Thesis Project Portfolio

Student Lead Subsonic High-Powered Rocket Capstone

(Technical Report)

Reclaiming the Final Frontier: The Sociotechnical Impact of Reusable Rockets

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring, 2025

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Table of Contents

Sociotechnical Synthesis

This portfolio contains a technical project for the design and launch of a subsonic sounding rocket and an STS research paper investigating the public's views on space exploration. Both endeavors aim to enhance an understanding of the current aerospace industry and rocket technology.

Technical Project Overview

In the world of academia, students in aerospace undergraduate programs across the nation are embarking on small-scale designs of mechanisms and systems in the field of rocketry. As discussed by students and faculty involved in the project, one of the main goals of the rocket capstone at UVA was to design, build, and fly a high-powered rocket to set a precedent for future UVA capstones. The goal behind the *HooRizon* subscale rocket was to launch up to 4,000 ft in altitude and sound atmospheric conditions including humidity, pressure, temperature, ultraviolet rays, and send this data via live telemetry. The rocket's avionics system's function was collecting, storing, and communicating information between the rocket and the ground station. It was designed to house internally and externally mounted sensors to collect data throughout the flight time.

One of the core ideas reflected in the design and the system was the aim of creating a modular design for the hardware integration that is feasible to recreate within short periods. Keeping that goal in mind, at minimum, two iterations of most components were made after testing and initial construction in response to lessons learned. The avionics involved two additional priorities, including altimetry and recovery. This involved triggering a CO2 ejection charge to separate the upper body tube and the lower body to recover the rocket with a parachute. An extra goal added

to the project's objectives was providing an audience with a livestream from a camera included in the rocket.

STS Research Summary

Curious about how the public perceives the impacts of different technologies in the aerospace industry and how innovations can shape public expectations and narratives regarding space. The paper will evaluate historical data on public attitudes towards space, ranging from optimism to skepticism, and will examine how commercial successes have revived support. Drawing on Actor-Network Theory, the interconnected nature between private industry, the government, and the people's opinions will be assessed. In addition, media, pop culture, and other portrayals of what space exploration and industry activities could look like will be examined to uncover potential impacts on public perception and future expectations. How both current activities shape public perception and how public support in turn can shape private industry goals and activities will be discussed. Key examples of high-performing firms like Blue Origin, SpaceX, and Rocket Lab, and their investments in a specific form of reusable rocket technology, will be presented.

The topic of reusable rocket technology is emphasized in the paper to demonstrate how specific advancements can sway public support as the industry strives towards particular goals like commercial space travel or repeat launches for scientific curiosity. SpaceX with Falcon 9, Rocket Lab with Electron, and Blue Origin's New Shepard are all firms that have shown that with innovation, we can change previous system designs to be sustainable. These firms have found a means to reduce the cost per launch for themselves, but also demonstrate that it's possible for emerging startups and other players entering the industry.

Interconnection Between Technical Work and STS Research

The relevance of these independent projects to one another is rooted in the future of sustainable aerospace research and development. As we continue to question more and want to learn more, we will require increased access to space. Conversely, if we want to enjoy the low Earth orbit system around us, it will be imperative to do so sustainably. The objective of the UVA sounding rocket technical capstone was to set an example that a project of that scale could be produced within a set time frame and a set budget. Also, it could be manufactured to be lightweight and stiff, and it can conduct scientific exploration without costing the department or the team excessive money or time. Testing manufacturing processes and modifying solid body designs to optimize geometries and ease of assembly were ways in which the team examined how simple decisions could make processes more efficient.

Reusable technology, whether considered a sustainable design of a component or sustainable engineering of a process, has a similar objective: to make space exploration more sustainable. Most technologies prosper with public support, including reusable rocket technology and the UVA sounding rocket capstone. When attempting to launch a level II rocket as first-time rocketeers to set a precedent at UVA, many design iterations and physical assembly checkpoints had to be reviewed by faculty members. The need to build trust and confidence with department faculty and members of other sub-teams to ensure smooth collaboration and progress made many members think about what working on projects like this in industry would entail in terms of external relationships.