Dumbo Aviation

3D PRINTED GLIDER PLANE

2025 COHORT

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Agenda

Objective

Introduction

Methods
- Fuselage
- Wing
- Electronics

Results
- Prototype 1
- Prototype 2
- Prototype 3
- Prototype 4
- Prototype 5

Conclusion – Final Glider



Project Objective

- Design and build a fully 3D-printed glider for sustained flight after Spring-loaded catapult launch
- Use additive manufacturing to create modular, aerodynamic parts with reinforced structure
- Integrate servos and radio-controlled surfaces for in-flight maneuverability
- Implement morphing wings to reduce drag during launch and withstand high acceleration forces

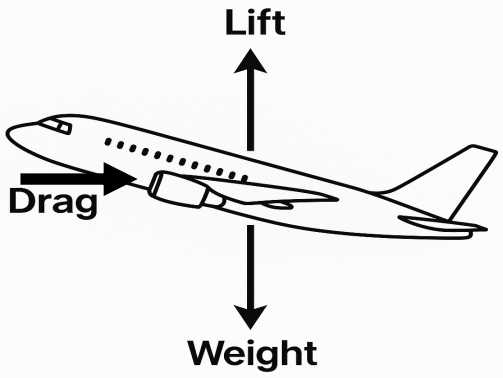
Introduction

Lightweight aircraft

No propulsion

Control surfaces to control movement

High lift, low drag is essential



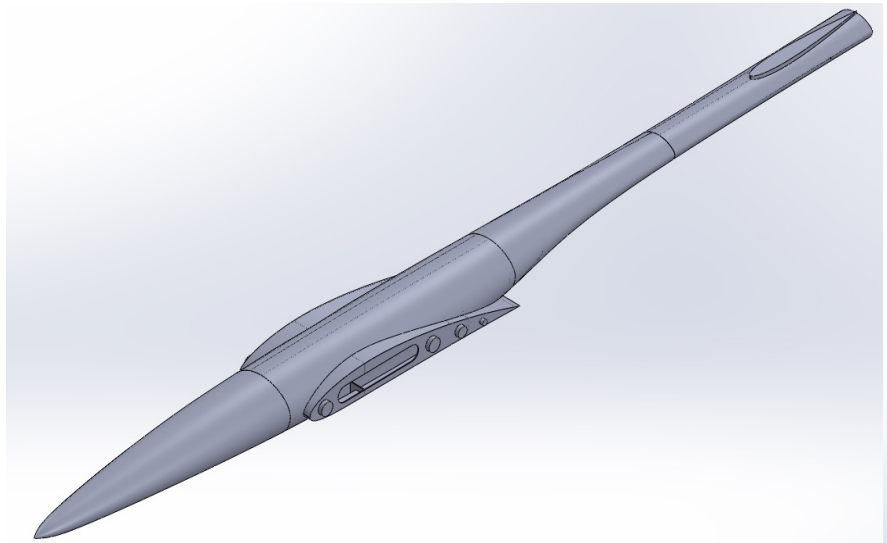


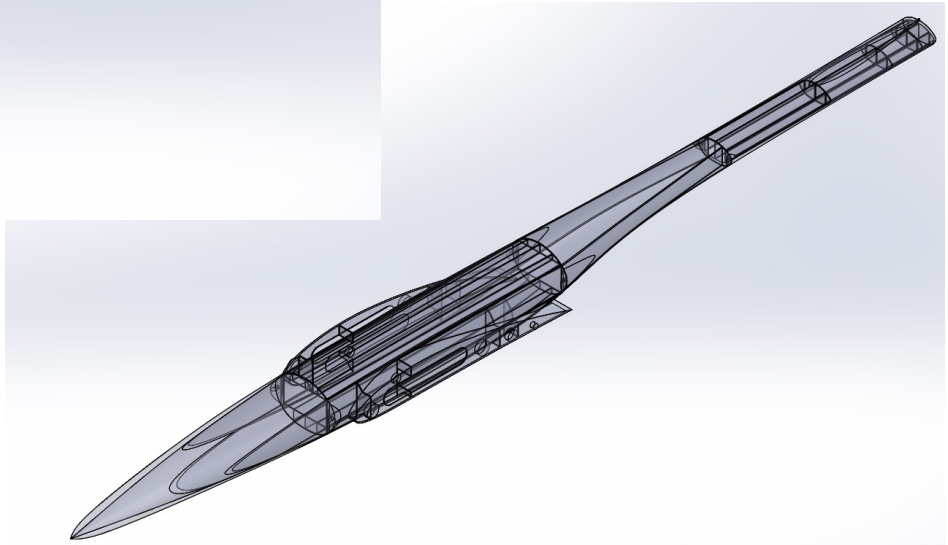
Requirements

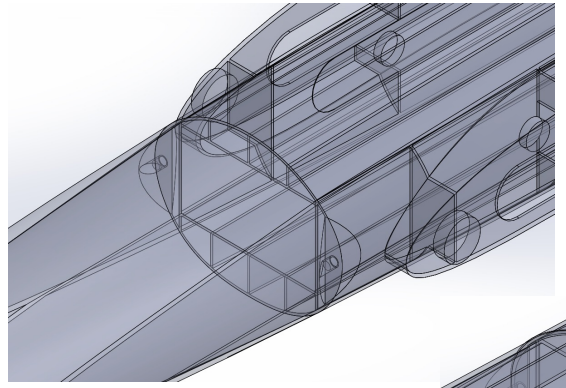
Parameters	Requirement
Flight capable	20 seconds of flight (ideal)
Weight Constraint	<1 kg
Wingspan	1.5 m
Launch Angle	25°
Sweep Back Morphing Wing	Withstand launch acceleration
Battery	5 V / 3 A
Servo	Assorted Servos
Radio Controller	Transmitter/Receiver
3D Printer Material	PLA

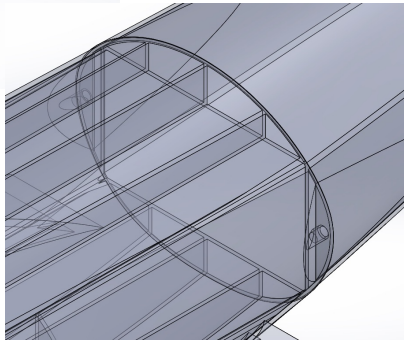


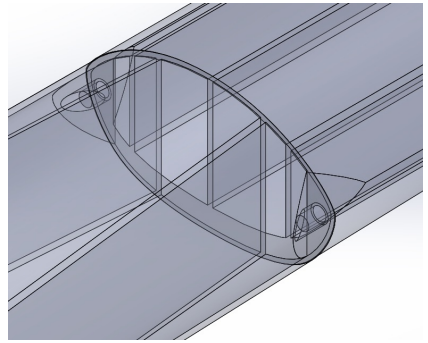
Fuselage (CAD)





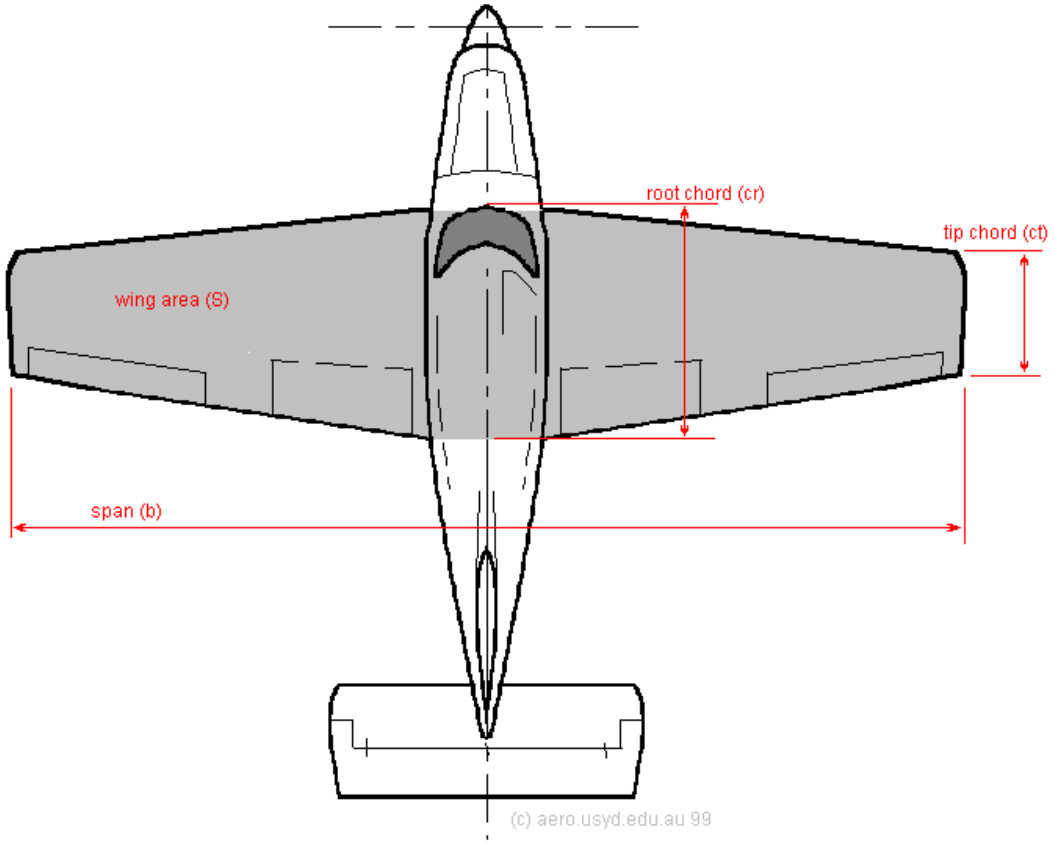






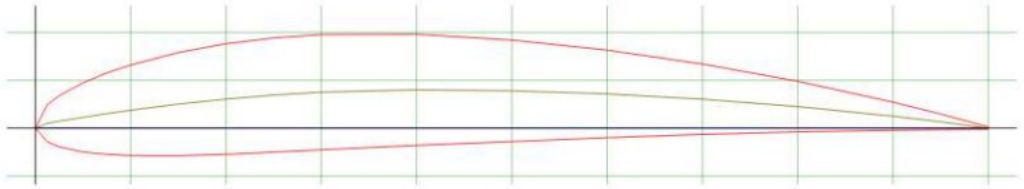
Wing Design Calculations

- Aspect Ratio(AR) for Glider: 8-14
  - Selected: AR = 12
  - Given: Wingspan (b) = 1.5 m
- Taper Ratio for Glider: 0.4-0.6
  - Selected: 0.4 taper ratio
- Calculated:
  - Mean Aerodynamic Chord: 0.127m
  - Wing Area: 0.1870964m^2
  - Root Chord: 0.1778m
  - Tip Chord: 0.0762m



NACA 4412 (naca4412-il)

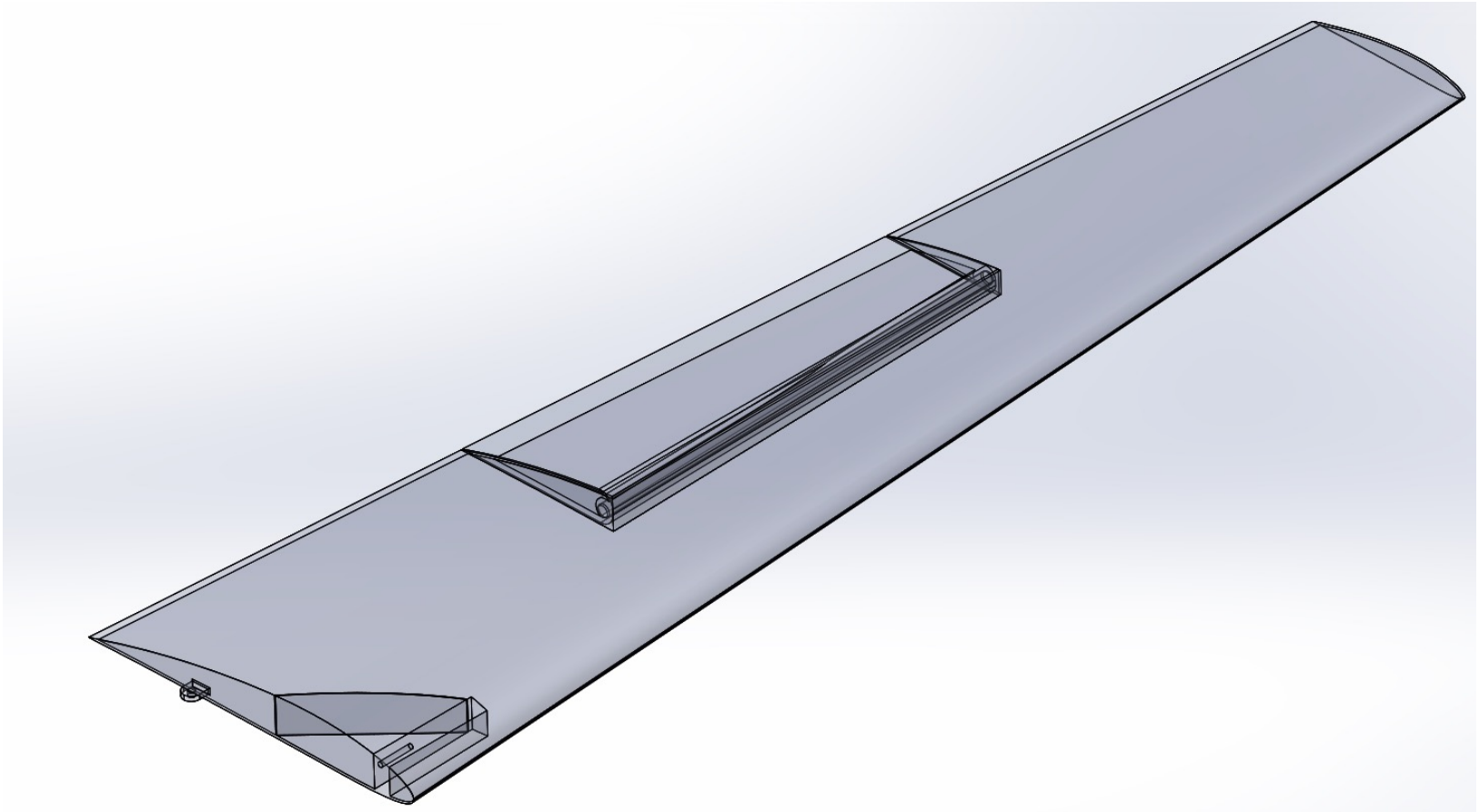
NACA 4412 - NACA 4412 airfoil

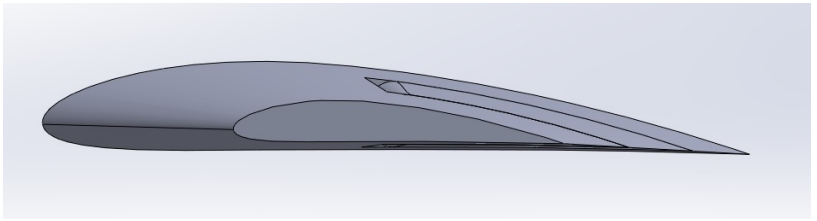


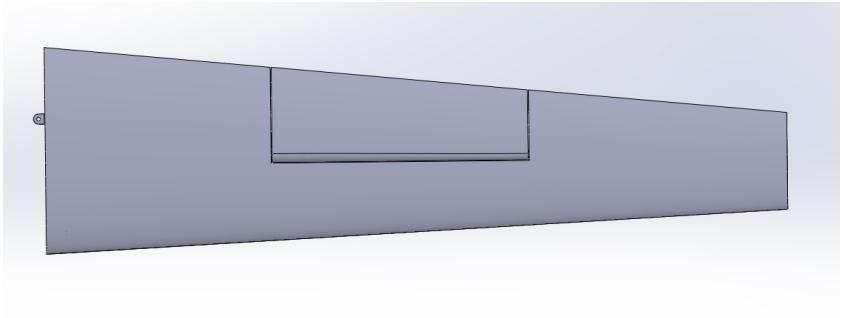
Airfoil Decision Matrix

Airfoil	Lift coefficient 25%	Drag coefficient 20%	L/D 30%	AOA range 20%	Feasibility of printing 5%	TOTAL
NACA 4412	0.5-1.47 SCORE:10	0.0075-0.018 SCORE: 10	67-82 SCORE:10	0-10 (0<AOA<4) SCORE: 10	SCORE: 8	9.9
AG35	0.4-1.2 SCORE: 7	0.005-0.02 SCORE: 7	80-60 SCORE: 3	0-10 (0<AOA<3) SCORE:10	SCORE: 5	6.3
GEMINI	0.2-0.8 SCORE: 5	0.009-0.01 SCORE: 5	22-80 SCORE: 5	0-5 (0<AOA<4) SCORE: 5	SCORE: 10	5.25

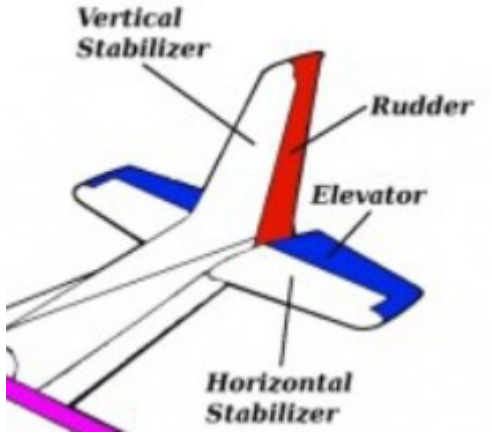
Wing Design (CAD)

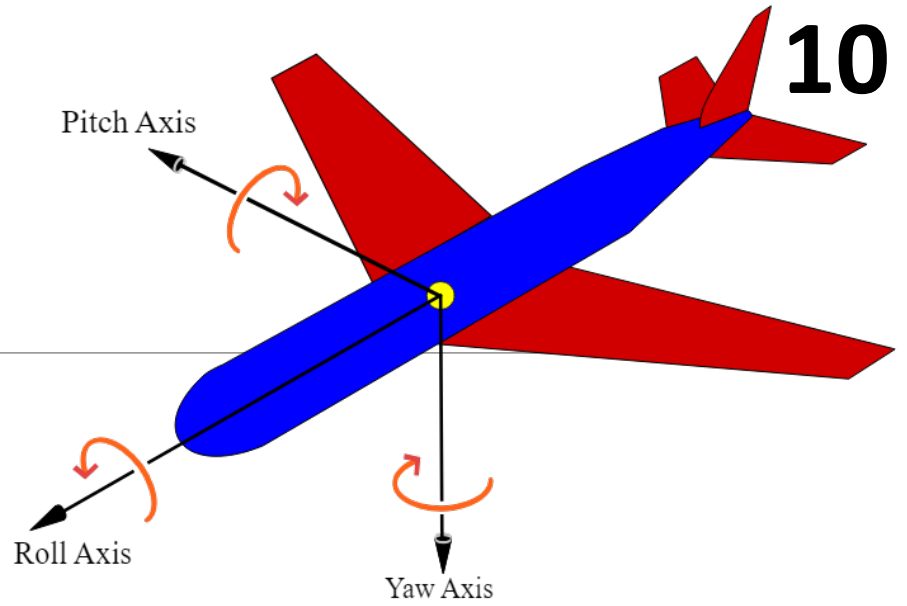


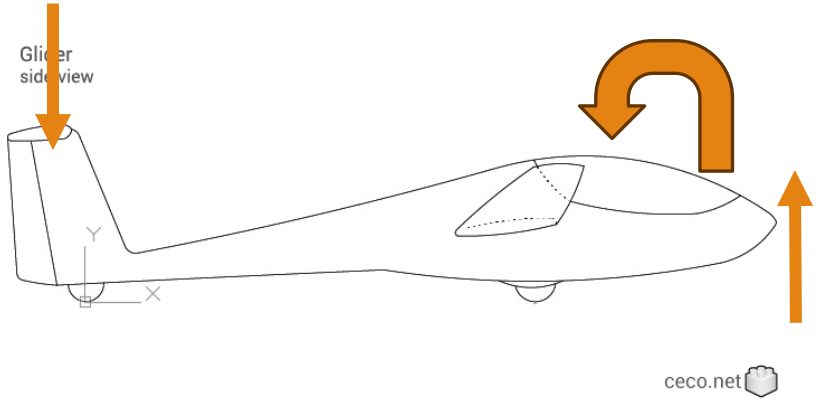


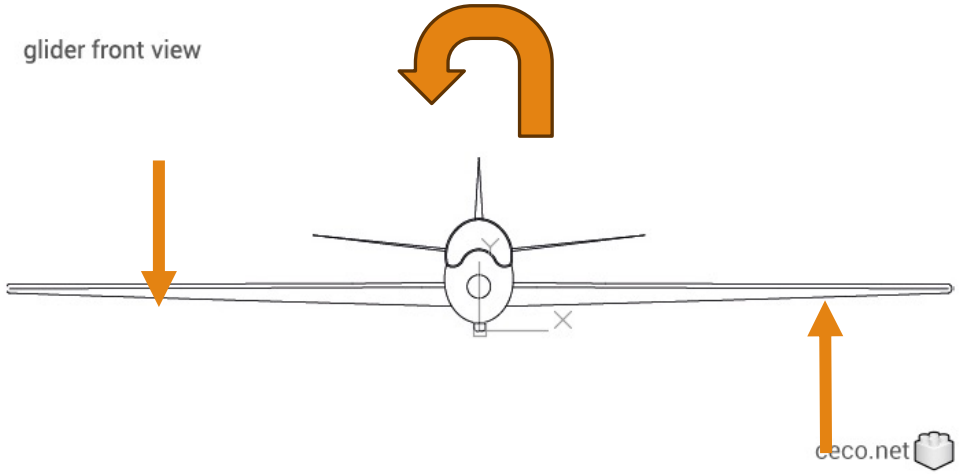


Control surfaces









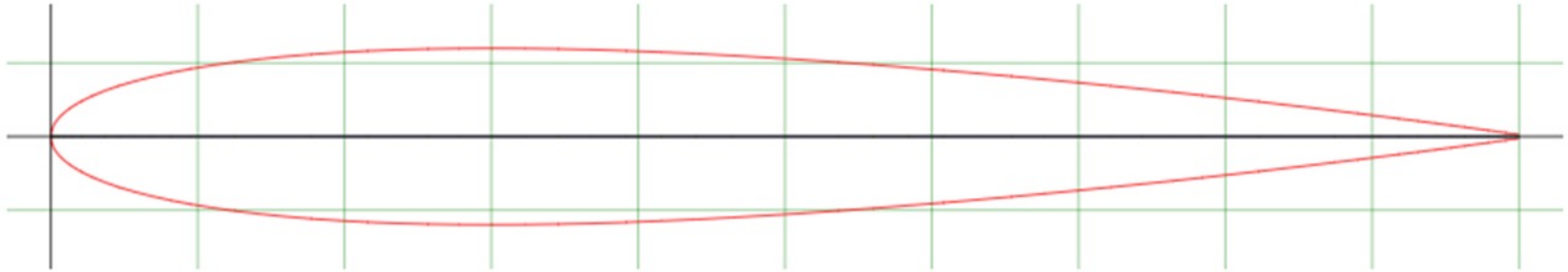
Horizontal Stabilizer Design

Naca 0012 – Symmetric airfoil

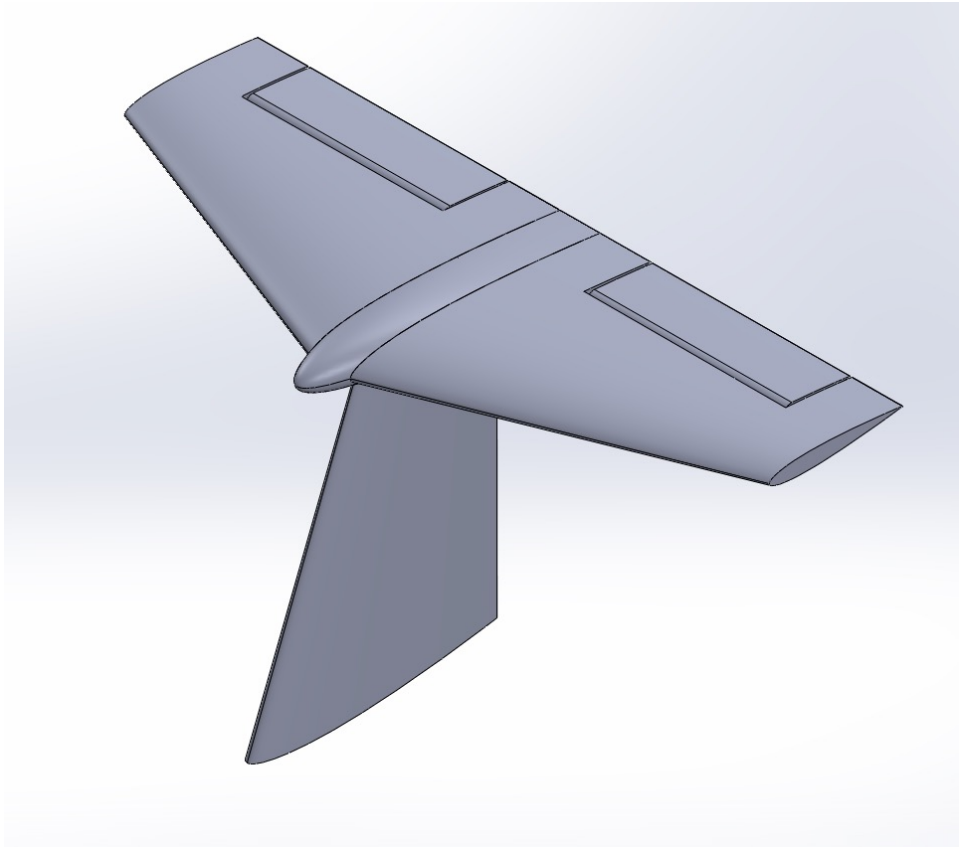
Elevators on horizontal stabilizers control pitch

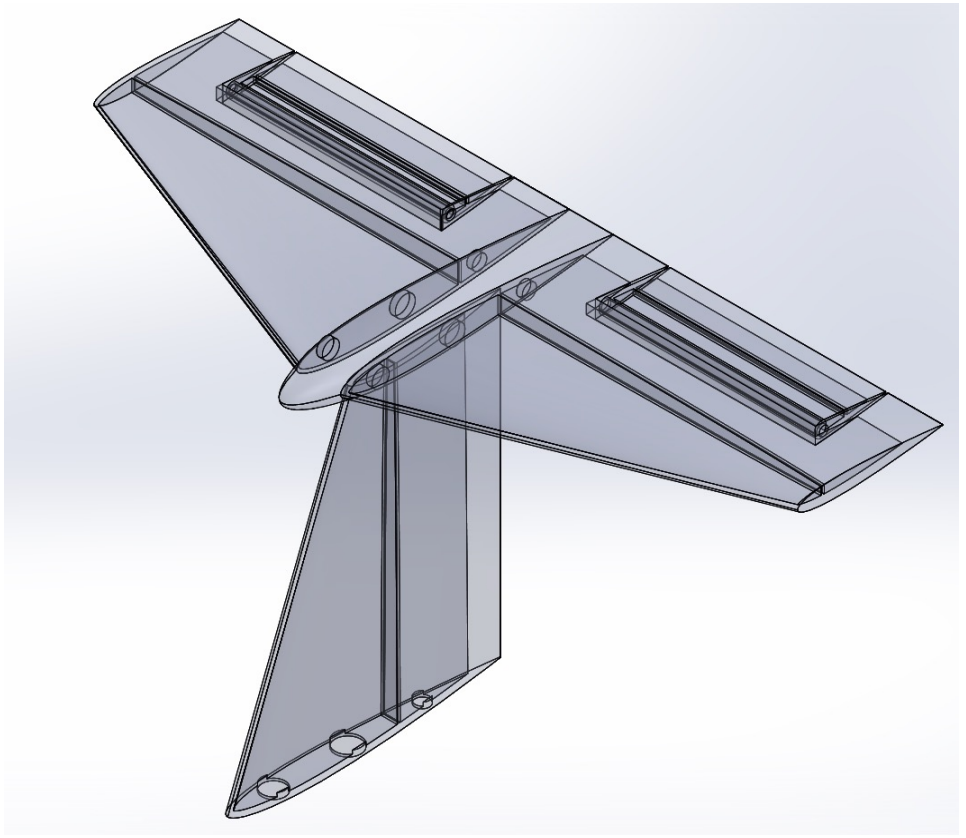
NACA 0012 AIRFOILS (n0012-il)

NACA 0012 AIRFOILS - NACA 0012 airfoil

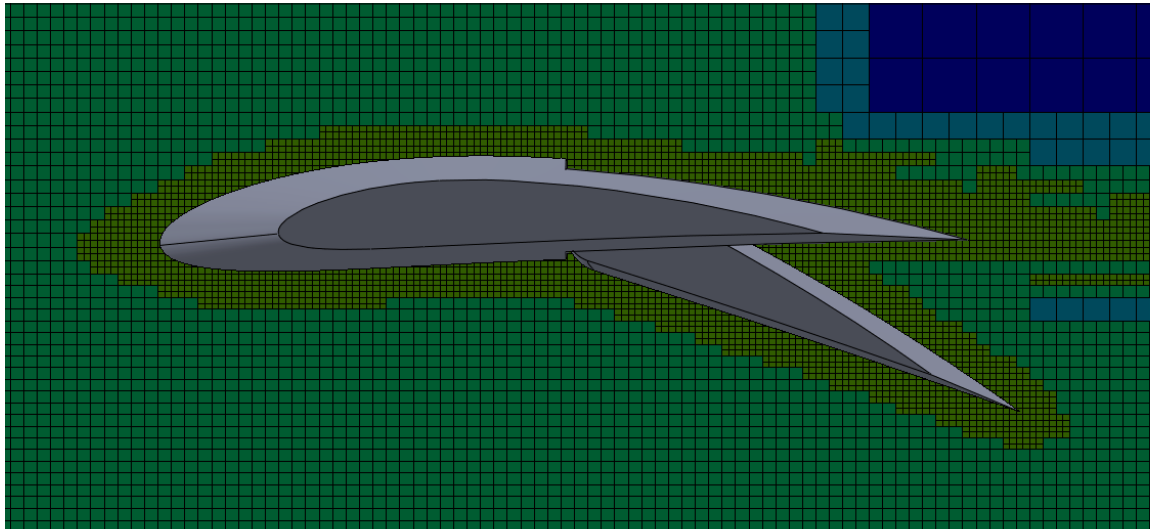


Tail & Stabilizer Wings (CAD)





Simulation (Setup & Global Goals)

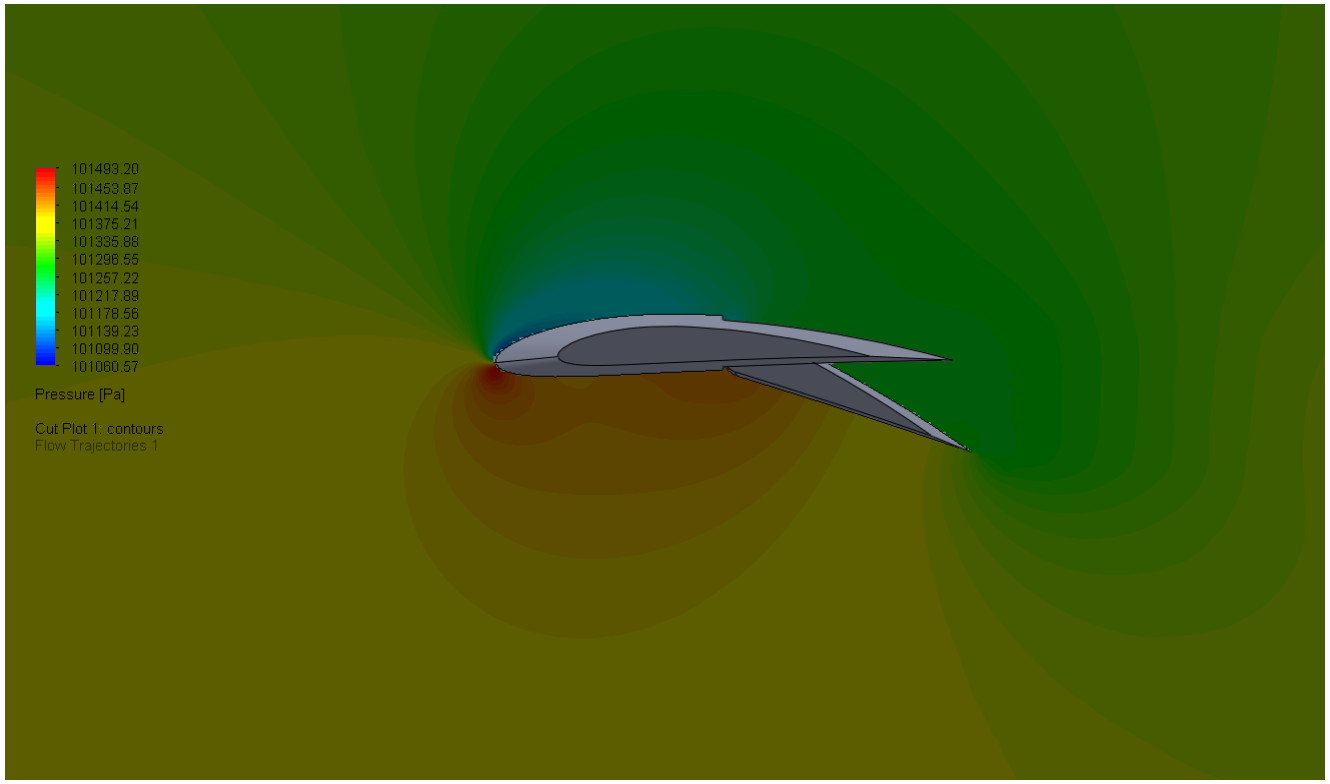


- Steady-state, turbulent airflow simulation at (your flight velocity)
- Analyzed aileron deflection at ±20°
- Mesh: Fine refinement along the wing's control surface
- Objectives: quantify lift, drag, pressure distribution, and flow behavior

Simulation (Aileron Deflection: –20°)

- Downward deflection increases camber → higher lift
- Flow slows over hinge region → increased static pressure
- Slight rise in drag due to increased pressure and induced drag

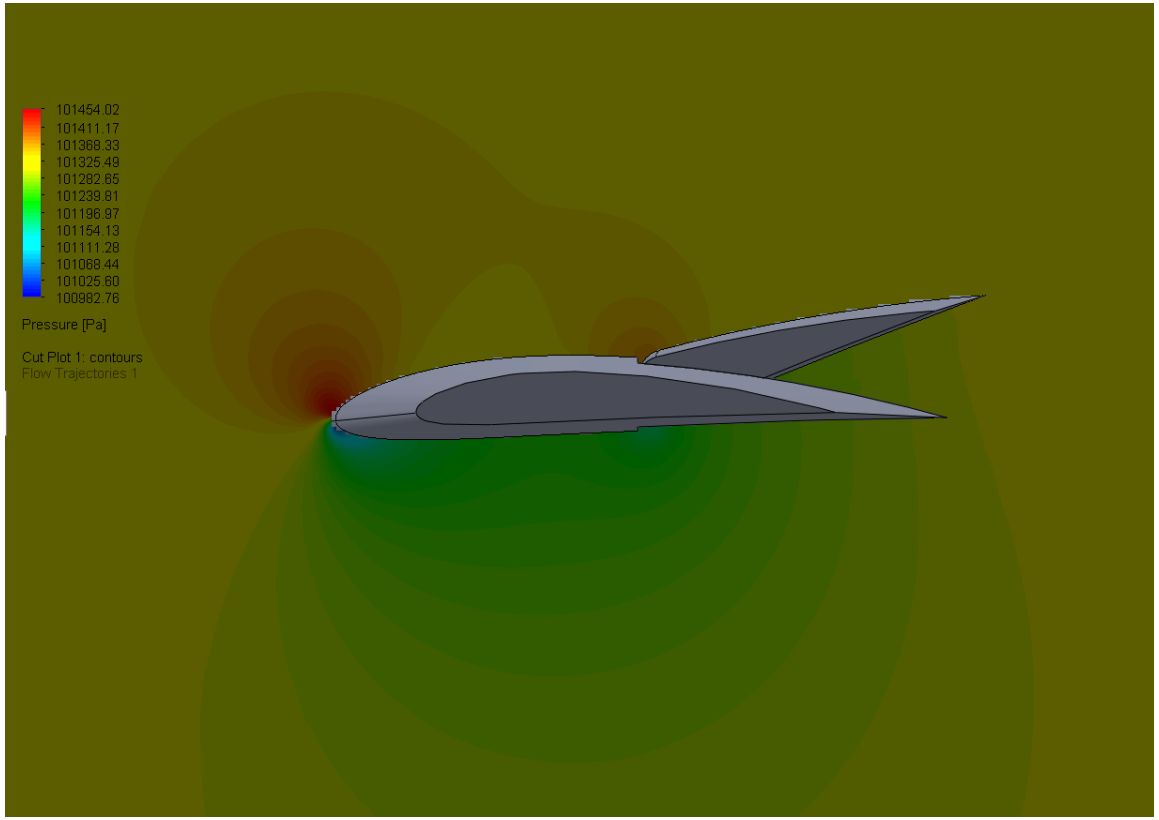
Results	
Lift Force:	18.036 N
Lift Coefficient (CL):	0.1635
Drag Force:	1.407 N
Drag Coefficient (CD):	0.01275
Max Static Pressure:	101,493 Pa
Max Total Pressure:	101,538 Pa



Simulation (Aileron Deflection: +20°)

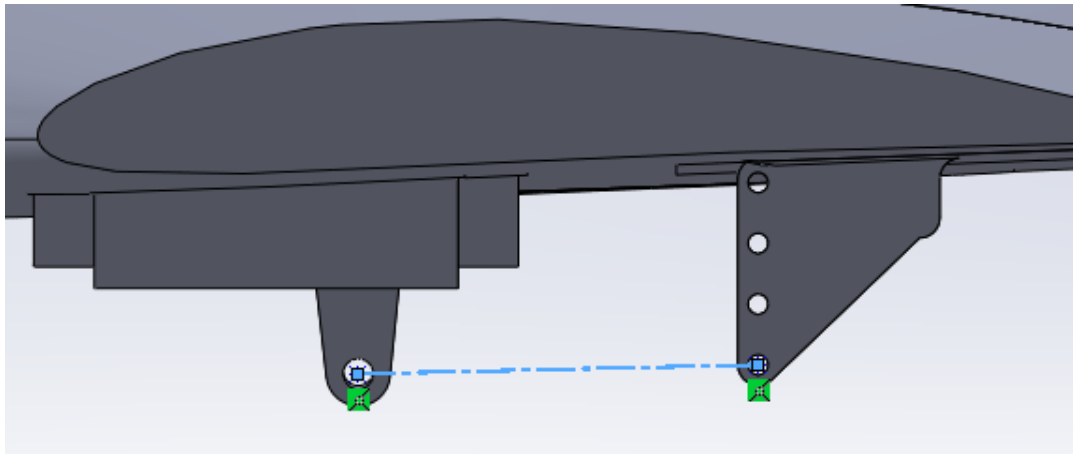
- Upward deflection reduces camber → lift decreases
- Wing produces negative lift (downforce)
- Drag decreases slightly due to reduced lift generation
- Lower static pressure region forms above the wing

Results	
Lift Force:	–10.040 N
Lift Coefficient (CL):	–0.0910
Drag Force:	1.352 N
Drag Coefficient (CD):	0.01225
Max Static Pressure:	101,454 Pa
Max Total Pressure:	101,478 Pa



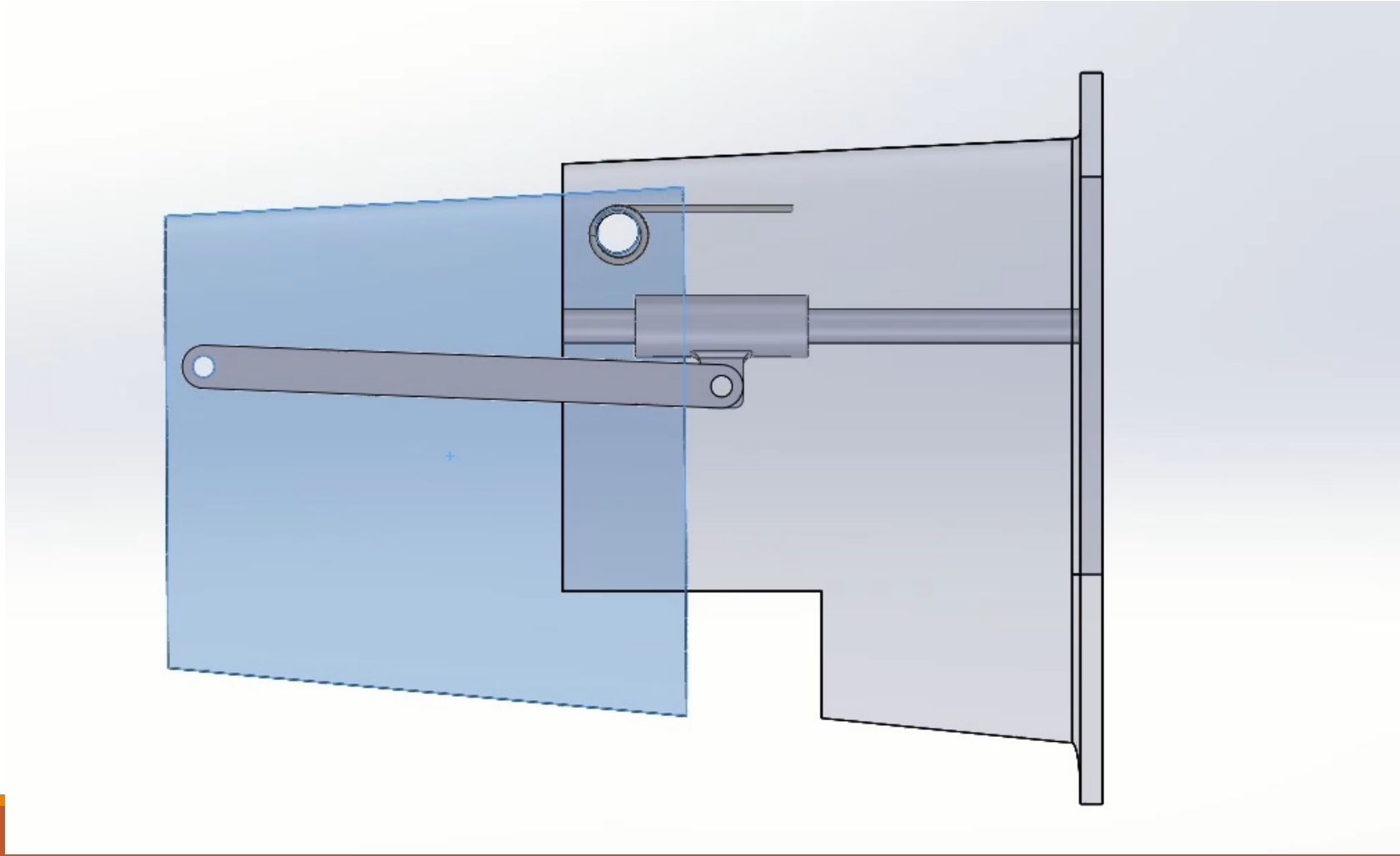
Servo Linkage Design

- A 4-bar linkage transfers the servo's rotation directly to the aileron control horn.
- The mechanism provides a 1:1 motion ratio, ensuring equal servo and control-surface deflection.
- Link geometry minimizes mechanical bias and keeps deflections symmetric in both directions.

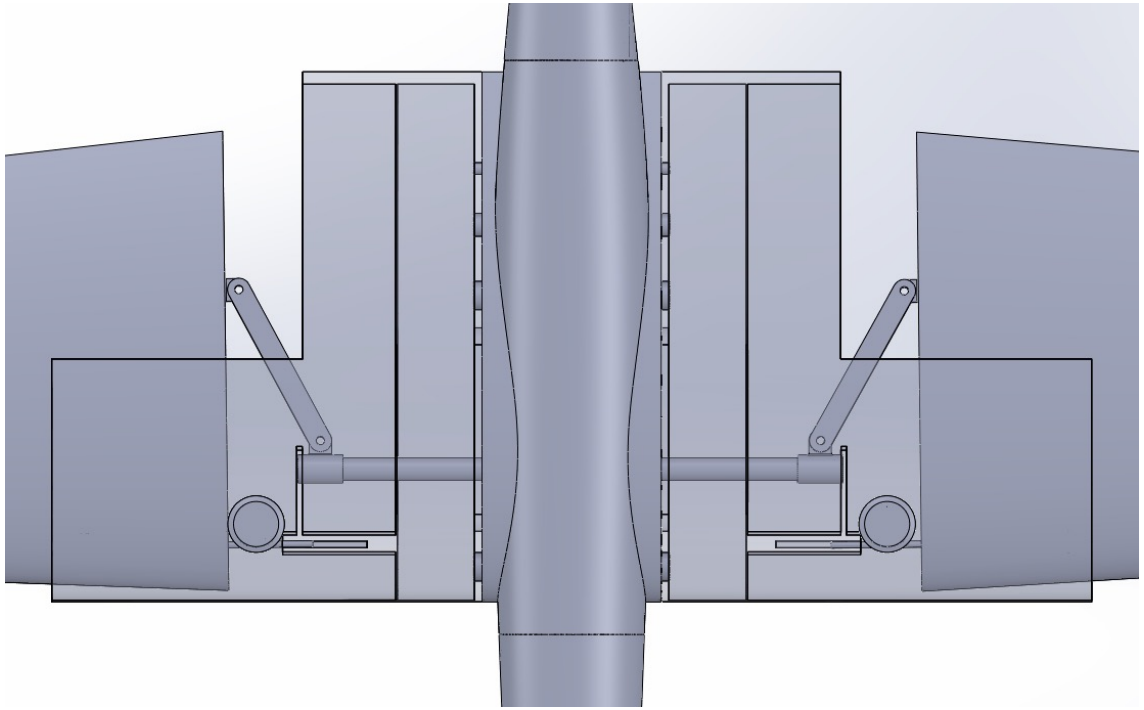


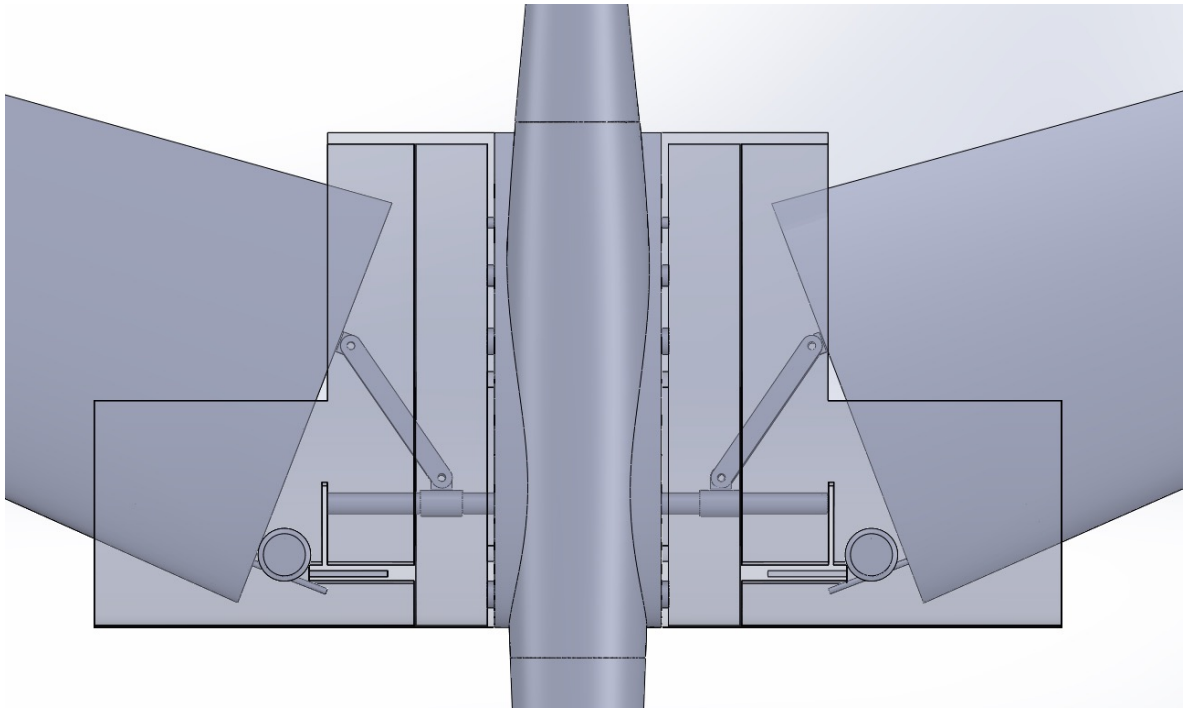
Dimensions	
Servo Horn (Input Link):	$0.015748m$
Pushrod (Coupler Link):	$0.0251m$
Control Surface Horn (Output Link)	$0.019812m$

Morphing Wing Mechanism



Morphing Wing (CAD)





3D Printing

- 3D printing enabled rapid prototyping and fast iteration of our glider components.
- Bambu Studio was used to slice all parts for consistent manufacturability.
- Parts were printed at 0% infill with 1-wall thickness, relying on internal supports for strength.
- A 0.4 mm nozzle set our minimum dimensional constraints during design



Radio Control

The glider utilizes radio control to maintain balance in flight.

A radio control (RC) requires a transmitter and receiver to work.
The receiver is placed inside the plane and receives commands from the transmitter to perform a desired action.

Typical RC systems consist of a battery, an electronic speed controller, and motors.

Our system has a battery, a buck converter, servos, and a camera.





Power Requirements

Receiver: RadioLink R12DS

Transmitter: RadioLink AT10

Motors: MG90S

Camera: AKK AIO SA 5.8 GHz

Battery: Cecicebb LiPo RC 2S 30C 500 mAh

Part	Voltage	Current	Power
Receiver	5 V	0.04 A	0.2 W
Motors	5 V	(Idle) 0.10 A (Heavy) 0.40 A (Stall) 0.80 A	0.5 W 2.0 W 4.0 W
Camera	5 V	0.20 A	1.0 W
Total	**5 V**	**0.74 - 4.24 A**	**3.7-21.2 W**

Part	Voltage	Current	Power
Battery	7.4 V	15 A	111 W

First Person View Glider

The AKK AIO SA camera is a micro FPV camera that transforms any RC vehicle with first person view.

The camera comes equipped with a video transmitter and an antenna that runs at 5.8 GHz. It features 40 channels and several power outputs.

The camera provides video to either goggles or a display monitor. Our group used the SoloGood 4.3" monitor to display the video.



Panel usage

There are 3 design options for this in increasing order of simplicity

- 1) connecting the panels to both the glider components and to the battery
  - The panel charges the battery in use while providing power to the rest of the glider to limit current draw on the battery thus extending the battery life.
  - This will be used.
- 2) connecting the panels to just the battery
  - The panels will just provide power to the battery constantly trying to return power lost from the components, thus still prolonging the battery life though alteration to the overall deign will be needed.
- 3) connecting the panels to just the onboard components
  - The panels will provide supplemental power to just the onboard components as a redundancy backup.



Battery usage

Total current draw from each of the components at max load is approximately 3.8 Amps.

The idle current is approximately 0.38 Amps.

Using the formula for battery life, the total time the battery can be used under a certain load, is:

$$\text{Battery Life} = \frac{\text{Battery capacity in milliampere-hours}}{\text{Load current in milliamperes}}$$

This means that that under max load, the battery will last 10 minutes of constant use.

While in idle conditions, the battery will last 1.3 hours.



5V Micro Solar Panels, 10PCS 5V 200MA Solar Cells



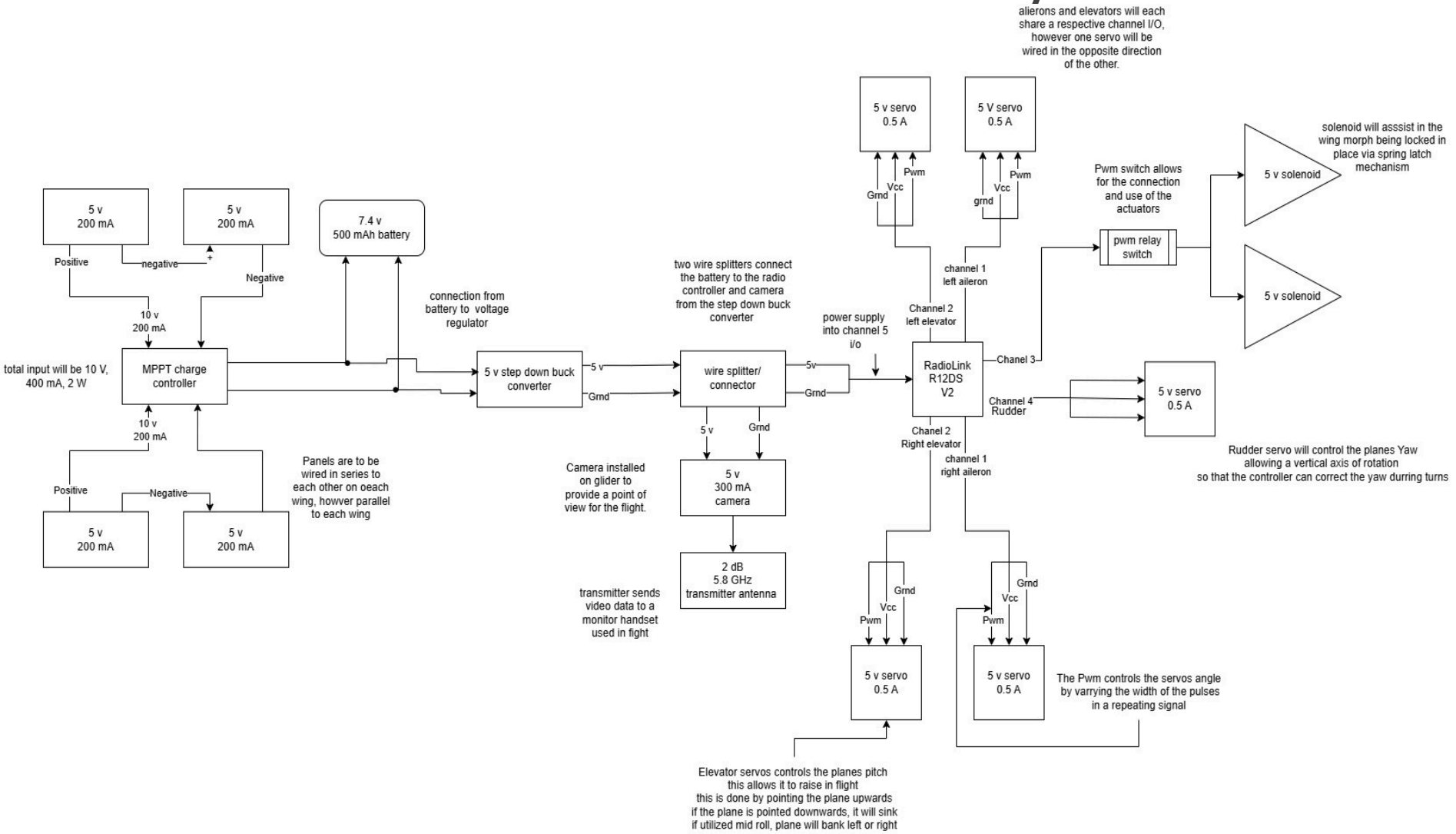
Material	Polycrystalline Silicon
Product Dimensions	109mmL x 59.9mmW x 2.54mmH
Efficiency	High Efficiency
AC Adapter Current	200 Milliamps
Maximum Voltage	5 Volts
Maximum Power	200 Watts
Manufacturer	FellDen
Part Number	5V
Item Weight	20.27 grams

Low weight of 20 grams makes this panel an ideal selection.

Panel dimensions fit within wing surface area of 290 mm^2

Acceptable balance between voltage and current output.

Panels connected to whole system



explanation

Due to the rating and dimensions of the 5 v panel, two panels may be able to be fixed to each wing allowing them to be wired in series to each other, but parallel to each wing.

Voltage increase when added in series but not amperage, so each wing generate 10 Volts 200 milliamps 2 Watts

Wired in parallel the total optimal output becomes 10 V, 400 mA, 4 W

Panels are wired to an Mppt charge controller to protect the onboard battery as well as protect the solar panels.

Panel/battery configuration then connects to a step-down buck converter and then provides power to the camera separately from the radio receiver

Connected Radio receiver then transmits power to the other devices connect to it in series.



Prototypes 1-3



Conclusion – Final Glider

