

Thesis Project Portfolio

**A Space-Based Solution to Improve Roadway Safety and Efficiency in Virginia:
Real-Time Winter Weather Data for Navigation**

(Technical Report)

**The Existence and Dangers of Accumulation of Space Debris in Low Earth Orbit and How
Analogies Can Be Used to Better Explain Complexities in New Technologies**

(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

Colin Purcell

Spring, 2021

Department of Mechanical and Aerospace

Table of Contents

Sociotechnical Synthesis

A Space-Based Solution to Improve Roadway Safety and Efficiency in Virginia: Real-Time Winter Weather Data for Navigation

The Existence and Dangers of Accumulation of Space Debris in Low Earth Orbit and How Analogies Can Be Used to Better Explain Complexities in New Technologies

Prospectus

Sociotechnical Synthesis

Roadways become significantly more dangerous and accident prone when they are covered in snow or ice. My technical project used satellite imaging technology to analyze when roads are hazardous as a result of weather conditions. The project team researched and created a conceptual design proposal on a spacecraft that can analyze roadway status and provide real time safety data on the conditions of Virginia highways. The team is using a 6U CubeSat design, fit with a camera, ADACS control system, various antennas and radios, solar panels and a computer. My specific role as part of the team was to integrate all of the different components into the overall structure and to ensure the satellite was properly conformed to the predetermined constraints of volume, mass and center of gravity. The biggest challenge in this project was finding suitable pieces of instrumentation that were small enough to fit in our constrained volume and budget. This piece of technology if properly implemented could provide a great service and extra levels of safety to society.

Despite the many benefits and services satellites like this provide to humans on Earth, there is a growing problem in outer space. Due to consistent launches and a few accidents, the number of objects in Low Earth Orbit is increasing. My STS research explored the various reasons this is occurring, such as ignorance of international guidelines and lack of responsibility, as well as the potential impacts it could have on society and our future in space exploration. Schwarz-Plaschg shows how the use of analogies can change people's perceptions of new technologies. I was able to use her work to show how analogies can be used to better explain complicated technological developments to non-experts by comparing the space debris problem to the pollution problem here on the surface. This is important as it is a way to get people engaged in a topic that needs more attention, but often gets overlooked due to the complexity of the situation.

My technical and STS research projects combine to show the necessity of understanding potential consequences of new technologies and the various problems they may create. Research on the technical side showed how valuable satellites and satellite constellations can be, while the STS side shows how they contribute to an ever growing problem. It shows how steps need to be taken to better regulate the space industry to ensure spacecraft manufacturers are making their satellites in a way that mitigates potential problems as much as possible. My STS research was inspired by my work on the technical project, but certain details of the technical project were then influenced by the STS research. While the knowledge I gained from doing the STS research made the technical project more complicated, it was important to understand the dangers of creating faulty technology and avoid polluting Low Earth Orbit. This project exemplifies the themes of STS 4500 and 4600 by showing how engineers are responsible for consequences that may happen from their technological developments. The Hurricane Katrina levee system was a piece of technology and system that existed but was so underdeveloped that it did not really exist. This is similar to the current system of regulating the amount of space debris currently in Low Earth Orbit.