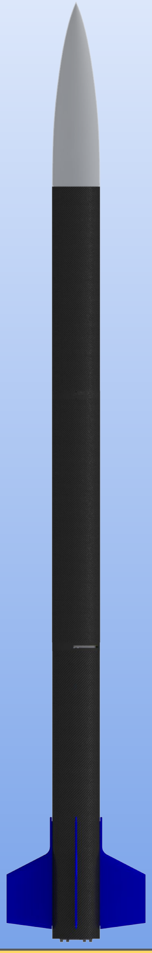
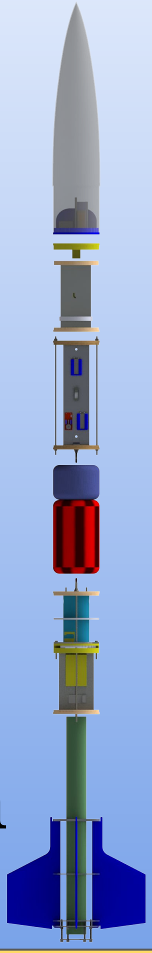


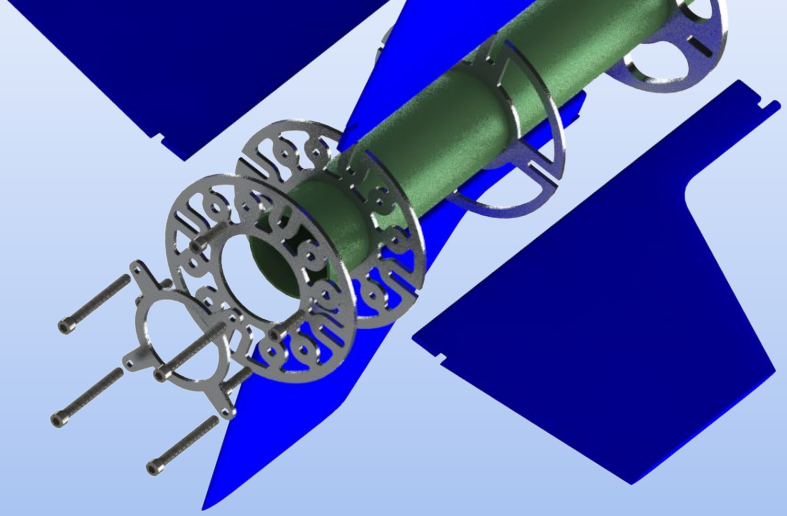
NASA Student Launch 2018 - 2019
Flight Readiness Review -- Presentation



Vehicle Design and Dimensions

Length (inches)	Diameter (inches)		Mass (lbs)	Final Motor Selection	Recovery System (inches)		Predicted Altitude (feet)	Vehicle Material	CG (in, nose)	CP (in, nose
	Outer	*Inner*			*Drogue*	*Main*				
104.27	5.52	5.34	18.1	L1000	18	60	5280	Carbon Fiber	59.873	78.878

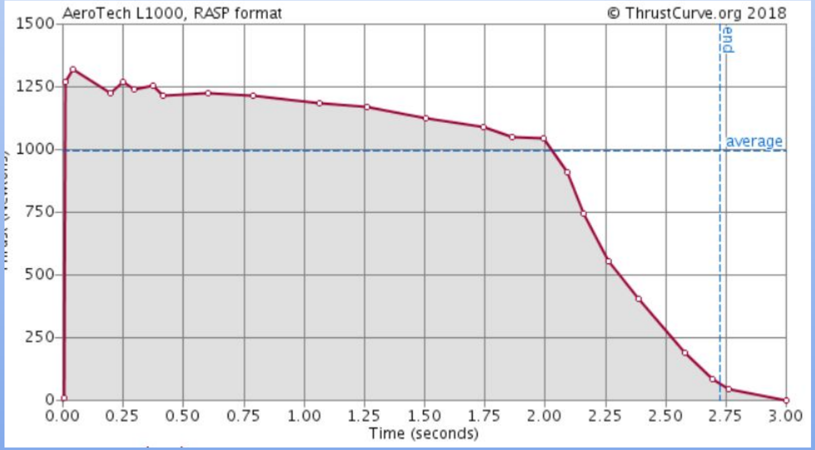
Key Design Features



- Carbon Fiber Airframe
  - Rolled in house
- Removable Fins
  - As Built CP adjustment
- ADAS (ADaptive Aerobraking System)
  - Adaptive deployment of drag fins
  - Guides vehicle to predetermined altitude via apogee reduction from drag
- Rover Payload
  - Compact rover
  - Object detection system
  - Actuated Landing Correction

Motor Characteristics

AeroTech L1000



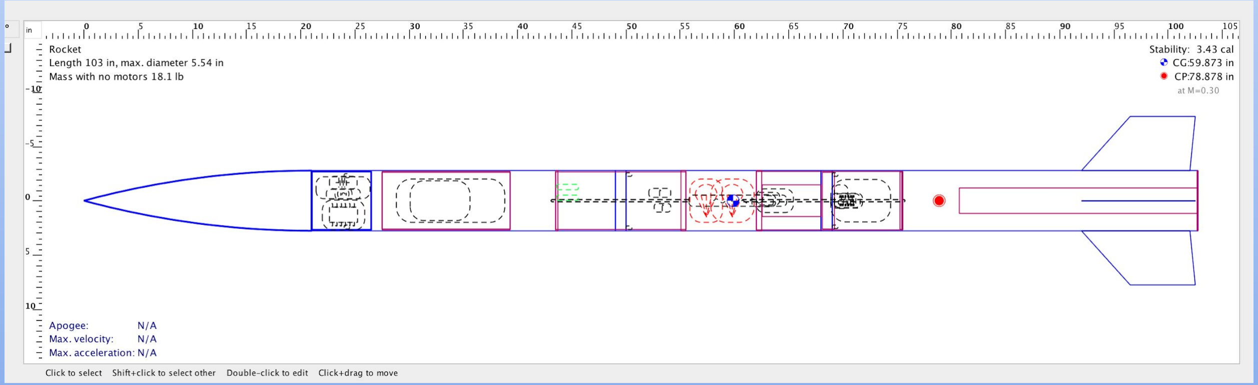
Total Impulse: 2714.0Ns

Length x Diameter: 63.5cm x 54mm

Weight (Wet, Dry, Prop): 2194g, 1400g, 794g

This motor was chosen as it makes the vehicle overshoot the mile target by a suitable amount, allowing ADAS to work and bring the altitude to exactly one mile.

Vehicle Stability and Flight Characteristics



CP	78.878”
CG	59.873”
Stability margin	2.28 cal
Thrust to weight ratio	9.8
Rail exit velocity	61 ft/s

Mass Statement

The figure to the right outlines the mass of the vehicle and its subparts.

The vehicle weighs an additional 2194g due to the motor at ignition, and after motor burnout, weighs an additional 794g.

Tethered Section	Subsystem	Mass
Upper (above ADAS)	Nosecone	757g
Upper (above ADAS)	Payload	1622g
Upper (above ADAS)	Recovery	1956g
Upper Section Total: 4335g		
Lower (ADAS & below)	Thrust (no motor)	1658g
Lower (ADAS & below)	ADAS	1508g
Lower (ADAS & below)	Fins	708g
Lower Section Total: 3874g		
ALL	**Rocket Total: 8209g**	

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Parachute Sizes, Decent Rates and Kinetic Energy

Parachute	Diameter	Decent Rate (Predicted)
Drogue	18"	60.27 ft/s
Main	60”	14.86 ft/s

- The tethered rocket must hit the ground at a velocity **less than 6.42 m/s** in order to meet NASA SLI recovery requirements.
- Simulations predict rocket will land at 6.04 m/s.

Winds

The table to the right outlines the drift of the vehicle from two methods, OpenRocket simulation and by hand. It should be noted that even under 20mph winds, the vehicle remains within the 2500ft limit.

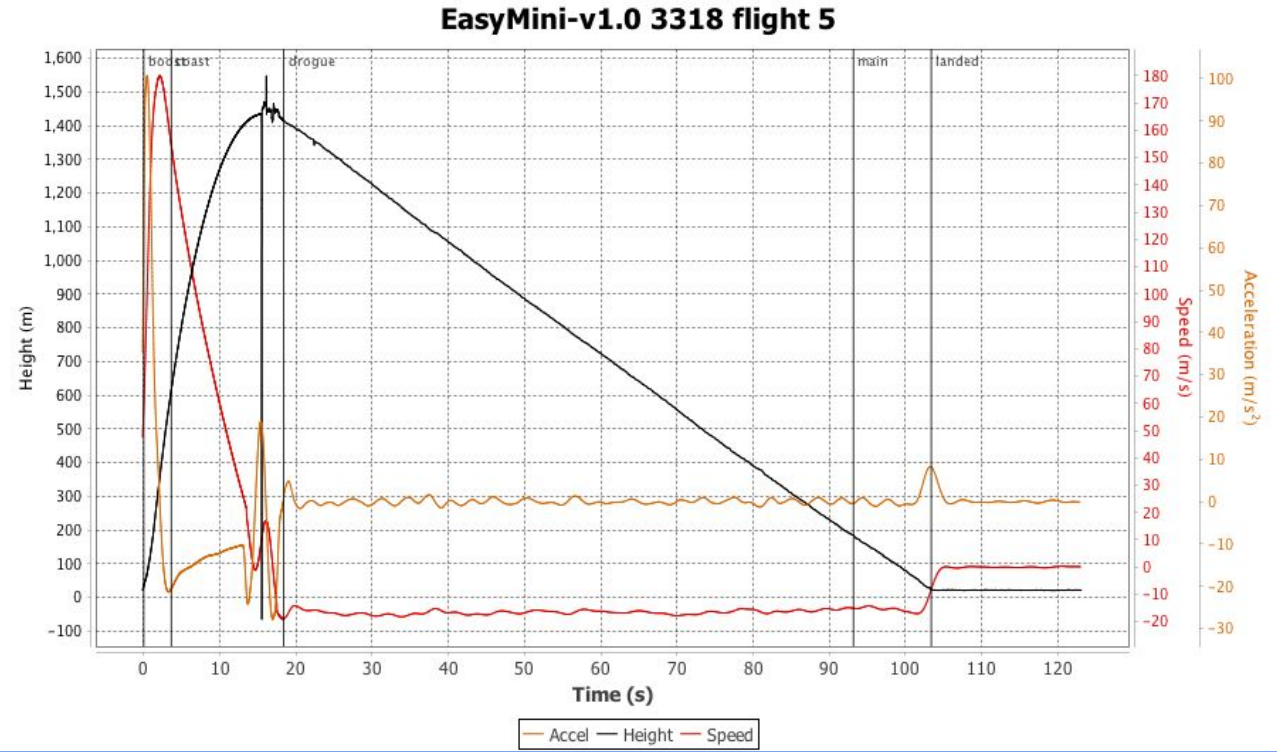
Wind Speed	Drift (OpenRocket)	Drift (by hand)
0 mph / 0 m/s	2.4m / 8 feet	0m / 0 feet
5 mph / 2.2 m/s	63.5m / 208 feet	158.4m / 519.7 feet
10 mph / 4.47 m/s	129m / 423 feet	321.84m / 1056 feet
15 mph / 6.7 m/s	224.5m / 737 feet	482.4m / 1581 feet
20 mph / 8.9 m/s	320.5m / 1052 feet	640.8m / 2101 feet

Vehicle Demonstration Flight Results

Failure	Potential Solutions
Parachute cords became tangled and the main parachute was not able to deploy	Practice folding parachutes in order to prevent tangling in the future
The shear pins holding the payload broke and the payload was lost during decoupling	Larger, stronger shear pins that are able to resist forces of parachute deployment at apogee.
Connecting wires for the ADAS came loose and the fins were unable to deploy	Solder wire connections in order to prevent disconnection

Vehicle Demonstration Flight Results

EasyMini (altimeter) data from full scale flight 1



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Recovery Tests

Recovery system tests:

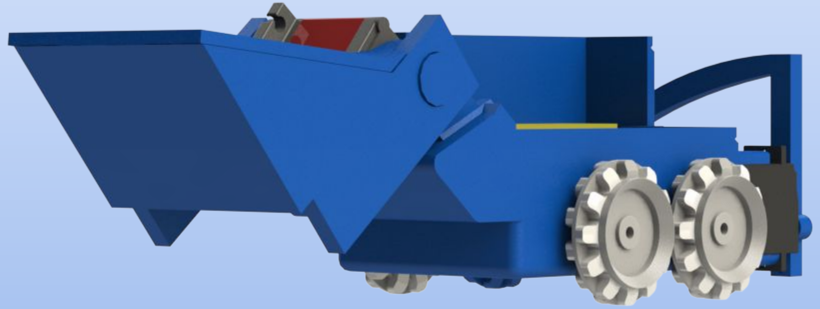
- Ground deployment test to verify black powder charge is sufficient.
- Drop tests to verify parachute packing technique is effective

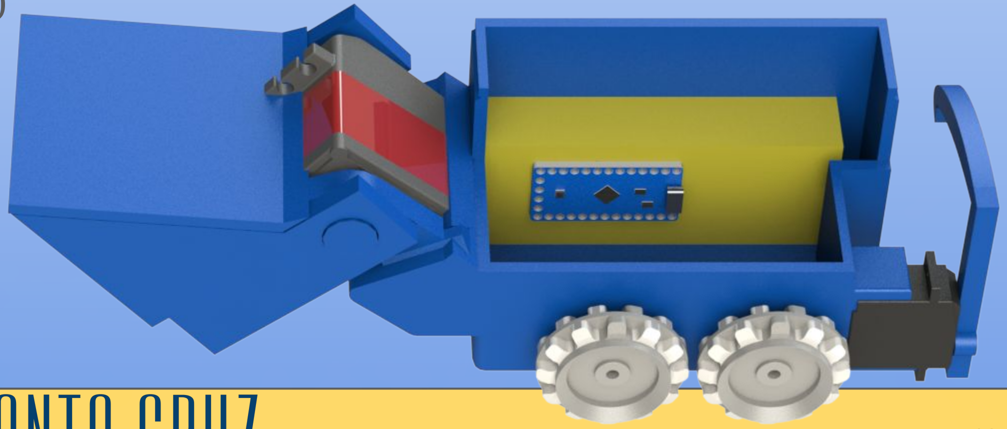
Requirements Verification Summary (Vehicle)

The majority of the Vehicle requirements have either been completed or are in progress. The lack of total competition is partially due to the need to re-fly the full scale, and because some requirements are only completed at the competition. Despite this, steps are being taken to complete as many requirements as possible before the competition in April.

Payload Design and Dimensions

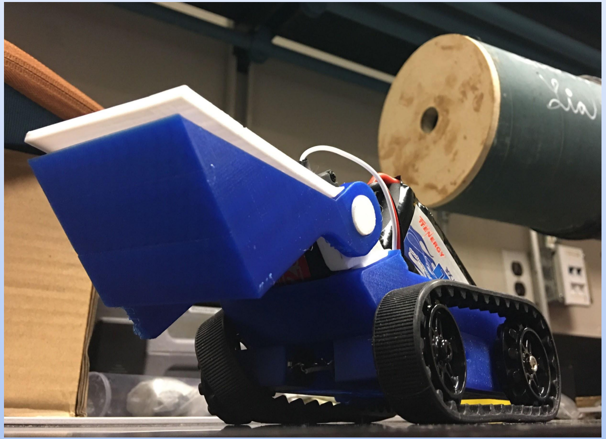
- Systems
  - Soil Collection (Bulldozer design)
  - Drive
  - ODAS (Object Detection and Avoidance)
  - ALC (Actuated Landing Correction)
- Dimensions
  - Depth: 2.87 inches
  - Width: 3.49 inches
  - Length: 8.79 inches
  - Weight: 13 oz
  - Material: PLA

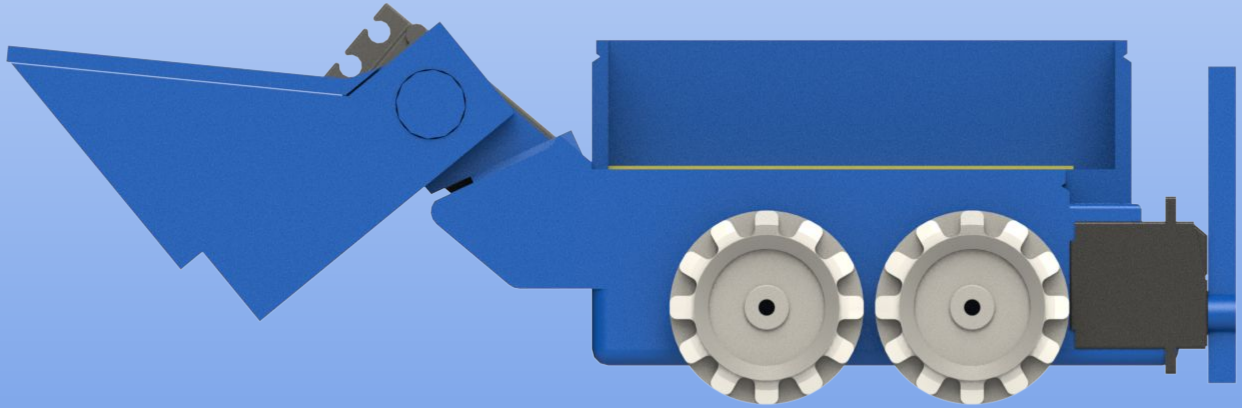




Kay Design Features of Payload

- Actuated Landing Correction
- Forward bulldozer like scoop
- Small form factor





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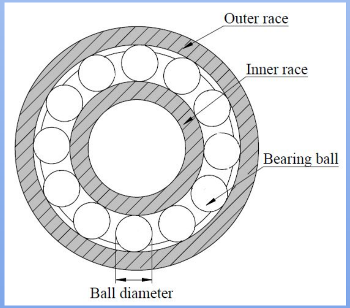
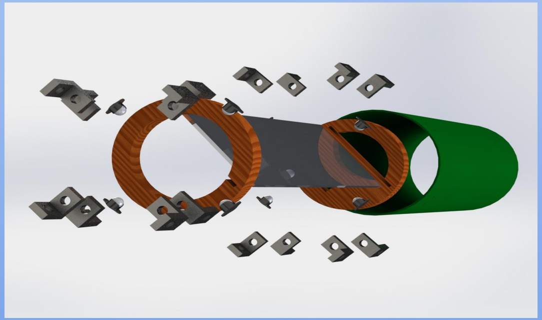
Payload Integration

Payload ALC system redesigned for stability and simplicity

Ball bearing passive actuation

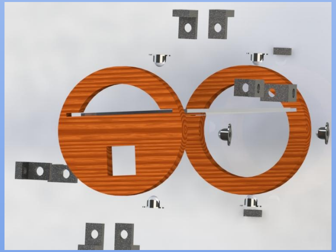
- Support force split across large section of airframe
- Securement through use of semi permanent bolts





Nose cone locking mechanism

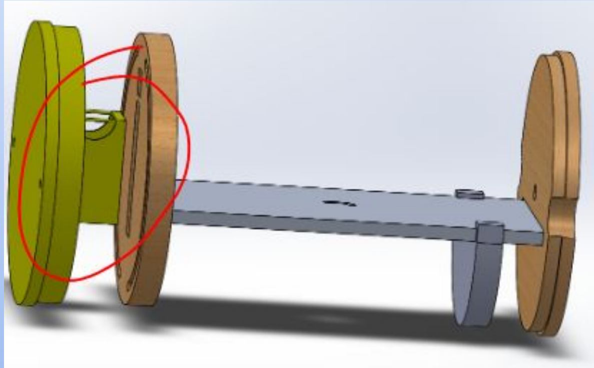
- Rotating coupler held in place through commutative attachment to airframe
- Utilizing stronger shear screws to withstand launch forces
- Redundant securement cable still in place, just secures nose cone so less force

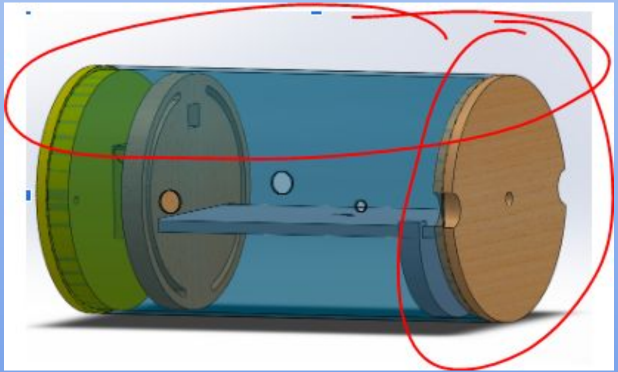


Payload Demonstration Flight Results

- Payload bay and rover failed in several key ways:

1. Sled came unsecured
2. Rover came unsecured
3. Shear pins broke prematurely
4. Payload bay opened up mid air
5. Secondary retention system failed





- **As a result the payload system underwent freefall from apogee**

Payload Securement Flight Results

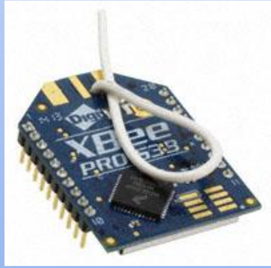
Failure	Solution
Load-bearing ALC-powering servo bit snapped	Implement a passive, bearing-based ALC system that is bolted to coupler
The shear pins holding the payload broke and the payload was lost during decoupling	Implement stronger shear pins
Rover hook to sled was loose	Modify design for a tighter fit of “lock key” piece
3D-printed PLA end piece holding sled snapped	Redesign new sled system using metal or wood to prevent snapping

Requirements Verification Summary (Payload)

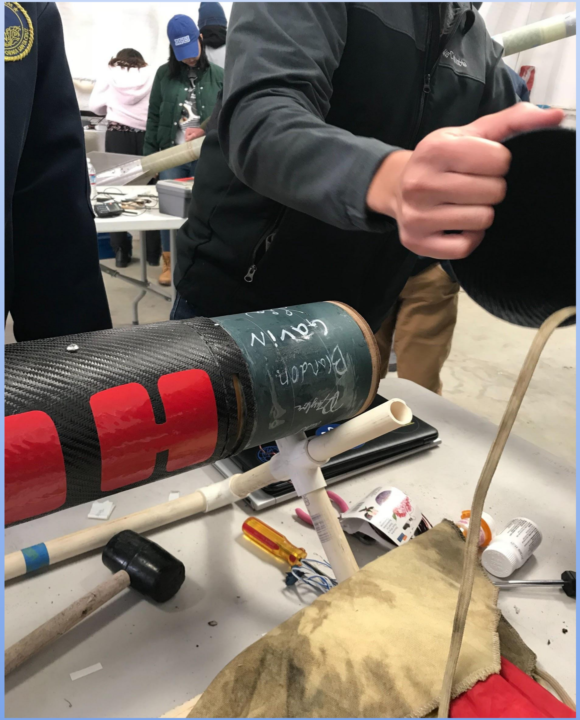
- A large number of the payload requirements have **not yet been completed**. This is due to the **loss of the payload during the first full scale** launch and the necessary redesigns that came with that. However, it is **foreseeable to have all possible requirements completed** before the Payload Test Flight deadline of March 25th.
- **Radio telemetry** has been completed
- **Basic drive system** has been completed
- **Scoop actuation** is in progress/nearly completed

Interfaces with Ground Systems

- The vehicle utilizes the normal motor ignition method and is built to accept the ignitor.
- The payload features an onboard radio that is linked to a ground receiver handled by one of our team members. Upon receiving the proper instructions, the team member will activate the payload bay through the transmitter, activating black powder charges and setting rover on its way.
- Radio operates at frequency of 900MHz and has been verified for short distances



ADAS Initial Flight Results



- The initial flight proved that the ADAS system was **structurally unreliable**
- Components became undone resulting in a **failure to deploy**
- 3 main sources of failure:
    a. Constant beaglebone issues
    b. Motor driver shortage
    c. Loose pin connections

ADAS Hardware Changes

- The new ADAS system has **modularized components** to alleviate single points of failure and make it **simpler to swap** out and replace parts
- These hardware changes **do not change the physical characteristics/energy** of the vehicle apart from minor mass changes and deployment profile