THESIS PROJECT PORTFOLIO

AIAA Undergraduate Design Competition: Aerial Firefighting Aircraft

(Technical Report)

How Californians Are Dealing with Water Shortages

(STS Research Paper)

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TABLE OF CONTENTS

Sociotechnical Synthesis

As climate change continues, the number and intensity of wildfires is expected to rise over the next century. According to the American Institute of Aeronautics and Astronautics, the majority of current aerial firefighting vehicles are modified civilian or military aircraft, where compromises and inefficiencies arise from differences from the aircrafts' original mission. Converted passenger airliners have limited options for tank placement without compromising structural integrity, while systems for military aircraft sacrifice capacity for modularity. By designing a purpose-built firefighting aircraft, the specifics required for aerial firefighting missions can be accounted for and optimized.

My team's solution to this problem is the *Dragonforce*. This aircraft draws inspiration from the Lockheed C-130 but with some significant modifications. The Dragonforce will have an Entry-Into-Service date of 2030 and function as an "airtanker" that can drop 8,000 gallons of fire retardant onto wildfires. The aircraft has a full range of 800 nautical miles with full payload and is capable of cruising up to Mach 0.6 (400 knots). Two internal 4,000 gallon tanks will use computer controlled gravity fed systems to allow for multiple drops. These tanks are baffled to prevent sloshing and centered around the aircraft's center of gravity, both of which will reduce c.g. shifts during the design mission. The aircraft has a low mounted wing with a 6 degree dihedral angle to improve lateral stability and a conventional empennage for its lower weight and cost. It's powered by two CFM56-7B engines for their reliability and commercial availability; these engines power aircraft with similar weights like the Boeing 737 and Airbus A320. The Dragonforce meets all certification rules in FAA 14 CFR Part 25. Assuming 10 aircraft are initially produced, the acquisition cost will be roughly $232.4 million per plane with a flyaway

cost of $200.1 million per plane. The Dragonforce's cost per flying hour is approximately $4,000 per hour, which is significantly cheaper than current airtankers with similar capacity.

Climate change will also increase water scarcity worldwide. Currently, two billion people live in countries with inadequate water supplies, four billion people experience severe water scarcity for at least one month every year, and 700 million people could be displaced by water scarcity by 2030. This is partially driven by drought-induced water scarcity, as semiarid regions like the Southwestern United States will experience increased frequency and duration of drought periods. Many of these will be perfect droughts, where all of a region's water sources experience drought at once. Countries across the world will be searching for the best methods to mitigate water scarcity, and one U.S. state has already demonstrated several of these: California.

In California, most rainfall occurs in Northern California, while most people live in Southern California. The more populous and arid South must source much of its water from hundreds of miles away, with government agencies and water distributors constructing billions of dollars worth of water infrastructure to achieve this task. These differences set the stage for government agencies, water distributors, agricultural industries, environmental advocacies, and local communities to respond and interact with each other differently regarding water supplies.

After the 2012-2016 drought, the California Natural Resources Agency released a report detailing the state's response and the lessons learned, noting that each facet of the response required multiple government agencies, departments, and/or boards to work together to respond effectively. Water storage and conveyance infrastructure, though extremely expensive, can effectively build drought resilience. California has a long history with water mega-projects, and infrastructure like the Colorado River Aqueduct will remain vital for supplying water when it can't be sourced in-state. Furthermore, the state owned State Water Project (SWP) and the

federally owned Central Valley Project (CVP) are two water storage and delivery systems that provide clean water to millions of California residents and much of California farmland, aid water management, and generate hydroelectric power. States and countries with semi-arid and arid regions should note the importance of the SWP and CVP in California, along with how those projects have helped California manage its water resources during droughts. However, waning public trust in U.S. government institutions may limit support for policy responses to water shortages. California environmental advocacies have already collaborated on litigation against regulatory agencies, forcing these agencies to roll back particularly strong policies. Water scarcity mitigation must be sustainable, and sustainability groups will continue watching water management policies and water infrastructure projects to ensure governments, water distributors, and corporations aren't acting against public interest.