Project Portfolio

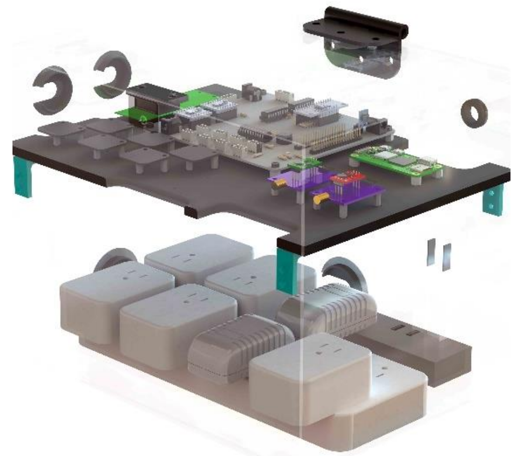
Kyle Tam

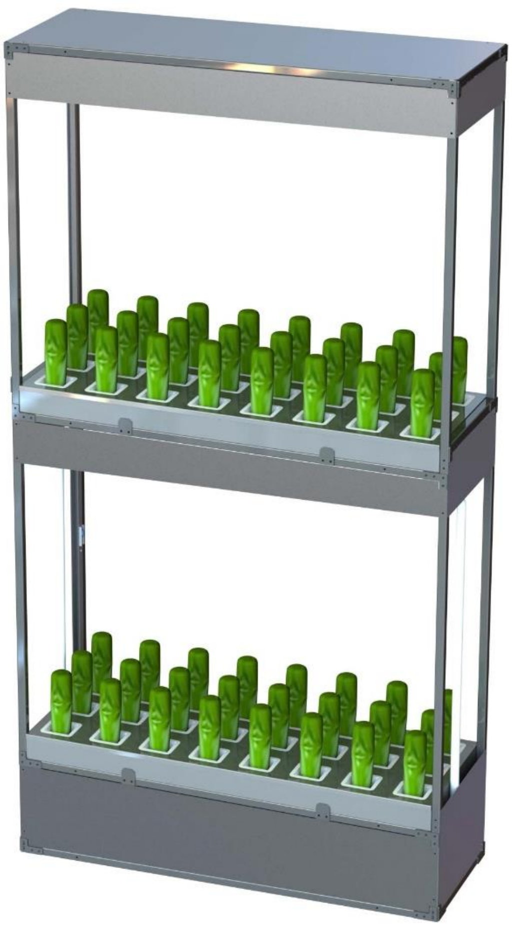
This is a collection of some of the most interesting and challenging projects I have worked on. These projects reflect just some of the work I have done through design teams, past internships, and extracurriculars. I hope they exemplify my passion for engineering and problem solving.

A Holistic Automated Hydroponics System – Fourth Year Capstone Project (Sep 2022 – Present)

Hydroponics systems that exist on the market today lack automation and have a high barrier to entry for small-scale users. Planter's mission is to build a system that fully automates all the key components of a plant's growth lifecycle while making it super user-friendly!

In hydroponics systems, the roots of plants are submerged in nutrient-rich water providing them with the essential elements needed for them to grow. In comparison to traditional growth methods, hydroponics requires less water, less space to grow, and provide faster growth rates.



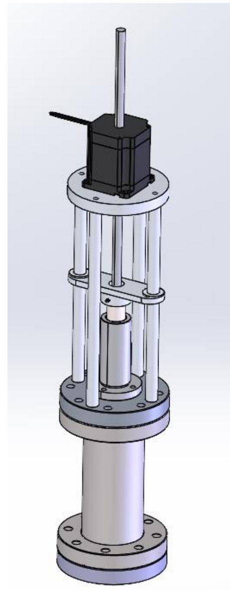


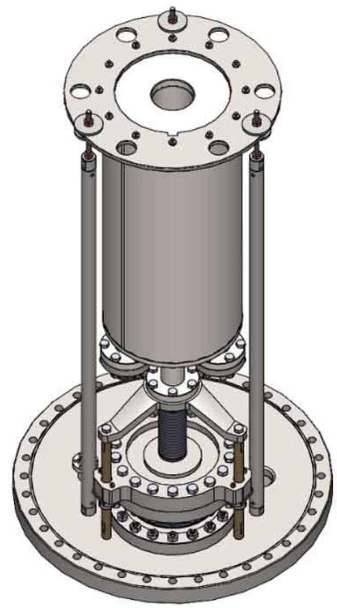
My focus in this project was the mechanical design and electro-mechanical integration. This included the design for manufacturing and assembly of the structure, electronics enclosure, and peripheries. As both a prototype and a consumer product, the structure was designed to be strong and durable while easy to assemble in minutes. The electronics module was in turn designed for easy access and display throughout manufacturing and testing. A full failure and tipping analysis was also conducted for the system.

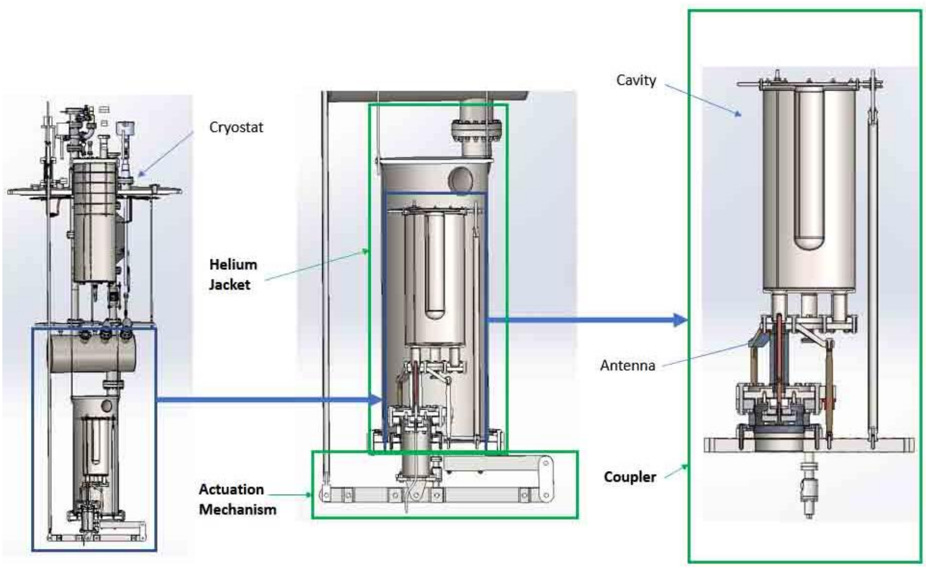
Co-Axial Cavity Research & Test Platform (Jan – Apr 2022)

SRF cavities are the heart of most modern particle accelerators. As a member of the SRF Team at TRIUMF, I worked on the conceptual and detailed design of a setup used to qualify the performance of accelerator cavities destined for organizations around the world and to provide a platform to conduct superconductive radiofrequency research.

This design would allow cavities to be submerged within a pressure vessel filled with cryogenic liquid helium at 2°K and surrounded by a vacuum.

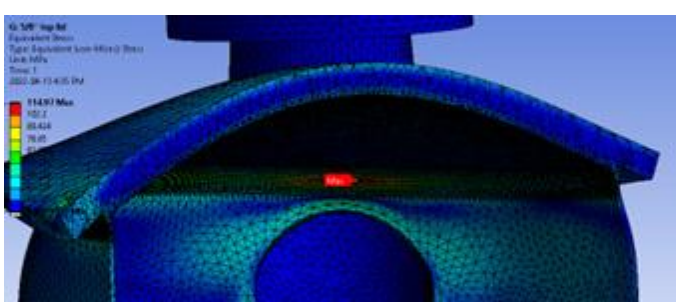


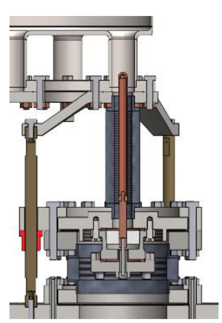


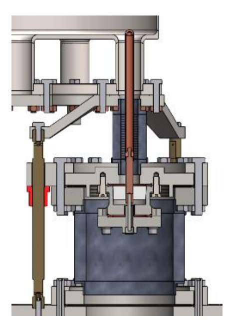


The entire cavity test platform hangs from the lid of a 10 ft tall cryostat. It can be broken up into 3 sections:

1. Co-Axial Coupler
2. Actuation Mechanism
3. Helium Jacket Pressure Vessel

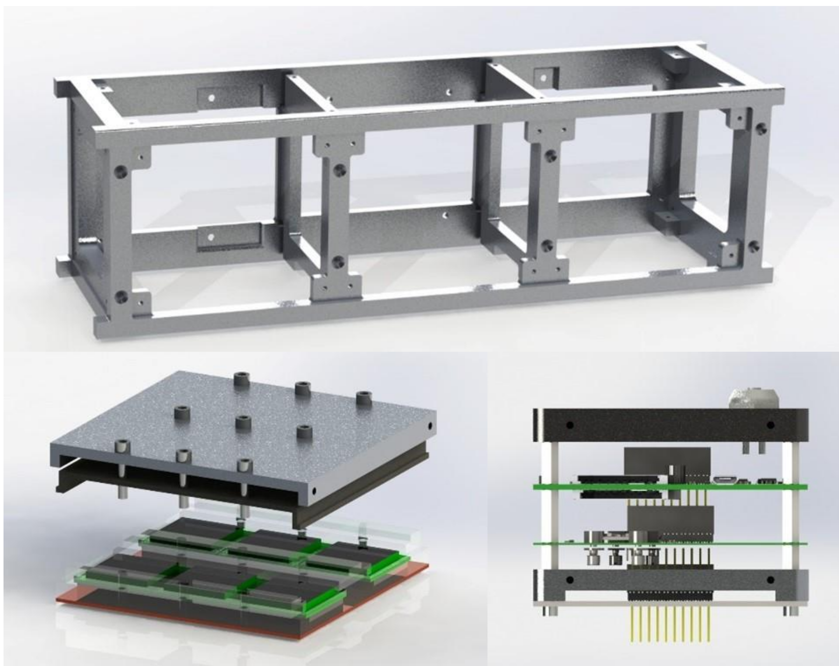






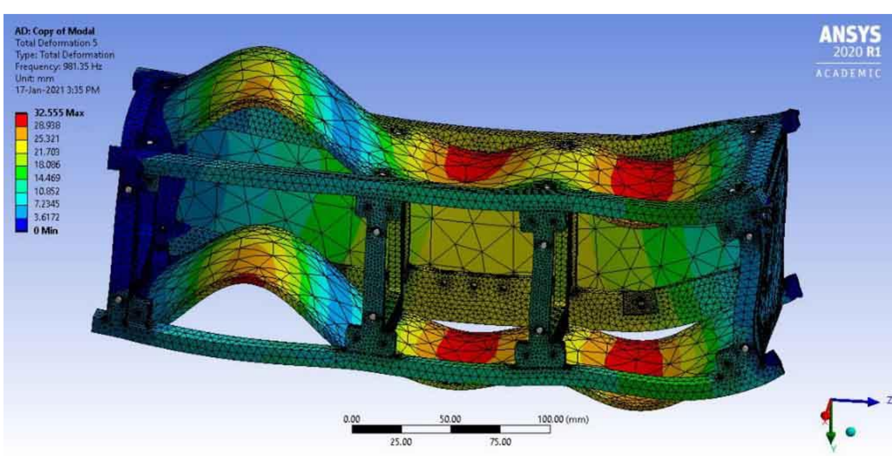
Payload CubeSat - Structure & Modules (Sept 2019 – Jun 2022)

Payloads developed by the team are scientific experiments that take advantage of the high altitudes, extreme launch forces and micro-gravity experienced in our flight up to 30,000 ft. As Payload Lead, I led the design of a 3U CubeSat and radiation sensor suite to test material samples and detect secondary cosmic radiation passing through our rocket. Our payload was eventually selected as one of the Top 10 Payloads in the SDL Payload Challenge and won the prize for Most Professional Design at the Spaceport America Cup 2021/2022 competitions.



CubeSats are a type of standardized nanosatellites. The CubeSat structure on the left was designed to be a modular assembly that minimizes the number of unique parts. Each module slides into the satellite for easy access and operation in the field.

Shown here are renderings of the CubeSat Structure, Detector Module, and Systems Module.

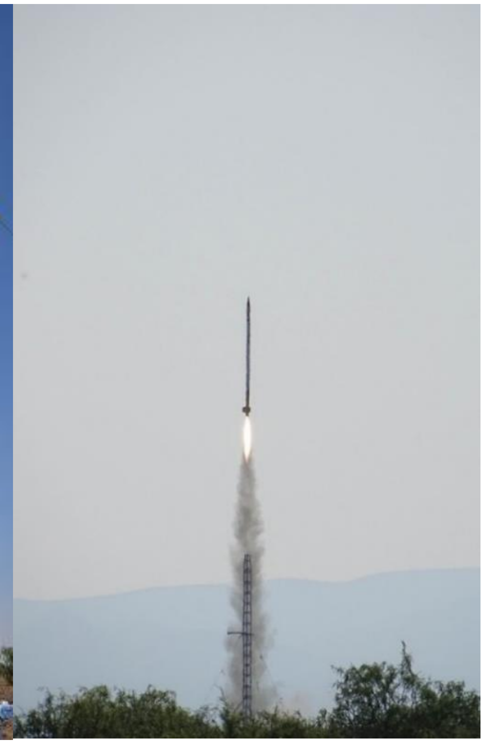


Testing and analysis are important to validate the performance of the payload. Shown above is a screenshot of an ANSYS Modal analysis of the CubeSat and a photo of the anodized/powder coated CubeSat submitted for the 2022 competition.

Shark of the Sky [SotS] (2019)

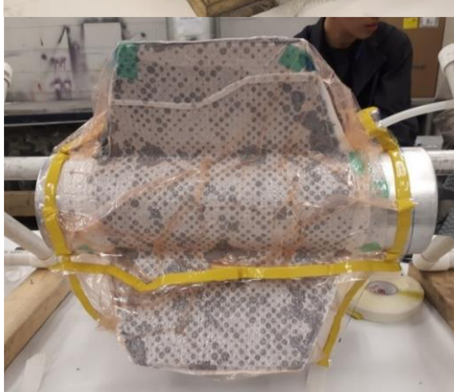
Each year Waterloo Rocketry designs and builds a high-powered sounding rocket for competition at the Spaceport America Cup. Here are some statistics from our 2019 hybrid rocket Shark of the Sky:

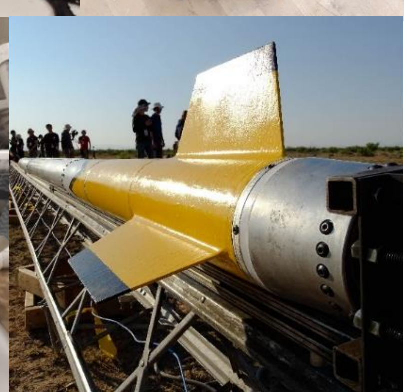
Dry Mass: 45 kg
Wet Mass: 72 kg
Height: 5.3 m / 17.4 ft
Maximum Altitude: 15,568 ft
Total Impulse: 39,000 N s
Propelants: Liquid N_2O, Solid HTPB
2nd Place in the 30,000 ft hybrid division at the 2019 Spaceport America Cup



Airframe Manufacturing & Design (2019)

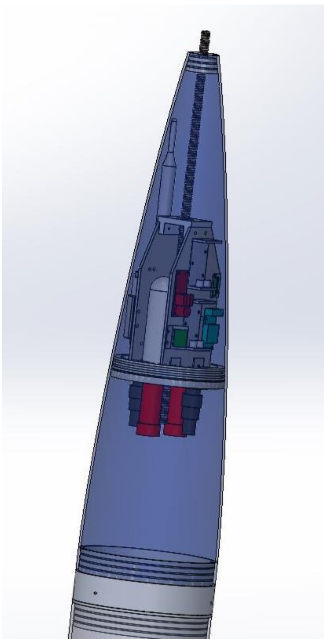
The airframe is the main structure of the rocket. As this is a large contributor to overall weight of the rocket, great efforts were made to reduce the weight of the airframe while keeping it strong. This included the designing and manufacture of carbon fibre and fibreglass components such as a Von Kármán nosecone and fin can. Vacuum bag layups were conducted to manufacture both of these parts.





Recovery Avionics Design & Testing (2019)

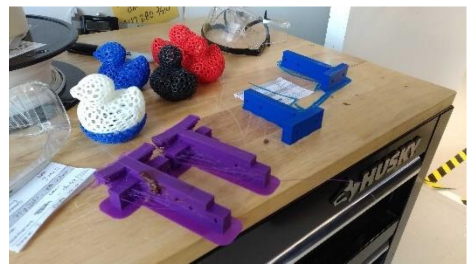
The recovery system is integral to safely retrieving the rocket after launch. While the team had a history of past recovery failures, the system from 2019 I worked on successfully deployed the drogue parachute, leading to a safe recovery.

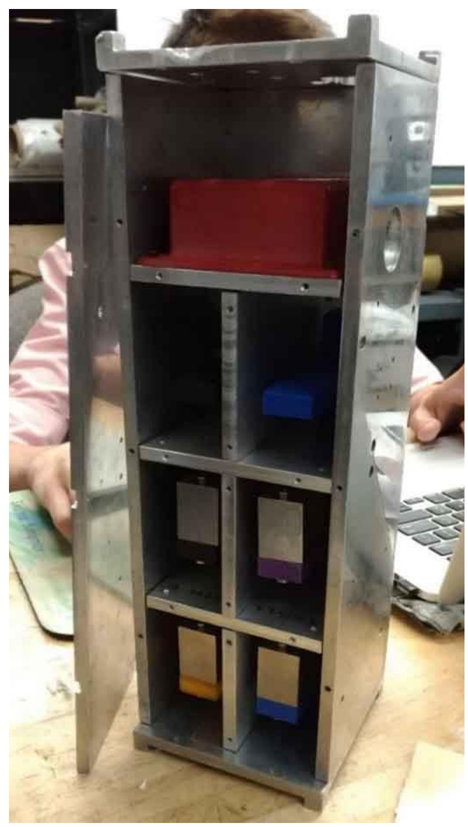


The task was to design the recovery avionics section. This included the electronics sled and bulkhead. Integration concerns with the electrical team and design for assembly were major considerations in this project. Additional consideration was put into determining how to attach this section without recreating the recovery failure case that occurred in 2018 where the sled section deformed leading to loss of connection in the electronics. Subsequent recovery tests were conducted to validate system functionality and parachute deployment.

3D-Printed Materials Analysis (2018-2019)

The goal of the 2019 payload was to evaluate the suitability of different 3D printed materials for use in sounding rockets. “T” shaped test samples made using a variety of 3D printing methods including FDM & SLA were placed under steel & aluminum weights. The high launch forces were used to evaluate the viability of the materials underloading during flight.



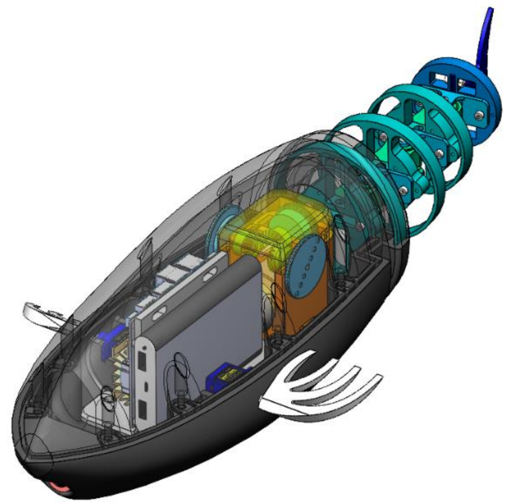


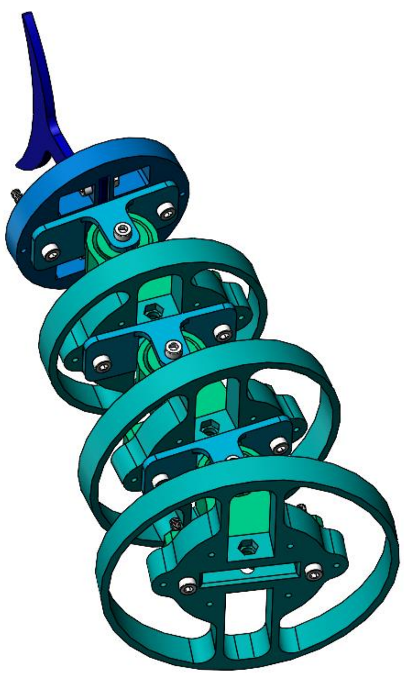
LamperLabs

Robotic Fish - Mechanical Design (May 2021 – Sept 2021)

Lamper Labs is a project focused on developing a robotic fish capable of gathering data in shallow ocean environments and blending into its environment for marine biology research. The robotic fish is wirelessly controlled and features a range of sensors and instrumentation to facilitate research purposes.

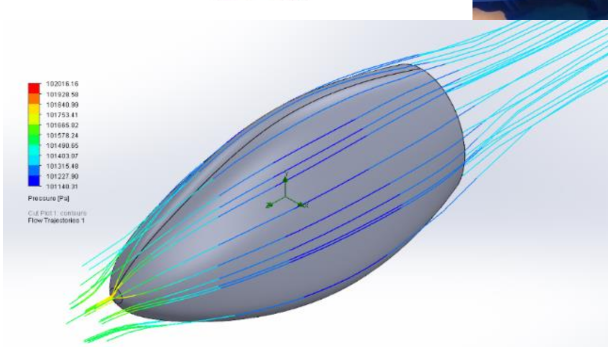
A major component of the fish is the mechanical design of the propulsion system and enclosure. Mimicking the natural movements of a fish is challenging to replicate and has required multiple design iterations to fine-tune the caudal fin propulsion system.

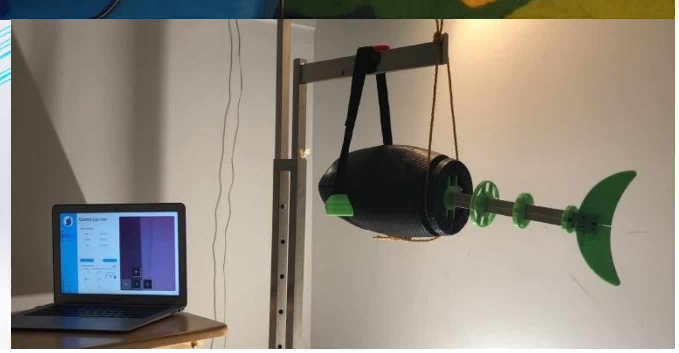




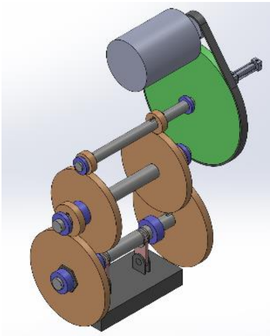
The propulsion system is a continuous-rotating system where two oppositely rotating turntables (green box below) pull on a set of wires routed through the ribs of the tail seen on the left.

As the turntables rotate opposite of each other, each wire will alternate being in tension while the other remains slack, oscillating the tail similar to the movements of a tuna when swimming.





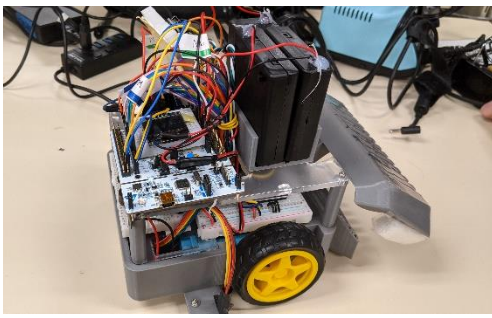
And Much More…



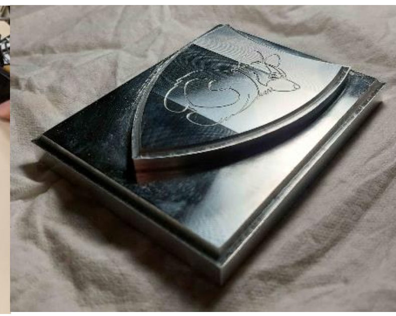
Double-Geared Twin-End Drive
Sheet Metal Press Design & Analysis

MSAM - 5-Axis Laser Metal Deposition
3D Printer Control Software & Paper

Canadian Reduced Gravity Experiment –
Microgravity Fluids Experiment and Flight Campaign



Autonomous Navigation & Rescue
Robot Design Project

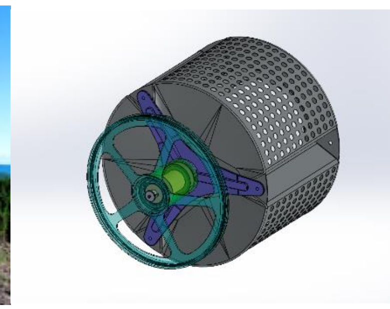


MasterCAM CNC Programmed and Machined
Aluminum Shield

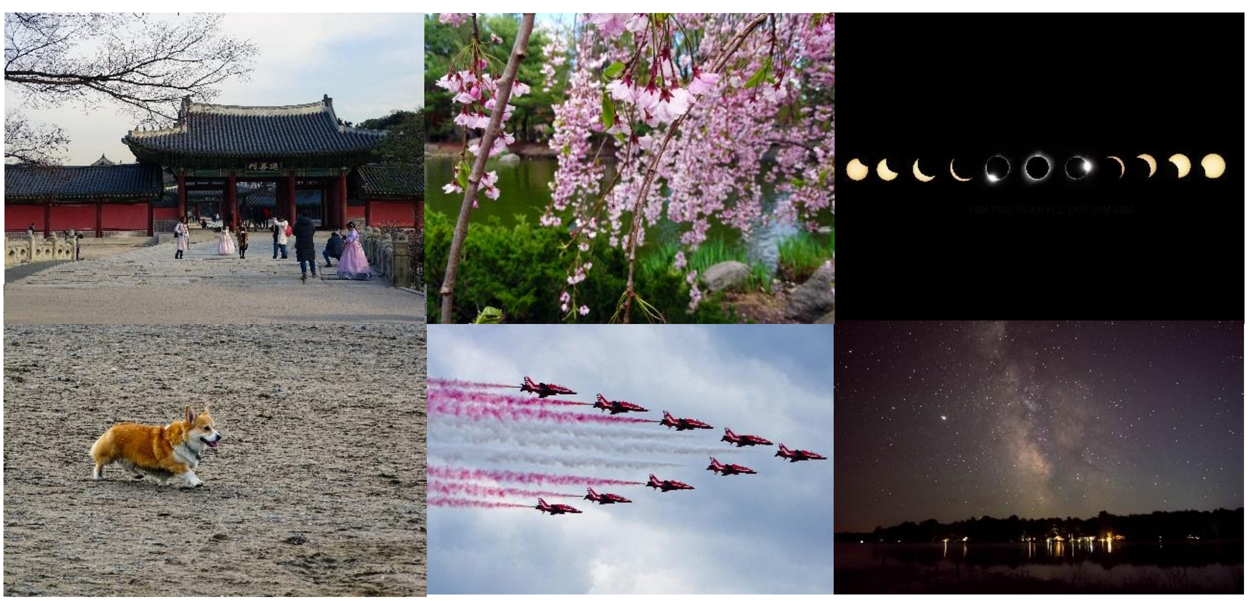
Canadensys Aerospace – Space Cameras
Manufacturing, Testing, Calibration, Design

Hatch – Large, High-Speed Bearing and Damper
System in Collaboration with General Fusion

Flash Forest – Semi-Automated Seed Pod
Manufacturing and Design of Drone Planting System



Front Load Washing Machine Drive Assembly
– Bearing, Shaft, and Seal Design & Analysis



Digital and Film Photography – Nature, Landscapes, Astrophotography (Nikon D5300, Nikon FG)