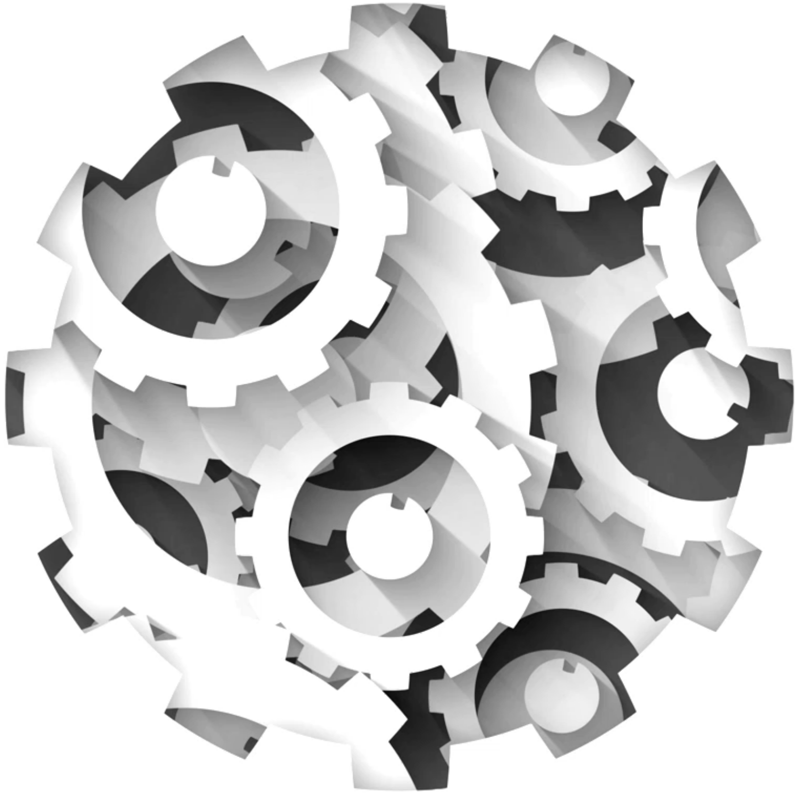


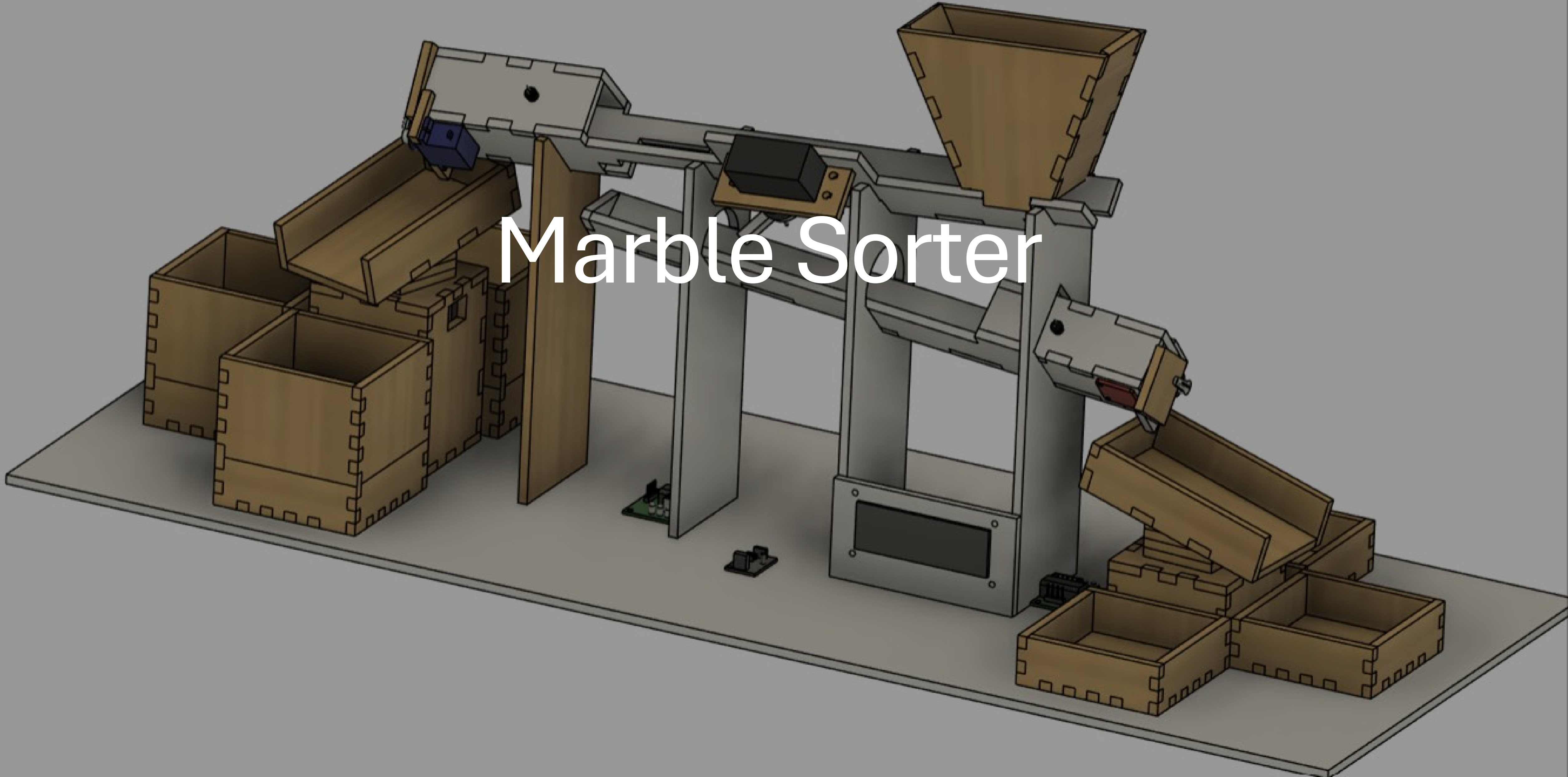
Engineering Portfolio

Ben Lisenby

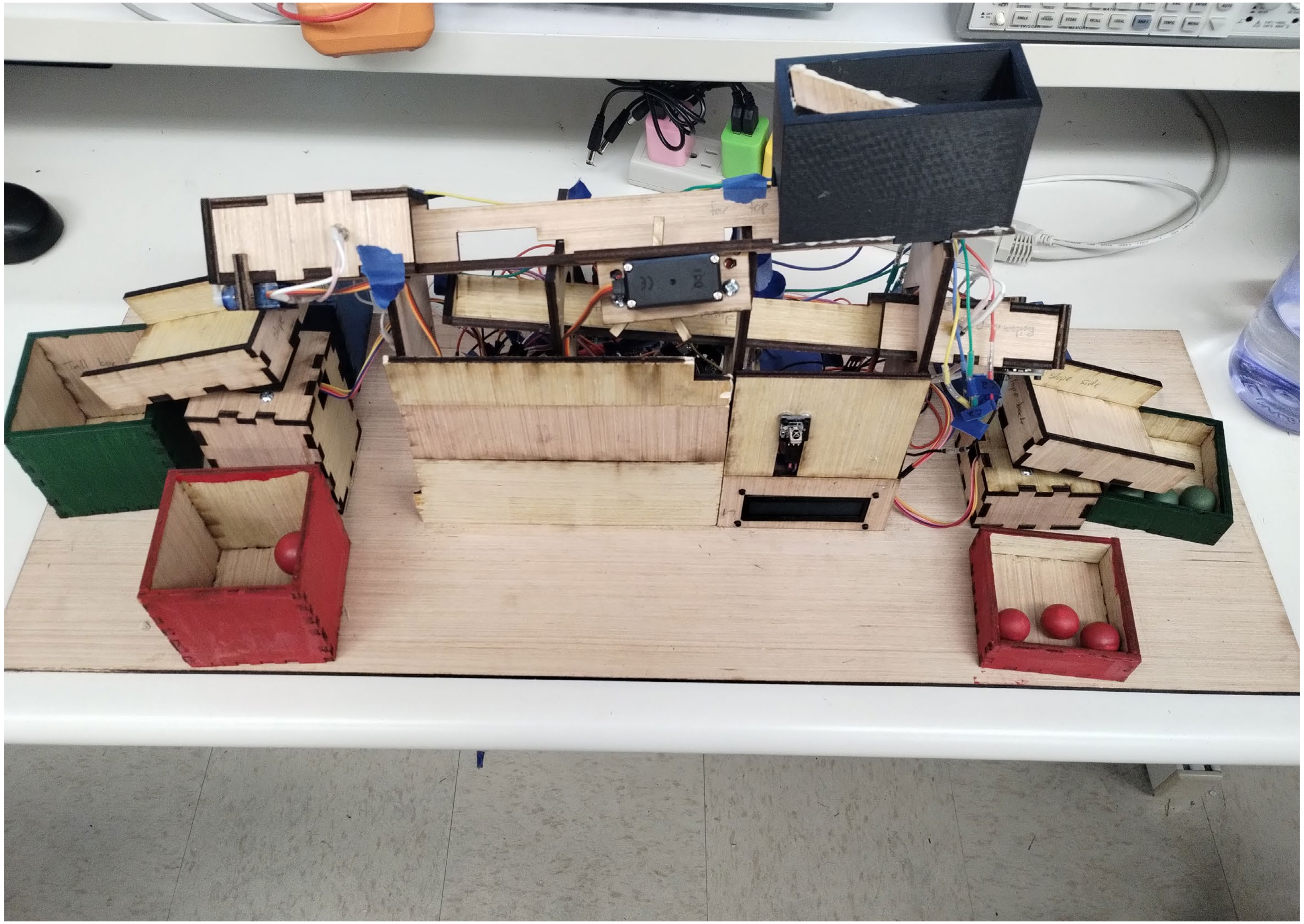
TAYLOR UNIVERSITY

2023-2027

Mechanical Engineering Undergraduate Projects

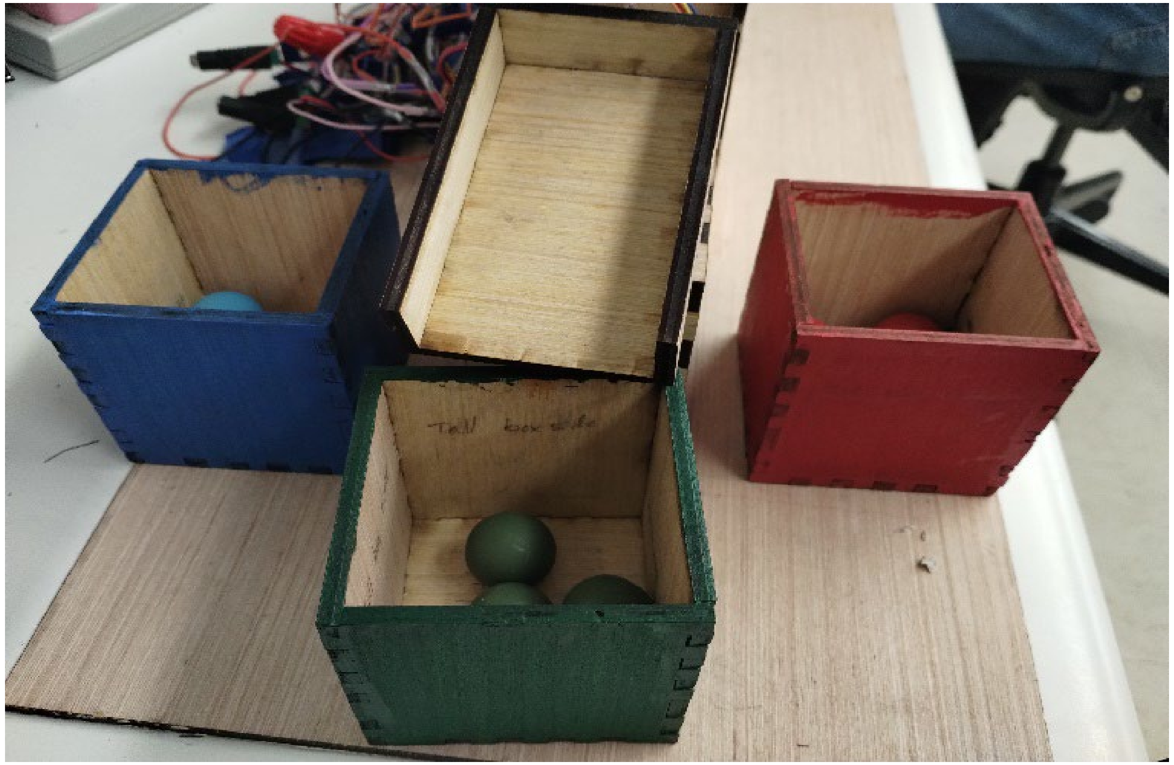


Marble Sorter

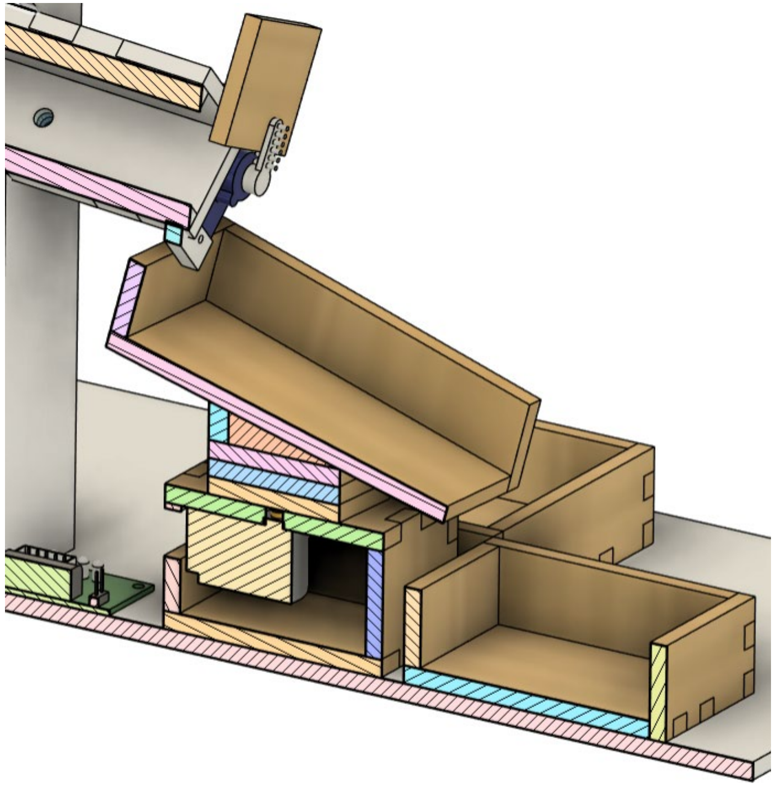


Final Integrated System

- I worked as part of a two-person team to design a machine to sort marbles my color and size.
- Subsystems that I was responsible for:
  - Color sorting system (turntables and gates)
  - Mechanical integration of stepper motors, servos, and sensors
  - Funnel and loading subsystem

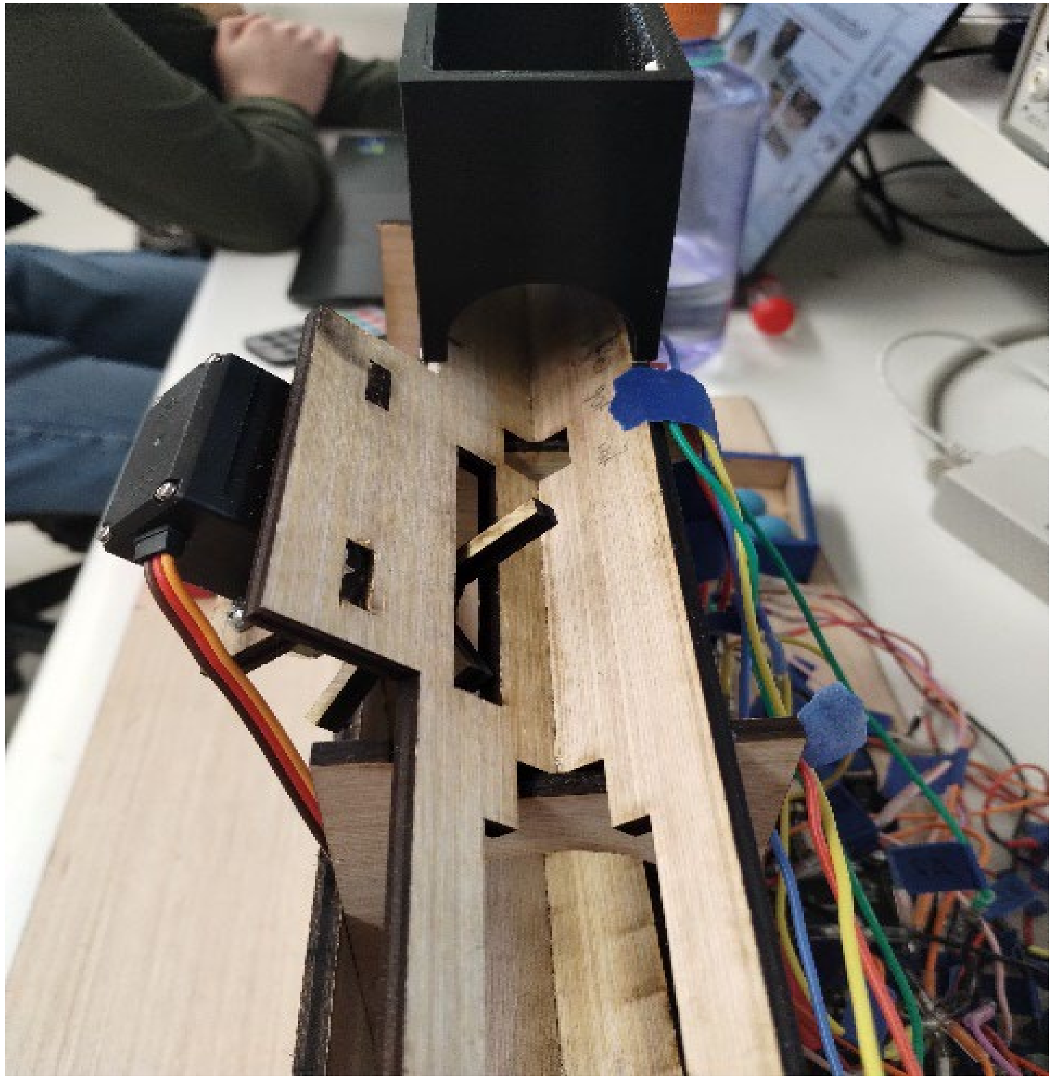


Integrated Color Sorting System



Color Sorting System CAD Section View

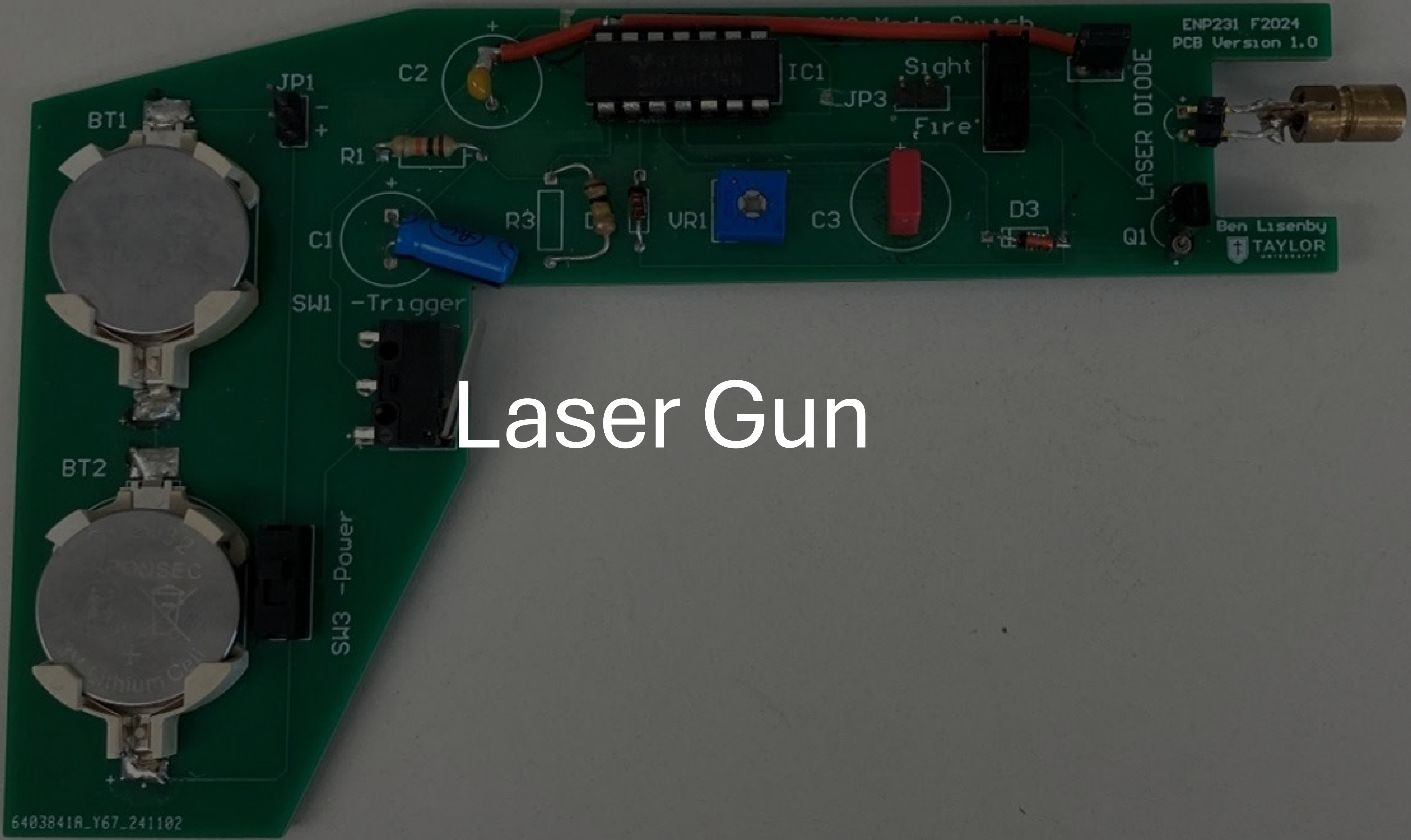
- Responsible for design of the color sorting system
- Required interfacing with motors, sensors, and wiring
- Designed for reliability and repeatability
- Gate and turntable design achieved design goals and performed as expected

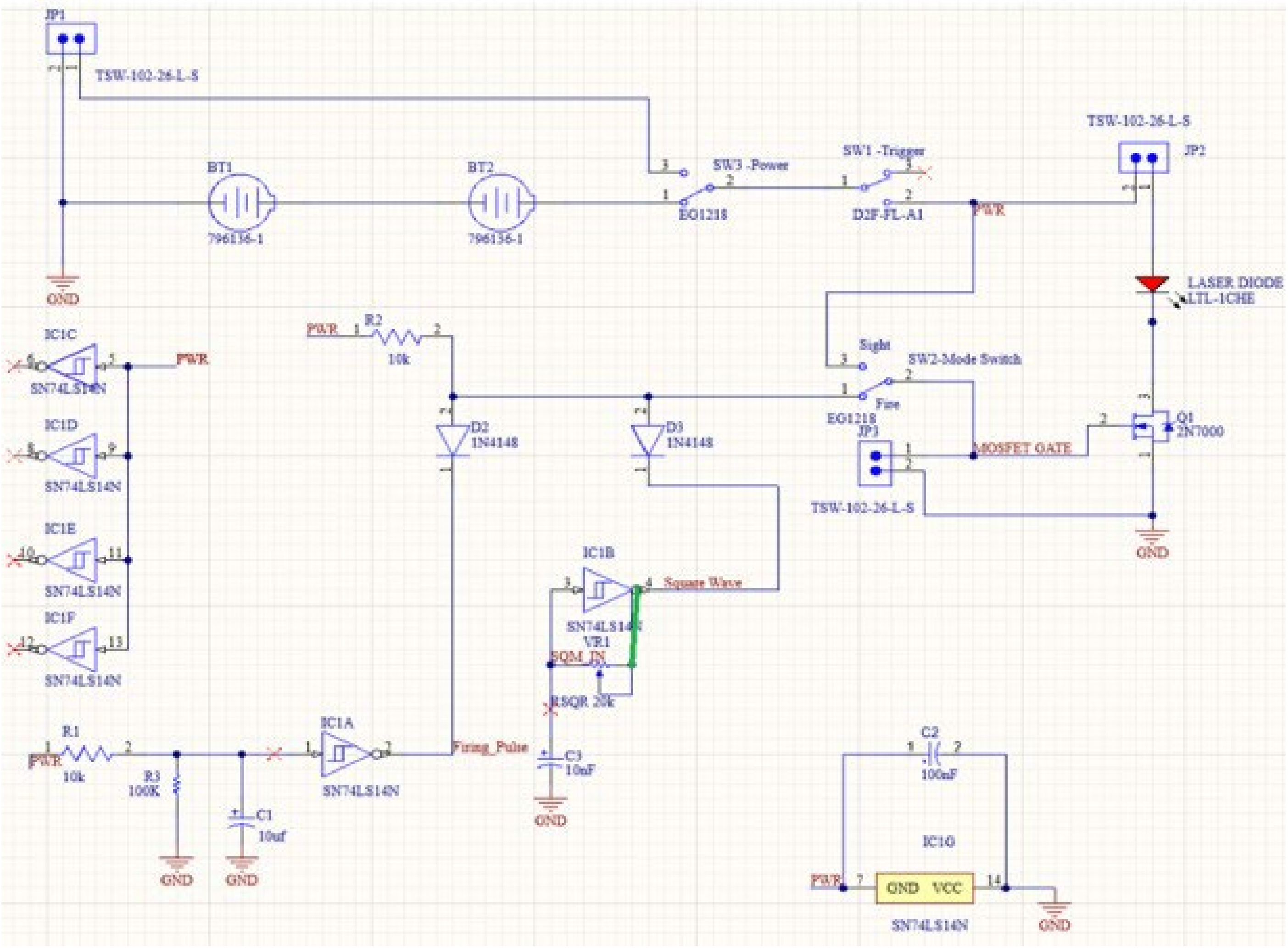


Integrated Loading System

- Responsible for design of loading system
- Solving key problems of single-marble loading and jamming
- Turnstile design ensures one marble is in system at a time.
- Funnel design holds ~10 marbles at a time, reduces jamming, and ensures smooth release
- Design refined through rapid iteration and testing to ensure optimal performance

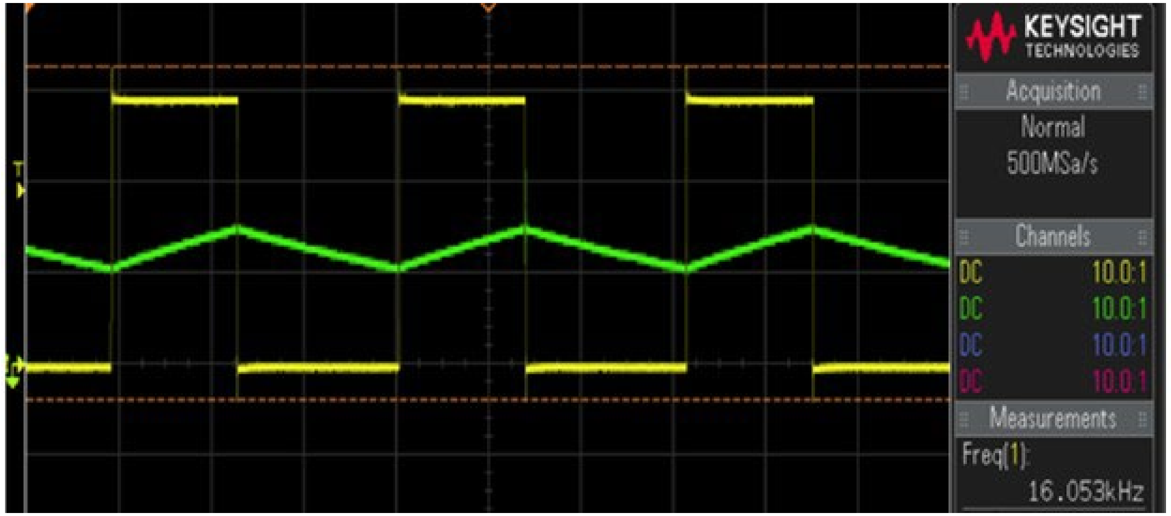
Laser Gun


ENP231 F2024
PCB Version 1.0
JP1
BT1
BT2
C1
C2
C3
R1
R3
IC1
JP3
Sight
Fire
VR1
D3
Q1
LASER DIODE
Ben Lisenby
TAYLOR
SW1 -Trigger
SW3 -Power
6403841A_Y67_241102



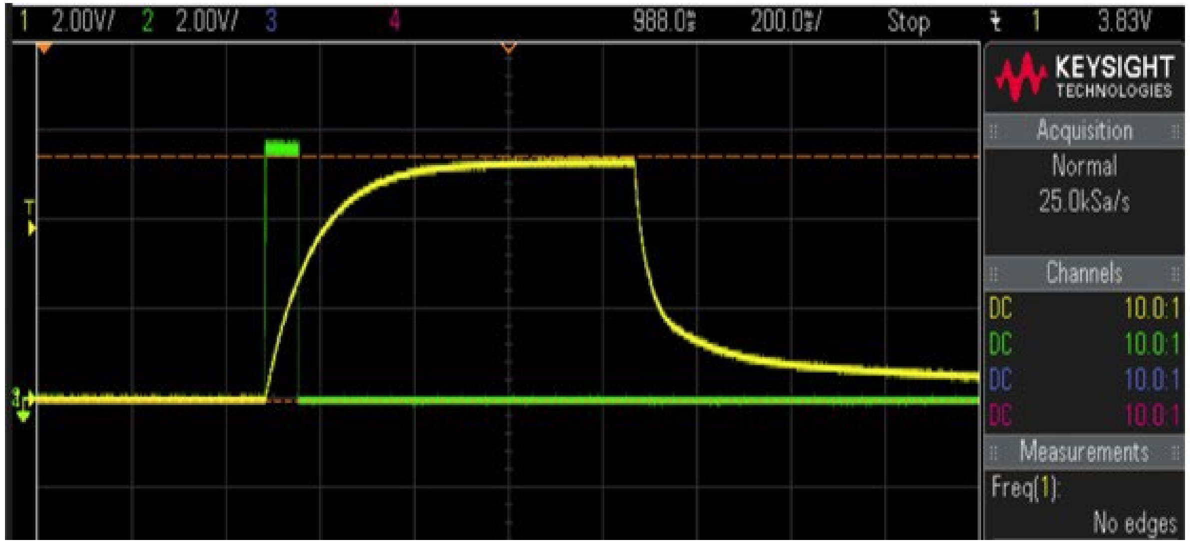
Circuit Schematic

- I designed a laser gun to activate a target by delivering a 16 KHz laser pulse.
- My responsibilities:
  - Designing PCB layout
  - Selecting components to meet design constraints
  - Breadboard prototyping of each subsystem
  - Final assembly and testing

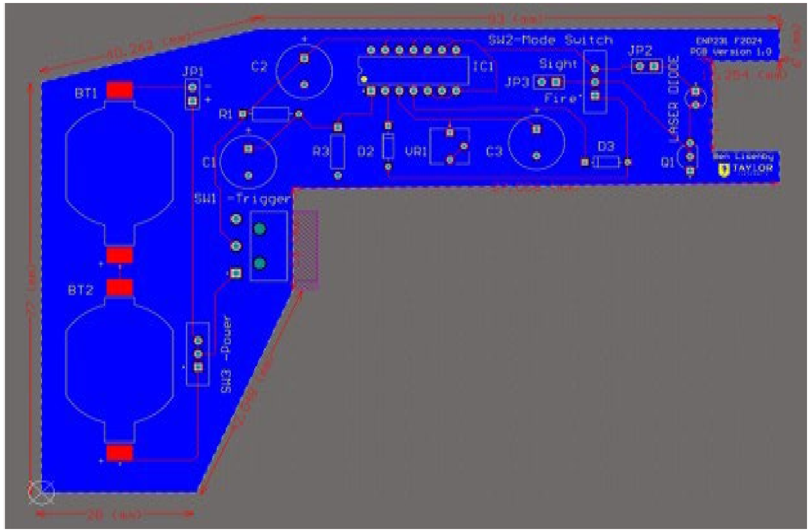


Timing Pulse Verification Oscilloscope Image

- Testing verifies laser gun pulse is set to 16 KHz.
- Capacitor charging curve determined by trigger (leads to firing of laser pulse)
- PCB design completed in Altium and successfully assembled and tested

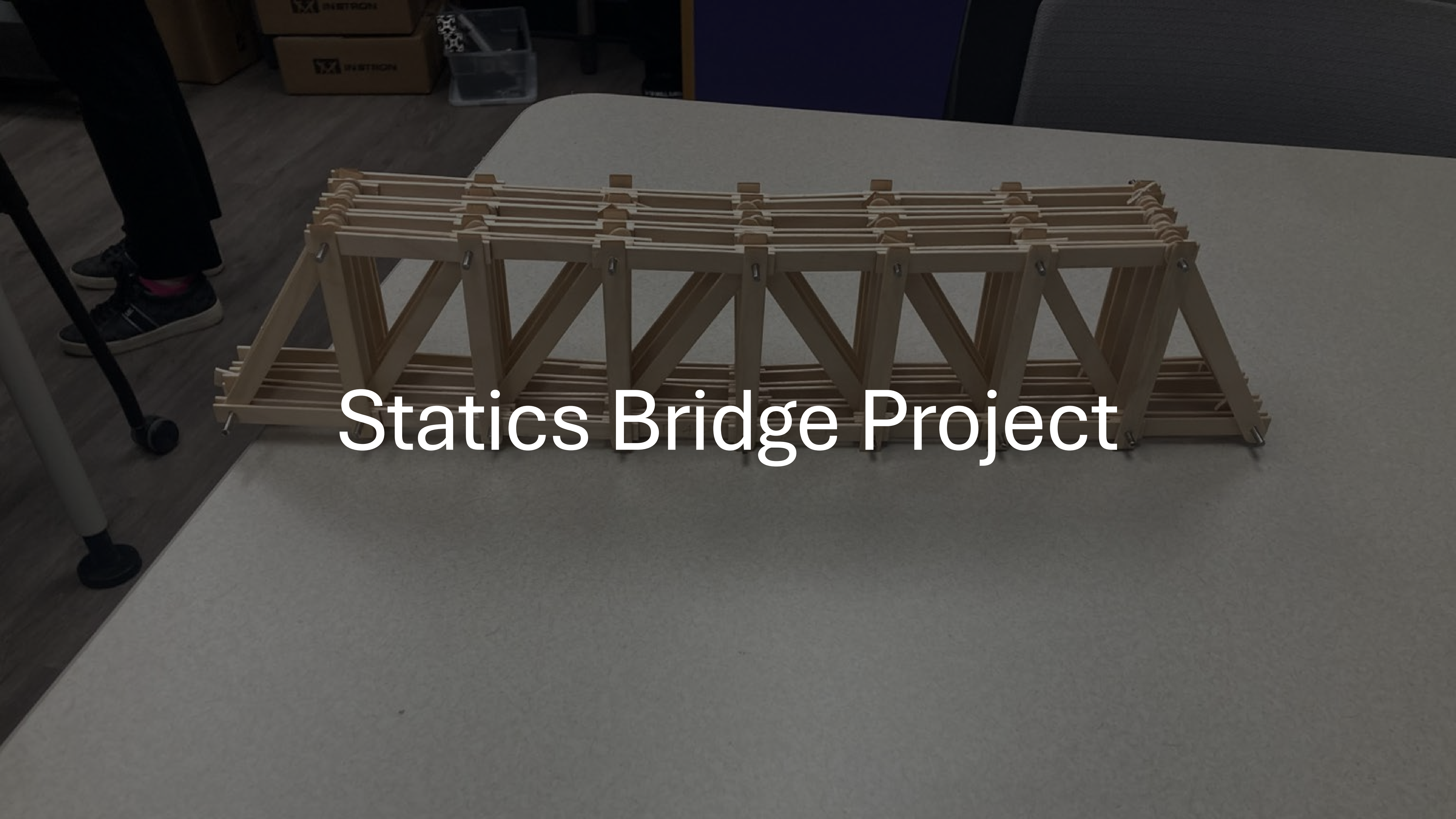


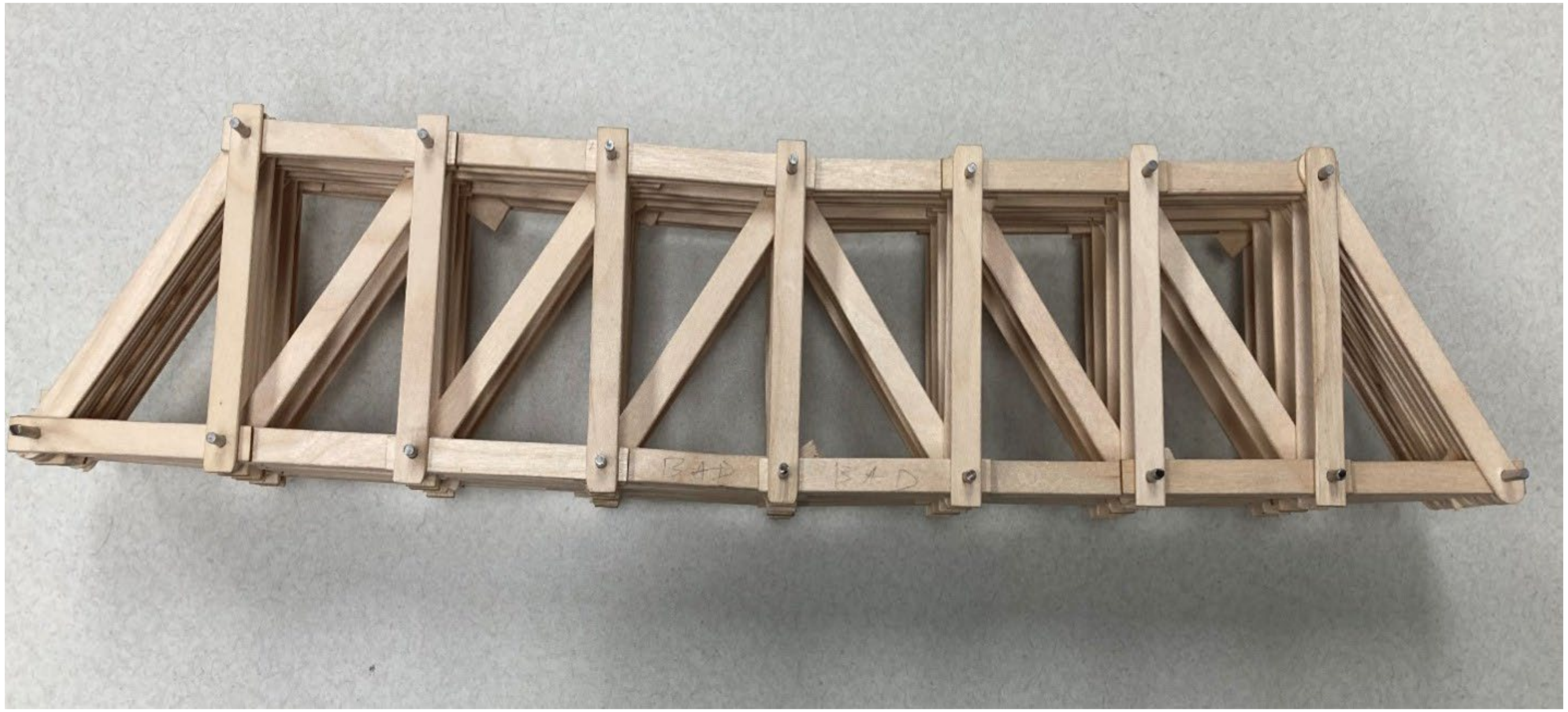
Trigger Verification Oscilloscope Image



Final PCB Layout

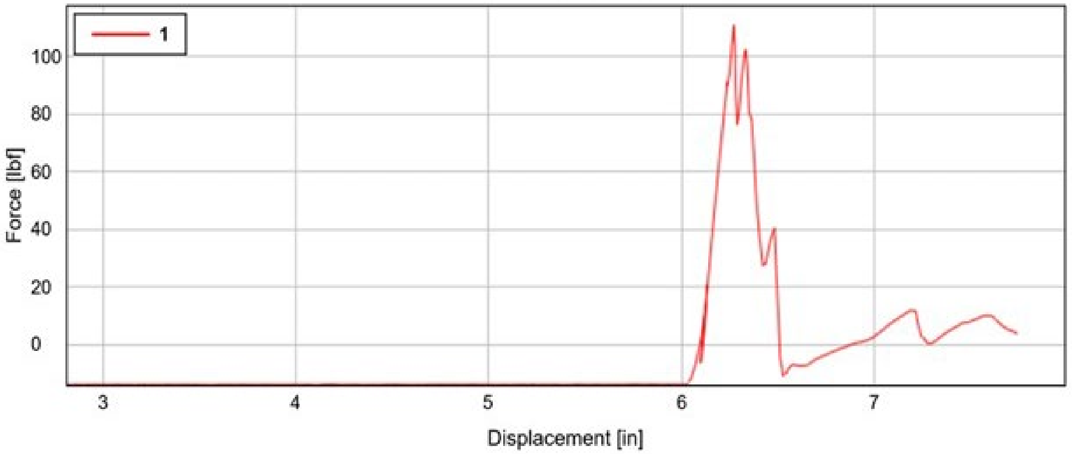
Statics Bridge Project





Final Bridge Design

- I designed a bridge to withstand an impulse load of 50 pounds-force.
- My responsibilities:
  - Assembled bridge from popsicle sticks and stainless-steel pins
  - Completed structural analysis in excel to validate design and predict failure points
  - Tested to failure to determine actual strength



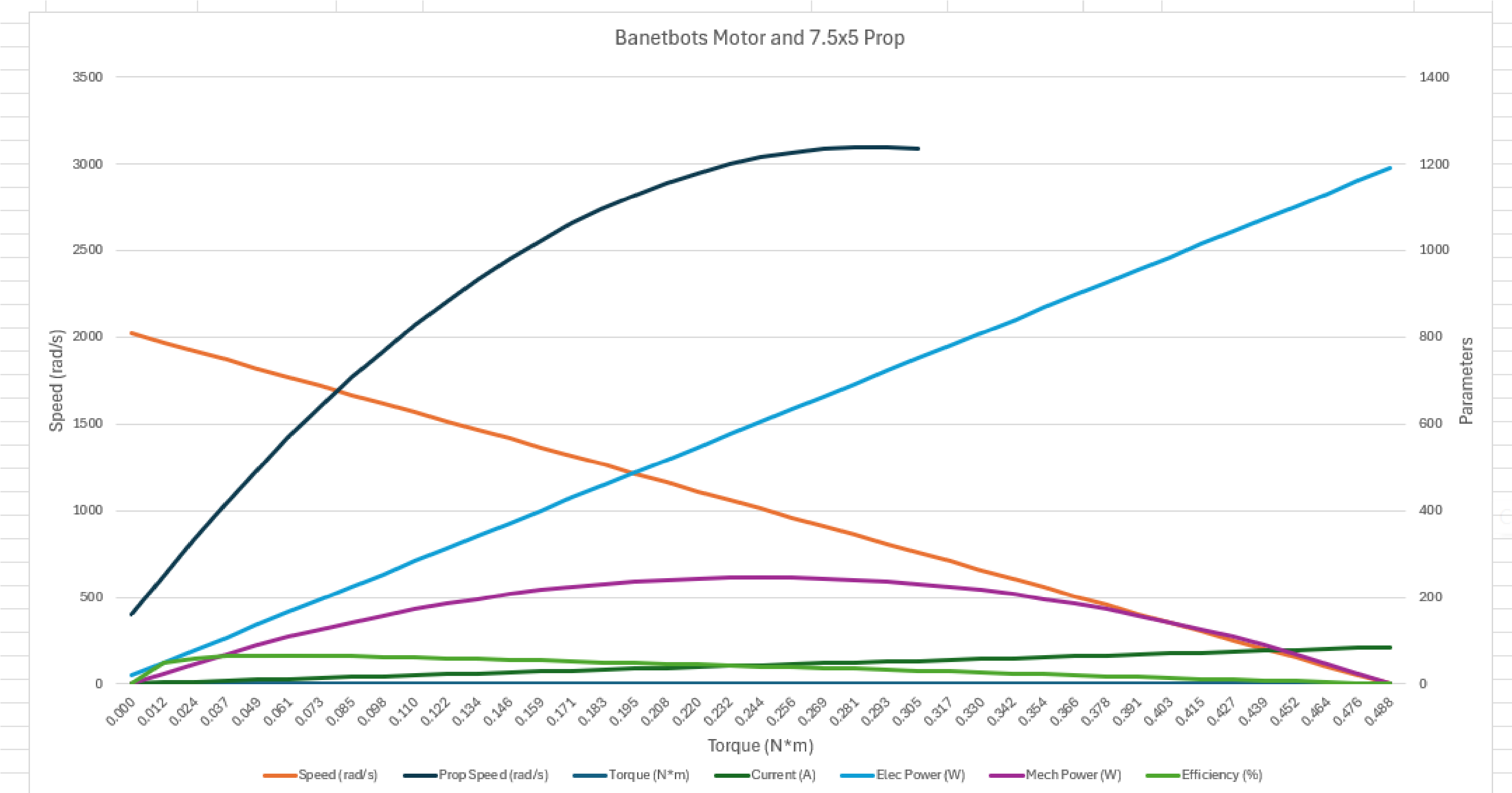
	Force at Break (Standard) [lbf]	Maximum Force [lbf]	Data point at Yield (Zero slope)
1	6.14	111.57	6272

UTM Testing Data

Bridge Failure Points

- Tested with Universal Testing Machine (UTM) to failure
- Over 50% stronger than original goal
- Analysis correctly predicted failure points
- Second highest force withstood in Statics class

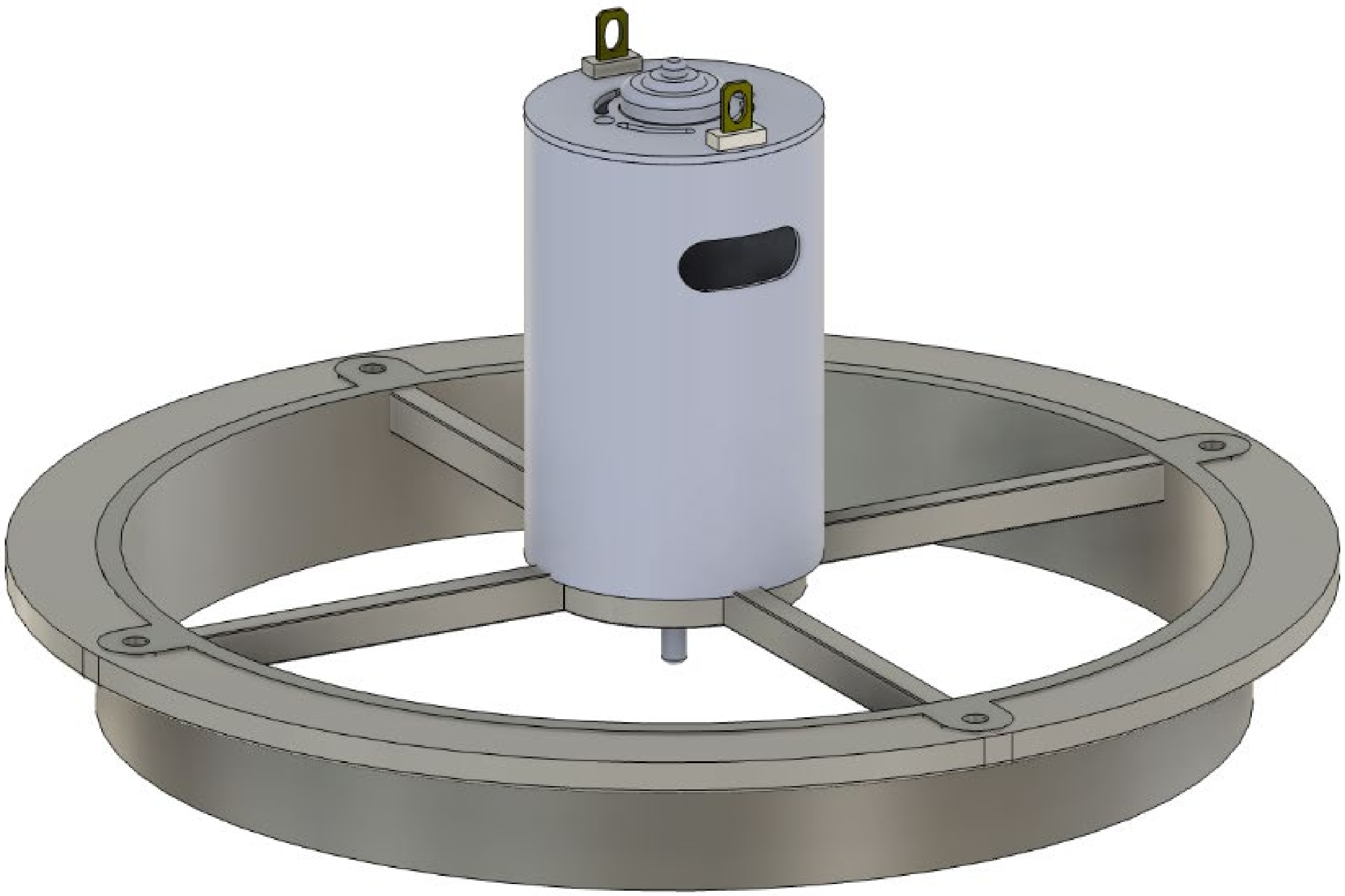
Hovercraft Competition



	Torque (N*m)	Speed (rad/s)	Current (A)	Elec Power (W)	Mech Power (W)	Efficiency (%)	Prop Speed (rad/s	Prop Thrust (N)
At Operating Point:	0.07	1730.68	13.41	187.78	121.42	64.66	1555.17	5.93

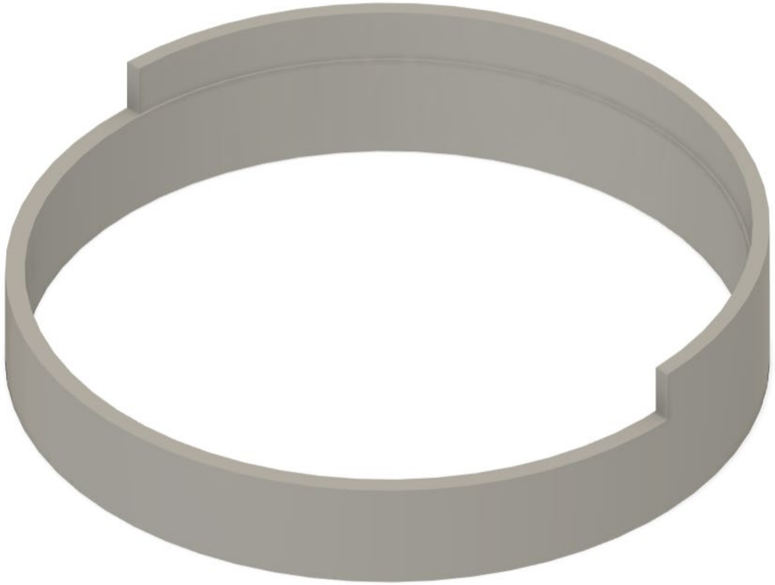
Motor Analysis Plot and Data

- Performed Motor Analysis and calculations based on propellor and motor data.
- Found operating point to confirm viability of motor-prop combination.
- This work allowed team to understand behavior of motor and propellor
- Lead to design validation



Lift Fan Subsystem

- Responsible for lift subsystem design
- Key design parameters:
  - Ensuring mounts withstand force of motor
  - Efficient air flow to produce lift
  - Robust interface with hovercraft body



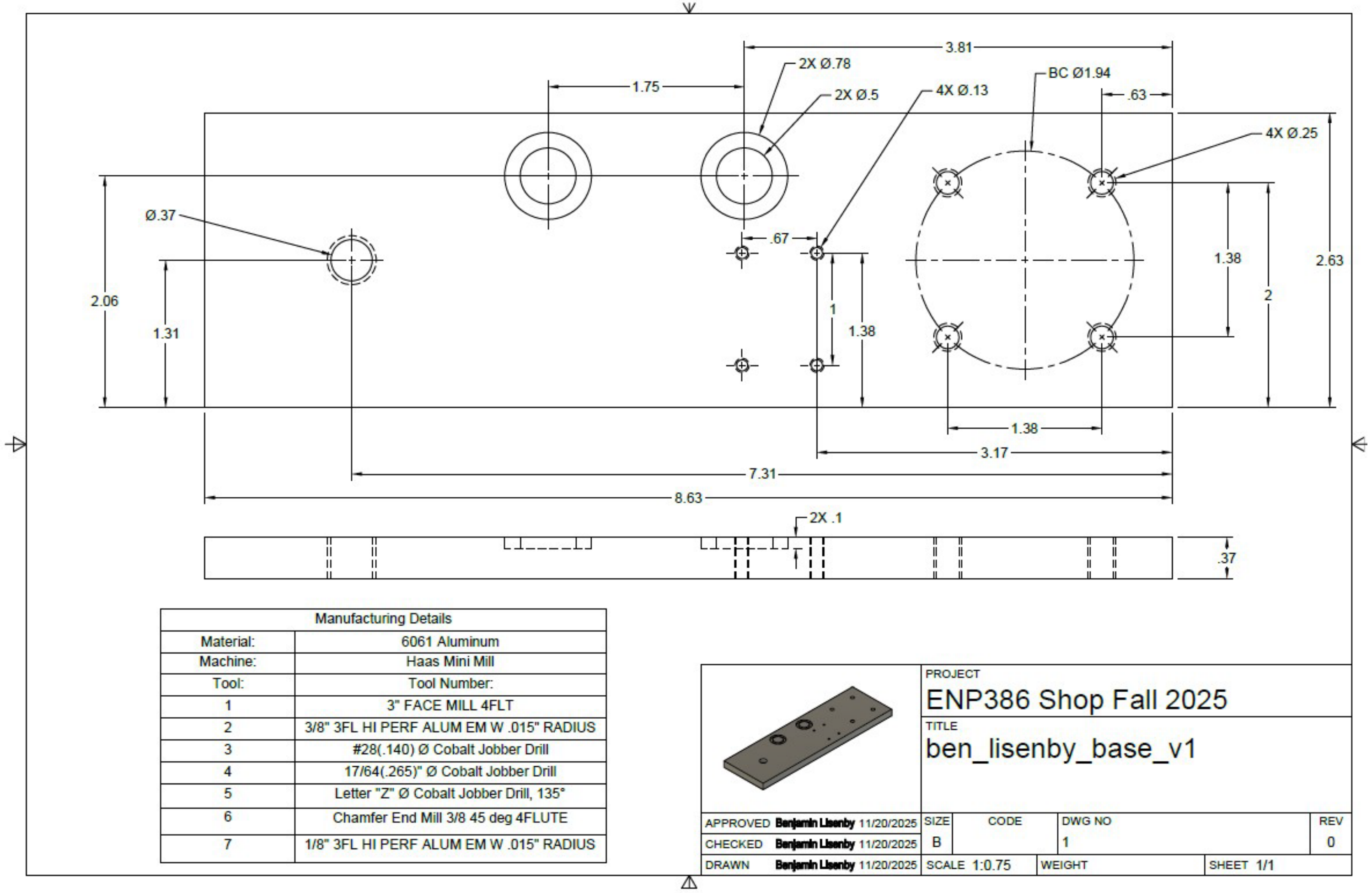
Thrust Fan Addition

- Key issue was speed (important for competitive edge in competition) Analysis correctly)
- I designed addition to thrust fans to increase speed by 35-50%
- This design addition allowed our team to finish 2nd overall

Integrated Hovercraft Image

- Responsible for interfacing with electrical components
  - Mounting solutions for PCB, battery, and motor controllers
  - Wire routing
  - Electrical system integration and testing

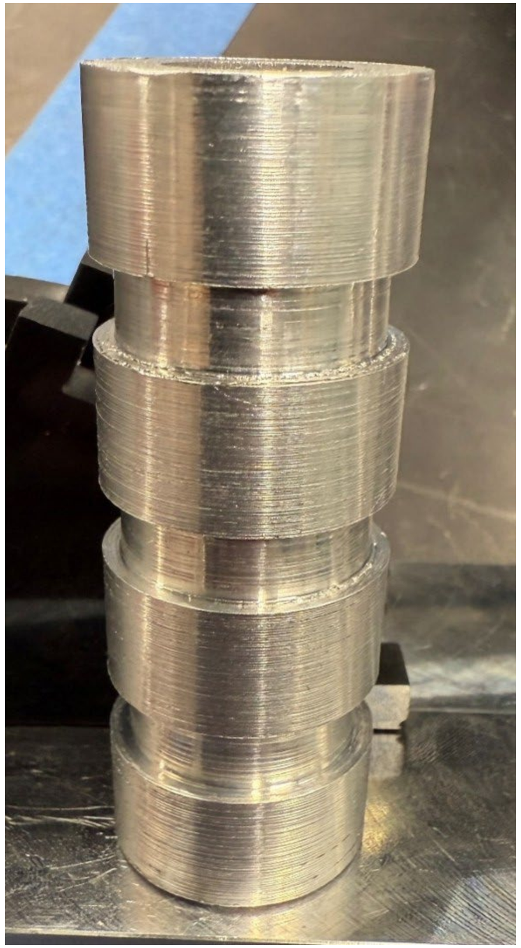
Manufacturing Methods Project



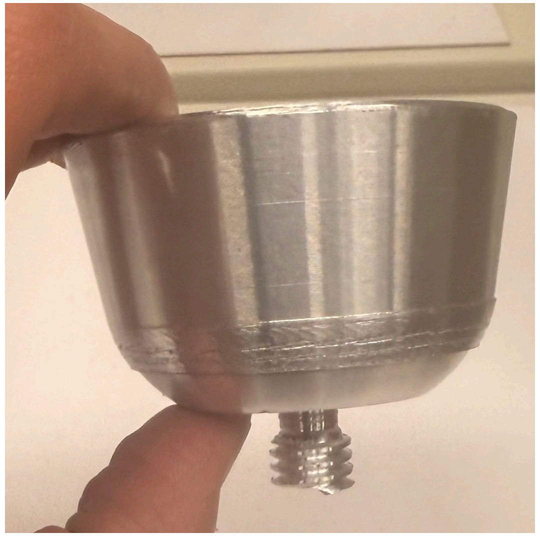
Manufacturing Details	
Material:	6061 Aluminum
Machine:	Haas Mini Mill
Tool:	Tool Number:
1	3" FACE MILL 4FLT
2	3/8" 3FL HI PERF ALUM EM W .015" RADIUS
3	#28(.140) Ø Cobalt Jobber Drill
4	17/64(.265)" Ø Cobalt Jobber Drill
5	Letter "Z" Ø Cobalt Jobber Drill, 135°
6	Chamfer End Mill 3/8 45 deg 4FLUTE
7	1/8" 3FL HI PERF ALUM EM W .015" RADIUS

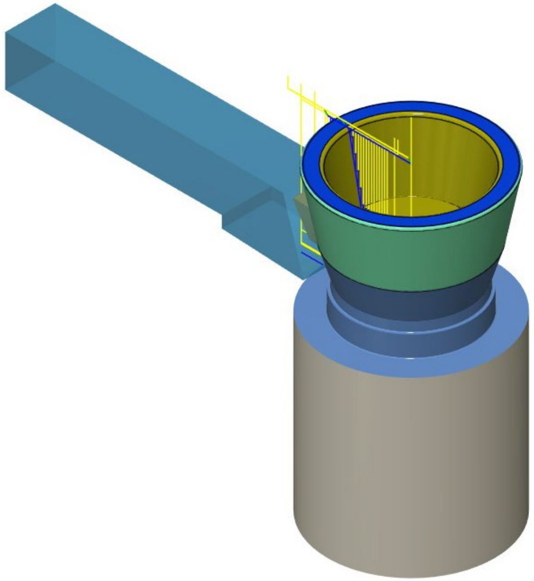
Sample Drawing

- Main focus of class was design for manufacturing principles and engineering drawings with a focus on CNC machining
- Designed a custom “desk organizer”, using a combination of CNC and manual machining methods



Part Designed for
Manufacturing on Lathe

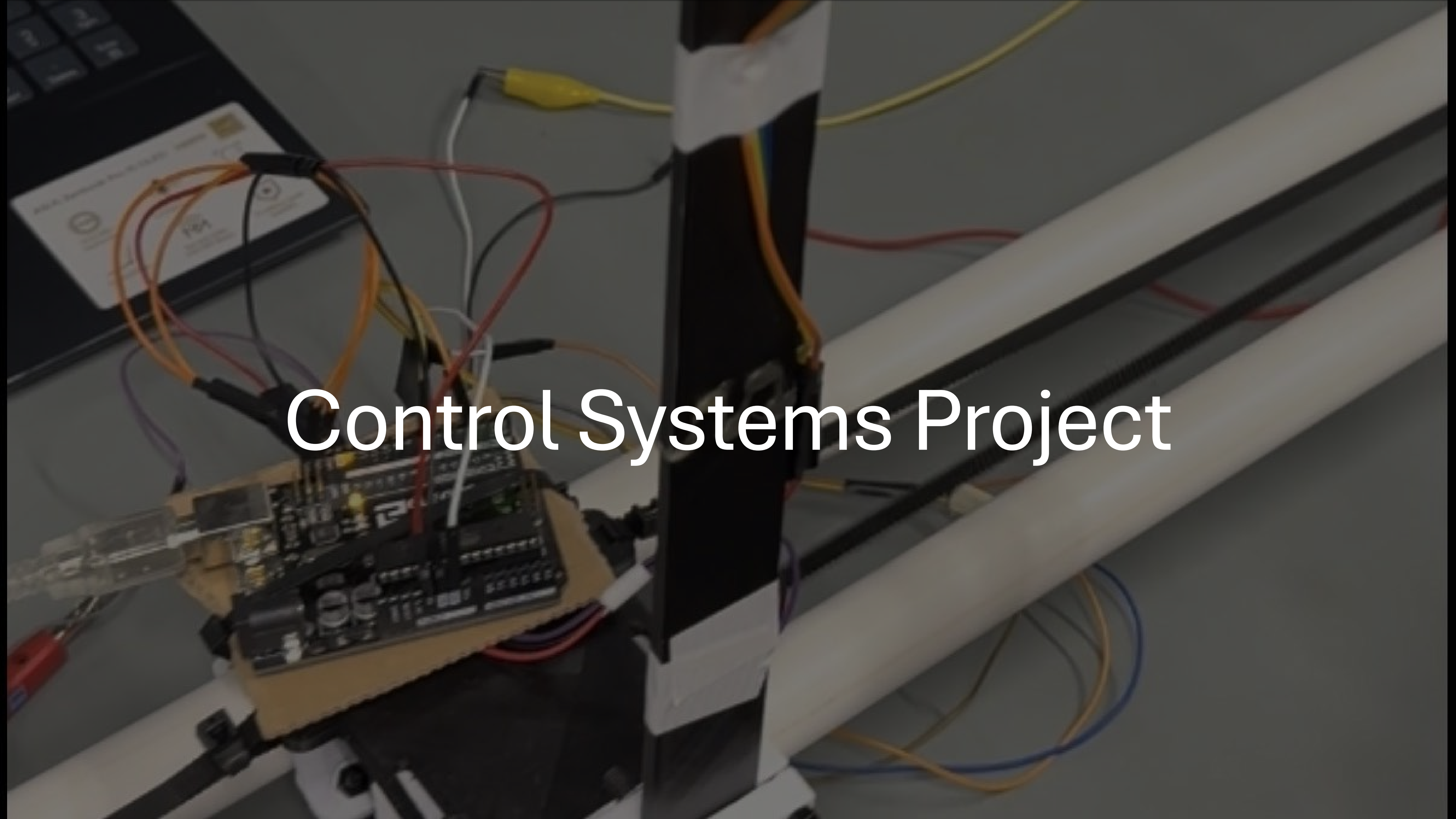


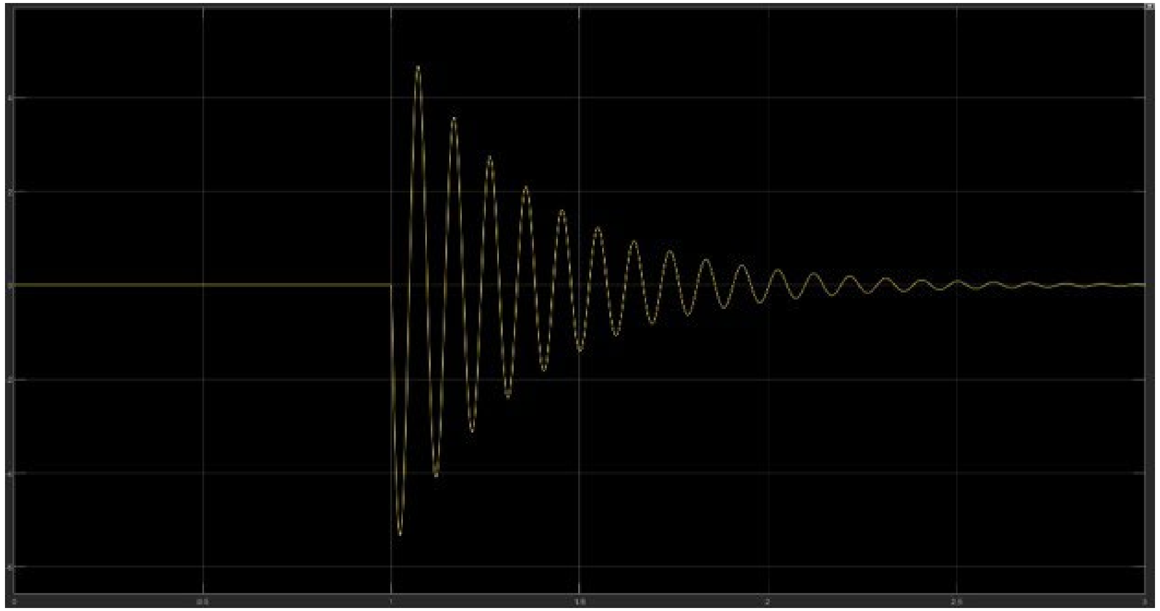


CNC-Machined Part and CAM Simulation

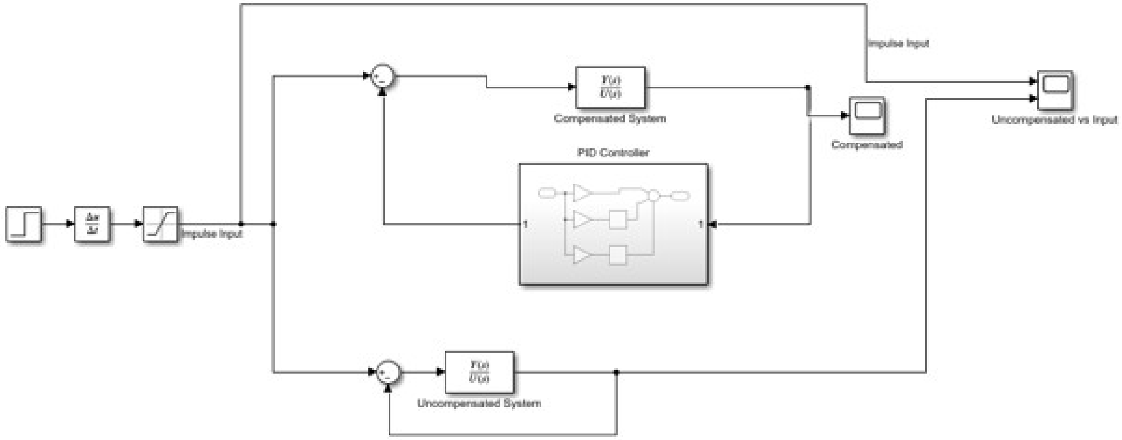
- My deliverables for this project:
  - Part designs that met requirements for manufacturability, function, and form
  - Clear and accurate engineering drawings for all parts, according to drafting best practices
  - CAM programs for all CNC machined parts
  - Fabrication and assembly for each part

Control Systems Project





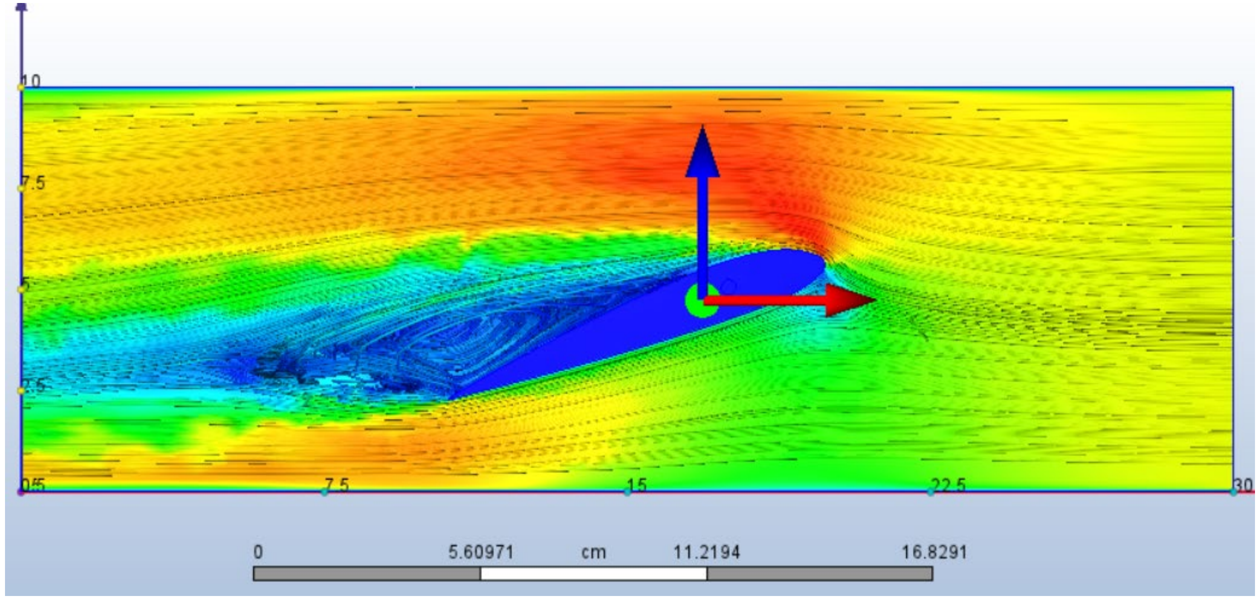
PID Controller Simulation Result



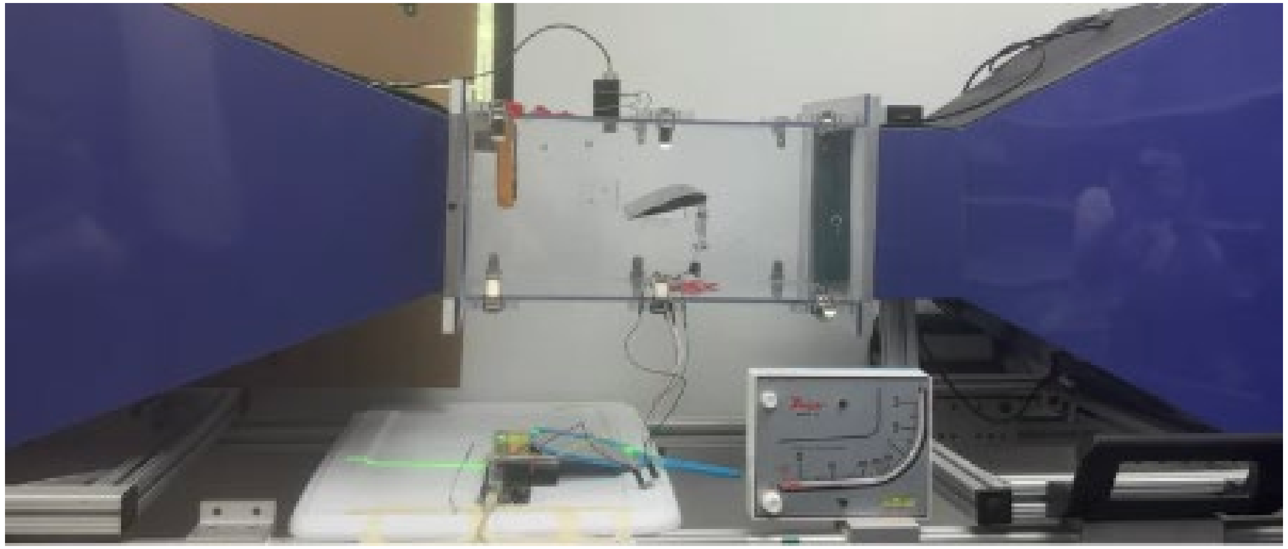
System Block Diagram in Simulink

- Goal: balance inverted pendulum for at least 3 seconds
- Control achieved with linear actuation-determined by PID control
- My responsibilities:
  - Mathematical Modeling of uncompensated system
  - MATLAB/Simulink simulation of uncompensated system
  - Simulation and design of PID control to fully balance system

Wind Tunnel Simulation and Testing

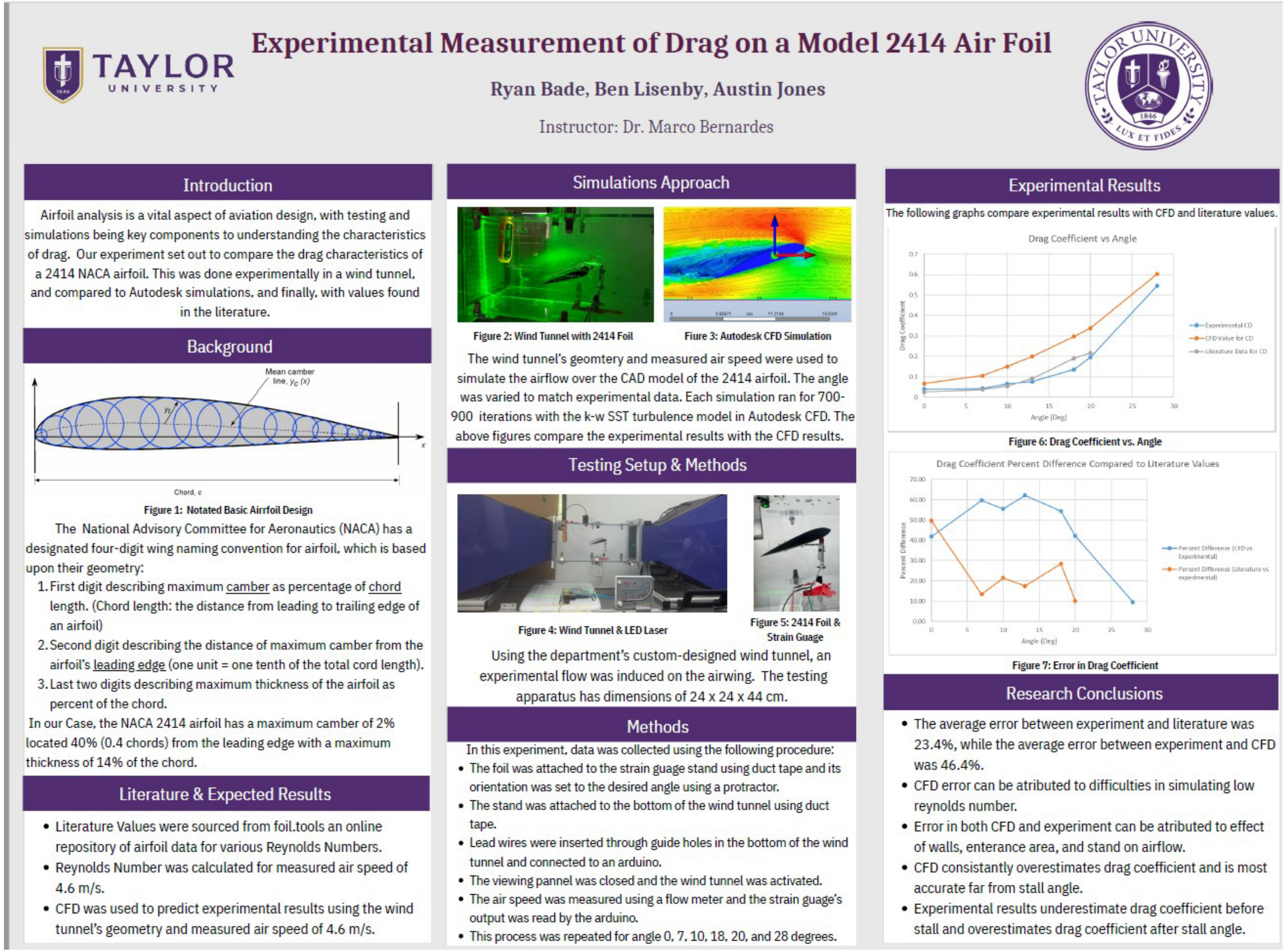


Sample CFD Simulation



Experimental Setup

- I worked in a team to measure the drag coefficient of a NACA 2414 Airfoil for varying angle.
- My responsibilities:
  - Literature review to determine accepted values for experiment and determine CFD methods
  - CFD simulations of airfoil at various angles with our experimental constraints
  - Data analysis to compare experimental results with literature and CFD results



Experimental Measurement of Drag on a Model 2414 Air Foil

Ryan Bade, Ben Lisenby, Austin Jones

Instructor: Dr. Marco Bernardes

Introduction

Airfoil analysis is a vital aspect of aviation design, with testing and simulations being key components to understanding the characteristics of drag. Our experiment set out to compare the drag characteristics of a 2414 NACA airfoil. This was done experimentally in a wind tunnel, and compared to Autodesk simulations, and finally, with values found in the literature.

Background

Figure 1: Notated Basic Airfoil Design

The National Advisory Committee for Aeronautics (NACA) has a designated four-digit wing naming convention for airfoil, which is based upon their geometry:

1. First digit describing maximum camber as percentage of chord length. (Chord length: the distance from leading to trailing edge of an airfoil)
2. Second digit describing the distance of maximum camber from the airfoil's leading edge (one unit = one tenth of the total cord length).
3. Last two digits describing maximum thickness of the airfoil as percent of the chord.

In our Case, the NACA 2414 airfoil has a maximum camber of 2% located 40% (0.4 chords) from the leading edge with a maximum thickness of 14% of the chord.

Literature & Expected Results

- Literature Values were sourced from foil.tools an online repository of airfoil data for various Reynolds Numbers.
- Reynolds Number was calculated for measured air speed of 4.6 m/s.
- CFD was used to predict experimental results using the wind tunnel's geometry and measured air speed of 4.6 m/s.

Simulations Approach

Figure 2: Wind Tunnel with 2414 Foil

Fiure 3: Autodesk CFD Simulation

The wind tunnel's geomtery and measured air speed were used to simulate the airflow over the CAD model of the 2414 airfoil. The angle was varied to match experimental data. Each simulation ran for 700-900 iterations with the k-w SST turbulence model in Autodesk CFD. The above figures compare the experimental results with the CFD results.

Testing Setup & Methods

Figure 4: Wind Tunnel & LED Laser

Figure 5: 2414 Foil & Strain Guage

Using the department's custom-designed wind tunnel, an experimental flow was induced on the airwing. The testing apparatus has dimensions of 24 x 24 x 44 cm.

Methods

In this experiment, data was collected using the following procedure:

- The foil was attached to the strain guage stand using duct tape and its orientation was set to the desired angle using a protractor.
- The stand was attached to the bottom of the wind tunnel using duct tape.
- Lead wires were inserted through guide holes in the bottom of the wind tunnel and connected to an arduino.
- The viewing pannel was closed and the wind tunnel was activated.
- The air speed was measured using a flow meter and the strain guage's output was read by the arduino.
- This process was repeated for angle 0, 7, 10, 18, 20, and 28 degrees.

Experimental Results

The following graphs compare experimental results with CFD and literature values.

Figure 6: Drag Coefficient vs. Angle

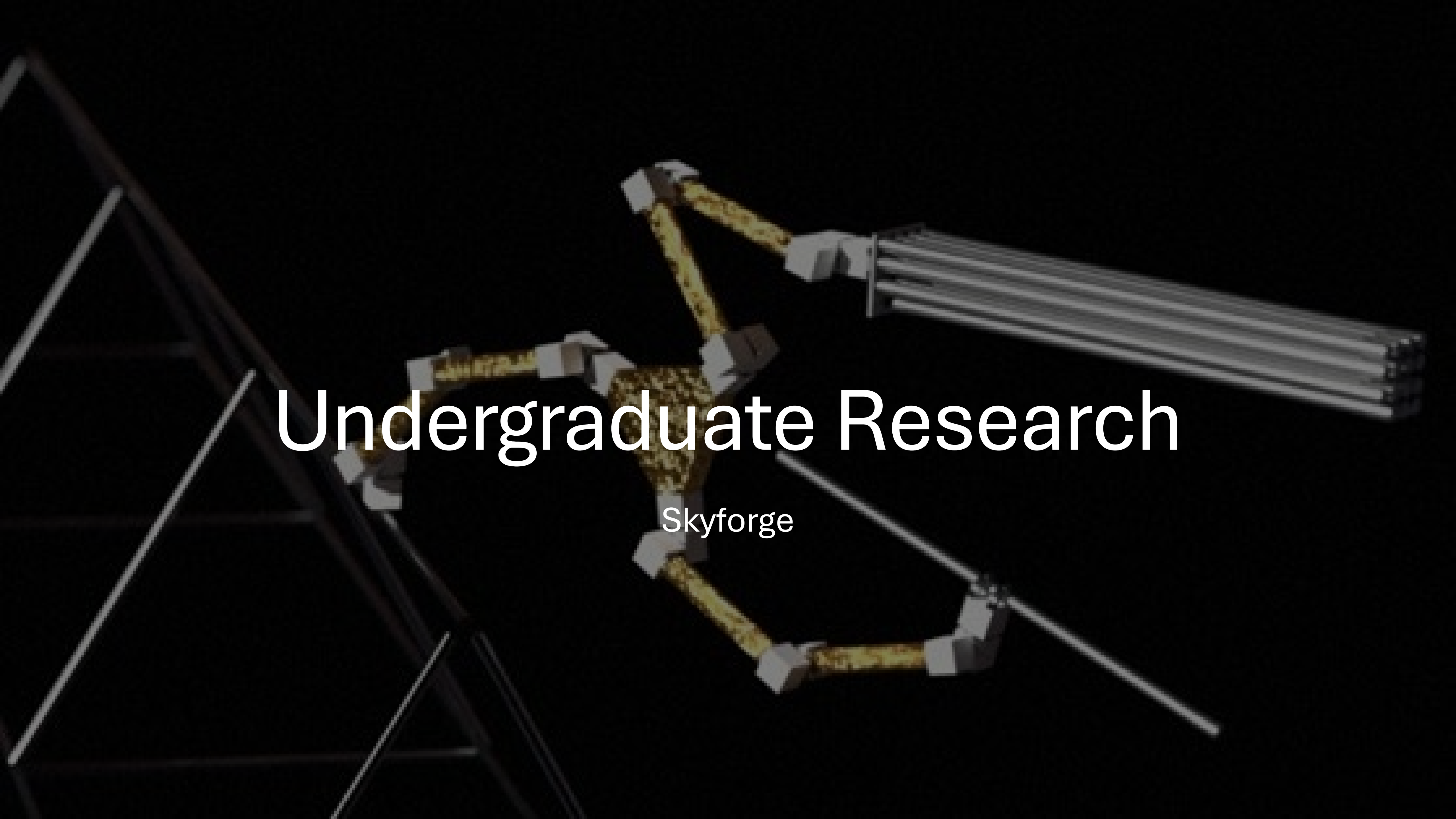
Figure 7: Error in Drag Coefficient

Research Conclusions

- The average error between experiment and literature was 23.4%, while the average error between experiment and CFD was 46.4%.
- CFD error can be atributed to difficulties in simulating low reynolds number.
- Error in both CFD and experiment can be atributed to effect of walls, enterance area, and stand on airflow.
- CFD consistantly overestimates drag coefficient and is most accurate far from stall angle.
- Experimental results underestimate drag coefficient before stall and overestimates drag coefficient after stall angle.

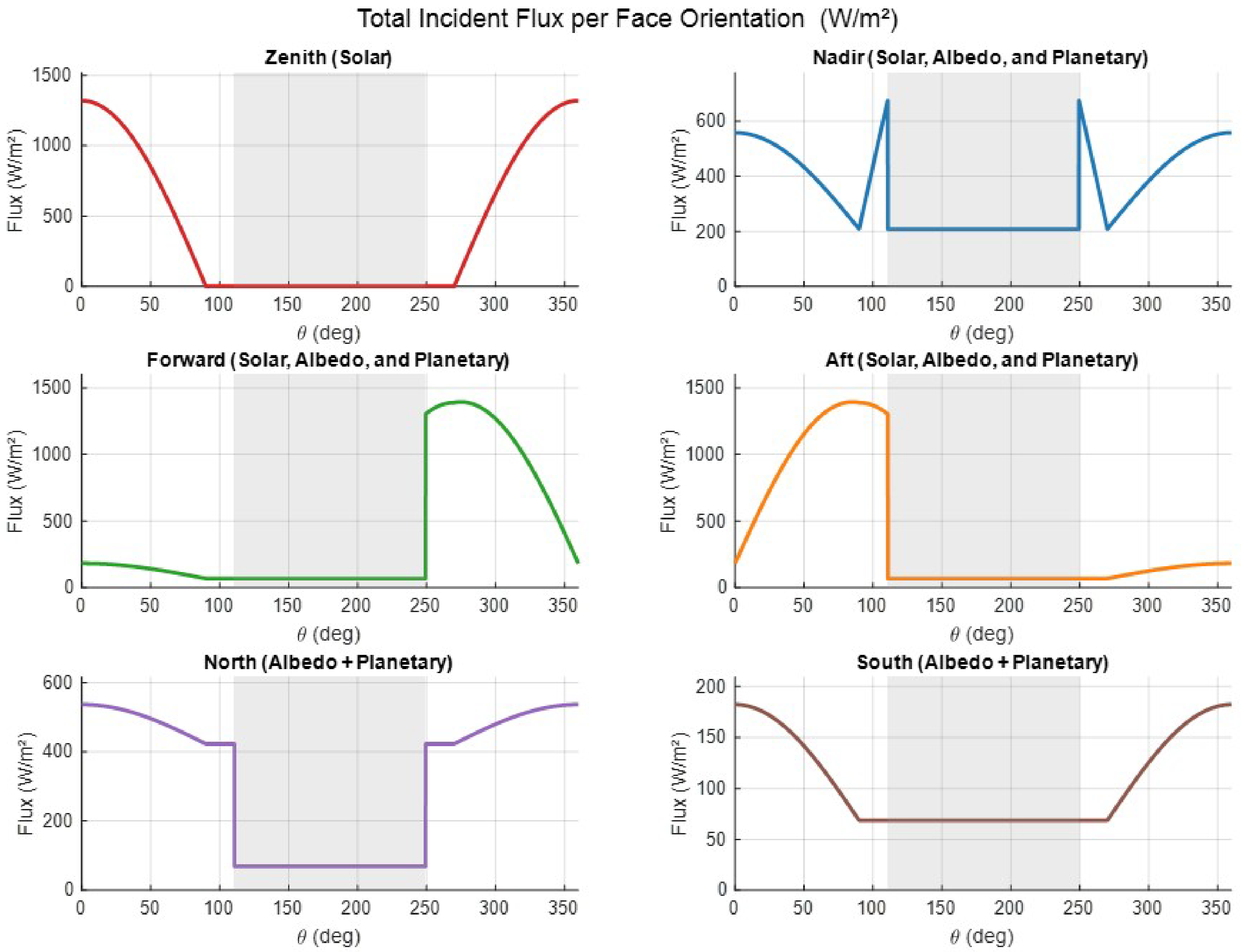
Project Poster

- My team designed a poster, summarizing our project
- We presented our findings at a spring poster session



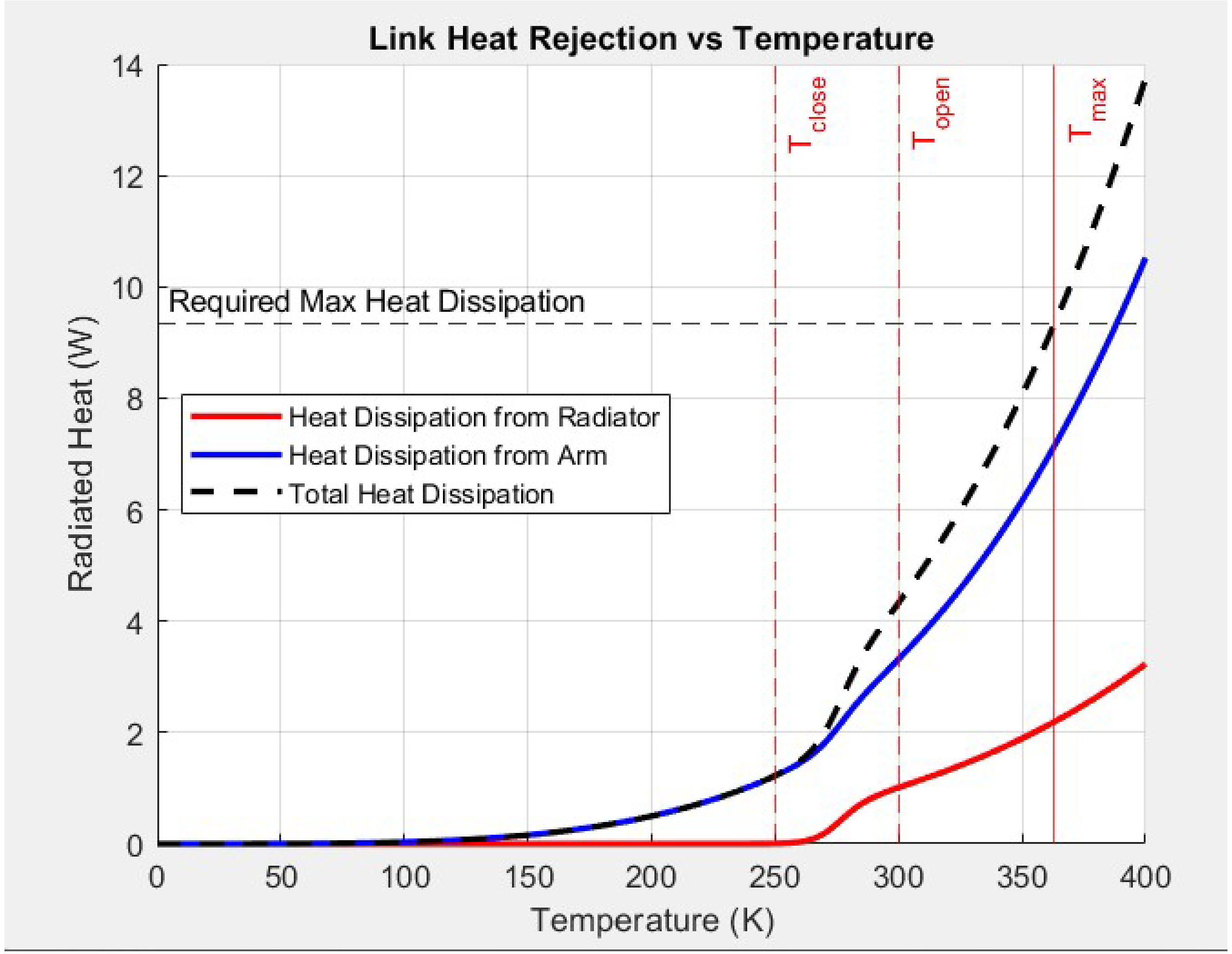
Undergraduate Research

Skyforge



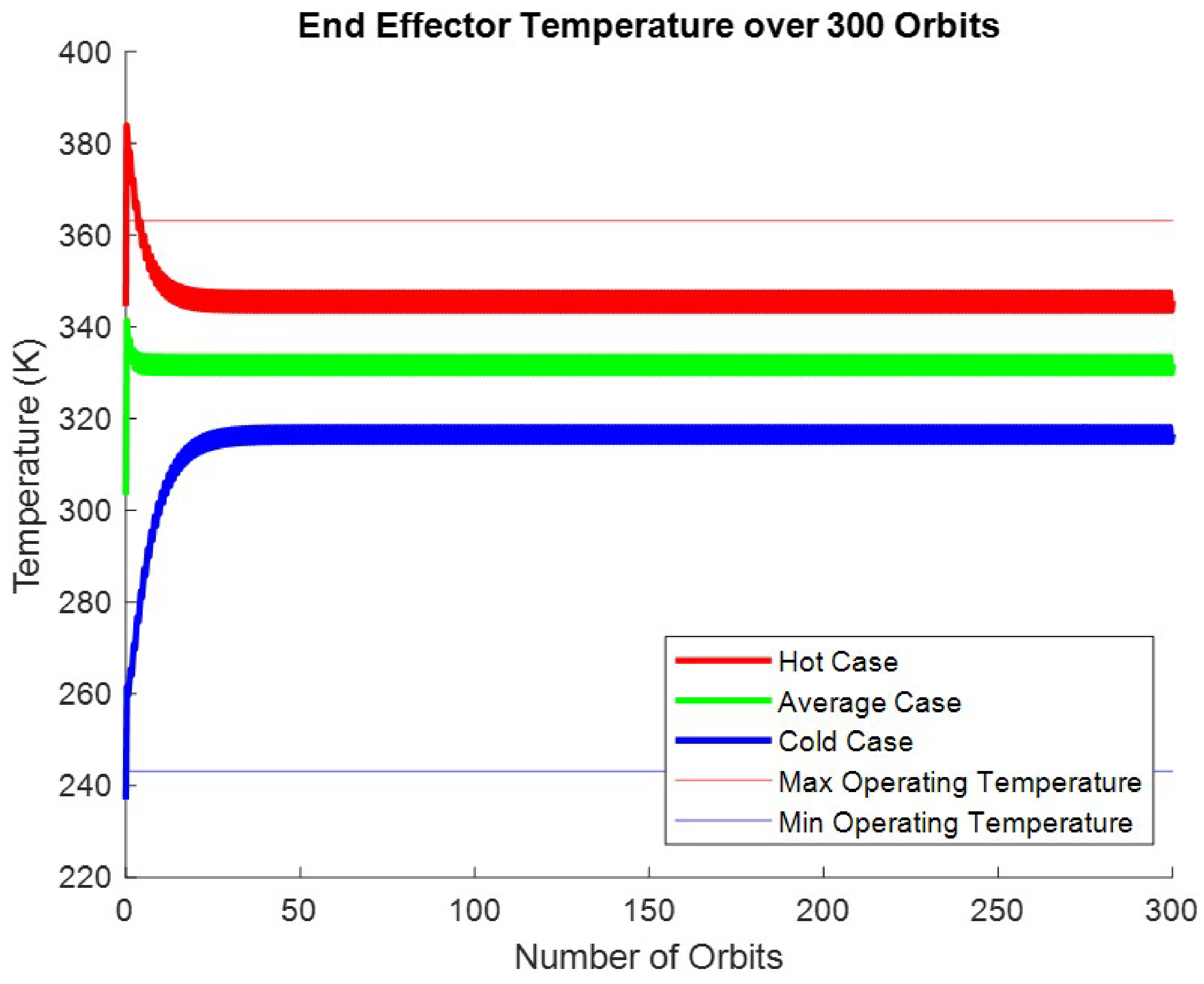
Environmental Heat Flux Based on Spacecraft Orientation

- I own thermal modeling and simulation for a space-based robotic system
- Cross-disciplinary research:
  - Coding
  - Thermal simulation
  - Mission architecture
  - Orbital dynamics
  - Mechanical design for space-based operation
  - Interfacing with electrical and mechanical engineers on other research teams
  - TVAC testing



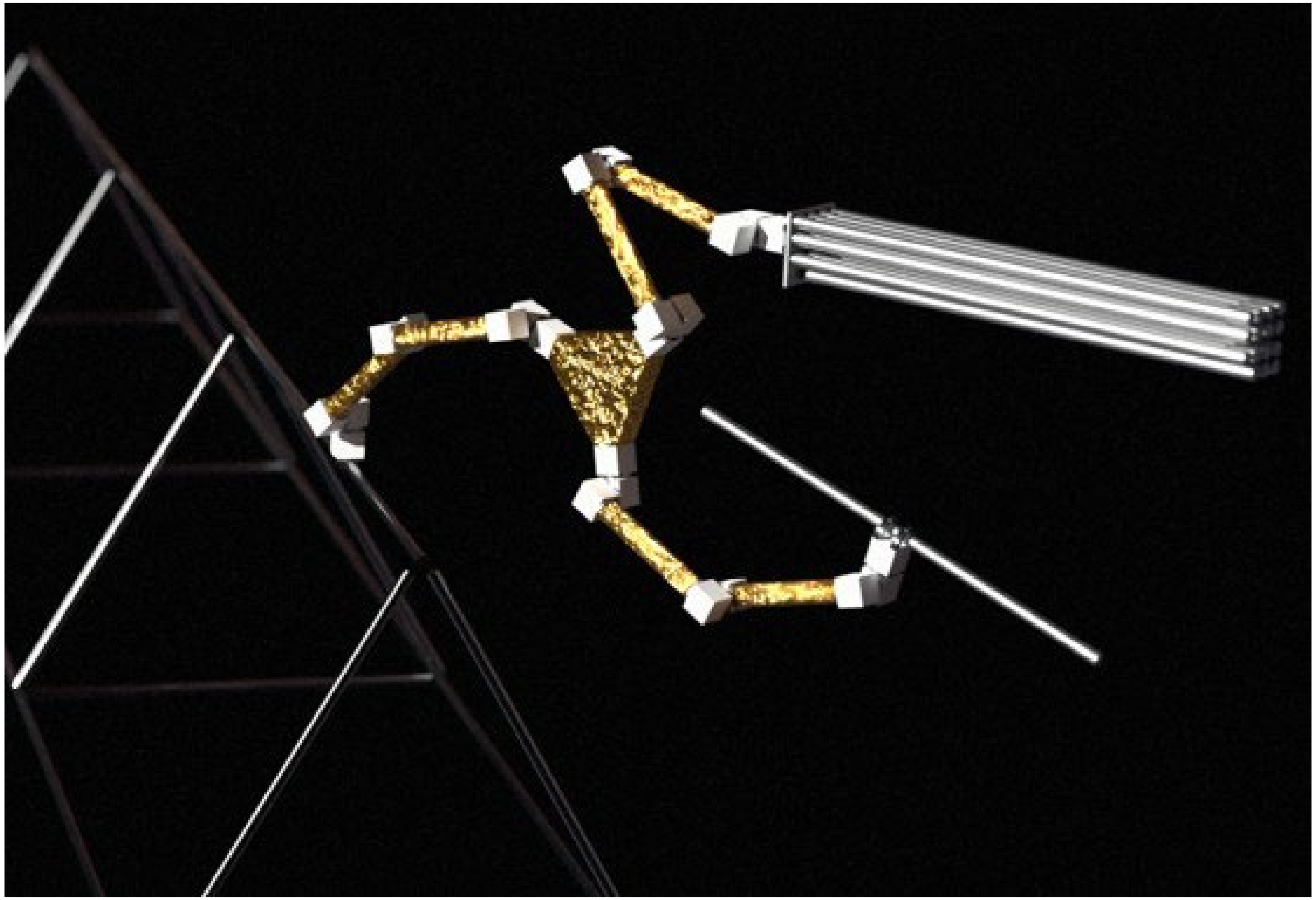
Heat Rejection impact from Thermal Louver Actuation

- My research team's goal is to develop an actively actuated thermal louver to vary radiator area with response to temperature
- Main part of my work is modeling the thermal behavior of the robot arm
- Louver actuation increases radiator area, which increases heat dissipation
- My work helps both establish and validate the current thermal louver design



Temperature of End Effector over 300 Orbits

- Researched and formulated worst case scenarios for hot/cold cases
- Final code displays temperature over desired number of orbits for each joint and link in 6 DOF robot arm
- Incorporates contact resistance from bolted connections, transient conduction modeling, radiation losses, and environmental heating



Artist's Render of Robotic System in Space during Operation

- Impact of work:
  - Inform thermal design requirements for other design teams
  - Validate louver design
  - Inform mission architecture
- Research is still ongoing (I will update once my work in this research group is complete in Spring 2027)
- Future work (Fall 2026 & Spring 2027):
  - Thermal Simulation to refine initial design
  - Heat Sink/Thermal Strap Design
  - Electrical System Integration
  - Design and Manufacturing of Thermal Louver
  - Integrated system testing in TVAC conditions