Thesis Project Portfolio

HEDGE

Hypersonic ReEntry Deployable Glider Experiment

Critical Design

(Technical Report)

Exploring the Potential and Challenges of Supersonic Technology for Commercial and Educational Use: Revolutionizing Air Travel and Scientific Research

(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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Sociotechnical Synthesis

My thesis will address a Hypersonic ReEntry Glide Vehicle experiment (HEDGE) for my technical project and history, uses, and impacts of supersonic aircrafts for my STS thesis. These two topics are closely related because of both going faster than the speed of sound, but HEDGE is defined to be a spacecraft in orbit then reentering in the atmosphere, while my STS portion focuses aircrafts on the avionic side staying in the atmosphere. The motivation for my technical project was to gain knowledge about how work is done within industry and to be a part of a multiyear project. While motivation for the STS portion was based on the questions: why do we care about supersonics and why is the aerospace industry still trying to use them?

My capstone worked to develop a mission for hypersonic reentry. The project is called the Hypersonic ReEntry Glide Vehicle experiment (HEDGE) and is a proof-of-concept mission to determine the feasibility of using CubeSats as a means of low cost sustained hypersonic flight. HEDGE will demonstrate the ability for undergraduate students to perform hypersonic experiments at lower cost and with greater accessibility than traditional programs. Currently, HEDGE is undergoing the critical design review step of NASA's project life cycle. The critical design review determines if the system design is mature enough to proceed with full-scale fabrication, assembly, integration, and test. In other words, to pass the critical design review the design must be almost completely completed and feasible enough to proceed with fabrication. The primary objectives of HEDGE are to demonstrate the feasibility of affordable CubeSats as a platform for hypersonic glider flight research, demonstrate a materials screening method for hypersonic flight conditions at an extremely low cost, and show that undergraduate students can conduct hypersonic glider flight experiments at lower cost and with greater accessibility than traditional programs. The secondary objectives are to integrate undergraduates into an industry,

government, and university partnership involving complex systems engineering and program management with multiple stakeholders, and conduct STEM and hypersonics outreach to community and potential engineering students.

My STS project explores the history and uses of supersonic technology, including its development for military, commercial, and educational purposes. While supersonic flight has the potential to revolutionize air travel and scientific research, it also poses challenges related to safety, sustainability, and cost-effectiveness. It examines the environmental impact of supersonic flight, including noise pollution and emissions. I used the Concorde, the only successful supersonic commercial aircraft to date, to show the problems related to supersonics. Additionally, I discuss new technologies and designs in the commercial field that are trying to address these challenges and break down barriers to pure militaristic applications. Currently, supersonic technology is being developed for future defense, and newer designs are in the form of unmanned drones. The military also developed missiles and rockets that fall into the category of hypersonic technology, which was not heavily invested in until the early 2000s due to technological hurdles. On the Educational side, I use Universities such as Stanford and Washington to show investment outside of the industry. Finally, I explore the implications of this paper and the hopeful outcomes.

Working on both the technical and STS projects simultaneously allowed me to broaden my discussion of past CubeSats and hypersonics. My technical project was very niche and did not have many opportunities to branch out past CubeSats. However, my STS thesis did not stay with CubeSats, and it branched out into aircrafts in general. Without having my capstone class, I am not sure how I would have written my STS thesis. This is because I was about to research and learn about a topic based on a small satellite and then use some of the terms that I learned to see

how it applied to other aircrafts. Since HEDGE is a proof-of-concept mission and does not have a propulsion system, we did not look at the environmental impact of it. This was an issue that I had with the project since we would be ablating material in the atmosphere. I took this frustration and researched sustainability and environmental issues with supersonics and used it in my STS paper. Lastly, both projects gave me insight on the aerospace industry. My technical project gave me information about the astronautical side, while my STS project gave me knowledge on the avionic side.