Thesis Project Portfolio

Space Debris Tracking CubeSat

(Technical Report)

Halting Orbital Pollution: A Study on Air Pollution Regulation as a Means for Regulating Orbital Pollution

(STS Research Paper)

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Introduction:

Developing a debris-tracking cubesat would prove useful for reinforcing and improving on current knowledge on the status of debris in space. Real-time detection would allow for empirically accurate and up-to-date data, and trends over time could be monitored, which could in turn prove the necessity for action against debris accumulation. However, it was known from the beginning of this project that debris tracking technology was only a single step in the solution to preventing such accumulation. The increased risk of orbital debris pile-up is an issue contributed to by many organizations around the globe, and with orbital technology becoming more prevalent and complex, a coordinated effort is undoubtedly necessary to mitigate orbital pollution spiraling out of control. To that end, researching what kind of legislation would be effective in mitigating orbital debris attempts to answer this question of how debris mitigation efforts should be organized. In an attempt to answer this research question, inspiration was drawn from successful legislations that arose as a result of environmental and atmospheric pollution.

Capstone Project Summary:

In order to assess the pressing matter of growing debris concentrations in low Earth orbit (LEO), our team has made it the objective to conceptually design and prototype a method of detecting space debris smaller than ten centimeters in diameter. We hope to develop a technological breakthrough that would not only detect debris through the utilization of radio frequency transmission, but also extract useful information from the particles such as relative velocity, size, and distance from the radar. With said information, the intention would be to register it to a database that tracks the currently unidentified objects in orbit so that existing

satellites can plan their orbital maneuvers accordingly, as well as prevent the accumulation of debris through further collisions.

In the early stages of the project, the emphasis was placed on designing a 3U CubeSat that would hoist the technology capable of detecting this small, untracked debris. Following the Preliminary Design Review, however, the attention was directed away from designing the CubeSat and shifted towards conceptualizing and prototyping the sensor that would perform our mission goals. This shift reshaped many of the initial objectives, constraints, and design requirements, yet it has honed the focus of the project on a singular satellite subsystem that would serve as its payload. The mission statement as a result of this transition has been to design and test a sensor capable of detecting orbital debris smaller than 10 cm, taking the technology from a Technology Readiness Level (TRL) of 1 to 3. The implementation of the TRL levels have highlighted a milestone for our team to achieve, improving the design from a TRL of 1, entailing that the basic principles have been observed and reported, to a 3, where an analytical or critical function has been developed as a proof of concept

STS Research Paper Summary:

The Clean Air Act (CAA) has been a cornerstone of environmental legislation in the United States, demonstrating a robust framework for regulating air quality standards and controlling emissions. This research paper examines the socio-technical systems surrounding power-plants (through primarily the CAA) and space technologies through the lens of Actor-Network Theory (ANT) to identify key actors, networks, and socio-technical dynamics that govern how these technologies are used and managed. By deconstructing the relationships between policymakers, scientific institutions, industry stakeholders, and environmental advocacy

groups, this study highlights how the networks around the CAA and power plants influenced legislative development and emission-reduction enforcement. The insights drawn from this analysis are applied to the rapidly evolving space industry, where environmental concerns such as atmospheric contamination, orbital debris, and launch emissions are gaining prominence. By mapping actors and their roles in both legislative frameworks, this research aims to identify strategies that can facilitate effective environmental policy in the space sector. Ultimately, this comparative analysis aims to provide insight from the successes and failures of the CAA, to prospectively apply these insights to future policies on space technologies and the agencies and regulatory bodies that govern their use.

Concluding Reflection:

Both of these projects on their own have many lessons that they teach, though perhaps the most pervasive lesson that these two projects in tandem have is that technology alone cannot always solve the issues they seek to solve. Effective technology is only a step in the right direction, and the way that these technologies are implemented and utilized is what completes the picture. As stated earlier in this summary, debris tracking technology ideally can track all orbital debris if the technology is successful, however it is simply a tool to allow for humans to then organize and coordinate themselves to plan missions around these debris, or to clean said debris via another technological method.