Thesis Project Portfolio

A New Solution to Offer More Affordable Hypersonic Glider Flight Research

(Technical Report)

Analyzing CubeSat Risk to Orbital Debris and Their Impact on Future International Regulation in Space Waste Mitigation

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

A CubeSat is a square-shaped miniature satellite that is roughly the size of a Rubik's cube. The advantage of CubeSats over traditional satellites is that they provide a cost effective platform for science investigations, new technology demonstrations, and advanced mission concepts using constellations. Being of a small size, CubeSats only take roughly a year to design, manufacture, and launch, which renders them rapidly deployable as compared to traditional satellites where this process can take up to 10 years. Additionally, their lightweightedness allows them to be launched for a fraction of the cost in the payload of another rocket. This lower cost expands the barrier to entry for satellites, space observation, and data collection to universities, commercial companies, and hobbyists.

The technical portion of the project was focused on the design, development, and manufacturing of the hardware and software for a CubeSat. The objective of the technical section is to launch a CubeSat into space, where it will orbit Earth for 1 week, and then re-enter earth's atmosphere and burn up. During re-entry, the CubeSat will employ thermocouple sensors and a pressure transducer to measure the temperature and pressure of the aircraft while it is at hypersonic speeds. This data will be transmitted through the Iridium satellite network back to Earth. The objective is to demonstrate the feasibility of affordable CubeSats as an alternative platform for hypersonic glider flight research.

CubeSats, as a whole, lower the barriers to entry for space-based scientific study by providing a cost effective platform that is capable of being rapidly deployed. This has resulted in the popularity of the technology exploding in recent years, particularly within government, commercial organizations, and academia. However, despite their small form factor, the increasing number of CubeSats in orbit poses the risk of adding to the challenging problem of

space debris. In my STS paper, I use the Social Construction of Technology framework to explore CubeSat waste mitigation and its effects on international regulations for space waste. I find that while the threat of CubeSat debris is minimal when compared to the orbital debris of traditional satellites, international regulation must be improved to help mitigate the generation of new debris and facilitate debris removal efforts. I find that the current U.S. regulation is sufficient in suggestion for the mitigation of new debris, however is not entirely enforceable. The current international regulation, alternatively, outlines accountability for space debris and waste but lacks a regulatory agency for action. Additionally, the current international regulation does not mention the need to reduce or remove current debris in earth-orbit. Furthermore, I find that while the debris level that CubeSats generate is miniscule compared to traditional satellites and pre-existing waste, the amount of CubeSats launched has increased by 500% in the last 8 years. This suggests that the debris from CubeSats could eventually prove to be a concern if international regulation is not improved upon.

The technical portion of my report explores the extent to which CubeSats can be used as a more affordable alternative to space research. In my STS paper, I examine whether the societal and ethical concerns currently placed upon CubeSats in their risk to space waste outweigh the benefits examined and garnered in my technical paper. In totality, I found that the risk to space waste composed by CubeSats does not outweigh the benefits in affordability and rapid deployment, barring the addition and supplementation of current international regulations to include space waste and debris mitigation plans.

CubeSats offer an alternative for more affordable, rapid deployment of satellites for scientific study within space and low earth orbit settings. In the technical portion of my project, I explored the technical details of CubeSat design, manufacturing, and development. This included

exploring its feasibility and reliability as a miniature satellite option. In my STS research, I delved into the ethical considerations of using Cubesats with the risk they impose on space waste. I further demonstrated the need for increased regulation internationally in regard to space waste mitigation, through mitigation of future debris, collisions, and collection. CubeSats offer a more affordable, rapidly deployable alternative to both hypersonic and space research, and are being employed increasingly in recent years. This usage needs to be regulated to ensure proper usage and guidelines are met to mitigate addition to space waste.