

Thesis Project Portfolio

AIAA 2022-2023 Undergraduate Hybrid-Electric Regional Turboprop

(Technical Report)

**Aviation and the Environment: An Analysis of the Environmental Implications of Aviation
and the Interplay Between Society and Practical Mitigation Strategies**

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Ryan Grant

Spring, 2023

Department of Mechanical and Aerospace Engineering

Table of Contents

Sociotechnical Synthesis

AIAA 2022-2023 Undergraduate Hybrid-Electric Regional Turboprop

Aviation and the Environment: An Analysis of the Environmental Implications of Aviation and the Interplay Between Society and Practical Mitigation Strategies

Prospectus

Sociotechnical Synthesis

As society has begun to place a growing emphasis on sustainability and the environmental implications of our day to day operations, few industries have faced greater scrutiny than the aviation industry. As reported by the EPA, commercial airplanes and large business jets contribute 10 percent of U.S transportation emissions and account for 3 percent of the nation's total greenhouse gas (GHG) emissions. In terms of the global CO₂ emissions, aviation contributed 2.4 percent of the total in 2018. Though this contribution may seem insignificant, if global commercial aviation had been its own country in the 2019 GHG emissions standings, the industry would rank number 6 in the world. Thus the significant scrutiny pertaining to environmental sustainability that the aviation industry has found itself under is not without warrant. As a result, extensive research has been conducted into the practicality of many proposed mitigation strategies for the environmental implications of the aviation industry. This is the topic of concern for both my technical paper and my STS research paper.

My technical paper focuses on the design of a hybrid-electric regional turboprop aircraft with an entry into service date of 2035. Analysis has shown that in terms of minimizing environmental impact, regional turboprops are superior to regional jets. This is largely due to the higher fuel efficiency of regional turboprops relative to regional jets. Thus the design of improved regional turboprops that could leverage hybrid-electric propulsion highlights a specific mitigation strategy pertaining to the environmental implications of the aviation industry. My STS research paper explores the role that society, comprising myriad relevant social groups with differing values and perspectives, plays in the exploration and implementation of potential mitigation strategies. This interdependency between the technology and the society must be understood in order to assess the complete sociotechnical consequences associated with the implementation of each of the most prominently proposed mitigation strategies. To aid in this

understanding, it utilizes the framework of the social construction of technology (SCOT) to explore how the values of various groups in society including but not limited to the aviation industry, environmentalists, governmental stakeholders, and passengers both interact with the primary mitigation strategies being considered and conflict with one another in the development of a sustainable aviation industry. It then proceeds with a general analysis of these practical mitigation strategies through a sociotechnical lens to address environmental sustainability. By studying both the specific design of a hybrid-electric regional turboprop aircraft and the role society plays in the exploration and implementation of a sustainable aviation industry in concert, my research yields a more comprehensive understanding of the practicality and consequences of the most prominent mitigation strategies being pursued.