

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

**A Utilitarian Ethics Analysis of the collision between Iridium-33 and Cosmos-2251**  
(STS Research Paper)

An Undergraduate Thesis Portfolio

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Bachelor of Science in Aerospace Engineering

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### Socio-Technical Synthesis: Utilitarian Ethics and CubeSat Weather Missions

The topic of my technical project over the course of the past two semesters has regarded the improvement of roadway safety in Virginia through the use of a remote-sensing application (e.g. satellites). In doing so, the Spacecraft Design I/II students sought to develop a constellation of miniature spacecrafts, known as CubeSats, to detect the accumulation of snow and ice on Northern Virginia roadways. This technical project was coupled with STS research that concerned the ethical analysis of the Iridium 33 – Cosmos 2251 satellite collision. My technical project focused on the implications satellites would have on improving roadway safety whereas my STS research focused on the ethical ramifications of launching satellites into an already debris – dense environment by referencing the Iridium – Cosmos collision event.

The basis of my technical project focuses on the concept of using satellites to improve roadway safety through providing a source of real-time weather data. My capstone course members developed a Conceptual Design Review (CoDR) which establishes the details for a spacecraft mission. The CoDR proposes for an initial constellation of 24 CubeSats in an orbit of 400km to detect snow and ice accumulation on roadways in Virginia. The information gathered by these satellites would be relayed to roadway users and local government agencies to ensure that weather-related accidents can be reduced through traffic rerouting and dispatching road crews accordingly to treat roads. Through liaison with subject matter experts, industry professionals, and other professors, the team was able to identify the equipment needed for a

successful mission, the location for ground stations at the University of Virginia and Virginia Tech to process data, and opportunities to seek fundraising to prototype and launch the satellites.

The focus of my STS research also focused on satellite constellations, but from an ethical standpoint on the responsible use of space. Given the increased commercialization of space exploration, the Low Earth Orbit (LEO) environment is getting increasingly crowded with spacecraft and debris. My research focuses on the ethical implications of satellite constellations in an already dense environment, with the focus on a certain incident: the Iridium – Cosmos collision in 2009. Through the use of utilitarian ethics, I seek to further understanding on who is to take blame for such an incident through looking at violations of the freedom principle and utility principle. Additionally, I emphasize the importance of a utilitarian-based analysis in mission planning in an attempt facilitate discussion on satellite de-orbit policies based on the utilitarian framework.

Understanding the sociotechnical nature of these two projects has allowed my team and I better understand the intertwined nature of satellites and ethics. My technical project provided additional understanding into common space mission and design practices when proposing a spacecraft – oriented solution. These industry – best practices further helped provide context and background for my STS research paper, which highlighted the long-lasting impact space mission planning can have on the future viability of space exploration. These two distinct, yet united endeavors have inspired me to develop next-generation space systems that ensure the responsible use of space and allow for space missions to take place without abusing the domains of human space exploration. Also, these projects have allowed me to consider space technology in a more holistic manner and to plan for more sustainable missions.

## **Table of Contents**

Socio-technical Synthesis

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

A Utilitarian Ethics Analysis of the collision between Iridium-33 and Cosmos-2251

Prospectus