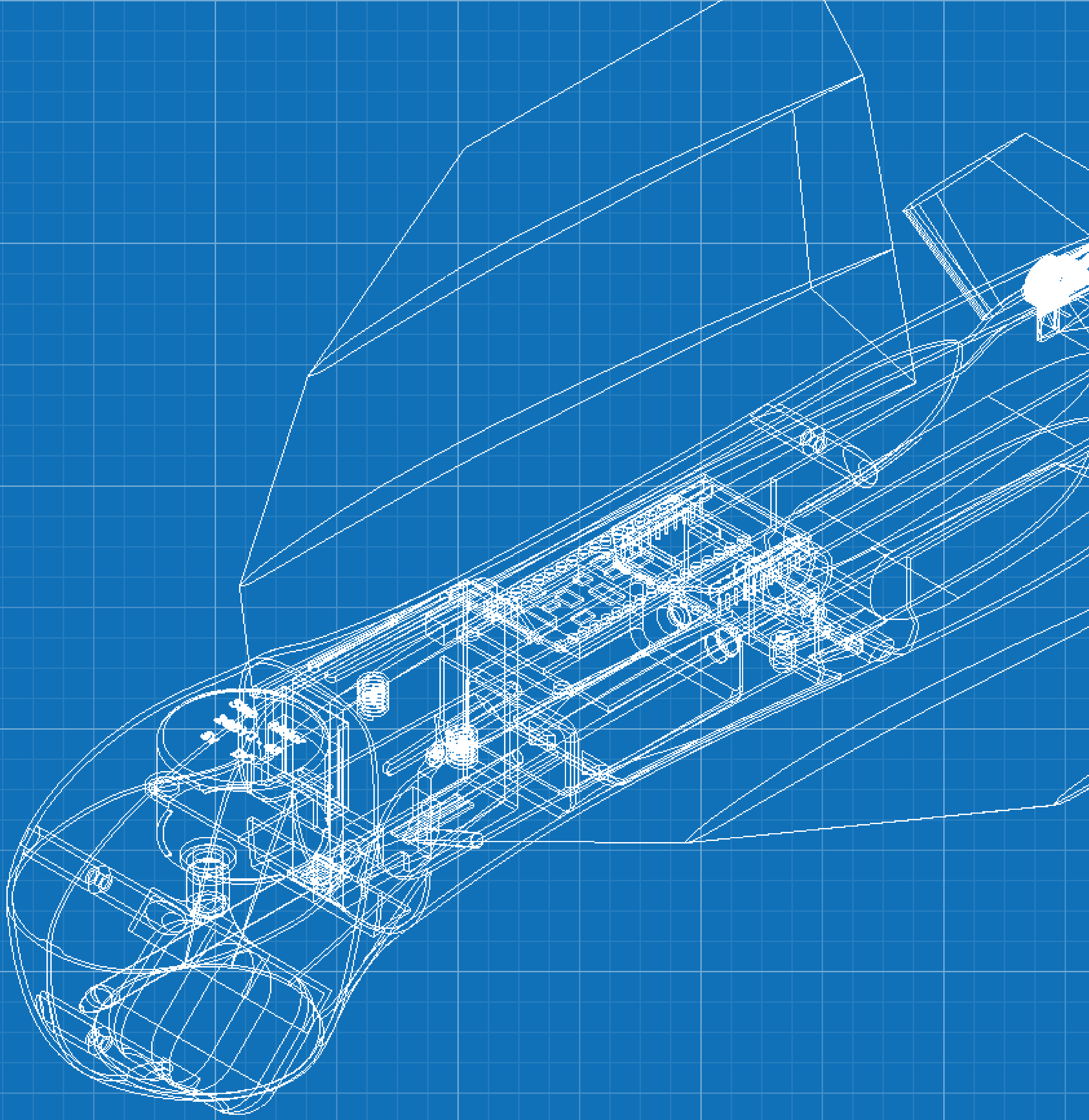
PROJECT PORTFOLIO

AMAN DADHEECH
MECHANICAL ENGINEER
MS ROBOTICS

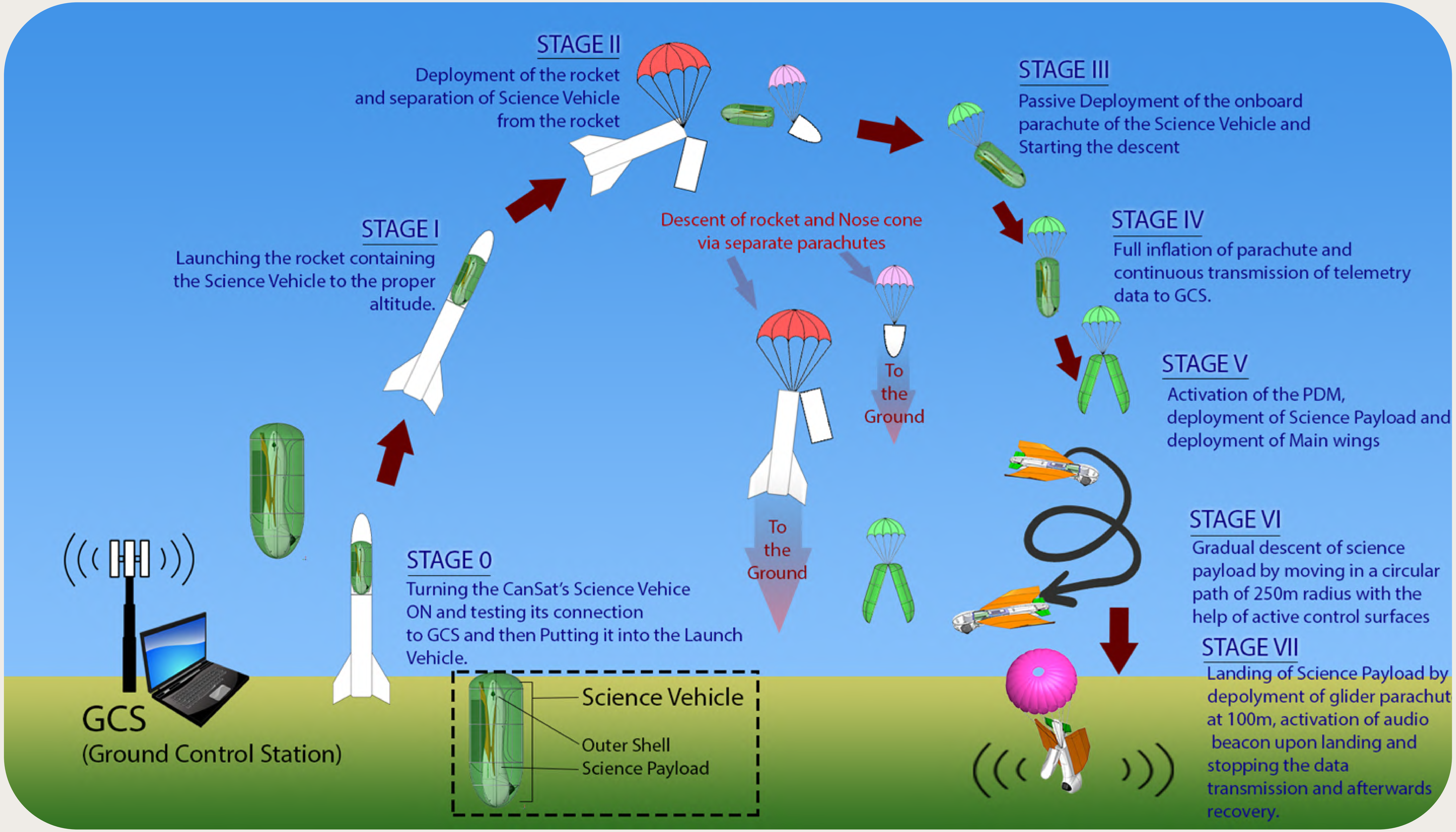
NASA CANSAT (NANOSATELLITE)



Team project
8 months
Contribution: Descent control system
Skills: SolidWorks, CFD, PDM

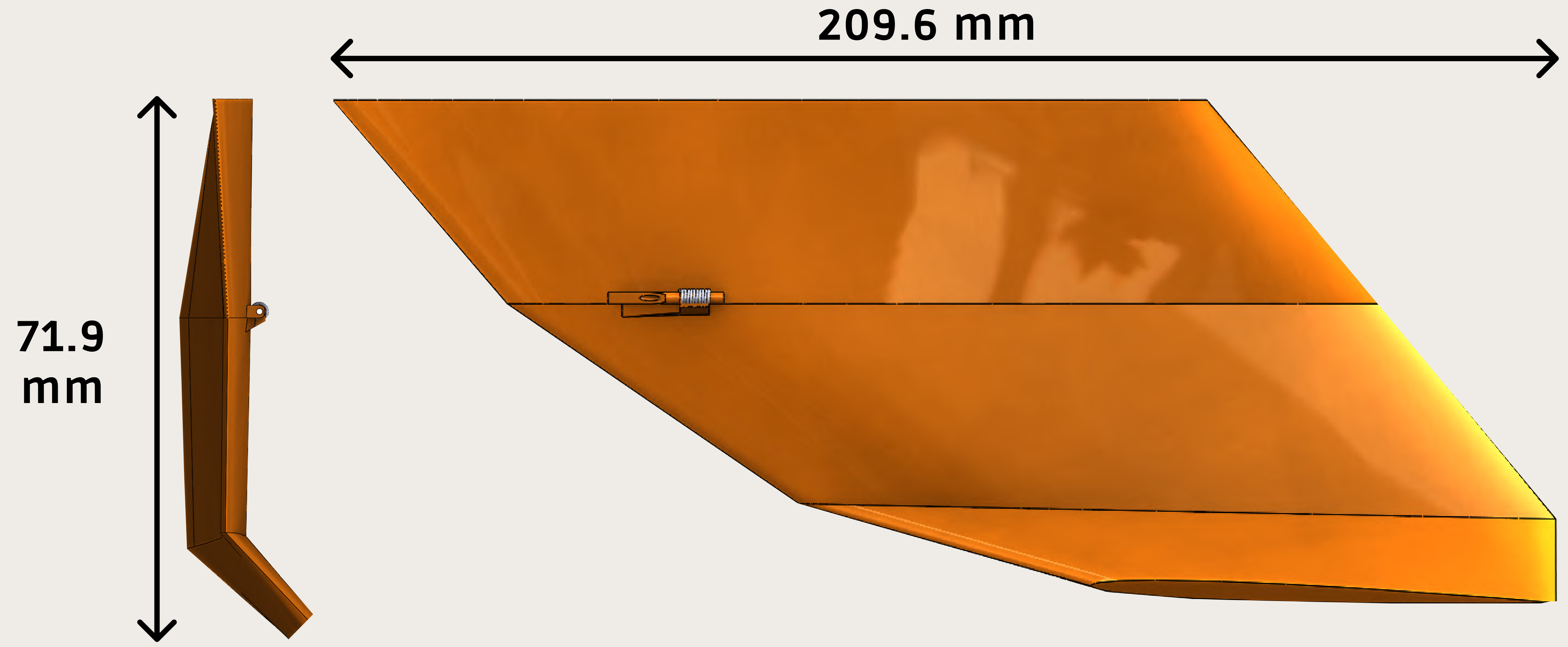
PROJECT BACKGROUND

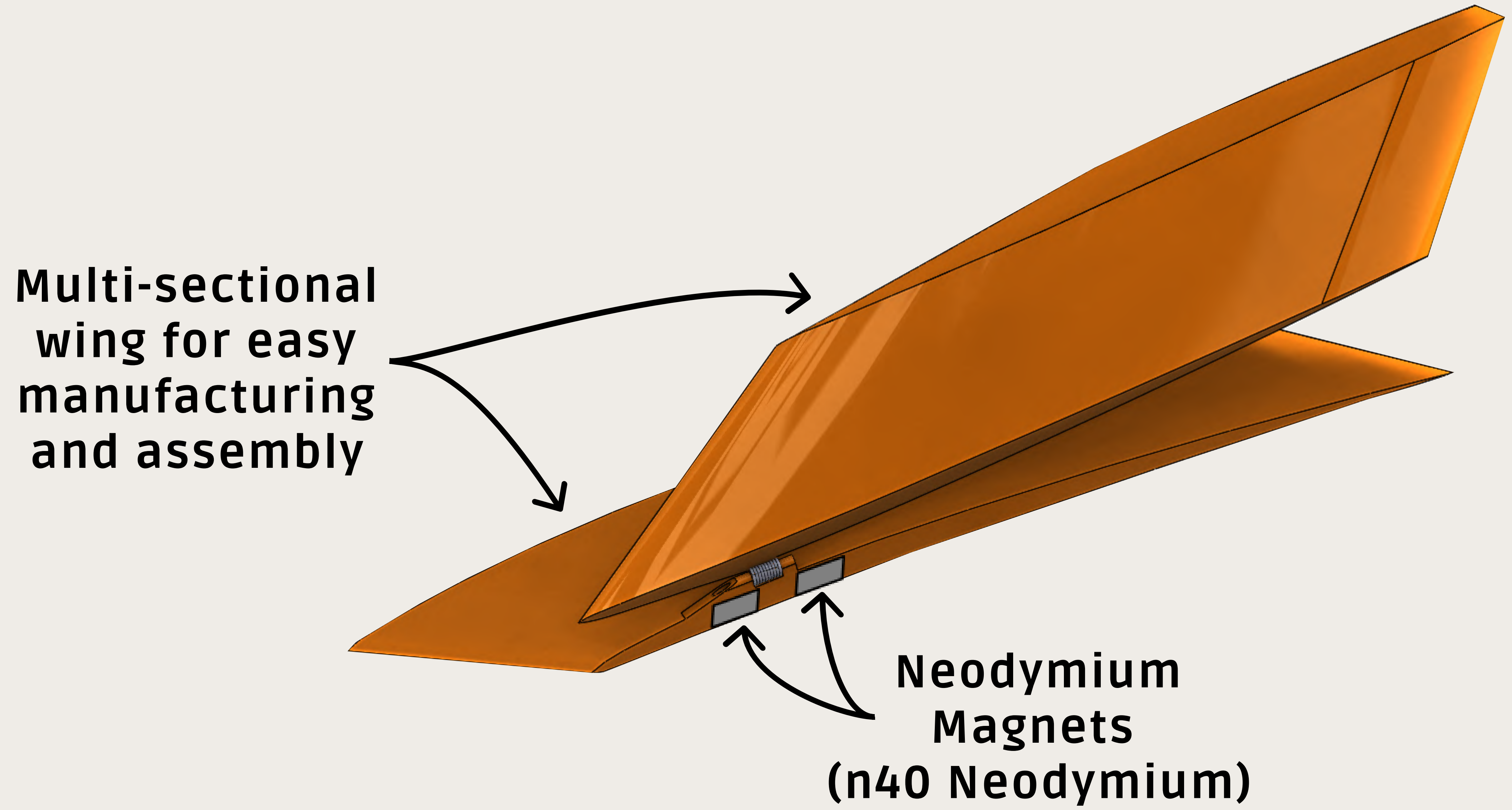
Objective: To design and launch a can-sized nanosatellite containing a science payload (delta-wing glider), that transmits real-time telemetry data during its descent

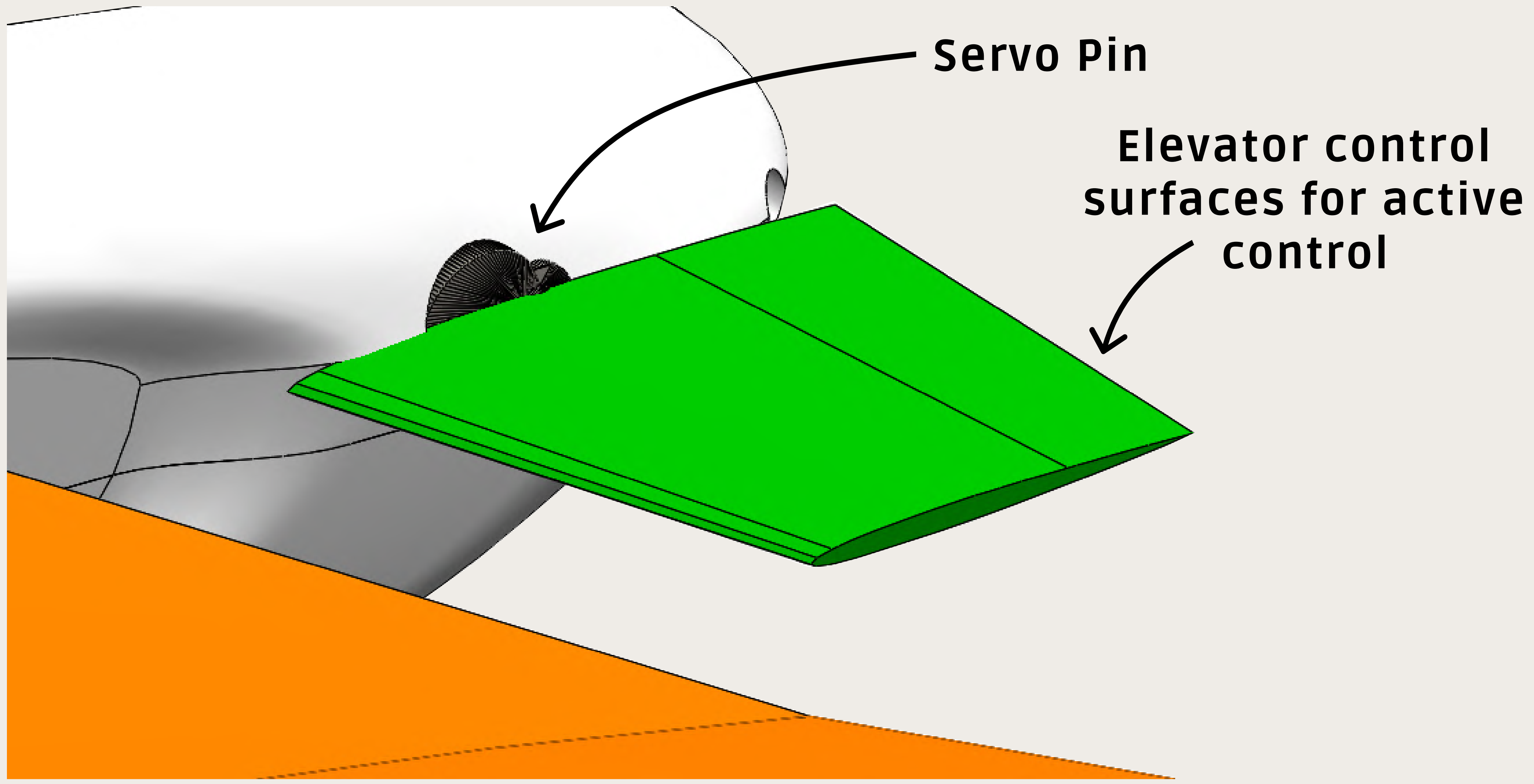


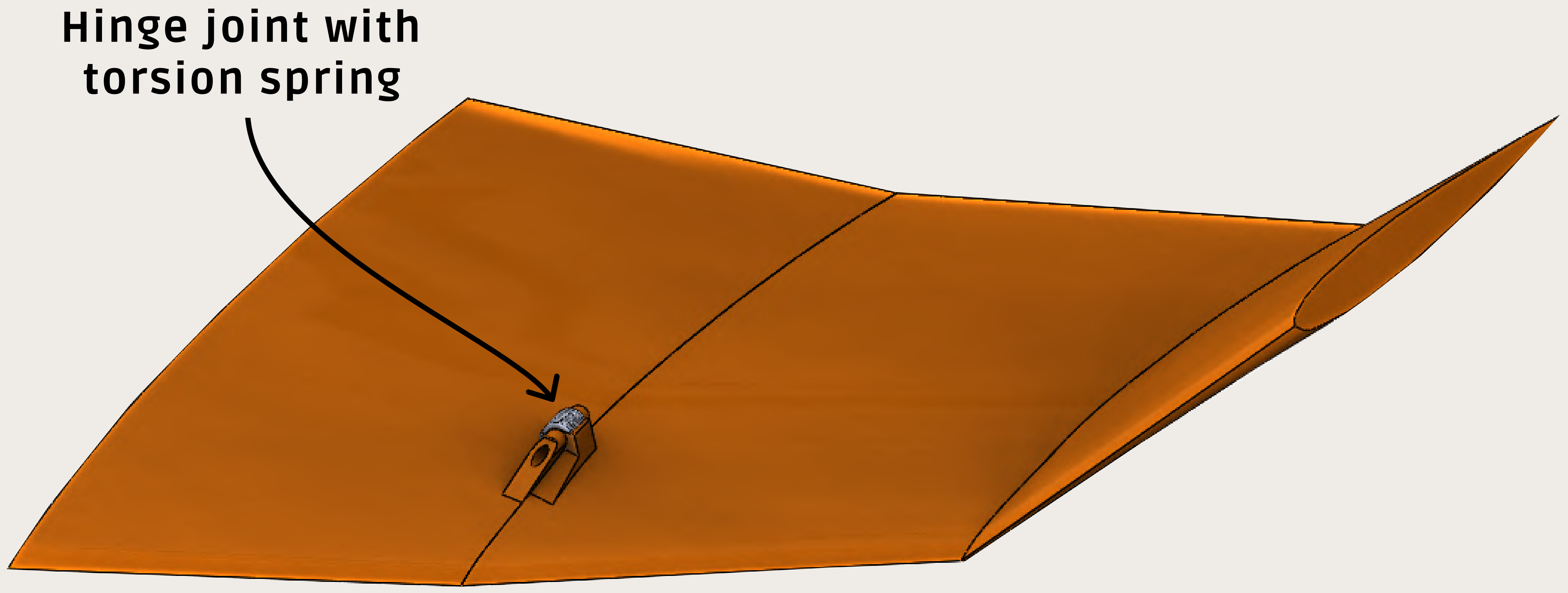
DELTA-WING GLIDER

DESCENT CONTROL SYSTEM









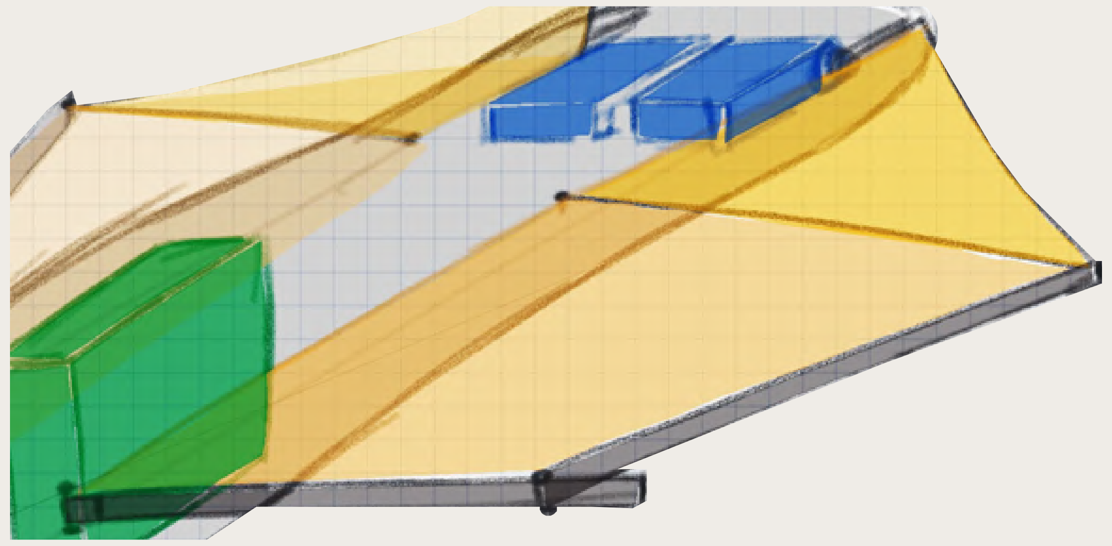
DESIGN TRADES AND ITERATIONS

Wings

Wing 1: Cloth wing

Flexible

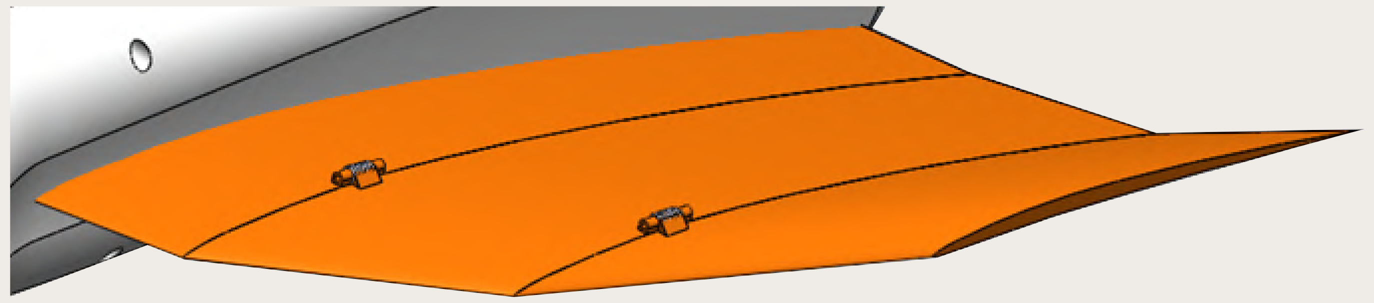
Easy to tear and uncertain shape



Wing 2: Solid Airfoil (3-Sections)

Customizable, sturdy

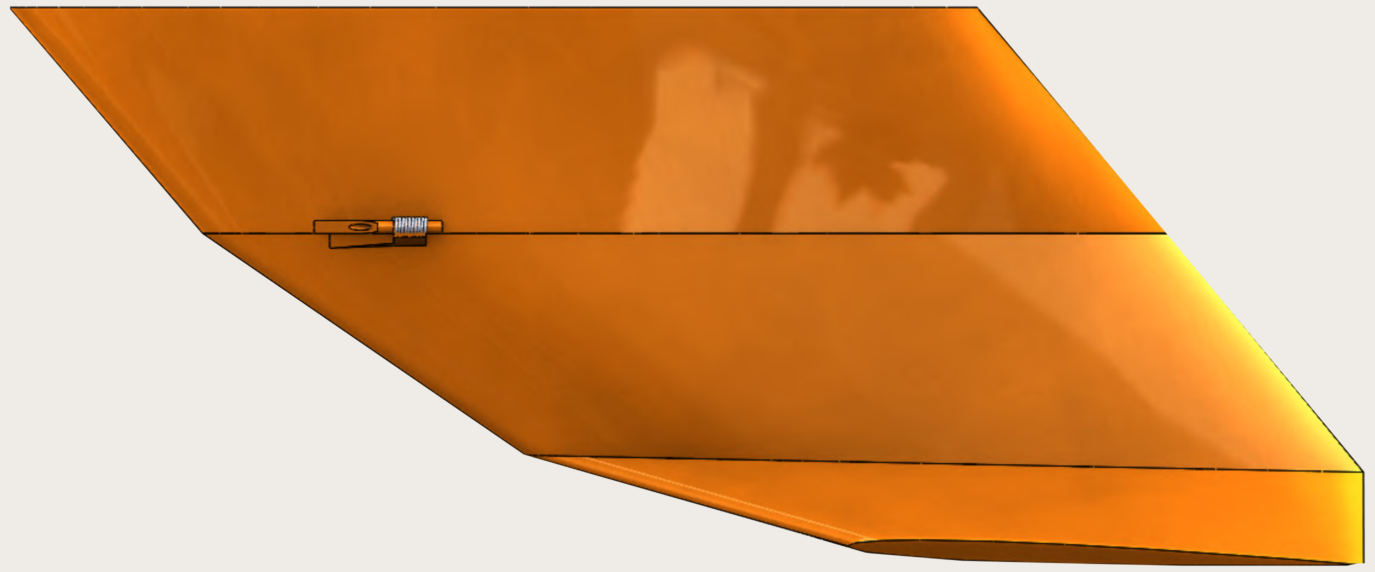
Can be damaged on impact



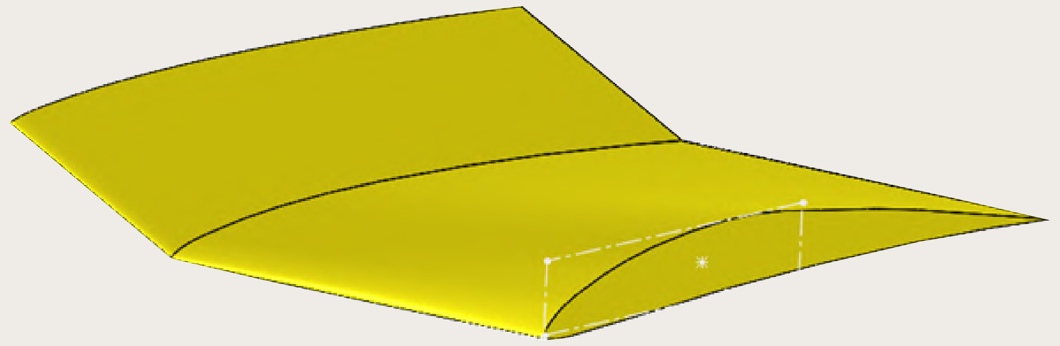
Wing 3: Solid Airfoil (2-Sections)

Easier to manufacture/assemble

Can be damaged on impact

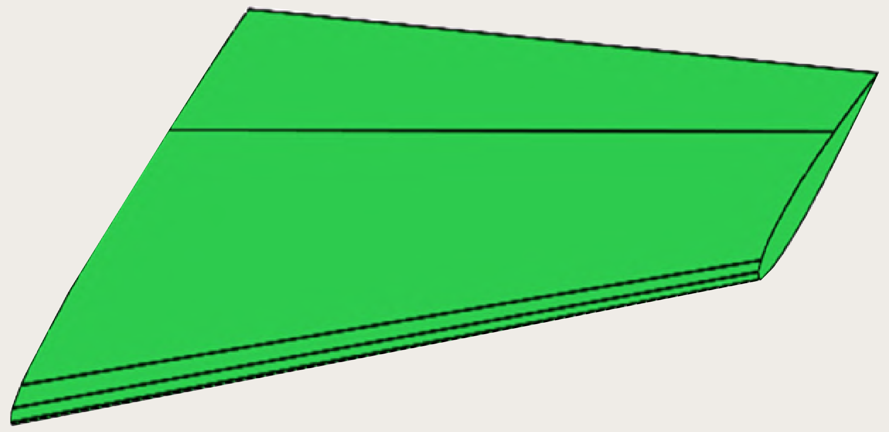


Control Surfaces



Canards (Selected in Round 1):
Easy incorporation, active stabilization

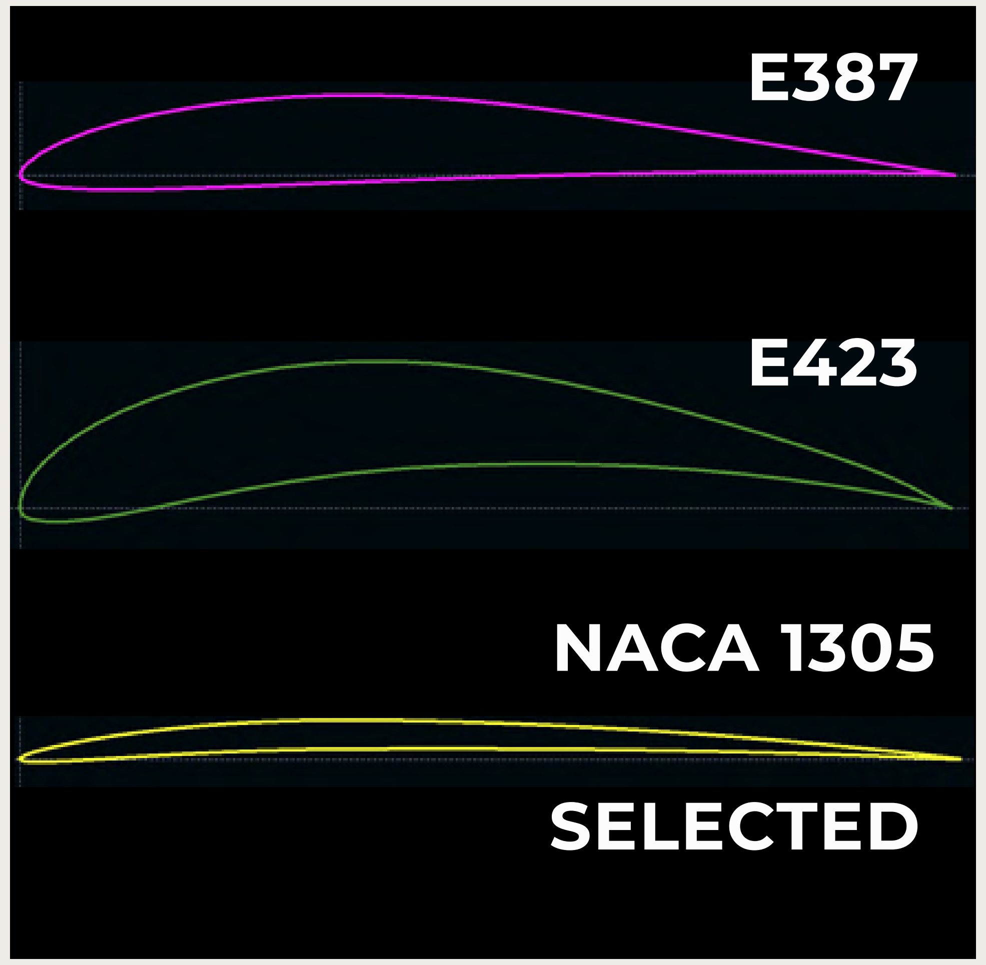
Placed at the front, vortices created hindering airflow



Elevators (Selected in Round 2):
Reduced lateral forces on joint

Placed at the rear, no airflow hinderance

Airfoils

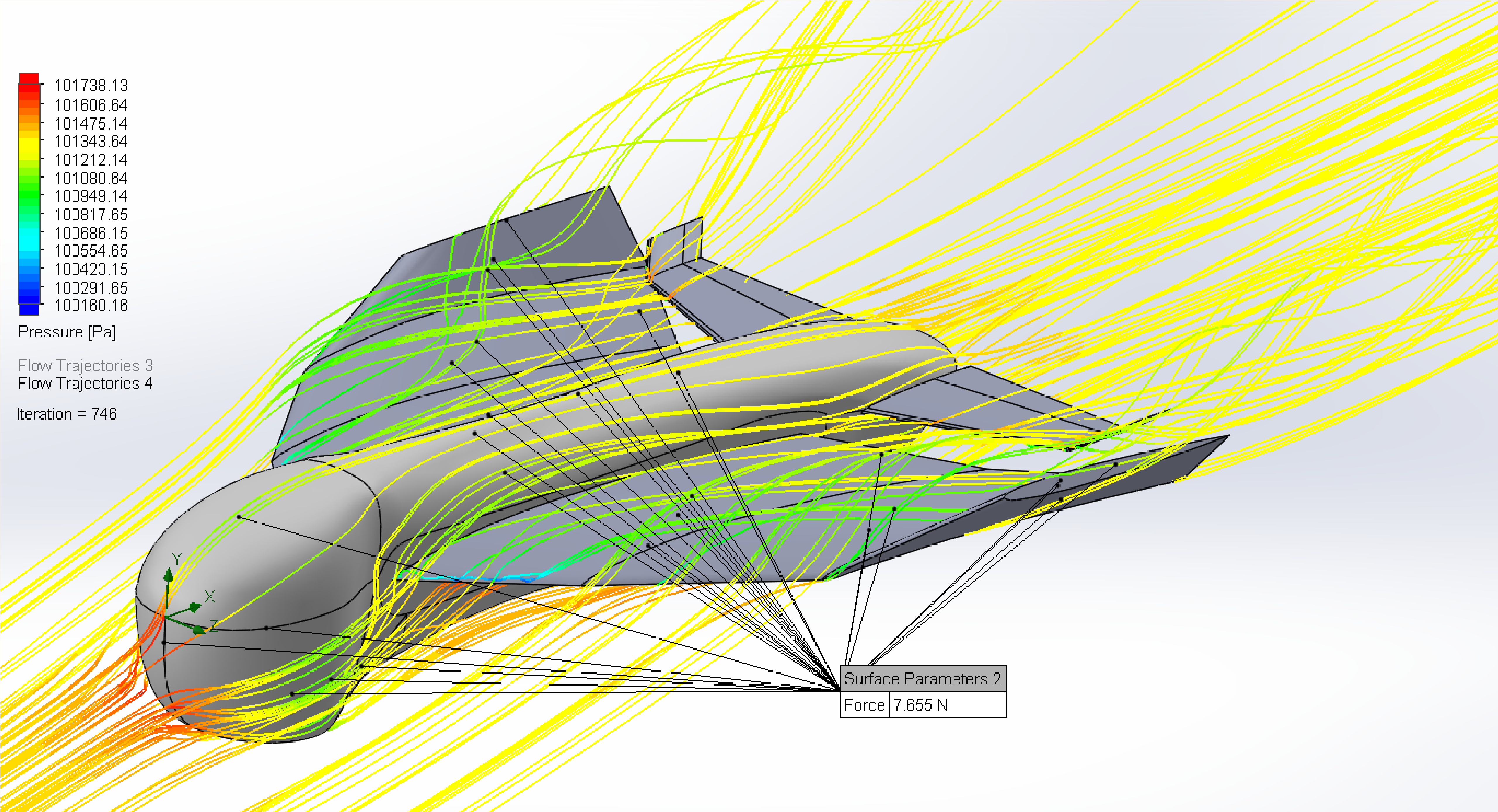


E387: Good lift, unpredictable lift coefficient

E423: Higher lift, less drag but too thick to incorporate easily in design

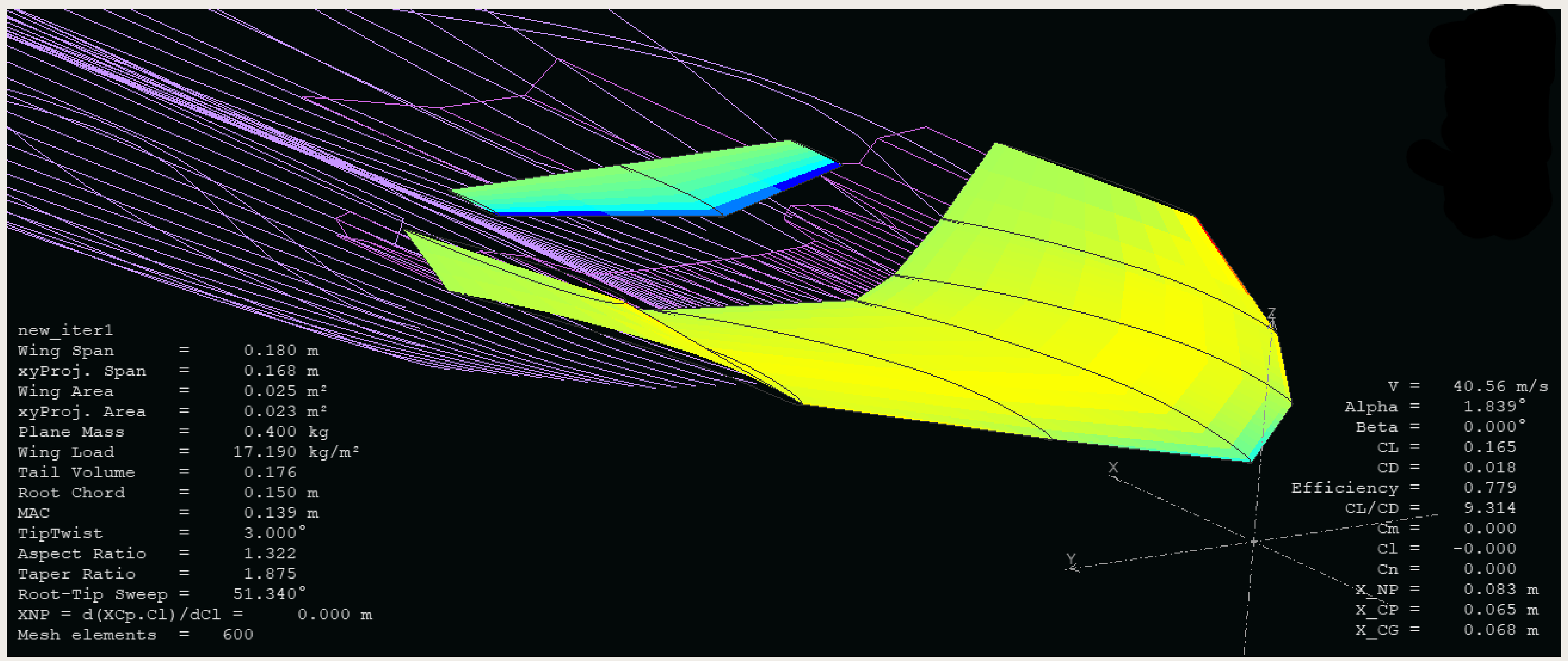
NACA 1305: Balance between lift coefficient and stability. Fits well within thickness tolerance

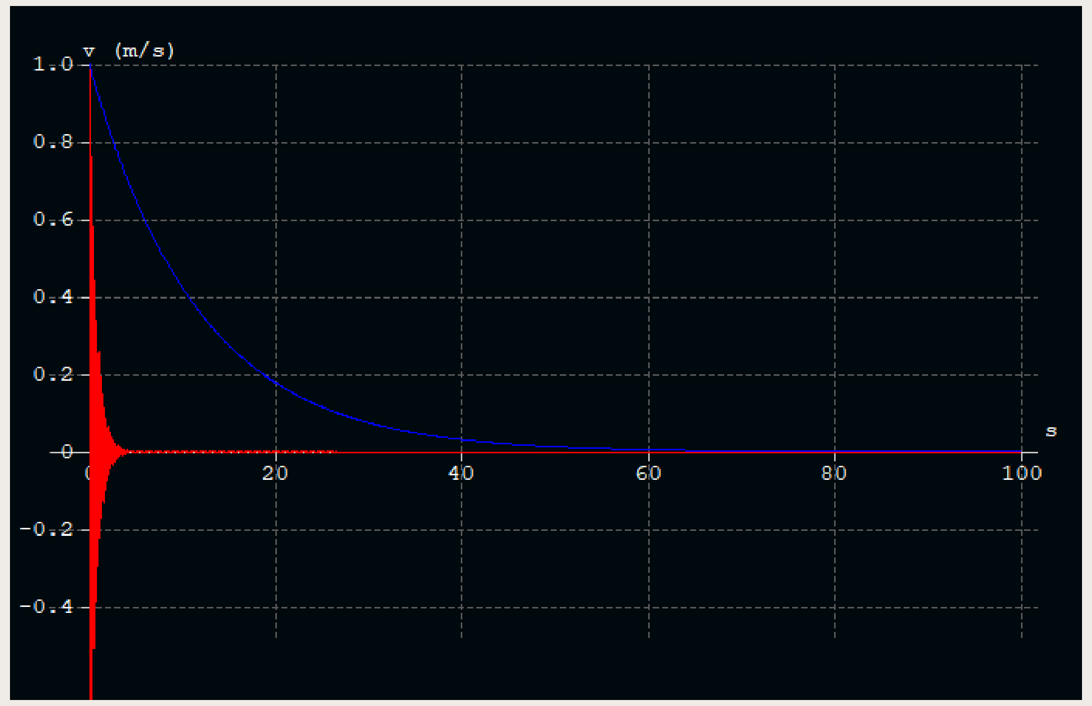
SIMULATIONS

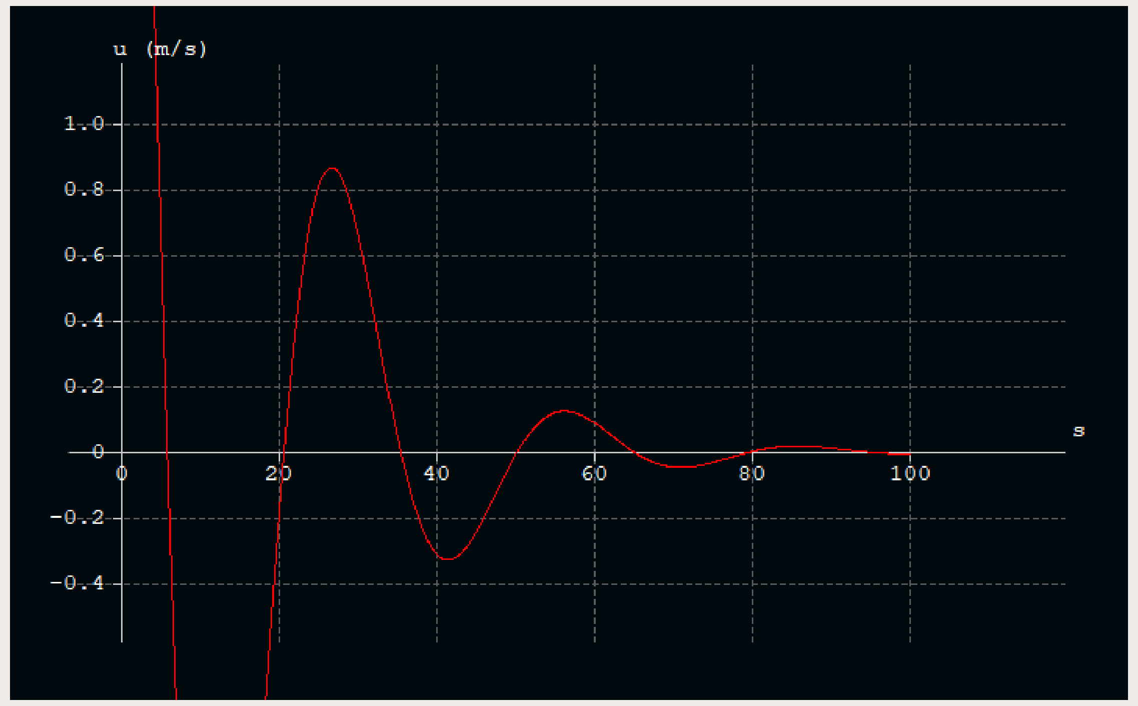


SolidWorks Flow Simulation demonstrates that a **Net lift of 7.655N** is achieved.

The glider is aerodynamic as seen by the flow trajectories passing seamlessly around the model







XFLR5 wing analysis shows a **stable flight** (top).

Wing is designed to be longitudinally and laterally stable as seen by the damping curves.

ACHIEVEMENTS

STABLE WING SYSTEM WITH EFFECTIVE DEPLOYMENT

GENERATED NET LIFT OF 7.655N

106% MORE LIFT THAN REQUIRED

RANKED #1 IN INDIA

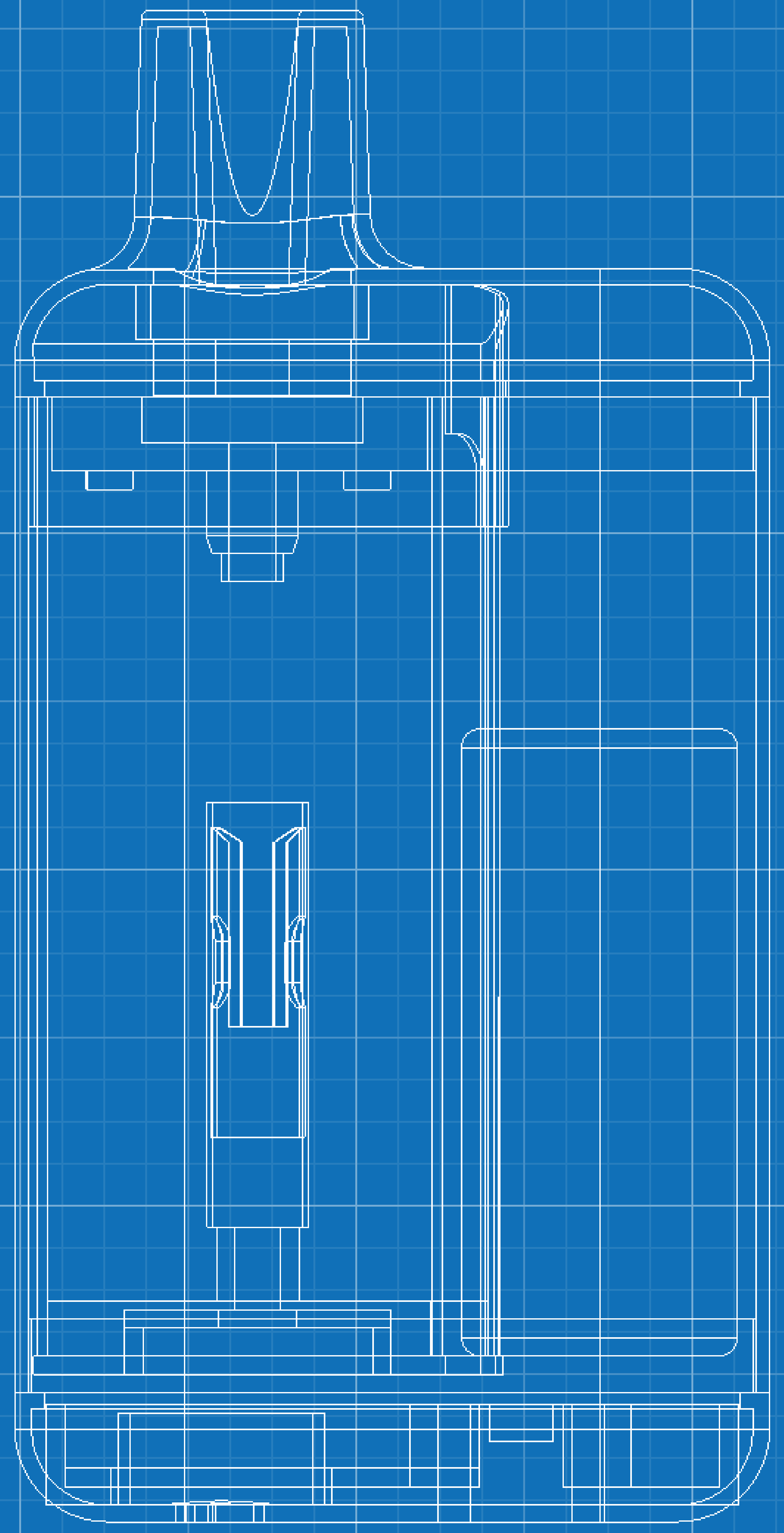
RANKED #6 GLOBALLY

40+ PARTICIPANTS

SUCCESSFUL **PRODUCT DATA MANAGEMENT** AND CROSS FUNCTIONAL TEAM COLLABORATION

VAPE TEARDOWN AND ENGINEERING ANALYSIS

Individual project
3 weeks
Skills: SolidWorks, BOM, Manufacturing Methods, User experience



PRODUCT BACKGROUND

MARKET SIZE

$22 BILLION

IN 2022

10% OF CIGARETTE MARKET

MAIN COMPONENTS

1. BATTERY
2. ATOMIZER
3. E-LIQUID

CATEGORIES

1. CIG-A-LIKES (GEN 1)
2. VAPE PENS (GEN 2)
3. MODS (GEN 3)
4. POD MODS

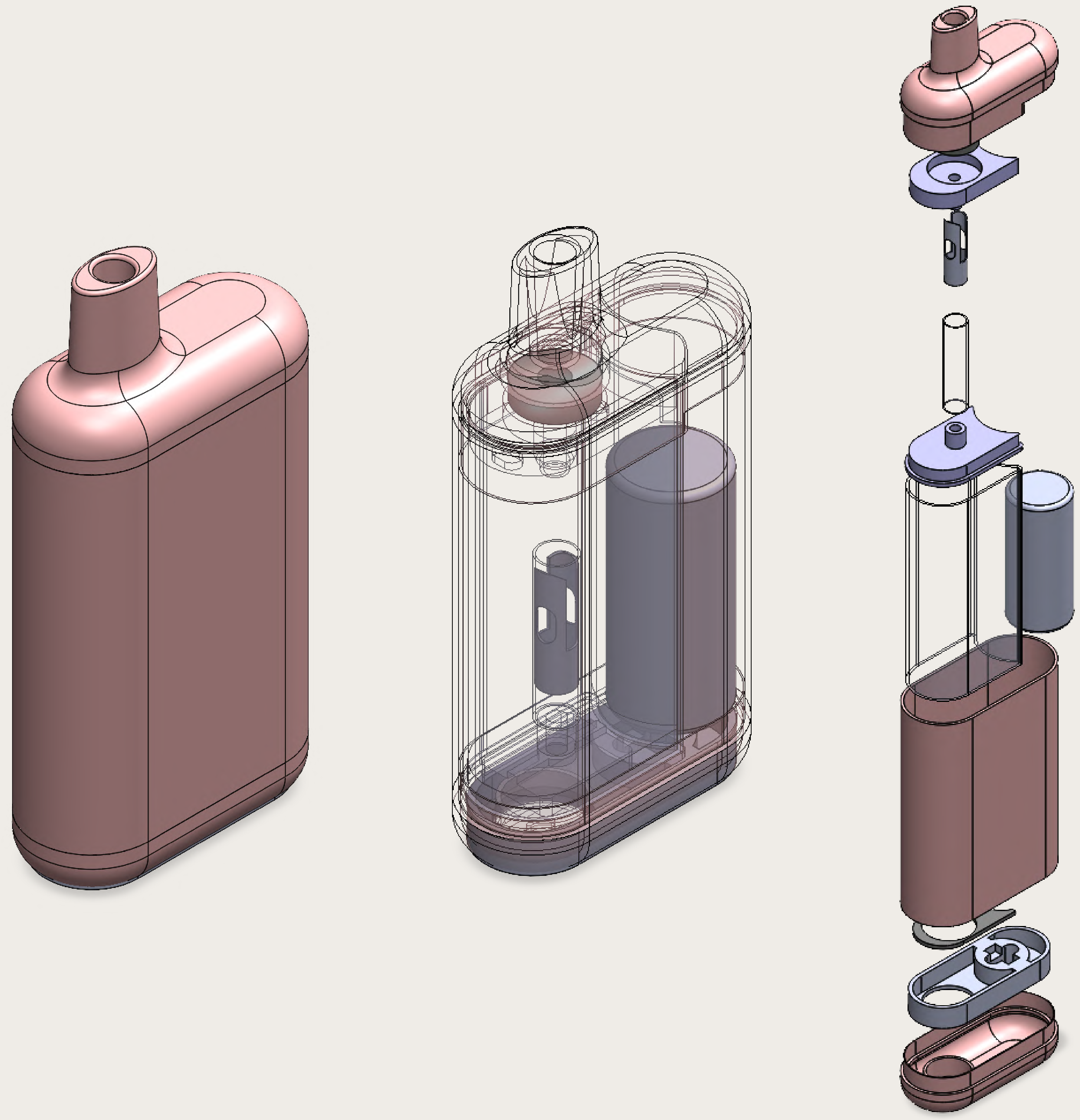
MARKET GROWTH

30.6%

FROM 2023 TO 2030

TEARDOWN AND INSIGHTS

SOLIDWORKS MODEL AND BOM



PART NAME	MANUFACTURING PROCESS	ESTIMATED COST*
TOP CASE	INJECTION MOLDING	$0.17
BOTTOM CASE	INJECTION MOLDING	$0.16
GASKETS (3 PIECES)	INJECTION MOLDING	$0.17 ($0.51)
MAIN CASING	ALUMINIUM EXTRUSION	$1.64
FOAM CASING	EXTRUSION	$1.30
FOAM	OFF THE SHELF	$0.3
DESSICANTS (MIN. 2 PER VAPE)	OFF THE SHELF	$0.16 ($0.32)
BATTERY	OFF THE SHELF	$0.98
COIL	WIRE DRAWING	$0.34
	TOTAL COST	$5.72

*ESTIMATED COST IS PER PIECE FOR 10,000 PIECES

MANUFACTURING

Contacted manufacturers in China to obtain cost estimates on the product.

4. Summary				
	Cost	DHL Freight	Total Expense	Total period
500sets	USD 12,188	TBD	USD 12,188	25
1000sets	USD 14,297	TBD	USD 14,297	9
5000sets	USD 33,688	TBD	USD 33,688	13
10000sets	USD 46,344	TBD	USD 46,344	18

Wholesale profit margin is ~30%

Average wholesale **profit per unit** is **~$6.75***

*Average profit is assumed without accounting any labor and miscellaneous costs. It may vary for an established manufacturer.

KEY TAKEAWAYS

High waste generation

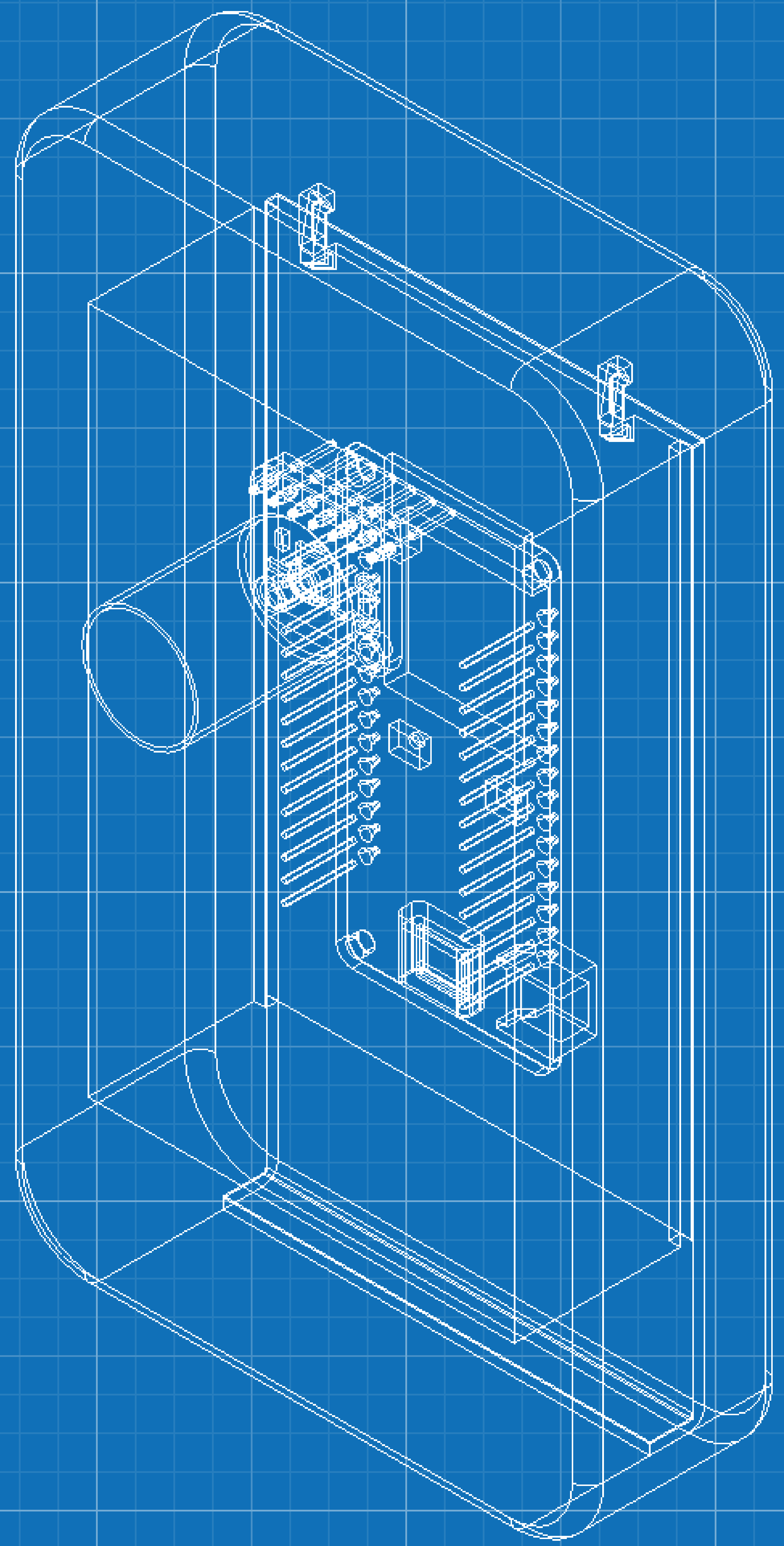
Only 2 mL vape fluid worth ~$0.33 consumable

$25 worth of material is discarded.

Excellent UX

The secret to vape addiction is least thought of: the pressure switch, making it easy to simply pick up and start smoking

DIGITAL SPIROMETER WITH GAMIFICATION



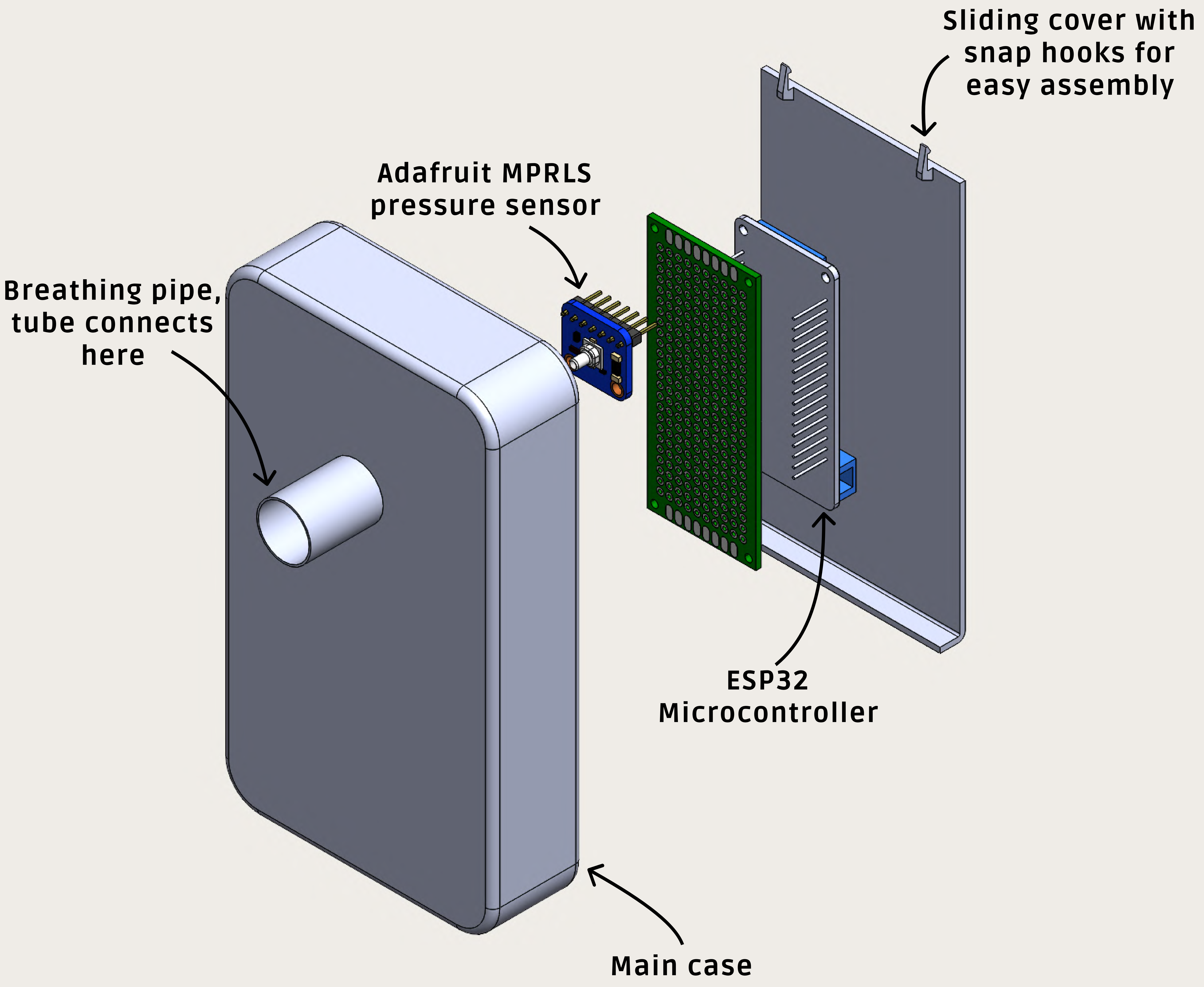
Team project
8 months
Contribution: Mechanical Design, FEA, Testing
Skills: SolidWorks, CFD, PDM

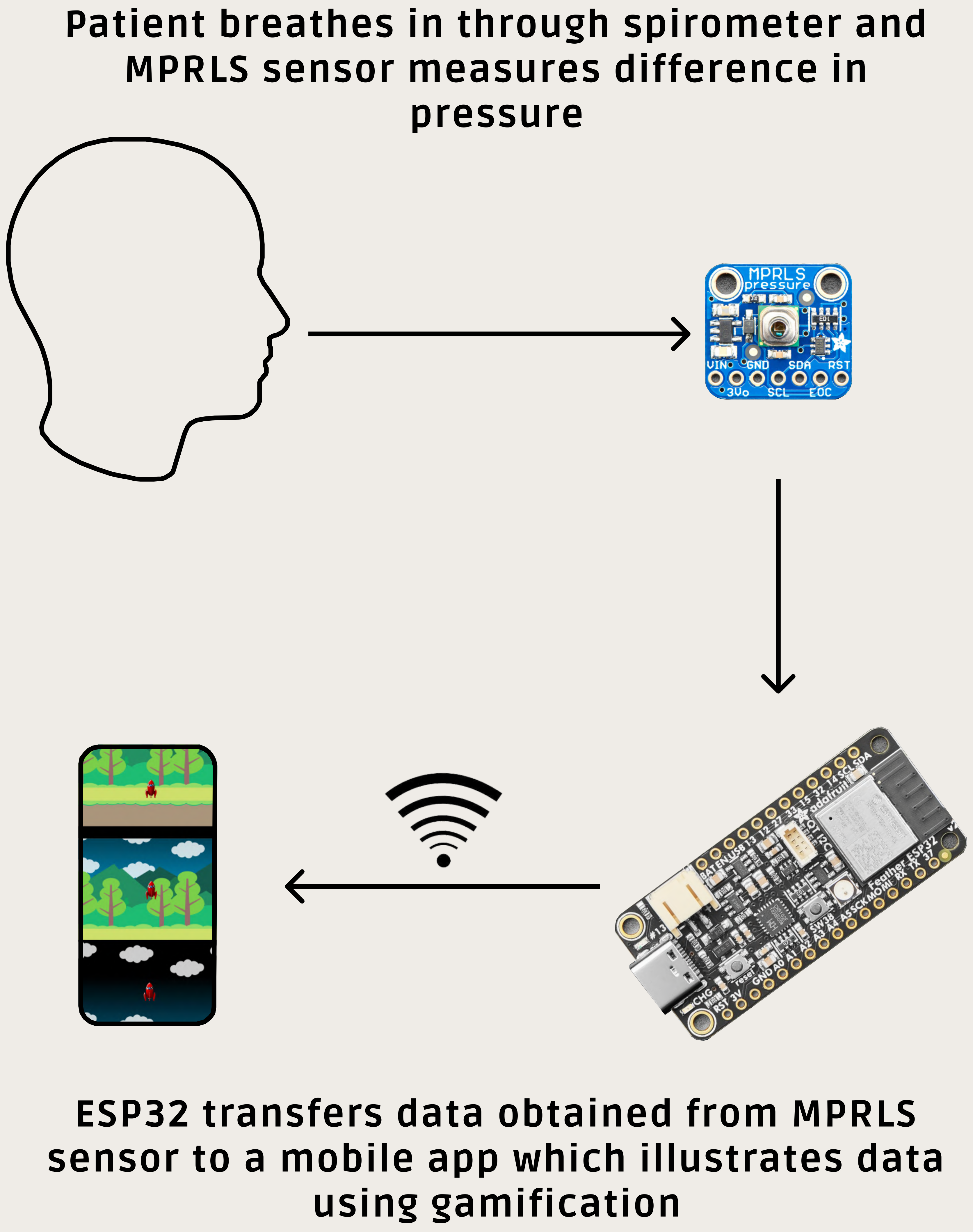
PRODUCT BACKGROUND

A spirometer is a device provided post lung transplant to improve lung capacity, strengthen lungs, prevent pneumonia

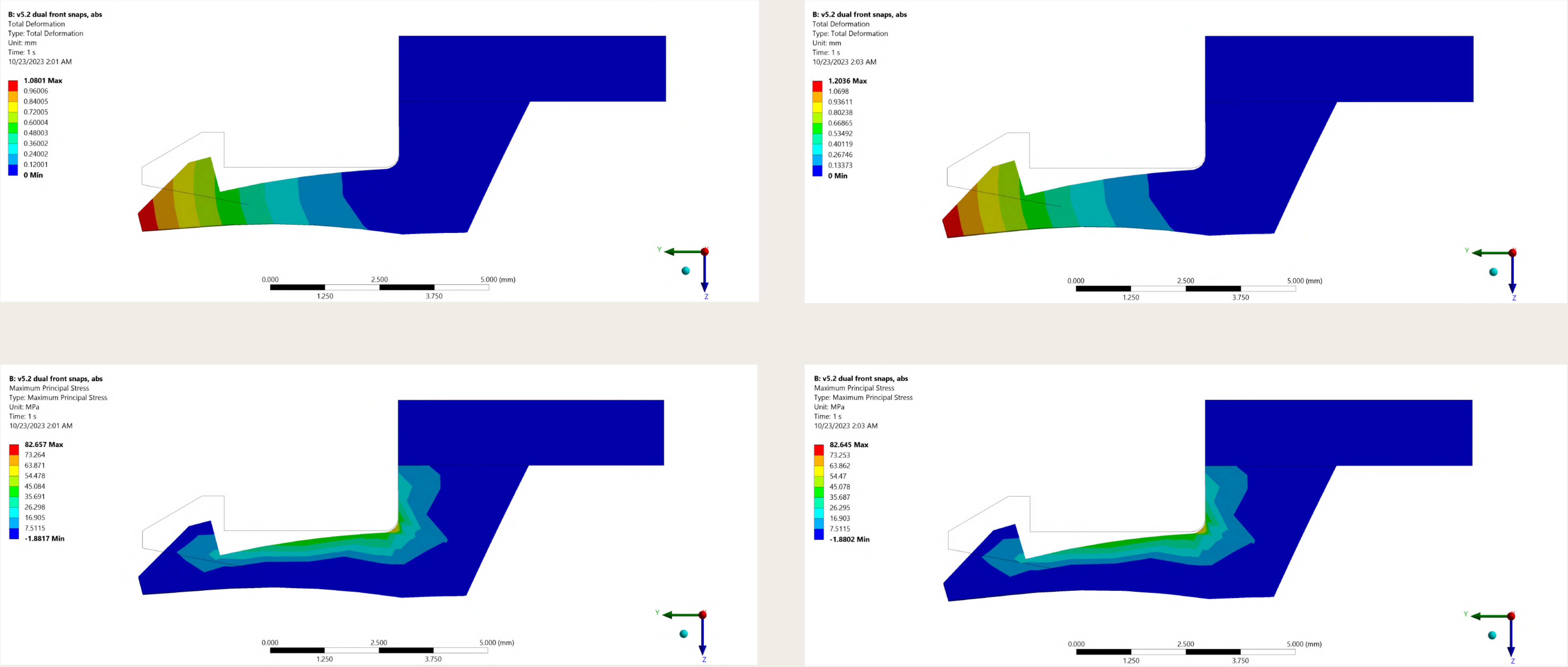
This project explores the mechanical design and prototyping of a digital spirometer with gamification

CAD MODELING AND COMPONENTS





SNAP-HOOK JOINT DESIGN

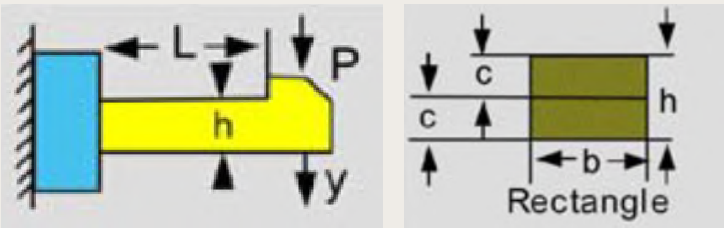


Simulations show total deformation (top) and stress (bottom) of two different materials: ABS (left) and PP (right).

PP hook has a slightly greater deformation than ABS

Simulation data supports the calculated dimensions of the snap-fit joint

Formulae



Max (permissible) strain, y

$$y = (0.67*\varepsilon*L^2)/h$$

(Permissible) deflection force, P

$$P = (b*h^2/6)*(E*\varepsilon/L)$$

Mating force

$$W = (\mu + \tan(\alpha))/(1 - \mu\tan(\alpha)) * P$$

where

ε = permissible strain of material

E = secant modulus at strain εl

α = angle of inclination

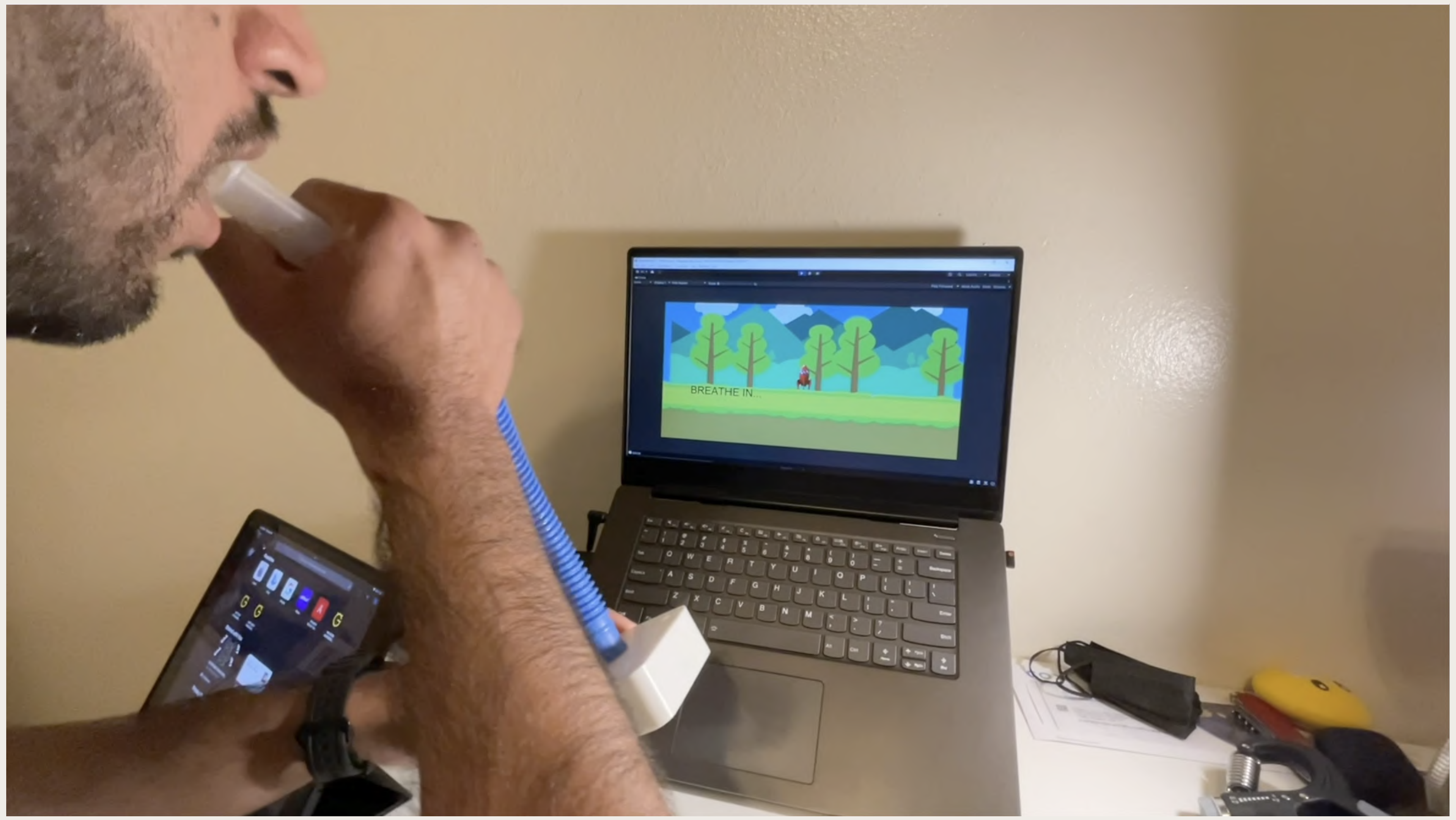
μ = coefficient of friction

Calculations:

$y = 0.80$ mm	$R/h = 0.20$
$h = 1.50$ mm	$\mu = 0.60$
$h = 0.75$ mm	$\alpha = 15.0°$
$L = 4.00$ mm	$P = 8.76$ N
$b = 1.50$ mm	

PROTOTYPE TESTING

A 3D printed prototype was created to test the electronic components and the gamification elements



Rocketship gamification was achieved in response to user inhaling and exhaling (left)

Successful data transfer between the spirometer and a device was achieved (right)

ACHIEVEMENTS

Prototype Development

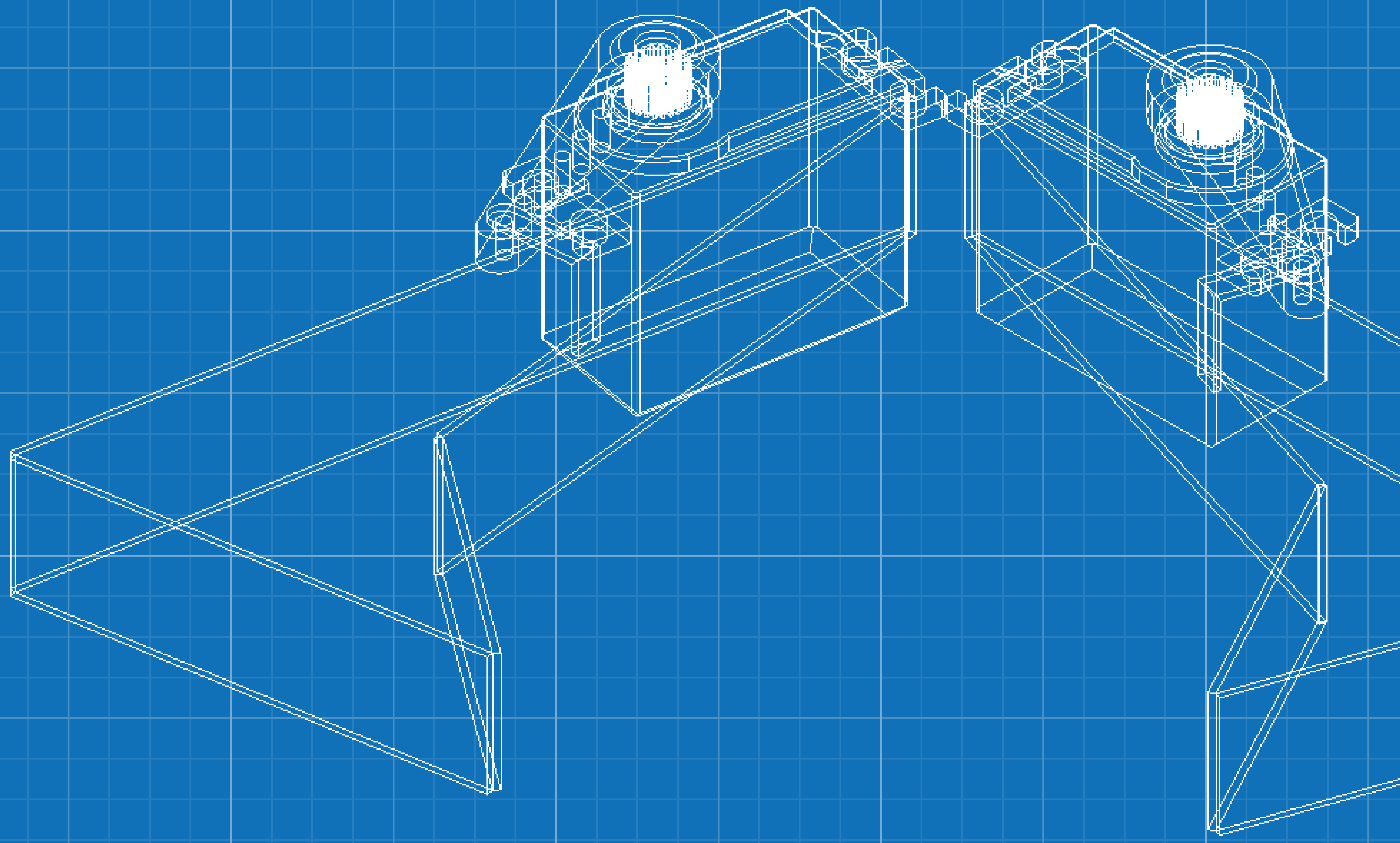
Prototype developed was used to test gamification elements successfully. When implemented as a product, the gamification may influence patients to carry out spirometry

Publication

The research and findings were published in IEEE Xplore and presented at the IEEE CSDE 2022 conference

DOI: 10.1109/CSDE56538.2022.10089329

ORIGAMI-BASED FOLDABLE GRIPPER



Team project
5 months
Contribution: Mechanical Design, Optimization, Testing
Skills: SolidWorks, Rapid Prototyping, Laser Cutting

PROJECT BACKGROUND

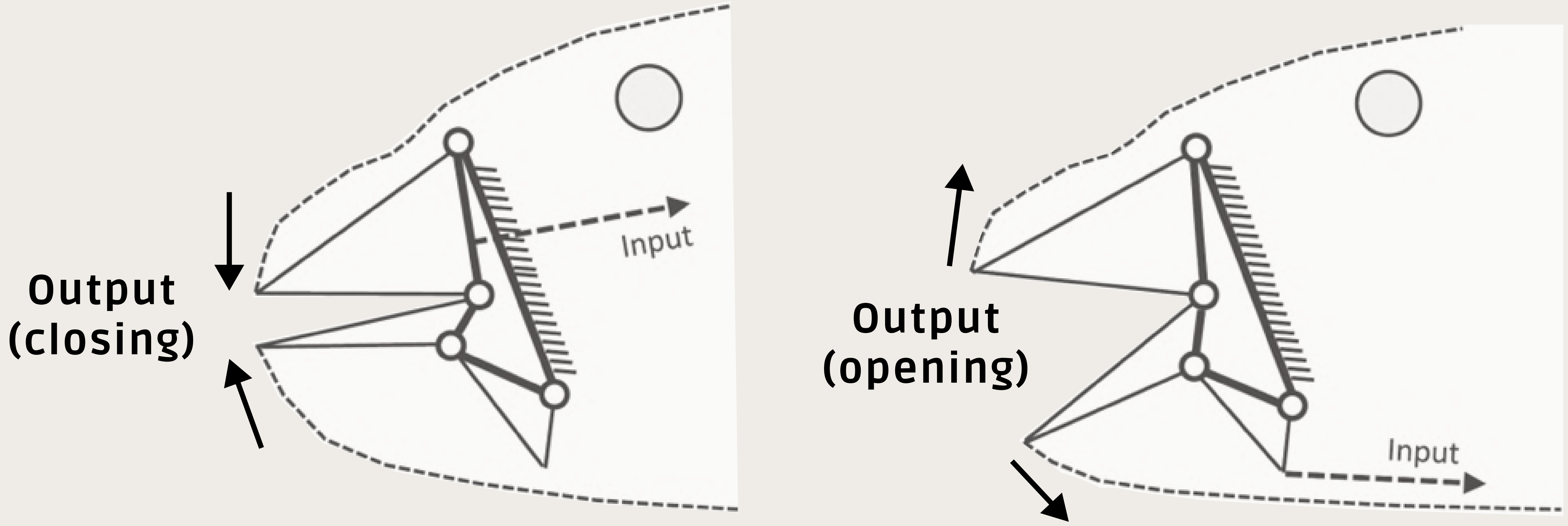
Objective: Use bio-inspiration to create a low-cost, foldable, origami-based robotic gripper

ANIMAL	BITEFORCE/WEIGHT (PSI/KG)	SNOUT LENGTH (INCHES)
SALTWATER CROCODILE	9.25	62
TIGER	2.50	13
ALLIGATOR	5.80	78
PARROT FISH	11.78	4

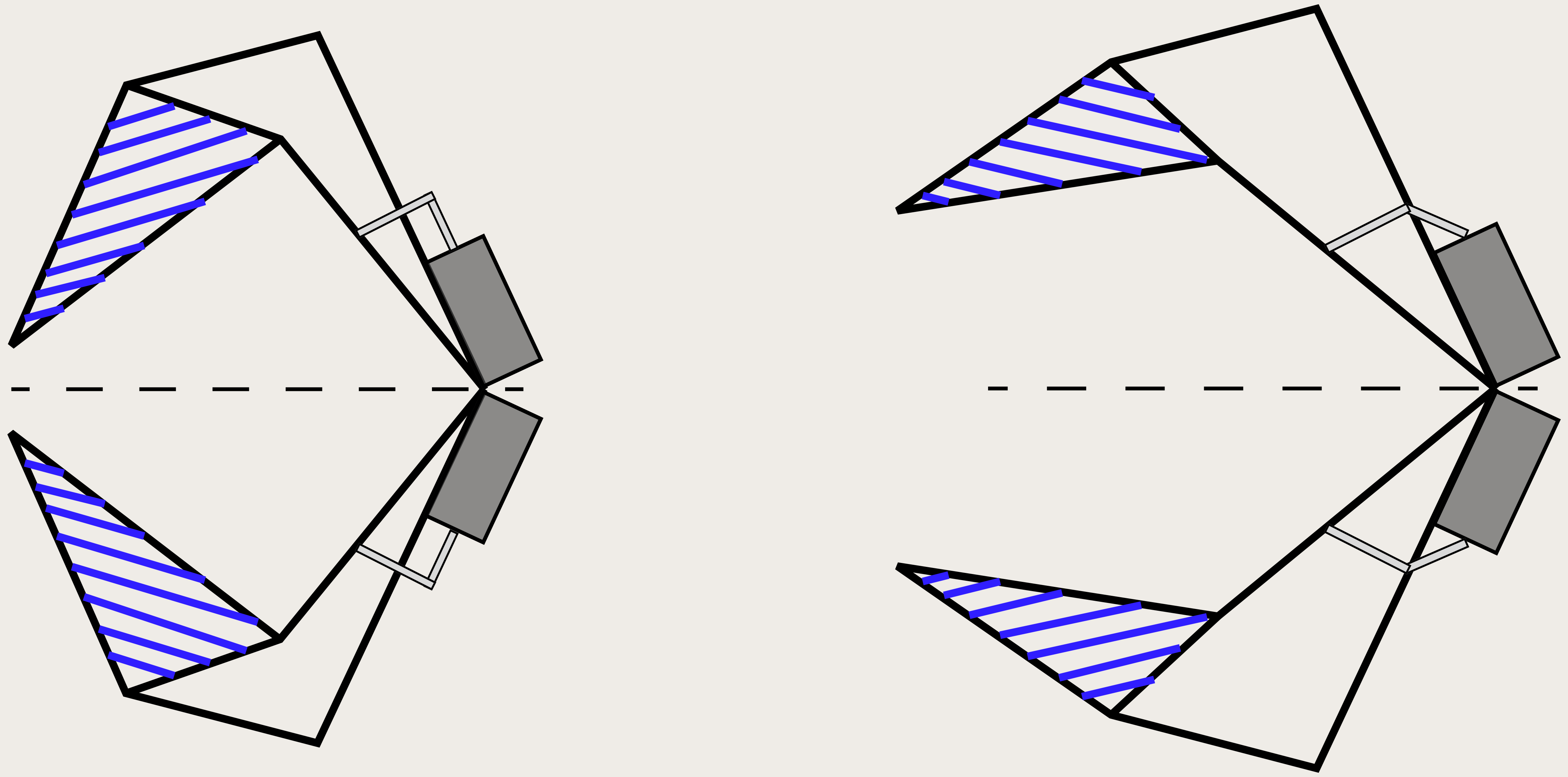
For the scope of this project, the parrot fish jaw mechanism is selected due to its impressive biteforce:weight ratio despite a small snout length

MECHANISM ANALYSIS

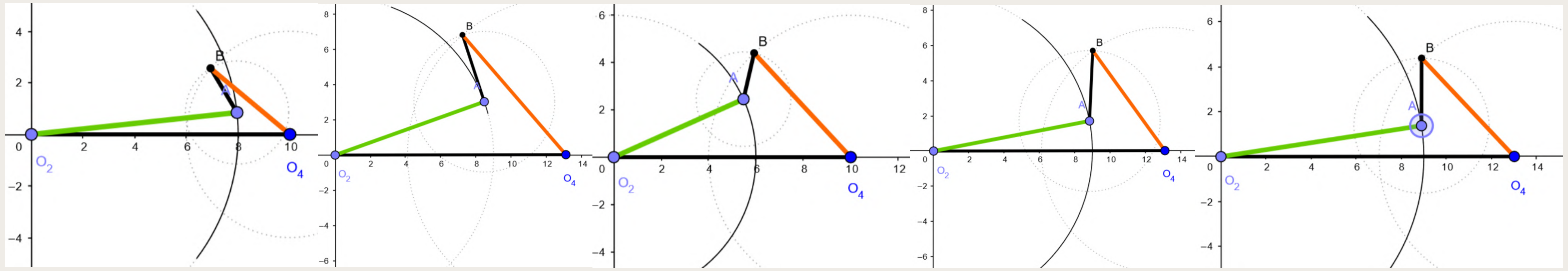
The jaw mechanism can be simplified as a 4-bar linkage



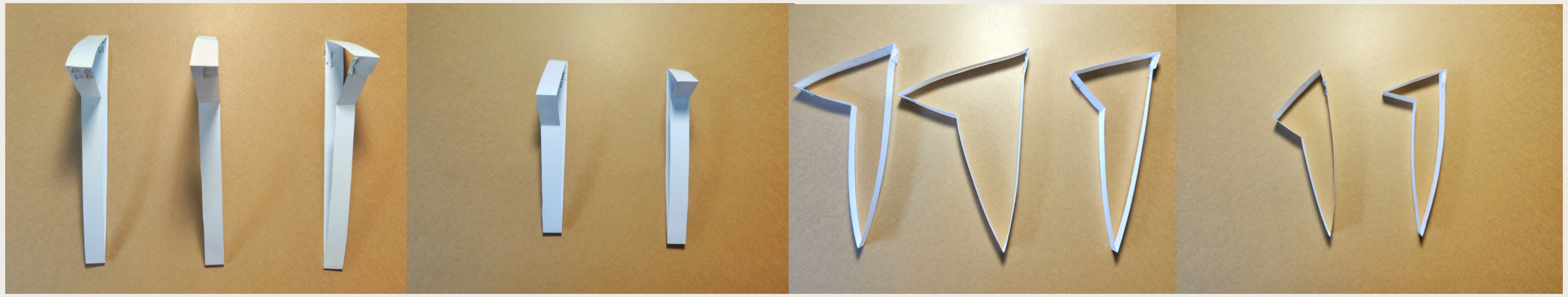
Using servo motors, a 4-bar linkage mechanism can be developed to serve as a low-cost, gripper



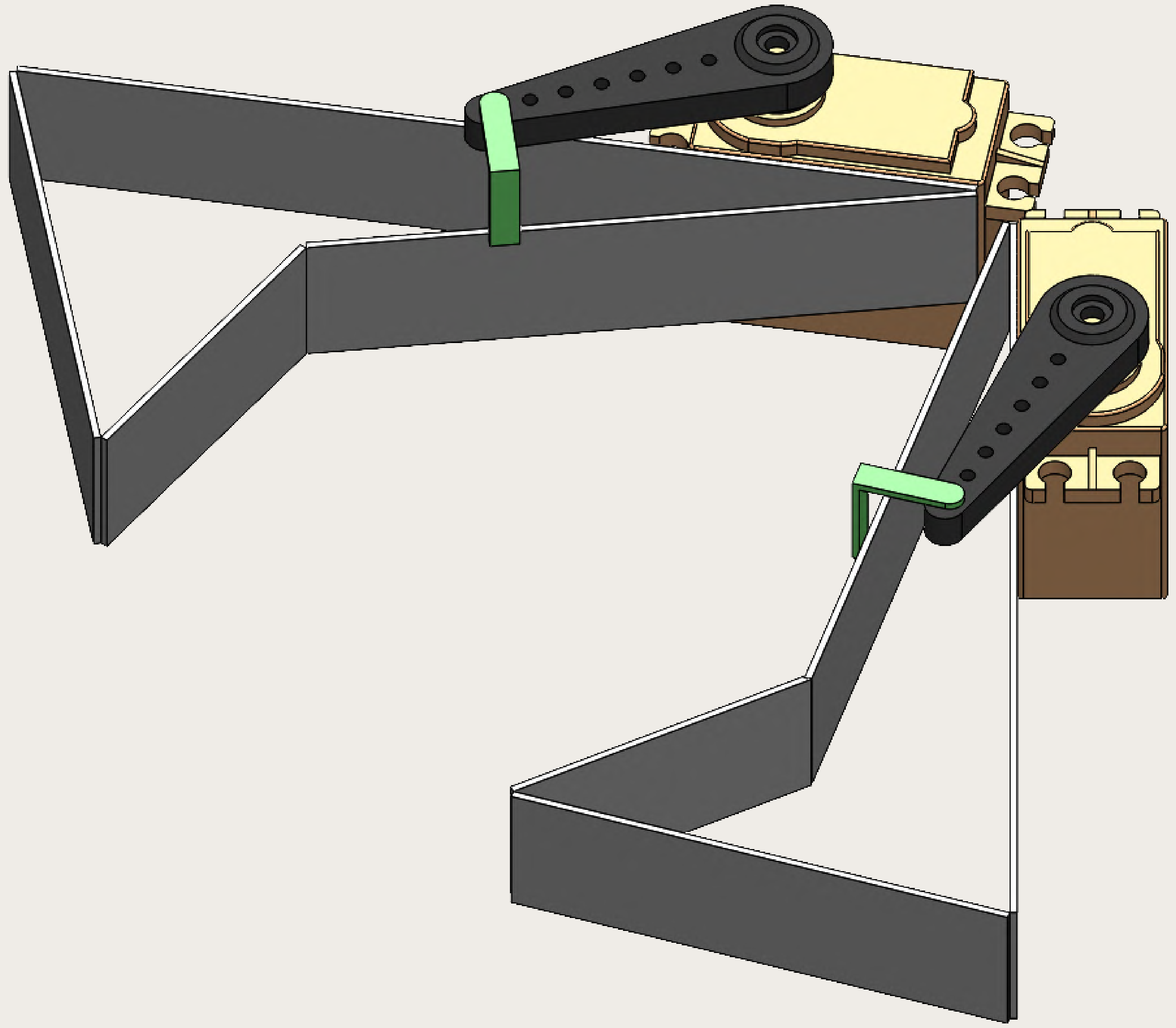
PROTOTYPING AND CAD MODEL



Analyzed several link lengths to find the an appropriate solution which was later optimized using Python optimization techniques



Created paper prototypes to test out concept and different link lengths

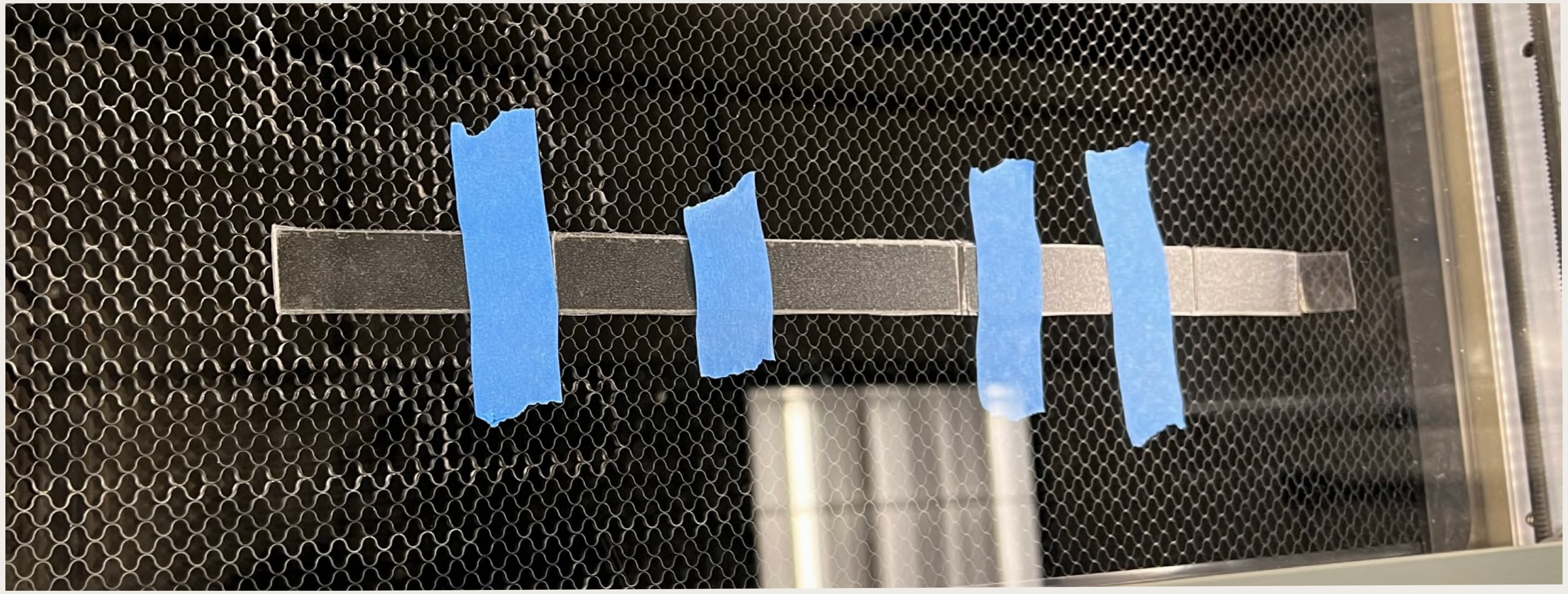


Designed a 3D model to visualize a fully-assembled gripper mechanism

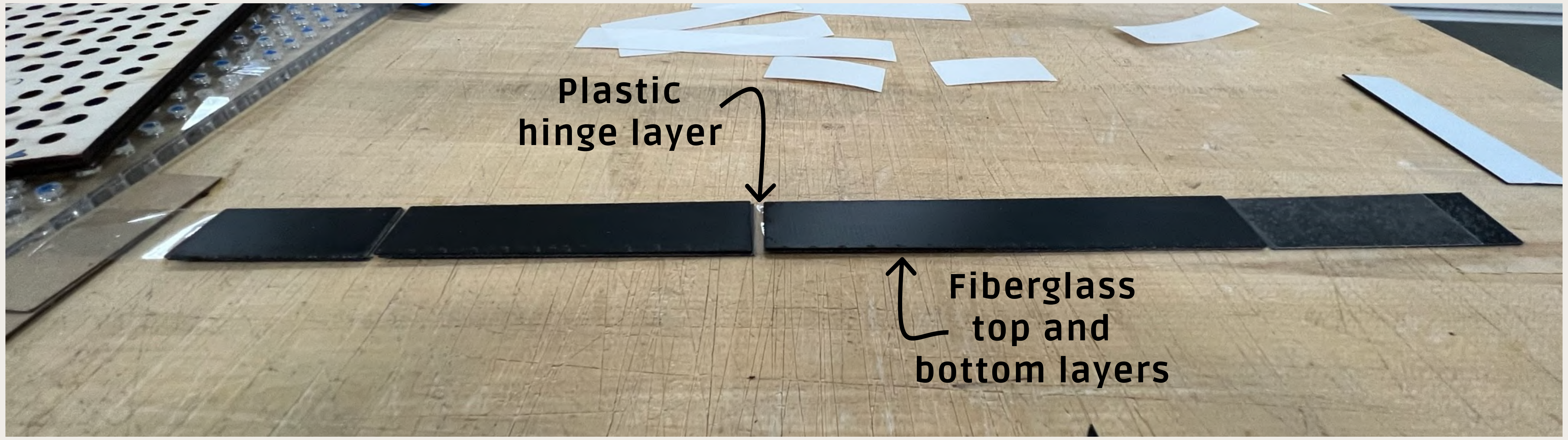
MANUFACTURING

The prototype consists of **7 layers:**

2 fiberglass layers
2 plastic sheet layers
2 adhesive layers
1 plastic hinge layer

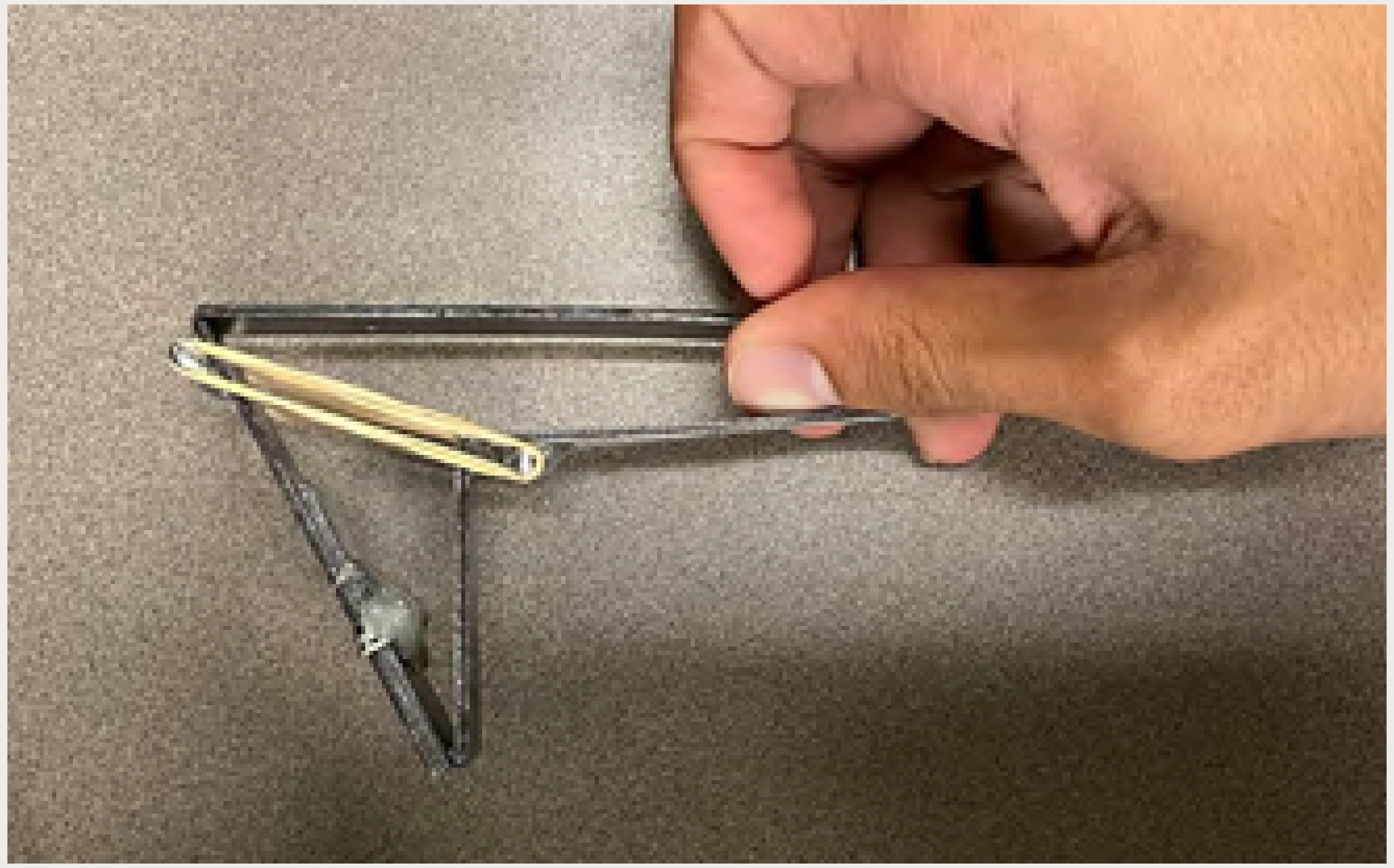


The layers are laser cut and laminated together ensuring the layers stay together when assembled in the system



ASSEMBLY

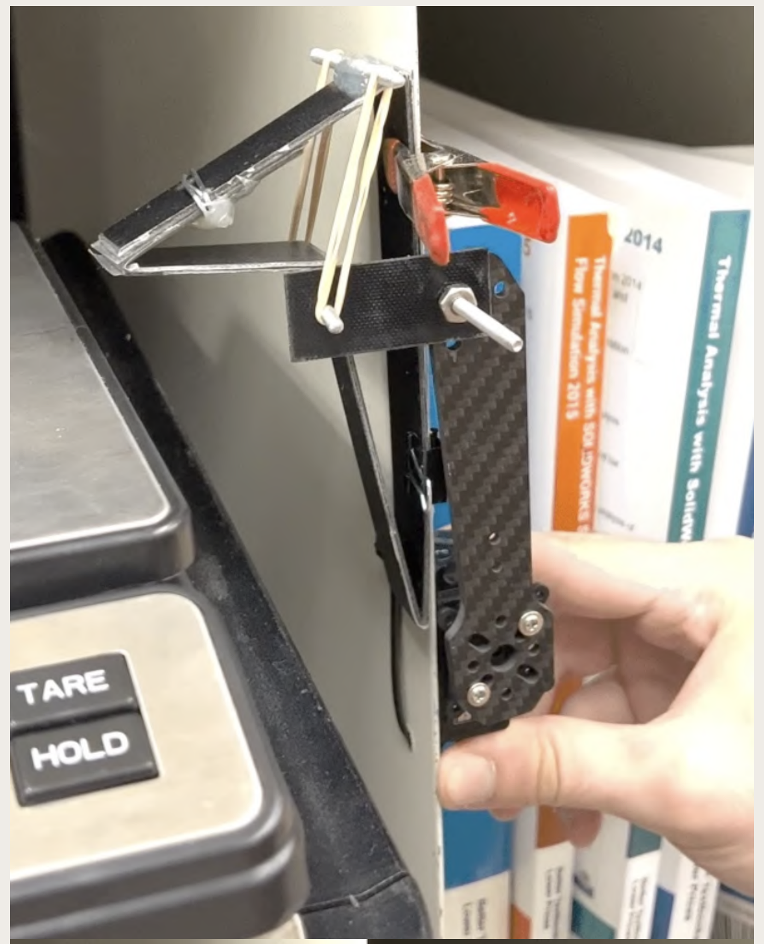
The links are connected with a simple wire for quick assembly and testing

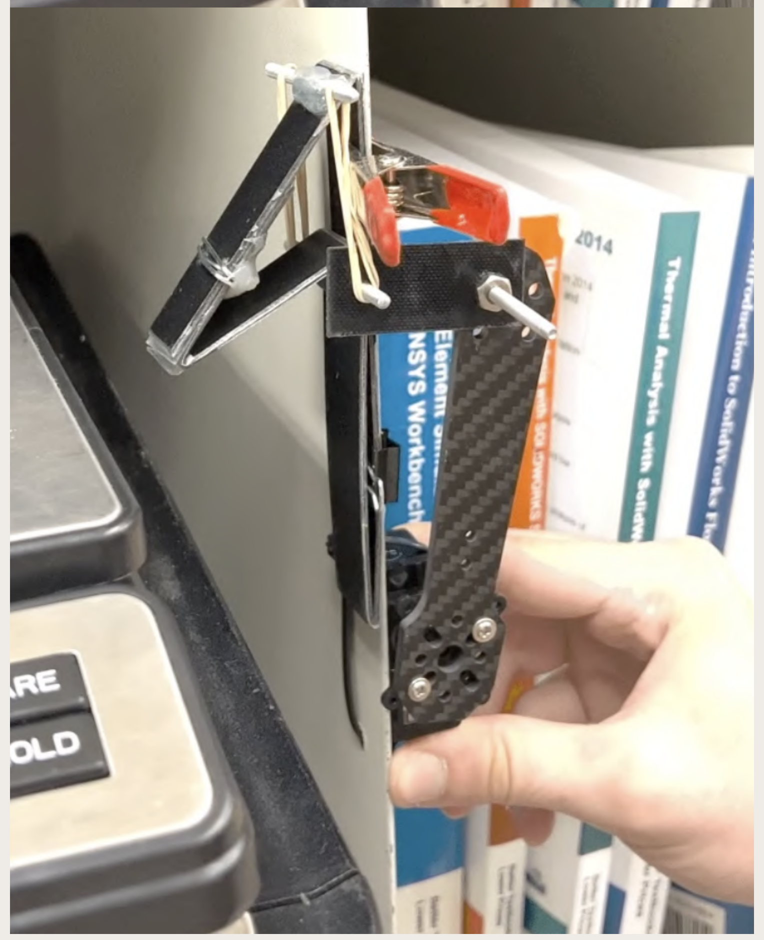


Rubber bands are used to replicate a spring system. The rubber bands ensure that the gripper returns to the initial position

A carbon fiber lever is connected to the motor and provides the input motion for the open and close positions

TESTING





Gripper exerts ~20N of force

ACHIEVEMENTS

Low Cost

Full prototype was developed under $150.
This low-cost design can be used by educators and researchers to explore origami-inspired robotics

High Biteforce:Weight Ratio

The gripper has a ratio of ~20.1.
With further research and optimization, this ratio can be improved to create an effective gripping mechanism

LET'S CONNECT

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