Thesis Portfolio

Corvus: Urban Air Mobility Solutions for Package Delivery

(Technical Report)

Socioeconomic and Ecological Impacts of Urban Rail Transportation

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

Transportation is a fundamental aspect of modern life. As the volume of people and goods moving from point to point grows annually, it is imperative that the infrastructure required to support these needs is both effective and efficient. Both the technical and STS research papers in this portfolio investigate the future of transportation in cities. The technical topic is concers the movement of packages in urban environments through the usage of small unmanned aerial systems (UAS). System design requirements for the UAS include aircraft performance, acoustics, profitability, and logistical integration. The STS topic covers the social, economic, and environmental elements of rail transportation networks in city cores and their suburban periphery. Emphasis is not placed so much on a single technology, as with the technical topic, rather than on system level benefits that can be provided to a metropolis. While not directly related to one another, both projects seek to outline and generate solutions to future mobility issues in the world's growing urban cores.

In order to address the issue of insufficient assets for the sustainable and rapid transportation of goods in urban areas, a technical design study has been performed. This effort, undertaken as a part of the NASA University Design Contest, was undertaken to design an unmanned aerial system that will deliver packages in urban environments. This future network will replace or augment existing automotive package delivery systems, cutting costs for both companies and consumers, and improving atmospheric pollution and roadway congestion by taking delivery vehicles off of the roads. This system will be successful through its implementation of next-generation technology and economic integration with existing commercial infrastructures. Specific technologies used include solid state batteries, tilt-wing drones, and modular package delivery methods. Through performing a thorough aeronautical

design, successful market analysis, and cooperating with proposed drone infrastructure, the development of a well-functioning and efficient urban air package delivery system was accomplished.

When considering the costs associated with legacy methods for package delivery, many of these same issues arise when considering urban rail transportation. Operational networks are too small, timetables are inconvenient, and infrastructure is outdated and crumbling. These factors combine to cause many to take more pollutive forms of transportation, such as cars and buses, to locations where many travel. Additionally, many who more heavily rely on public transit, such as those in less advantageous socioeconomic situations, are underserved by existing infrastructure. This lack of service hampers the ability of city residents to find a job, increase their level of wealth, and improve their social mobility. Improving the accessibility to reliable transit should be a priority of city planners, however it is imperative that these networks are in fact a net benefit. Pollutive forms of transit provide a smaller advantage over automobiles, property values near train tracks can both rise and fall depending on the circumstances, and government corruption and lobbying can result in mismanagement of assets. Analyzing the successes and failures of current systems, both domestic and international, has provided valuable insight in how to best construct a well-functioning rail transit network. In order to improve the current state of urban rail transportation in the United States, a series of case studies examining the successes and failures of existing systems were undertaken, emphasizing economic, social, and political issues. As a result of this research, it was discovered that decreasing dependence on automobiles and switching to public transit directly improved the health and productivity of workers. Traveling by trains also left more disposable income available to said workers, due to lower commuting costs. Additionally, air pollution and social mobility statistics saw a significant

improvement. Finally, through improvements in scheduling, existing infrastructure is able to increase passenger throughput and decrease demands of rolling stock, representing large cost savings and increases in operating budgets. Overall, rail transit serves as an economic driver in urban metropolitan areas, making the lives of all residents better.

Working on both projects simultaneously enabled for similar problems to be analyzed from different perspectives, as both a supplier and a consumer. While both projects seek to use environmentally friendly, efficient, effective, and cost-effective technologies to solve a problem, the aims of producing an aircraft that is not yet a reality rather than repurposing and retooling existing railway technologies represents a divergence. Designing a UAS to provide a specific service requires analysis of the current state of a market and to successfully deliver a product that can surpass existing technologies. Changes can be made to the product being delivered much more easily, as the precedent for a package delivery drone is virtually nonexistent. On the other hand, when seeking to retool a system from the outside, the challenges differ. As a contract to compete for is not on the table, recommendations and change are not as impactful and are slow in coming. Also, the scale of completely retooling a city's transit system is far larger than adding a new service that is largely devoid of intermediary transit structures. However, using the knowledge of cities, societies, and technological frameworks gained in both projects enabled a deeper understanding to be made.