Thesis Project Portfolio

Undergraduate Responsive Aerial Firefighting Aircraft

(Technical Report)

The Effects of Outdated Wildfire Suppression in California

(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

Andrew Michael Wheatley

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Department of Mechanical and Aerospace Engineering

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Sociotechnical Synthesis

STS 4600

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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

Advisor

Joshua Earle, Department of Engineering and Society

As urbanization and climate change continue to accelerate at alarming rates throughout the developed world, society will need to evolve to survive in an increasingly harsh environment. While it is easy for lots of people to live in blissful ignorance of our impact on nature, increasing frequency and severity of natural disasters is forcing a reevaluation of how society can mitigate damage. In the arid regions of the United States and abroad a recent uptick in wildfires has shown how ineffective our current technology is at protecting human lives and property, and moreover how easily wildfires can be triggered by human activity.

The technical portion of this project deals with development of a new state of the art firefighting aircraft to replace current outdated technology. Due to common practice of retrofitting aircraft for usage in firefighting roles, there is a serious concern about a lack of efficiency and efficacy in the future as wildfires become even more common. The sociotechnical portion of this project analyzes the impact on an affected community and the survivors, and how new practices and laws may help to further mitigate damage after a disaster. This portion will focus largely on how ineffective disaster reporting methods do not address the full concerns of a natural disaster and how technology and behavioral changes can help communities recover quicker.

The majority of the technical portion of this project was developed in conjunction with the Aircraft Design Course taught by Dr. Jesse Quinlan. The objective of this course is for teams of senior aerospace engineering students to design an aircraft to compete in an annual competition sponsored by the American Institute of Aeronautics and Astronautics. The AIAA releases a document containing all the technical requirements each team most meet in their design and includes potential objectives for teams to further design around for additional points in the competition. The 2021-2022 design focused on replacing the outdated aerial firefighting

fleet used in the American Southwest and featured design objectives such as fire retardant capacities and minimum flight speeds for accurate fire fighting missions. The class was divided into three different teams and each team member chose different aspects of the aircraft to optimize. The design of this aircraft went through several iterations based on research and simulations conducted over the year, but ultimately a medium sized aircraft was developed to meet all the requirements of the competition at the minimum cost possible.

To accompany the technical portion of this project, the sociotechnical report focuses on how firefighting methods are not enough to prevent future devastation. Particular importance was placed on examining the existing methods of crisis reporting and relief systems currently utilized. The first portion of the report walks through the different aspects of wildfire impacts including housing losses, pressure on health care systems, long term mental trauma, ecological impacts, and economic consequences. In addition to the immediate impacts of a wildfire, there exists a very long domino effect that impacts the entire economy and wellbeing of a community for years to come. These long term consequences are rarely reported due to the difficulty of keeping track of so many statistics, but considerations must still be taken into account when developing appropriate relief systems. The second half of the report focuses more on how aid programs utilize technology and resources to help survivors currently and what improvements could be made. This section walks through some of the proposed relief technologies such as replacement housing solutions and federal aid reformations. In particular, California is used as a model to analyze to narrow down the research and avoid discrepancies in aid programs. Some of the solutions analyzed in this section include affordable temporary housing for survivors and the development of increased fire camera coverage surrounding rich regions. The final portion of the

essay discusses the culture of fire prevention in the United States and the need to hold large corporations responsible for their involvement in natural disasters.

This project could not have been accomplished without the amazing assistance from my teammates and peers throughout the aerospace department and my professors and advisors. A special thanks to Dr. Joshua Earle for assisting with the development of my thesis and Dr. Jesse Quinlan for his assistance with the technical aspects of this project.