Team #5
BOMBER BARONS

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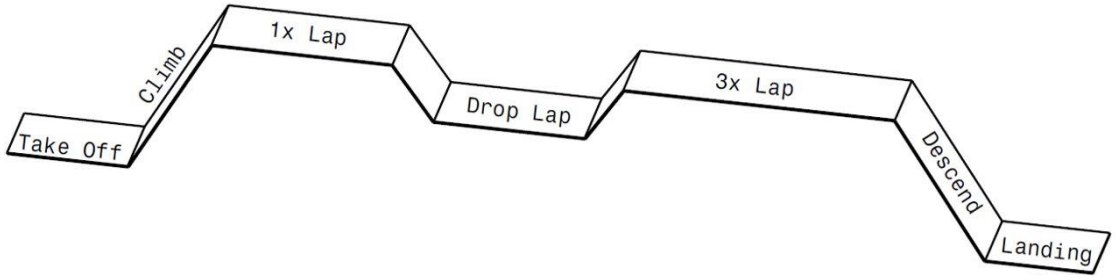
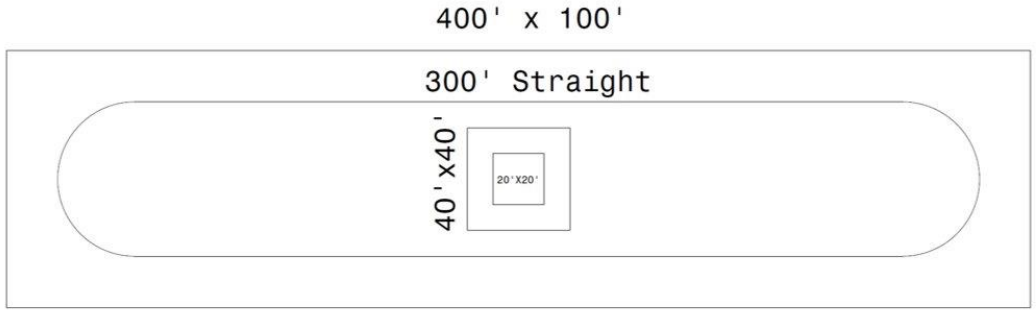
MISSION IDENTIFICATION

“A Storable Semi-Autonomous Emergency Supply Aircraft”

Goal: To design a storable aircraft that will fly 5 laps and autonomously deliver the payload within the designated target zone.

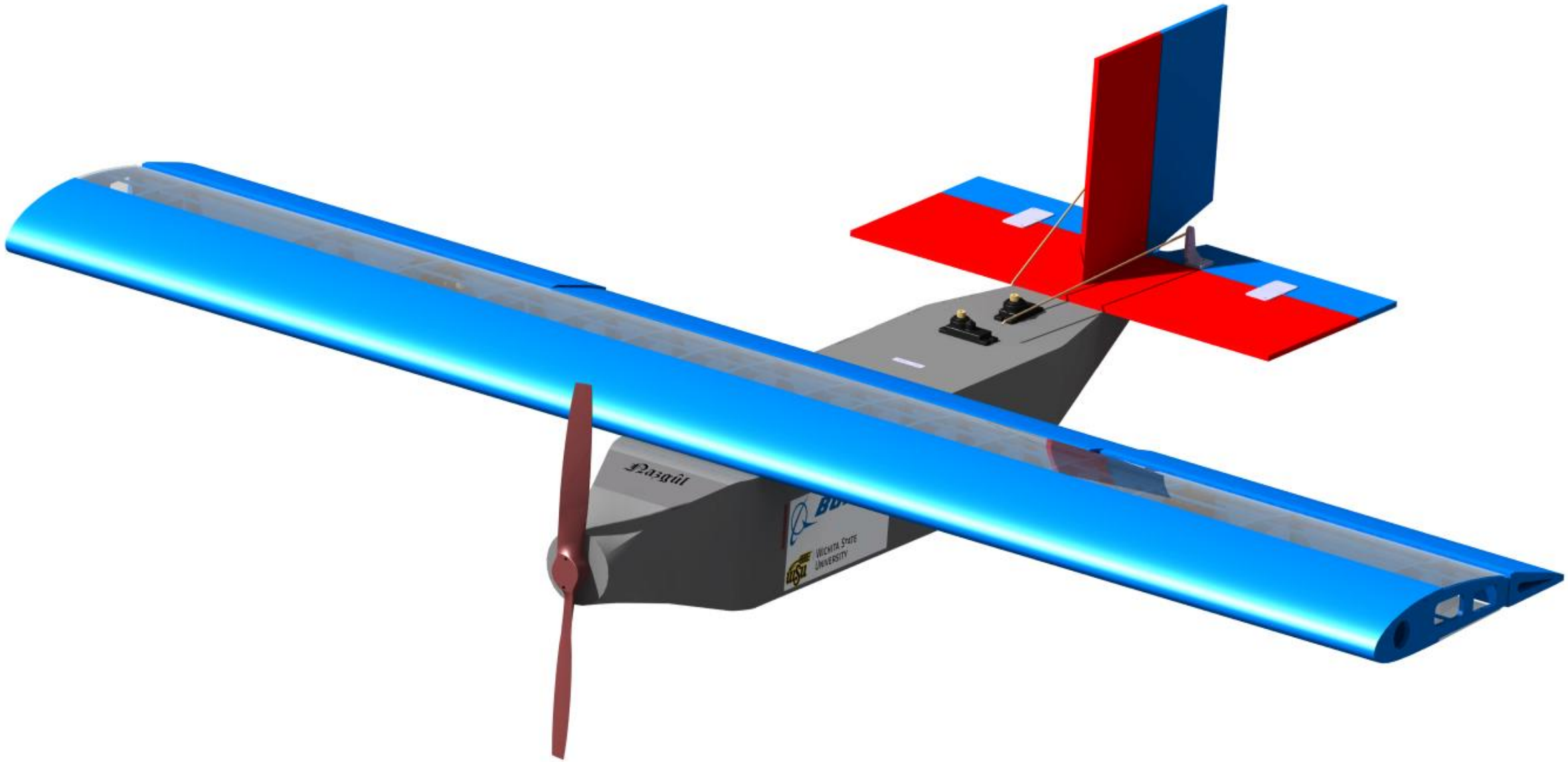


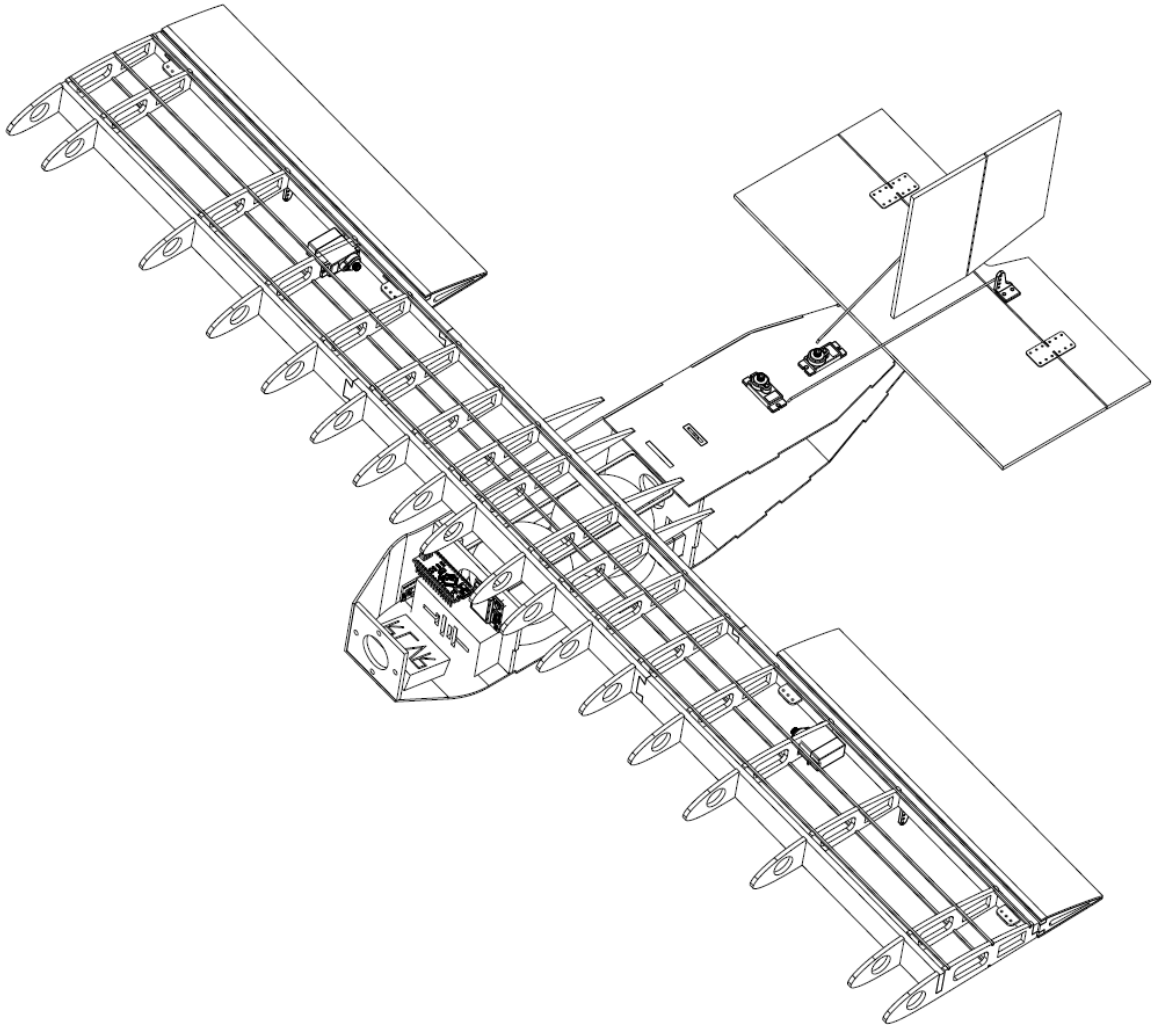


Relative Track Map and Scoring Zone

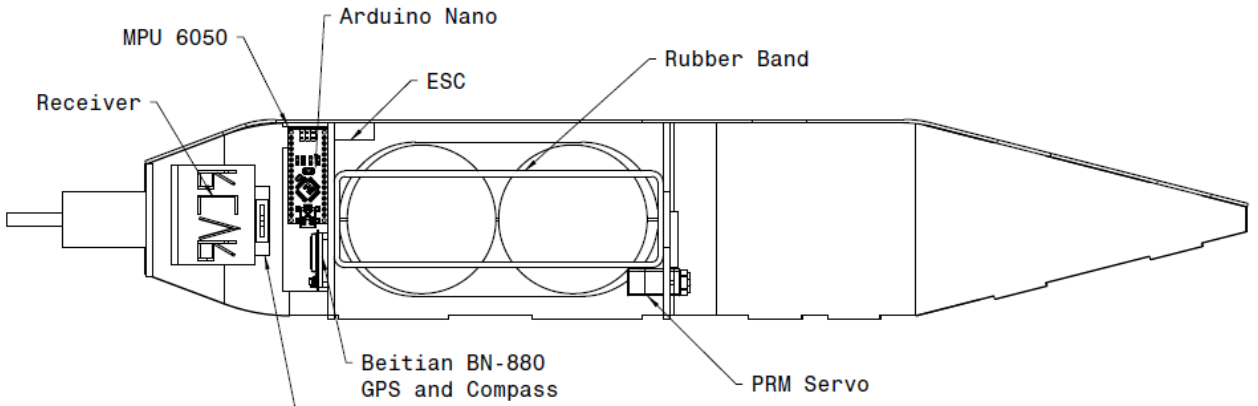
Team’s Strategy:

- Shortest mission time
- Carry minimum number of payload
- Drop payload immediately after 2nd lap
- Durable aircraft for durability to fly multiple missions

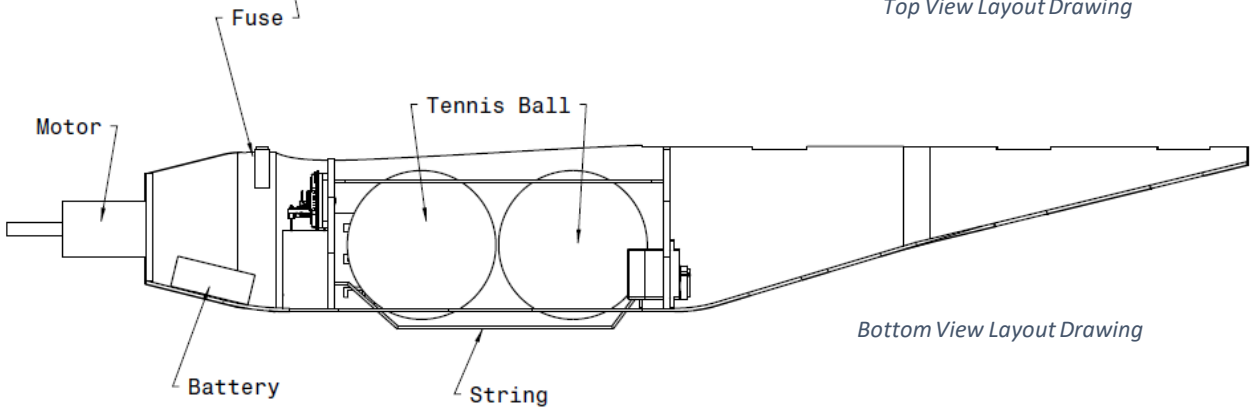

Wichita State
University



Iso-View Layout Drawing



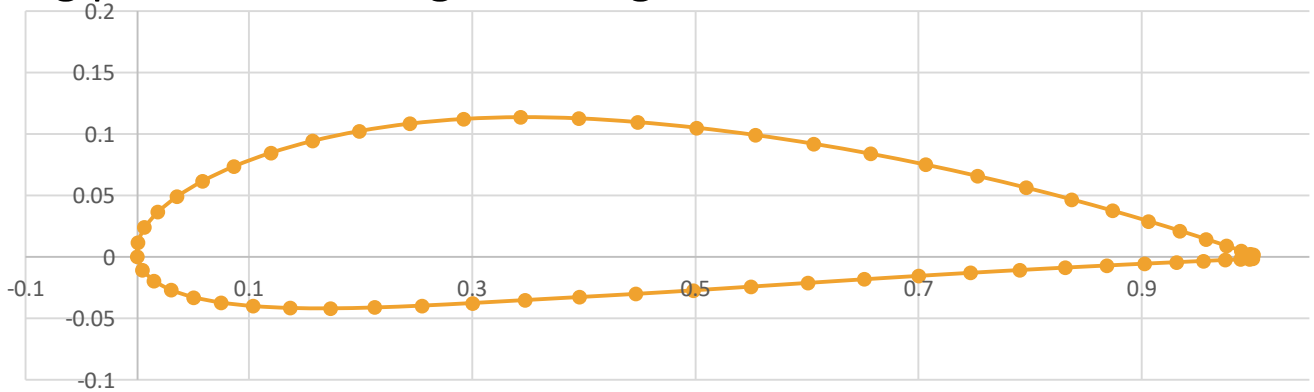
Top View Layout Drawing



Bottom View Layout Drawing

AERODYNAMICS

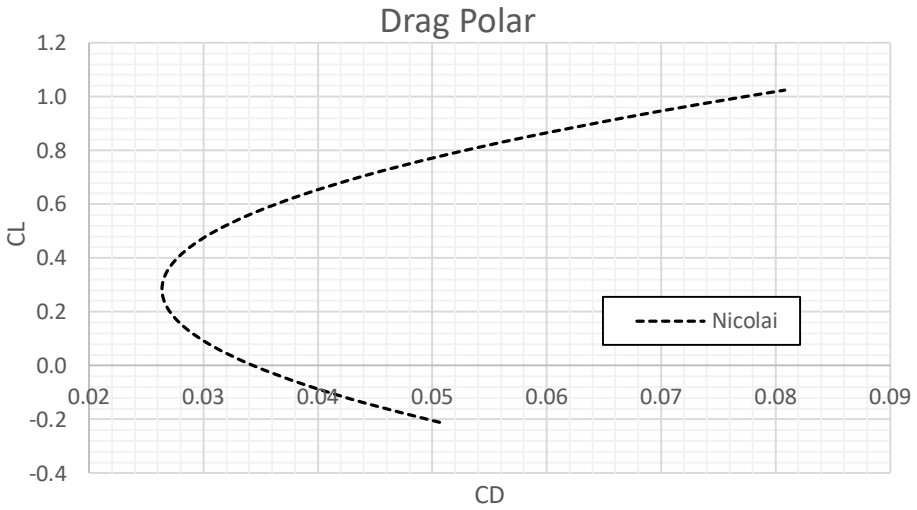
- NACA 4415
  - Properties: high C_L, low C_D
- Wing Dimensions
  - Chord = 0.6 ft, Area = 1.8 ft^2
- $C_{L,max}$ = 1.02
- $C_{D,min}$ = 0.026
- L/D_{max} = 16.5
- Wing produces the highest drag coefficient



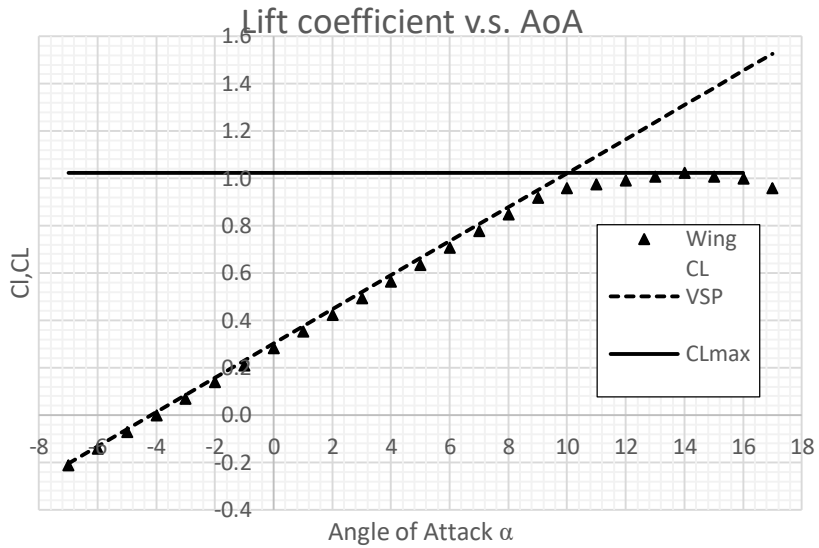
Cross-sectional view of NACA 4415

Nicolai Drag		
Fuselage	Cf	0.0051
	FR	5.7999
	FF	1.3220
	CDmin	0.0048
Wing	Cf	0.0064
	L	1.2000
	R	1.0500
	t/c	0.1500
	FF	1.2922
	CDmin	0.0171
H-Tail	Cf	0.0036
	L	1.2000
	R	1.0500
	t/c	0.0000
	FF	1.0500
	CDmin	0.0032
V-Tail	Cf	0.0040
	L	1.2000
	R	1.0500
	t/c	0.0000
	FF	1.0500
	CDmin	0.0014
CDmin		0.0264

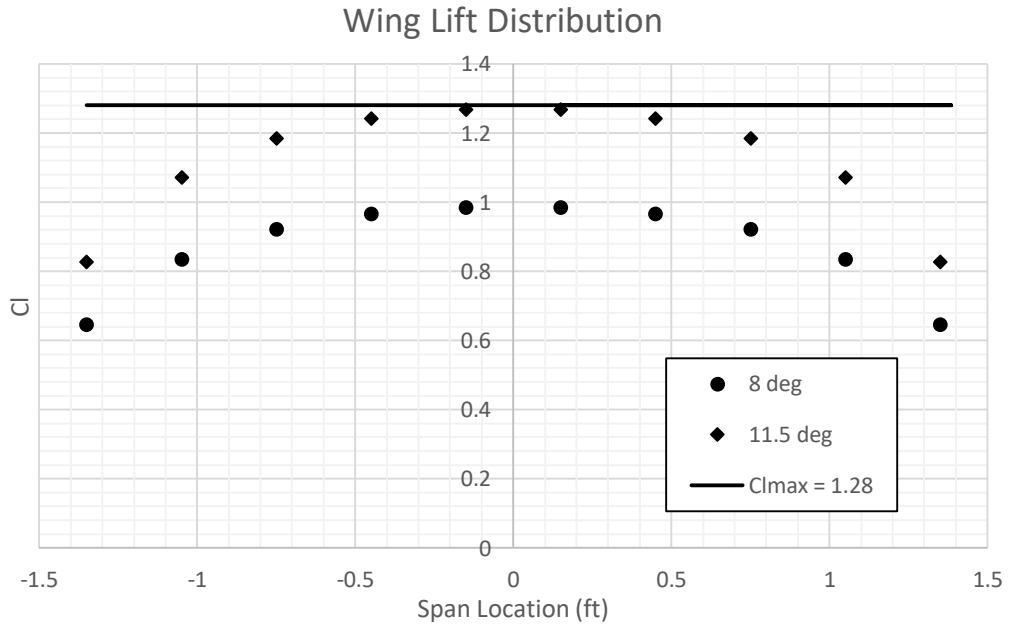
Nicolai Drag Method Results



Drag Polar of Nicolai

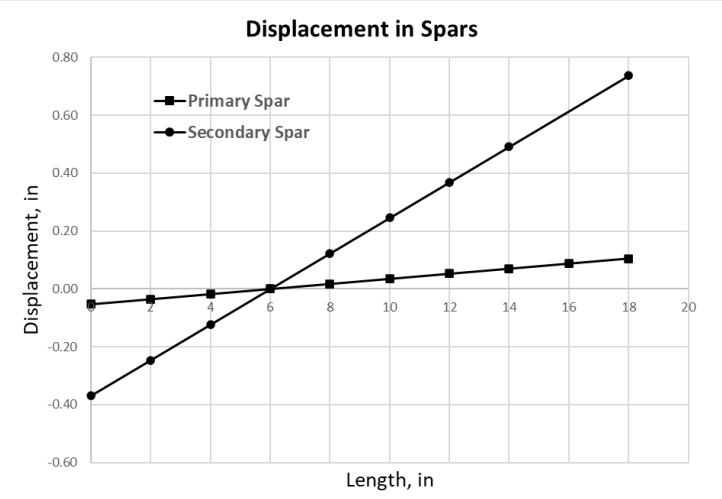


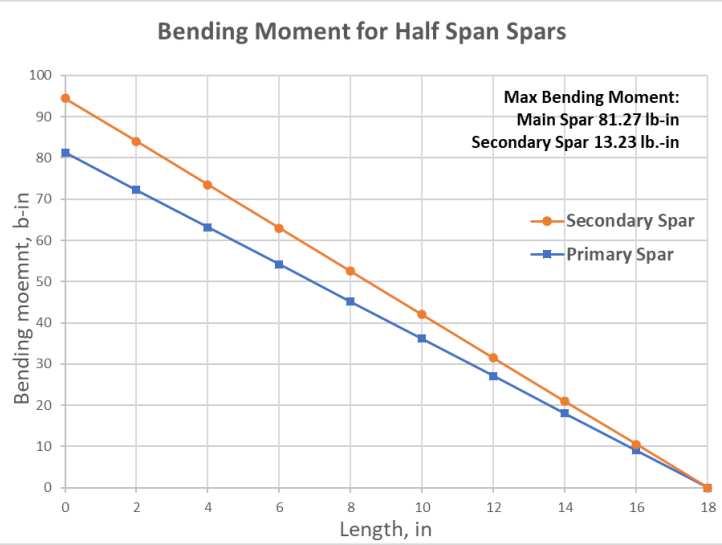
Lift coefficient v.s. AoA for Airfoil, Wing and VSP



Wing Lift Distribution

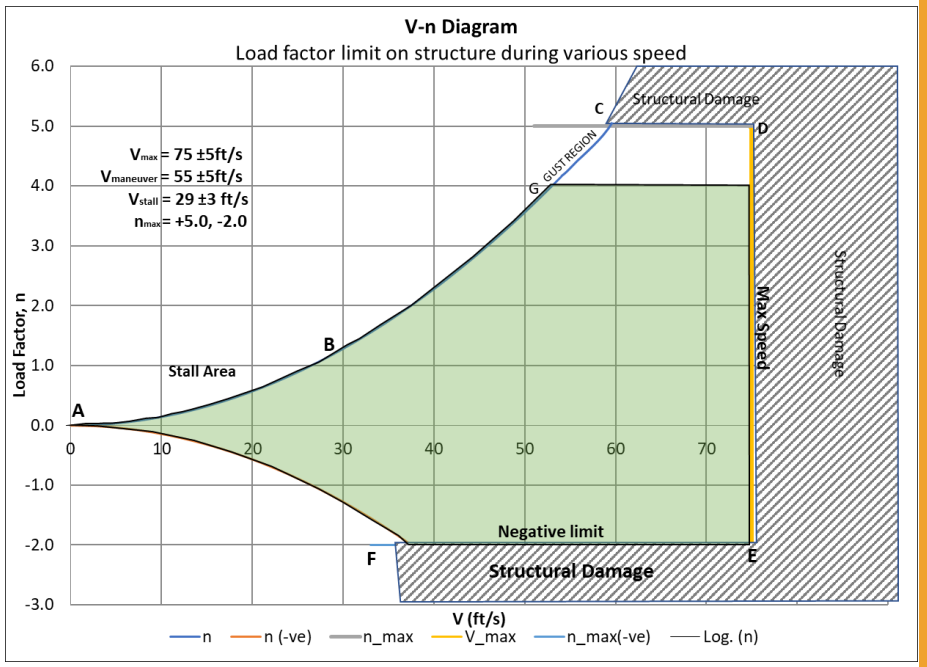
STRUCTURES





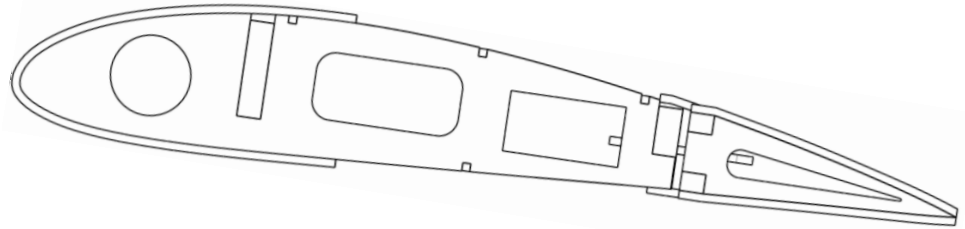
- 2 Spars configuration
- Wing was idealized to be a box and under linear load.

- Analysis methods:
  - Advanced beam theory.
  - Thin-walled Torsion theory.



Materials

Skin	1/16	Balsa
Ribs	1/8	Balsa
Flaperons	1/8	Balsa
Stringers	1/16x1/16	Bass
Main Spar	3/16	Bass
Aft Spar	3/16	Bass

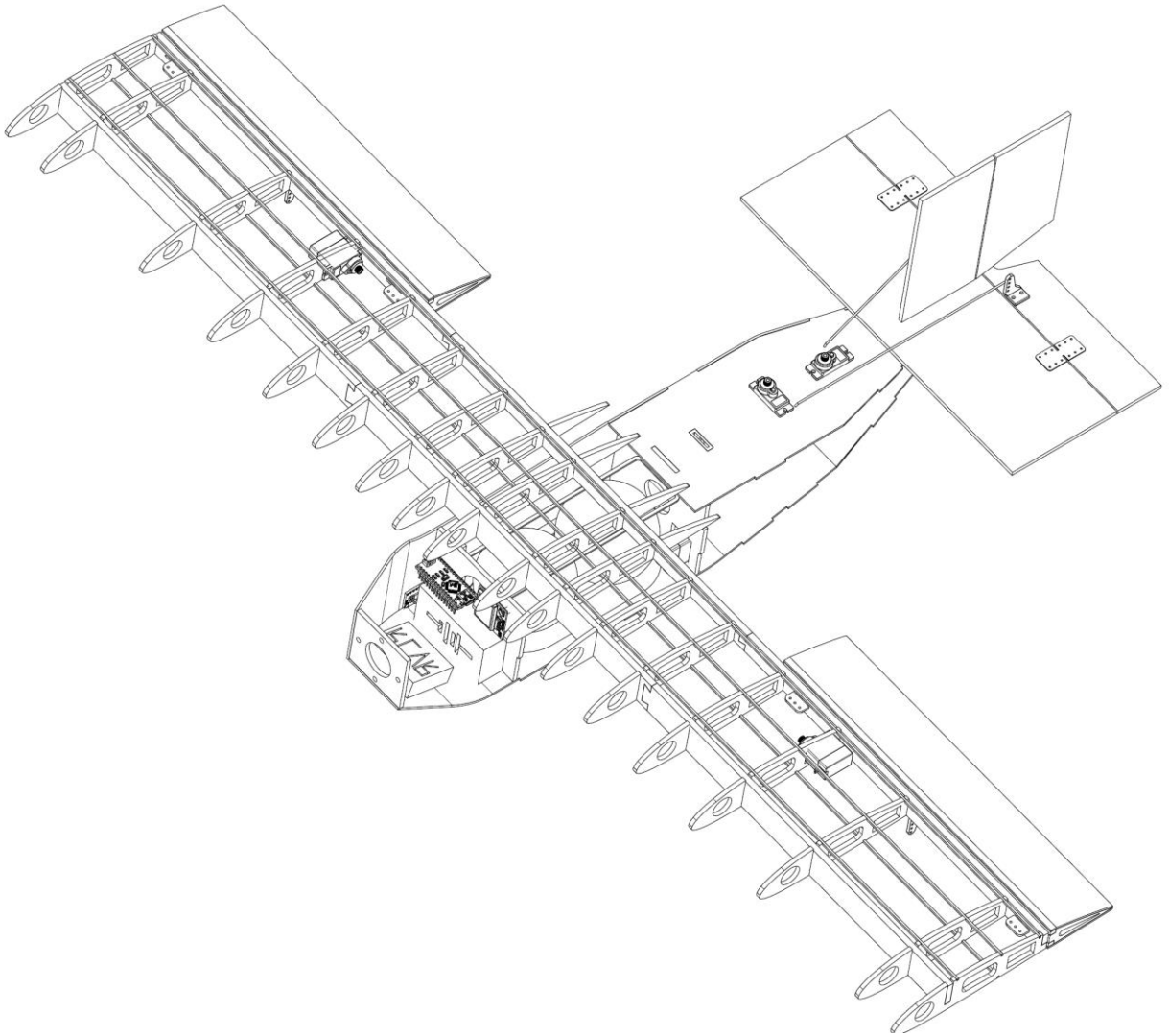


Fuselage:

- Skin carrying most of the load.
- 3x Bulkhead strategically placed to mount Internal components.
- Payload mechanism mounted between 2nd and 3rd bulkhead.
- Bass sheet used to increase rigidity.

Materials

Fuselage Skin	1/16	Bass
Bulkheads	1/8	Bass
Horizontal Tail	1/8	Bass
Vertical Tail	1/8	Bass
Elevator	1/8	Bass
Rudder	1/8	Bass



PROPULSION

- **Venom Fly LiPo Battery**
  - Number of Cells: 3S (11.1 V)
  - Capacity: 1300 mAh
  - Maximum Charge: 30C
- **Great Plane RimFire 400**
  - Continuous Current Supply: 14A
  - Burst Current Supply: 20A
- **APC Propeller**
  - Diameter: 10 in
  - Pitch: 7
- **Castle Creations Talon ESC**
  - Max Amperage: 25A

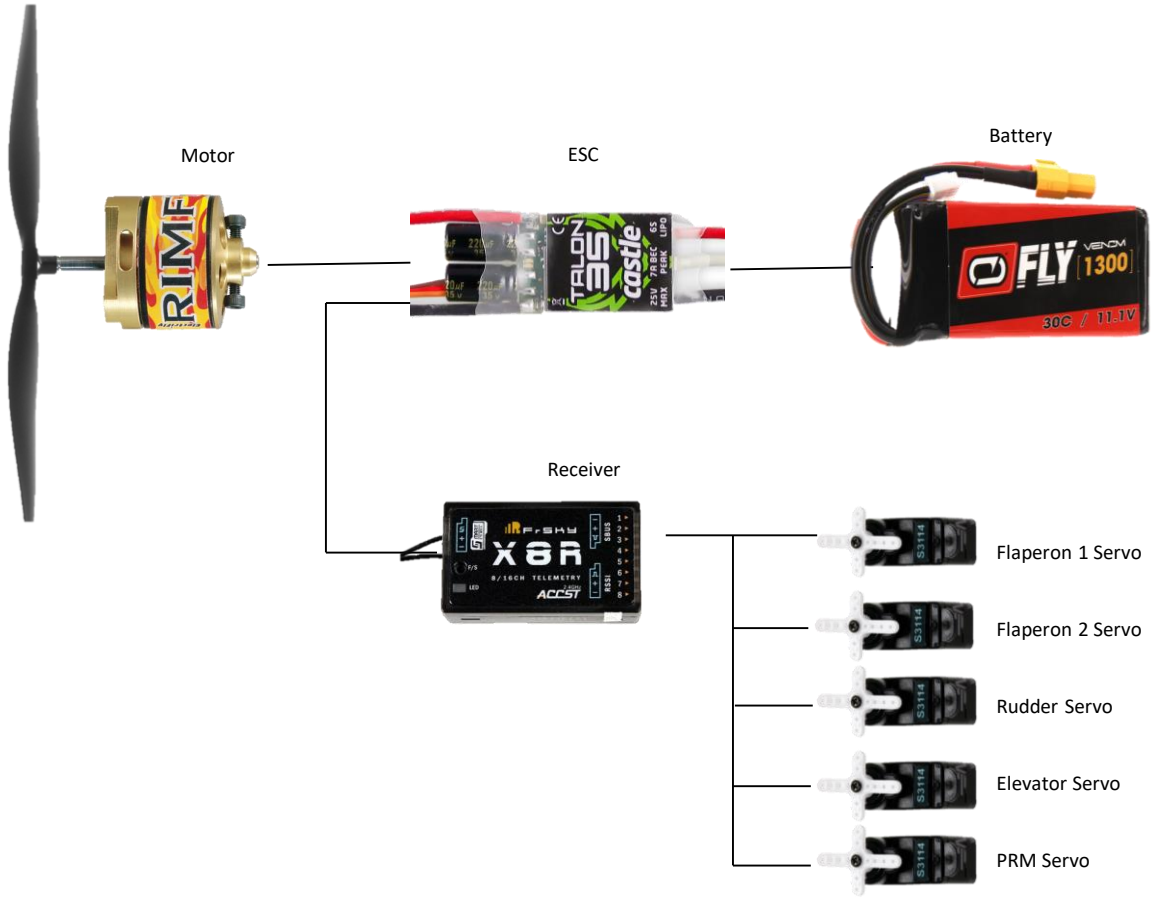


Figure: Simplified Layout of Propulsion System

- Power Required: 85W
- Power Available: 140W
- Maximum Thrust Required: 1.6 lb
- Maximum Thrust Available: 2 lb
- Maximum RPM: 7,500 RPM
- Maximum Current Draw: 20A

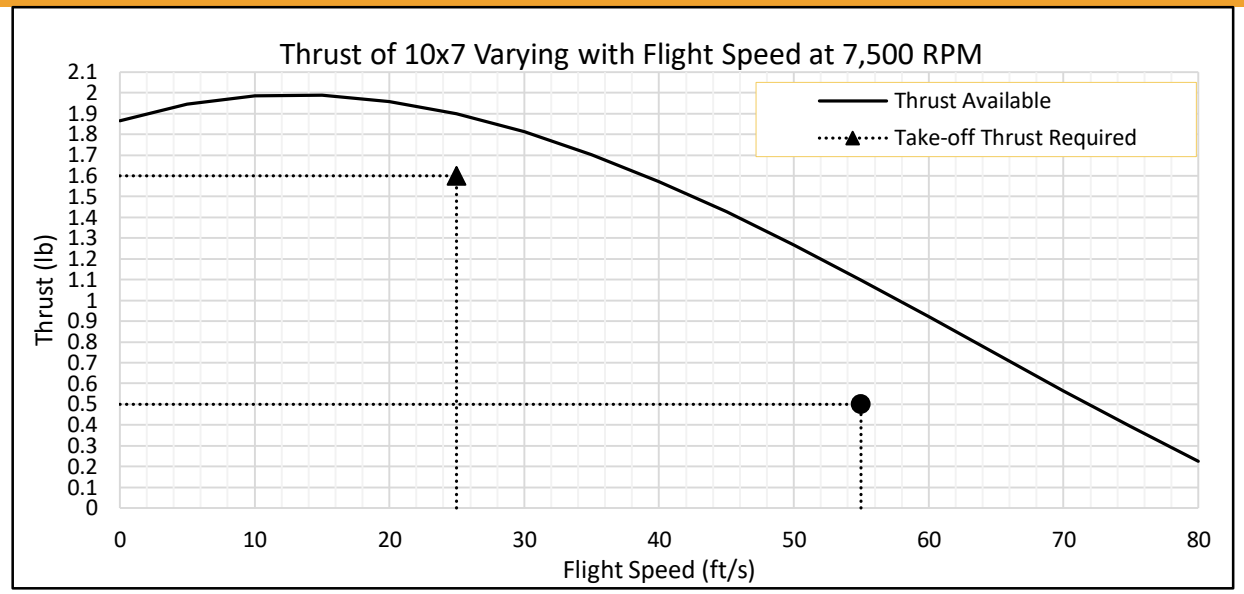


Figure P.1: Thrust produced by 10x7 APCE Propeller at Varying Flight Speed with Maximum Take-off Thrust and Cruise Thrust Required

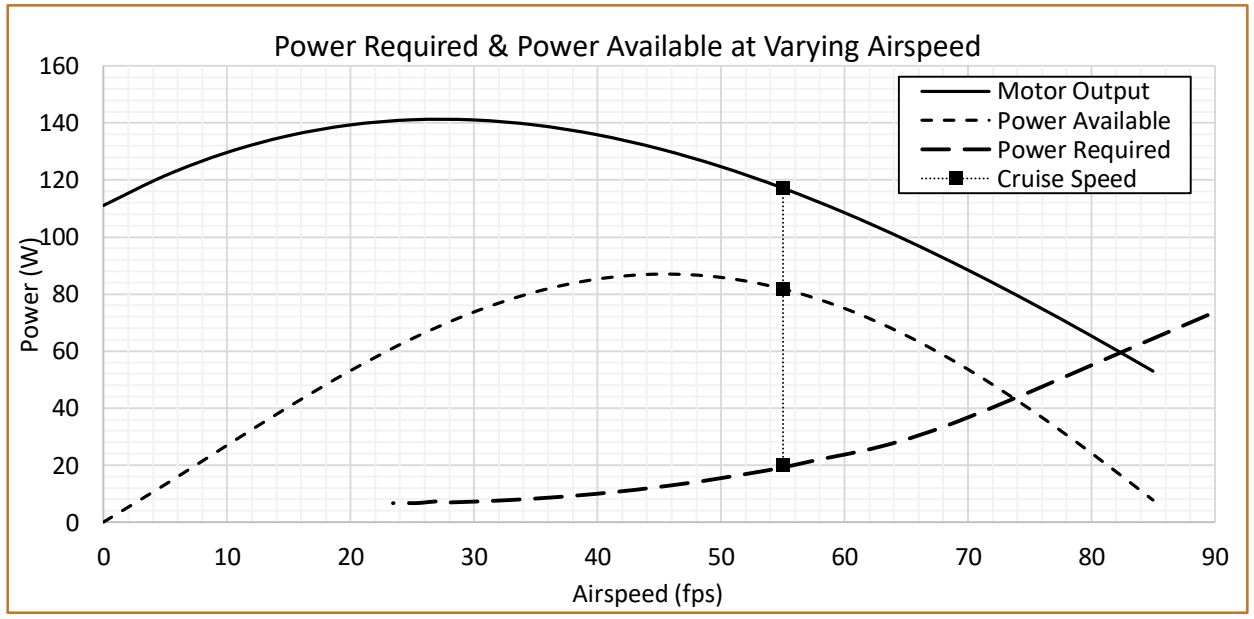
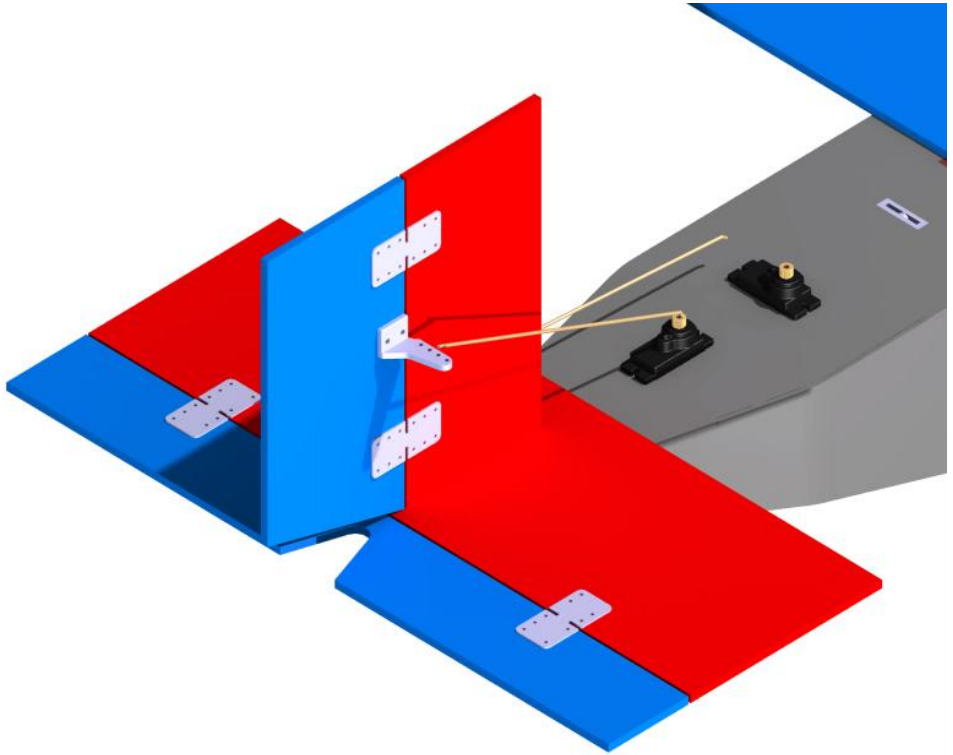
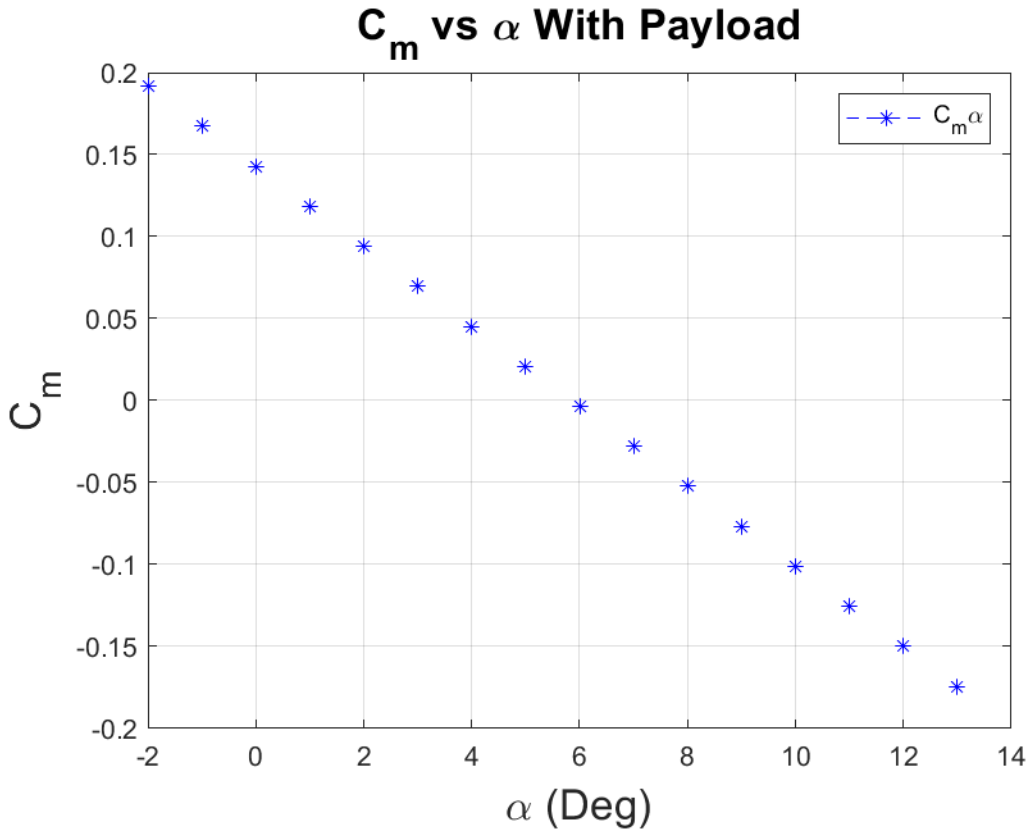


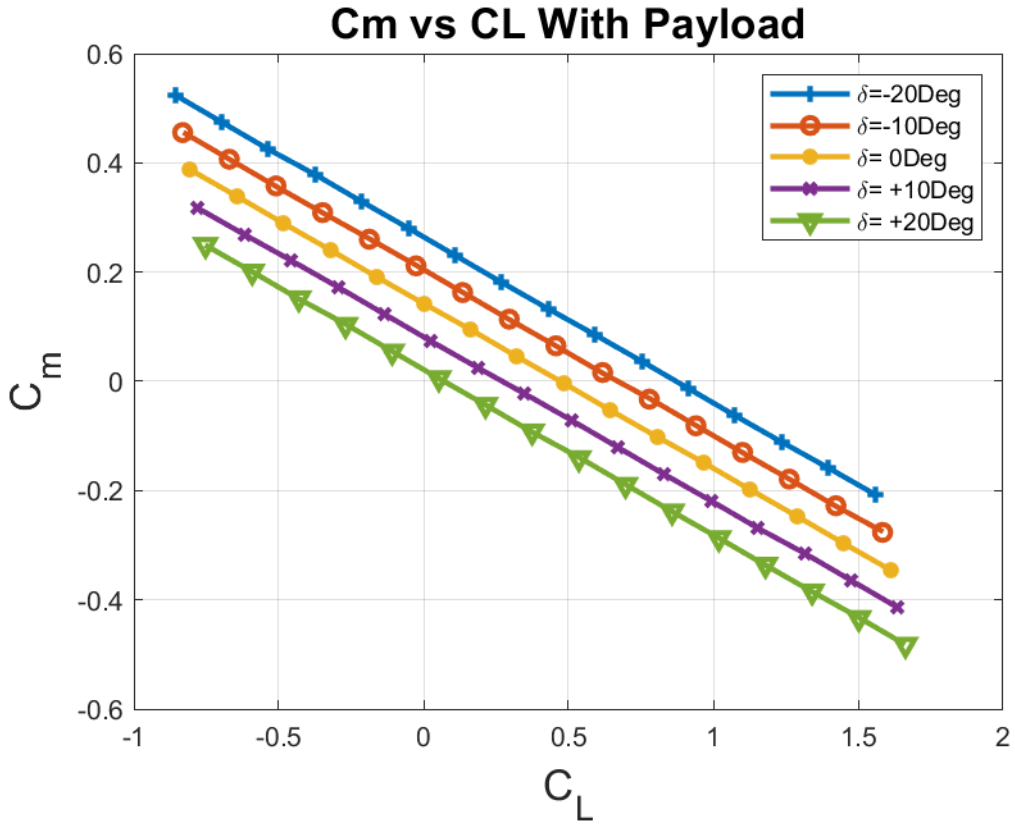
Figure P.2: Power Curve of 10x7 Propeller at Varying Flight Speed

STABILITY AND CONTROL

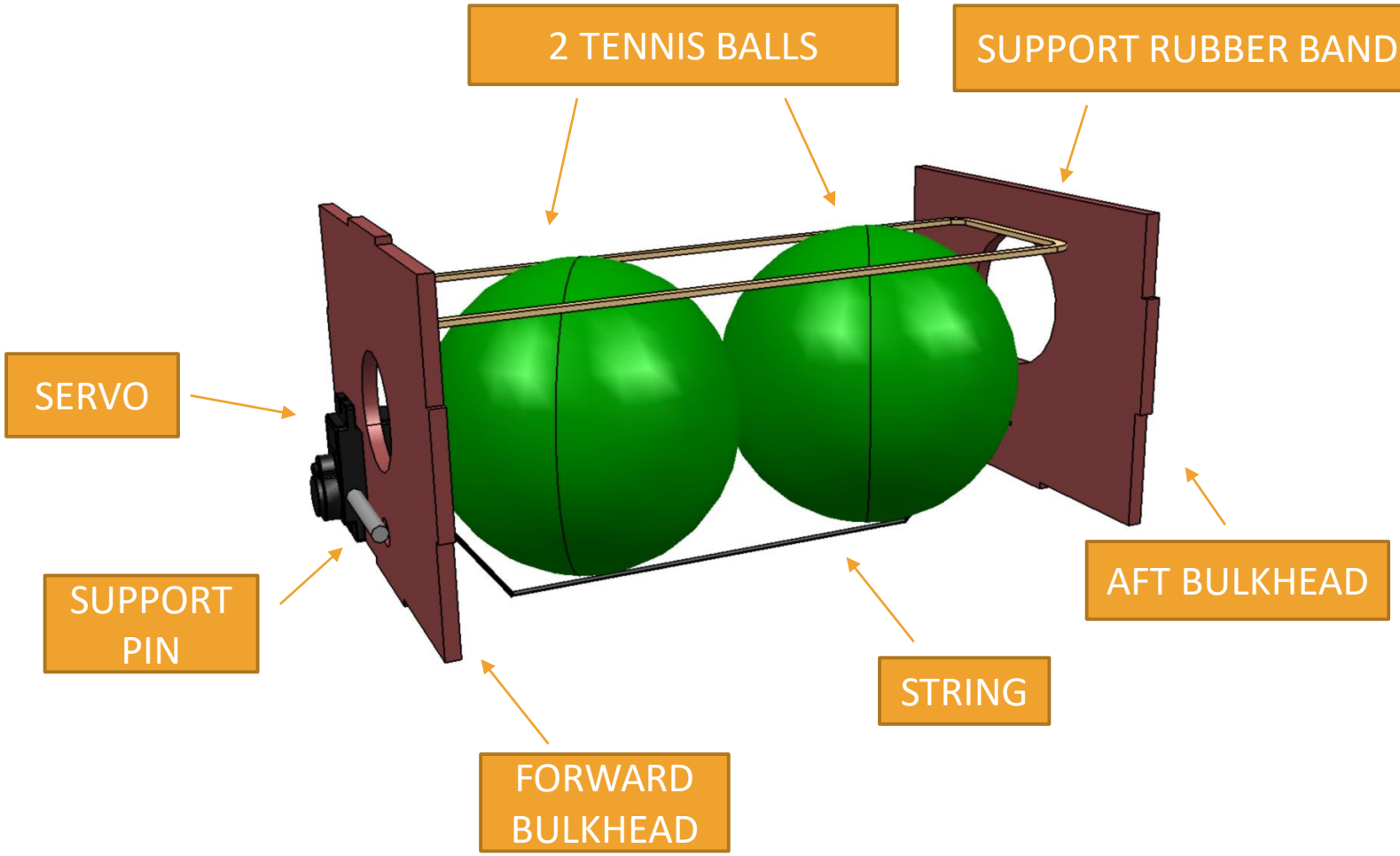
- Static Margin 12%
- $C_{m,\alpha}$ = -0.5
- Elevator Deflections
  - Cruise 2°
  - Stall -11°
- Flaperon Deflections
  - Cruise 3.3°
  - Stall 9°




C_m vs α With Payload
$C_m\alpha$
C_m
α (Deg)
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-2
0
2
4
6
8
10
12
14


Cm vs CL With Payload
δ=-20Deg
δ=-10Deg
δ= 0Deg
δ= +10Deg
δ= +20Deg
C_m
C_L
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-1
-0.5
0
0.5
1
1.5
2

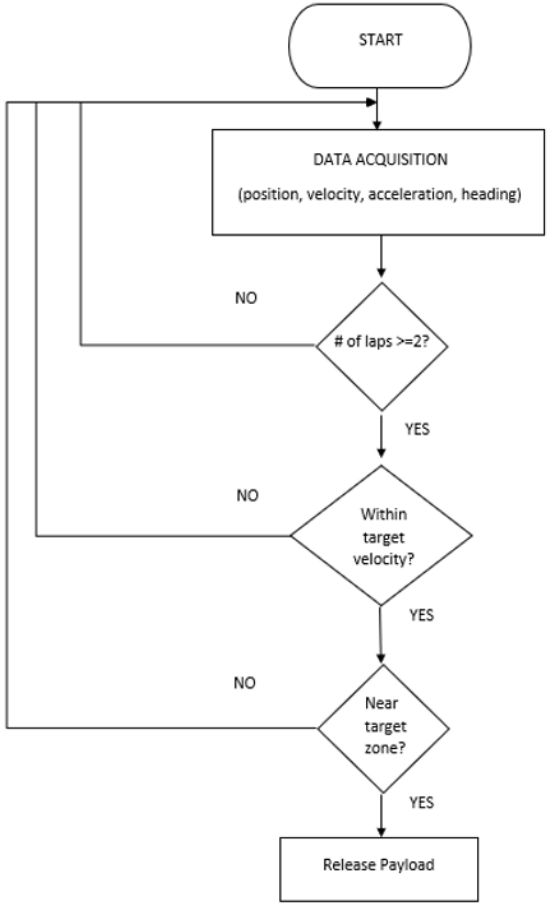
OTHER IMPORTANT ASPECTS



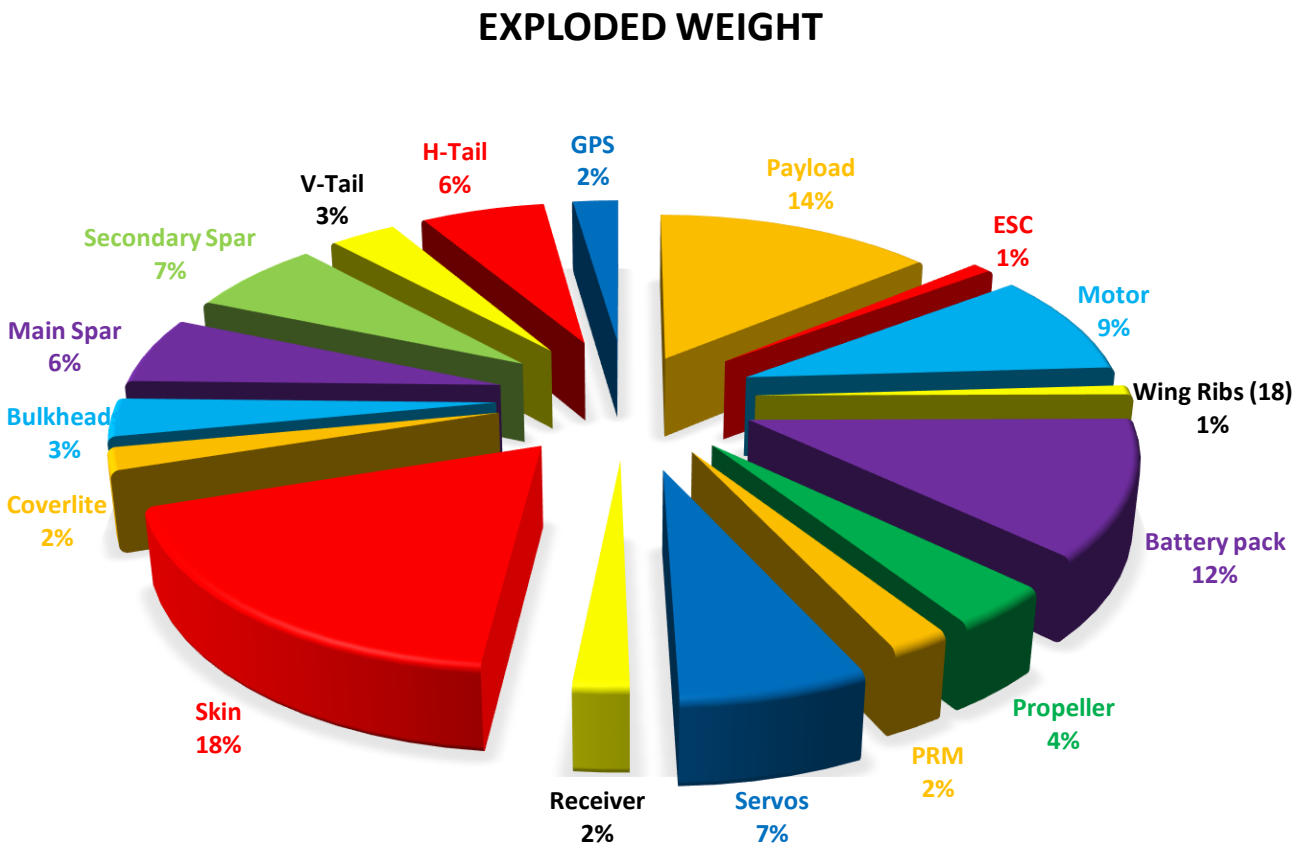
- The payload sits between two bulkheads
- A string prevents the payload from falling
- A servo with a pin holds the string in place
- When the pin is released, the string slackens and the payload is released
- Rubber bands sit at the top of the bulkheads to help secure the payload

PAYLOAD RELEASE LOGIC

1. Aircraft determines position, speed, and direction
2. Determines which lap aircraft is on
3. Determines if the aircraft is travelling at a safe speed to release the payload
4. Determines if the aircraft is near the target
5. Payload Release!



WEIGHT BUILD-UP & COST



Estimated Total Weight: 1.85 lb

AIRCRAFT INVENTORY & COSTS	
Item (materials, parts, etc.)	Total Cost
RAW MATERIALS	
Balsa Wood Sheets	$17.58
Basswood Sticks	$1.12
Basswood Sheets	$23.13
PROPULSION SYSTEM	
Motor	$49.99
Battery	$37.98
ESC	$44.95
X8R Reciever	$35.62
Electric Propeller	$7.36
Dubro 1-1/2" Spinner	$4.75
Cross Motor Mount	$3.99
Prop Adapter	$4.99
Bullet Connectors	$5.48
Servos	$63.96
PAYLOAD RELEASE MECHANISM	
Arduino Nano	$6.40
MPU 6050	$9.30
BN-880	$22.56
Tennis Balls	$6.23
Rubber Bands	$5.99
Servo	$3.89
String	$4.99
MISCELLANEOUS	
Control Horn	$7.50
Nylon Hinges	$6.25
Coverlite	$76.96
Insta-Cure Glue	$18.29
Music Wire	$9.02
	$478.28