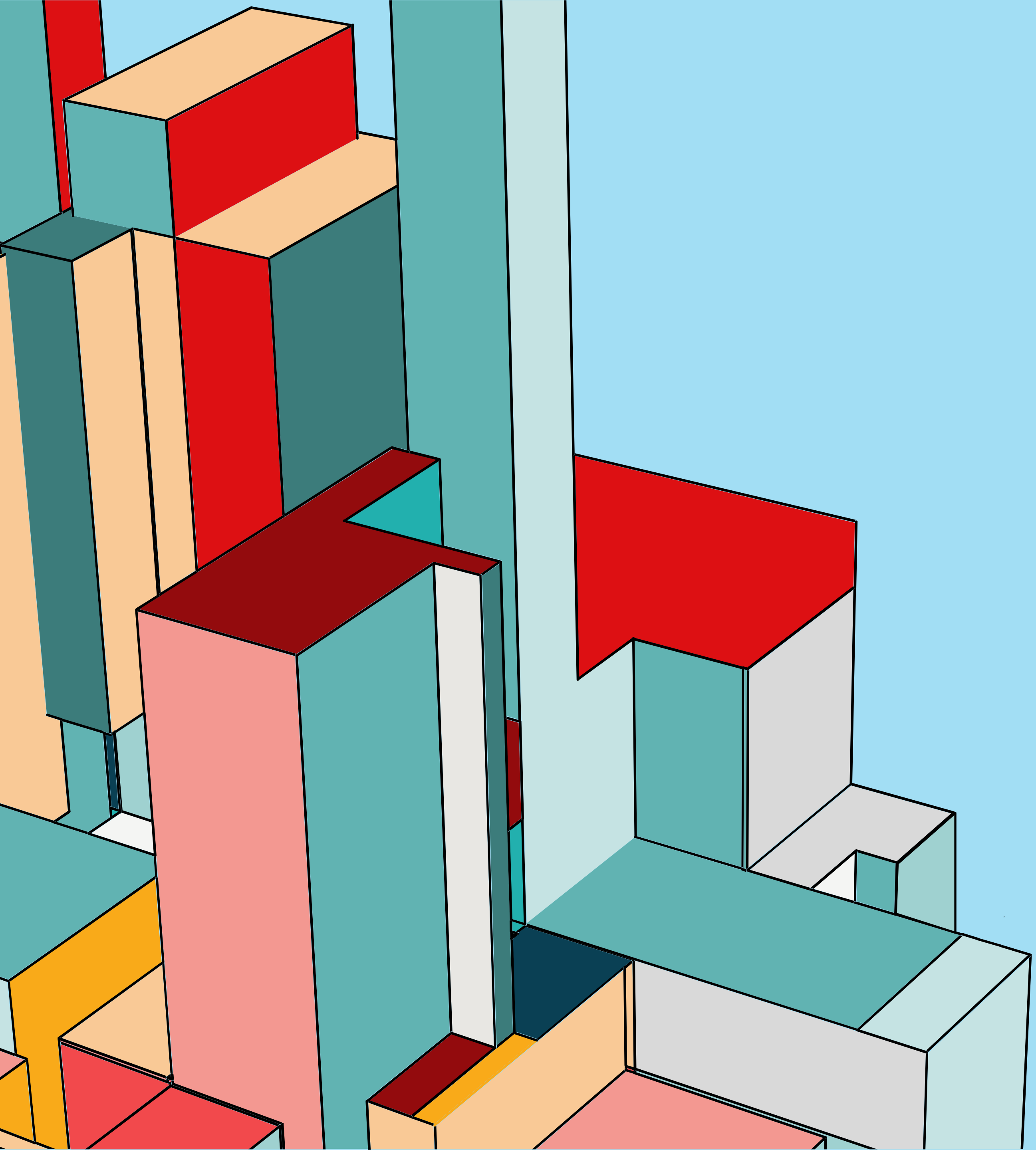

ENGINEERING PORTFOLIO

Han Zheng

ABOUT ME

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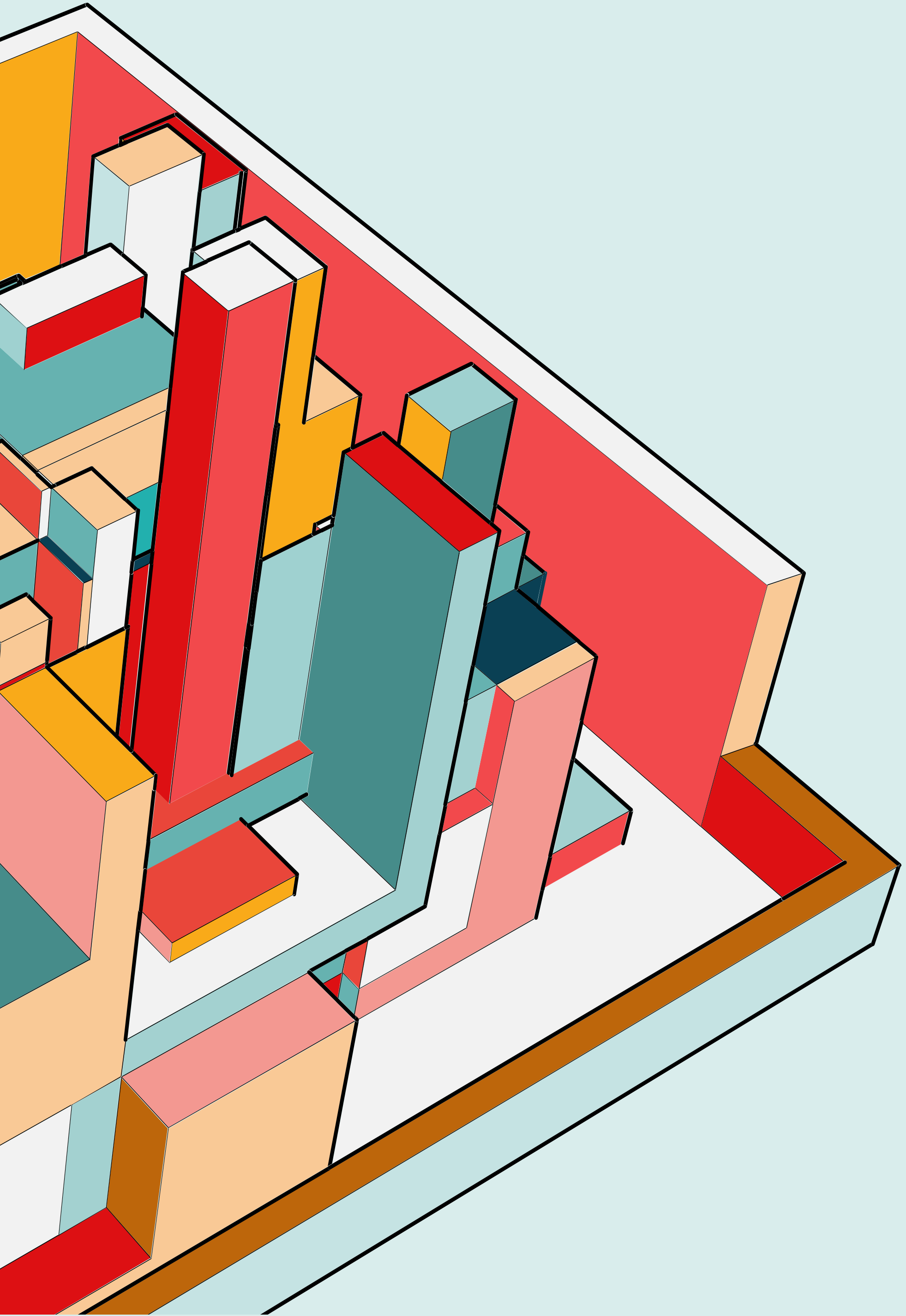
Hi! My name is Han (spelled the same as "Han Solo" from *Star Wars* and "Han" from *Fast & Furious*), and I am a junior majoring in Mechanical Engineering with a focus on Aerospace.

I have been a passionate builder from a young age, crafting creations out of hot glue and cardboard. Today, I've taken that passion to the next level by using advanced tools like SolidWorks and MATLAB, solving real-world engineering challenges. What drives me is the belief that even the smallest innovations can create lasting, positive change. I hope eventually the little changes I've made would benefit our society!

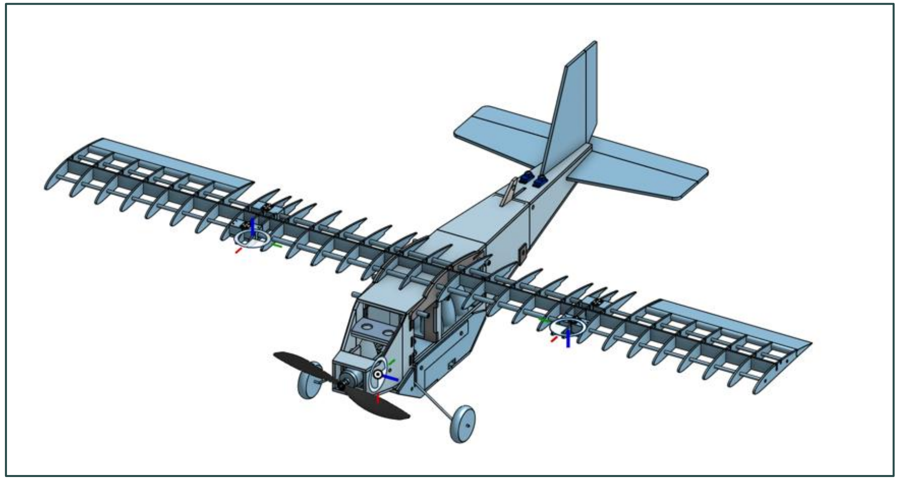
Formula 1 race cars, tanks, sniper rifles, etc. that I made in middle school



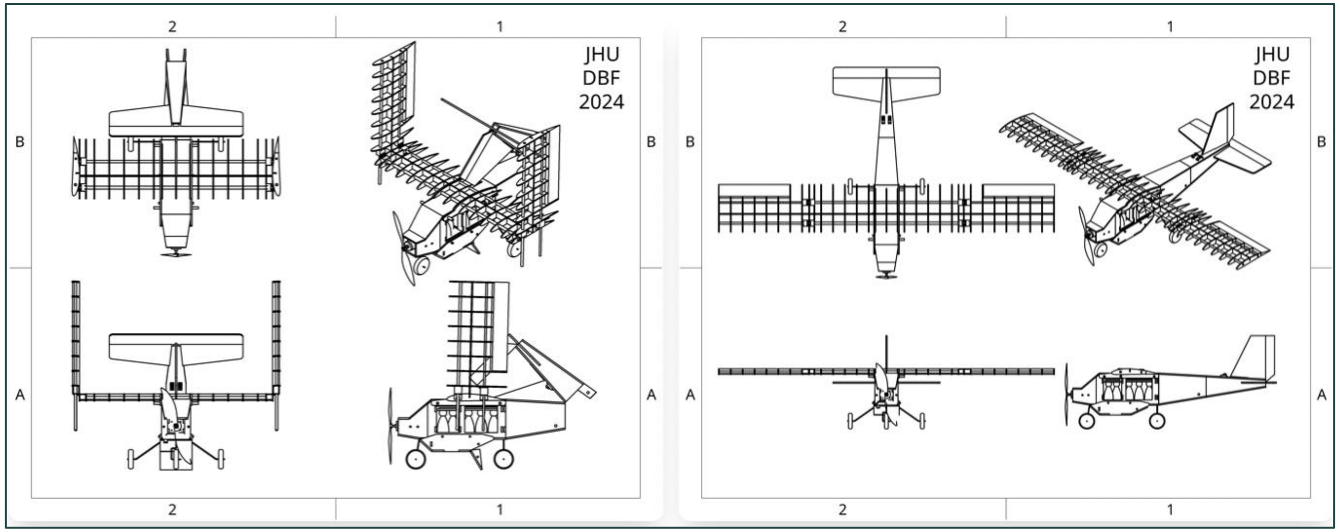
CONTENT

DESIGN/BUILD/FLY (DBF)

Background: At JHU DBF, our mission is to learn everything about airplanes and use that knowledge to design, build, and fly our plane against top teams from the world in the annual DBF competition hosted by American Institute of Aeronautics and Astronautics (AIAA)



An isometric view of our 2024 DBF plane model, designed on Onshape



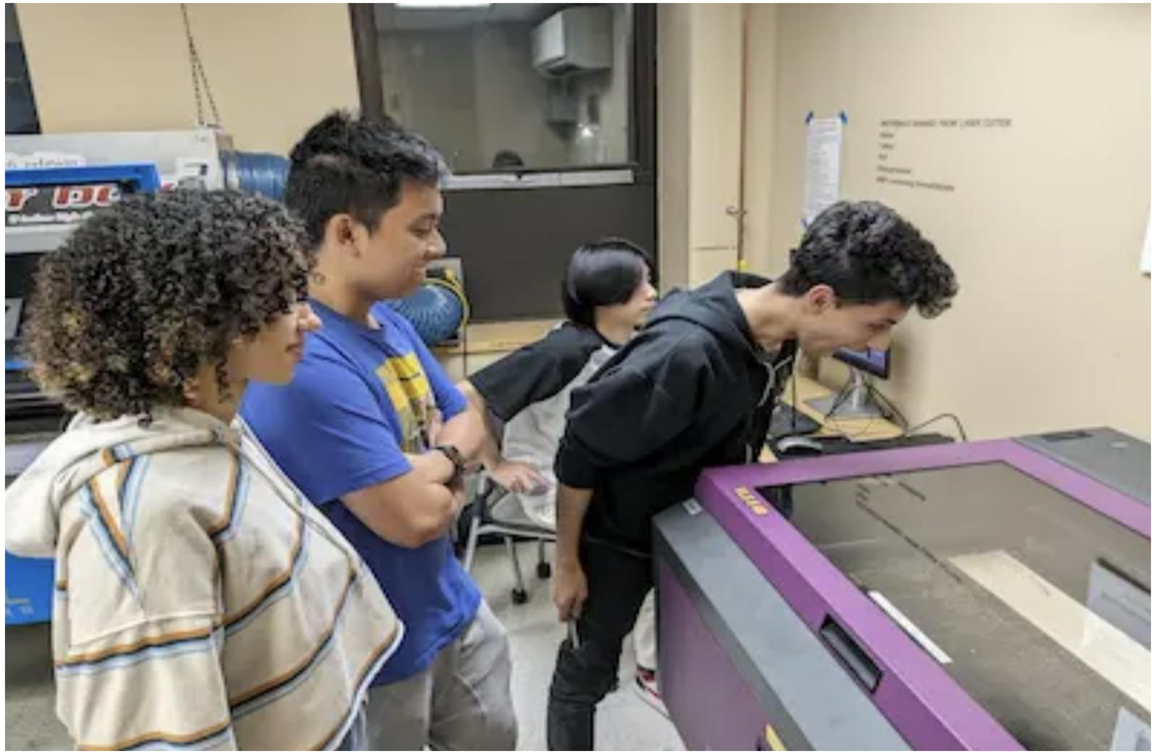
The engineering drawings of our 2024 DBF plane, which features a foldable wing and tail to accommodate the restriction on aircraft size.

DBF (CONT.)

<u>The story</u>: I first joined DBF at JHU in 2023 Fall, which at that time the club has been inactive for a year. With very limited resources–including a lack of and professional support–we went from building simple foamcore planes to placing 67th out of 149 teams at the competition.

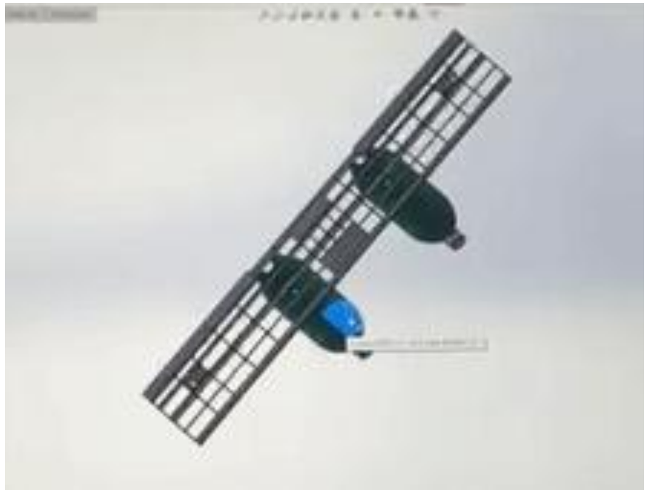
<u>My Role</u>:

- I designed airfoil ribs on Onshape based off of the NACA-2412 model to allow implementation of servo motors, ailerons, flaps, and the wing spar. I then manufactured copies of airfoil ribs using a laser cutter
- I conducted stress-strain analysis and determined that our aircraft model would have a maximum wing tip deflection of 0.7”
- I assembled the plane with the DBF team. After multiple iterations, we developed a standardized manufacturing process.

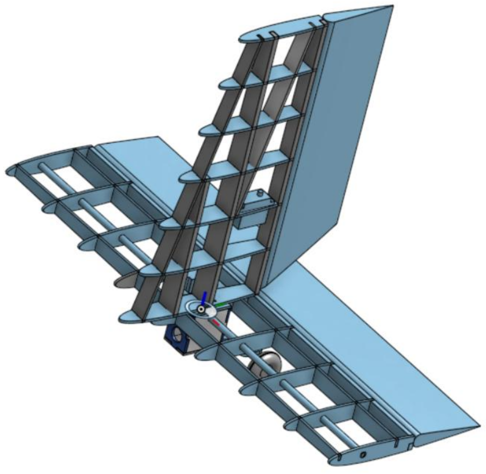


Me (sitting on the chair) and other DBF members watching our first airfoil rib manufactured by the laser cutter

DBF (CONT.)



Wing and fuel tank assembly in SolidWorks, where the fuel tanks can be attached to pylons on the carbon fiber spar

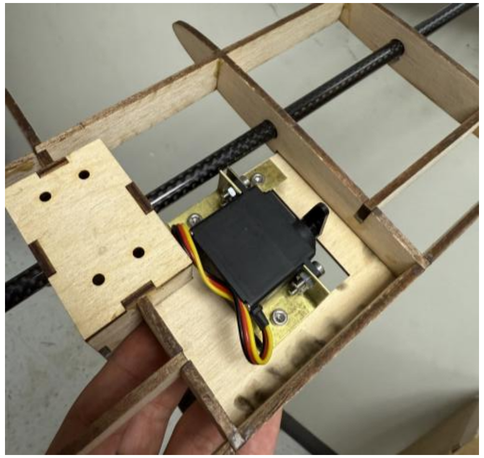


The tail assembly that I made

<u>2024-2025 Progress:</u>

- I created a wing-fuel tank and determined that the optimal placement of the fuel tanks is 32.4" from the wing butt line to limit bending moment in the fuselage while minimizing wingtip-deflection, using a self-developed beam analysis tool in MATLAB
- I calculated that the optimal outer diameter for the carbon fiber tube (spar) is at least 0.738", based on a 4G load factor and a factor of safety of 1.5
- I led a team of two in designing a tail assembly, integrating modified airfoil ribs, servo motors, rudder, elevator, and structural supports

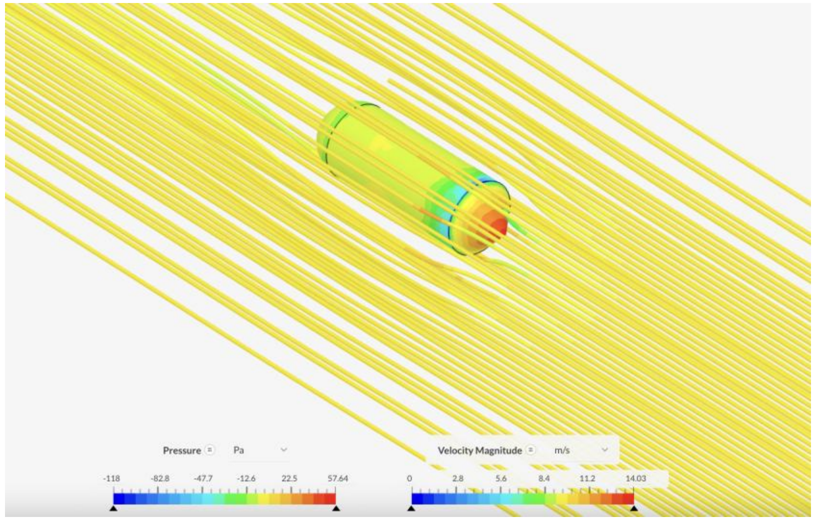
DBF (CONT.)



The elevator servo motor constrained by brass brackets and a plywood platform I manufactured

2024-2025 Progress (cont.):

- I designed and manufactured servo motor mounts for the empennage and wing using sheet metal techniques, including shearing, bending, and punching
- I am using SimScale to simulate the fuel tank-pylon assembly and visualize airflow around it. I am also redesigning the pylon to improve its aerodynamic performance

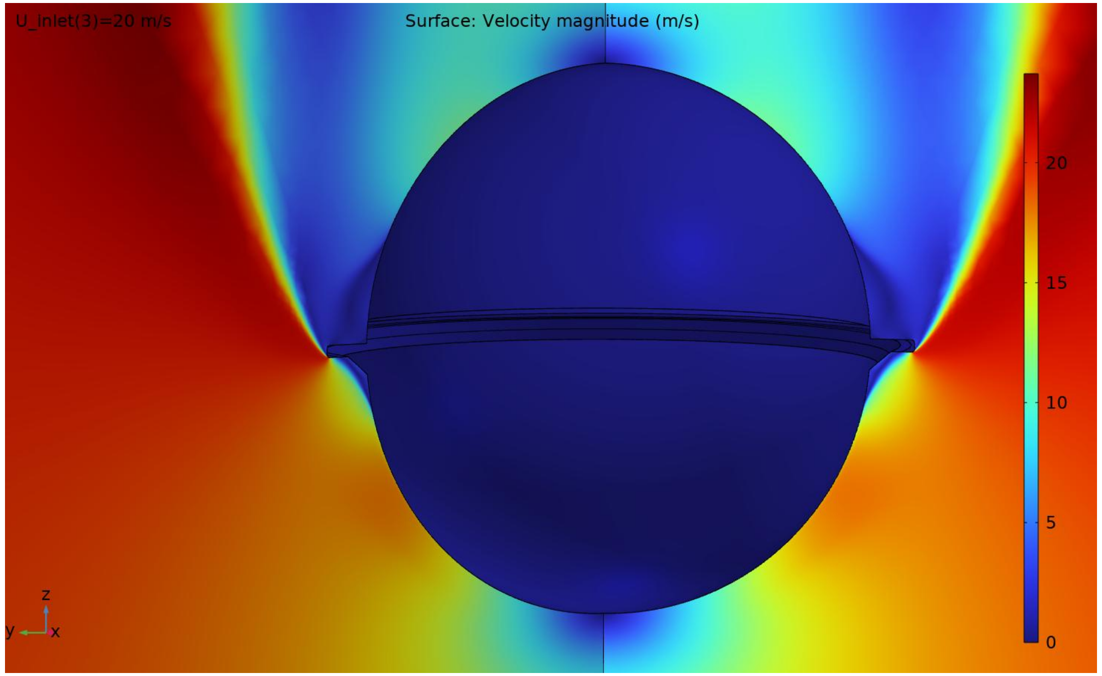


A simplified initial simulation of the fuel tank at 10m/s. Note the laminar flow around the tank and a very minimal wake behind it

DBF (CONT.)

Our current progress on the aircraft

VFOX ACCOMMODATION, DAVINCI MISSION



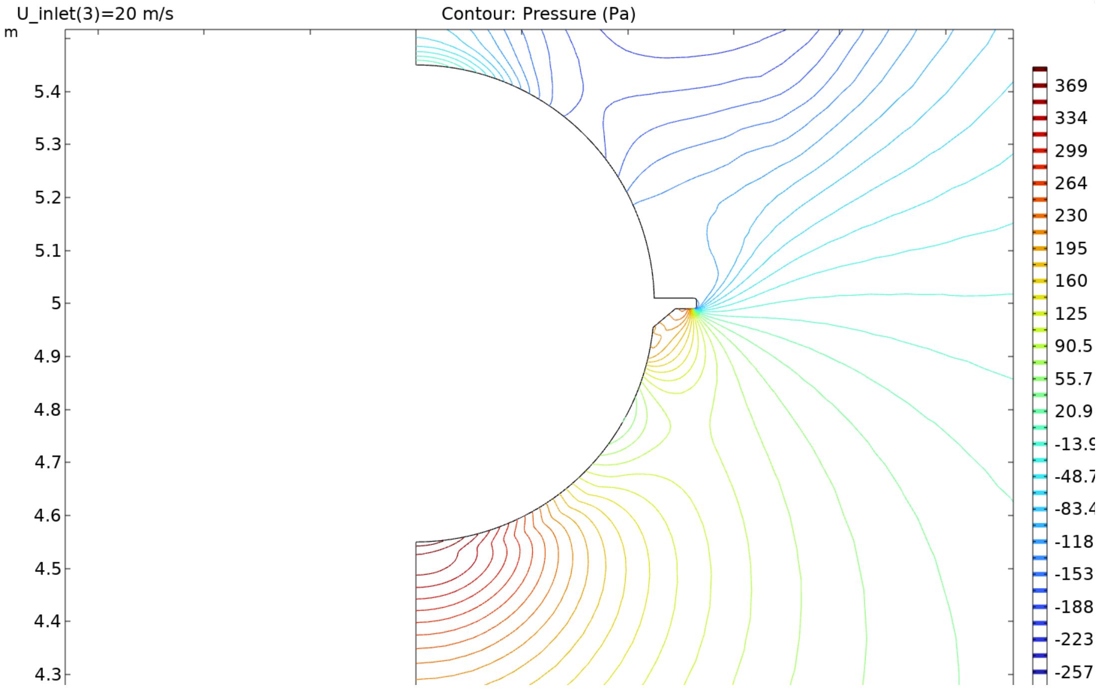
The airflow speed distribution (3D) around the descent sphere at a descent speed of 20 m/s

<u>Project Details</u>: As a student collaborator in the VfOx (the Venus Oxygen Fugacity sensor) team, a part of the DAVINCI (Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging) Mission, I was tasked with assessing the proposed VfOx accommodations on the descent sphere.

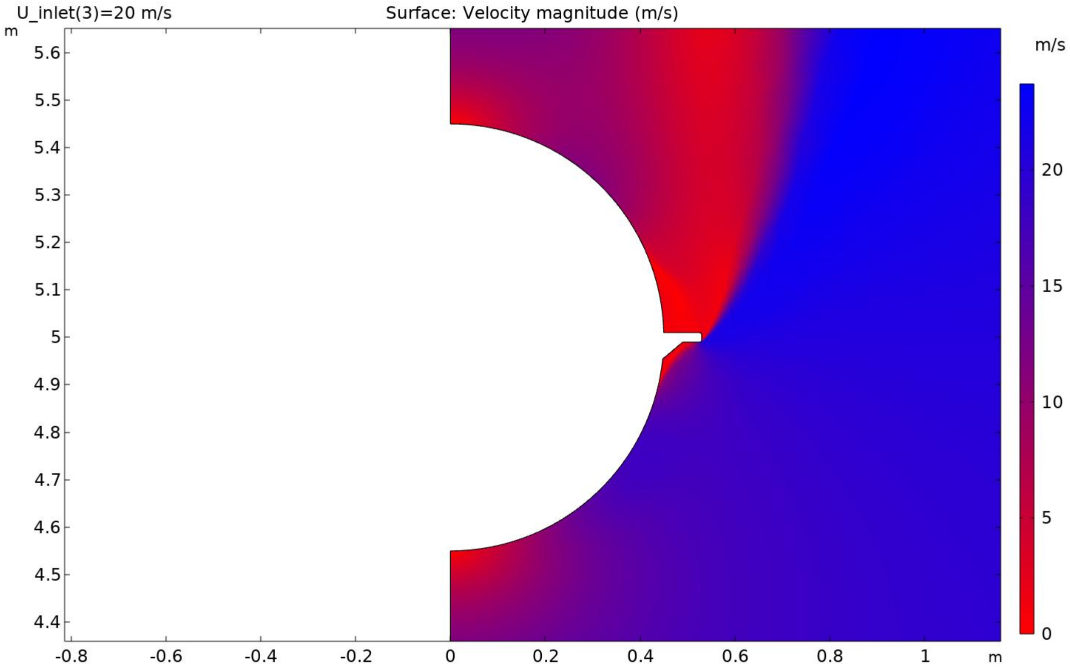
<u>My Role:</u>

- I used COMSOL Physics to simulate the airflow around the descent sphere and observed regions of flow separation
- I proposed that VfOx should not be placed in regions with stagnant airflow or in the wake region due to a lack of fresh airflow
- I created a 5x5 risk matrix for each VfOx accommodation to assess the pros and cons (e.g. signal noise, structural stability, data accuracy, and aerodynamics)

VFOX ACCOMMODATION, DAVINCI MISSION (CONT.)



The pressure distribution around the descent sphere at a descent speed of 20 m/s

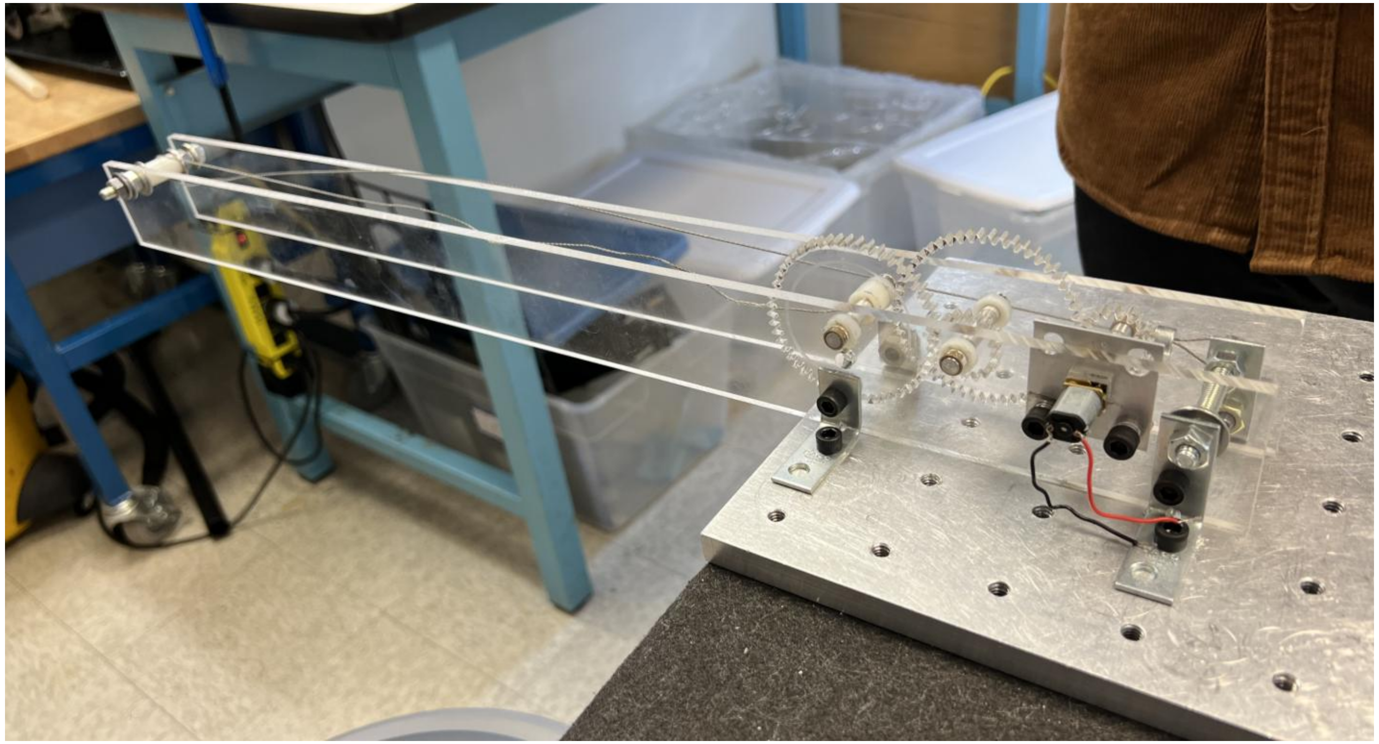


The velocity distribution (2D) around the descent sphere at a descent speed of 20 m/s

Final Presentation: https://docs.google.com/presentation/d/1vXlPrKgjhwT1P39-aW1dar2u0NNSE2wrfpaP0NO6CsQ/edit?usp=sharing

ACRYLIC CRANE

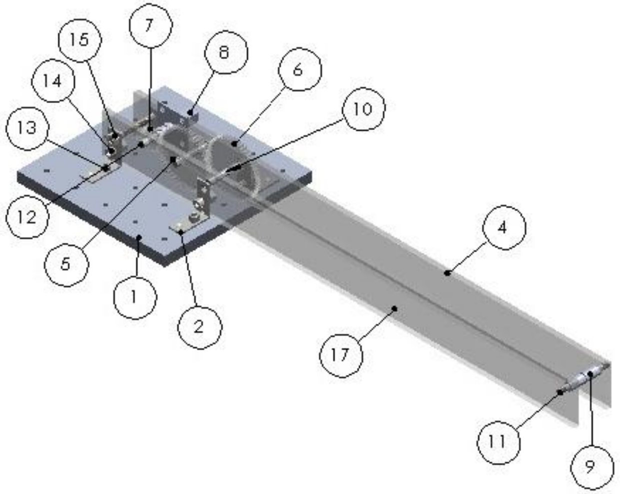
Group photo of my team and the crane



The acrylic crane secured on a mounting plate with angle brackets

<u>Design Requirements</u>: In this project, we are required to design and construct a crane that is capable of lifting a 10lb weight up by one inch under one minute. The crane should not have a maximum deflection of more than 0.5". We are given a 6V gearmotor with a stall torque of 12 oz-in and a 7.75" x 7.75" x ¼" acrylic plate, and we are allowed to purchase $25 worth of materials.

ACRYLIC CRANE (CONT.)



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	CMP	Crane Mounting Plate	1
2	1556A63	Zinc-Plated Steel Corner Bracket	4
17	AW	Acrylic Wall	1
4	AWMS	Acrylic Wall - Motor Side	1
5	6391K126	Oil-Embedded Bronze Sleeve Bearing	5
6	AG51T	Acrylic Gear - 51T	2
7	AG18T	Acrylic Gear - 18T	2
8	GMSA	GearMotorSubAssembly	1
9	SP1	Spacer	1
10	8974K221	Multipurpose 6061 Aluminum	2
11	91565A552	Low-Strength Steel Threaded Rod	2
12	8974K221	Multipurpose 6061 Aluminum	1
13	91251A537	Black-Oxide Alloy Steel Socket Head Screw	5
14	91251A539	Black-Oxide Alloy Steel Socket Head Screw	3
15	95505A601	1/4" - 20 Steel Hex Nut	12
17	SW20	1/4" - 20 Steel Washer	8

530.216 MBD LAB	TITLE: CRANE ASSEMBLY	UNITS: INCHES	SCALE: 1:4	MATERIAL:	QTY. REQ.: 1
	TEAM: HALTech	DRAWN BY: ALVAREZ, GARG, ZHENG	DATE: 24APR24	DWG. NO.: 1	REV. NO.: 1

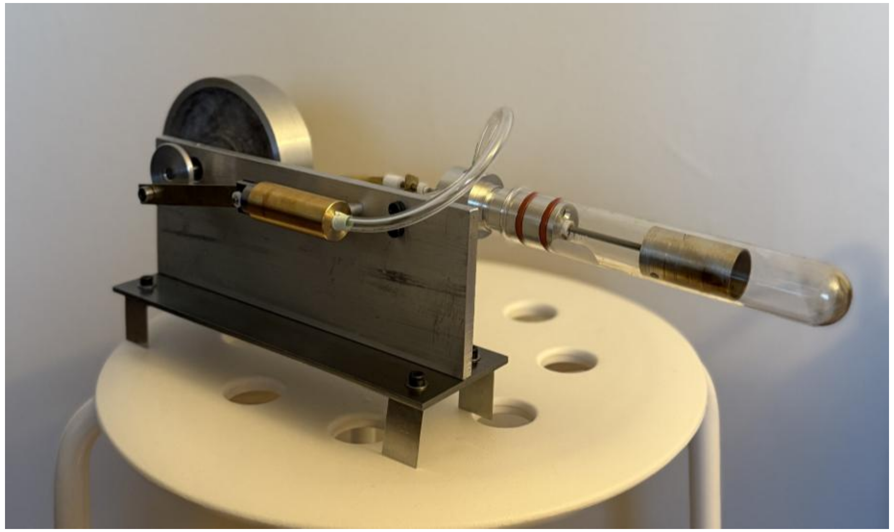
The drawing (isometric) of the crane with a bill of materials (BOM) labeled

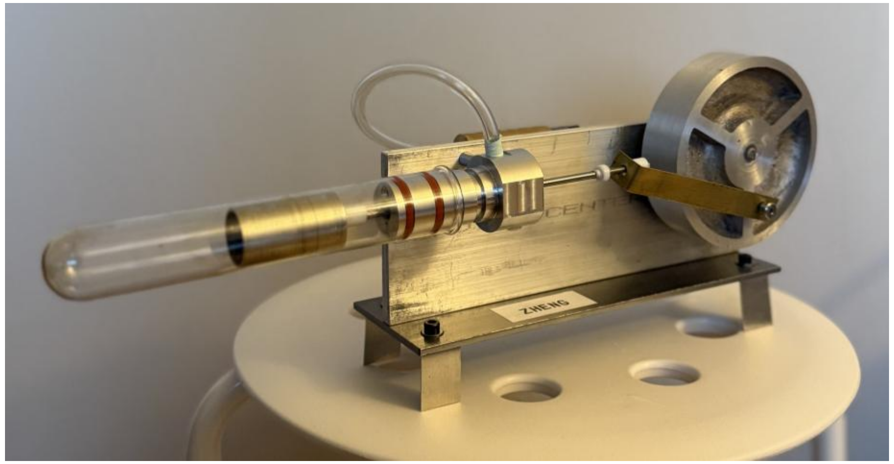
<u>My Role</u>:

- I conducted a comprehensive numerical analysis on the stress state of the beam, including bending stress, shear stress, and deflection
- I finalized the cross-section dimensions and material (2″ × 0.25″ acrylic bars), balancing between strength and price
- After performing gear train calculations, I decided an optimal gear ratio of 8 for a four-gear system and the optimal gear diameters to satisfy the crane constraints and requirements
- I designed the booms and the gear trains on Solidworks using the gear train calculations. I also made additional adjustments to the parts to incorporate other components (e.g., adjusting gear hole diameter for attachment to a shaft and bearing)
- I machined the acrylic bars into desired shapes and dimensions on a lathe

<u>Result</u>: Our crane successfully lifted the 10 lb weight by one inch in just 14 seconds, well within the required time limit of one minute. The measured beam deflection was 0.24 inches, which aligns with our designed safety factor of 2.

STIRLING ENGINE

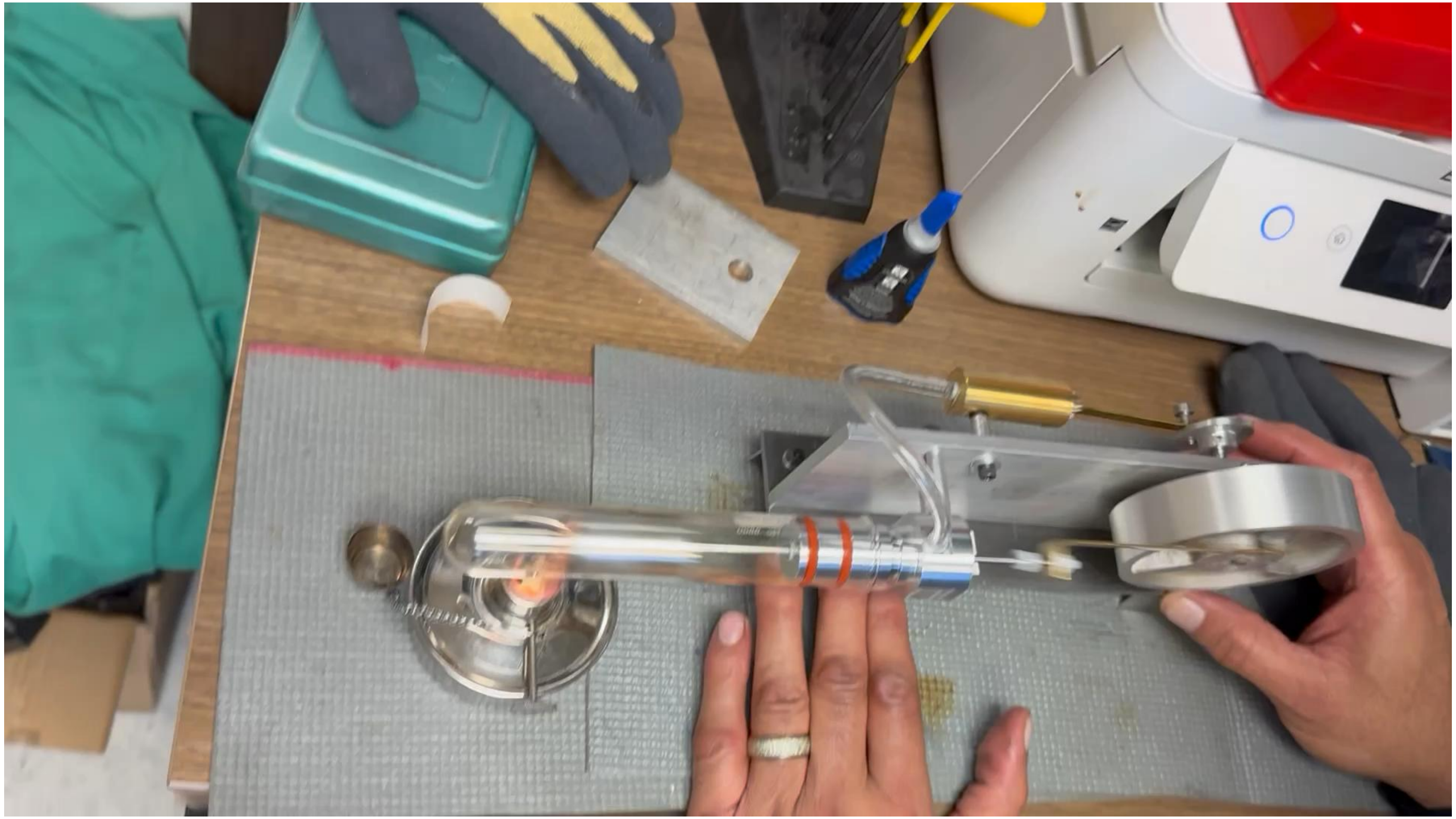




Isometric views of the stirling engine

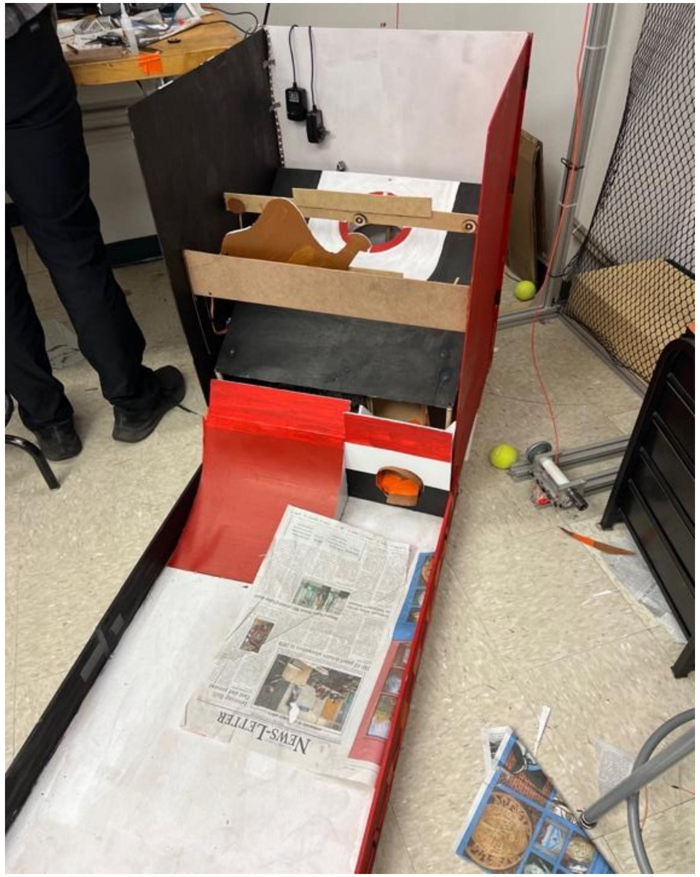
<u>Design Requirements</u>: For the manufacturing lab class, I was given CAD drawings of individual parts for a stirling engine. I wrote a process sheet that specifies the steps to manufacture a part for every component (e.g. flywheel, piston housing, piston wheel, etc.). Using the lathe, mill, and other machine tools in the lab, I successfully manufactured a stirling engine that runs at approximately 200 rpm (sample demonstration shown on the next slide).

STIRLING ENGINE (CONT.)



Sample demonstration of the stirling engine

ARCADE MACHINE

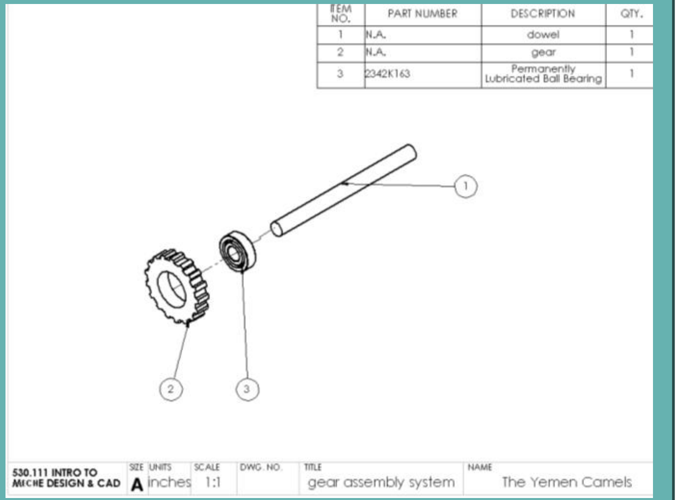


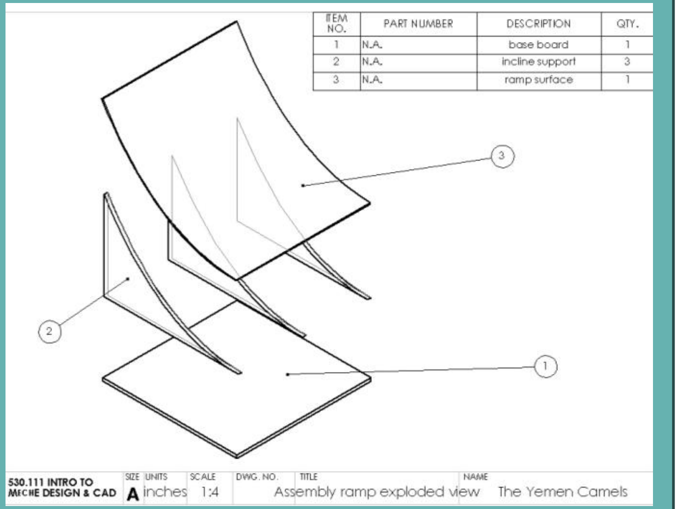
My team's arcade machine ("Camel Jumper"), a game inspired by skee-ball. The player has to throw a tennis ball up the ramp and over the moving camels to get it in the hole to score.

<u>Design Requirements</u>: In this project, we are asked to build a cultural-themed arcade machine. The major requirements are summarized below.

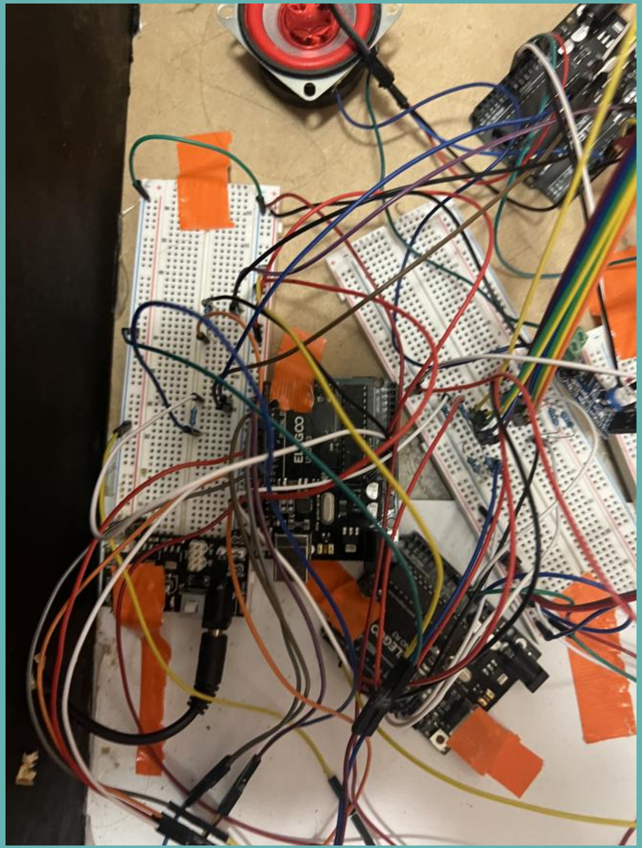
- At least one sensor and one controller device (e.g., button, joystick)
- Must have moving parts that respond to user input
- Must include lights and sounds that react to user interaction
- Should be automatically reset for the next user
- $50 budget limit for additional parts, in addition to provided Arduino kit components

ARCADE MACHINE (CONT.)





CAD drawings of selected components



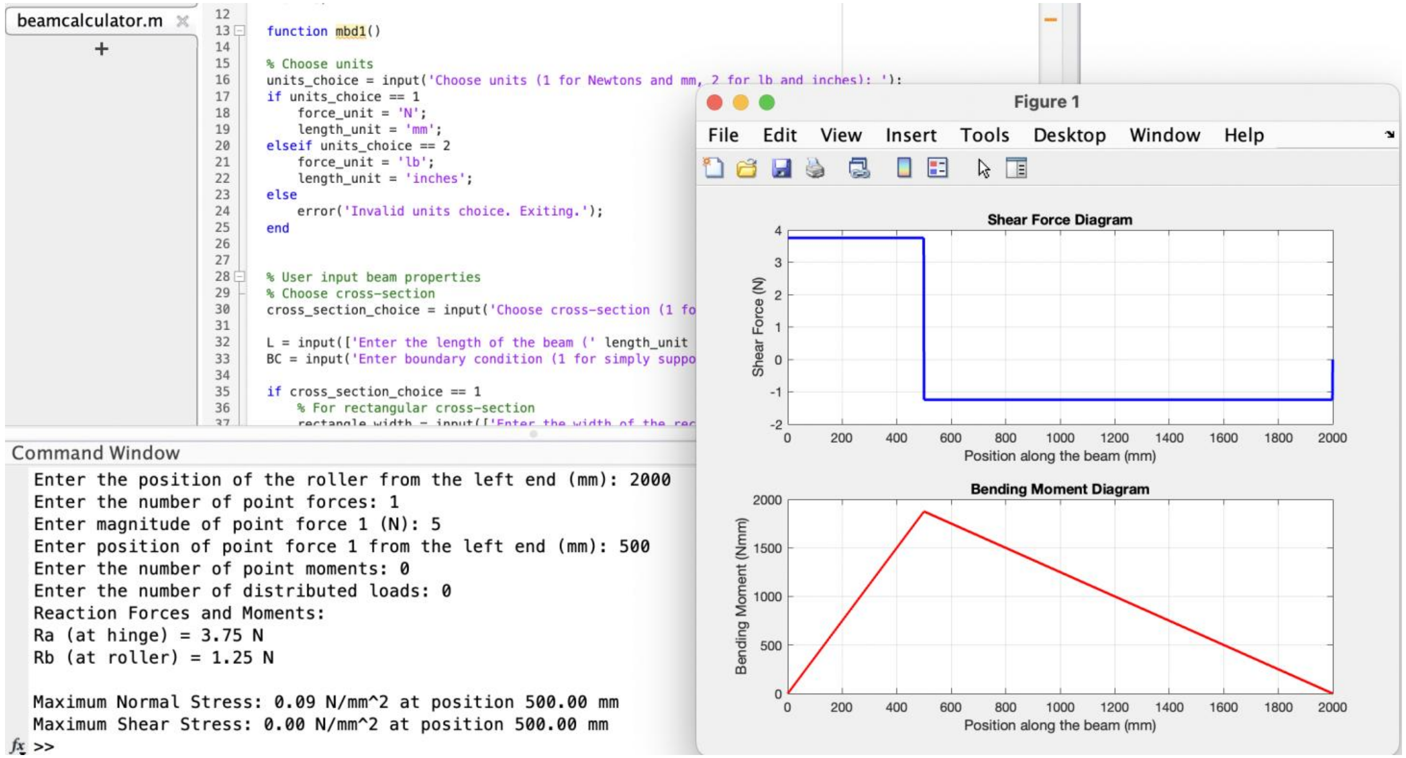
The electronics (e.g. breadboard, Arduino Uno, jumper wires, etc.) of the machine

<ins>My Role</ins>:

- I designed the gear system and the ramp in Solidworks and manufactured individual partsusing a laser cutter
- I troubleshot wiring issues by referencing to online forums, circuit diagrams, and conducting test trials
- I integrated the breadboards, Arduino UNO's, and other instruments into the machine's structure, making necessary adjustments (e.g., attaching the beam breaker to both sides of the return chute for scoring detection)

<ins>Result</ins>: Our arcade machine performed very well in the final exhibit, and all components were functional. It was rated as the second-most fun game in the post-project survey.

BEAM CALCULATOR

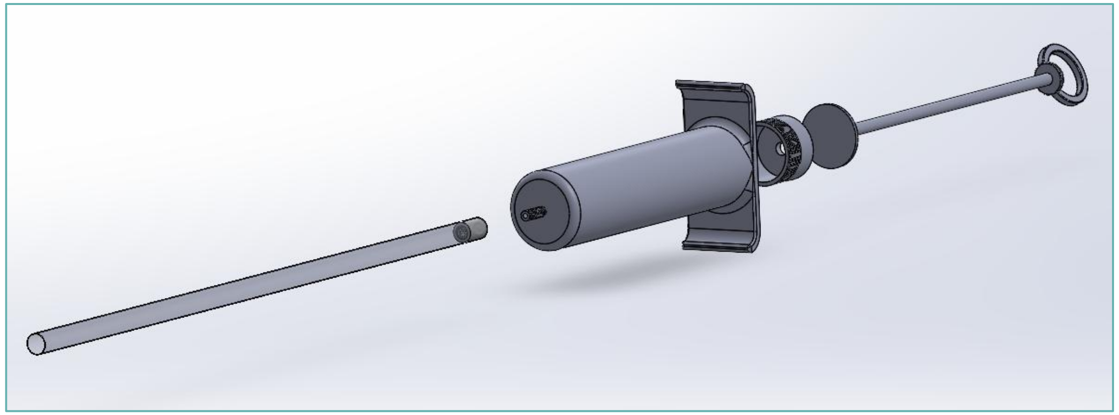


Selected user interface of the MATLAB program for beam bending analysis

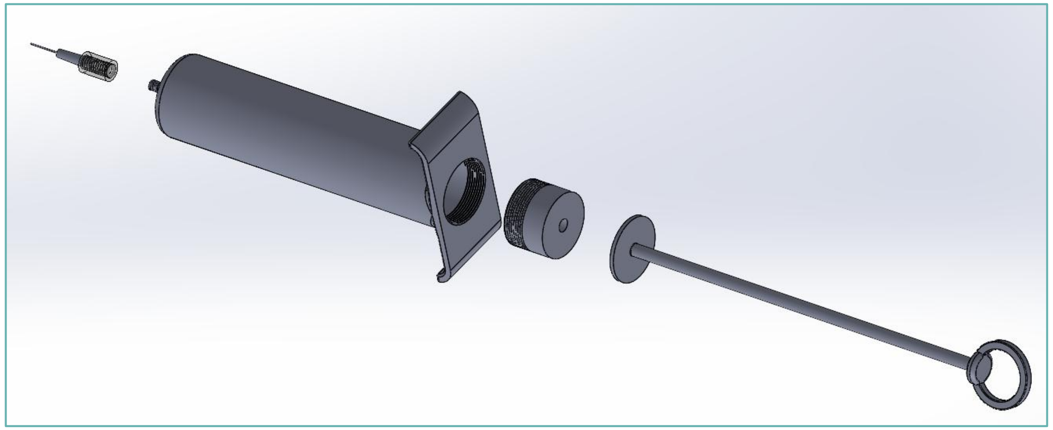
Project Details: Due to the need to analyze beam bending in various subjects, both inside and outside of class, I decided to develop my own “beam calculator.” It provides basic functions such as calculating reaction forces, shear forces, and bending moments along the length of a beam. The program accepts inputs such as unit preference (English or metric), cross-sections, support locations, point loads, point moments, and distributed loads. It then generates shear force and bending moment diagrams for enhanced visualization.

Link to the file: https://www.mathworks.com/matlabcentral/fileexchange/173285-beam_calculator

MULTIPURPOSE SYRINGE



Assembly of the feeding tube-syringe system in Solidworks



Assembly of the needle-syringe system in Solidworks

Project Details: As a product development intern for a Build Project sponsored by Open Avenues Foundation, I was tasked with redesigning a class II medical device. I designed a veterinary syringe that can be used with either a needle to deliver medication or a feeding tube to deliver nutrition. Additionally, I incorporated a more ergonomic plunger handle that combines the traditional circular plunger flange with a ring-shaped handle. I also documented the user needs and product specifications.

THANK YOU!