

Thesis Project Portfolio

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

(Technical Report)

Examining Social and Scientific Aspects of the Satellite Constellation Controversy

(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

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Sociotechnical Synthesis

The technical project was completed as part of the MAE 4600/4700 Spacecraft Design capstone course. As part of the MITRE University Innovation Exchange (UIX) Space Initiative, the capstone class was tasked with developing solutions to improve transportation efficiency and safety in Virginia. The class developed a conceptual design solution to address one aspect of Virginia's transportation problems using remote sensing and data fusion methods. The solution is a remote sensing CubeSat constellation that will help alleviate weather-related traffic congestion and improve roadway safety. A high-resolution camera on the spacecraft will observe roadways from low-Earth orbit (LEO) and detect snow or ice conditions using an assortment of spectral bands, and this data will be delivered to drivers, roadway managers, and first responders.

The STS research paper focuses on the evolution of satellite constellations. Recent advancements in technology and consumer demand have led to a new wave of ambitious internet constellations. The number of satellites in orbit is expected to skyrocket as these networks become more common. At the forefront of this new era is SpaceX with its internet project known as Starlink. While this endeavor hopes to provide internet access to users anywhere on the entire planet, several opponent groups have expressed their concerns about the light pollution effects, which are detrimental to astronomical observations, and the dangers of rapidly accumulating space debris. The evolution of this technology will be analyzed through co-production, an STS framework that relates the inseparable influences of science, technology, and society.

The topic of the STS research paper was partially based on the technical project and partially based on my personal interests. The proposed solution to the technical problem is a remote-sensing satellite constellation. Since satellites are becoming increasingly widespread, the

detrimental effects on astronomy are becoming more well-known. I have seen the effects of abundant satellite trails firsthand through my hobby as an amateur astrophotographer. Both of these influences led me to research the ethical considerations related to large-scale constellation projects. Hopefully, companies planning future mega-constellations like Starlink will find ways to help underserved communities while minimizing the impacts on astronomy and space debris.