

Thesis Project Portfolio

Hypersonic ReEntry Deployable Glider Experiment (HEDGE)

(Technical Report)

**Analysis of Viability and Potential Applications for Hypersonic Technologies as They
Pertain to Military Strategy and Diplomacy for the United States**

(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

Ian Lumsden McAninley

Spring, 2024

Department of Mechanical & Aerospace Engineering

Table of Contents

SOCIOTECHNICAL SYNTHESIS

HYPersonic REENTRY DEPLOYABLE GLIDER EXPERIMENT (HEDGE)

Technical Advisor: Christopher Goyne, Department of Aerospace Engineering

ANALYSIS OF VIABILITY AND POTENTIAL APPLICATIONS FOR HYPersonic TECHNOLOGIES AS THEY PERTAIN TO MILITARY STRATEGY AND DIPLOMACY FOR THE UNITED STATES

STS Advisor: Gerard Fitzgerald, Department of Engineering and Society

PROSPECTUS

Technical Advisor: Christopher Goyne, Department of Aerospace Engineering

STS Advisor: Gerard Fitzgerald, Department of Engineering and Society

Sociotechnical Synthesis

Global conflict has always been a driving force for developing new strategy and capabilities throughout human history. This past century, technological capabilities have grown at an exponential rate and have become the focal point of competing countries' attention. The newly developed technologies that are relevant to this discussion are the atomic bomb, hydrogen bomb, anti-missile defense systems, and hypersonic-airbreathing-maneuverable missiles. Another sub-development that could be included in this family of technologies is the development of intercontinental ballistic missiles, which were the main focus between the creation of the hydrogen bomb and the systems designed to destroy incoming missiles. These technologies are all interrelated because each prior technology was the driving force for the creation of the subsequent technology. Within the political perception of the world through the lens of the theories of balance of power and mutually assured destruction, each technology is an attempt by the leading country to tip the diplomatic balance of power back in its favor. Flash back to today, and hypersonic missiles are the conceptual counter to anti-missile systems. However, there have been examples of developmental technologies that did not live up to the promised capabilities and expectations. These technologies can be organized into three categories: technologies that can still be utilized but need an adjustment to their intended purpose, technologies that eventually function as intended but are limited by the technology of the time, and technologies that fail entirely. Missiles are an example of the second category as their promised capabilities led to a complete reliance on them with F-4 Phantoms during the Vietnam War. This was a mistake at the time, but a few decades later and some technological catch up and traditional dog fights have been largely replaced with beyond-visual-range missiles. The Strategic Defense Initiative is a hybrid example of the first and third categories. The concept

of intercepting ICBMs ended up being a fruitful one, but the intended methodology for doing so with the Strategic Defense Initiative was a complete failure. Stealth was believed to be the end of diplomatic reliance on nuclear ballistic missiles for deterrence, but the technology failed to realize this potential. This paper analyzes the hypersonic missile in order to establish if there is a strategic niche for the United States either diplomatically or militarily for the technology or if it is another example of an over-promised and impractical technological venture.

In order to analyze the hypersonic missile system and determine the presence of a strategic niche for the technology, a few things will be explored, identified, and analyzed. The first thing that will be examined are the proposed applications for the hypersonic missile system. The second thing that will be examined are the challenges that the development of hypersonic technology will have to overcome in order to become a practically applicable technology. The third thing that will be explored is a comparison of hypersonic missiles and their potential capabilities to the capabilities of already possessed technologies. The final thing that will be examined is a cost analysis of past technological ventures that shared similar strategic and diplomatic intentions such as MaRVs and low-observable (stealth) technology.

These methods for examination and analysis have revealed that there are strategic niches both diplomatically and militarily for hypersonic weapons. Hypersonic weapons are an opportunity for the United States to demonstrate its continued ability to successfully develop and master new technologies. The technology has the potential to surpass the nuclear ICBM as the primary method of deterrence.

Key Terms: Hypersonic, Balance of Power, Strategic Niche, Deterrence