Engineering Design Portfolio

Joao Pedro Boaventura

01

Design of UAV Flight Test Facility for Flight Path Reconstruction

May - Jul 2024

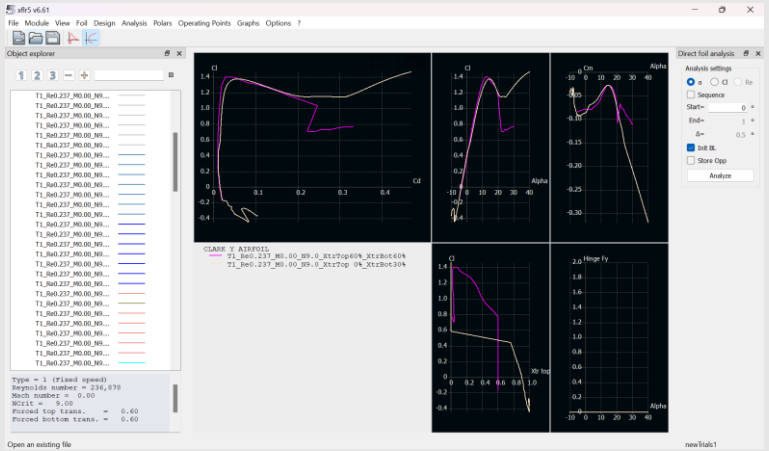
Prof. Peter R. Grant Vehicle Simulation Laboratory

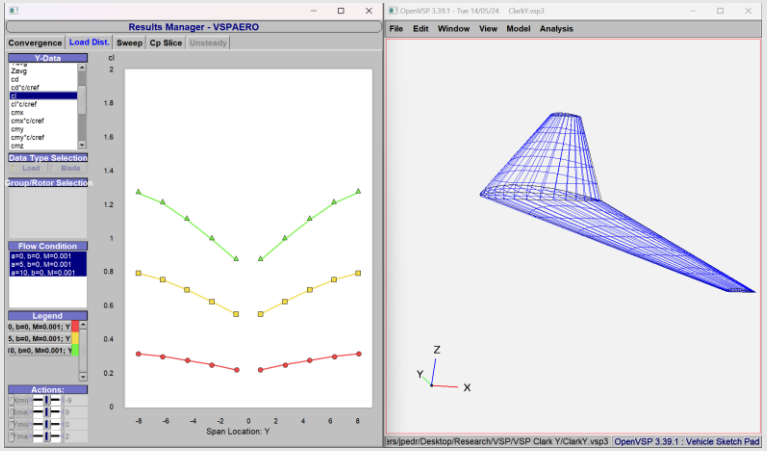
Description:

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 Cl vs Cd, Cl vs Alpha, Cm vs Alpha and Cl vs Xtr 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 Cl 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, magnometers and barometers.





02

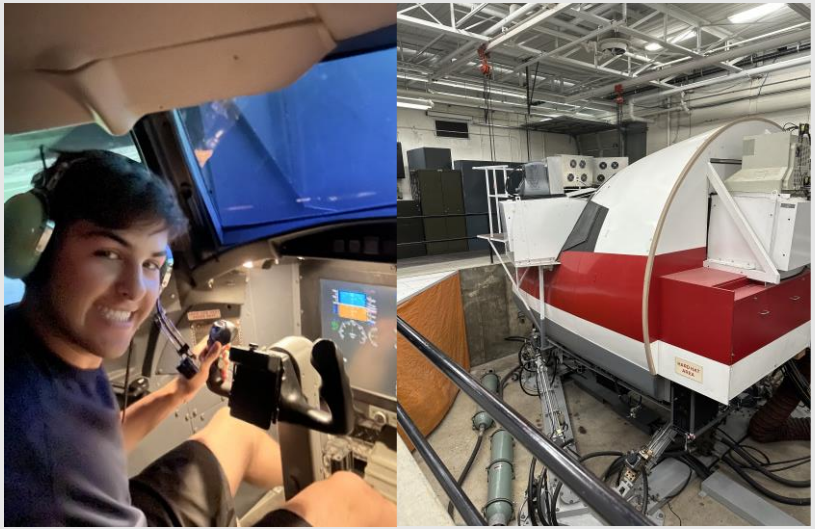
Development of Flight Simulator EFIS Display

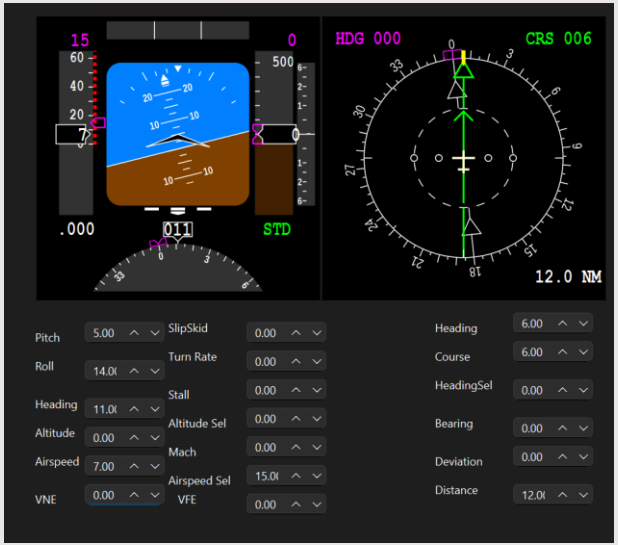
Jul - Aug 2024

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





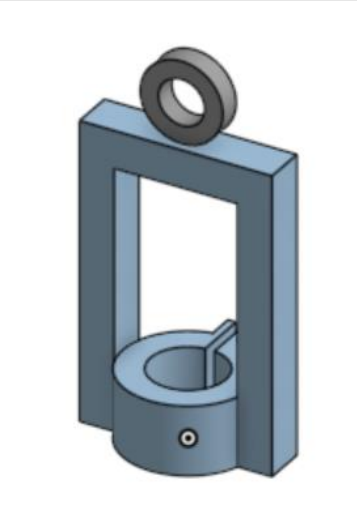
03

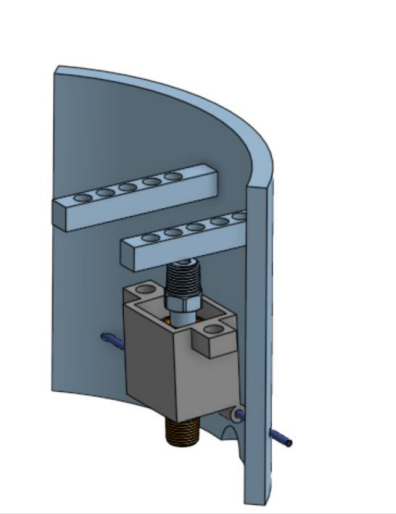
Quick Disconnect for Liquid Rocket

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.

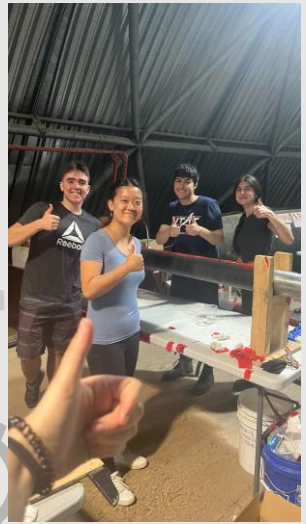
05

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.

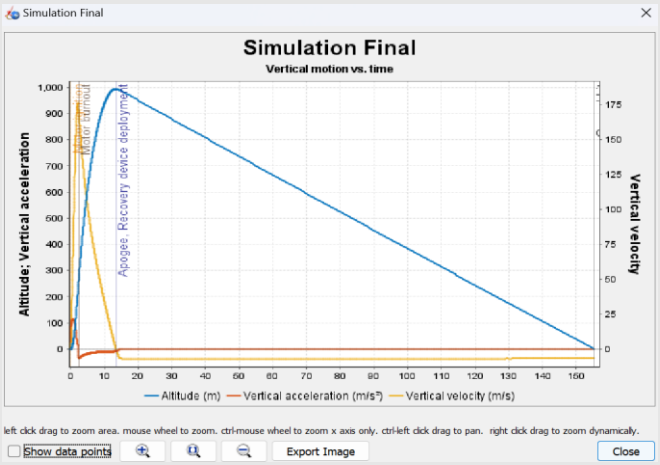
07

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.



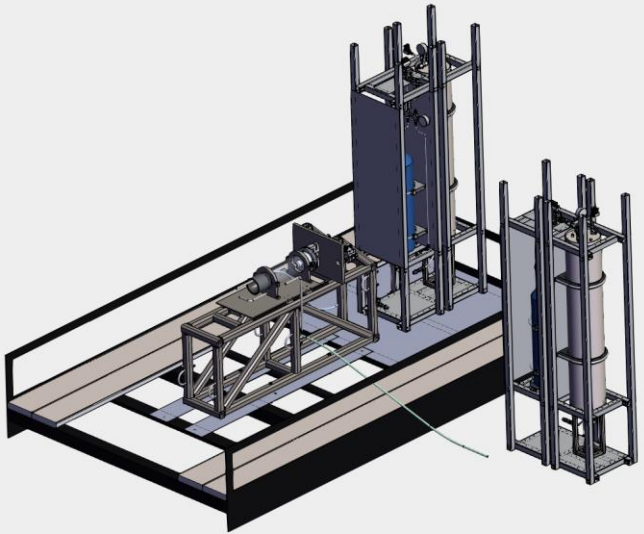
08

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.

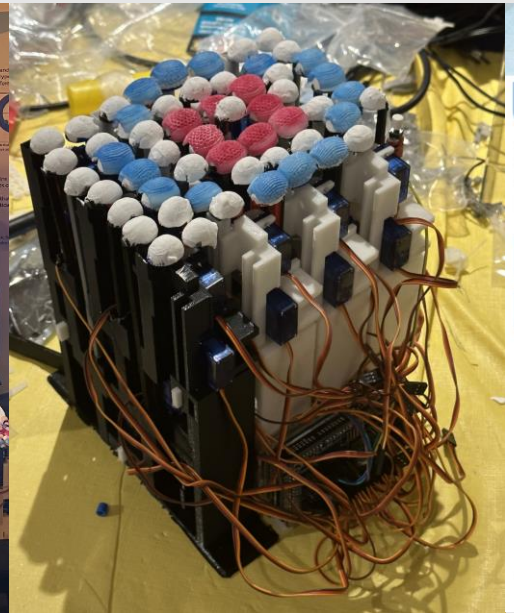


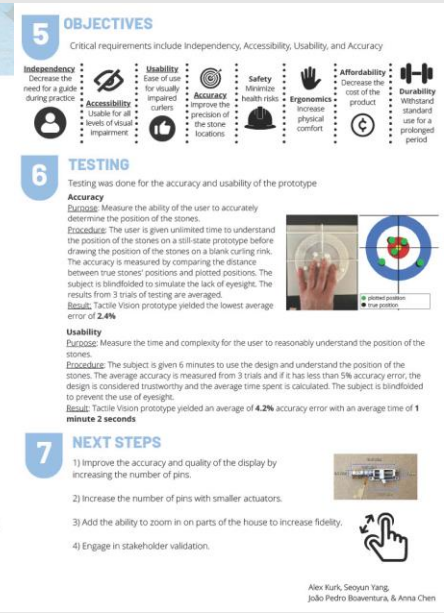
09

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.





10

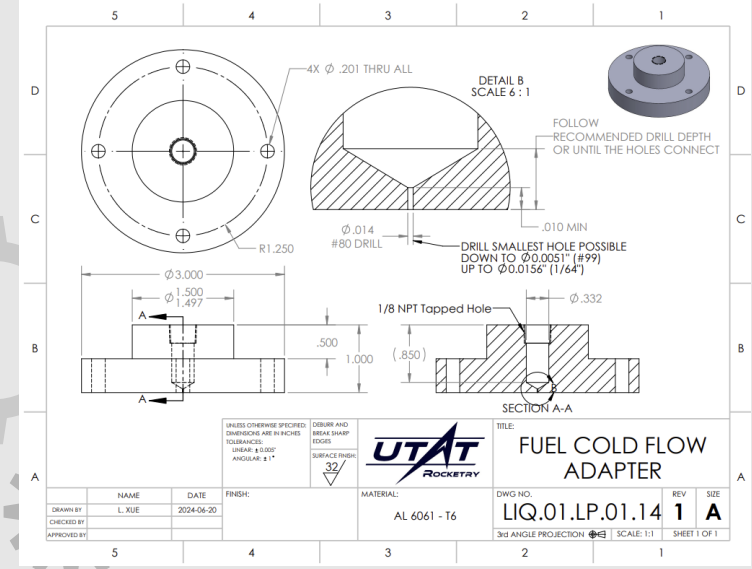
Fuel Cold Flow Adapter

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.



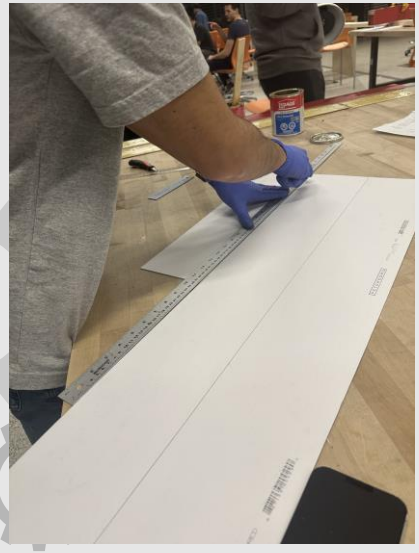
11

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.



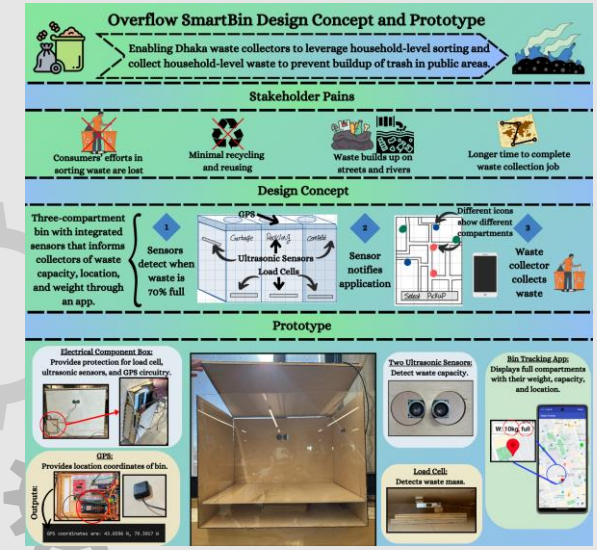
12

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 a 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.