Capstone: Rocket Altitude Correction System

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PROBLEM DEFINITION

Design a rocket capable of carrying an 8.8 lb payload to reach a precise apogee of 10,000 ft.

Fundamental Design Requirements

- The rocket was to be designed with The Spaceport America Cup regulations as the primary design requirements. Some notable requirements are listed in tables 1 and 2.

- From the SA cup rulebook:

Table 1: Some important design requirements from SA cup rules.

1	Requirement	Value	Units
2	Rocket apogee	10,000	ft (AGL)
3	Payload weight	8.8	lb
4	Maximum motor impulse	40,960	N*S
5	Redundant recovery systems	2	n/a

- Other requirements:

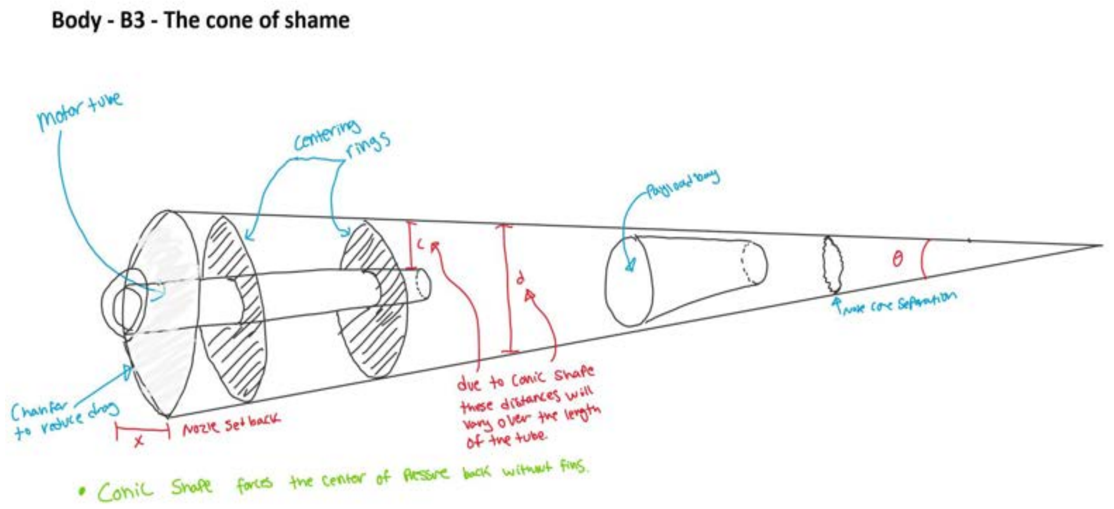
Table 2: Other requirements determined in the problem exploration phase.

1	Requirement	Value	Units
2	Stability caliber	>1	n/a
3	Fin orientation accuracy	<1	deg
4	Acceleration tolerance	539.55	m/s^2
5	Project budget	5,500	$

Concept Generation and Selection

Concept generation was performed in a collaborative and iterative manner.

- The conceptual rocket design was split into various individual components including concepts for an altitude correction method.

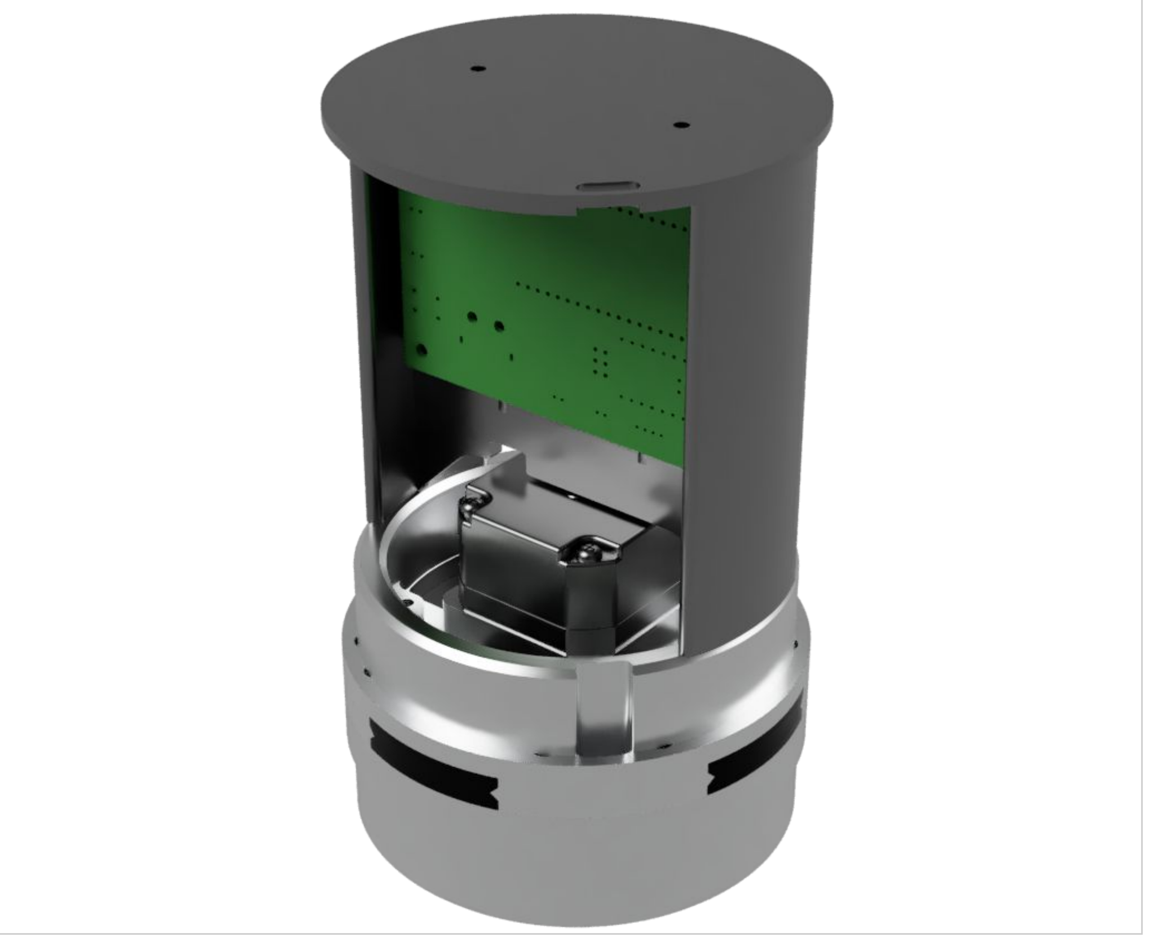


- Component concepts were discussed and mixed to create full concept rockets.

Concept selection used a process of filtering and scoring matrices based on design requirements.

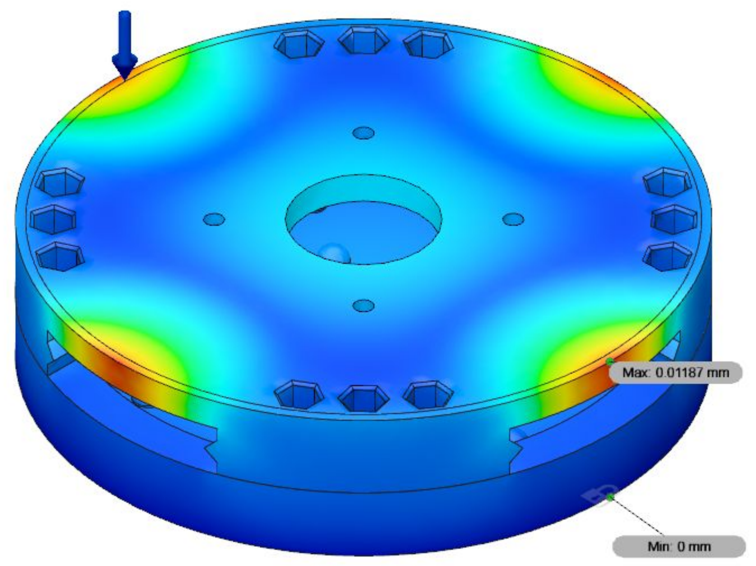
- In addition to the rocket body design, a method of regulating altitude accuracy was selected which was given the name Altitude Control System, ACS.

A Stepper motor driven ACS was designed to deploy flaps at a given time during flight. This would cause a higher drag coefficient and slow the rocket velocity. The flaps are designed to deploy via their attachment scroll wheel which is connected to the motor shaft. Dedicated flight computers would dictate the timing of deployment



Design, Analysis, and Prototyping

FEA was used to determine the deflection of the ACS components, After the analysis, an aluminum part would be manufactured to withstand the forces.

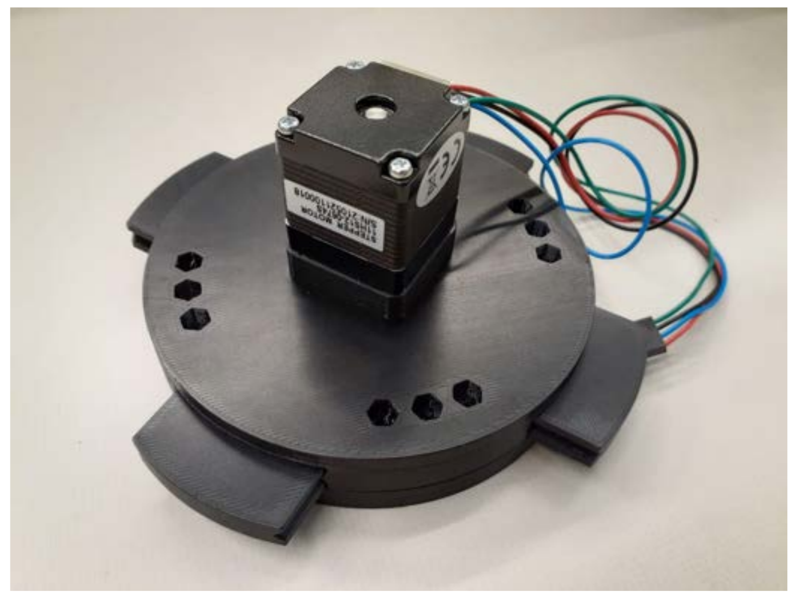


In addition to the ACS analysis, there was also flight dynamics simulations done in rocket simulation software. These software provided crucial information and approximations on:

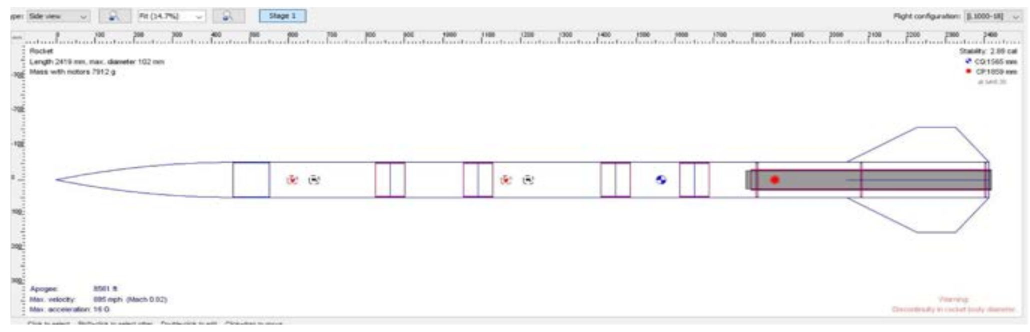
- Maximum altitude (apogee)
- Speed
- Maximum G forces
- Velocity at parachute deployment
- Rocket stability caliber

The process of rocket design and refinement was largely iterative and experimental when improving body and fin design. Simulations were used to adjust and refine the selected concept

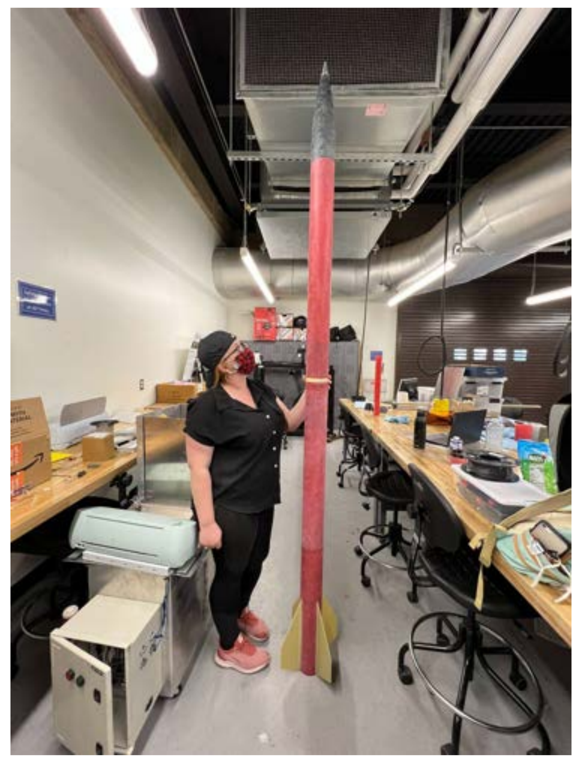
- 3D printing played a crucial role in the prototyping process. Being able to test functionality and fit before construction allowed for errors to be discovered that weren't observed in CAD models or other simulations.



Results



The final rocket design is 9.2 ft long and 4 inches in diameter. Final launch day of the rocket is April 16th.



Lessons Learned

After working with the Utah Rocket Club, members of this project were able to become TRIPOLI certified and learn about the regulations for high power rocketry. Flight certification was a time sensitive factor and team members had to undergo testing.

Applications

An Altitude Correction System (ACS), such as the one designed for this project, could act as a useful tool for companies and researchers using Experimental Sounding Rockets (ESR). When scaled correctly the ACS provides a lightweight, compact, and efficient method for achieving a precise apogee which is a crucial requirement for most rocket based research projects.

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