Thesis Project Portfolio

The Development of an Autonomous Multirotor Drone in Conjunction with OptiTrack
(Technical Report)

The Social Construction of Biobased Materials and Aviation

(STS Research Paper)

An Undergraduate Thesis

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Table of Contents

Sociotechnical Synthesis

The overarching problem behind this research involves making aviation sustainable. Aviation is responsible for a small, but significant, percentage of anthropogenic climate change; this figure includes both freight and passenger flight. Any increase in global average temperatures results in exponentially deleterious effects on both the planet and humanity. Thus, it becomes important to reduce both the breadth and the degree of anthropogenic effects. The technical project involves developing both a drone capable of autonomous tasks and a standard operating procedure for testing it, while the Science and Technology Studies (STS) portion deals with the usage of biobased materials in aircraft design. The STS research directly ties into the general problem by not only reducing the carbon emissions of flights themselves via lighter aircraft, but by making the production of these aircraft as carbon-neutral or negative as possible.

The technical research is not directly tied to this overarching problem, but advancements in autonomous flight could make for more efficient flights and reduce generated emissions given that the aircraft in question is electric instead of fuel powered. The investigated technical research involved developing a multirotor drone capable of autonomous tasks and a standard operating procedure to test said drone. Large aircraft produce significant amounts of emissions when burning fuel, contributing to climate change. Smaller drones have the potential to break up long flights into decentralized deliveries powered by electricity instead. This was entirely direct work with testing different sensors, parts, and code. The research conducted mainly involved creating and optimizing a system rather than forwarding an unknown field of engineering. Reviewed literature included documentation on commercial drones and various manuals. With the potential end goal of electrified passenger or freight flight, developing and optimizing an advanced drone now allows for more specialized tasks simulating the end goal tasks in the future.

The investigated STS research involved determining the principal stakeholders involved with the implementation of biobased materials in aviation. Biobased materials can be a sustainable alternative to traditional aerospace materials, but stakeholder concerns should be addressed before adoption. These concerns were primarily based on material performance, sustainability, and profitability. Biobased materials are any material derived from biological matter; no particular organism is required for a material to be considered biobased. Biobased materials could match or even exceed traditional aerospace materials in some respects, including thermal performance, but key issues were identified that could prevent biobased materials from being used as structural parts. It was also unclear if using biobased materials would be economical given the novel production method involved with obtaining these materials. For sustainability, using a biorefinery makes biobased materials much more carbon neutral than traditional aerospace materials as during the preproduction phase, plants absorb more carbon dioxide than is released in the production to refined material. Overall, further research into the material performance and profitability of biobased materials needs to be conducted to allay stakeholder concerns.

This research contributed a moderate level to solving the general problem of aviation's contribution to anthropogenic climate change. Despite the technical projects generally loose connection, it has the potential to contribute by finding applications in small-scale electric freighter flight to reduce emissions generated from air shipping. The project itself is still in its infancy. Although much progress was made regarding the construction of the drone itself, constant troubleshooting and an uncooperative motion capture system hindered potential progress the team could make. The STS research shows another promising infant technology – it has the potential to contribute greatly towards the goal of reducing anthropogenic climate change but concerns regarding its material performance and profitability prevent it from reaching its potential. More research into biobased materials, perhaps even combining the technology with autonomous electric flight, can possibly shed light on further use cases. However, it is important not to veer into advocacy. Biobased materials are just one of many possible solutions to the problem of aviation's contribution to anthropogenic effective radiative forcing.

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