Capstone: Active Drag System (ADS) for Rockets

It's Not Rocket Science….. OH Wait!

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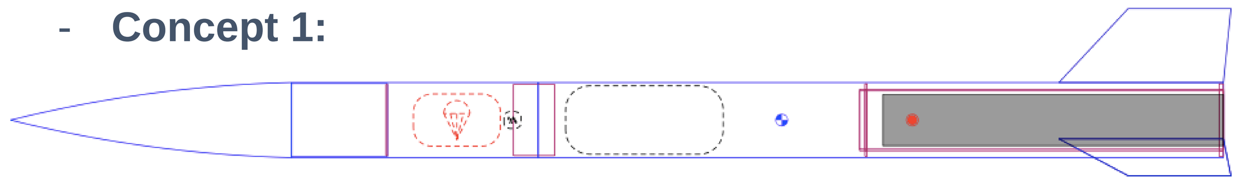
UVURT – Utah Valley University Rocket Team

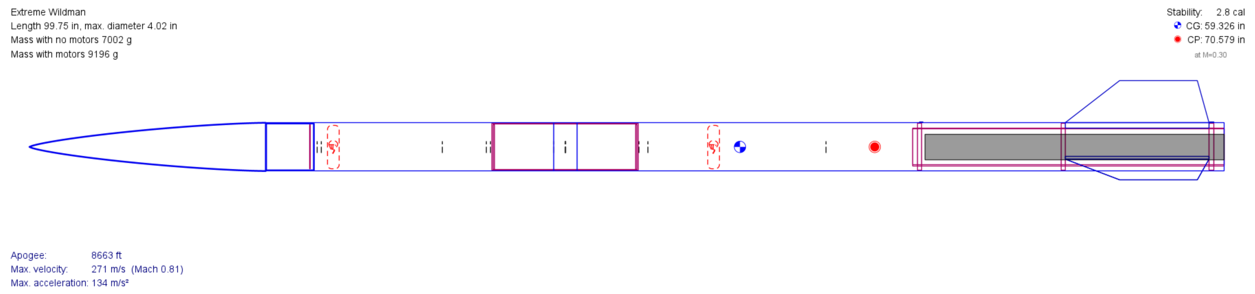
Using a custom Active Drag System (air brakes), a rocket was designed to reach its apogee at a specific desired altitude

Design Requirements and Concept Drawings

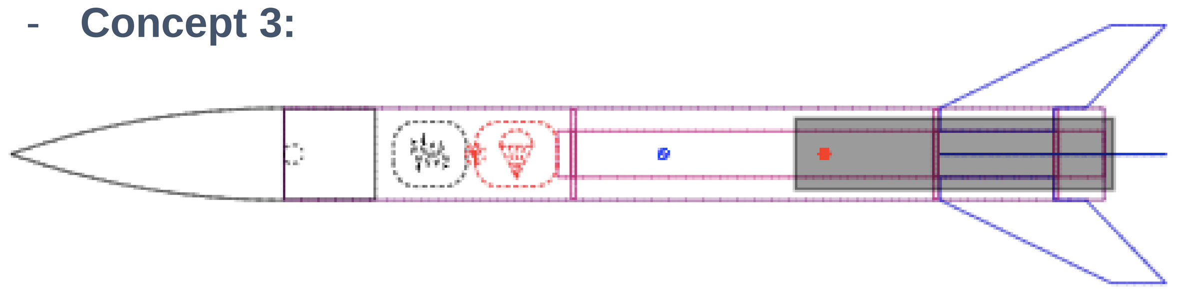
- Design and build a level 2 rocket that could reach exactly 10,000 feet above ground level at its apogee
- Design and implement a custom Active Drag System (ADS) to provide additional drag on the rocket
- Have a Factor of Safety of at least 2
- Use dual deployment for recovery
- Redundant altimeters and electronics
- GPS tracking for ground recapture
- Capable of carrying an 8.8-pound payload 3 CubeSats in size
- **Concept 1:**

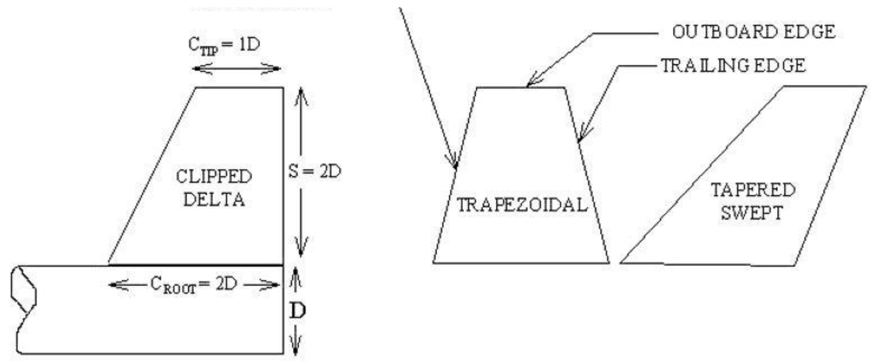


- **Concept 2:**



- **Concept 3:**

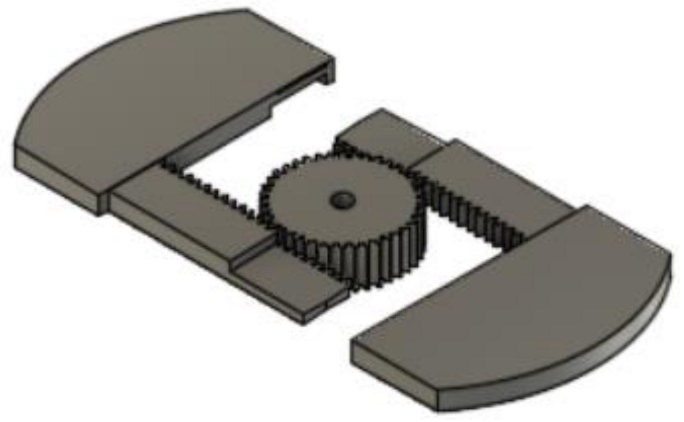




Active Drag System Implementation

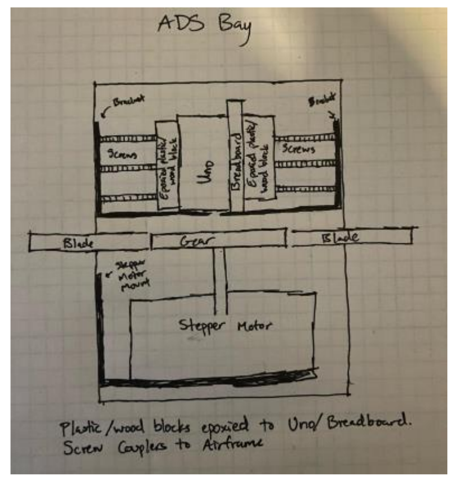
Multiple brainstorming and concept-generating iterations were performed for the rocket and ADS. Ultimately, it was decided to use the Extreme Wildman, a 10-foot-long fiberglass rocket with a 4-inch diameter.

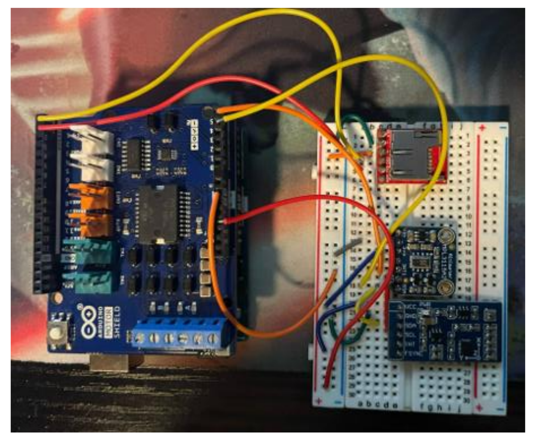
The rocket houses important components such as the ADS bay, the Avonics bay, parachutes, motor casing, and gins. The ADS bay consists of two blades and a gear driven by a motor that is controlled by a microcontroller.



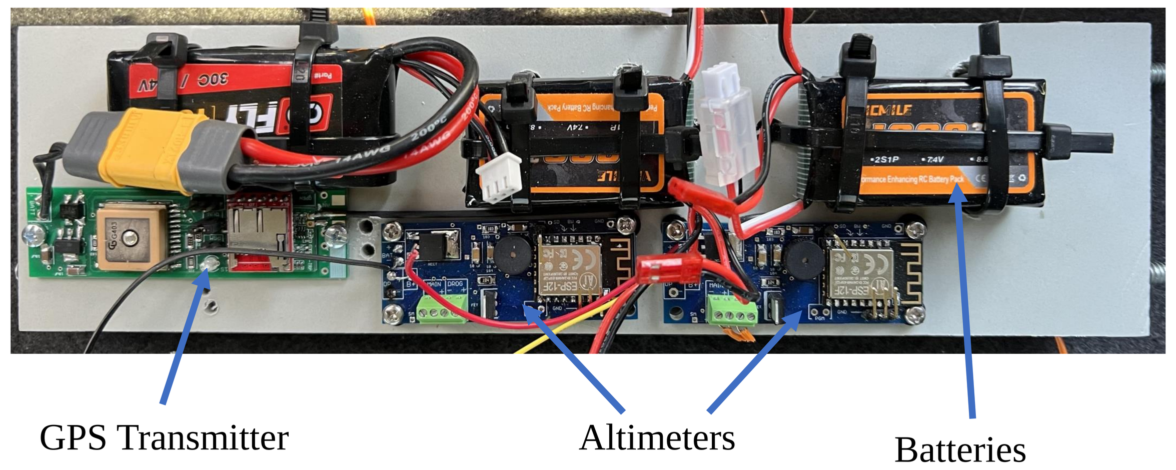
(add picture of ADS bay assembly (with labels?))

The microcontroller is an Arduino UNO, and it contains code to control the deployment and retraction of the ADS blades based on projected apogee, velocity, acceleration, estimated drag force of the blades, and current altitude.





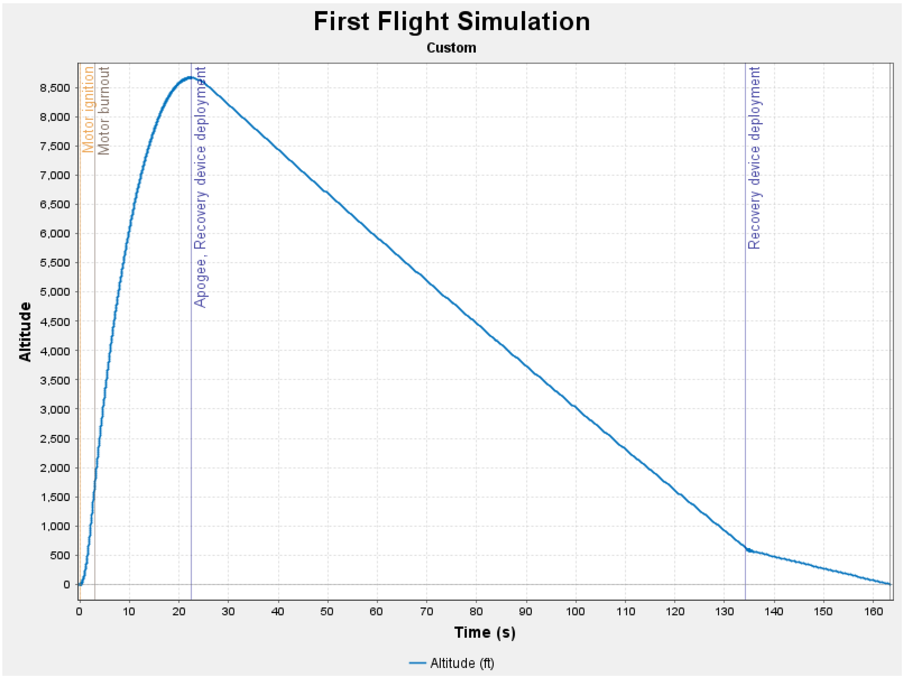
Inside the Avionics bay are altimeters, and a GPS. The altimeters control the ejections of the parachutes based on altitude, which is important for a safe and recovery after landing. This ejections are triggered by ignition of gunpowder, so the parachutes are wrapped with Kevlar blankets to protect them from burning.

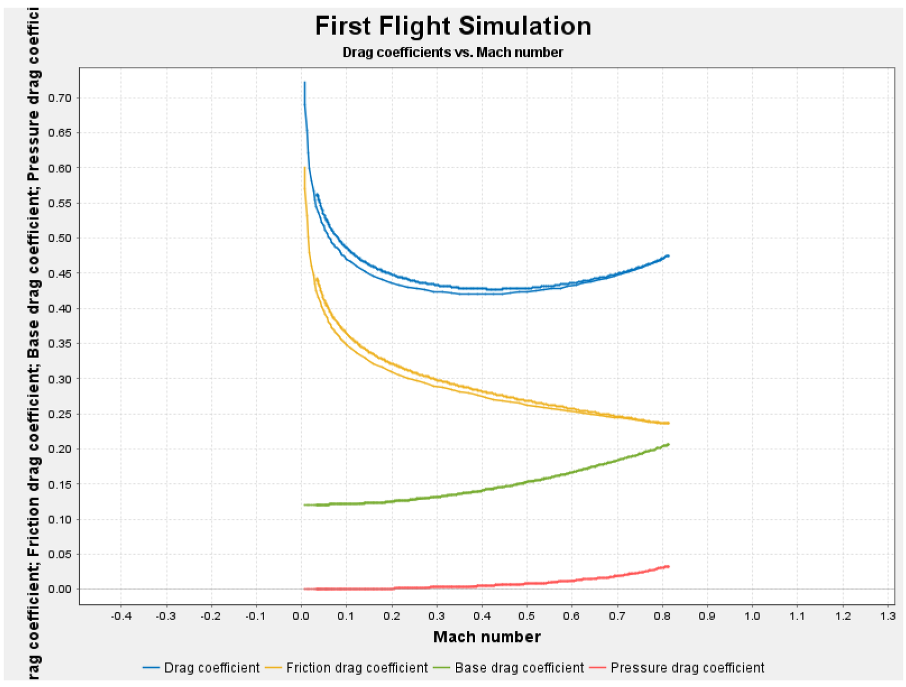


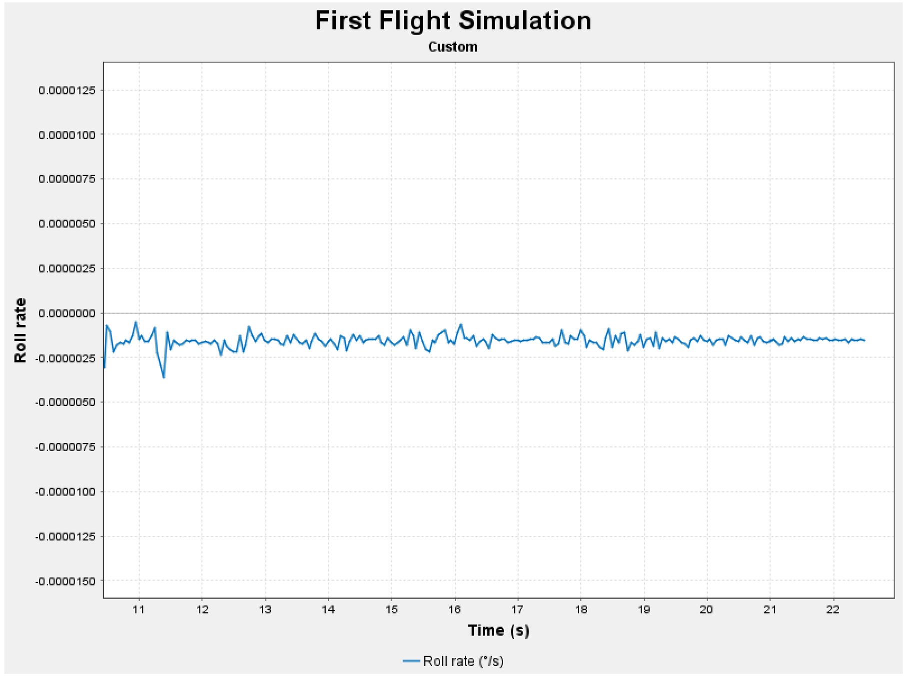
Analysis and Simulations

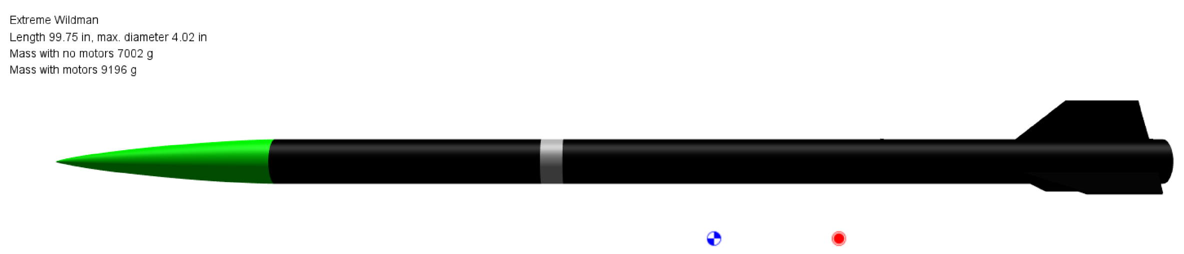
Many types of simulations were done using the open-source software *Open-Rocket*. The three major simulations are listed below and their respective plots.

1. Altitude vs Time with deployment locations
2. Drag Coefficients vs Mach Number
3. Roll Rate vs Time
4. Computational Fluid Dynamics (CFD) analysis



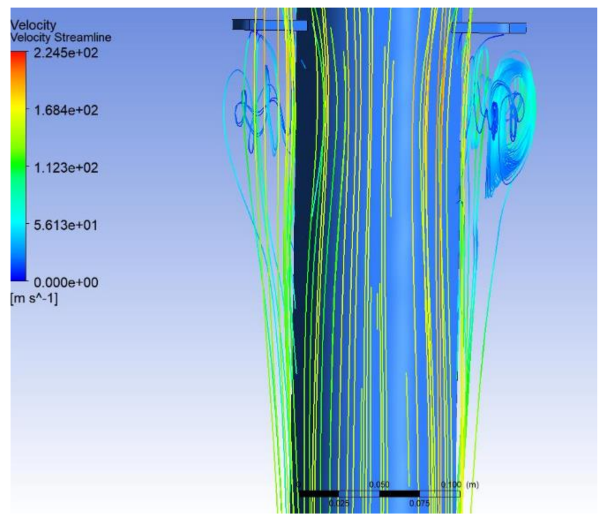


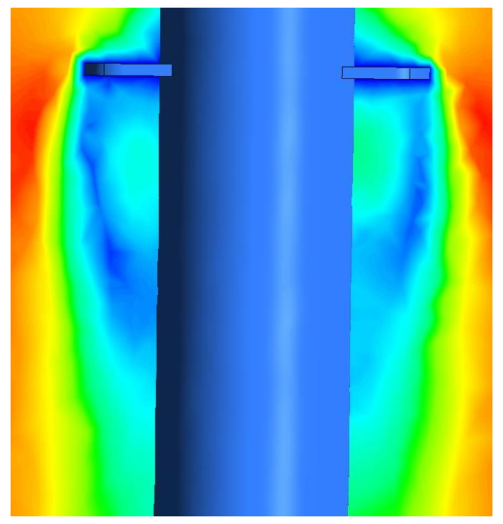




Simulations Continued

Computational Fluid Dynamics analysis to show vortex shedding near the ADS blades. This specific analysis helped the team determine the best location and placement of the blades. It was found that if said blades were directly above fins, less vortex shedding occurred.





Certifications and Qualifications

To be able to launch High Powered Rockets(HPR), it is required to have certain certifications depending on the altitude and size of a rocket motor. To launch a rocket above 5300 feet, the team had to obtain level 1 and 2 certifications by using smaller rocket kits to develop the skills and knowledge needed for a safe rocket launch.

Altimeters and Avionics Electronics

The rocket has an avionics bay that requires multiple electronics for safe testing and deployment of the two recovery devices; a drogue chute to prevent drifting, and the main parachute for safe landing. The purpose of dual deployment is to have the rocket land closer to the launch site.