THESIS PROJECT PORTFOLIO

Hypersonic Atmospheric Reentry Deceleration Experiment (HARD-E)

(Technical Report)

CubeSats and Effective STEM Education

(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

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SOCIOTECHNICAL SYNTHESIS

HYPERSONIC ATMOSPHERIC REENTRY DEACCELERATION EXPERIMENT (HARD-E)
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CUBESATS AND EFFECTIVE STEM EDUCATION
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PROSPECTUS
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My technical project and STS research paper addressed the importance of using CubeSats in the classroom setting for research and enhancing STEM education experiences. CubeSats currently serve as a platform for students of all educational levels to launch payloads into space at a low cost. Currently, there are various organizations that support the launch of student CubeSat projects on pre-planned missions. For instance, the CubeSat Launch Initiative (CSLI) is a program in which students submit CubeSat project proposals to NASA for launch approval. CubeSats also show evidence of increasing student attraction and retention in STEM fields. This is important as current projections for our technologically advanced society reflect that by 2025, approximately 3.5 million jobs will remain open due to the lack of individuals with STEM skills. Additionally, according to a White House report, only 20% of high school graduates are prepared for the rigorous coursework of STEM majors. Therefore, increased student attraction and retention in STEM fields will ultimately minimize the deficit of qualified individuals to fill these open positions. The CubeSat platform is an effective tool that provides a hands-on, engaging learning experience for students while expanding opportunities for research.

For my technical project, a team of 14 students and I addressed the challenge of designing a CubeSat with a blunt leading edge to collect data during its reentry into the Earth's atmosphere at hypersonic speeds. The overarching goal of the project was to assess the feasibility of using a CubeSat to study the conditions experienced by spacecraft decelerating from hypersonic speeds. As a member of the Structures and Integration Subsystem Team, I was responsible for the physical design of the CubeSat as well as the layout of the internal components. To begin the design process for the technical project, my team researched various publications from NASA detailing general CubeSat designs and potential components to use. We sketched an optimal CubeSat design based on our research and developed a Solidworks model of

the structure. Based on the calculations of the center of pressure and center of mass, we concluded that our proposed design would be aerodynamically stable. My STS Research Paper discussed how the CubeSat platform can be used to enhance STEM education and ultimately increase student attraction and retention to the STEM field. I read several scholarly papers and articles that discussed various frameworks on how to cultivate an effective learning environment in STEM education including the Deliberate Pedagogical Teaching with Technology Theory, the Growth Mindset Theory, and the Situated Cognition Theory. I then analyzed how the CubeSat platform applies these theories by supporting my analysis with scholarly articles, news reports, blog posts, and YouTube videos. Ultimately, I concluded that student-led CubeSat projects successfully apply all of the aforementioned frameworks, and therefore hold high educational value for future scientists and engineers in addition to fostering increased student retention and attraction to STEM fields.

In my technical project, my team and I did achieve the intended overall goal of designing a CubeSat to potentially collect hypersonic flight data. However, since the CubeSat has yet to have been launched, we are unable to draw a conclusion on the feasibility of using a CubeSat to study the conditions experienced by spacecraft decelerating from hypersonic speeds. Therefore, future work would consist of subsequent capstone classes carrying out the proposal and executing the scheduled CubeSat launch in 2024. I also achieved much of the research that I had intended to complete in my STS research paper. I was able to find various frameworks that researchers have developed that help attract and retain students in STEM disciplines as well as information on overall impacts on student learning when a more hands-on education approach is used. However, there are still some areas that I believe are in need of more attention from researchers. I was unable to find sources from students describing how CubeSat projects have

affected their STEM learning experience and preparation for a STEM career. This would be useful as this feedback comes from the students themselves and can provide more evidence for whether CubeSats are a useful platform for promoting effective STEM education.