Thesis Project Portfolio

Student Researched and Developed High Power Rocket

(Technical Report)

Commercialization and the Future of Spacecraft

(STS Research Paper)

An Undergraduate Thesis

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The problem investigated in this thesis is the design and optimization of spacecraft, particularly rockets. This is an important process to understand, because the spaceflight industry is growing rapidly and garnering more attention. As engineers, it is vital for us to be able to take a specific goal and a set of parameters, and design a system that works. Compromise is an important part of the design process, but it cannot be done at the expense of safety. Additionally, scientific and engineering interests are heavily tied to societal needs and interests, a fact which spacecraft design reflects.

For the technical aspect of this project, we researched, designed, and built a rocket and a payload able to conduct a small scientific experiment. The goal was to introduce our capstone team to the design process in a space where we had lots of creative freedom. While the option to buy off-the-shelf parts was available to us, in many cases, we opted to design and fabricate the parts ourselves. Because of this, however, our initial plan to construct and launch the rocket before the end of the year had to be reevaluated and ultimately scrapped. Construction will still be completed, but because of time constraints, we were unable to complete the proper testing and evaluation before the prospective launch date. As a team, this experience taught us first hand about compromise and group decision making.

For the STS portion of this project, I investigated the past and current states of the spaceflight industry in an effort to predict whether more traditional technologies will become obsolete in the near future. In other words, I focused on the prevalence of expendable launch vehicles (ELVs) versus reusable launch vehicles (RLVs). As the number of launches per year increases, ELVs could be a less sustainable option than they have been in the past. However, sustainability must not compromise reliability and safety. To complete this analysis, I used the Social Construction of Technology framework to identify relevant stakeholders, both past and present, and to evaluate phenomena such as interpretive flexibility, stabilization, and closure. The sources used in this analysis ranged from technical papers to newspaper and magazine articles in an attempt to capture the opinions of all relevant social groups. While it is impossible to ensure an accurate prediction, I have determined that RLVs will continue to see a spike in interest and use, but that ELVs will remain relevant for a while yet due to their reliability and relative ease of operation.

Overall, I believe that I achieved my goals for both the technical and the STS portions of this research project. On the technical side, while it is disappointing that we will not be able to launch, we were still able to implement our own designs, which was a much more valuable use of our time than simply getting off-the-shelf components. As for designs that we were not able to implement, we hope that they will still be useful resources for future students working on similar projects. Additionally, designs that we were unable to implement still gave us experience with practical skills that we will be able to use later in our careers, such as computer aided design, finite element analysis, and computational fluid dynamics. My recommendation for future researchers working on such a project would be to make sure that communication is efficient, and that parameters are made explicit and readily available. For the STS portion, my recommendation for future researchers would be to continue watching the development of reusable systems and relevant technologies, particularly materials, as the field continues to focus on improving reliability to enable increasingly ambitious goals.

Finally, there are many people I would like to thank for their invaluable help on this project. First, I would like to thank my technical project advisors, Professors Haibo Dong and Michael McPherson, as well as my advisors in the STS department, Professors Caitlin Wylie and Travis Elliott. Additionally, I would like to recognize the members of my capstone course who have shown incredible hard work and dedication throughout the year despite the setbacks and challenges that arose. Their creativity and persistence was inspiring, and I can only hope to display a similar work ethic moving forward. Finally, I would like to thank my friends, roommates, and my partner whose support has meant the world to me. They have been my sanity and voice of reason throughout this process, and I cannot possibly thank them enough.