**Hypersonic reEntry Deployable Glider Experiment**

**Designer Bias and the Growth of Diversity, Equity, and Inclusion in STEM Fields**

**A Thesis Prospectus**

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**By**

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**On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.**


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## Introduction

The field of hypersonic flight has continued to grow exponentially in the 21st Century. The United States, Russia, and China in particular have taken painstaking efforts to develop their hypersonic weapons capabilities (Stone). Hypersonic speeds are defined as speeds in excess of Mach 5, usually accomplished through unmanned flight vehicles (i.e. missiles and drones). Given the rapidly advancing computational and manufacturing technologies employed in the aerospace industry today, the development of flight technologies holds greater importance over the world as a whole. Hypersonic flight vehicles in particular have grown to dominate the majority of weapons development, going so far as to warrant billions of dollars in research and development across the U.S., Russia, and China (Stone, U.S.D.O.D.).

The technical project with regard to the field of hypersonics is to demonstrate the feasibility of  extremely low cost hypersonic research through a hypersonic reentry glider experiment (HEDGE). This is a project funded and in partnership with the University of Virginia, as well as the U.S. Government and a few industry partners. As a dedicated team of undergraduate and industry partners, we will work to gather hypersonic flight data using HEDGE as a means to develop a future workforce in hypersonic technologies, advance the current state of hypersonic flight technologies, and to accomplish both goals with an extremely low budget. Some of the most important design questions we seek to answer include the different types and amounts of data we seek to capture, the duration of hypersonic flight we seek to attain before glider disintegration, which hardware and software components will satisfy the aforementioned requirements, and finally, how to transmit the recorded data before glider disintegration.

The STS component of this project is to determine how the homogeneity of the aerospace industry, and STEM as a whole, has influenced the development of artifacts and their relationships with different social groups. Given the homogeneity of the team behind the technical project above, I will approach this question using ethnographic, historical, academic evidence.

**Technical Project**

HEDGE seeks to primarily accomplish three objectives: to create and fly extremely low-cost hypersonic research vehicles, to develop a sparse hypersonics engineering workforce, and to demonstrate feasibility of state-of-the-art hypersonics research at the university level. The glider takes the form of a cubesat in order to leverage backpacking capabilities on commercially available rocket boosters. With the help of  industry partners, the most involved being NASA, we plan to "piggyback" off of a standard satellite or ISS mission into low-Earth-orbit (LEO). Once our desired altitude is reached, HEDGE will detach during first stage separation and, upon a successful ping with the ground station, will begin its descent down from the edge of space. Once flap deployment is triggered and the attitude of the glider is aligned to its predetermined flight path, gravity will increase the velocity of the glider to hypersonics speeds (>Mach 5). Once all relevant flight data is collected during flight, HEDGE will send packets of data to the ground station and will subsequently burn up in the atmosphere before hitting the ground as per FAA regulations.

Some of the main challenges with regard to the mission objectives will be to create reliable hardware and software that is operational in extreme environments, timely flap deployment prior to reentry, attitude determination following first stage separation, data acquisition and telemetry through the plasma shield, and timely disintegration of the vehicle. The predominant method by which these objectives will be accomplished is thorough testing and evaluation prior to mission launch. Additionally, the method of launch is still in early stages and may allow for greater degrees of freedom in glider design pending the final launch platform. Irrespective of the accomplishment of the primary technical objectives of HEDGE, the secondary, passive goals of developing engineering skill sets to supplement a limited hypersonics workforce and demonstrating the utility of university student-led hypersonics research will be assuredly achieved as any experience is valuable experience given the low-costs of this experiment compared to industrially funded projects, which typically cost around 200 million dollars per flight.

**STS Project**

Increasing development of hypersonic capabilities has likewise resulted in an increase in the aerospace workforce (aia-aerospace.org). As more underrepresented groups enter STEM fields, there are shifting social dynamics amongst an aerospace industry which has historically been dominated by homogeneous groups of engineers (Pew Research Center). I seek to define the social implications of these technologies, the root contributors to these changes, and how these changes should be guided in order to ensure that diversity, equity, and inclusion are upheld in these STEM fields.

In the design process, it is certainly true that a designers' own politics are incorporated into their projects. Whether intentional or not, an individual's perspectives contribute to the form and functions of an artifact. Thus, the presence of diversity amongst a design team is paramount to ensure that an artifact is not only successful in achieving its intended purpose, but that it does not unintentionally discriminate against any groups of people. The importance of thoughtful and inclusive design is especially evident to  individuals who are members of underrepresented groups in STEM and who are now finding themselves in the same positions as past designers.

Although these social changes are being widely embraced by those in STEM fields, and more specifically those in the aerospace industry, it should not be the onus of underrepresented groups who are breaking into these fields to educate and guide incumbent individuals in these fields regarding diversity and inclusion. Too often, minority groups in STEM fields are overlooked, unfairly criticized, and are faced with higher expectations than their majority counterparts. Despite efforts to self-advocate and educate others, the same biases which plague majority groups and their treatment of minority groups in STEM prevent thoughtful listening and implementation of inclusivity (National Academies of Sciences, Engineering, and Medicine). It is therefore essential that those who are a part of the majority in STEM learn to advocate, and not speak for, underrepresented groups such that true diversity, equity, and inclusion are achieved and made available to all social groups.

**Key Texts**

The first source to be used to inform the STS topic is “The Disordered Cosmos" by Chandra Prescod-Weinstein, who is a renowned theoretical physicist. It is a written account of both her work in the field of theoretical physics and her experiences as a Caribbean woman in a STEM field. Her experiences and calls for unequivocal participation and representation in STEM fields are poignant reflections of the historical discrimination and exclusion of STEM fields, in addition to present-day experiences of BIPOC in STEM fields.

Secondly, ethnographic research will be conducted using experiences in the form of interviews of BIPOC individuals in STEM fields. These interviews will be advised by PhD students whose specialities include inclusivity and diversity in STEM fields, in particular at the university and professional levels. Firsthand accounts of minority experiences in STEM fields will be used to analyze common trends and struggles underrepresented groups face and will build the most direct insights into how present-day workforces in STEM fields are developing given drastic cultural change with regard to diversity, equity and inclusion in recent years.

Another source to be employed will be Kirsten Koopman's "An invisible Gorilla in the Lab", an article written for the *American Scientist*. One of the primary insights given by this source beyond information concerning the barriers of entry for women in STEM fields is the harmful workplace environments often in place towards women. This article is somewhat of a departure from previous sources in that it offers insight into the experiences of women who, despite having acquired positions within technical fields, yet face discrimination and harassment as a result of cultural sexism. These accounts will be used to expose these harmful trends as a means to best construct solutions to environments where these toxic cultures subsist.

Furthermore, Simone Browne's *Dark Matters* will be utilized to not only expose other harmful trends towards BIPOC individuals in STEM fields, but to also further develop solutions and practices to best change these trends to facilitate diversity. Browne gives excellent examples of both successful and unsuccessful movements to advocate for inclusivity. The aspects of the most successful political movements to improve the status of underrepresented groups in STEM will in turn be used to fortify arguments to include these same aspects in present-day movements as well.

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