

AIAA 2022-2023 Undergraduate Hybrid-Electric Regional Turboprop Design Proposal
(Technical Paper)

**Aerospace Technologies: How Drone Technologies and Society Play a Role in Shaping the
Future**
(STS Paper)

A Thesis Prospectus
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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

It is estimated that more than 2,000 commercial drone deliveries are occurring every day, contributing to the \$26.3 billion global drone market revenue (Carter et al., 2022; Laricchia, 2022). The creation and use of unmanned and autonomous aerospace systems for different purposes draws a lot of back and forth from the public in regards to their objective, cost, and even morality. Currently, the aerospace sector is booming, with large amounts of funding being spent on different unmanned and autonomous aerospace technologies. Commercially, these aerospace technologies are being used for a variety of purposes from delivering packages to delivering medicine in remote areas in the world. On the other hand, unmanned and autonomous aerospace technologies are being used for militaristic uses such as reconnaissance and missile strike capabilities. Both uses of these technologies, draw different opinions from society. After conducting research into the drone industry, it becomes obvious that the sociotechnical nature of drone technology shapes society, and vice versa. The question remains, how do they shape each other? These technologies are continuing to evolve based on society's wants and the successes of current technologies, in addition to society itself changing with all of these new developments. With this in mind, the American Institute of Aeronautics and Astronautics (AIAA) decided to center its annual undergraduate design challenge around newer aerospace technologies that try to implement these wants and successes. Within the airline industry, there are growing calls for more sustainable and eco-friendly aircraft. As a result, the AIAA has decided to assign undergraduate students to conceptually design a hybrid-electric regional turboprop aircraft. In doing this, the AIAA hopes to further the interest in developing new aircraft systems while keeping the idea of sustainability and efficiency in mind. The technical paper will look to describe the process and final conceptual design of a hybrid-electric regional turboprop aircraft.

The STS research paper will look to analyze the influence between drone technologies and society on each other.

Technical Topic

The objective of the technical topic was to create a conceptual design of a hybrid-electric regional turboprop aircraft. Hybrid-electric aircraft use sources of electric energy, combined with conventional propulsion, to increase the efficiency and thrust of the engines that power the aircraft. As of January 2019, the world's commercial aircraft fleet consisted of 28,289 aircraft ("January 2022," 2022). Currently, 16% of the commercial aircraft fleet consists of turboprop aircraft (von Schoenberg & Doran, 2021). These aircraft play a large role in regional flights. In fact, the amount of regional air traffic is expected to increase yearly at an average rate of over 4.5%, indicating the ever-present demand for shorter, more efficient flights ("Clean Aviation," n.d.). While the increased regional air traffic presents a significant increase in the airline industry, this does present calls for a more sustainable and efficient aircraft to be created. According to Overton (2022), commercial aircraft produced approximately 920 million tons of CO₂ emissions as of 2019. The FAA has recently announced its push to provide more than \$100 million for contracts that push manufacturers and researchers to develop new technologies and aircraft that increase aircraft efficiency, reduce noise, and reduce emissions ("FAA Proposes Requiring," 2022). AIAA's undergraduate design request for proposal (RFP) calls on students to address these challenges and pushes. Students will design a hybrid-electric regional turboprop aircraft in hopes of meeting a lot of these goals set forth in the RFP.

The aircraft must conform to a variety of requirements. The aircraft should: have an entry into service (EIS) date of 2035, use existing engine technologies, be able to carry 50 passengers,

have a design range of 1,000 nautical miles with full capacity of passengers. In addition to this, the aircraft must conform to a number of performance and design parameters such as target airspeeds, aircraft dimensions, mission operations, and FAA certifications (“Hybrid-electric,” 2022). Ultimately, the conceptualized aircraft will also be designed in order to meet the following objectives: minimize production cost, create a visually appealing aircraft that is marketable and useful for different aircraft operators, make the aircraft’s reliability better or equal to current day comparator aircraft, and make the aircraft maintenance better or equal to current day comparator aircraft (“Hybrid-electric,” 2022).

Various different tasks will be completed in hopes of designing a successful hybrid-electric turboprop aircraft. Initially, design teams will work together to complete a systems requirements review (SRR). The SRR will cover the various mission requirements and other information needed for an overview of the RFP. Within this, basic conclusions will be made on what needs to be done in order to successfully design the aircraft. After the SRR, individuals will research different state-of-the-art (SOA) technologies in hopes of becoming a subject matter expert in a specific area. With a wide range of subject matter experts, the groups will be able to gain more insight for the design process. Conceptual designs of the aircraft will be made by each group member using OpenVSP, a parametric aircraft geometry tool. Each group will be able to choose three designs from the group, and focus on those designs as potential baselines for the hybrid-electric turboprop aircraft. After this selection, scripts will be developed to calculate the takeoff gross weight of the three selected designs. Different sizing plots will then be developed for the three baseline designs. Further work will be done to come to a final conclusion as to what the best design and layout will look like to meet the guidelines set forth in the RFP.

After designing the aircraft, a final report will be created, explaining the design process and conclusions made during the overall design process. With this in mind, the final aircraft is one that has successfully implemented hybrid-electric technologies. The aircraft will have significantly reduced carbon emissions and stand out in the aircraft market. The aircraft should be a baseline and provide influence for other aircraft manufacturers. With this improvement in carbon emissions, other manufacturers can try to implement these technologies themselves and provide additional reductions in emissions.

STS Topic

Aerospace technologies are thriving in today's world as funding for new opportunities is continuing to increase. Specifically, drones are continuing to stand out in this market. Within the United States alone, 865,505 drones are registered through the FAA ("Drones," 2022). This statistic shows the significant number of drones in circulation in the United States alone, not including unregistered drones in the United States, or even other drones in other countries. Beginning in the late 1990's, the push for more advanced drones in the military became more prevalent after the launch of the U.S. military's new drones under the Predator program (Alkobi, 2019). Moving into the 2010's, the use of drones for commercial purposes kicked into action. Most notably occurring in 2016, Flirtey completed the first autonomous drone delivery in the US ("The first fully," 2016).

Public opinion on the uses of these drone technologies widely varies. These displays of public opinion can mainly be seen in the use of military drones for their various uses, and commercial drones that are unmanned and autonomous. Looking at military drones, people are for their use when looking at the drone's ability to provide vital support for the military, helping

to save lives. On the other hand, others believe that these drones are immoral as they can cause collateral damage as a result of their strike capabilities. When looking at the use of drones in the commercial sector, people support these drone's abilities to improve the operations of a business, while others draw concern for a variety of safety and privacy reasons (O'Donovan, 2022). All of these opinions and uses of these drones play a role in each other's development. In the commercial sector, more and more companies are beginning to seeking future developments in unmanned and autonomous drone delivery. These future developments can be seen most recently after a notable company, Amazon, received FAA certifications that allowed it to use small, autonomous drones for delivering packages in 2020 (Palmer, 2020). In addition to this, drones are being used for aerial photography, geographic mapping of inaccessible terrain, crop monitoring, storm tracking, and even search and rescue operations (Intelligence, 2021). Drones are beginning to play a significant role in how different businesses and organizations operate. While analyzing the influence both society and drone technologies have on each other, it is important to understand the various parties involved. In terms of society, parties include: ordinary civilians, aerospace manufactures, businesses, and the government. Drone technologies serve as the main party and source of technology. Ultimately, it is important to conduct research on the sociotechnical nature of drone technologies for several different reasons. The development of new technologies plays a role in many of the uses and purposes of these technologies in society, bringing discussion regarding the morality of these uses. Advances in society or drone technologies can also bring increases in revenue and taxes on one another due to the ever-increased cost to manufacture devices or new requirements for stricter regulation.

Within the STS research paper, the theory of technological momentum will be used to further analyze the influences society and technology have with drone technologies. According

to Thomas Hughes (1994), an American historian of technology, “technological momentum infers that social development shapes and is shaped by technology” (p. 102). In addition to this, technological momentum is time dependent. This time dependence means that within a certain period of time, one can see the influence of society on technology and the influence of technology on society. The idea of time dependence is important as there might be periods in which influence can be heavily one sided, bringing technological momentum out of the picture. Eventually, this theory can shift more into a society where technology shapes society (Hughes, 1994, p. 112). On the other hand, there are some critiques about technological momentum. One might say that technological momentum is incorrect as it believes that both society and technology influence each other for a given period of time only. An individual might argue that regardless of a given time period, technology and society will continue to influence each other regardless of time due to society’s current push against a fully incorporated technological deterministic society or state of social constructivism. Despite this critique, technological momentum presents a relevant STS framework for the STS paper. Technological momentum will be useful for analyzing the influence drone technologies and society have on each other. Specifically, a time period after the late 1990’s will be used to show the level of influence both drone technologies and society have.

Research Question and Methods

After understanding the developing aerospace industry, it is important to ask: How does the sociotechnical nature of drone technology shape society, and vice versa? To answer this research question, discourse analysis will be used. To use discourse analysis, different news articles, marketing websites, and journal articles will be used to research different pieces of

background information. When looking for these various types of sources a few different keywords will be used. These keywords include: drone, technology, commercial, military, autonomous, unmanned, UAS, UAV, aerospace, system, privacy, delivery, public opinion, and drone usage. Different keywords will be chosen based on the desired information desired when searching for sources. Using discourse analysis is important to answering the research question as it gives one the flexibility to pull information from a variety of sources. Additionally, this analysis is useful as it provides one the opportunity to use various sources and media in which commercial information, military information, and public opinion is openly displayed. For discourse analysis, research will be organized in different groups that serve to show the commercial and military applications of drones, and then separated further into subgroups that show either society's influence on technology, or technology's influence on society. Through this type of analysis, one will be able to further analyze the complexities involved between drone technologies and society.

Conclusion

Both the STS topic and technical topics help to show how influence works between society and technology. The technical paper will dive into the design needed to create a hybrid-electric regional turboprop aircraft, with an EIS date of 2035. Through the many design phases and steps needed to conceptually design this aircraft, a hybridized aircraft able to hold 50 passengers will be designed. The aircraft design will ultimately help to reduce carbon emissions, in addition to setting an example for other aircraft manufactures as to how upcoming aircraft can move to a more sustainable future.

On the other hand, the STS paper will provide deeper analysis into the relationship between society and drone technologies. Different pieces of information will be introduced to show just how important influence has in its role in the construction and shaping of different technologies and society. As a result of this evidence and analysis, one will be able to come to the conclusion that the sociotechnical nature of drone technologies influences and is influenced by society.

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