Thesis Project Portfolio

Lake, Wind, and Fire: Design of a Large Firefighting Air Tanker

(Technical Report)

The Fire Fighting Foam Fight: The Controversy over Toxic Fire Retardants

(STS Research Paper)

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Sociotechnical Synthesis

Wildfire acreage, specifically in the southwestern United States, has seen significant increases in the past decade. In addressing this issue, firefighting departments often deploy Large Air Tankers (LATs) and Very Large Air Tankers (VLATs), which are specialized transport aircraft designed to fly to a set destination and release a load of fire retardant, typically used to redirect or slow the spread of fire. The vast majority of firefighting aircraft, especially in the LAT/VLAT category, are converted transports which were originally designed for different missions – as a result, they are unoptimized for the firefighting mission and, being re-purposed aircraft, have a typically significant amount of wear on the airframes when adapted to the firefighting job, a matter of potential hazard given the high loads experienced in the demanding aerial firefighting mission. To address this concern, as part of the American Institute of Aeronautics and Astronautics (AIAA) aircraft design challenge, our group designed and proposed a clean-sheet purpose-built firefighting aircraft. To meet requirements set forth in the design challenge request for proposal, the aircraft was built to accommodate an 8,000-gallon fire retardant load, in addition to meeting particular range, performance, and maintenance requirements, notably a request for maximized maintainability and a desire to reach entry into service by 2030. To reach these particular design objectives our aircraft was designed with a heavy emphasis on "off-the-shelf" parts usage and systems that were at or very near technological maturity – these same design considerations helped in reducing cost. In order to analyze and spec out the airframe, multiple aerospace design programs were used, including but not limited to VSPAero, GasTurb, FLOPS, Flightstream, and AAA (Advanced Aircraft Analysis). In the sociotechnical synthesis, I explored one potential source of harm, and a unique dilemma, in the firefighting system – Aqueous Film-Forming Foam (AFFF), a chemical compound used to suppress flammable liquid fires, is particularly effective in these dangerous

situations – however, per- and polyfluoroalkyl substances (PFAS) included in the compound, which give it its firefighting efficacy, also generate significant environmental hazards, being linked to health problems seen in people in areas with elevated concentrations of PFAS. This matter was evaluated through both a sociotechnical and ethical lens – the STS lens, being how different people viewed the use of AFFF, was used to inform the ethical lens. Using the social construction of technology (SCOT), the use of AFFF was evaluated through the lenses of several groups – most broadly categorized they are the military, which broadly considers the increased efficacy of AFFF critical due to large-scale fires that have occurred in the past, manufacturing groups, who are primarily concerned with AFFF as a profitable product, and various organizations, governmental and nonprofit, who perceive AFFF as a major source of PFAS leaching into water supplies and resulting in adverse health effects. In discussing SCOT with respect to these groups I suggested the idea of a "pseudo-closure", wherein all parties are agreed on the need for a new technology which has yet to be applied, yet the status quo is held relatively steady. In discussing ethical considerations, I primarily focused on the core tradeoff between mitigating potential for disaster vs near certain long-term harm, concluding that while the need to prevent disaster is key, there remains an ethical imperative to act to at least mitigate the near-certain harm wherever possible – and while this is occurring in reality, one could argue it needs to occur more rapidly and with greater effect.