Thesis Project Portfolio

HEDGE: Hypersonic ReEntry Deployable Glider Experiment

(Technical Project)

Understanding the History of Anti-Satellite Weapons and Assessing the Threats They Pose to Society

(STS Research Paper)

An Undergraduate Thesis

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Table of Contents

Sociotechnical Synthesis

Anti-satellite weapons (ASATs) are an incredibly destructive technology that prominent militaries have taken a keen interest in developing. Russia, China, India, and the United States all have robust ASAT programs and are the only four countries that have conducted successful ASAT tests. ASATs have become increasingly important in recent years due to the world's complete reliance on satellites for some of society's most basic functions along with their national security implications. ASATs come in a variety of forms, but recently the most common and dangerous are direct-ascent ASATs (DA-ASATs). DA-ASATs function by launching a projectile into space and destroying a satellite through a kinetic impact. This impact obliterates the satellite, breaking it into thousands of pieces and creating a large cloud of space debris. This debris might eventually strike another satellite, resulting in more debris and causing a chain reaction known as the Kessler Syndrome to ensue. If this occurs, society will no longer be able to use space as a resource and will lose the benefits it provides.

It is the responsibility of policymakers to ensure this does not happen by creating treaties that can be agreed upon by all nations with ASAT capabilities. Past attempts at such treaties have failed because some stipulations were too restrictive or were a masked attempt by one nation to gain a strategic advantage over adversaries. However, a partial ASAT ban that targets DA-ASATs may be a viable path forward. Such a ban would eliminate the primary source of debris and would be widely accepted because all countries have a vested interest in preserving space.

The technical portion of this thesis involves designing a cheap, quick, and effective method for obtaining data on how target materials behave during a hypersonic atmospheric re-entry. A CubeSat titled the Hypersonic ReEntry Deployable Glide Experiment (HEDGE) will be loaded onto a rocket and then placed into a low earth orbit. Once in orbit, the CubeSat will

morph into a glide vehicle configuration and naturally de-orbit, performing an atmospheric re-entry. During the re-entry phase, four panels containing the material being tested will collect pressure and temperature data then transmit it to a ground station before the vehicle fully burns up. This research is important because it offers an alternative to modern hypersonic testing, allowing a material's baseline capacity for use in hypersonic vehicles to be quickly assessed. Having access to such information will assist researchers who are seeking to develop hypersonic weapons by accelerating their progress, significantly impacting the race for functional hypersonic weapons.

A common trend within engineering is that as time progresses, rare and expensive technologies slowly become more widespread and easy to produce. The technical portion of this thesis seeks to prove that this trend can also be applied to technologies that both reside in space and have significant military applications. It is reasonable to expect that ASAT research will experience a similar trend, and that ASATs will become more prevalent around the globe as countries continually improve their capabilities. As this occurs, it is imperative that the risks posed by ASATs are known so that their use can be regulated in a way that does not jeopardize the sanctity of space. If the issue of ASATs is not handled with care, not only would experiments such as HEDGE be unable to function, but all other experiments of a similar nature would come to a grinding halt. This loss of research opportunities would put a massive damper on society's ability to technologically progress at a constant rate, but it can be avoided if the proper attention is given to ASATs and nations begin collaborating to prevent the pollution of space.

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