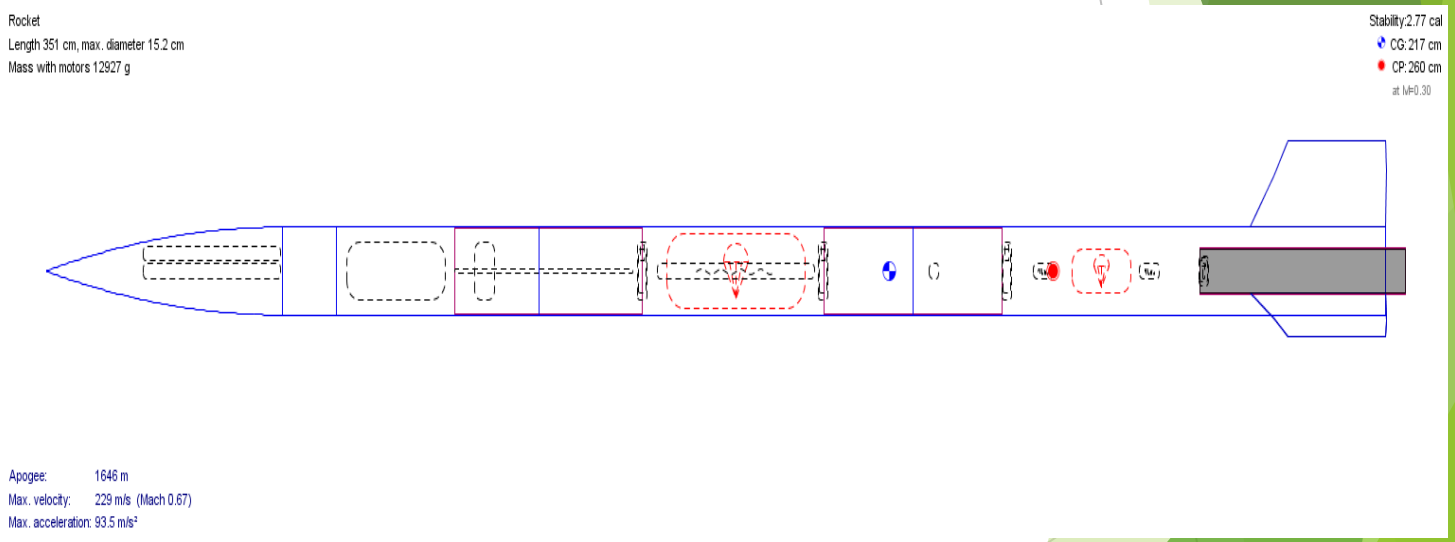
Critical Design Review

YCP Student Launch

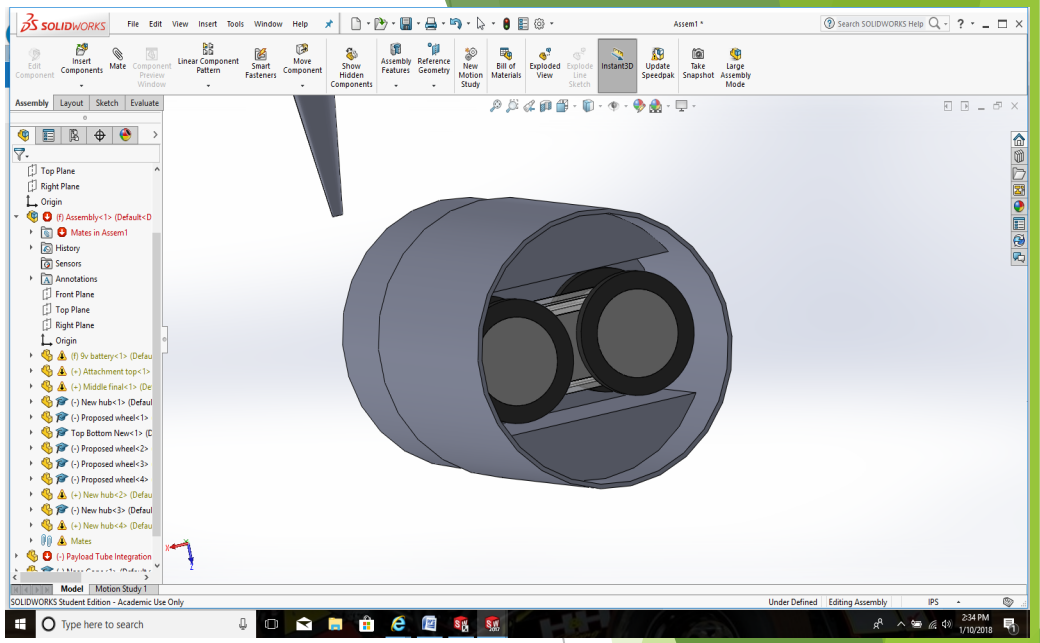
Vehicle Dimensions

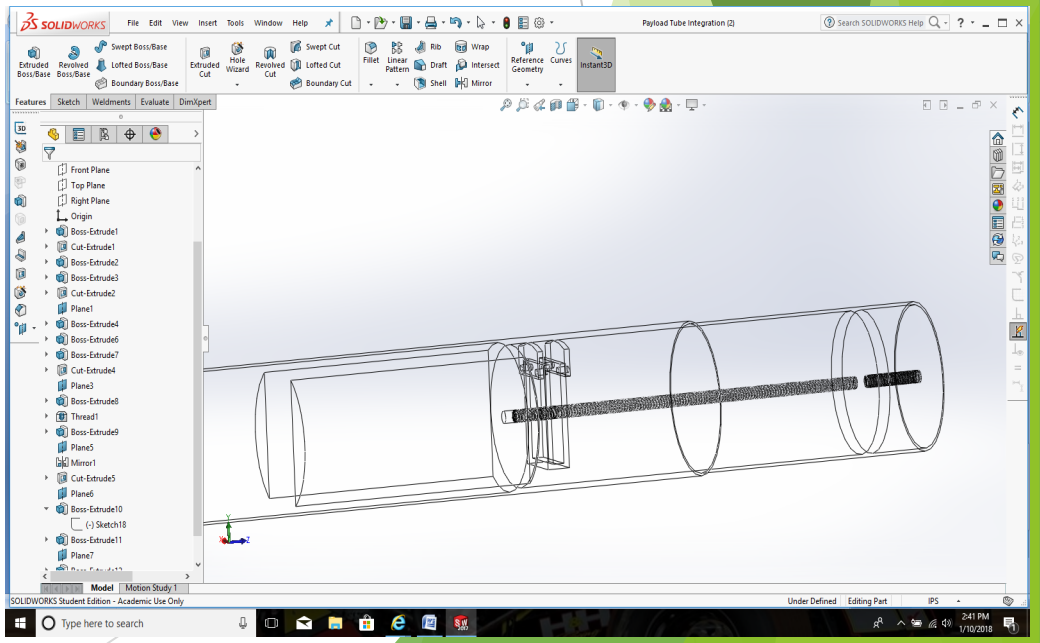
- Overall length: 138 inches
- Bottom body tube: 48 inches
- Middle body tube: 38 inches
- Top body tube: 26 inches
- Diameter: 6 inches
- Fin Dimensions :
  - Chord Root: 36 cm
  - Chord Tip: 25 cm
  - Height: 15 cm



Design Features

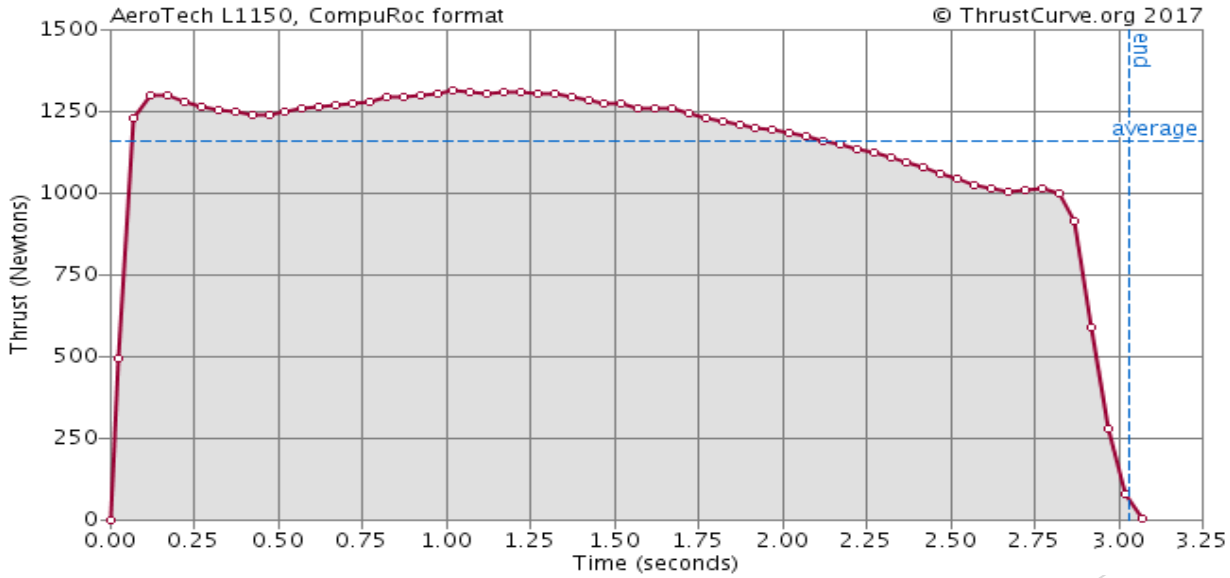
- Gear crank used for payload ejection
- Gear and motor are assembled to make the fully functioning dispensing mechanism.
- 3D printed fin can will be used
- CO2 ejection system used to separate the nose cone from the payload tube





Motor

- Motor Designation: Aerotech L-1150R
- Max average thrust: 1150 Newtons
- Impulse of 3517 Newton-seconds over a burn time of 3.10 seconds
- Backup motor: CTI L-645
- Impulse of 3419 Newton-seconds over a burn time of 5.30 seconds



Major Calculations

- Thrust to weight ratio of over 9:1
- Rail exit velocity: 83.99 ft/s
- Static stability margin: 2.77

Mass Statement

- Total Mass: 28.49 pounds
- Based on our design we have planned for an increase in weight of the rocket by 2%, due to added supports and epoxy weight.
- Given this weight increase, our projected 5,400 feet height drops to 5,292 feet which is just over the target.

Component	Weight (lb)
Nose Cone with CO_2 Ejection System	2.50
Upper Body Tube	1.76
Payload	3.50
U-Bolts in Upper Body	0.18
Middle Body Tube	2.58
Coupler	0.65
Electronics Bay	1.50
Main parachute	1.02
U-Bolts in Middle Body	0.18
Shock Cord in Middle Body	0.30
Lower Body Tube	3.25
Motor Tube	0.60
Drogue Parachute	0.194
Shock Cord in Lower Body	0.30
U-Bolts in Lower Body	0.18
Motor	8.099
Fins	1.22
Gear System	0.50
Total Weight	28.513
Simulation Mass	28.499

Recovery Subsystem

- Drogue: 24 inches in diameter made by Fruity Chutes
- Main Parachute: 120 inches in diameter made by MediChutes
- Recovery harness: 1” Tubular Nylon
- Recovery harness length for drogue: 16ft
- Recovery harness length for main: 14ft
- Terminal velocity for drogue: 73.5 ft/s
- Terminal velocity for main: 12.7 ft/s

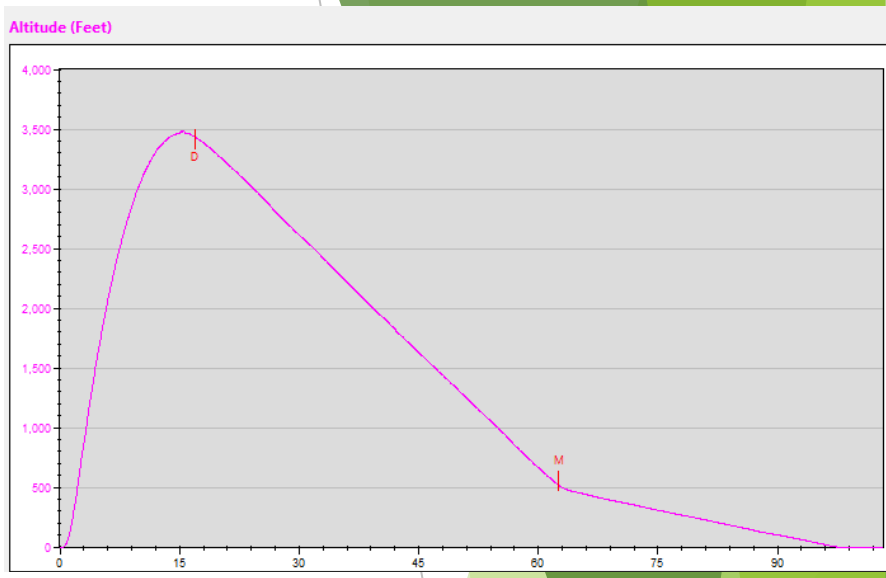
Major Calculations

- Kinetic energy at landing: 75ft-lbf or $2413.1 \frac{ft^2 - lbs}{s^2}$
- Predicted drift with 5-mph wind: 300.1 ft
- Predicted drift with 10-mph wind: 600.2 ft
- Predicted drift with 15-mph wind: 900.3 ft
- Predicted drift with 20-mph wind: 1200.4 ft

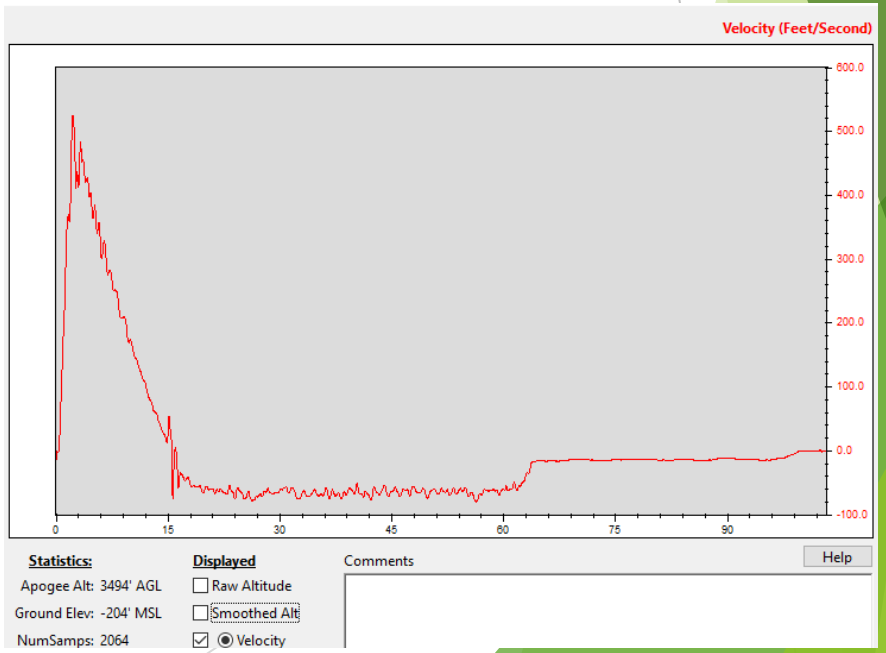
Test Plan and Procedures

- Shear Pin Testing – Between nose-cone and payload tube
- CO2 Ejection Testing – To ensure that nose-cone does not travel further than 10 feet away from launch vehicle
- Ejection Testing – To ensure the correct amount of black powder charge mass for drogue and main parachute deployment
- Fin Can Testing – Additional CFD and Wind-Tunnel Testing
- Additional testing will be performed on the shock cord

Sub-Scale Flight Test

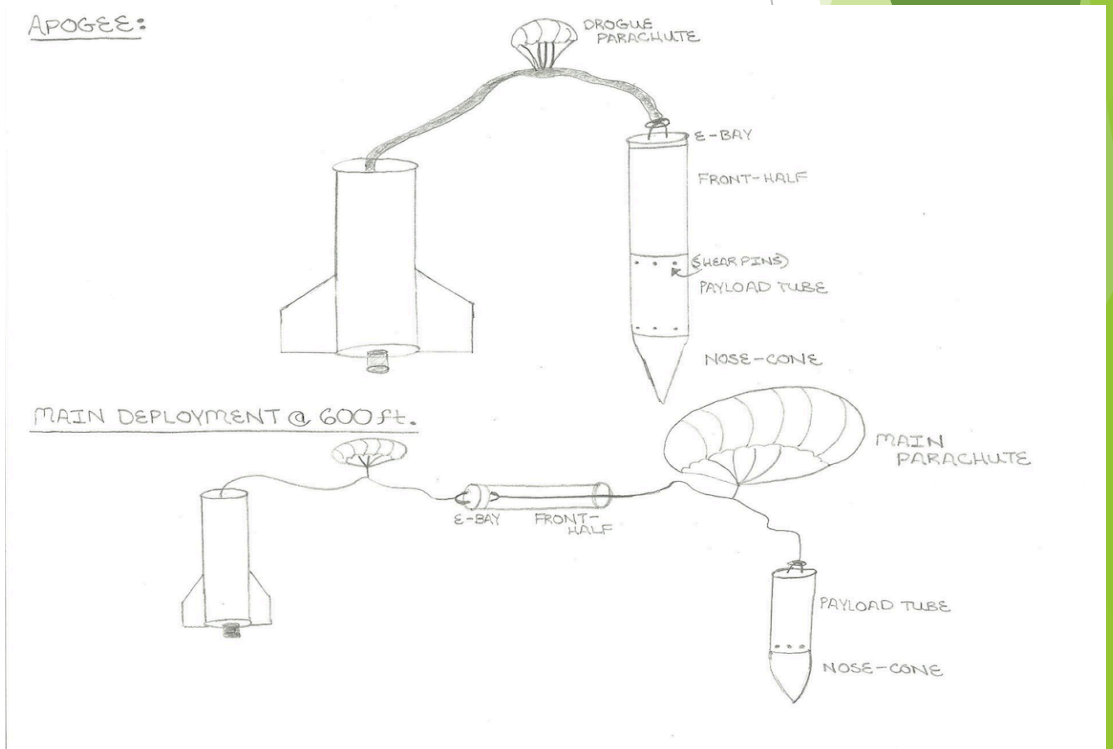


- First Flight altitude: 3494 feet
- Second launch altitude: 3650 feet
- **Subscale Launch Conditions**
- Temperature = 36 degrees Fahrenheit
- Pressure = 30.15 inches
- Humidity = 63%
- Wind Speeds = Sustained @ 8 mph / Gusts @ 15 mph
- UV Index = 1/10



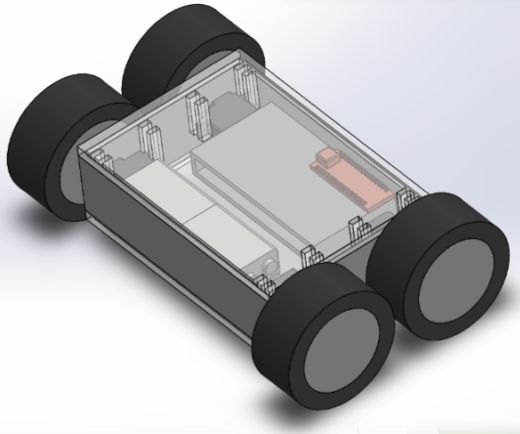
Sub-Scale Recovery

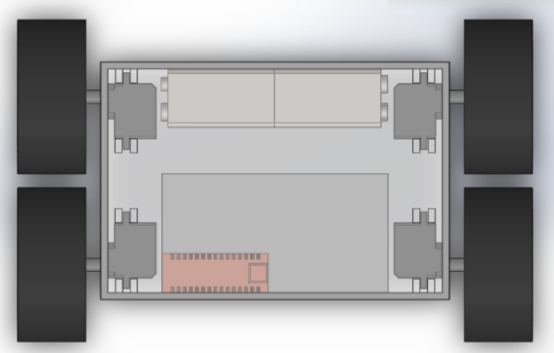
- Similar recovery materials were used on the sub-scale rocket that will be used on the full-scale rocket. This was to test that our calculations were accurate and that the shock cord, quick-links, and U-bolts could withstand the dynamic loads during flight.

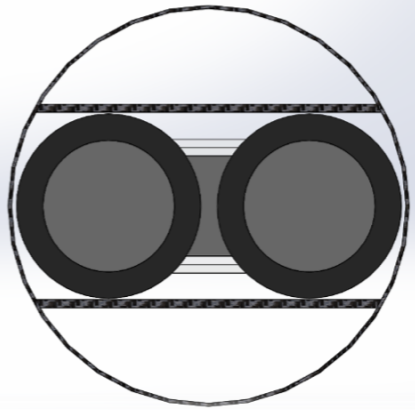


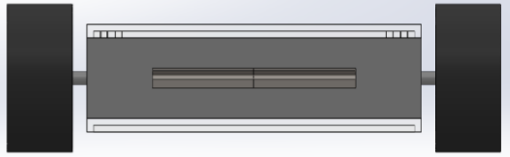
Final Payload Design

- Overall dimensions:
  - Length: 10 inches
  - Max width: 5.998 inches
- Arduino Programmed
- Four independent servo motors
- Can travel in any direction and can also operate upside down

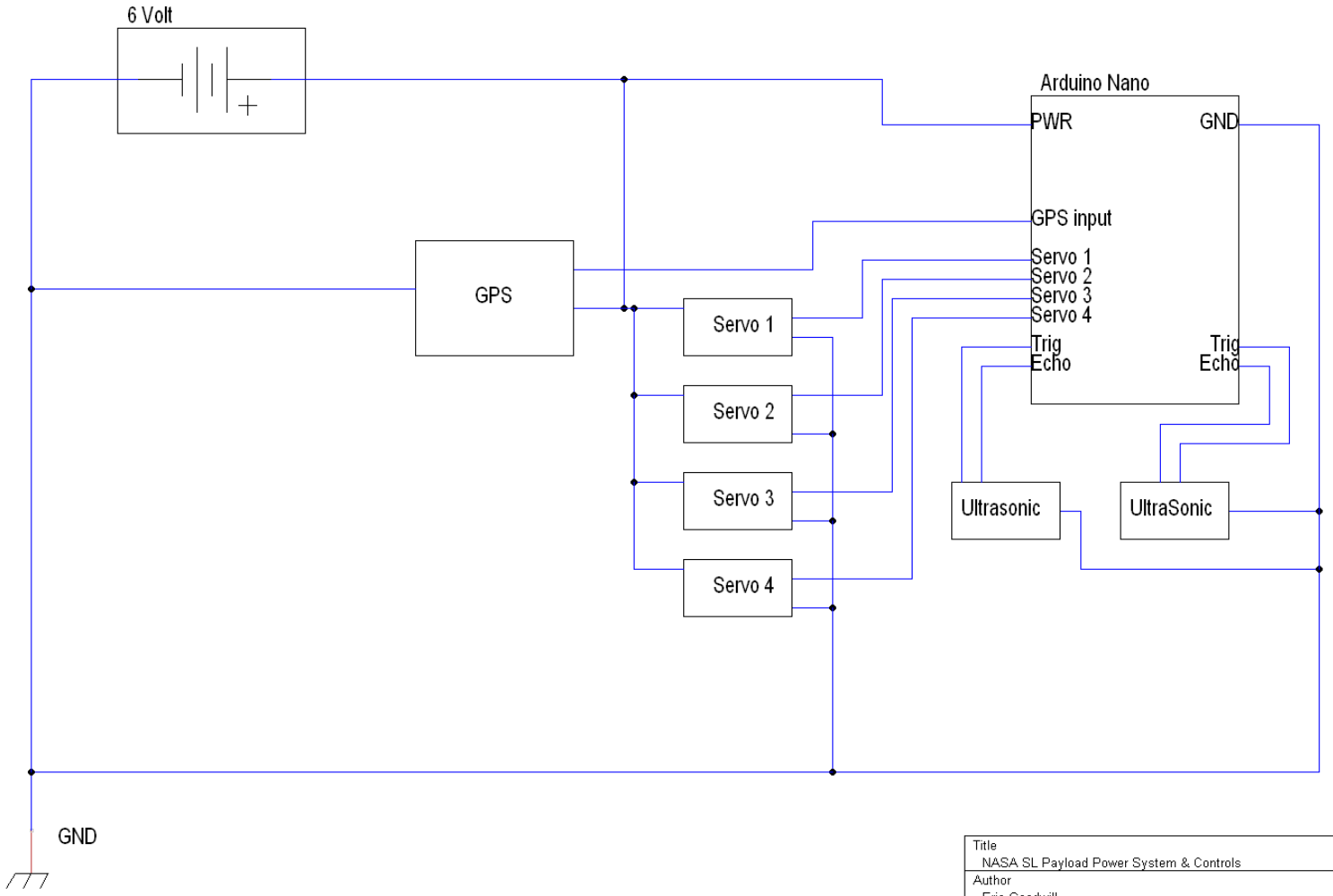








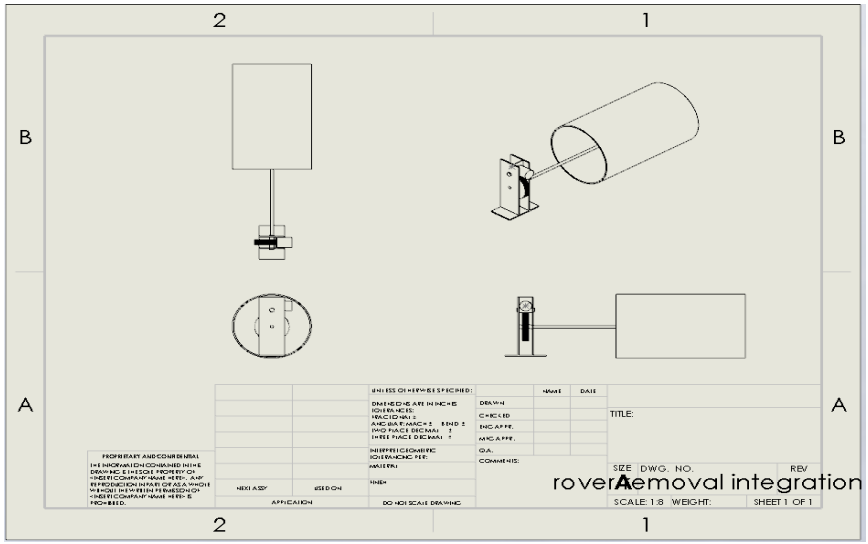
Payload Design

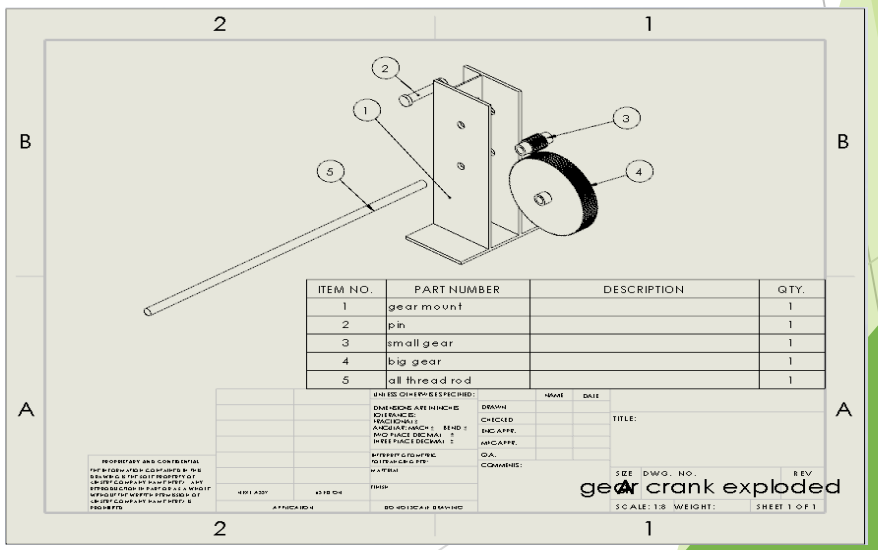


Title NASA SL Payload Power System & Controls		
Author Eric Goodwill York College of Pennsylvania		
File C:\Users\Eric\Documents\Capstone\NASA SL		Document
Revision 2.0	Date 1/5/18	Sheets 1 of 1

Payload Integration

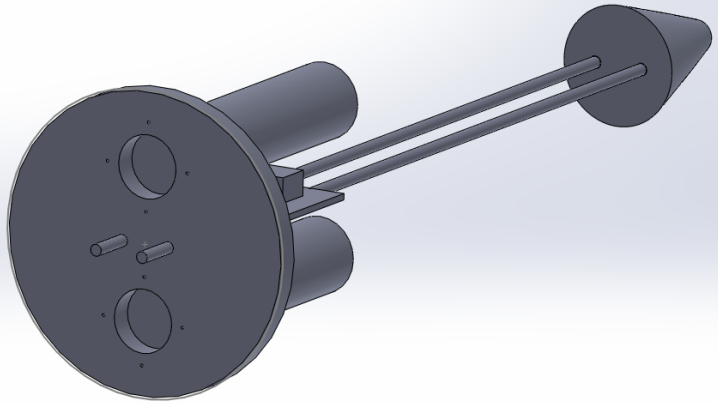
- Payload housed within the payload tube at the front of the rocket
- Payload Deployment System: After ejection of the nose cone off the front payload tube, the gear mechanism will push the payload out.
- Integration: To integrate the gear housing and motor it will be riveted to the coupler tubing. Once the gear housing has been attached the coupler tubing will be epoxied to the body tube.

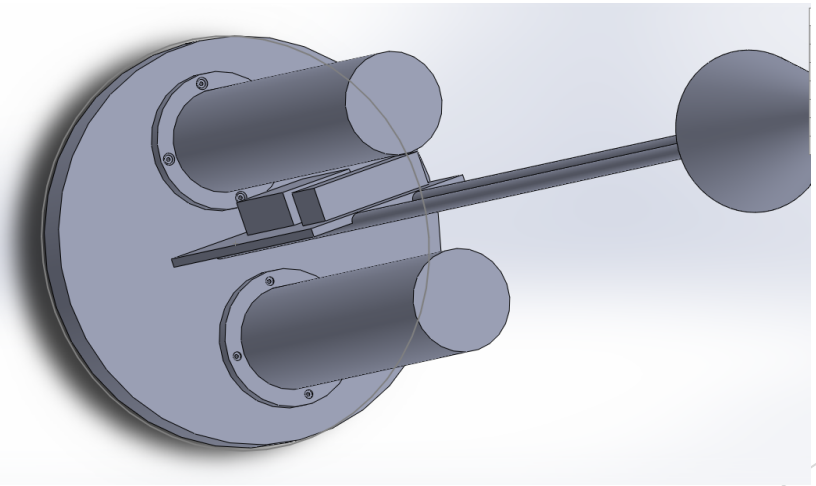


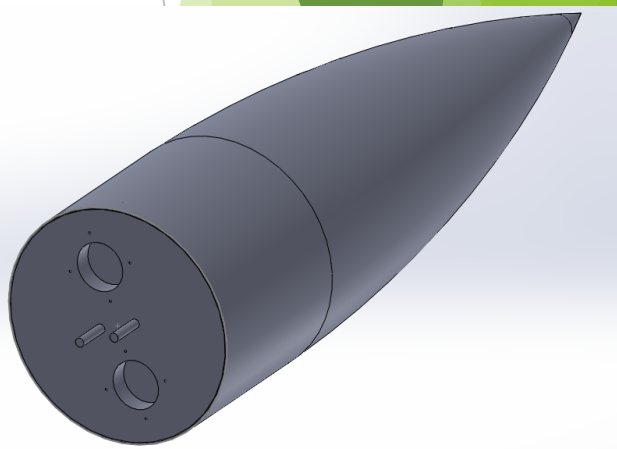


Nose-Cone Ejection System

- CO2 ejection system integrated within the nose-cone to eject the nose-cone and to break the shear pins that were holding the payload tube and nose-cone together during launch
- Peregrine Exhaustless CO2 Ejection System







Interfaces

- Wireless Communication: HC-12 Wireless Serial Port Communications Module with communication distance of 1000m in open space
- PerfectFlite Altimeter in the nose cone for the CO2 ejection system
- We will use a *FeatherWeight Magnetic Switch* which we can wire directly to our PerfectFlite Altimeter
- The altimeter itself will be programmed to have a delay of 65 seconds from the time that the rocket lands until the nose-cone is ejected off.

HC-12 Wireless Serial Port Communication Module

User Manual V1.1

```
#include <SoftwareSerial.h>

SoftwareSerial HC12(10, 11); // HC-12 TX Pin, HC-12 RX Pin

void setup() {
  Serial.begin(9600);             // Serial port to computer
  HC12.begin(9600);               // Serial port to HC12

}

void loop() {
  while (HC12.available()) {        // If HC-12 has data
    Serial.write(HC12.read());      // Send the data to Serial monitc
  }
  while (Serial.available()) {      // If Serial monitor has data
    HC12.write(Serial.read());      // Send that data to HC-12
  }
}
```

```
Done uploading.
Sketch uses 3122 bytes (9%) of program storage space. Maximum is 32256
```

Status of Requirements Verification

- PDR completed, CDR completed, and successfully launched the sub-scale twice
- Completed testing: Quick-Link testing, U-Bolt testing, Shock cord testing
- Additional testing required: Shock cord, Ejection, CO2 ejection, Shear pin, Wireless signal testing