Engineering Design Portfolio

Bhakti Chohan

Launch Rail

May 2022 - Present




Description

Used to hold the rocket horizontal during the remote fill process, stabilize the rocket until it has sufficient speed where enough aerodynamic force is generated by fins to keep trajectory straight, and angle the rocket to appropriate angle guided by the LSO before launch. The launch rail is 30 feet tall, can withstand 10kN of blast thrust force, and is Designed for Assembly and Reliability.

Previous Role

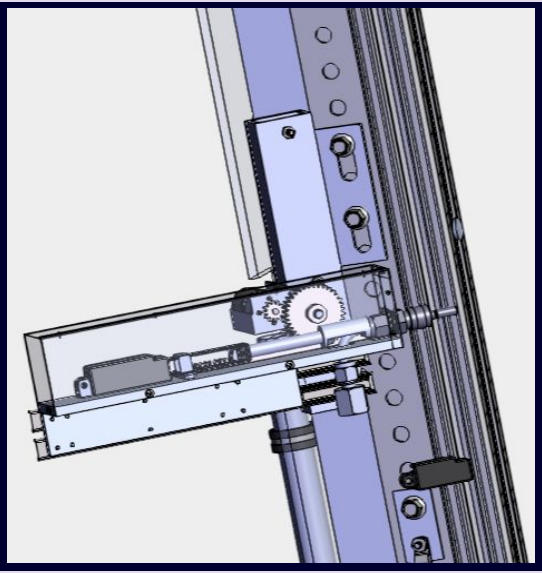
Fabricated, tested and assembled rail in preparation for and during launch. Added truss supports to previous design (as seen in CAD) to create a stiffer launch rail support bigger rockets (as seen in pictures). Credit: Original base design was performed by previous members of the team.

Current Role

Chiefly responsible for the redesign of launch base to make it more sturdy and robust, and the addition of a lever arm to support easier and safer lifting of the launch rail rail. Additionally, writing the testing and assembly procedure documents for Launch Canada 2023.

Quick Disconnect

May 2022 - Present



Description

Used to automatically load liquid propellent into the rocket remotely just before launch using ground station equipment. Uses two linear actuators and supporting circuitry to attach to quick disconnect coupling present inside the rocket. Has a detachment period of 1.2 seconds.

Previous Role

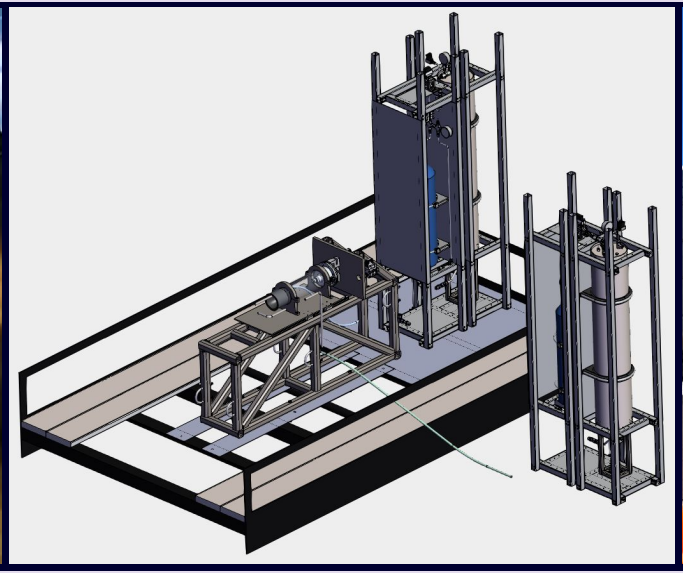
Fabricated, tested and assembled in preparation for and during launch. Added functionality for accuracy by performing accurate calibration right before launch. Credit: Original gear box design (as seen in CAD) was design by previous members, this design was changed during testing.

Current Role

Overseeing the redesign of extended arms to make it more sturdy, the replacement of a new coupling to support an accurate and reliable fill process before launch, and the addition of functionality by allowing for live z-axis correction. Additionally, writing the testing and assembly procedure documents for Launch Canada 2023.

Test Stand

Sept 2022 - Present



Description

The propulsion testing facility (test stand) is used to support testing campaigns for UTAT's engine cold flows and hot fire tests. It is used to practise fill-bay fill procedure and processes, and demonstrate the capacity to measure maximum blast force produced by engine using load cells precisely placed (can withstand upto 30 kN). Work with liquid propulsion division to meet requirements and deadlines.

Previous Role

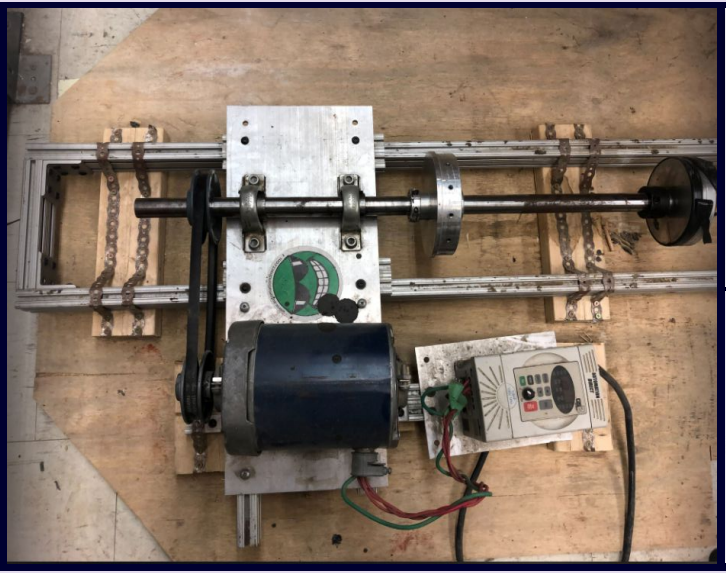
Supported the assembly and set up procedure before cold flows and hot-fire tests. Credit: The design, part sourcing and assembly for the hybrid rocket was done by previous members.

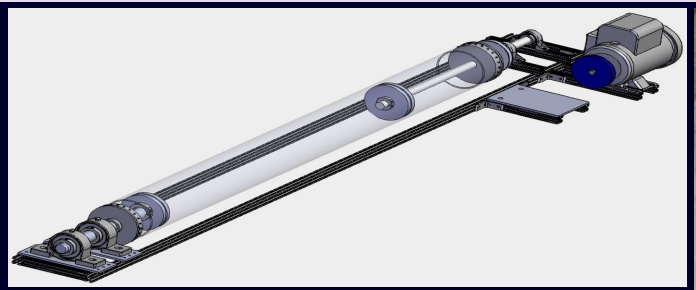
Current Role

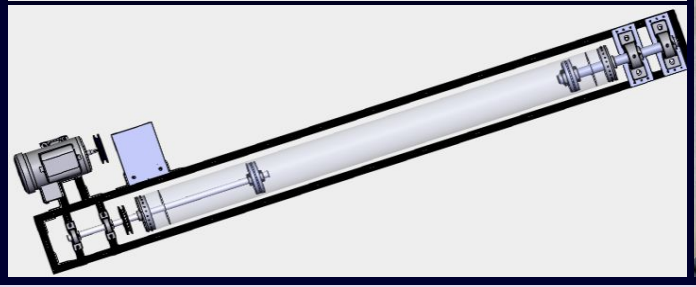
Overseeing the redesign of test stand to support the liquid rocket: adjusting the length of combustion chamber holder to support the reduced length of the liquid engine, and adding an additional tank holder to the test stand for liquid rocket (as seen in CAD).

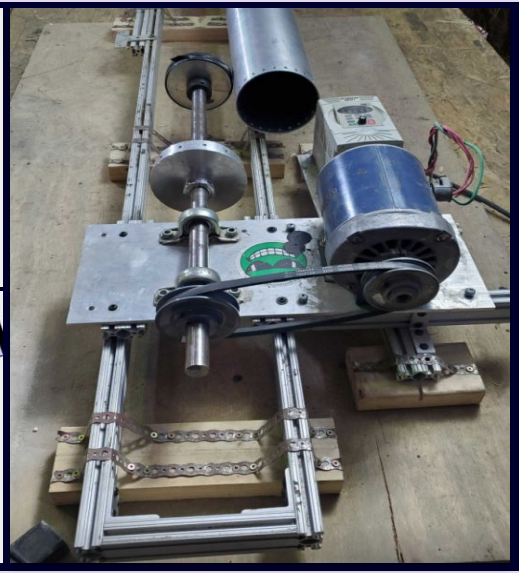
Spin Caster

May 2022 - Present









Description

UTAT's hybrid rocket uses paraffin wax as its solid fuel. Using the spin caster, paraffin wax is cast into a cylindrical tube to fit inside the combustion chamber of the rocket. The system contains a spinning bulkhead that moves lengthwise within the tube, and uses centrifugal force to distribute wax evenly and cast a hollow solid fuel core.

Previous Role

Supported the testing and use of spin caster to cast solid fuel cores for the hot fire tests and launch at Launch Canada. Credit: The design, part sourcing and assembly was done by previous members.

Current Role

Overseeing the redesign of the spin caster: designing a better attachment mechanism to the base for better absorption of vibrations when in use, machining and outsourcing parts for replacements, and optimizing the existing assembly to make the system more efficient.

Launch Canada Competition

August 2022

Description

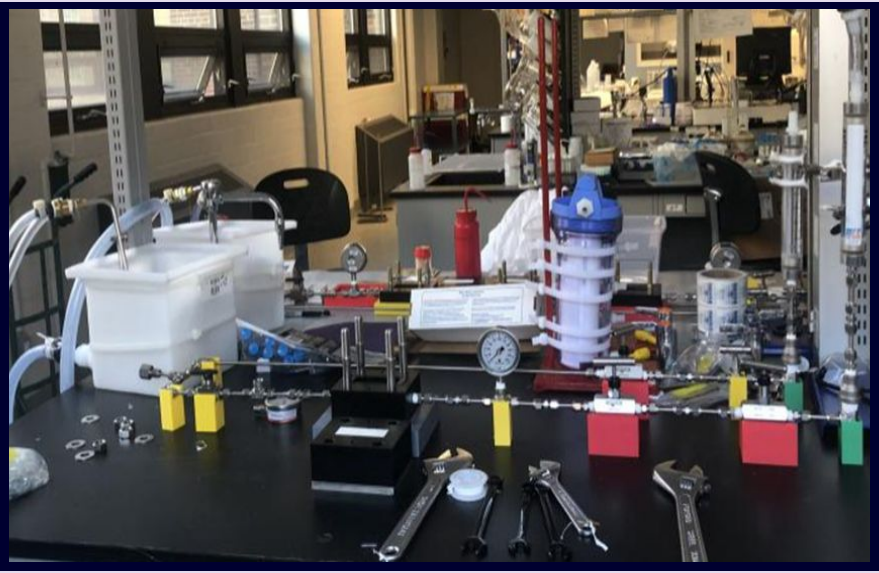
Represented the University of Toronto Aerospace Team at the inaugural Launch Canada competition in Ontario, Canada. Flew Canada's first experimental (not COTS) hybrid-propulsion rocket to 23,000 feet to Mach 1.2. Placed First in the Advanced Category. Heavy timeline-dependence and quick-moving hands-on work on the field.

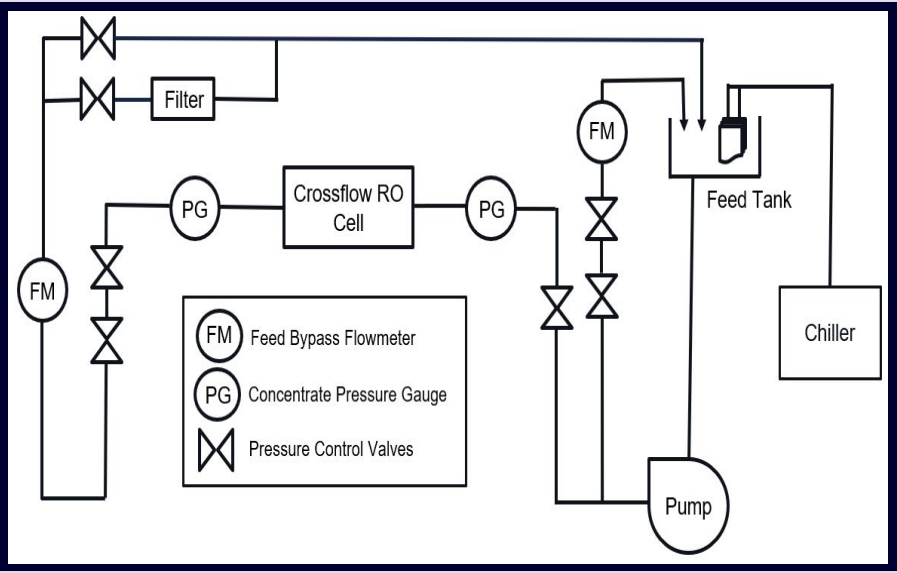
Role

As the lead of the structures division, Led the set-up of ground supporting infrastructure including the launch rail assembly, quick disconnect integration, antennas, and liquid fuel tanks. Learned to work under pressure in high-stress and atypical environments, pushed forward with teammates to develop skills and experience in the field. Spoke with multiple industry professionals and gained new outlooks on our developments.

High Pressure Reverse Osmosis System

May - August 2022





Description

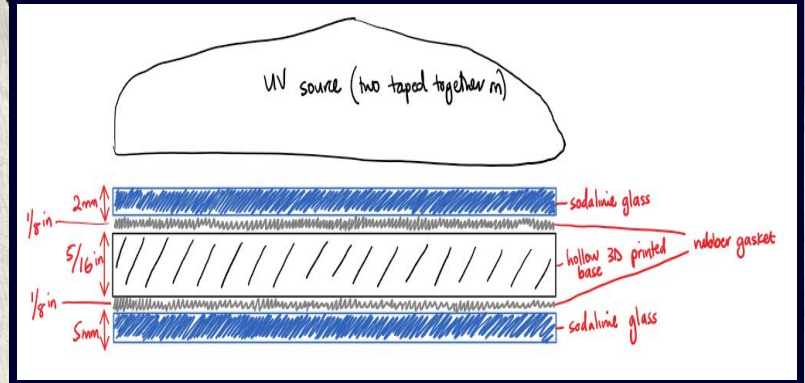
Optimized and assembled a bench-scale high-pressure reverse osmosis system capable of pressures up to 150 bar, will be used to test the selectivity and water permeability of membranes developed within the lab. Uses a high powered pump, chiller, pressure gauges, pressure control valves, and a in-house machined crossflow RO cell setup (see in system diagram). CAD and 3D printing was a big part of the project.

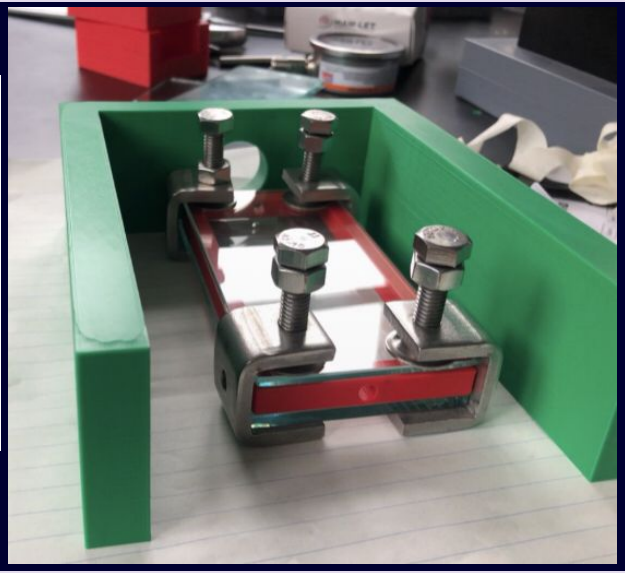
Role

Tasked with ordering all relevant parts of the system, fabricating + machining relevant RO cells for testing, optimized parts of the system for efficiency (achieved 15% more optimization), CADed and 3D-printed relevant supports for components to sit on to ensure equal height for the system to sit on, and finally assembled full high pressure system within the lab in 3 months (as seen in the picture). System considerations included the use of pressure components rated 170 bar and PTFE tape to maintain a hard seal. Credit: The design for the system was inspired by a research design paper found online.

Photosensitive Reactor for Interfacial Polymerization

June - August 2022





Description

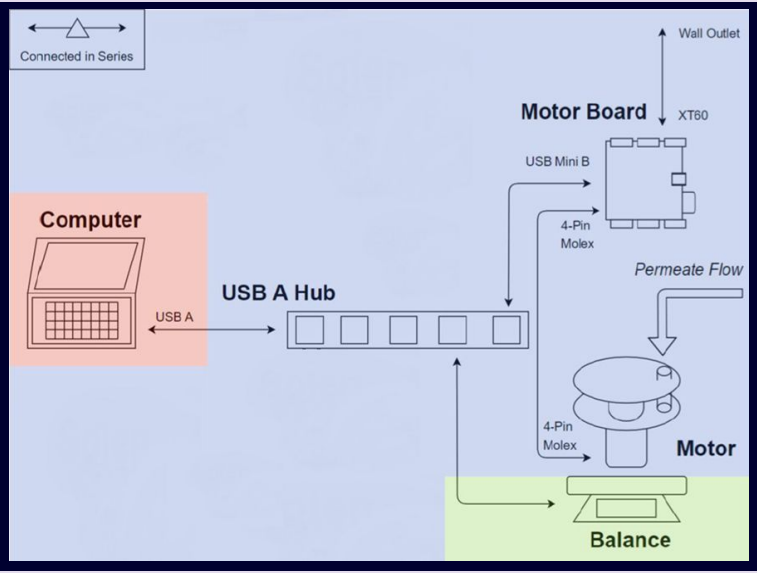
Designing and building a photo-sensitive reactor for the chemical reaction known as interfacial polymerization. System ensures that synthesis occurs entirely under a UV light source, with only inert nitrogen gas present internally. Design involved a 3D printed base, soda-lime glass, rubber gaskets, and c-clamps to hold the structure together to ensure a vacuum seal (as seen in pictures). This was used by graduate students in the lab for synthesis of membranes.

Role

Tasked with designing this system within a small budget, significant brainstorming was involved. Design process included repeated cycles of iteration and discussion with my supervisor, Professor. Jay Werber to ensure that all design criteria were met. CADed, 3D printed, and outsourced all required components of the system.

Photosensitive Reactor for Interfacial Polymerization

May - August 2022



Description

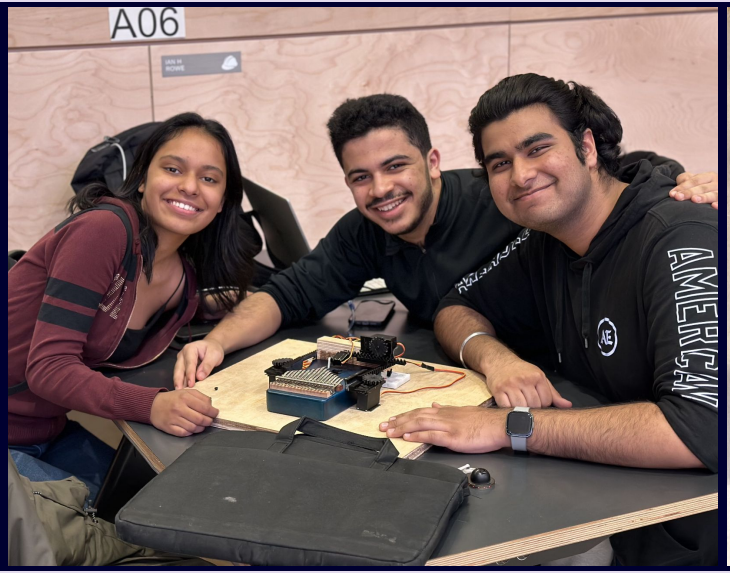
The system is intended to automate the collection of samples at a desired user-input mass for ongoing chemical reactions in the lab. It is comprised of a servo motor, motor board, and mass balance, each controlled via a custom GUI user interface, which is also a custom in-house code design.

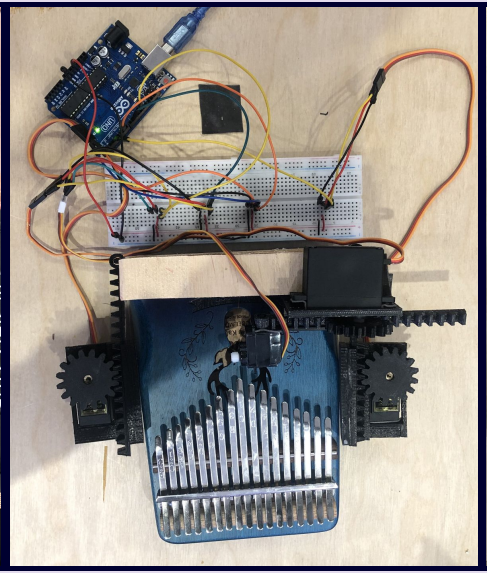
Role

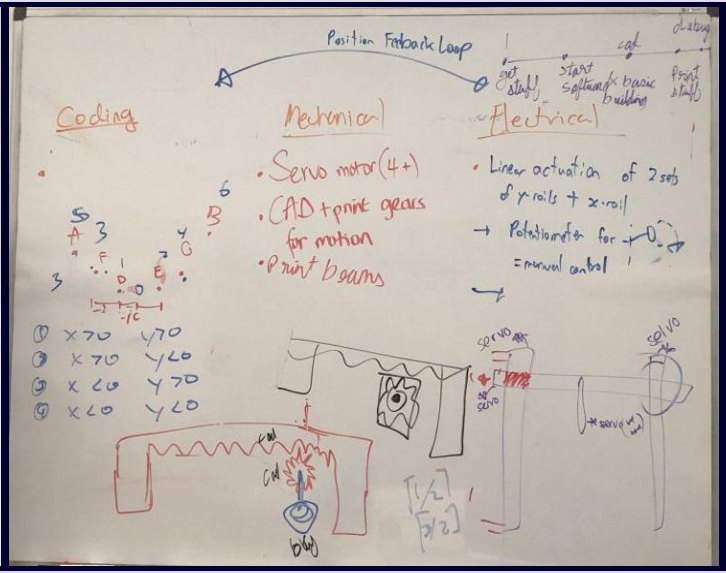
I had full autonomy over the design and integration of the system. Involved ordering all relevant electrical components, writing and testing GUI code with integration of the servo motor, CADing and 3D-printing necessary structural components. The system allowed lab members to save 4+ hours of work by eliminating the need for user to spend the day next to reaction in order to take samples at different intervals. System considerations included allowing for different types of chemical reactions taking place, letting user choose servo rotation based on mass or time iterations. Credit: The design for the system was inspired by a supporting lab's research design paper.

Automated Kalimba Player (Make-A-Thon Event)

February 2023







Description

A hack-a-thon like event where we had 24 hours to design and build a physical system in the category of music. We automated music playing on the Kalimba instrument. We divided our project into 3 subsystems: software, electrical, and mechanical. Our design process involved iterative brainstorming and design, and no shortage of quick-thinking due to our time constraint. This was an incredibly fun experience with my friends and I look forward to taking part in more design competitions in the future.

Role

I was responsible for our mechanical system: composed of two y-axis servos, one mobile servo that moves with the y-axis to guide the x-axis, and an additional rotary servo that flexes particular Kalimba tines to create the sound. Gears were attached to the servos to simulate a linear actuator system which was then guided by the code. Within this system, I CADed the mechanical and structural components, and 3-D printed them using simple PLA filament.

High Powered Rocketry (Level 1 Rocket Launch Certification)

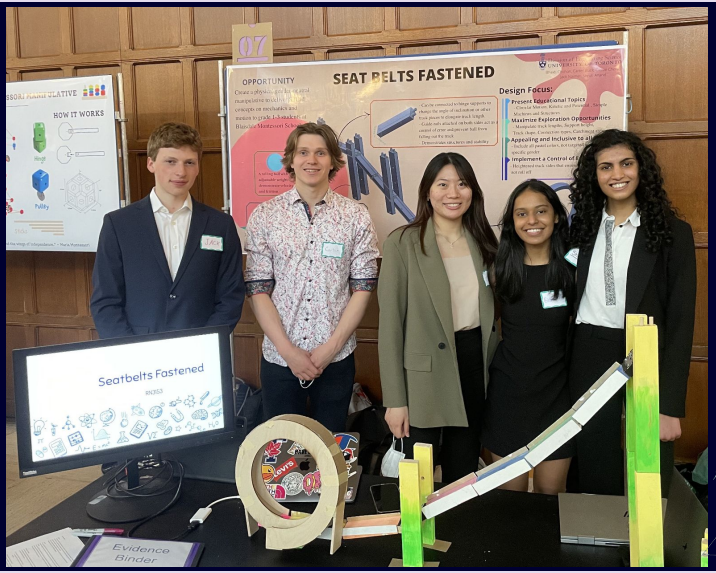
July 2022

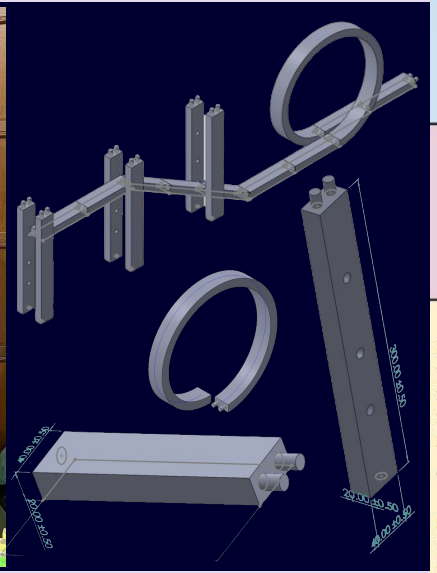
Description

Personally built a custom model rocket to fly at the Upstate Rocketry Research Group (URRG) in New York, and obtained an L1 High Powered Rocketry Certification. Simulated design in OpenRocket and estimated apogee, stability, and flight-time using estimated center of gravity and pressure. Launched as the first successful flight of our group, utilizing a weighted payload ballast to improve stability (previous launches were determined to be less stable than expected). Successfully recovered rocket in perfect condition to refly. Incredibly fun experience both in design and team-bonding! Will fly again in the future to teach others and attempt L2 and L3 certifications.

Montessori Roller Coaster Design Project

Jan - March 2022





<u>Description</u>

As part of a design course, we interacted with a local community: a Montessori school, to develop a requirements model to fit their needs and experience. The task was to create a Montessori toy that taught the kids simple physics concepts as they played with it. We iterated on the requirements and came up with a candidate design: a roller coaster named “Seatbelts Fastened”.

<u>Role</u>

Assigned the “Design Engineer” of the team. Tasked with designing and fabricating the attachment mechanisms to ensure it to be child-safe. Tested it with stakeholders and presented the design at the annual showcase.

Opportunity: Create a physical, gender-neutral, manipulative to deliver STEM concepts of mechanics and motion to grade 1-3 students at Blaisdale Montessori School.

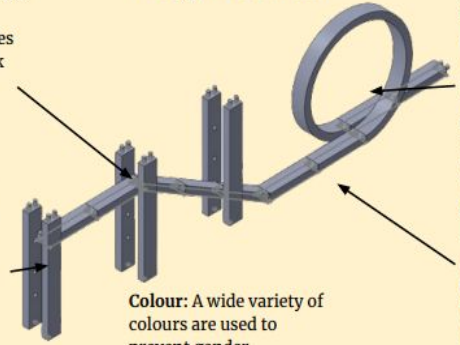
Objectives:

- Present appropriate educational topics
- Ensure ease of assembly and disassembly
- Implement a control of error
- Provide variety of Exploration Opportunities
- Distinguish between components
- Be inclusive and appealing to all genders

Design Features:

Hinges: Demonstrates usage of simple machines and enables for variation in track incline.

Supports: Enables track to be elevated to different heights, demonstrating the impact of height on potential energy and transfer of energy.



Colour: A wide variety of colours are used to prevent gender exclusion.

Loop: Demonstrates circular motion and introduces ideas of centripetal / centrifugal forces.

Tracks: Demonstrates structural stability and implements a control of error, through the orientation of the guide rails.

What do kids and staff think?

- **Kid 1:** “I like that it can be fixed together in different ways, and that you can build different things with it!”
- **Kid 2:** “I learnt that changing the steepness can make the ball go faster
- **Kid 3:** “I feel like I am doing engineering!”
- **Ms Neefjes:** “There is a very good control of error implemented into the design”