Thesis Project Portfolio

American Institute of Aeronautics and Astronautics: Aerial Firefighting Aircraft Design Competition

(Technical Report)

Preventing the Utilization and Proliferation of Hypersonic Weapons

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

My technical report presents an original design for an aerial firefighting aircraft to fill a hole in the U.S. Forest Service fleet. As a team, we were motivated by the rising number of wildfires around the world, caused in part by global warming. The conceptual design satisfies all three fundamental sizing relationships and includes extensive aerodynamic, structural, and propulsive analysis. My team submitted the design report to the American Institute of Aeronautics and Astronautics undergraduate airplane design competition.

While aeronautics can solve global problems such as wildfires, it can also create weapons capable of mass destruction. The international community has struggled to contain evolving weapon systems and prevent their dissemination. To add to this debate for an emerging class of arms, my STS research paper examines the utilization and proliferation of hypersonic weapons—highly maneuverable missiles that travel at speeds greater than five times the speed of sound. This class of arms presents a host of novel threats to the U.S., including target ambiguity, warhead ambiguity, and one-upmanship. Target and warhead ambiguity refer to the inability of an adversary to discern the weapon destination and payload, respectively. In this paper, I argue for the stoppage of hypersonic weapon use and proliferation, and I proceed to offer effective arms control strategies to meet this goal. To provide a framework for analysis, I leverage the technological momentum theory—a concept created by Thomas Hughes to describe the development of large-scale technical systems. I emphasize the connection between hypersonic weapons and four analytical elements of technological momentum: transfer, reverse salients, momentum, and invention. This analysis employs expert testimony to gather a consensus on the state of hypersonic technology and its geopolitical implications. I interviewed ten hypersonic weapon experts from government, academia, and non-partisan think tanks and coded their responses according to the analytical elements. This paper distills policy recommendations from thematic coding, poignant quotes, and prior literature. The recommendations were threefold: (1) enact export controls to slow (but not stop) proliferation, (2) negotiate a bilateral agreement with China to limit the number of hypersonic weapons each country is allowed to have, and (3) modify the New START treaty to specifically control hypersonic weapons. If enacted, these three recommendations would stem major development efforts and halt hypersonic weapon spread to other nations.

Despite the disparity between the two topics, my technical capstone and STS research connect through the control of advanced aeronautical systems. Aerial firefighting is a dangerous environment, so my technical capstone team emphasized autonomy in our design. Likewise, hypersonic weapons use similar subsystems to maneuver towards a target. Furthermore, these two topics represent my shifting interests from specialized conceptual airplanes to emergent propulsion technologies.