Thesis Project Portfolio

Design Proposal for Responsive Aerial Firefighting Aircraft
(Technical Report)

Sustainability Transitions of Additive Manufacturing in an Aerospace Context
(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

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Sociotechnical Synthesis

The innovation of manufacturing methodologies has created significant and lasting impacts in engineering and society. For example, the introduction of a moving assembly line from Ford Motors has rapidly evolved to become a major mechanism in the global manufacturing ecosystem. Within the past several decades, the development of advanced composite materials – such as carbon fiber reinforced plastics and ceramic matrix composites – and additive manufacturing, more commonly referred to as 3D printing, have introduced creative and novel paths of engineering design that can foster lasting change in society.

The capstone project challenged students to draft a proposal for a conceptual design of next generation aerial firefighting aircraft to be submitted to the Aerospace Institute of Aeronautics and Astronautics (AIAA) 2021-2022 Aircraft Design Competition. This design challenge was created in response to the lack of specialized aerial firefighting aircraft and the increased frequency of wildfires in light of the worsening effects of climate change. While meeting the technical design mission requirements and objectives outlined in the competition rules, students were challenged to develop an affordable, sustainable, and high-performance aircraft through a blended use of pre-existing and state-of-the-art technologies. Some of the explored avenues are autonomous aircraft systems, advanced air breathing propulsion systems, and additive manufacturing.

In relation to sustainability and emerging manufacturing technologies, the STS thesis explored the sustainable transition from traditional manufacturing to additive manufacturing within the aerospace industry. The objective was to grasp a holistic understanding on the current socio-technical landscape of manufacturing in the aerospace industry through analysis of the incumbent regime and niches. This study was approached by utilizing the multi-level perspective framework from sustainability transitions research to present case studies of early adopter aerospace corporations and case studies of current adopter aerospace entrepreneurial ventures

within the context of an evolving landscape. This research demonstrated that the early investment from government bodies and corporate leaders into this emerging technology enabled rapid technological advancement which lessened the challenges impeding an early adoption and transition in the aerospace industry. It also provided key insight into the progressions and challenges of additive manufacturing from a historical lens.

The capstone project allowed me to utilize key aerospace engineering design frameworks and to gain insight into a dynamic team environment apparent in the aerospace industry. It also taught the value of utilizing a systems-thinking approach for successful engineering practice. The STS thesis enabled a deeper understanding of additive manufacturing as a prominent, emerging technology in the aerospace industry from a socio-technical context. The study offered me an opportunity to answer and fulfill a personal curiosity and inquiry.

I would like to thank my both my capstone team and class for the collective effort in creating a proposal for a next-generation firefighting aircraft. I would also like to thank my friends and family for engaging in scholarly conversation about my STS thesis and capstone project. I would finally like to give thanks to Prof. Ferguson and Prof. Quinlan for helping guide my STS thesis and capstone work.