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

An Analysis of SpaceX's Starlink Megaconstellation Network
(STS Research Paper)

An Undergraduate Thesis Portfolio

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Socio-technical Synthesis: Satellite Constellations

Satellites are a relatively new technology that are being rapidly developed in the aerospace industry. They are progressively decreasing in size while their processing power continues to rise. While this advancement is great for scientific research and allows more people to access this technology at cheaper prices, it is important to also understand the significance of technological reliability and what the increasing number of satellites in orbit around Earth could mean for other areas of science. My Capstone project focuses on developing a satellite prototype in order to detect ice and snow on Virginia roadways. My Science, Technology, and Society (STS) project uses Actor Network Theory to analyze vulnerable areas in SpaceX's Starlink constellation. As my Capstone's satellite is proposed to be just one in a larger constellation, the technical project relates to the STS project via an analysis of a larger constellation already in place. Though they are connected from their focus on satellites and satellite constellations, the technical project is an applied research topic whereas the STS project is purely a research project.

My team's technical report laid out the framework of a CubeSat satellite which would detect snow and ice on Virginia's roadways. The satellite that we designed would ideally become a part of a larger constellation of identical satellites upon the demonstration of the usefulness and effectiveness of the first one. Our initial region of study was the Northern Virginia area. The satellite consists of an imager, solar panels, a battery, various on-board computers, and the exterior shell that holds it all together. This satellite would collect this roadway data so that the Virginia Department of Transportation could release said data to roadway commuters so that they may make safer driving choices upon inclement weather.

My STS paper analyzed SpaceX's Starlink satellite constellation. I argued that this network was vulnerable due to a significant failure rate in the constellation's satellites and by SpaceX's oversight in not recruiting ground-based astronomers into their network so that both could influence decisions that would allow the network to not interfere with ground-based astronomy. The failure rate of these satellites is alarming because, if the constellation is fully implemented, it would mean that between 360-600 satellites would be launched into Low Earth Orbit just for them to fail and further exacerbate the current issue of space pollution. SpaceX's failure to recruit astronomers left these scientists no choice but to seek legal protections of the night sky which would threaten not only SpaceX's constellation but also other proposed constellations by other companies and governments.

Working on both of these projects simultaneously has given me a better perspective on the non-technical issues that can threaten constellations of satellites upon their implementation. By analyzing a current constellation and understanding why certain issues were arising, I could better inform my own team on these problems and create solutions before our satellites would even be launched. My STS project also made me more aware that not all potential problems will be known to me and my team during the construction of our satellites. Issues can arise from unforseen actors that the network builder was not even aware of upon designing its network. In analyzing SpaceX's network, I feel that I am now better equipped to understand both the technical and social factors behind satellite design and can use this information to better design not only my Capstone project but any future aerospace projects that I may work on in my career.