Thesis Project Portfolio

Student Researched and Developed Rocket

(Technical Project)

Exploring the Shortcomings of Current Federal Regulations on the Environmental Impacts of SpaceX Rocket Launches in the U.S.

(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

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Table of Contents

Sociotechnical Synthesis

My technical project and STS research both revolve around rocket launches. My technical project focuses more on the small-scale development and launch processes whereas my research looks at how large companies, such as SpaceX, conduct their launches and the resulting environmental impacts. The hands-on work from my technical project has given me a better understanding of the complexities of rocket launches, even at such a small scale, that I was able to consider when conducting my research.

My technical capstone project involved working in a team to design, fabricate, and potentially launch a roughly ten foot tall rocket. We spent our first semester dividing the class into sub teams and conducting research on possible designs, presenting our findings along the way. As a member of the body team, my focus was on finding the most optimal material, size, and fabrication method for the body tubes while also communicating with the other sub teams and taking into account their design decisions. We ultimately chose to build our own tubes instead of purchasing premade ones since we wanted to use fiberglass as a relatively low-cost, low-weight, and high-strength material, and we were able to customize our diameter to fit the other teams' needs. We used phenolic tubing as a lightweight and durable frame to cover with a fiberglass sleeve and resin to strengthen it. Our second semester, we continued research on manufacturing methods and decided to fit the fiberglass sleeve over the phenolic tube, rotating it like a barbeque spit, while coating it with the resin. Using this method, we then fabricated two tubes to house the parachute and couplers, and the fins and fuel. Ultimately, we were unable to launch the rocket, but we still learned valuable lessons in the development and design process, presenting our ideas in a formal setting, and the communication involved in working towards a collective goal in smaller sub teams.

My STS research centered around the environmental impacts of SpaceX Falcon 9 and Starship rocket launches, specifically at the Boca Chica, Texas launch site. I researched statistics relating to the environmental impacts of launching these rockets, and found that they release significant amounts of harmful soot and CO2 into the atmosphere. Additionally, at the Boca Chica launch site, there have been several incidents where the Starship test launches have exploded and resulted in considerable damage to the surrounding environment and ecosystems, with little repercussion from the FAA. This information led to my research question of why has SpaceX been allowed to operate within current regulations while negatively impacting the environment and pollution levels, as seen in the Boca Chica, Texas launch incident in 2023? Under the National Environmental Policy Act, before a rocket launch can occur at any launch site in the U.S., SpaceX must submit mission proposals and detailed descriptions of their planned operations so the FAA can issue permits and complete environmental evaluations in the form of Environmental Assessments (EAs) or Environmental Impact Statements (EISs) (Federal Aviation Administration, 2022). While SpaceX did conduct the required EA for their Starship launch, an EIS would have been more thorough in mitigating environmental impacts, but was not deemed necessary by the FAA. This sentiment led to my thesis statement, that SpaceX has been able to function within current federal regulations while negatively impacting the environment because of a lack of motivation to improve environmental protection procedures at the administrative level, and deficiencies in regulations at the federal level. I utilized ideas from Merritt Roe Smith's *Technological Determinism in American Culture* to show how SpaceX views technology as an end itself, rather than a means to an end, and fails to properly account for relevant social and environmental issues. I also investigated the April, 2023 Boca Chica Starship launch and showed how the FAA failed to make significant corrective actions to prevent incidents like this

one from happening in the future. My research shows that there is a need for significant change in both administrative and federal environmental regulation procedures in order to properly protect the environment.

My work from both of these projects showed me the value and difficulty of environmental considerations within the aerospace industry. When I first began my technical project, I did not put much thought into how our rocket design would impact the environment since it seemed insignificant in comparison to larger-scale designs, such as Starship. However, once I began my research, I saw the importance of considering environmental impacts in the design process. Working on my technical project, I sometimes found it difficult to minimize the negative environmental impacts in our design while working within our materials and budget scope. This difficulty helped me better understand why companies like SpaceX do not tend to hold the environment in very high esteem, and guided me towards the federal side as a potential solution, rather than arguing that SpaceX should do more to care for the environment because it is the right thing to do. Overall, I learned many valuable lessons from both of these projects that I hope to uphold and utilize in my career as an aerospace engineer.

Works Cited

Federal Aviation Administration. (2022). *Final PEA for the SpaceX Starship/Super Heavy Launch Vehicle Program at the SpaceX Boca Chica Launch Site, Cameron County, Texas*. https://www.faa.gov/sites/faa.gov/files/2022-06/Final_PEA_Executive_Summary.pdf