Undergraduate Thesis Prospectus

Hypersonic ReEntry Deployable Glider Experiment (HEDGE)

(technical research project in Aerospace Engineering)

For the Fans or Financial Gain: How FIFA Lost the Trust of the World's Soccer Community

(sociotechnical research project)

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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General Research Problem

How do opportunities for financial gain distort the missions of nonprofit enterprises?

It's an unfortunate norm for nonprofit enterprises to turn their backs on the cause they support in the pursuit of money. Words from former Wounded Warrior Project supervisor, William Chick, show an example of this: "It slowly [Wounded Warrior Project] had less focus on veterans and more on raising money and protecting the organization" (Philipps, 2016). While this case directly involves a nonprofit enterprise, the same behavior is observed on a larger scale within the U.S Government. The Department of Defense (DoD) plans to increase spending on its Hypersonic Missile Program, requesting around 15 billion dollars over the next five years (Kramer, 2023). In the interest of defense, some may view this appropriate, but many taxpayers feel the opposite. In an Oversight Hearing on Defense Spending, Congresswoman Summer Lee voiced this opposition to the DoD and in conclusion said, "Your department accounts for 15% of our total budget. You need to be more mindful in not only how you spend American's tax dollars but also how you account for it" (Summer Lee Pennsylvania's 12th District, 2023). If the DoD and nonprofit enterprises alike fail to prioritize their missions, what value do they really hold?

Hypersonic ReEntry Deployable Glider Experiment (HEDGE)

For material screening, how may hypersonic glider flight be more economically simulated?

CubeSats were developed in 1999 by professors at California Polytechnic State University and Stanford University, enabling students to design and execute satellite missions. They're classified by number of units (1U, 2U, or 3U), and a 1U CubeSat has a volume of 10 cm^3 (Government of Canada, 2022). Size limits operational ability but allows CubeSats to be integrated into the payload of a larger mission (Woellert, 2011). Our capstone, *Hypersonic*

ReEntry Deployable Glide Experiment (HEDGE), aims to demonstrate the viability of CubeSats as an affordable platform for conducting hypersonic glider research, using the Iridium network for communications.

A rocket will launch our 3U CubeSat into low earth orbit (LEO). HEDGE will deploy fins after release, morphing into a hypersonic glide vehicle, and live in LEO until naturally deorbiting (Goyne, 2023). To simulate a real mission planning scenario, the capstone is split into various sub-teams: program management; communications; software and avionics; attitude determination; power, thermal, and environment (PTE); structures and integration. Our group has been assigned to PTE.

The power subsystem has the main objective of supplying electrical power to all other subsystems in the CubeSat, and it must produce more power than what is required by the satellite. The thermal subsystem's objective is to tailor the design of HEDGE to the thermal conditions expected throughout the mission. Considerations include thermal protection in both LEO and reentry, and a complete burnup of the CubeSat after necessary data collection. The environment team's objective is to calculate the mechanical loads experienced by the spacecraft during launch and reentry, as well as to determine the potential space debris or radiation HEDGE will encounter based on the timing and location of its launch.

The power team will combine previous work with industry experts to estimate power generation, collaborating with other sub-teams to determine system requirements and optimal products. The thermal team will run tests and simulations to examine previously selected structures and materials. We will use CFD and FEA software to analyze reentry conditions and thermal loads, ensuring that HEDGE can collect data before burnup. The environment team will

conduct research to find values needed for load calculations as well as debris and radiation trajectories.

To determine the power budget, we will use the documented hardware specifications for the components and previous calculations. For thermal analysis, we will use Ansys Fluent and Mechanical to carry out CFD and FEA on an existing CAD model of HEDGE. Prior teams identified Niobium Alloys as the best high temperature material and Teflon as the best ablative material for the hypersonic nose cone, and we will work to predict performance. The environment team will use loads and testing parameters found within the NASA Sounding Rockets User Handbook and the SpaceX's Falcon User Guide to perform structural tests using the aforementioned resources. Online databases will be used to track orbital debris and radiation.

The primary task facing the power team is to recalculate the power budget and power flow chart with new EnduroSat components (Figure 1).

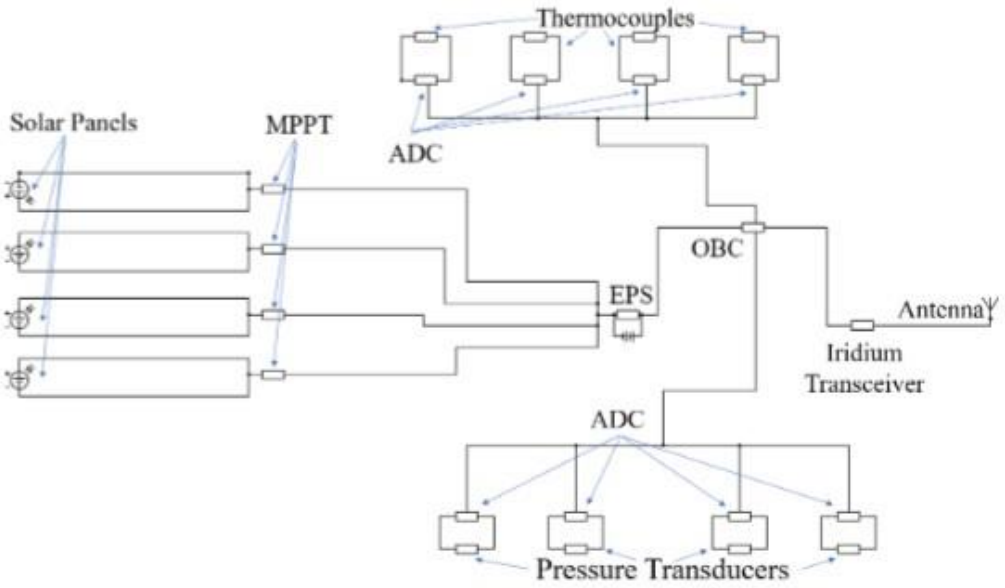

Figure 1. HEDGE Power subsystem circuit diagram (2022-2023 *HEDGE* Thesis, 2023)

Components must generate and store more power than the maximum power draw (MPD). The final task is configuring a battery pack that will fit in the nose cone to operate the CubeSat when solar panels aren't producing power. The primary goal of the thermal team is to analyze HEDGE performance under a variety of expected conditions. We will review completed CFD analysis, modify the CAD model and CFD parameters to meet current objectives, and run several iterations of CFD and FEA testing. Part of our work will include predicting the reentry burnup time for the final design to minimize uncertainty. The environment team aims to find the mechanical and vibrational loads during launch and reentry and determine any protections against radiation or space debris.

The fall semester of MAE 4690 will finish with a Technical Interchange Meeting (TIM) where the sub-teams will merge our work into one Critical Design Review (CDR) and present the research done and future design plans.

For the Fans or Financial Gain: How FIFA Lost the Trust of the Soccer Community

Since 2007, how has FIFA lost much of the world's soccer fans' trust?

As the rich fill their pockets, the poor struggle to obtain basic human needs. In October of 2007, Brazil was selected to host the 2014 FIFA World Cup, an initial excitement to all Brazilian's yet to understand the tragic outcome. Following the award to host, the Brazilian government invested billions of dollars into building stadiums, neglecting the country's underfunded education and health systems (Conway, 2013). This funneling of money resulted in a contraction of Brazil's economy which, in 2007, was experiencing its best period in decades. Brazilian public opinion polls in 2008 showed initial excitement with 79% of respondents in support of the event, but by April of 2014 the same polls reported 55% of respondents feeling

that “the event will bring more harm than good to Brazilians” (Antunes, 2014). Maria de Lourdes, a street vendor in Rio de Janeiro, provides an explanation for the polling results in saying, “Brazil, with all its problems, Rio with all its problems – many people still die from hunger while others are spending money on these games” (Antunes, 2014). While FIFA claims their mission is to “contribute to a harmonized way forward in the overall interests of football” (FIFA, n.d.), this statement is defied by their tendency to influence government spending away from what citizens need and their misuse of workers.

Two major participants include the citizens of São Paulo who protested the event and resulting government spending, and Brazilian construction workers facing low pay and unsafe working conditions (Conway, 2013; Karlsson, 2014). In the São Paulo protests the citizens aimed to voice their discontent with paying increased taxes for “inadequate government services” (Conway, 2013). This idea is echoed by the words of protester Vinicius de Assis: “They are building these overpriced stadiums and are not worrying about the situation of their own people” (Conway, 2013). Brazilian workers, tasked with building the stadiums, commonly faced 84-hour work weeks in dangerous conditions leading to eight deaths (BBC, 2014). Antonio de Sousa Ramalho, former president of the Sintracon-SP Civil Construction Workers Union of São Paulo, vocalizes the workers concerns by saying, “The construction workers are among the poorest in Brazil and are often not aware of their rights. And the world soccer body FIFA has never shown any concern about the workers” (Karlsson, 2014).

Three other major participants shed light on the continued avaricious behavior of FIFA relating to the 2022 World Cup in Qatar. One of these is an NGO named Human Rights Watch, which seeks compensation for misused migrant workers who “made the tournament possible while they faced months of unpaid wages, dangerous working conditions, and unexplained

deaths" (Human Rights Watch, 2023). The second participant is Amnesty International, an NGO that aims to bring attention to FIFA's misuse of their workers (Amnesty International, 2016). The third participant includes migrant workers from India, Pakistan, Nepal, Bangladesh, and Sri Lanka who were responsible for World Cup related construction in Qatar. Since being awarded hosting rights in 2011, 6,500 migrant workers have died in Qatar (Pattisson & McIntyre, 2021).

Researchers have examined FIFA's disregard for others. For example, Khan (2014) details how a push for a World Cup in Qatar is unethical considering the heat for players and workers. Khan proceeds to discuss how FIFA has been accused of corrupted bidding practices and entertains the idea of FIFA favoring Qatar solely due to their wealthy status. While FIFA insists their events help boost local economies, work from Hummel (2018) suggests that "few businesses benefit while high prices and event-specific laws exclude poor citizens." This idea is backed by Onis (2014), who claims that these mega-events do not remedy economic issues but rather exacerbate them. FIFA paints the picture that hosting the world's most popular sporting event will bolster local economies when the opposite is true. In the cases of both the 2014 and 2022 World Cup the host countries, while not logistically ideal hosts, enabled FIFA to profit tremendously at the expense of others. Looking forward, research from Becker (2013) predicts that if the corrupt nature of the World Cup bid process remains, then inadequate countries will continue to host giving rise to the same issues each time.

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