A SPACE-BASED SOLUTION TO IMPROVE ROADWAY SAFETY AND EFFICIENCY IN VIRGINIA: REAL-TIME WINTER WEATHER DATA FOR NAVIGATION

INVESTIGATING SOCIAL DIVIDES IN WASTE REDUCTION POLICY: HOW CONGESTION PRICING CAN INFLUENCE SPACE DEBRIS MITIGATION

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SOCIOTECHNICAL SYNTHESIS

Roadways and outer-space orbits are waste generating arenas responsible for unfavorable effects on the environment, health, and economy. To alleviate this problem, the spacecraft design capstone team aims to develop a constellation of satellites that observe weather conditions on the road to better inform roadway users, roadway managers, and first responders. Current methods drivers use to check the weather draw misleading conclusions, while offering higher data resolution and real-time updates creates a more accurate representation of the drive ahead. To implement this technical project, the team must consider the mission's role in sustainability issues, as both vehicle emissions and space debris jeopardize our quality of life. As a result, this STS research looks to study how lessons learned from traffic congestion social policy can influence space debris mitigation policy. The technical and STS projects are tightly coupled since waste reduction policy complements a space-based technical transportation solution.

The dangers and annoyances of driving in adverse weather are well known on an individual level from experience. On a global scale, reducing traffic pollution in Virginia will limit the state's contribution to climate change. Despite research suggesting weather affects the safety and throughput of our roadway system, a combined weather and traffic data platform is unavailable to individual drivers. Not to mention, checking the weather before driving may not always provide as much information as drivers may think. Implementing accurate, real-time weather-related information that distinguishes road conditions from their surroundings can alleviate many of the aforementioned burdens and reduce weather-related traffic congestion.

The 2020-2021 spacecraft design capstone team underwent a conceptual design review proposing a constellation of 24 satellites working together. To start, this constellation will observe the intersection of route 95 and route 495 in Northern Virginia as a proof of concept. If

practical, with minimal improvements and enhancements, this project can grow to a national scale. Our research shows that remote sensing within certain spectral bands at a sufficient resolution can improve detection of dangerous roadway conditions. When the proper data delivery channels exist, through the help of external partnerships, then our target audience can make informed driving decisions that improve safety and efficiency. Throughout this year, feasibility assessments show that this project can continue development. As such, we recommend that the incoming spacecraft design capstone team proceed with a Preliminary Design Review (PDR) in the Fall Semester and Critical Design Review (CDR) in the Spring Semester.

Social policy often supplements technological innovation to reduce waste. For instance, congestion pricing is a toll paid when using a busy road during peak hours. This policy is well-researched and currently implemented in many cities. Orbital Use Fees (OUFs) are taxes on commonly used orbits to incentivize de-orbit upon mission completion and they are so new there is little research on the social impact of this policy. An additional complication comes from the lack of modernized outer space treaties and regulations. A case study analyzing the advantaged and disadvantaged social groups arises using Pinch and Bjiker's Social Construction of Technology (SCOT) theory as a framework.

The benefits and drawbacks for disadvantaged groups, such as low-income earners and non-drivers, help assess the social good of congestion pricing. Paying these tolls placed undue financial hardship on these groups. In contrast, the improvements to public transportation and reduction in pollution improve vulnerable populations' well-being even if such groups are not paying the fee. In space, underprivileged groups, namely students and Third World countries, are threatened by the growing militarization of space. If space debris policy applies lessons learned from congestion pricing, the policy can curb the sustainability issue and promote equitable space

participation. Most importantly, reinvesting generated revenue from OUFs back into vulnerable groups will lower the barriers to entry and improve the social good of space debris policy.

In essence, the sustainability issues pertinent to this work, traffic congestion and space debris, will only worsen without immediate intervention. The newness of space debris policy requires assessment of long-standing studies, such as those done on congestion pricing. Identifying and correcting harmful effects before enactment creates waste reduction social policy that promotes social justice and technological innovation.

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