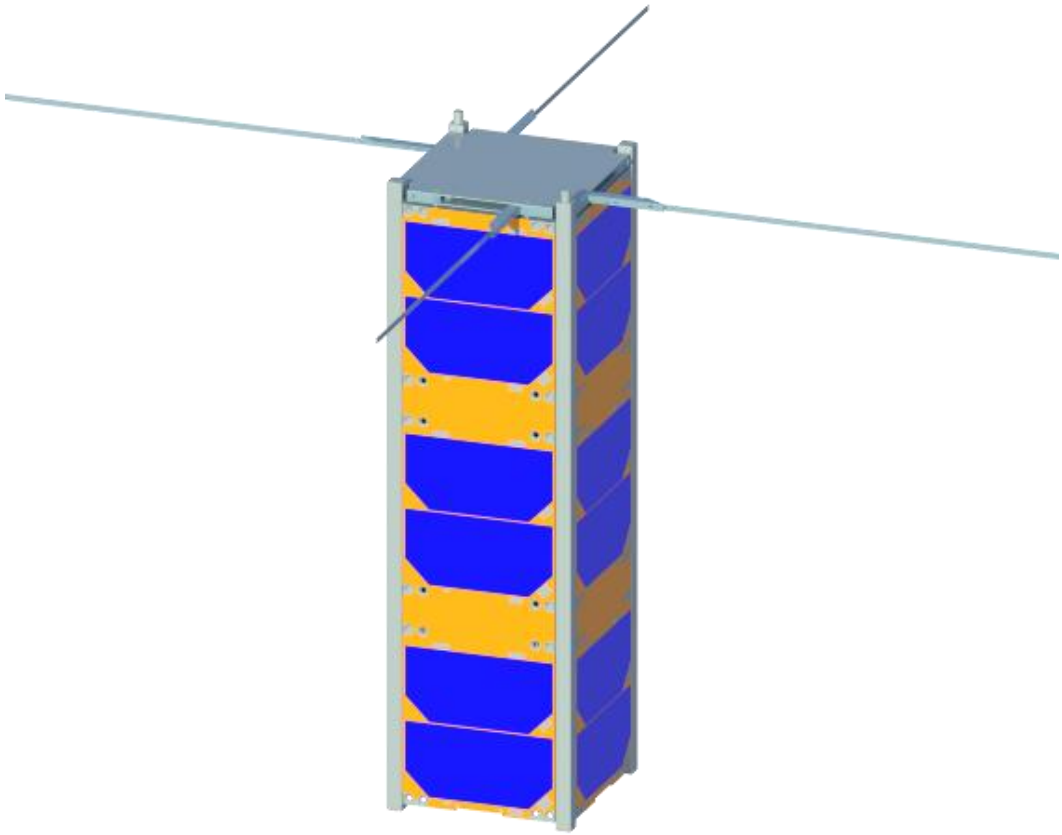

# Matthew Thomas

ENGINEERING PORTFOLIO

mathomas2241@gmail.com

# Table of Contents



## INTRODUCTION

Hello! My name is Matthew Thomas, and I am an Aerospace Engineering Student at the University of Maryland. This portfolio is intended to supplement my resume and give you a more profound understanding of my practical experience. Throughout my college career, I have always sought out the most rewarding projects available. As a result, I have participated in variety of projects, inside and outside of the classroom, allowing me to improve my engineering knowledge and diversify my skillset beyond what I have learned through my internships. I hope that this portfolio will allow you to better assess my skills and how they can be applied at your company. Thank you for taking the time to review my portfolio.

## ABOUT ME

The origin of my interest in the cosmos and spacecraft emerged when I was in grade school. One of the most famous images captured by the Hubble Space Telescope was the “Pillars of Creation”. Even if the name does not call an image to your mind, I am certain you have seen it. It portrays a star-forming region of the Eagle Nebula and within its tall columns of cosmic dust you can see stars just barely peering through from the far side. But in the center of the image there is a single star that lingers between the columns and screams through at you. Dead silent, it screams from light years away and here on the other end of a telescope we can only sit and watch. I remember seeing this image for the first time in grade school and it left me enthralled by its presence. There was so much I wanted to know about this star. I wanted to know how something so stark—so striking could silently cast itself across the galaxy for us to idly watch on the other end. That is what drives me to pursue space; I do not want to simply watch anymore. We are entering a new age of human space exploration, and I am excited to play my part and drive technology forward in an ever-growing space industry.

# TerpSat

The reason for starting this project was to build a team, SEDS@UMD, dedicated to the design of CubeSats and provide the students at UMD a new opportunity that cannot be found anywhere else on campus. UMD has not successfully launched a satellite in over two decades and we hope to change that with TerpSat. As one of the founding members of SEDS@UMD, I am building a foundation at the University of Maryland which will provide resources and encourage other students to continue the development of satellites long after I graduate.

After much deliberation, our team decided to focus TerpSat's mission on the triboelectric effect. The triboelectric effect is a phenomenon present on the Moon, where grain-like particles transfer charge by rubbing against each other. Because this effect can cause dangerous electrical discharge, a more capable predictive model of triboelectric charging is needed to ensure that future human or robotic surface operations are carried out safely. TerpSat uses a shaker mechanism to charge particles stored in a test tube and then records the resulting behavior of the particles.

| ID | Functional Requirement | Traceability |
|---|---|---|
| STR.001 | TERPSat factors of safety shall be 2.0 for yield and 2.6 for ultimate for structural design and analysis. | Imposed |
| STR.002 | TERPSat shall have a first fundamental frequency greater than 100Hz | Imposed |
| STR.003 | TERPSat main structure shall use Aluminum 7075, 6061, 5005, and/or 5052 | SYS.008 |
| STR.004 | TERPSat rails shall use Aluminum 7075, 6061, 5005, and/or 5052 | SYS.008 |
| STR.005 | CubeSats shall be designed to accommodate ascent venting per Ventable Volume/Area < 2000 inches in accordance with accepted standards such as JPL D-26086, Revision D, Environmental Requirements Document (ERD). | SYS.008 |
| STR.006 | No components on the X,Y, or Z faces shall exceed 6.5 mm normal to the surface | SYS.008 |
| STR.007 | Deployables shall be constrained by the CubeSat, not the P-POD. | SYS.008 |

Table 1 Structures Subsystem Requirements (page 1)

As the Structures Lead, I was responsible for not only ensuring the structural integrity of the CubeSat, but also managing TerpSat's internal layout and subsystem mounting. After conducting some research into the basics of satellite design and reaching out to other university satellite teams, I developed structures requirements ensuring that they flowed down from mission goals. I then led my team through a trade study comparing a variety of COTS frames as well as developing our own custom satellite frames. While the trade study determined that COTS frames were preferred due to their simplicity and reduced manufacturing cost, I was able to design several custom options based on our requirements. Utilizing ANSYS, I was able to determine preliminary information about the frame itself, such as the first fundamental frequency.

Once we had a frame concept in place, I assigned some team members to continue development, but I turned my attention to the internal layout of the satellite. Utilizing the center of mass position requirements derived from our P-POD deployer and some preliminary mass estimates for the subsystems, I was able to formulate an internal layout for TerpSat. Because many of the subsystems are still under development, our CAD uses primarily placeholder components, but the position and mounting of the subsystems are accurate to what we expect in the final design. The CAD contains a series of X-shaped mounting racks which bolt into the frame of the CubeSat and provide an attachment point for the various subsystems. While there is a noticeable open space at the top of the CubeSat, this was intentionally left as a margin of error in the volume budget. We expect the final subsystems may need to exceed their allowed volume, particularly the payload and power subsystem, which currently contains only a single battery.

Fig. 1 Custom CubeSat Frame

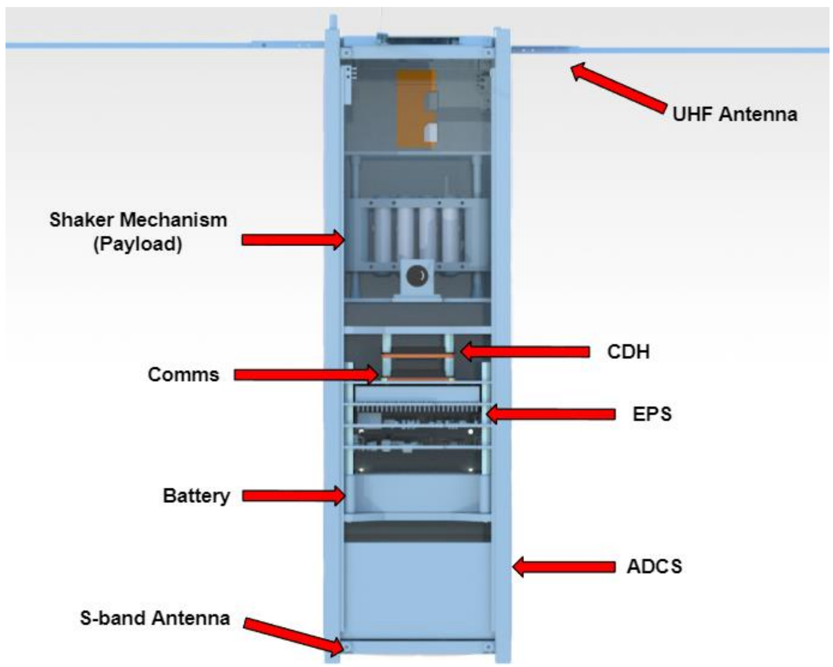


Fig. 2 TerpSat Full Assembly

Due to difficulties integrating the tribocharging payload, the team has decided to transition to an event-based vision payload. Our proposal was accepted by the University Nanosatellite Program, and our team will be funded for the development of an engineering development unit and a flight model which will be ready for launch. While our team has already begun the experimentation with event cameras, the satellite program will begin in January of 2022.

# Autonomous Micro Aerial Vehicle

I began this project as part of an introductory aerospace engineering course but continued work after the course concluded. The goal of the project was to develop an Autonomous Micro Aerial Vehicle (AMAV) capable of operating in mild wind conditions. Our team utilized the drone frame and autonomy code from previous groups as the foundation of our design. Learning from the shortcomings of previous designs, I created a weight-efficient frame and motor mount in Autodesk Inventor.

After finalizing the design, the team had the frame waterjet from carbon fiber, and we mounted our 4 motors, the Electronic Speed Controller (ESC), remote-control transmitter, and flight controller. Once mounted, the motors were soldered to the ESC and all components were wired to the flight controller. For spatial awareness, our team utilized two cameras, one downward facing LiDAR and one front facing Intel RealSense.

Upon successful completion of the assembly, we utilized QGroundControl to calibrate all the drone's sensors and prepare a connection between the remote-control transmitter and the ground computer. We then installed Ubuntu and all the necessary packages onto the ODROID, the onboard computer. The Drone was tested by using our autonomous position-hold function in simulated indoor wind conditions. The LiDARs and the autonomous position-hold function proved effective, maintaining low drift in varying wind speeds up to 10 mph.

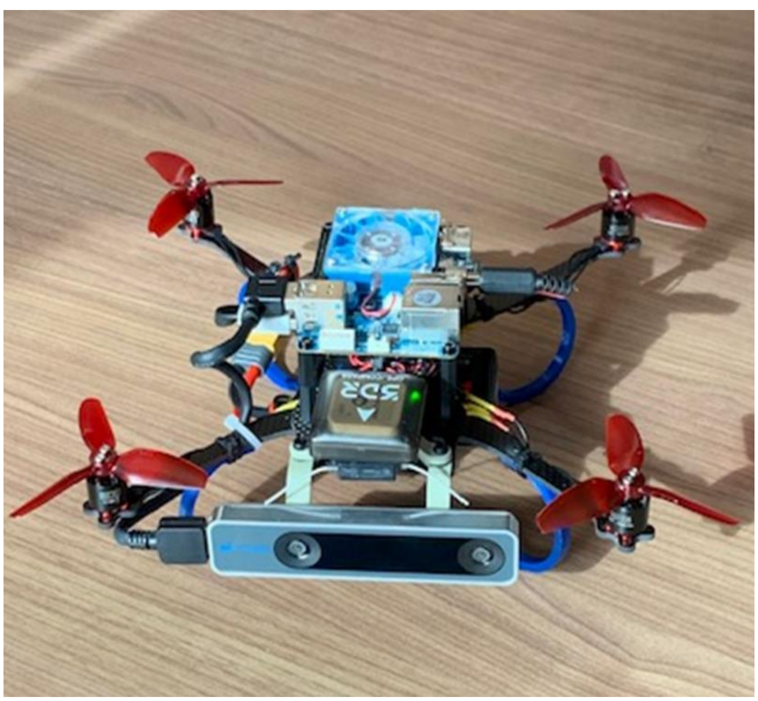

Fig. 3 AMAV Full Assembly

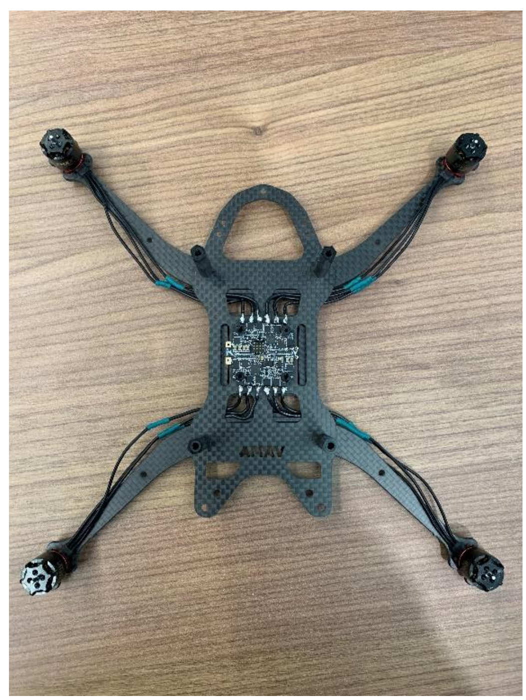

Fig. 4 AMAV Frame with ESC

# SpaceX Hyperloop Pod Competition

As a freshman, I joined a well-established engineering team, UMD Loop, which was dedicated to the design and production of hyperloop pods for competition. As a member of the Powertrain sub team, we were responsible for the development of a powertrain system capable of propelling our 330-lb pod through a 1.25 km vacuum tube at a speed of at least 300 mph. My work on UMD Loop exposed me to Siemens NX and Teamcenter and allowed me to build on my existing CAD experience with Autodesk Inventor. Additionally, the team gave me the opportunity to participate in important engineering practices, such as trade studies and design reviews.

After completing some minor projects, I was assigned my first major task: redesign the powertrain utilizing an EMRAX 268 motor. Working with two team members, we began looking through previous assemblies to see what aspects of those designs could be reused. Given that the EMRAX 268 was significantly more powerful than the previous motor, we verified which old components could handle these new stresses by utilizing FEA. For the components that could not be used in the new design, such as the springs, I had to search for alternatives and reach out to suppliers to guarantee that they were sufficient for our purposes. I developed several iterations of the CAD throughout the component selection process. Once the team was confident in our selections, I finalized the CAD, and we presented our design to the rest of the Powertrain team. There were several other teams developing their own powertrain assemblies with different motors, but ultimately my team's assembly was selected by team leadership to be used in our final design.

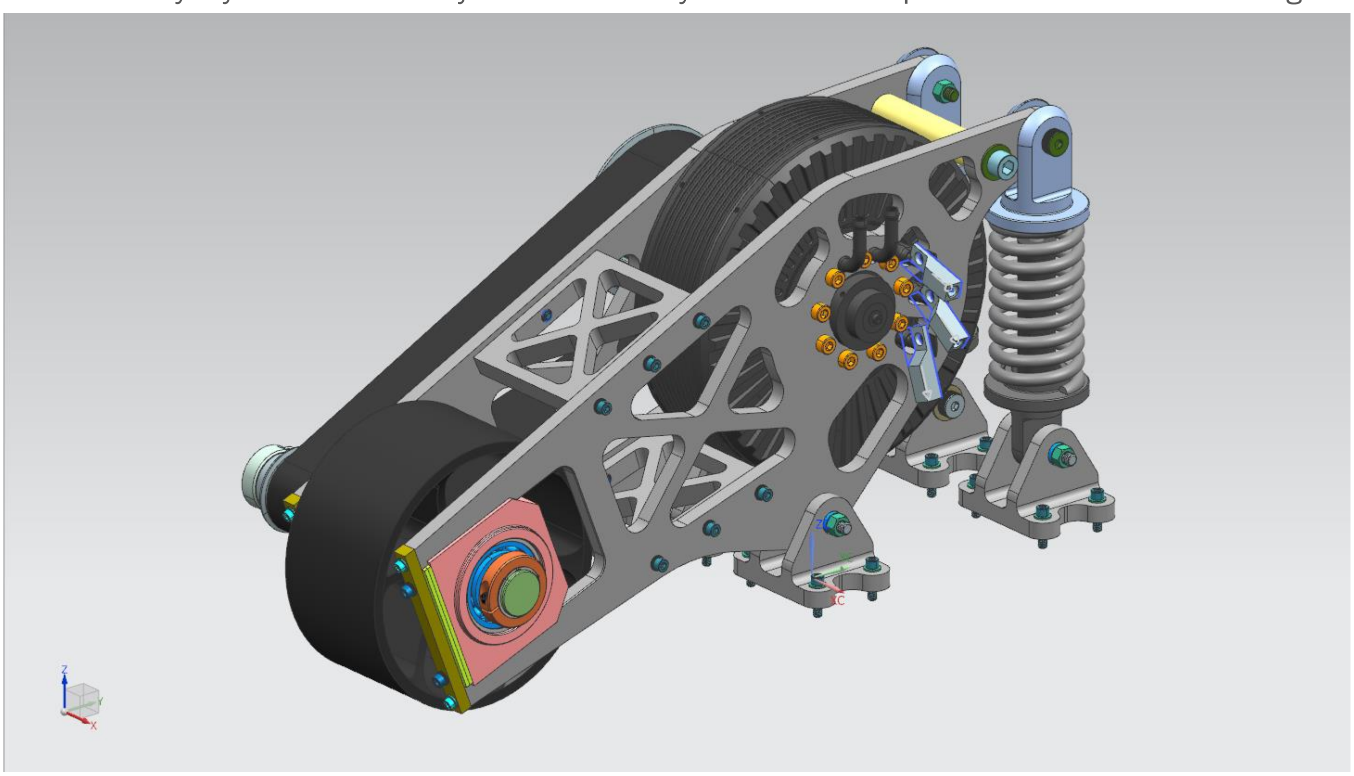

Fig. 5 Full EMRAX 268 Powertrain Assembly