Thesis Project Portfolio

Hypersonic ReEntry Deployable Glider Experiment

(Technical Report)

Space Debris: How Technology as a Self-Determining Entity in Space Impacts Social, Economic, Political and Other Forms of Developing Technology

(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 capstone project focused on hypersonic orbital flight and technology. My STS research paper focused on the impacts of space debris on society as well as other forms of technology. Together, these topics relate to one another under the umbrella of space technology. Space debris and hypersonic orbital flight vehicles are the subjects of research due to personal interests in national defense and limited flexibility in department resources respectively. Research involving space debris required minimal resources other than what was publicly available which made the topic highly appealing when also considering its relevancy to current sociotechnical issues. As for hypersonic research within the department of mechanical and aerospace engineering, the topic was essentially chosen well in advance of the Fall semester, hence the limited flexibility.

The capstone project's purpose is to perform a hypersonic experiment using a test article deployed from a CubeSat in Extreme Low Earth Orbit (ELEO). There are three primary objectives supporting the overarching objective: demonstrate the feasibility of CubeSats as a platform for hypersonic glider flight research, show that undergraduate students can conduct hypersonic glider flight experiments at lower cost and with greater accessibility, and provide an opportunity for undergraduates to gain hands-on experience and generate interest in the spaceflight industry. The process of planning for and designing the hypersonic glider space mission will be completed within the Mechanical and Aerospace Engineering department's Spacecraft Design course advised by Professor Christopher P. Goyne at the University of Virginia (UVA) over the course of the next two years. The final proposal will outline design considerations, schedules, costs, and benefits to implementing our proposed design into a government funded space flight.

My STS research paper served to answer the question of how technology, in the form of space debris, as a self-determining entity in space impacts social, economic, political and other forms of developing technology. To investigate this question, several research methods are used: wicked problem framing, policy analysis, and network analysis. These research methods were then tied back to several STS frameworks to support the bigger picture of the research. With research and discussion surrounding the STS frameworks, it was determined that space debris and society impact each other and evolve alongside one another. The research question proposed framed space debris as a potential influence for sociotechnical change. With the research presented, and the compelling argument made using the co-existence framework, it was also determined that space debris should not be analyzed as a stand-alone form of technology. The significance of its impact on social, economic, political, and other forms of technology varies depending on the context of and scale of its relationship to potential areas of influence. For smaller areas of influence such as everyday technology (smartphones and computers, etc.,) the scope of its impact is far-reaching and significant. Until the issue space debris garners a larger following and base of interest, it is unlikely that its impact can be thoroughly investigated.

Working on the capstone and STS research projects separately would have taken away from the combined acquisition of technical knowledge and knowledge surrounding sociotechnical issues. Hypersonic space flight and space debris are connected via the implications they pose on one another. With space debris, hypersonic researchers and vehicle operators need to consider the ramifications of their actions in space and the potential of mission interference from space debris. During the initial stages of our capstone research, there was significant discussion surrounding the minimization of space debris by-products as a result of launching and deorbiting the hypersonic CubeSat. I was able to contribute the knowledge gained

from my STS research to form responsible solutions to the possibility of introducing new debris into space. The key takeaway from doing both projects simultaneously is that the advancement of new space technologies such as hypersonic spacecraft require extensive consideration of engineering ethics. Much of the space debris currently in orbit and interfering with space flight is a result of negligence and a lack of understanding on how old technologies interfere with the new.