NASA Student Launch

Aerospace Engineering Capstone Senior Design 2023-2024

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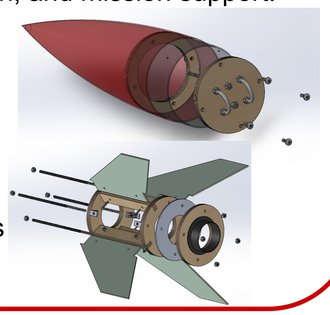
Course Instructor: Dr. Ewere | Section Instructor: Matthew Ayoola | Customer: NASA

Vehicle Design

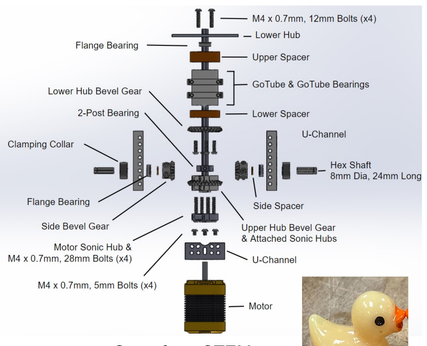
The launch vehicle was designed to reach a target apogee and to retain and support payload systems. Vehicle requirements include reusability, flight survivability, payload retention, and mission support.

Key Vehicle Features:

- New removable fin system (RFS) design.
- G10 fiberglass fins.
- Removable nose cone bulkhead.
- Ballast adjustment systems in nose cone and RFS



Payload Design



One of our STEMnauts

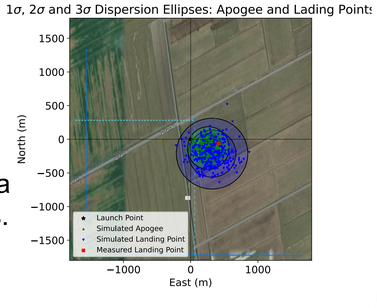
The payload was designed to deploy from the vehicle upon descent, descend safely, and land in a pre-determined orientation, without the use of parachutes or streamers, while retaining STEMnauts within.

Mission Performance

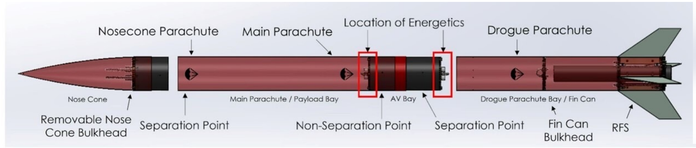
- Motor: Aerotech L1940X
- Stability: 2.29
- Weight: 51.6 lbs
- Thrust-to-weight ratio: 10.61 (max) 8.53 (avg)
- Overall descent time: 80.81 sec
- Applications such as OpenRocket and RocketPy used to predict apogee of vehicle under a variety of wind conditions.
- Can also be used to predict the drift distance, descent time, and potential landing locations.

Target Altitude: 4050 ft.

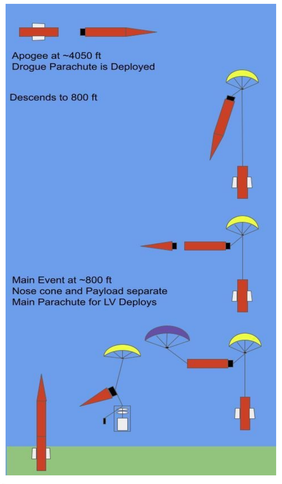
1σ, 2σ and 3σ Dispersion Ellipses: Apogee and Lading Points



CAD Models and Prototypes

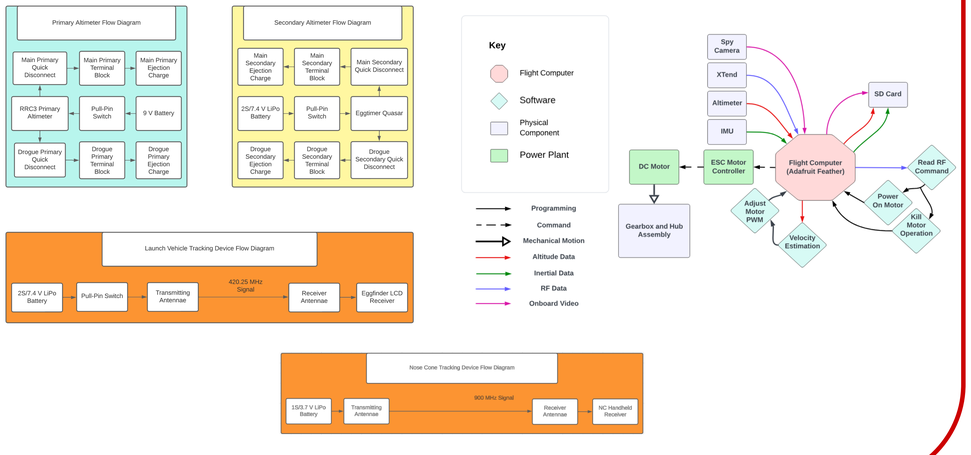


Concept of Operations



1) Vehicle is launched.
2) Vehicle reaches apogee.
3) Drogue parachute deployed via black powder.
4) Nose cone separation at 800 ft via black powder.
5) Payload bay pulled out, hanging under nose.
6) Main parachute deployed from main bay.
7) Wait for payload bay to settle. Receive RSO permission to deploy.
8) RF signal sent to release payload at 450 ft.
9) Payload released from nose cone
10) Rotors commanded to start up.
11) Payload lands on legs in upright position.

Functional Block Diagrams



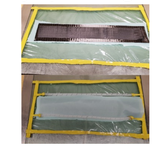
Manufacturing

Vehicle

- Airframe: G12 fiberglass
- Fins: G10 fiberglass
- Bulkhead layups: birch wood and epoxy under vacuum.
- Permanent connections epoxied.
- Hardware purchased from manufacturers.

Payload

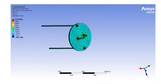
- Gear box: machined aluminum.
- Landing legs: hollow aluminum.
- Rotor blades: 3D printed CF-PC, carbon fiber layup using VARTM

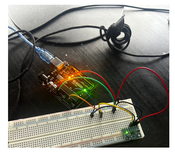


Testing

Vehicle

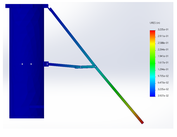
- Bulkhead stress test
- Fastener shear test
- GPS operational test
- Altimeter test
- Fin impact test
- Ejection test





Payload

- Rotor blade adhesion test
- RF signal test
- Camera test
- Thrust verification test
- Landing leg bend test
- Deployment test



Test Flight Results

VDF

- Predicted Altitude: 3950 ft
- Recorded Altitude: 3812 ft
- Ballast: 4.55 lb
- Wind: 7 mph
- Nominal takeoff and landing.
- All recovery events executed as expected.

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- Dropped payload under parachute.
- Deployment successful.
- Data collection failed.
- STEMnauts successfully retained.