.cccs.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Biology/Experiments Team Lead</td>
<td>Santana Padilla</td>
<td>720-520-4480</td>
<td>720-520-4480</td>
<td>Yes</td>
<td><a href="mailto:projectharmony3@gmail.com">projectharmony3@gmail.com</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Mechanical Team Lead</td>
<td>Sina Lufau</td>
<td>714-402-7967</td>
<td>714-402-7967</td>
<td>Yes</td>
<td><a href="mailto:flufau@student.cccs.edu">flufau@student.cccs.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Advisor</td>
<td>Jennifer Jones</td>
<td>303-797-5839</td>
<td>720-985-5806</td>
<td>Yes</td>
<td><a href="mailto:jenniferjones@arapahoe.edu">jenniferjones@arapahoe.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Mechanical Team Lead</td>
<td>Cid Quezada</td>
<td>720-288-9305</td>
<td>720-288-9305</td>
<td>Yes</td>
<td><a href="mailto:cid.quezada@outlook.com">cid.quezada@outlook.com</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Mechanical/Material Team</td>
<td>Shannon Walters-Dorchak</td>
<td>720-233-0753</td>
<td>720-233-0753</td>
<td>Yes</td>
<td><a href="mailto:shannon.kathleen96@gmail.com">shannon.kathleen96@gmail.com</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Mechanical Team</td>
<td>Jared Stroud</td>
<td>209-623-5730</td>
<td>209-623-5730</td>
<td>Yes</td>
<td><a href="mailto:jared.stroud@gmail.com">jared.stroud@gmail.com</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Mech/Programming</td>
<td>Onterrio Morris</td>
<td>816-694-9676</td>
<td>816-694-9676</td>
<td>Yes</td>
<td><a href="mailto:omorris64@student.cccs.edu">omorris64@student.cccs.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Managing Director</td>
<td>Spencer Madison</td>
<td>970-208-6990</td>
<td>970-208-6990</td>
<td>Yes</td>
<td><a href="mailto:spencermadison@gmail.com">spencermadison@gmail.com</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Software/ Biology</td>
<td>Mac Grove</td>
<td>303-903-3008</td>
<td>303-903-3008</td>
<td>Yes</td>
<td><a href="mailto:stackchase7@icloud.com">stackchase7@icloud.com</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Advisor</td>
<td>Barbra Sobhani</td>
<td>303-914-6366</td>
<td>303-914-6366</td>
<td>Yes</td>
<td><a href="mailto:Barbra.Sobhani@rcc.edu">Barbra.Sobhani@rcc.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
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Team Mentors

- Team Mentors: Jennifer Jones (ACC)
- Barbra Sobhani (RRCC)
- Chris Koehler (Colorado Space Grant)
- NASA
Management Team Availability Matrix

<table>
<thead>
<tr>
<th>Team Name/School Here: Lil G's (Arapahoe Community College, Red Rocks)</th>
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<tr>
<td>Fall RS-X Team Availability Matrix</td>
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Please Place priority levels for times you are available. This is done by simply typing a 1, 2, 3, or 4 in each clear box.

Example

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Highest Priority | Lowest Priority
## User Guide Compliance: Summary

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<th>Status/Reason (if needed)</th>
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<tr>
<td>Center of gravity in 1” plane of plate?</td>
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<tr>
<td>Weight 30.0+/- 1.0 (15.0 +/- 0.5) lbs?</td>
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<tr>
<td>Max Height &lt; 10.75” (5.13”)</td>
<td>Yes</td>
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<tr>
<td>Bottom of deck has flush mount hardware?</td>
<td>Yes</td>
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<tr>
<td>Within Keep-Out Zone</td>
<td>Clear</td>
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<tr>
<td>Using &lt; 10 A/D Lines</td>
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<tr>
<td>Using/Understand Parallel Line</td>
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<tr>
<td>Using/Understand Asynchronous Line</td>
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<tr>
<td>Using X GSE Line(s)</td>
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<td>Using X Non-Redundant PWR Lines (TE-1, TE-2, TE-3)</td>
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<td>Using X Redundant Power Lines (TE-R)</td>
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<td>Using &lt;= 28 V</td>
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<td>Using deployable?</td>
<td>Yes</td>
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<tr>
<td>Whole team consists of US Persons</td>
<td>Yes</td>
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<tr>
<td>Using ITAR and/or Export Controlled hardware</td>
<td>No</td>
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Risks/Worries

- Camera overheating
- Protecting the payload from water and heat
- Interfacing the camera with a data collection system
- Data corruption
- Data transfer (camera -> storage) time window
- Arm jamming
- Image stabilization failure
- Sun glare washing out footage
Conclusion

Why Choose Our Mission?

• VR/AR applications of 360-degree video footage enhance STEM and NASA outreach.
• Machine learning analysis enhances vehicle systems and creates robust integrative technologies for future space exploration missions.
• Microbial analysis of orbital environments is imperative for astronauts and health science applications.
Next Steps to PDR

- Test various boom arm designs
- Complete ground experiments with recording and data systems
- Investigate ways to insulate the data storage and microbial canisters
- Begin full system prototyping
- Determine Length needed for arm extension
- Start finding and purchasing parts for our payload
- Research how to interface camera with onboard computer system