Thesis Project Portfolio

Student Researched and Developed High Power Rocket

(Technical Report)

Flying Into the Future: How the Spaceflight Industry has Unfolded after the Decommissioning of the Space Shuttle

(STS Research Paper)

An Undergraduate Thesis

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

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In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Executive Summary

The sky stars have always fascinated humanity, and for thousands of years people have looked to the sky and tried to discern the secrets of the cosmos, and dreamed of one day walking among the stars. Not until recently has a distant dream of flying into space become a tangible reality, and perhaps in the near future a common occurrence. Within the span of one lifetime, people went from the first space flight to well over 100 launches a year, and numerous human spaceflights included in that number. This development has not been smooth sailing however, with many failings, accidents, and tragedies in the short history of spaceflight, and still a long road ahead until people travel to space on a regular basis. How the future of spaceflight has unfolded, and how it will unfold is paramount to the progress and security of humankind. This leads to the question "*How can spaceflight be improved for the benefit of humankind?".* The technical thesis is about the development of a solid rocket for use in small launch applications. The Sociotechnical thesis in this portfolio is focused on the development of the American space industry after the decommissioning of the space shuttle.

The Technical thesis documents the development of a solid rocket flight vehicle designed to deliver research payloads to high altitude. This rocket would have delivered one glider to approximately 5000 feet, the rocket would be recovered with a parachute, and the glider would have collected atmospheric data on a slow descent. The design of this rocket was split into 3 teams, Aero Structures, Propulsion, and Mechatronics. Aerostructures designed the body and separation systems of the rocket, as well as the recovery system. Propulsion designed the solid rocket engine, including the propellant grains, nozzle, and motor casing. Mechatronics designed the scientific reading equipment as well as the glider payload to collect data. Each part of the

rocket was designed, 3D modeled, and had various aerodynamic and structural simulations run to verify the functionality of the rocket. The rocket engine was custom machined to the specifications designed for, and the body parts of the rocket were fabricated partially in house as well. Due to safety constraints, there was no launch of the vehicle. There will be tests of the separation system, parachute deployment, glider, and a hydrostatic test of the engine casing.

The Sociotechnical thesis is on the development of the spaceflight industry after the decommissioning of the space shuttle in 2011. The U.S. has long been a world leader in spaceflight throughout history, and this development has helped the world in numerous ways, including GPS, imaging, communications and more. Despite experiencing a lull and losing many capabilities in 2011, spaceflight has experienced a boom including exponential launches and more companies in the industry than ever before. This was achieved by lowering costs and increasing the supply of launch capabilities, which helped expand the market to customers other than the traditional governmental entities. This is shown through analysis of the major competitors, with the largest of those being SpaceX, and how launch costs have lowered and launches have increased, as well as the type of launches and the capabilities provided. The data also shows that the number of satellites is increasing exponentially, and that the companies with the lowest launch costs are launching unprecedented numbers of flights compared to any other time in history. The space industry has more than just recovered from the loss of the space shuttle, it has surpassed any expectations of growth through innovation and opening to public ventures, expanding space as an opportunity for all.

The technical research went fairly well despite the inability to launch. The rocket was built and the subsystems will be tested for their viability, but it would have been nice to be able

to launch the rocket to test full capabilities and to gather data from the launch. Luckily the project can be continued in the future, so next year the rocket may have the chance to launch and finish where we left off. The Sociotechnical paper went well, and much of the data needed to form conclusions was available. The largest data set that could not be obtained without a paywall was market analysis and the number of companies that use spaceflight services. Much of this data is either secret as many of the companies involved are not public, or the research the could be found on the subject was behind steep paywalls. Access to this information would be able to strengthen the examples and arguments in the paper.