Thesis Portfolio

American Institute of Aeronautics and Astronautics: Aerial Firefighting Design Competition
(Technical Report)

The Effects of Past and Current U.S. Wildfire Policy
(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

The issue of damaging wildfires has been thrown into the public consciousness as wildfires have grown tremendously in recent years. The 2021 California Dixie fire burned 963,309 acres over the course of 3 months and became the second largest wildfire by acreage in California. As wildfires become an increasingly prominent issue, it is imperative to ensure the effectiveness of current policies and technologies regarding wildfires. Both of my projects focused on wildfire management. For the technical project, my UVA Aircraft Design Capstone team made a conceptual design of a responsive aerial firefighting aircraft for submission to the AIAA 2022 Design Competition. My STS research focused on the effects of past and current U.S. wildfire policy. This topic was chosen to closely relate to my technical project because firefighting aircraft will only be as effective as the wildfire policies they enforce. To understand the effectiveness of these aircraft, it is necessary to study the greater picture of U.S. wildfire policy as a whole.

My Capstone group, Team Splashzone, analyzed the AIAA request for proposal (RFP) requirements and objectives for a responsive aerial firefighting aircraft. A key objective we focused on was a fire retardant capacity of 8,000 gallons. With this objective chosen, we selected a design mission that includes three 2,000 gallon retardant drops. As 8,000 gallons (72,000 lbs) of retardant greatly increased the maximum takeoff weight of our aircraft, we set a goal to minimize aircraft size and weight while maintaining stability and structural integrity. From the preliminary design to critical design, we reduced our aircraft length from 160 ft to 83.5 ft and take-off gross weight (TOGW) from 273,386 lbs to 181,806 lbs. These changes greatly contributed to significant cost reductions for our aircraft. These large weight and size reductions

were made possible by wing and tail trade studies, optimized tail volume coefficients, aerodynamic and structural analysis, cost analysis, and optimized tank design. A key contributor to maintained aircraft stability throughout the mission is the placement of key changing weights (e.g., changes in weight from payload drops or use of fuel). The aircraft maintains its center of gravity (CG) throughout the design mission by centering the payload about the CG and placing fuel in the wing which is close to CG.

While firefighting aircraft are a key portion of wildfire management, they are only effective as long as wildfire policy is. In my STS research I investigated the research question "What are the impacts of past and current U.S. wildfire policy?" using the STS methods of history through literature study, public policy through research on current and future wildfire policy, and ethnography through the gathering of interviews of key groups of interest such as Indigenous fire stewards. My research finds how the U.S. fire regime shifted greatly from millennia of natural wildfires and Indigenous fire stewardship to fire exclusion and active suppression. The 100 years of these policies had many negative effects, with some of the greatest being the marginalization of Indigenous peoples and the buildup of plant material which in turn helped spawn damaging wildfires called high-impact mega-fires. Current policy has made some progress to right these wrongs, and new policies are in the works to further impact the U.S. fire regime. Based on my research I make informed recommendations such as strengthening Indigenous peoples' right to conduct controlled burns, expanding programs which bring together a diverse set of perspectives to wildfire management, and choosing more comprehensive fire management strategies over greater suppression force.

By executing STS research in addition to my technical project, I was able to greater understand the bigger picture of U.S. wildfire management that my technical work contributes to.

Both projects combined reveal the fine line wildfire policy and procedure must tread between suppressing and using fire to minimize costly damages that high-impact mega-fires pose while maximizing the benefits fire can bring.

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