HEDGE: Hypersonic ReEntry Deployable Glider Experiment
(Technical Paper)

Analyzing Influences and Barriers to Nutritional Health
(STS Paper)

A Thesis Prospectus
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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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Prospectus

Introduction

While scurvy is no longer a common affliction in the United States, the incidence of this disease among pirates is a prime example of the need for effective nutrition research as humans explore new horizons. Despite increasing awareness of nutritional factors affecting health, there are numerous influences affecting one's ability to care for themselves through nutrition, and barriers to this aspect of health. Food insecurity and the rise of processed food have created a divide between socioeconomic classes regarding nutritional health (Caporuscio, 2020). There needs to be more information available to the public about genetic predispositions, food allergies, accessibility of dietary needs, and how these factors play a significant role in one's well-being. Different lifestyles have different nutritional requirements, and the average American is not afforded constant monitoring of bodily function like the average astronaut in the International Space Station (ISS).

Space travel is a lifestyle that requires expert tracking of nutrition. Different stresses are exerted in space and efforts to combat these stresses requires space flight data which can be collected jointly with hypersonic flight research. Hypersonic flight is an expanding field within space travel necessary for space access and reentry into the Earth's atmosphere. A CubeSat is a small satellite flown in low earth orbit, flying at hypersonic speeds. Undergraduate research of hypersonic flight will be performed by studying CubeSat capabilities and the deployment of a test article, a hypersonic glider deployed from the CubeSat after launch into orbit. The inaccuracy and difficulty of hypersonic experimentation on Earth compels CubeSats to be utilized by university students in order to conduct this research at a lower cost for greater accessibility. Previous CubeSat experiments have provided, "valuable opportunity to work

hands-on with actual space systems," and, "practical project management experience," (Goyne, 2021). More research of hypersonic flight increases the accessibility of space travel and opportunities in the exploration of the technologically expanding horizon.

Hypersonic Glider Flight Experiment Using a CubeSat Platform

Another area in need of more research is hypersonic flight, better described as aeronautical crafts moving at five times the speed of sound. A CubeSat is a small satellite flown in low earth orbit that is designed for undergraduate students to be able to conduct hypersonic experiments. As CubeSats orbit the Earth, they fly at hypersonic speeds and re-enter the atmosphere in around five to seven days if launched into Extreme Low Earth Orbit (ELEO) (Panwar & Kennewell, 1999). The technical project surrounds the ability of a CubeSat to house a hypersonic glider. The technical goals of this project are to introduce a new method for low-cost hypersonic experimentation, successfully deploy the hypersonic test article, ensure the stability of the glider, and relay data upon reentry of the glider into Earth's atmosphere.

Objectives

In order to successfully launch the proposed CubeSat, there are three primary objectives; first, demonstrate the feasibility of CubeSats as a platform for hypersonic glider flight research. Secondly, show that undergraduate students can conduct hypersonic glider flight experiments at lower cost and with greater accessibility. Lastly, provide an opportunity for undergraduates to gain hands-on experience and generate interest in the spaceflight industry. Within these main objectives includes smaller technical goals: introduce a new method for low-cost hypersonic experimentation, successfully deploy the hypersonic test article (the hypersonic glider), ensure the stability of the glider, and relay data upon reentry of the glider into Earth's atmosphere. Broader anticipated outcomes include successful partnership with government organizations

such as NASA, establishment of professional relationships within the University of Virginia for future collaboration, and the demonstration of undergraduate student capabilities within the field of hypersonic aeronautics.

Approach and Resources

This technical project will be completed within the Mechanical and Aerospace Engineering department's Spacecraft Design course advised by Professor Christopher P. Goyne at the University of Virginia (UVA) by a team of undergraduate students. The team involved in this project consists of fifteen members, each assigned to a functional sub-team: Communications; Software and Analysis; Power, Thermal, and Environment; Attitude Determination and Control System (ADACS) and Orbits; and Structures and Integration, led by one project manager. Success of the project will conclude when the CubeSat system is launched onboard a Northrup Grumman (NG) Antares rocket and deployed into Extreme Low-Earth Orbit (ELEO). After five to seven days, the CubeSat will reenter the atmosphere. The objectives stated in the previous section will be accomplished by following this general timeline: concept exploration, detailed development, production and deployment, and operations and support.

Additional resources provided by the University of Virginia include lab spaces and testing equipment in the School of Engineering as well as student experimental facilities providing mechanical manufacturing capabilities and machinery for construction of future prototypes. Available labs include Lacy Hall, the mechanical engineering building basement, and the Architecture School Fabrication Lab. Group project grant funding from the University of Virginia is under consideration for additional funding of the project. The success of the CubeSat using these resources will establish a framework by which hypersonic and other space travel research can be conducted in a more accessible manner.

Nutritional Health Research

Research Question

What are the influences and nutritional barriers to dietary choices and how do they affect subsequent health of individuals and populations? The importance of nutrition is evident through its impact on preemptive health care, mental well-being, and a generally healthy lifestyle. Yet many are prevented from adequate education about this topic, limiting their health and life expectancy.

Background

To what extent are we responsible for our own health? Individual health balances a complex combination of genetic and environmental factors which may create subsequent health implications. One piece of evidence is a 2013 study by the Robert Wood Johnson Foundation (RWJF) which found that the life expectancy of inner-city neighborhood residents was 25 years less than that of suburban neighborhood residents in New Orleans, Louisiana (American Academy of Family Physicians, 2019). The drastically different standards of living between such a small area regarding access to proper nutrition correlate with areas of food insecurity, creating a greater likelihood that these risk factors have such an impact on life expectancy (Caporuscio, 2020). These areas are doomed with poor dietary options and health conditions. The average life expectancy of the New Orleans inner city population was 55 years (Robert Wood Johnson Foundation, 2017); comparatively the national life expectancy for the White population was 79 years and 75 years for the Black population (Xu, Bastian, Kochanek, & Murphy, 2016). While New Orleans is an extreme example of the environmental influences on one's health, it shows the limitations imposed that counter personal responsibility.

Considering one's environment and their genetics, nutritional health is a complex subject because its factors can be both environmental and genetic, both in an out of one's control. Additional nutritional barriers are the preexisting health conditions such as allergies, obesity, and various chronic diseases that necessitate nutritional education in order to combat these predispositions (Mayo Foundation, 2019). "Assessments of human nutrition are not complete without consideration of the underlying genetic variability, which may be reflected as differences in nutritional processes such as absorption, metabolism, receptor action, and excretion," (NRCCDH, 1989). A pilot study on the impact of a ketogenic diet on women with Polycystic Ovary Syndrome (PCOS) is a prime example of the positive influences nutrition can have on one's health. PCOS is an endocrine, or hormonal, disorder that affects women (Mavropoulos, 2005). There are many studies about effects of various diets such as the keto diet and the Mediterranean diet to improve these lifelong conditions (Leblanc et al., 2015). These studies promote analysis of nutrition intervention such that one may improve their quality of life for both chronic conditions and the average human being.

Framework

There are a wide variety of influences to dietary choices that affect one's health. It is important to analyze the topic of nutritional health and all its complexities through the Social Construction of Technology (SCOT) Framework. Social constructions are collective perceptions or beliefs. The SCOT framework is defined by social scientists Trevor Pinch and Wiebe Bijker and further analyzed by Hans K. Klein and Daniel Lee Kleinman in "The Social Construction of Technology: Structural Considerations." The direction of this theory is such that all forms of technology are shaped by the interactive sociotechnical process and that human interactions shape technology. Social interactions and personal desires are drivers of nutrition, however, there

are many subconscious and systemic barriers preventing groups of people from making better nutritional choices.

Considering dieting as a technology, the influences of social interactions, human behavior, and systemic barriers will be analyzed to discern the effect they have on one's nutrition, health, and lifestyle (Higgs & Thomas, 2016). There are four main components to SCOT: interpretive flexibility, relevant social groups, closure and stabilization, and wider context. The component of interpretive flexibility is based on the idea that technology design is not a concrete process, it is dependent on social circumstances and may have various results. Relevant social groups are the idea that social groups have the same concerns regarding specific technologies, and closure and stabilization is the next step in the framework's analysis where any conflicting views are attempted to be resolved so the various social groups can agree on the issue and work to solve it most efficiently.

The last component of this framework is the wider context which is when the technology is considered with respect to broader environments and its impact socially and politically. The impact of the government is categorized in the wider context component, ", but it is important to note that state interventions can influence the ways in which artifacts stabilize" (Klein & Kleinman, 2002). Government regulations and policies impose many effects in the field of nutritional health for various demographics, therefore it is important to utilize all components of the SCOT framework for the best analysis (Eisenhauer, 2001). The SCOT framework uses these components to view various influences on specific communities and society as a whole.

The social construction of technology framework is a useful tool to analyze how technology is impacted by social groups and their collective beliefs, but also makes assumptions creating room for error in its discussion which was criticized by Klein and Kleinman. The

framework assumes all social groups are equal and present during discussion of technology. Not only does it not recognize power asymmetry both between and within social groups, but it also ignores any dynamics and varying relationships between collective group thinking (Klein & Kleinman, 2002). There is inaccurate comprehension of group identification missing a risk of technological influences. Additionally, there is missing discussion of group capacity relative to resources, consumers, and developers. The availability of economic, political, and cultural resources all affect design, and in a more social sense, advertising and social norms are not given enough influence in the analysis of technology using the SCOT methodology. The SCOT framework will be used by focusing on the influence of various social groups, interactions, and their complexities to analyze barriers to nutritional health to best analyze the issue and society's influence.

Methodology

Historical case studies, discourse analysis, and network analysis will be utilized in order to analyze social influences and barriers to dietary choices. For example, Census Bureau data will discern overall health and the intersection between race, regions, and socioeconomic status. Online databases such as the University of Virginia Virgo Database and Google Scholar will be tools for nutritional health resources as well. Keywords such as, "nutrition," "preventative health care," "dietary health," "genetic health predispositions," "environmental health factors," and "government regulations" will further develop this research. Different lifestyles, such as humans living in low gravity environments, will also be studied as evidence of the importance of nutrition for well-being (NASA, n.d.; Mars, 2021). As low-income population data will be analyzed within the realm of the effect nutrition has on health, groups of higher authority such as

politicians will be used to analyze systemic barriers to nutrition, adequate education, and the implications for these populations.

Conclusion

This prospectus introduces a technical project that aims to develop a framework to perform hypersonic experimentation by a CubeSat satellite and an STS research paper that explores the potential impact on nutrition and healthcare cannot be understated. The anticipated outcomes of the proposed CubeSat design and experimentation include the creation of an accessible field of research for space flight, established professional relationships, and the successful launch data. This technical proposal will create more accessible space research data, greater hypersonic experience for undergraduate students, and the advancement of space research.

The influences and nutritional barriers to dietary choices will be analyzed within the Social Construction of Technology (SCOT) framework to best analyze the subsequent health of individuals and populations. The anticipated outcomes of this nutritional research, aside from the identification of social and political nutritional barriers, are providing more accessible information to the public and discerning factors that play a significant role in one's well-being. Examining diet and nutrition under the scope of social interactions, human behavior, and systemic barriers will lead to conclusions regarding healthcare that will provide more accessible education about nutrition and promote healthier lifestyles.

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