Thesis Project Portfolio

American Institute of Aeronautics and Astronautics: Aerial Firefighting Design Competition

(Technical Report)

Can Planes Go Green?: Using the Multi-Level Perspective to Determine the Commercial Aviation Industry's Progress Towards Sustainability

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

(Executive Summary)

Developing Solutions for the Damages Caused by Carbon Emissions and Reducing Them at the Source

When it comes to wildfire trends, the last five years in California have really been something else. It's really been hard to watch. it's pretty rare to see such large, dramatic step changes as what we've seen in California in the last five to 10 years. We've broken every record, and we've broken them several times. Largest, most destructive, deadliest—all of these have now been set and, I think, set again. — **Daniel Swain**, Institute of the Environment and Sustainability, UCLA, via Inside Climate News

Researchers have determined that global warming has increased economic and insured losses by over 61 Billion USD due to extreme weather patterns since the 1950s. Along with the increased severity of the weather, the hotter temperatures are increasing the desertification of the planet. From the economic cost alone, it's clear that drastic steps need to be taken to reduce carbon emissions on a universal scale. Both of my projects are centered around climate change and its direct effects on our world. The technical portion of the research involved developing a conceptual aerial firefighting aircraft to combat the effects that climate change has had on forest fires worldwide. My STS project focuses on the progress of the current transition towards sustainable practices in the commercial aviation industry. I discovered that holistic system analysis on each project was necessary for producing the best final result possible.

The technical portion of my thesis produced a state-of-the-art large air tanker utilized for aerial firefighting to be submitted to the undergraduate aircraft design competition put on by the American Institute of Aeronautics and Astronautics (AIAA). The design process began with analyzing the AIAA request for proposal (RFP) document which outlined a thorough set of objectives, requirements, and constraints. With that in mind, our group designed basic

configurations that could be acceptable to the RFP. From there, three designs were chosen and initial tests and simulations were run to determine the feasibility of each option. After a final design was selected, the team followed an iterative process of testing in order to size and configure the aircraft to be optimal. The final design is comparable to Lockheed Martin's C-130 aircraft but with increased payload capacity by reducing the overall size and weight of the plane and switching the engine type to increase the thrust capabilities. From the project, I learned how iterative the aircraft design process is. The design of future aircraft specifically made to fight fires has large importance to me. Living in the pacific northwest, I was directly impacted by the increase in wildfires within the last ten years. Making more effective aerial firefighting systems for the future has the potential to save lives, millions in damages, and protect the forests that naturally reduce carbon in the atmosphere.

In my STS research, I analyzed the progress of the commercial aircraft industry towards sustainability by using the multi-level perspective (MLP) created by Frank Geels. The MLP allows for the categorization of agents into 3 distinct levels. Analyzing the interaction between levels allows for the determination of the progress of the transition. Additionally, I used an analogy with Norway's successful transition to electric vehicles (EV) in order to determine the missing agents within the commercial aviation industry and those that could be doing more in order to push the transition along. From the analogy and the MLP, I learned that government regulation is significantly limited regarding the commercial aviation industry's emissions within the United States. The hesitation to regulate industries in regards to climate change initiatives stems from the partisanship within the US government. While there are some in the government that deny the existence of climate change entirely, others know that intense regulation of industries causes the poorest people in the country to suffer. Adding tax incentives for

commercial aviation would progress the adoption of sustainable jet fuels (SJFs), however, this would cause the price of tickets to increase industry-wide rendering air travel inaccessible to some people. Ideally, the research done on the transition of the commercial aviation industry can help with future categorization and improvement of sustainability transitions as trends are identified in multiple successful transitions.

My STS and technical research projects combine to show how systems are being used to directly counter and try to slow down the effects of carbon emissions. Analyzing the multifaceted issue of carbon emissions and its effects as a whole will help me apply my engineering knowledge to the bigger picture of future projects. Ideally, with a reduction in carbon emissions universally, aerial firefighting systems wouldn't be as needed due to a reduction in the size and scope of wildfires. These projects are important to me because they impact the future of my life and that of my family for generations to come. Without a significant change to worldwide carbon emissions, not only in the commercial aviation industry, the effects of climate change could become irreversible significantly impacting the future of the planet.