

The background features a light gray design with technical motifs. On the top left, there is a large, faint gear mechanism with concentric circles and a smaller gear. On the top right, a series of parallel lines leads to three small circles. On the bottom right, there is a partial gear and a series of parallel lines extending from the left.

# Engineering Design Portfolio

Joao Pedro Boaventura




01

# Design of UAV Flight Test Facility for Flight Path Reconstruction

May – Jul 2024

Prof. Peter R. Grant Vehicle Simulation Laboratory

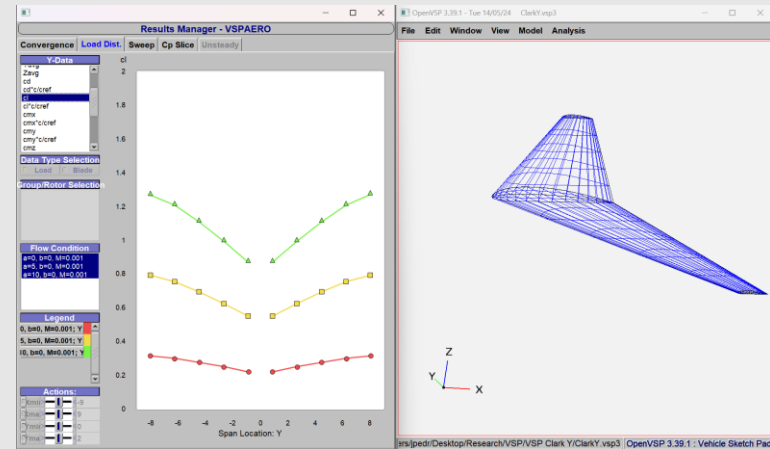
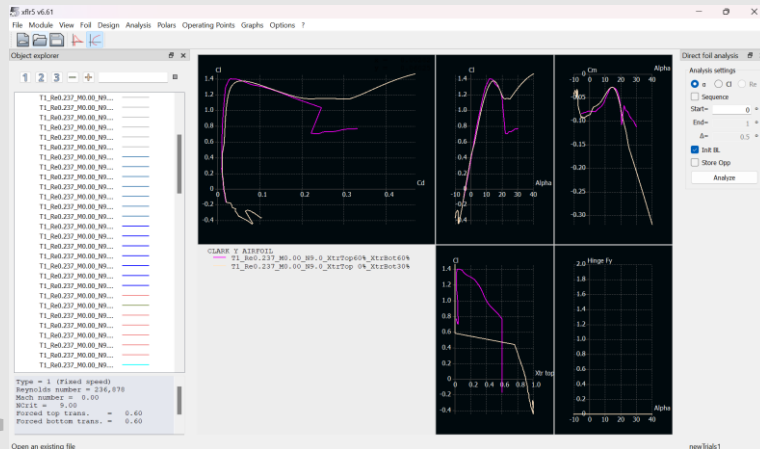


## Description:

The project is aimed at developing a flight test facility for a small UAV that could be flown indoors in a large building where the wind conditions are known to get ground truth data for Flight Path Reconstruction. The project involved the design of an aircraft, the selection and/or design of sensors and testing the equipment

## Role:

As a summer research undergraduate student, I was responsible for finding the most optimal trip conditions so that the UAV would behave analogous to a real aircraft. Used XFLR5 software to compare the plots  $C_l$  vs  $C_d$ ,  $C_l$  vs  $\alpha$ ,  $C_m$  vs  $\alpha$  and  $C_l$  vs  $X_{tr}$  top of a normal aircraft and an UAV. Analysis with multiple trip conditions for the UAV were made. Used VSPAero software to analyze properties such as  $C_l$  of the selected airfoil throughout the span. Used Excel spreadsheets to compare the most promising trip conditions to find the one that should be induced for when the UAV is built. Also selected sensors to acquire required data such as accelerometers, pitot tubes, gyroscopes, GPS, magnetometers and barometers.





02

# Development of Flight Simulator EFIS Display

Jul – Aug 2024

Prof. Peter R. Grant Vehicle Simulation Laboratory

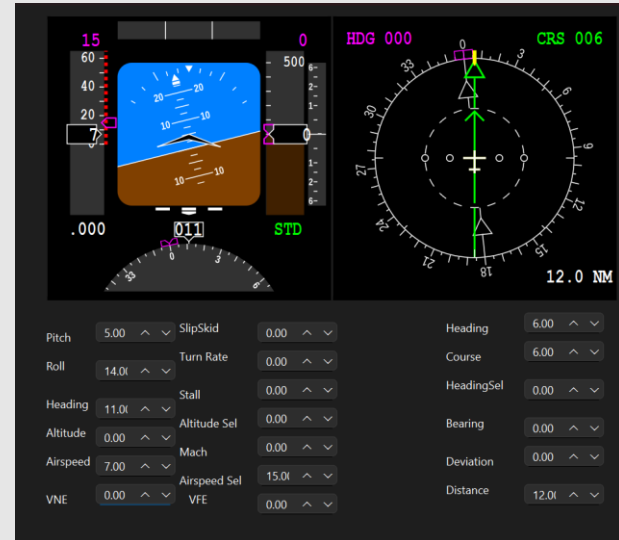


## Description:

This project involved the development of an Electronic Flight Instrument System (EFIS) display for a fixed-wing flight simulator. The existing simulator hardware had become outdated and prone to occasional failures, compromising the reliability of the simulation environment. To address these issues and ensure the system's functionality in case of complete hardware failure, a new software-based EFIS display was created using the Qt framework.

## Role:

I led the development of the new EFIS display, utilizing C++ within the Qt Creator environment. My work focused on designing a user-friendly and highly functional interface that could seamlessly integrate with the existing simulator hardware. Through iterative development, I completed the majority of the software-hardware integration, ensuring that the new display could function as a reliable backup and eventual replacement for the outdated system.





03

# Quick Disconnect for Liquid Rocket

Apr 2024 – Present

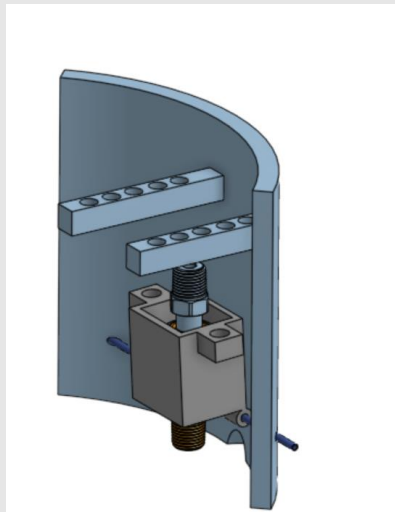
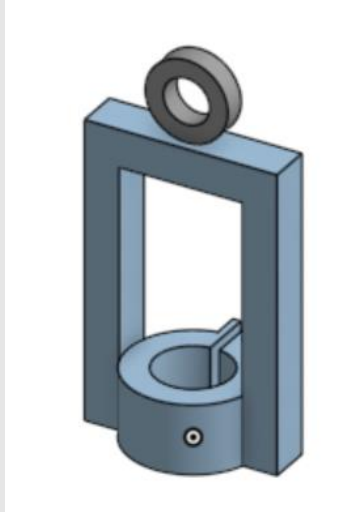
University of Toronto Aerospace Team Rocketry Division

## Project Description:

This project involves designing a new Quick Disconnect (QD) system for a liquid rocket, essential for safely starting the engine. The previous design showed limitations, so the goal is to develop a system that improves safety and optimizes the disconnection force. The project covers all aspects of design, testing, and iteration, with the use of CAD for modeling and 3D printing for initial prototypes. Working together with Liquid Rocket Management to fulfill all necessary constraints required by them

## Role:

As co-lead of the structures subsystem, I have been involved from the start, researching potential designs like breakaway couplings and working with the team to select an appropriate QD. I helped design test components to measure disconnection force and improve the secure mechanism. Moving forward, I will be focusing on refining the actuation mechanism and testing the system to ensure it meets the project's safety and performance goals.





04

# Launch Canada 2024

Aug 2024

University of Toronto Aerospace Team Rocketry Division





### **Project Description:**

Represented the University of Toronto Aerospace Team at the Launch Canada competition in Ontario, Canada. The team flew a hybrid-propulsion rocket to 30,000 feet and Mach 1.2, placing second in the Advanced Category. The project required adapting to tight timelines and hands-on problem-solving in the field

### **Role:**

As the structures co-lead, I was responsible for the setup of the ground support systems, including the launch rail assembly, integrating the quick disconnect, and managing the ox tanks and. Working in a fast-paced and high-pressure environment, I collaborated closely with my teammates to ensure everything was prepared for launch. This experience provided valuable hands-on learning and interactions with industry professionals.





05

# Liner Manufacturing



Feb 2024 - Present

University of Toronto Aerospace Team Rocketry Division

## Project Description:

Liners are critical thermal insulators placed inside the combustion chamber of the rocket to protect it from the intense heat of combustion. For the Hybrid Rocket, they were 49.5 inches long and were made with 4 layers of EPDM. For our new liquid rocket, a custom liner must be designed to precisely fit the updated combustion chamber using 6 layers of EPDM. This project involves designing and testing a new liner to ensure optimal protection and performance during engine operation.

## Role:

As a co-lead of the structures team, my responsibility for the hybrid rocket was to manufacture liners that fit properly in the combustion chamber. For the Liquid rocket, I am responsible to calculate the dimensions for the new liner and design test mandrels using CAD software and 3D printing to support liner manufacturing. Looking ahead, we are also exploring the use of phenolic liners to improve the efficiency of the manufacturing process and enhance the thermal performance of the liners





06

# Launch Rail and Launch Rail Base Assembly

Jul - Aug 2024

University of Toronto Aerospace Team Rocketry Division

## Project Description:

The launch rail secures the rocket in a vertical position during fueling, providing stability until aerodynamic forces from the fins maintain its trajectory, and allows for precise angle adjustments before launch. The 32-foot structure is designed to withstand up to 10kN of thrust, while ensuring ease of assembly and reliability. The base of the rail is specifically engineered to support the entire system.

## Role:

I contributed to the assembly and preparation of the launch rail for the Launch Canada 2024 competition, ensuring stability and proper alignment for a successful rocket liftoff. My responsibilities included manufacturing parts of the launch rail base, where I MIG welded sections of the legs, cleaned the welds using an angle grinder, and drilled connection points with a drill press. To enhance durability, I applied rust-proof paint to protect the base from corrosion and ensure long-term resilience.





07

# High Powered Rocketry (Tripoli Level 1 Rocket Launch Certification)

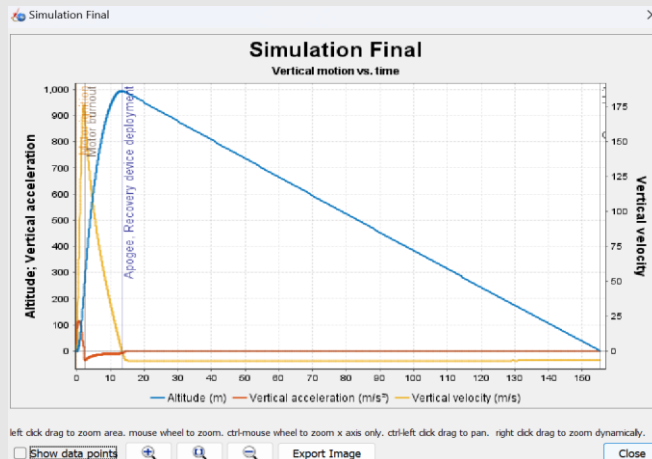
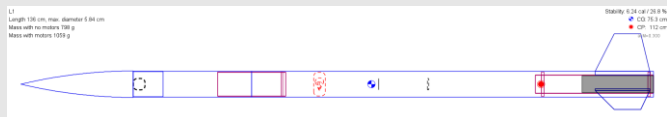
Jul 2024

University of Toronto Aerospace Team Rocketry Division



## Project Description:

I assembled a kit rocket for a launch at the Upstate Rocketry Research Group (URRG) in New York, USA, where I successfully earned my L1 High Powered Rocketry Certification by safely recovering the rocket after flight. Using OpenRocket software, I designed the rocket and conducted simulations to analyze key flight parameters, including apogee, stability, and the locations of the center of mass and center of pressure.





08

# Test Stand Modifications



Sep 2024 - Present

University of Toronto Aerospace Team Rocketry Division

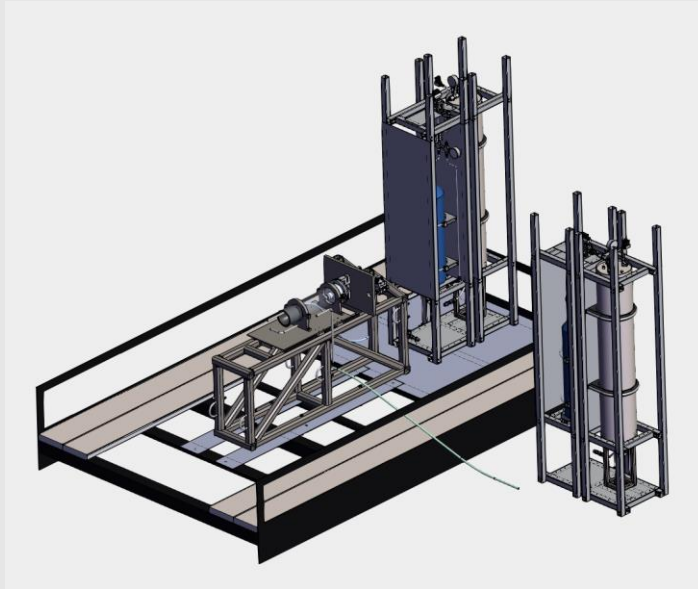


## Project Description:

The test stand is used for engine testing, specifically static fires and coldflows, to assess the performance of our rocket engines. The current test stand is optimized for our hybrid rocket engine, but with the shift to a liquid rocket project, modifications are required to better accommodate the new engine design and components.

## Role:

As co-lead of the structures team, I am responsible for manufacturing parts of the test stand, particularly the mounts for our flight oxidizer and fuel tanks. This involves reviewing and adapting the CAD models of our current tank mounts to fit the flight tanks, making necessary adjustments to ensure proper dimensions and alignment before fabrication.





09

# Tactile Vision Design Project

Feb – Apr 2023

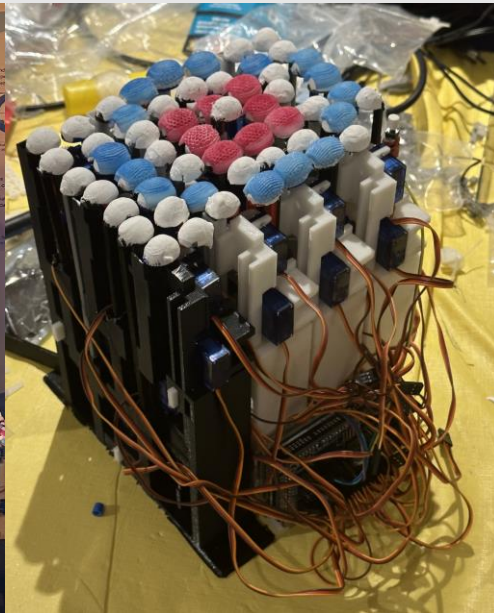
University of Toronto – PRAXIS II

## Project Description:

As part of the PRAXIS II Design course, we collaborated with the Leaside Curling Club to enhance the curling experience for visually impaired players. Through several iterations, we developed a solution called "Tactile Vision," a device that conveys the current state of the game using varying heights and textures to represent different elements of the curling rink.

## Role:

I researched reference designs to guide our approach, assisted with the 3D printing process, and helped test the prototype to ensure it functioned as intended. Additionally, I contributed to writing the project requirements, which shaped the development of our solution. At the end of the course, I presented our work at the PRAXIS II showcase, sharing the project with the public and receiving valuable feedback.



### Tactile Vision

#### 1 CONCEPT

Tactile vision for blind curling is a device that represents the stones' instantaneous location on the curling house using adjustable height and texture input. This provides visually impaired curlers with an ability to practice curling without a guide.

#### 2 BACKGROUND

In blind curling, visually impaired players commonly receive assistance from a guide on where to throw the stone and how their turn went. However, many players aspire to increase their independence while curling.

#### 3 OPPORTUNITY

Improve the independence of the training process for visually impaired curlers at Leaside Curling Club

#### 4 DESIGN

1. Scans the curling house using a 3D camera which has pins move up to represent the stones' location
2. Main Unit
3. Different textures on pins represent each concentric circle of the house

User feels the main unit with their hand to understand the exact location of each curling stone, and using a portable sliding stand, they can practice with it

#### 5 OBJECTIVES

Critical requirements include independence, Accessibility, Usability, and Accuracy

<b>Independency</b> Decrease the need for a guide during practice	<b>Usability</b> Ease of use for visually impaired curlers	<b>Accuracy</b> Improve the precision of the stone locations	<b>Safety</b> Minimize health risks	<b>Ergonomics</b> Increase physical comfort	<b>Affordability</b> Decrease the cost of the product	<b>Durability</b> Withstand standard use for a prolonged period
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#### 6 TESTING

Testing was done for the accuracy and usability of the prototype

##### Accuracy

**Purpose:** Measure the ability of the user to accurately determine the position of the stones.  
**Procedure:** The user is given unlimited time to understand the position of the stones on a still-state prototype before drawing the position of the stones on a blank curling rink. The accuracy is measured by comparing the distance between true stones' positions and plotted positions. The subject is blindfolded to simulate the lack of eyesight. The results from 3 trials of testing are averaged.  
**Result:** Tactile Vision prototype yielded the lowest average error of **2.4%**

##### Usability

**Purpose:** Measure the time and complexity for the user to reasonably understand the position of the stones.  
**Procedure:** The subject is given 6 minutes to use the design and understand the position of the stones. The average accuracy is measured from 3 trials and it has less than 5% accuracy error, the design is considered trustworthy and the average time spent is calculated. The subject is blindfolded to prevent the use of eyesight.  
**Result:** Tactile Vision prototype yielded an average of **4.2%** accuracy error with an average time of **1 minute 2 seconds**

#### 7 NEXT STEPS

- 1) Improve the accuracy and quality of the display by increasing the number of pins.
- 2) Increase the number of pins with smaller actuators.
- 3) Add the ability to zoom in on parts of the house to increase fidelity.
- 4) Engage in stakeholder validation.

Alex Kuri, Senyan Yang, João Pedro Boaventura, & Anna Chen



10

# Fuel Cold Flow Adapter



Jun 2024

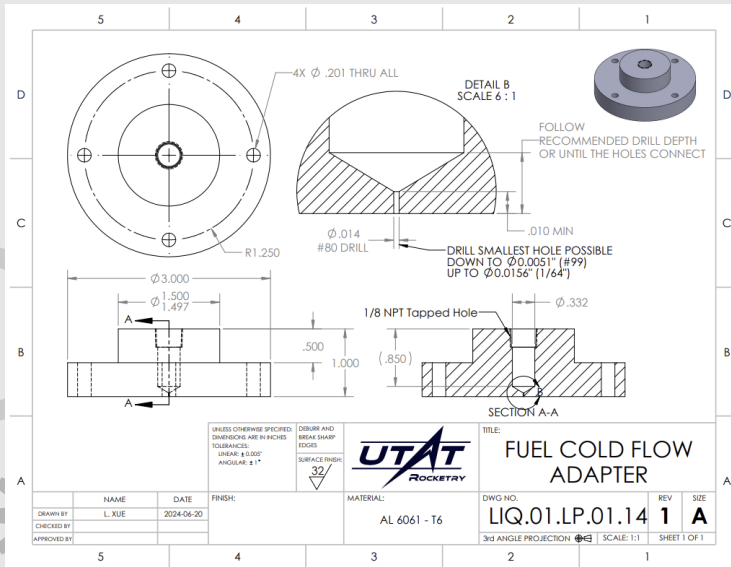
University of Toronto Aerospace Team – Rocketry Division

## Project Description:

For the liquid rocket cold flow test, the cold flow adapter was needed to connect the fuel lines to the test stand, allowing us to simulate fuel flow, pressure, and check the system's integrity before moving on to static fires.

## Role:

I was responsible for machining the cold flow adapter. I used a drill press to create the tapped holes and a lathe to machine the adapter to the required specifications. One challenge I encountered was machining a very small hole, which required finding a tiny drill bit and handling the machine carefully. The adapter was successfully used in the cold flow test and worked as expected.





11

# Matboard Bridge Design Project



Oct – Nov 2022

University of Toronto – CIV102

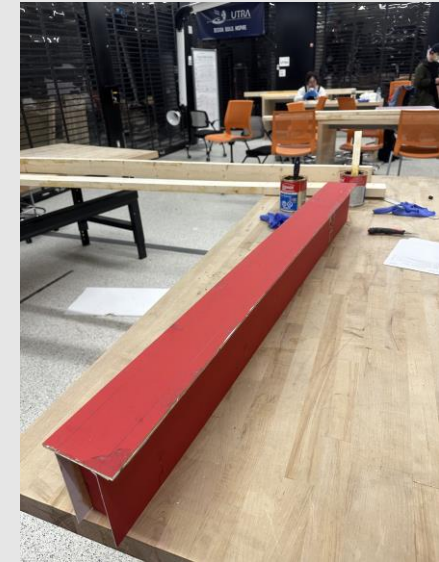



## Project Description:

As part of the CIV102 course, we designed and constructed a matboard bridge capable of withstanding as much weight as possible. This involved calculating the forces and stresses on different sections of the bridge, determining the optimal cross-sectional design, building the bridge, and testing its performance. Our bridge withstood 1kN of force, earning second place overall in the competition.

## Role:

I contributed by performing hand calculations to determine shear stresses and forces across the bridge's cross-sectional area. I also assisted in the construction of the bridge, ensuring precision by carefully cutting the matboard and assembling the components using contact cement. Additionally, I played a key role in writing the design report.





12

# Improving Waste Collection in Bangladesh

Feb - Apr 2024

University of Toronto - PRAXIS III



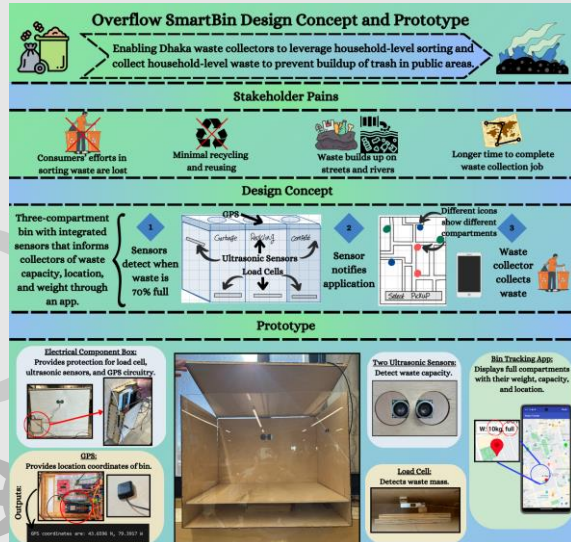


## Project Description:

As part of the PRAXIS III design course, our team collaborated with Dhaka waste collectors to improve their experience during waste collection. After multiple design iterations, we developed a trash bin that measures both the weight, using a load cell, and capacity of the waste, using an ultrasonic sensor, providing a warning when it is nearly full. Then, a map would be displayed which showed all the different trash bins. We successfully presented our design at the PRAXIS III showcase.

## Role:

I took the lead on the structural component of the project, focusing on designing and building the trash bin. I created part of the design using CAD software and guided teammates in using AutoCAD, allowing them to assist with the laser cutting process. Together, we assembled the bin and integrated the load cell. My role also involved overseeing the assembly process and ensuring that the structure was completed efficiently.






13

# Manufacturing of Pneumatic Piston

Feb 2024

George Brown College – Fundamentals of Machining



#### Description:

As part of the George Brown Introduction to Machining course, we were tasked with learning how to operate various machines and applying those skills to machine and assemble a pneumatic piston from a provided drawing.

#### Role:

I machined the necessary parts for the pneumatic piston using a lathe, mill, and drill press, while working with the required tolerances to ensure the pieces fit properly. In the end, I successfully assembled a working piston and received permission to continue machining in the University of Toronto's machine shop.

