Colin McWilliams

ENGINEERING PROJECT PORTFOLIO

JANUARY 2024

Table of Contents

Hello, my name is
Colin McWilliams

I am a 4th year Aerospace Engineering student at The Ohio State University, graduating in May 2024.

Email: mcwilliams.94@osu.edu
Website: https://www.colinmcwilliams.com/
LinkedIn: https://www.linkedin.com/in/col-mcwilliams/

Project Portfolio Overview

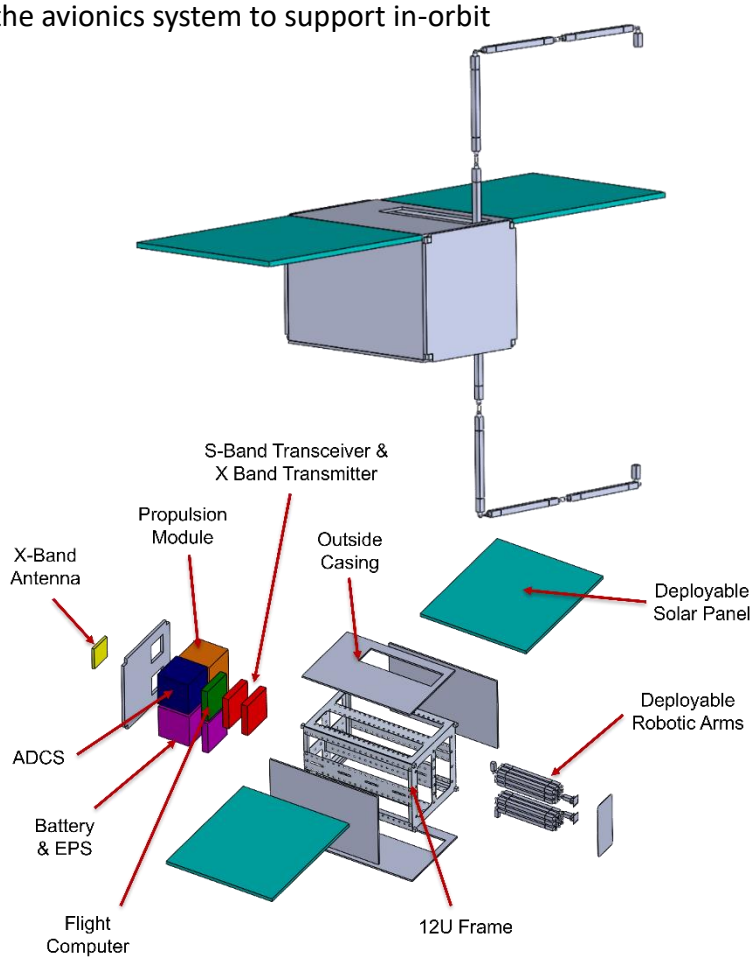
The purpose of this engineering project portfolio is to provide additional information about my experiences on various project teams throughout my undergraduate academic career. While many of these projects are reflected on my resume, this document acts to provide further details and visuals. In addition to my studies, I believe it is important to work on additional projects to further broaden my skill set and abilities. Not only I have worked on projects relating to propulsion, but I have also sought other opportunities to further advance my skills in areas that are not my strongest. Those journeys are highlighted here in this portfolio.

For each project, a project description is provided along with important key details and technical abilities applied and learned throughout the course of the project. Additionally, various graphics and visuals are provided, when possible, to give further context and help depict the project at hand.

STARFORM – Autonomous Robotic Satellite

Technical & Programming | August 2023 – Present

STARFORM, Space-born Technologies for Autonomous Robotic Formation and Orbital Manufacturing, was developed as part of my senior capstone projects for my undergraduate Aerospace degree. This CubeSat is being designed to service satellites in LEO and for the current scope of the project, NASA's COSMIC-2 is the target satellite for repair. Currently, I serve as the project manager and avionics lead for the project, overseeing the entire development of the satellite, including propulsion, structural, and robotic systems, while researching and designing the avionics system to support in-orbit operations.



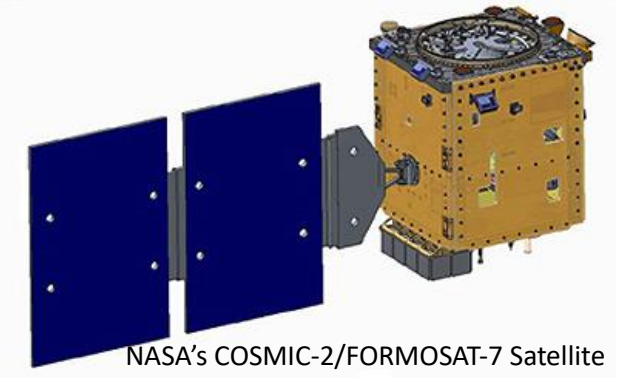
Key Details

- Size: 12 U
- Weight: 12 kg
- Dual Robotic Arm
- 78W Power Generation
- 150 Mbps Transmission Rate
- PC104 Avionics Form Factor
- Modular design

Technical Abilities

Within this project, I have utilized my project management, team leadership, and organizational abilities to keep the team on track, and ensure design of the satellite remains on schedule and the team can produce technical reports by set deadlines. Delivered a PDR report and presentation in December 2023 and a CDR report will be complete by April 2024.

I have completed research into CubeSat Avionic Systems, including computer design and selection, communication requirements, attitude and determination sensor and mechanisms, and battery composition and size. My current efforts are focused on developing a full-scale thermal model of the satellite in orbit, perform an in-depth power analysis, and run simulations showing 3DOF attitude and determination control system functionality.



NASA's COSMIC-2/FORMOSAT-7 Satellite

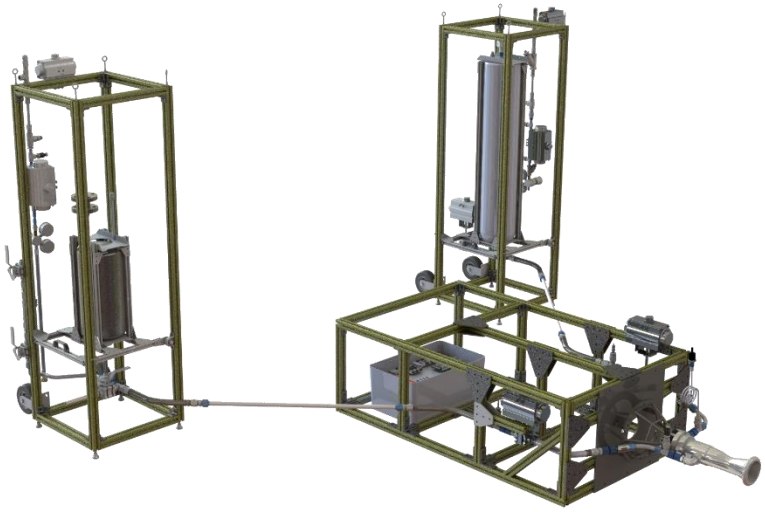
Buckeye Space Launch Initiative – Liquid Engine Project

Technical | August 2022 – Present

The Buckeye Space Launch Initiative (BSLI) was founded with the goal of completing a spaceshot. To achieve that goal, the club has begun development on liquid rocket engines. During fall 2023, the team completed a test fire of an LR-101 engine. While only lasting 2 seconds, a bunch of data was gathered, and lessons were learned. Currently, the team is working to implement new solutions, and further refine the test stand in preparation for another test fire. Throughout this project, I have assisted the fluids team working with both the fuel and oxidizer lines, to reduce complexity, improve reliability, and ensure cryogenic cleaned parts remain uncontaminated. Currently, my efforts are focused on learning being the lead engineer in charge of performing CFD simulations of the existing test stand setup and provide design recommendations for an injector test stand.

Key Details

- Thrust: 3.2kN / 710 lbf
- Isp: 193 sec
- Chamber Pressure: 2.1 MPa / 300 psi
- Mobile test stand design
- Kerosene/LOX configuration



Technical Abilities

To support this project, I utilized hand and power tools to reduce test stand complexity, by removing extra joints and sensors that are no longer needed to support hot fire operations. Additionally, I am learning NASA's Generalized Fluid System Simulation Program (GFSSP) to perform fluid flow analysis of the existing test stand system and provide design recommendations for a new injector test stand system.

Collaborating with other team members, team leads and project manager, I help to improve test stand mobility by implementing new transportation solutions such as caster wheel recommendations and new tank mounting designs. I also have helped to reduce fluid line complexity by reducing the number of fittings on the line and providing new actuator mounting solutions to aid in limiting potential points of leakage.

Scarlet & Gray Unmanned Aerial Vehicle

Technical & Programming | June 2023 – Present

In absence of a summer 2023 internship, I created the Scarlet & Gray UAV project. Scarlet & Gray serves as a testing ground for flight and ground control software development and testing, in addition to providing further experience with the design and development of spacecraft avionic systems. Scarlet is a custom-built flight computer running a Teensy 4.1 microcontroller, a BMP280 pressure sensor and BMI008 accelerometer. Gray is a 3D printed UAV using a single 80mm EDF propulsion unit with thrust vectoring control via four thrust vanes.

Key Details

- Mass: ~7 kg
- Thrust: 8.5 kg via EDF Motor
- LiDAR sensing for altitude
- Thrust Vector Control via thrust vanes
- 3D Printed
- Easy to configure and modify

Technical Abilities

In this project, I utilized OnShape to 3D model the entire UAV, 3D printing techniques to fabricate the vehicles body using PLA filament.

Scarlet, the flight controller, was designed and modeled in Altium. Once I finalized PCB schematics and had the board fabricated, the avionics board was assembled by hand. Scarlet is currently being verified to ensure all components are functioning properly.

Ground control software was developed in Processing, which is based on the Java programming language. Flight control software is planned to be developed using the Arduino programming framework.

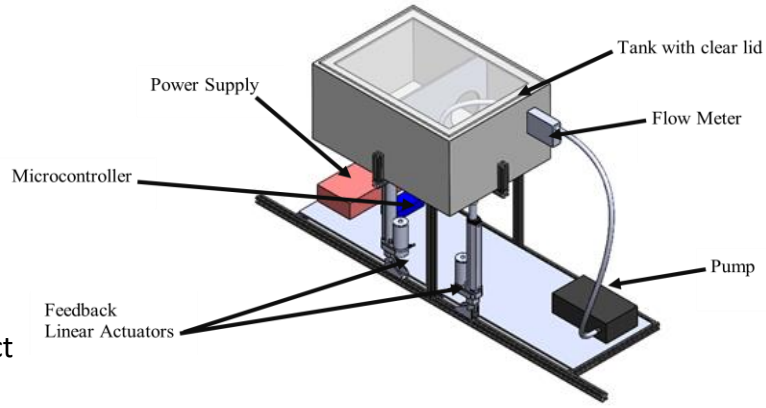
FLARE – Fuel Sloshing for Honda Aircraft Company

Technical & Programming | August 2023 – Present

FLARE, Fuel efficiency for Luxury Aircraft Research Endeavors, is my second capstone project for my undergraduate degree. This is a sponsored project by Honda Aircraft Company looking to develop a fuel slosh model to better predict and understand unusable fuel amounts within their aircraft tanks during flight. The purpose of constructing this model is to reduce the number of flight tests HACI will need to complete to certify their aircraft for flight. While I support and oversee the entire project, I am primarily responsible for the design, manufacturing, and experimental testing of a test apparatus to help validate the computational model.

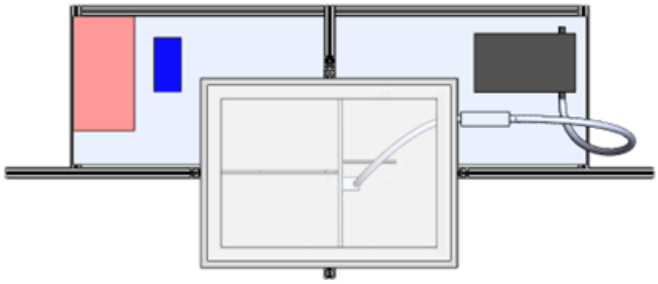
Key Details

- Must follow FAA AC 23-16a regulations
- Must be able to be scaled to larger aircraft
- Provides accurate (within 5% of test data) results
- Test apparatus must be able to perform maneuvers outlined in AC 23-16a



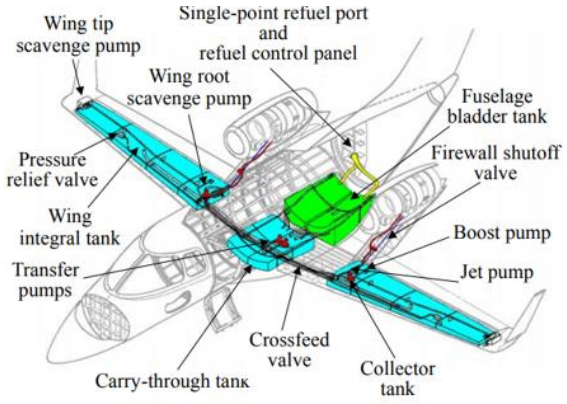
Technical Abilities

In this project, I serve as the experimental lead, working to design a small-scale version of this project to build and test in a lab. The test apparatus utilizes a 10-gallon tank supported on a 3-point system with a ball joint, and two linear actuators for movement. I also supported research efforts to help build a better foundation of knowledge needed to develop fluid slosh prediction models.



Research efforts include understanding how to apply design of experiments, Monte-Carlo simulations, or other similar simulation models to validate the fluid slosh model is accurate. Additional efforts focused on brainstorming apparatus ideas and researching existing designs.

Currently, I am finalizing the test apparatus design and CAD model before purchasing all materials for fabrication. Once materials are ordered, I will assemble the test apparatus, perform initial system checks, and then run define experimental tests and collect data for use in post-run analysis.



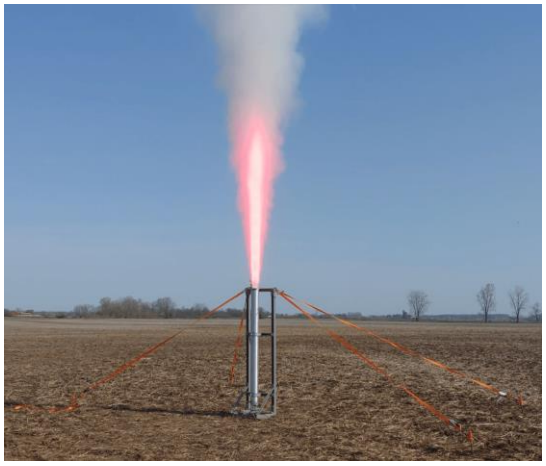
Buckeye Space Launch Initiative – Spaceport America Cup

Technical | August 2021 – August 2023

The Spaceport America cup project team focuses on designing, building, and launching a student researched and developed high powered rocket to 30,000 feet. During my time on this project, I supported the propulsion team, working to improve solid rocket motor design. I helped to design a preliminary test stand for examining the effects of varying nozzle geometry, assisted to analyzing hot-fire test data, and worked to research methods for simulating solid rocket motors.

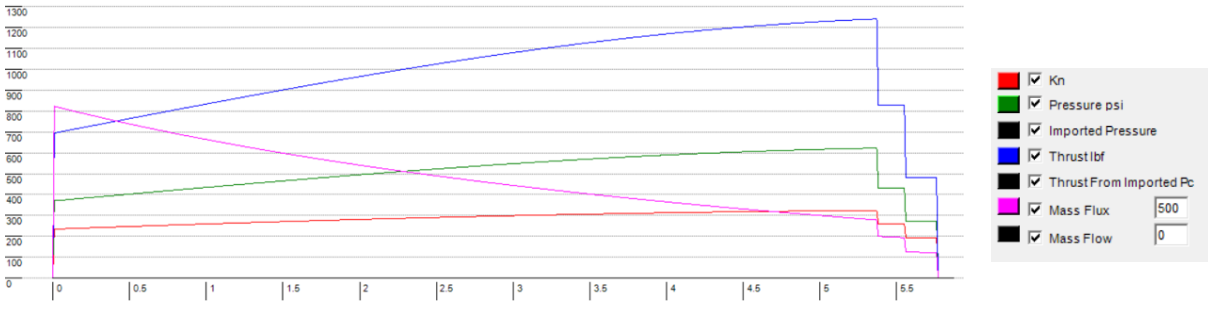
Key Details

- Height: 3.38 m / 11.1 ft
- Mass: 34.02 kg / 75 lbs
- Thrust: 4425 n / 995 lbf
- Motor: O-CLASS
- Apogee: 8.9 km / 29.2k ft
- Top Speed: Mach 2.05



Technical Abilities

To support this project, I utilized SolidWorks and 3D printing to develop a prototype engine and test stand to explore varying nozzle geometry. As well using Burnsim and Openrocket to simulate varying engine configurations for flight. Assisted with additional tasks as needed.



Mid-sized Automobile Exhaust Regulator

Technical | January 2021 – April 2021 *1st Place Award*

Mid-sized Automobile Exhaust Regulator (MAER) was the product of Ohio States Fundamentals of Engineering 2 (ENGR 1182) course during the spring semester (Spring 2021) of freshman year. The objective of the course was to improve an existing product or develop a new device to advance and better society. MAER was developed to further reduce greenhouse gas emissions from automobile tailpipes during operation. **This project was selected by Ohio State Engineering Faculty to be featured in Ohio States Annual First-Year Engineering Design Showcase and placed first**.

Key Details

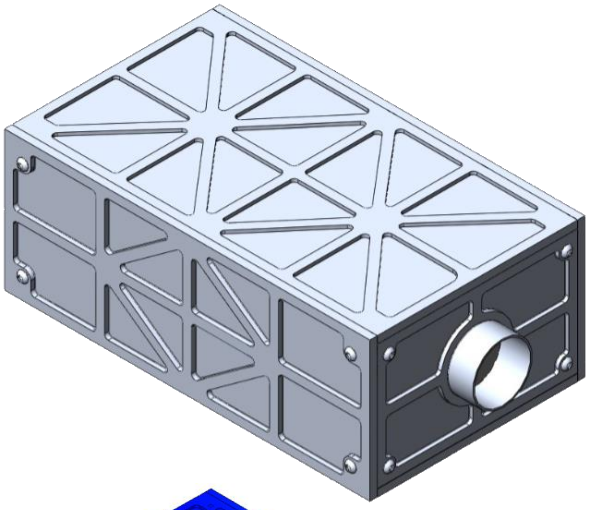
- Dimensions: 14 x 8.6 x 5.6 inches
- Weight: 17.21 lbs.
- Modular Design
- Expected lifespan: 15 years
- Projected Efficiency: ~98%

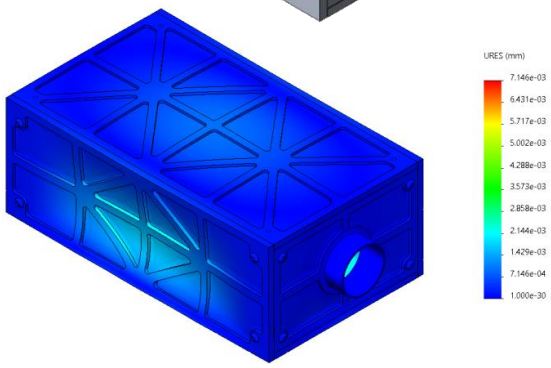
Throughout this project, I served as the project manager. I owned the design, development, and presentation of this project for Ohio States ENGR 1182 course.

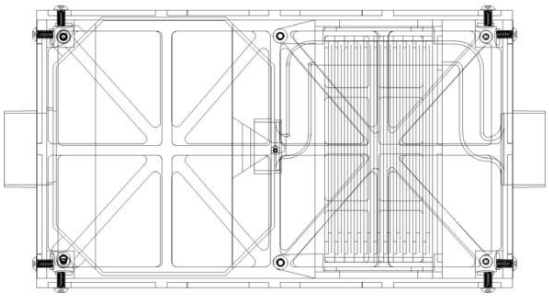
Technical Abilities

In this project, I utilized SolidWorks to develop 3D models of the prototype and verified the device design by running finite element analysis (FEA) and computational fluid dynamic (CFD) simulations.

I also demonstrated success in project management to meet all deliverable deadlines, team leadership and communication, as well as giving oral presentations.







NASA L'SPACE Proposal Writing & Evaluation Experience

Technical | January 2022 – April 2022

During this project, I served as the deputy principal investigator (DPI) and lead engineer to oversee the development of a NASA concept proposal. The objective of the team's proposal was to explore the use of power generation using Vertical Axis Wind Turbines (VAWT) manufactured from local resources on varying celestial bodies. In addition to researching, designing the conceptual solution, and writing a final proposal, I served on a review board to gain experience review other technical proposals using NASA technical proposal standards.

Key Details

- Savonius Style Turbine
- Reduce dependency on Earth-based materials
- Modular Design
- Manufacture time of <= 4 days
- Installation time of < 1 day
- Initial turbine efficiency: 35%

Serving as the deputy principal investigator and lead engineer, I oversaw a team of twelve students and worked closely with four others to support engineering efforts of this project.

Technical Abilities

In this project, I utilized trade-studies to analyze various wind-turbine designs, manufacturing techniques, and component requirements.

I also demonstrated success in project management to meet all deliverable deadlines, team leadership and communication, and writing effective technical proposals.

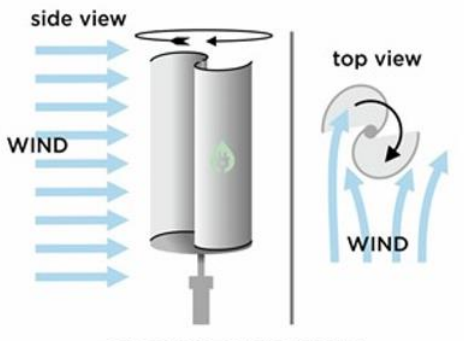


Image Credit: https://energyfollower.com/types-of-wind-turbines/