M.A.P.L.E.
Mesospheric
Autorotational
Payload
Lander
Experiment

Concept Design Review
College of the Canyons
Team Members
12/14/2018
PDR Presentation Content

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Section 1: Mission Overview
Mission Statement

College of the Canyons’ Makerspace/Astronomy Physics club Payload Program, or MAPPP, aims to be our student’s guide to a bright future in the field of STEM. Our project with Rocksat X provides our members with the experience they need to be competitive in today's job market while fueling their passions.

We expect that over the coming months, our members will grow from the challenges, failures, successes, and teamwork encountered. From a technical standpoint, we aim to discover just what it takes to build a true space-fairing vehicle and take our first steps into the real world of space exploration.

This project also has potential commercial and academic applications. If our project is successful, it opens up a new sector of low-cost, unmanned, autonomous reentry vehicles that could be utilized for interplanetary lander missions to worlds with heavy atmospheres, cargo return from Earth's orbit, sub-orbital research, or rapid cargo delivery. If the concept can be scaled and proven reliable, it even has potential applications for manned reentry capsules.

Small scale private space organizations and academic institutions stand to gain the most out of the success of our project by utilizing these vehicles for their relatively low cost and the ability to safely return cargo or scientific research from LEO. Much in the way cubesats or weather balloons are utilized, our proposed system provides a new way of accessing space.
Why we are a prime candidate for selection

- We are bringing a bold and innovative concept that is specifically tailored to the vehicle and mission Rocksat X provides.
- The success of our project provides a potential new avenue for the exploration of space and interplanetary bodies.
- While similar experiments have been attempted, success would prove the feasibility of a new type of reentry vehicle.
- Our team is comprised of several veteran members to other NASA collaborative projects, such as the High Altitude Student Program, as well as recent and former NASA interns.
- College of the Canyons is one of the only community colleges that attempts to undertake such projects without the collaborative efforts of larger institutions while delivering equal or greater results.
- Strong mentor and support network including former NASA and household name software/technology company employees.
- Strong financial support from local and national aerospace and manufacturing companies.
- Strong support from the cities of Santa Clarita, Valencia, and Los Angeles.
Mission Objectives

Our mission will be comprised of a relatively short sub-orbital flight that deploys at or near apogee of the RSX rocket using the timed events available to participants. As the capsule enters the atmosphere, the trajectory and center of g will enable it to orient with the heatshield forward to provide protection from the intense heat of reentry. The capsule’s blades will remain undeployed until it enters the atmosphere, where it will utilize helical air channels to force the blades open as the pressure and speed builds and also providing spin.

A successful mission is defined as utilizing the properties of auto rotation to provide the necessary lift for the capsule to slow and successfully splashdown with the vehicle and test cargo intact. The minimum criteria for success includes deployment from the rocket, as well as confirmed reentry and auto rotation from downlink data.

We are hoping to collect a wide set of data, including: Temperature, orientation, rpm speed, pressure, gps location/altitude, humidity, current, and flight computer communication. At the minimum, we would require altitude, rpm speed, and flight computer communication.
Much of our project’s conceptualization stemmed from both organic and scientific inspiration. The autorotation principles observed in falling maple or “helicopter” seeds combined with Apollo-era designs served as the catalyst for our payload’s design and operation. Deployable blades are used to provide the lift force necessary to slow the capsule’s descent velocity using the dynamic forces of the environment, in our case the air encountered upon reentry, to begin the autorotation process. The air density and the circular velocity of the blades, although not linear, should be in some sense directly proportional; we will rely on these principles in order to land successfully.
Theory and Concepts: Autorotation

- The reentry vehicle utilizes the principle of autorotation to decelerate.
- The aerodynamic forces at play produce a force tangential to the blade’s angle of attack. This, along with helical air channels designed into the capsule will drive the autorotation process.
- The negative velocity of the capsule is converted to rotational inertia, the trade-off being that this additional energy can be used to decrease the velocity of the craft more efficiently than drag alone.
Autorotation
Theory and Concepts: Learning from the past

In previous years, several attempts at utilizing auto rotation has been performed by private and federal institutions including NASA and Lockheed. While these past projects did not yield results or were deemed unfeasible, our team has several reasons why we believe the idea is valid:

- Past attempts were focused on extremely heavy craft or modifying existing vehicles for testbeds. Our capsule is tailored for smaller payloads while specifically created for this task.
- Our capsule relies heavily on the principles of physics and mechanical processes for operation. Air pressure and speed deploy the blades and mechanically lock them in place, weight and the center of gravity orient the craft, and special machining on the capsule such as channels or weighted blades assists in spinning the vehicle and driving auto rotation.
Concepts of Operation

Our autorotation capsule is a self-sustained system able to operate remotely and autonomously. It’ll remain attached to the rocket until apogee, transmitting housekeeping data throughout the time. At apogee, the capsule will jettison from the rocket and begin its descent to earth. Utilizing the services of the Iridium satellite network, we will have constant contact with the payload. Mathematical modeling is being used to calculate various parameters of the experiment like blade geometry, entry velocity, trajectory, terminal velocity, and angular velocity necessary to splashdown safely. Various sensors and instruments on board will be sending this data via Iridium to us in real time so we can assess the status of the payload. The principle of autorotation, generated by the payload’s body and blades, and airbreaking will slowly decrease the craft’s velocity until splashdown.
Expected Results

We expect to obtain valuable information about the journey from apogee to splashdown; this data will be critical in the payload’s potential future iterations. Through the predictions made from the mathematical modeling, we hope to come within 30% of those values. We do expect the payload to begin the autorotational process and would hope that despite the nonlinear conditions of actual flight, the rotation achieved during descent to be sufficient enough to slow the capsule enough to minimize damage on splashdown. Given the mission's proof of concept status, data acquisition is of great importance to the possibility of future missions.
Dataset Return Expectations

Typical scientific data should return via our proposed iridium communications transceiver through binary based data strings and translated project home side into graphs and text statuses.

If successful, we should expect to see:

- Successful confirmation of deployment from rocket
- Accelerometer and GPS information until reentry for tracking and orientation purposes.
- Reestablished communication link after reentry.
- Pressure, altitude, and GPS data on descent to track the descent path.
- Successful confirmation of blade deployment and locking.
- RPM, pressure, altitude, and GSP data until splashdown to monitor the rotational energy and descent path of the capsule.
- Accelerometer data nominal within tolerances on ocean impact to determine survivability.
Section 2: Team Overview
Mechanical Team Overview
Questions and Concerns from Leina

Payload Deck & Capsule:
- Downsize our payload and capsule to a half size.
- (Maximum constraints: Ø13 x 5.13 inches. 15lbs)

Actual Payload Dimension/Weight:
- (Ø13 x 5 inches. ~14lbs)
Capsule

Materials:

- Grade 5 Titanium will be used in the final design for the capsule.
- In the prototyping stage we will begin with a 3D printed version then move on to aluminum for more in-depth analysis.

Dimensions:

- $\varnothing 3'' \times 4''$ (diameter x Height)

Description:

- The main capsule exterior is a cylindrical shape with a 3 blade pocket design, giving a clean flushed appearance.
- Internally we have a triangle shape to house our electrical and software components.
- The housing will help keep all our programmable parts in tact during the payloads decent.
- A main concern that's come up is making sure that this pocket doesn’t get too hot and burn up what's inside.
- Some possible changes in the internal design could be the layering method and blade pocket depth.
Capsule Bottom Plate

Materials:

- Prototype will be made of Aluminum
- Finish product will be made with grade 5 Titanium

Dimensions: $\odot 3.00'' \times 0.25''$ (Diameter x Height)

Description:

- A plate fastened to our heat shield and capsule.
- By having a bottom plate under our capsule, we can machine our capsule without any issues.
Aeroshell

Materials:

● First round of prototyping will be 3D printed using PLA filament.
● Potential changes could be to change the weight on the capsule to make sure the whole thing is bottom heavy.
● Metallic shell with a layered and bonded ablative material constructed from:
  ○ Ceramic wool ----------------------------------------------- (temperature: 2300°F)
  ○ Carbon powder ----------------------------------------------- (temperature: 3700°C)
  ○ Metallic bonding epoxy ------------------------------------- (temperature: 2000°F)
  ○ Ceramic Adhesives ------------------------------------------ (Temperature: 3000°F)
  ○ Other Materials:
    ■ phenolic impregnated carbon ablator (PICA)
    ■ AVCOAT

Dimensions:

● Aeroshell Base: \(\varnothing 3'' \times 1.00''\) (Diameter x Height)
● Aeroshell Cover: \(\varnothing 3.50'' \times 1.75''\) (Diameter x Height)

Description:

● Our aeroshell design is a spherical shaped on the bottom end of the main capsule
● This shape will help ensure that the heat will be distributed evenly as we begin our descent
Capsule Hub

Materials:

- The capsule hub will be made out of grade 5 titanium to withstand the environments of re-entry.
- We will be using 3D printed material or aluminum for prototyping.
- This will allow us to test our capsule without using up material that we will need when it’s time to create the final product.

Dimensions:

- Ø3” x 1.25” (Diameter x Height)

Description:

- The Purpose of the capsule hub is to house our blades and pin locking mechanism.
Capsule Hub

Bottom View

Top View

Side Views
Blades

Materials:

- The blades will be made out of grade 5 titanium due to it being an incredibly strong and lightweight material.
- Prototype will be made out of Aluminum.

Dimensions:

- 1.5” x 5.25” x 1” (Length x Width x Height)

Description:

- The blades primary objective is to use auto rotation as a means of bringing the payload down without the need of fuel.
- The number of the blades for our mission will be three.
- The blades will keep the dolphin design because we believe the shape has the best characteristics for success.
- By keeping our blades to a wide enough width, it will ensure enough surface area to allow successful auto rotation of our capsule.
- As the payload falls and spins, wind and springs will assist the deployment of the blades.
- Once they have reached maximum point, the locking mechanism locks them into place via spring inside and prevents any sort of movement.
Aeroshell Blades

Blade
Blade Locking Mechanism

Materials:

- Blade Housing: Grade 5 Titanium. Prototype will be made with Aluminum.
- Blades: Grade 5 Titanium. Prototype will be made with Aluminum.
- Pin: Grade 5 Titanium or Tungsten

Dimensions:

- Blade Housing: ~1.20" x `1.20" x 1.00" (Length x Width x Height)
- Blades: 1.50" x 5.25" x 1.00" (Length x Width x Height)
- Pin: Ø0.25" x 0.405" (Diameter x Height)

Description:

- Our goal with the blade locking mechanism is to be simple and precise.
- The blades will be held securely by a linear actuator going through the bottom of the capsule holding them in place.
- When it is time to deploy the linear actuator pin will retract allowing the blades to deploy.
- The blades will lock once they are fully extended due to the aid of springs and air flow of our falling capsule.
Launcher Mechanism

The launcher mechanism is to be constructed on a platform measuring approximately 1.3 inches wide, 11.5 inches long, and 1.25 inches tall. The launching mechanism itself will be held down by a rectangular frame that will be welded with steel sheet metal. Pockets will be cut into the frame to reduce the weight of the launcher mechanism and will be closely fitted to the payload in order to maintain a fixed position.

The launching process works as such:

- Firstly, we will be unlatching our capsule which will be physical fastened by a solenoid.
- Next a timed event is activated through the microcontroller which allows a controlled amount of power to the motor that spins an aluminum drive screw at a maximum of 1 inch per second. To eject our capsule an attached plate will move parallel to the aluminum drive screw that will push the capsule out of the guide frame.
- Finally, an internal timer on the microcontroller will be a backup stop switch which will terminate the processes.

The most foreseeable issue with the launching mechanism will be the large amount of vibration that will occur during the launch. However, the mechanical team plans to mitigate this by utilizing threading screws with wire which will effectively secure the position of all components of the launcher mechanism. Our prototype will be different from the final product in that the prototype will be 3D printed and because of the difference in material it will be less capable of withstanding the strong vibrations that we anticipate the final product will have to endure.
Payload Deck

Similar to last year’s payload deck, we have improved our designs.

By keeping in mind the height of 5.13in and a diameter of ~13in, we have adjusted the size our capsule to meet the requirements of RSX guidelines.

By keeping our original launcher mechanism designs and improving them, we can ensure the speed of the ejection from the rocket at 1 inch per second without failure.

For housing our capsule during launch, we redesigned our guild frames. Instead of having pieces of aluminum fastened together, we made the frames 7 complete pieces. By having less fasteners compare to last years designs, we can ensure the structural integrity of the guild frames will hold. We can ensure our capsule will not move due to the forces of the rocket during launch.

Similar to the old model we will have a mount to connect our capsule and payload deck to the rocket. By having this mount it will keep our connection to the rocket stationary so when we eject from the rocket the power cord wont tether us to the rocket while ejecting from the rocket. Additionally, two solenoid latches will be employed at the exit to the frame to ensure that the capsule does not prematurely deploy or come loose.
Payload Deck

Check list:

- Within the height of 5in and a diameter of ~13in
- Houses our capsule within a guild frame to keep the capsule from moving during launch
- Capsule weight: ~4.5lbs. Payload Deck Weight: ~9.5lbs. Total Approximation: ~14lbs
- Weight will be reduced significantly once prototype is finalized
3D Printing

The main body of the prototype vehicle, and its blades, are printed from ABS filament. Being this is merely a mockup, it doesn’t need to be particularly strong- as such, it was printed with thin walls.

The capsule hub, locks and the cover are made from PETG polymer- a more impact-resistant material that was used for color differentiation, due to stock on hand. They were test-fitted individually, then as one cohesive unit. The aeroshell for the mockup is made from PLA, as that is what was loaded in the machine at the time of the print.

These prints will be used for design refinement and revision, with new parts being printed as-needed, until we reach our final design.
Machining

Keeping in mind the other mechanical concerns about vibrations, heat, and failure points. Manufacturing must also be taken into account, not only for logistical reasons, but also for the purpose of minimizing the possibility of mechanical failure due to erroneous manufacturing practices.

While mechanically-assisted hand machining will be used to rough out the raw materials in preparation for finer dimensions to be machined, CNC Machining will primarily be used.

Machining using CNC (Computer Numerical Controlled) Machines ensures that most possible errors can be caught before rather than after any tooling has touched--and therefore irreversibly altered--the capsule. The process also ensured precision down to 1 thousandths of an inch.
Machining Progress:
Software Team Overview
Payload Deck Overview

- Our launch controller will be an Arduino Mega 2560.
- Once the redundant timed event lines are up, the microcontroller will activate two relays powering a DC motor and a unlocking solenoid.
- The rod on the motor will stop once the timed event line is powered down or when the rod is pressed against a button pressure sensor.
- Our launch controller will also power on the capsule and signal the capsule to detach itself from the power line.
Payload Interrupt Timer

The software team will be using the two redundant lines (2 and 3) which will activate after $T + 100$ but before $T + 332$. The simultaneous activation of the redundant lines will ensure that all of the sections on our payload deck is powdered and ready to start our launch. $T_{dwell}$ time will be the interval of time between the start of the rod and a specific distance traveled by the rod. $T_{dwell}$ time will act as a failsafe in the case that our button pressure sensor does not signal our launch controller.

One redundant line will go through a step down of 28v to 12v supplying power to the motor. However, the power line leading to the motor will be closed until our launch controller activates the intermediate relay, allowing current to the motor. The other redundant line will be passing a step down from 28v to 5v supplying power to our payload deck controller and capsule.
## Payload Deck Inventory

<table>
<thead>
<tr>
<th>PAYLOAD INTERNALS</th>
<th>Weight</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMAKN® 5V Active Low 2 Channel Relay Shield Module</td>
<td>31g</td>
<td>50.5mm (L) * 38.5mm (W) * 18.5 (H) / 2.19” x 1</td>
</tr>
<tr>
<td>Arduino Mega 2560 R3 ATMega2560-16AU</td>
<td>35g</td>
<td>101.52mm x 53.3mm x 15.29mm / 4.0” x 2.1” x 0.6”</td>
</tr>
<tr>
<td>Button Pressure Sensor</td>
<td>-</td>
<td>10x 24mm</td>
</tr>
<tr>
<td>Lock-style Solenoid - 12VDC</td>
<td>147.71g</td>
<td>23.57mm / 0.92” x 67.47mm / 2.65” x 27.59mm</td>
</tr>
<tr>
<td>eBoot 6 Pack LM2596 DC to DC Buck Converter 3.0-40V</td>
<td>-</td>
<td>45 * 20 * 14 mm</td>
</tr>
</tbody>
</table>

The diagram depicts a schematic of the payload deck inventory. The components are interconnected to illustrate the flow of data and power within the system.
Payload Deck Flow Diagram

PAYLOAD

Rocket Timed Event
Open all relays Latch + motor Power on pin
Pressure sensor
Interrupt
Close all relays Power off pin
#include "TimerObject.h"

const byte buttonPressure = 1; //Pin button to stop rod  
const byte relayPin1 = 2; //Pin Signal relay to open latch  
const byte relayPin2 = 3; //Pin Signal relay to open motor  
const byte signalCapsule = 4; //Pin to signal capsule  

void setup() {
    pinMode(relayPin1, OUTPUT); //Initialize relay1  
    pinMode(relayPin2, OUTPUT); //Initialize relay2  
    digitalWrite(relayPin1, HIGH); //Open latch relay  
    digitalWrite(relayPin2, HIGH); //Open motor relay  
    digitalWrite(signalCapsule, HIGH); //Signal capsule to close latches.  
    attachInterrupt(digitalPinToInterrupt(buttonPressure), closeMotor, HIGH);
}

void loop() {
}

void closeMotor(){
    Serial.println("Closing...")  
    digitalWrite(relayPin2, LOW);
}
Payload Deck Hardware
Capsule Overview

- Our internal Microcontroller will be a Atmega 328P microcontroller chip.
- Once the internal microcontroller is turned on it will activate the relay leading to the internal batteries and disconnect itself from the payload microcontroller, also through a relay.
- There will be consistent altitude checks and a onboard timer.
- The microcontroller will maintain communication to our ground system using the Iridium transceiver.
Capsule Interrupt Timers

A signal from the payload deck controller will be sent to the internal microcontroller located inside the capsule. The microcontroller will process the interruption and detach itself from the payload deck’s power line. This process begins with the activation of the inhibited batteries via relay. Next the microcontroller will close the main power line from the payload deck also via relay. The payload deck controller will power down the signalling pin once the capsule has detached itself from the payload deck’s power line.

Once the microcontroller is turned on, an on board timer will start. This timer is a failsafe correlating to the release of our capsule’s blades. However, our main code to release the capsule’s blades would be a ubiquitous check for altitude. If the capsule is at an appropriate height, but the blades have not been released by the timer, then it will release the blades. If the on board timer goes off, and the blades have not been release by the altitude checks, then it will deploy the blades.
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Weight</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adafruit BME280</td>
<td>Temperature + Humidity + Pressure</td>
<td>1.0g</td>
<td>19.0mm x 18.0mm x 3.0mm / 0.7&quot; x 0.7&quot; x 0.1&quot;</td>
</tr>
<tr>
<td>Yost Labs 3 space sensor</td>
<td>Gyroscope + Accelerometer + Compass</td>
<td>1.3g</td>
<td>23mm x 23mm x 2mm / 0.9&quot; x 0.9&quot; x 0.1&quot;</td>
</tr>
<tr>
<td>Adafruit Latching Mini Relay FeatherWing</td>
<td>Switch up to 2A of resistive current at 30VDC or ~40VAC or lower</td>
<td>5.3g</td>
<td>50.8mm x 22.9mm x 11.4mm / 2&quot; x 0.9&quot; x 0.4&quot;</td>
</tr>
<tr>
<td>Atmega 328P + Components</td>
<td>Main Microcontroller</td>
<td>-</td>
<td>~ 22 x 49 mm</td>
</tr>
<tr>
<td>RockBLOCK Mk2 - Iridium SatComm Module</td>
<td>Iridium Transciever</td>
<td>36g</td>
<td>45.0 x 45.0 x 15.0mm</td>
</tr>
<tr>
<td>Small Push-Pull Solenoid - 12VDC</td>
<td>Blade deployment. 12 VDC operation (please note lower voltage results in we</td>
<td>39g</td>
<td>0.787&quot; L x 0.433&quot; W x 0.572&quot; H (20.00mm x 11</td>
</tr>
</tbody>
</table>
Capsule Flow Diagram
#include "timerObject.h"

Timer t; // New timer object for second interrupt
volatile byte bladeState = 0; // Blades have not unlocked
const byte activePin = 1; // Capsule MC will sense when the pin is high.
const byte relayPin1 = 2; // Detach relay pin
const byte relayPin2 = 3; // Attach battery pin
const byte relayPin3 = 4; // Activate blade relay pin
const int timeBlade = 10000; // Set time to unlock blades
double temp[]; // Store data from temp sensor
double gyro[]; // Store data from gyro sensor

void setup() {
  pinMode(relayPin1, OUTPUT); // Initialize detach relay
  pinMode(relayPin2, OUTPUT); // Initialize battery relay
  pinMode(relayPin3, OUTPUT); // Initialize blade relay
  attachInterrupt(digitalPinToInterrupt(activePin), detach, HIGH); // Interrupt 1 when payload MC sets pin to HIGH
  t.bladeUnlock(); // Interrupt 2 when timer goes off
}

void loop() {
  temp = 3in1Temp();
  gyro = 3in1Gyro();
  data = parsing(temp, gyro);
  iridium(data);
  t.update();
}

double 3in1Temp() {
  // Read in data return array
}

double 3in1Gyro() {
  // Read in data if altitude is a certain high call bladeUnlock() return array
}

double parsing(double temp, double gyro) {
  // Find out how Iridium likes to recieve data return array
}

void iridium(double data) {
  // Send data to the transceiver
}

void bladeUnlock() {
  SERIAL.println("Blade Unlocking...");
  if (bladeState == 0) { // Since we have to paths to get here we need to make sure that we dont activate the blade twice
    digitalWrite(relayPin3, HIGH); // Open battery to solenoid
    bladeState = 1;
  }
}

void detach() {
  SERIAL.println("Detaching...");
  digitalWrite(relayPin1, LOW); // Close payload MC power line
  digitalWrite(relayPin2, HIGH); // Open on board battery line
}
Capsule Hardware
Electrical Team:
Project Overview & Development
Electrical: Principles of Operation

-The overall principle of the electrical design is to maintain simplicity in supplying the necessary power to the electrical components on the payload and capsule. Use of a timed power line will simultaneously initiate the deployment of the capsule, engage current to the batteries on the capsule, and terminate current running from the rocket to the capsule components.

-The main payload and capsule components will utilize 1 rocket supplied GSE power line prior to and during initial launch sequence.

-GSE line 1, at 28 Volts and 1.85 Amps, will supply power through a 9 V DC/DC converter to the payload microcontroller and pressure sensor.

-Redundant timed event power line, TE-R, will be used to initiate the capsule release sequence with one line and simultaneously engage current from the batteries to the capsule components and also terminating the power draw from the rocket to capsule components.
- All wiring, fuses, and electrical hardware will consist of industrial grade or surplus military supplies to ensure that we do not encounter unexpected issues during flight. Connections will be soldered and covered in heat resistant paint and insulation to resist reentry heat.

- Our payload and capsule electrical budget and power draw has been determined to ensure we are within the required power parameters of RSX.
- Main power line GSE 1 will supply power to payload microcontroller, capsule microcontroller, iridium transceiver, & capsule sensors

- Time Controlled Power Line will power release latch, DC Motor; simultaneously engage current from battery & terminate power from rocket via relay
- Electrical components on the payload and capsule are designed to receive optimum power within the provided RSX power parameters.

- Capsule will be locked in place until the timed event supplies power to the locking solenoid and DC motor.
- Timed event: initiates relay engaging current from the battery to the electrical components on the capsule & terminating power draw from the rocket

- When capsule is released umbilical wire connection will disengage terminating power from the rocket

- Most components wired in parallel in order to receive optimum voltage from the batteries
Battery summary

- Lithium Iron Phosphate (LiFePO) batteries: 3.2 Volts & 1100 mAh
- Connected in series to provide maximum voltage, no greater than 12.8 Volts (4 batteries)
- Insulated with Kapton tape
- Fully charged & will only be engaged when power is supplied to a relay from a timed event at appropriate specified time during flight
- Will be engaged via latching relay
We have assembled operating voltages and currents for each component on the payload and capsule.

Maximum potential current draw on the payload and capsule will be well under the 1.85 Amps provided from GSE line and 3.75 Amps provided from TE line.

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>PART NAME</th>
<th>VOLTAGE</th>
<th>CURRENT DRAW (max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAYLOAD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC/DC Converter (12 V)</td>
<td>eBoot DC-DC Buck Converter</td>
<td>up to 40 V</td>
<td>0.01 Amps (from TE)</td>
</tr>
<tr>
<td>DC/DC Converter (9 V)</td>
<td>eBoot DC-DC Buck Converter</td>
<td>up to 40 V</td>
<td>0.01 Amps (from TE)</td>
</tr>
<tr>
<td>Locking Solenoid (Capsule Release)</td>
<td>Lock-style Solenoid - 12VDC</td>
<td>12 V</td>
<td>0.65 Amps (from TE)</td>
</tr>
<tr>
<td>DC Motor (Capsule Release)</td>
<td></td>
<td>12 V</td>
<td>0.62 Amps (from TE)</td>
</tr>
<tr>
<td>Microcontroller</td>
<td>Arduino Mega 2650 R3 ATMega2560-16AU</td>
<td>7-12 V</td>
<td>0.02 Amps per I/O pin</td>
</tr>
<tr>
<td>Relay</td>
<td>SMAKN® 5V Active Low 2 Channel Relay Shield Module</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAYLOAD TOTAL (GSE)</td>
<td></td>
<td></td>
<td>0.895 Amps</td>
</tr>
<tr>
<td>PAYLOAD TOTAL (TE)</td>
<td></td>
<td></td>
<td>1.29 Amps</td>
</tr>
<tr>
<td>CAPSULE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iridium</td>
<td>RockBLOCK Mk2 - Iridium SatComm Module</td>
<td>5 V</td>
<td>0.1-0.45 Amps</td>
</tr>
<tr>
<td>Microcontroller</td>
<td>Atmega 328P</td>
<td>5 V or 3.7 V</td>
<td>4.5 microAmps</td>
</tr>
<tr>
<td>3-IN-1 Temp</td>
<td>Adafruit BME280</td>
<td>1.7 - 3.6 V</td>
<td>3.6 microAmps</td>
</tr>
<tr>
<td>3-IN-1 Gyro</td>
<td>Yost Labs 3 space sensor</td>
<td>3.3 - 6 V</td>
<td>0.045 Amps</td>
</tr>
<tr>
<td>Relay</td>
<td>Adafruit Latching Mini Relay FeatherWing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solenoid x 3 (Blade Release)</td>
<td>Mini Push-Pull Solenoid - 5VDC</td>
<td>5 V</td>
<td>1.1 A (From battery)</td>
</tr>
<tr>
<td>CAPSULE TOTAL (GSE)</td>
<td></td>
<td></td>
<td>0.495 Amps</td>
</tr>
</tbody>
</table>
Further Development

- Development of a complete electrical schematic is in progress
- Design of the electrical harness is in preliminary stages, several options are being discussed
- Multi-cell battery connector options are being considered
Section 3: Management
Team Organization

Our program and RSX team is organized in a standard tiered system.

- Advisors/Mentors - Assist our team in skills development and support, as well as monitoring the team interaction.
- Joint Project Managers - MAPPP consists of several programs, and as such, two project manager positions ease the workload and provide support for scheduling or event purposes.
- Team Leads/Point of Contacts - To ensure that information is easily distributed, progress is updated, and schedules are adhered to, each area of our project has been assigned a lead or point of contact. They assist the project managers.
- Assistant Team Leads - RSX and MAPPP is a busy place, and to ensure that we give the leads the support they need, they work in tandem with an assistant lead, who can also act as a team lead in cases of absence or divided work.
- Team members - Our talented group of individuals support their respective areas and the team as a whole. They assist the team leads in accomplishing our important goals and deadlines.
Team Gantt Chart
Project Phases

To facilitate the successful development of our project, we have divided it into 4 distinct phases that allow us to separate the work out into a manageable timeline.

- Phase 1 - Restructuring, redevelopment, and conceptual planning (Sept - Oct 2018)
- Phase 2 - Prototyping, testing, and software development. (Oct - Dec 2018)
- Phase 3 - Design freeze, fabrication, RSX integration testing, assembly (Jan - Jun 2019)
- Phase 4 - Integration and launch!
Budget And Financing

To ensure that our program receives the necessary funding required for RSX, we have implemented the following actions:

- Partnered with the school’s financial contacts that are able to present our proposal to private and academic donors.
- Appealed to local aerospace companies for donations or materials or funding.
- Applied for several grants relating to our field.
- Are currently appealing to major companies such as NASA, Lockheed Martin, etc.
- Presented our project as a potential commercial avenue in the future, with this year being preliminary academic research and prototyping.
- Have planned a full schedule of outreach and funding events that connect with the community and the school district.
Budget Overview

MAPPP 2018/2019 Budget Request
Total Estimated Requested: $48,900

**HASP** - The High Altitude Student Platform, or HASP, is quickly becoming a yearly tradition for College of the Canyons. It offers an easier entry into collaborations with major Universities and agencies such as NASA, while still being challenging. HASP’s financial commitment is the lighter of our two planned projects, but unlike RSX, does not have the prior year’s ordered parts and resources to rely on. COC is applying for a larger payload slot this year, which requires more materials and components. Additionally, it was justified that due to the limitations placed on visiting teams to Wallops through the RSX program, that the budget should be increased to allow more students to travel to integration and flight for HASP. COC’s team has often been small in comparison to other participants, and we are attempting to give as many of our team the chance to experience the entirety of HASP from beginning to end, with the hope that the journey will mark the first steps on a very long and fulfilling career in the aerospace industry.

Total estimated cost: $17,500 - $19,000

**RockSatX** - RockSat X represents a major step forward in College of the Canyon’s emergence as a key player in providing students a foothold in gaining real and tested experience in the aerospace industry. The project however does require a significantly increased financial commitment in comparison to HASP. Although the project did not fly last year, $8,000 of the initial earnest deposit is still available to COC, with a remaining $16,000 needed if selected. Aerospace grade titanium and advanced ceramics account for majority of the materials budget and have proven difficult to obtain, but bulk manufacturer sources do exist. We at MAPPP however truly believe that the costs, while hefty, are justified to the students who pour their hearts and dedication into this intense, but rewarding project. Just like the rocket that will carry us to the edge of the Earth, we hope that RSX will carry our members to possibilities and careers that wouldn’t be possible without this experience.

Total estimated cost: $32,000-$35,000
Risk Assessment

At this stage of the design, without having tested concepts, it is very difficult to compile all of the potential areas of risk or complications that our project could encounter. Some main concerns however are:

- Development of a heat shield capable of surviving the heat of reentry. We currently have a proposed list of materials and tentative design in place to begin fabrication, and the solution to this issue is extensive testing.
- Establishing reliable and efficient downlink data through the untested iridium system. We will need to work closely with iridium support to allow us understanding of their system and to implement a text based data downlink.
- Initiating auto rotation. Several past experiments have had trouble with this area and the only way to solve any issues is extensive real world testing.
User Compliance

In order to facilitate conforming with RSX guidelines, team management has developed an internal audit sheet which condenses and cross references the information available on the user guide. This information is also addressed throughout the presentation, but will be compiled and delivered for ease of viewing.

Examples included in this guide include, but are not limited to:

- Footprint compliance
- Telemetry and power pin assignments
- Payload dimensions
- CofG compliance
- Weight compliance
- Special requests and notifications
- Power budget
Example compliance information

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Status/Reason (if needed)</th>
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<tbody>
<tr>
<td>Center of gravity in 1&quot; plane of plate?</td>
<td>Yes, in theory, needs physical confirmation</td>
</tr>
<tr>
<td>Weight 30.0 +/- 1.0 (15.0 +/- 0.5) lbs?</td>
<td>Yes, see mechanical section</td>
</tr>
<tr>
<td>Max Height &lt; 10.75&quot; (5.13&quot;)</td>
<td>Within compliance, see mechanical section</td>
</tr>
<tr>
<td>Bottom of deck has flush mount hardware?</td>
<td>YES</td>
</tr>
<tr>
<td>Within Keep-Out Zone</td>
<td>YES</td>
</tr>
<tr>
<td>Using &lt; 10 A/D Lines</td>
<td>Requires confirmation</td>
</tr>
<tr>
<td>Using/Understand Parallel Line</td>
<td>N/A</td>
</tr>
<tr>
<td>Using/Understand Asynchronous Line</td>
<td>YES, at 19200 Baud</td>
</tr>
<tr>
<td>Using X GSE Line(s)</td>
<td>YES, see electrical</td>
</tr>
<tr>
<td>Using X Non-Redundant PWR Lines (TE-1, TE-2, TE-3)</td>
<td>See electrical</td>
</tr>
<tr>
<td>Using X Redundant Power Lines (TE-R)</td>
<td>See electrical</td>
</tr>
<tr>
<td>Using &lt; 1 Ah (&lt; 0.5 Ah for half payload)</td>
<td>In compliance, see electrical</td>
</tr>
<tr>
<td>Using &lt;= 28 V</td>
<td>Utilizing &lt;=28 volts</td>
</tr>
<tr>
<td>Using RF (If yes, list frequency and TX Power)</td>
<td>No</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>
Mentors and Advisors

Teresa Ciardi - Amazing advisor and woman of action

Peregrine Mcgehee - Coding and Software wizard

Gregory Poteat - Machinist extroadinaire

Remi Drai - Premier Mathematician
Team Roster cont.
<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Major</th>
<th>Email</th>
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</thead>
<tbody>
<tr>
<td>Hunter Napier</td>
<td>Project Manager</td>
<td>Aerospace Engineering</td>
<td><a href="mailto:hunternapier@gmail.com">hunternapier@gmail.com</a></td>
</tr>
<tr>
<td>Patrick Gagnon</td>
<td>Project Manager</td>
<td>Aerospace Engineering</td>
<td><a href="mailto:pwgagnon16@gmail.com">pwgagnon16@gmail.com</a></td>
</tr>
<tr>
<td>Arthur Berberyian</td>
<td>Mechanical Team</td>
<td>Physics</td>
<td><a href="mailto:arthurberberyian@gmail.com">arthurberberyian@gmail.com</a></td>
</tr>
<tr>
<td>Oshoo Issar</td>
<td>Mechanical Team</td>
<td>Mechanical Engineering</td>
<td><a href="mailto:Oissar100@gmail.com">Oissar100@gmail.com</a></td>
</tr>
<tr>
<td>Paul Gotcher</td>
<td>Software Co-Lead</td>
<td>Computer science</td>
<td><a href="mailto:purplestone13@gmail.com">purplestone13@gmail.com</a></td>
</tr>
<tr>
<td>Nathan Furtado</td>
<td>Electrical Team</td>
<td>Engineering</td>
<td><a href="mailto:920jisun@gmail.com">920jisun@gmail.com</a></td>
</tr>
<tr>
<td>Jisun Kim</td>
<td>Software team</td>
<td>Computer science</td>
<td><a href="mailto:cliffordalvarez4@gmail.com">cliffordalvarez4@gmail.com</a></td>
</tr>
<tr>
<td>Clifford Alvarez</td>
<td>Mechanical Co-Lead</td>
<td>Mechanical Engineering</td>
<td><a href="mailto:ruben.rcuriel@gmail.com">ruben.rcuriel@gmail.com</a></td>
</tr>
<tr>
<td>Coulson Aguirre</td>
<td>Mechanical Lead</td>
<td>Mechanical Engineering</td>
<td><a href="mailto:ruben.rcuriel@gmail.com">ruben.rcuriel@gmail.com</a></td>
</tr>
<tr>
<td>Ruben Curiel</td>
<td>Electrical Team</td>
<td>Electrical Engineering</td>
<td><a href="mailto:matthew91342@gmail.com">matthew91342@gmail.com</a></td>
</tr>
<tr>
<td>Matthew Martinez</td>
<td>Electrical Team</td>
<td>Electrical Engineering</td>
<td><a href="mailto:unkownedashmail@gmail.com">unkownedashmail@gmail.com</a></td>
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Contact and Availability Matrix

Please note all times are in PST

<table>
<thead>
<tr>
<th>Name</th>
<th>Role</th>
<th>Cell Phone</th>
<th>Email</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
<th>Sunday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunter Napier</td>
<td>Joint Project Mgr</td>
<td>661 706-2859</td>
<td><a href="mailto:hunternapier@gmail.com">hunternapier@gmail.com</a></td>
<td>16:30-22:00</td>
<td>18:00-22:00</td>
<td>16:30-22:00</td>
<td>16:30-22:00</td>
<td>12:30-22:00</td>
<td>12:30-22:00</td>
<td>12:30-22:00</td>
</tr>
<tr>
<td>Patrick Gagnon</td>
<td>Joint Project Mgr</td>
<td>666 666-0278</td>
<td><a href="mailto:pwgagnon16@gmail.com">pwgagnon16@gmail.com</a></td>
<td>16:30-22:00</td>
<td>18:00-22:00</td>
<td>16:30-22:00</td>
<td>16:30-22:00</td>
<td>12:30-22:00</td>
<td>12:30-22:00</td>
<td>12:30-22:00</td>
</tr>
<tr>
<td>Teresa Ciardi</td>
<td>Advisor</td>
<td>661 313-6015</td>
<td><a href="mailto:teresa.ciardi@canyons.edu">teresa.ciardi@canyons.edu</a></td>
<td>Varies</td>
<td>Varies</td>
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<td>Varies</td>
</tr>
<tr>
<td>Mechanical Lead</td>
<td>Coulson Aguirre</td>
<td></td>
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</tr>
<tr>
<td>Software Lead</td>
<td>Luis Ivey</td>
<td></td>
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<tr>
<td>Electrical Lead</td>
<td>Tyler Bond</td>
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<td></td>
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<tr>
<td>Safety Officer</td>
<td>TBD</td>
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</tbody>
</table>
Section 4: Conclusions and Questions
Conclusion

While we still have a long road ahead of us to an actual flight ready payload, we have enough of the conceptual design behind our team to move to Phase 2, which will greatly advance the reality of our project.

Materials have already been ordered, prototyping and CAD models are underway, and we have no doubt that the leap from Phase 1 to Phase 2 will be impressive.