Designing and Building an R.C. Aircraft, SAE Aero: Micro Class

SAE AeroJacks- Micro Class, Team #327

NAU NORTHERN ARIZONA UNIVERSITY

Meet the AeroJacks

Carlo Boyd
Fuselage Lead & Manufacturing Engineer
- Ensure all assemblies are built to spec
- Create a structurally sound and lightweight fuselage

Ryan Carberry
Wing Design Lead & Testing Engineer
- Responsible for wing design and manufacturing
- Field-testing plan

Luke Chandler
Tail Wing Lead & Budget Liaison
- Design and manufacturing tail-wing assembly
- Manage budget and all expenses

Trey Cooper
Avionics Lead & Pilot
- Responsible for selecting and testing electronics
- Conducting Flight Tests

Cale Hines
Project Lead, Landing Gear Lead
- Manage deadlines, deliverables and prototype/product progress

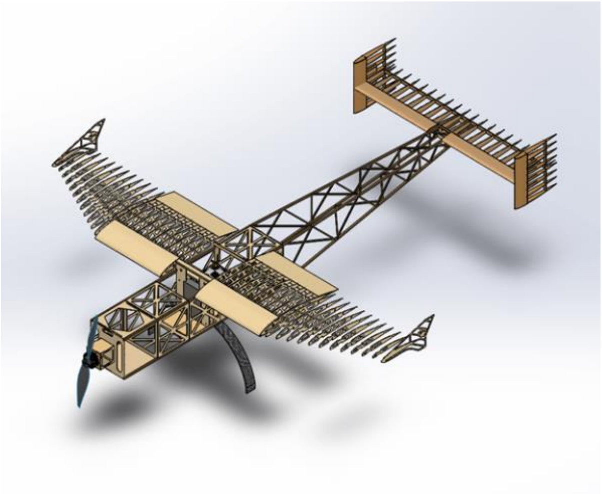
What is SAE? ADD Aero Pics

Cale

- SAE – Society of Automotive Engineers
- SAE Aero – International collegiate competition design around remote controlled aircraft.
  - 3 classes: Micro, Regular, Advanced
    - Regular: Big Payload = Big Points
    - Advanced: Precision Payload and Recovery
    - **Micro: optimize takeoff/payload, small-form-factor**

INTERNATIONAL®

Regular



Advanced

Micro

Mission Overview

Carlo

Overall Objective

- Design a fully remote-controlled small-scale aircraft
- Must be a fixed wing design
- Must be an original design
- Must be capable of carrying a payload of at least 67 fl oz of liquid water
- Fly a 360° Course

Initial Funding

- $5,000 from W.L. Gore
- Fundraising from families and friends ($2105.05)

Customer Requirements

- 450W power limiter
- Red arming plug for propeller
- Steering mechanism on landing gear
- Safety nut on prop (spinner)
- Electric motor
- Lithium polymer batteries

Key Deliverables

- In-class Fall deliverables
  - Team Charter
  - Fall Presentations (3)
  - Fall Reports (2)
  - Website Check
  - Prototyping (2)
- In-class Spring deliverables
  - Hardware Updates (3)
  - Website Checks (2)
  - Testing Presentations (2)

- Competition Registration (10/9/25)
- SAE Report (3/6/2026)
- SAE FRR (4/3/2026)
- Competition (4/17-19/2026)

Success Metrics

Luke

Design Requirements:
- Weight constraints met (empty & loaded)
- Dimensional limits satisfied
- Structural integrity under load conditions

Prototype testing:
- Flight testing validation (stability, control)
- Takeoff distance within specified limits
- Landing performance metrics achieved

Competition Performance:
- Overall ranking in SAE Aero Design competition
- Mission completion success rate
- Payload capacity achievement vs. Requirements
- Passing Tech inspection

Customer & Competition Requirements

Carlo

Customer Requirements	
CR1	Safely Taxi
CR2	Payload Capability
CR3	Fixed-Wing Design
CR4	Stable Flight
CR5	Safety Nut
CR6	Red Arming Plug
CR7	On/Off Switch
CR8	Electric Propulsion
CR9	Identification

Engineering Requirements		Competition Target	Team Target	Tolerance
ER1	Weight Limit	<55lbs	<10 lbs	0
ER2	Static Thrust to Weight Ratio	>0.23		0
ER3	Combined Power	≤ 450 W		0
ER4	Takeoff Distance	<100ft	<25ft	0
ER5	Landing Distance	<200ft		0
ER6	Payload Release	<60s		0
ER7	Payload Capacity	67 fl oz	≥ 67 fl oz	0
ER8	Wingspan	N/A	51 in	± 0.125 in
ER9	Total Length	N/A	48.64 in	± 0.0625 in
ER10	Total Height	N/A	13.78 in	± 0.125 in
ER11	C.G. Distance	18.27in		0

Ryan

House of Quality (QFD)

	ER1	ER2	ER3	ER4	ER5	ER6	ER7	ER8	ER9	ER10
Thrust to Weight Ratio	9									
Combined Power		9								
Takeoff Distance	9	9	9							
Landing Distance	6	3	3							
Payload Release										
Payload Capacity	3					6				
Wingspan		3	3	9	3					
Total Length	6						9	9		
Total Height										

Legend	
	No correlation
3	Small correlation
6	Average correlation
9	High correlation

Customer Requirements	Customer Weights (0-10)	Engineering Requirements: ER1 - Weight Limit	ER2 - Thrust to weight ratio	ER3 - Combined Power	ER4 - Takeoff Distance	ER5 - Landing Distance	ER6 - Payload Release	ER7 - Payload Capacity	ER8 - Wingspan	ER9 - Total Length	ER10 - Total Height	Competition: *SAE Aero Micro 2026*	*SAE Aero Micro 2025 NAU*
CR1- Safely Taxi	5	3	6	9	6	6			3	3	3	S	0
CR2 - Carry Payload	8	9	9	9	9	6	9	9	3	6	3	S	0
CR3 - Fixed-Wing Design	7								3			+	0
CR4 - Stable Flight	10	9	9	9	3	3			9	3	3	+	0
CR5 - Safety Nut	6											S	0
CR 6 - Red Arming Plug	6											S	0
CR7 - On/Off Switch	8											S	0
CR8 - Electric Propulsion	9		9	9	6				3			S	0
CR 9 - Identification	5											S	0
Technical Requirement Units		lbs		W	ft	ft	s	fl oz.	ft	ft	in		
Technical Requirement Targets		< 10	> 5	450	0<x<100	0<x<200	< 60	>67	3<x<6	1<x<5	12<x<36		
Absolute Technical Importance		177	273	288	186	108	72	72	177	93	69		
Relative Technical Importance		10	3	9	1	2	5	11	4	7	6		

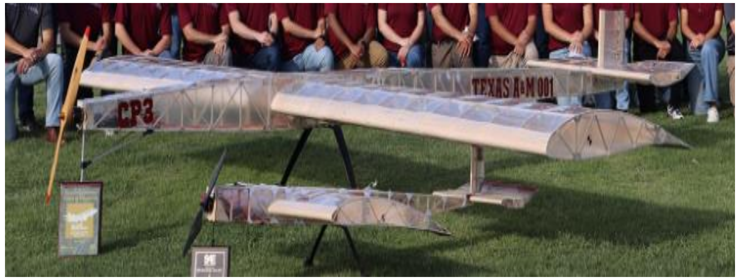
Trey

Benchmarking

Four high-scoring teams were used in the benchmarking analysis to decide what characteristics could lead to a successful performance

SAE Aero Design Micro Class — Combined Results

Rank	#	Country	University (Team)	Design Score	Presentation Score	Mission Score	Overall Score	Competition	Year
1	319	United States	**Georgia Institute of Technology**	41.9075	47.5800	96.2689	**185.7564**	Aero East	2021–2023
1	323	China	**Nanjing Univ of Aeronautics & Astronautics** (Violet)	38.1724	30.7200	107.5215	**171.4139**	Aero West	2025
1	318	United States	**Texas A&M Univ – College Station** (Farmers Flight Lite)	37.5150	43.5900	83.7196	**164.8246**	Aero East	2025
2	335	United States	**University of Portland** (Portland Pilots)	40.6741	38.2700	48.9084	**127.8525**	Aero West	2025



Texas A&M


Georgia Tech


Portland

Nanjing Univ

Cale

Research

Fuselage- Carlo	Electronics- Trey	Landing Gear- Cale
[1] SAE Aero 2026 Rulebook (Section 9.3-payloads) o Payload requirements, flight score calculation [2] Aircraft Performance & Design- John D. Anderson (7.3, 8.6.3, 8.7) o Optimization, fuselage configuration, weight estimate [3] Aircraft Fuselage Design Study-Ilhan Sen o **Fuselage configuration, load distribution, structural analysis** [4] Different Types of Fuselage and Their Role in Aircraft Design (website) o Importance of fuselage shape in different sized planes [5] Aero Toolbox-Fuselage Sizing and Design (website) o Structural design principles of different fuselage shapes [6] Model Aviation-Center of Gravity (website) o **Optimizing and finding center of gravity for model planes, Structure standards** [7] Modelling and Analysis of Fuselage (research paper) o **Fuselage design and aero optimization** Using Balsa wood and Carbon fiber for structures based on industry design [6]	[1] SAE Aero 2026 Rulebook o Chapter 9 describes power limit requirements [2] D. P. Raymer and R. M. Cummings, *Aircraft Design: A Conceptual Approach* o **Chapter 8 and 2 contain takeoff power equations** [3] K. Webb, "SECTION 6: BATTERY BANK SIZING PROCEDURES." o Contains depth of discharge equation [4] MIT Electric Vehicle Team, "A guide to understanding battery specifications," o Contains battery capacity equation [5] RCGroups, "Guidelines to help you choose your Plane's Power System," o Contains information about selecting electronics [6] R. Fowler, M. Germroth, B. Hayes, T. Miller, E. Neblett, and M. Statzer, *Low-cost Expendable UAV Project* o Page 74 describes electric load analysis [7] J. G. Leishman, "Electrically-powered aircraft," Introduction to Aerospace Flight Vehicles o Provides figures for net system efficiency [8] ASTM International, "Standard Specification for Batteries for Use in Small Unmanned Aircraft Systems (sUAS)." ASTM International, Dec. 8, 2022 o **Design standard that describes design requirements for batteries in UAVs**	[1] https://pilotinstitute.com/landing-gear-configurations/ o An elementary description of different landing gear configurations and their applications [2] https://forum.flitetest.com/index.php?threads/tri-or-tail-dragger.30681/ o **Blog for RC planes discussing Tail-Dragger vs. Tricycle configuration** [3] SAE Aero 2026 Rulebook (Section 1.7 - Airframe Design Requirements) o Rulebook [4] SAE Aero 2026 Rulebook (Section 2.6 - Controllability) o Rulebook [5] Aircraft Performance and Design (8.6.7 Landing Gear, and Wing Placement) o **Textbook – discusses placement of landing gear as well as C.G. as well as tire sizing** [6] Generative design of main landing gear for a remote-controlled aircraft o Study – discusses how to calculate forces on impact for landing gear [7] Chapter 9 Landing Gear Design (Chapters 9.7.2 and 9.7.4) o Textbook – discusses shock absorption impact upon landing as well as steering subsystem [8] Amateur-Built Aircraft and Ultra Flight Testing Handbook (Section 8: Weight and Balance o **Standards for amateur built air aircrafts for CG and multiple calculations**

Research

Cale

Main Wing- Ryan	Aerodynamics- Luke
[1] J. G. Leishman, "Airfoil Geometries," *eaglepubs.erau.edu*, vol. 24, Jan. 2023, doi: ○ A guide to various airfoil shapes [2] SAE Aero 2026 Rulebook ○ Rulebook used to find constraints for competition [3] "US3706430A - Airfoil for aircraft - Google Patents," ○ Patent of an aircraft airfoil [4] J. G. Leishman, "Aerodynamics of Airfoils," *eaglepubs.erau.edu*, vol. 31 ○ More mathematical approach to airfoil shapes [5] TrueGeometry, "Comparing Angle of Attack for Different Airfoil Materials in context of best angle of attackcalculator for airfoils," *True Geometry's Blog* ○ Different angle of attack in relation to material used for airfoil [6] Airfoil tools, "Airfoil Tools," *Airfoiltools.com*, 2019. ○ **Re calculations, airfoil database, comparison of different airfoils, graphs** [7] Aircraft Performance & Design- John D. Anderson (2.0, 2.1, 2.2, 2.3, 2.4) ○ **CH 2 goes into depth of airfoil engineering** [8] J. S. Duncan, AC 90-89B - amateur-built aircraft and ultralight flight testing handbook ○ Design Standard for airfoils on ultralight aircrafts (Balsa wood structure, carbon fiber shell)	[1] "Principles Of Flight," ○**Goes over the general forces and fundamentals required for flight.** [2]"Design and Analysis Notes," *RC Aero Notes* ○Design notes from users who have previously built RC airplanes [3] J. H. Storer, "Bird Aerodynamics," *Scientific American*, vol. 186, no. 4, pp. 24–29 ○Connects the aerodynamics seen in nature to man made objects [4] V. Chandra. C, S. Kumar, and T. Seshaiah, "Design and Angle of Contact (AoA) analysis of Remote Control (RC) Aircraft," *International Journal of Innovative Research in Engineering & Management* ○**Shows the impact that AoA will have on the aircraft in aspects such as lift, and drag, etc.** [5]Dr. L. Nicolai, "ESTIMATING R/C MODEL AERODYNAMICS AND PERFORMANCE," ○Various analytical methods and tips for estimating the performance of the aircraft [6]Model FMS, "RC Plane Wing Design: Understanding Aerodynamics," *FMS Model*, ○Fundamental principles behind RC wing design. [7]Harish, et al. "Design, Fabrication and Aerodynamic Analysis of RC Powered Aircraft Wing," *International Research Journal of Engineering and Technology*, vol. 9, issue. ○Covers all aspects involved for building a wing for a RC aircraft. [8]"14 CFR Part 25 Subpart D -- Design and Construction," ○Safety standards for design and manufacturing.

Mathematical Modeling-Wings

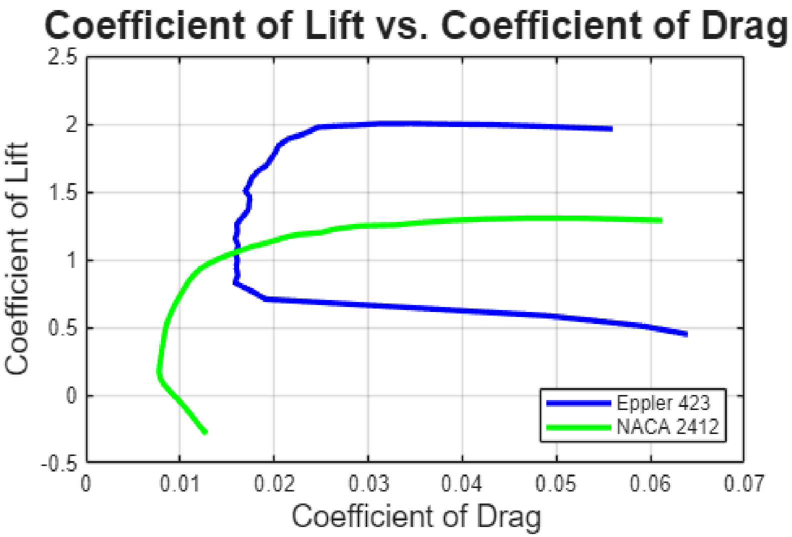
Ryan

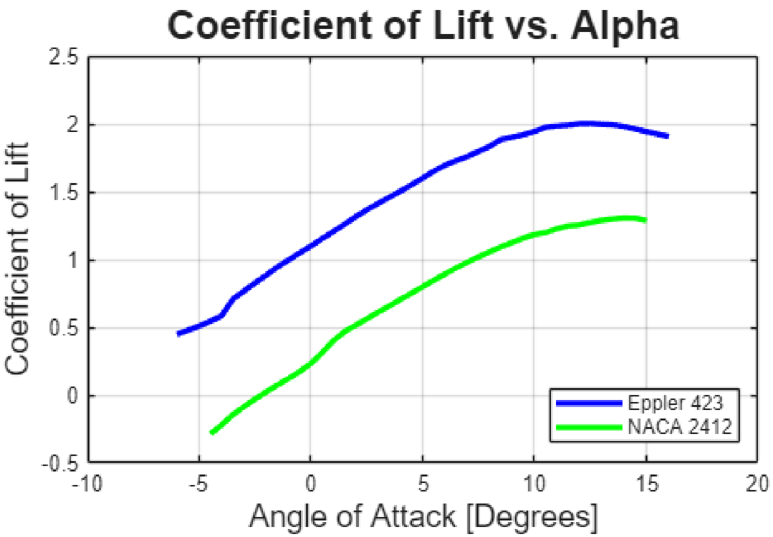
- Operating on 300,000 Re at –5 to 15 AOA
- Blue: Eppler 423 Green: NACA 2412

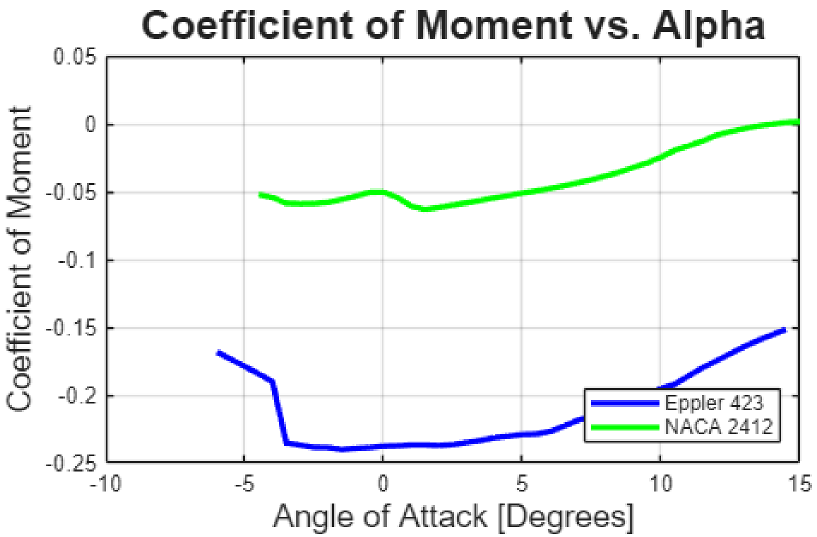
- Cl vs Cd: Looking for high coefficients of lift and low coefficients of drag
- "Knee" line shapes indicate stalling near

- Cl vs alpha: Don't want sharp decreases, indicates stall
- Cl > 0 at 0-degree AOA is favorable
- "Knee" shape indicates stall

- Cm vs Alpha: Negative is good
- Flat curves indicate pitch stability
- Changing curves indicate stall and unstable pitch

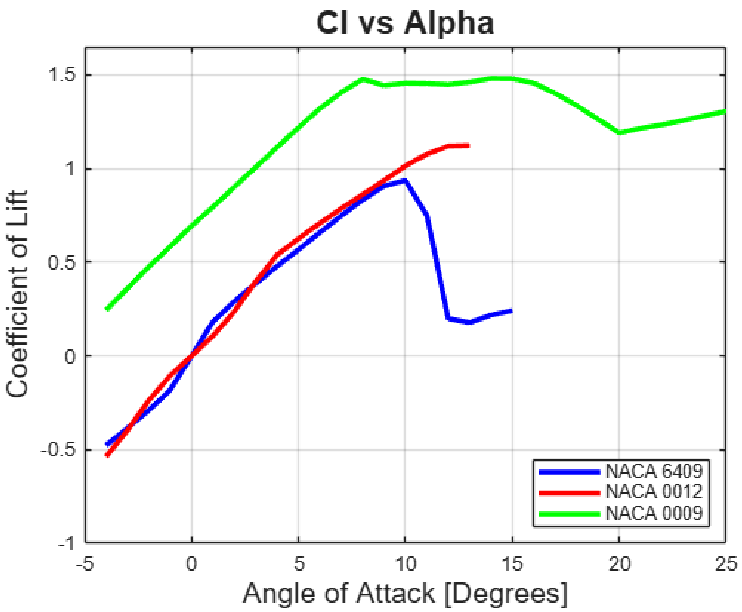


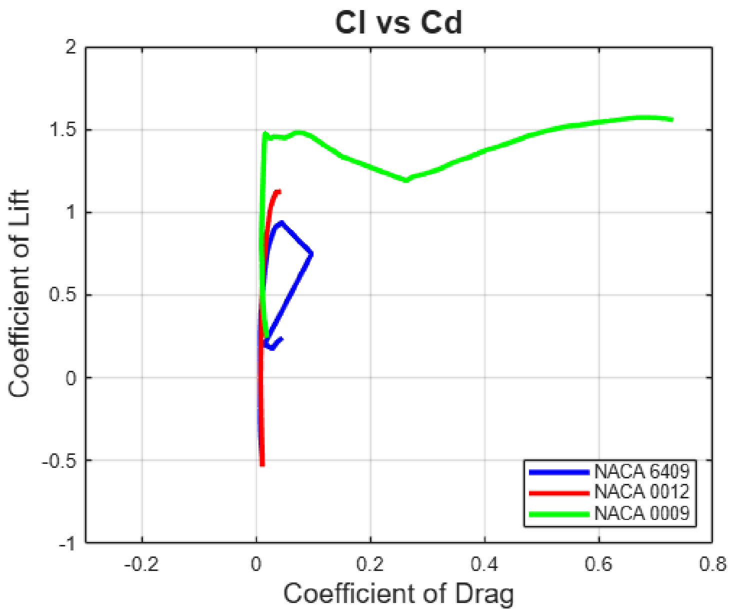


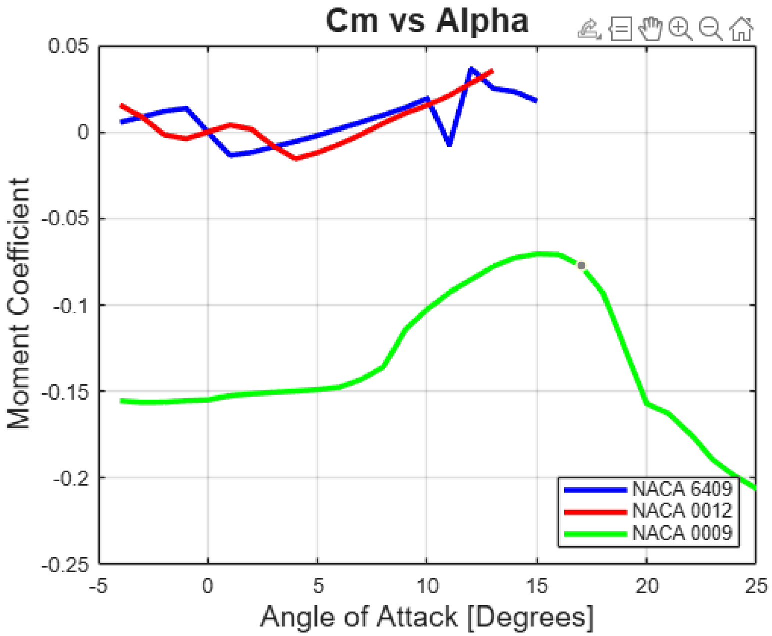


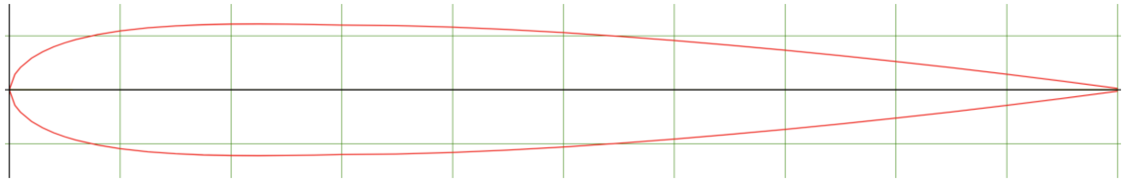
Tail Foil Selection

Luke







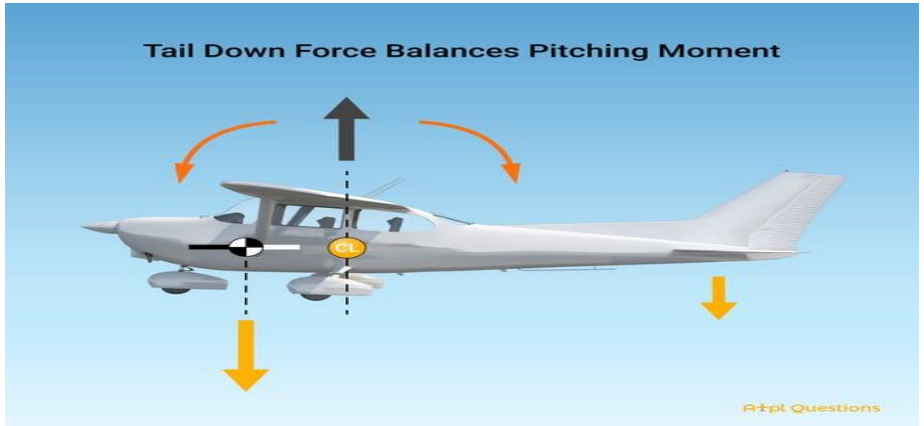


NACA 0012 (Red)

Mathematical Modeling-Stability

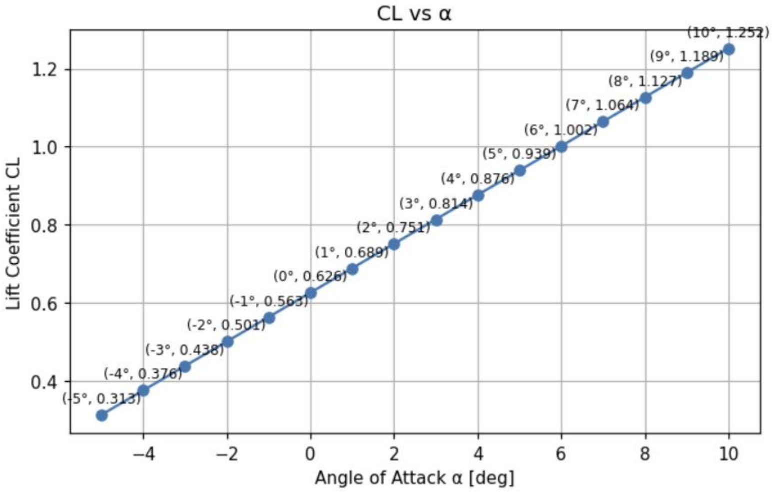
Trey

Moment ahead of gear from CG (only if CG ahead of gear):
M_CG_ahead = W * max(0, xg − xCG)
= 5.0000 * max(0, 14.00 − 12.00) = 10.00 lb·in



Moment behind gear from tail (only if HT qc behind gear and tail produces downforce):
M_tail = F_tail_down * max(0, x_qc,HT − xg)
= 0.4788 * max(0, 38.65 − 14.00) = 11.80 lb·in

Wing CL v Alpha Curve

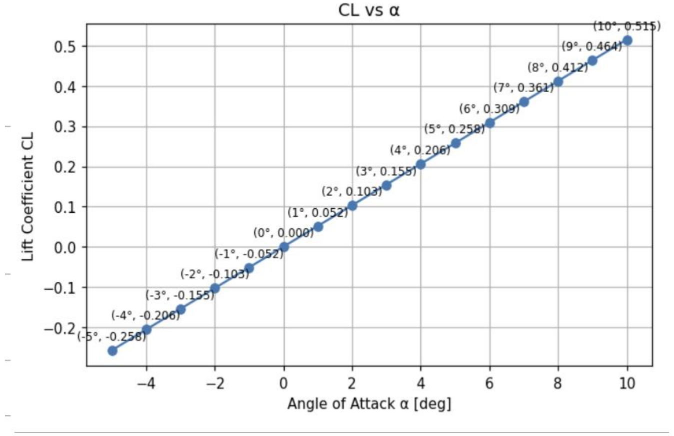


Objective: To ensure the moment produced by tail down force can exceed the moment ahead of the main gear, to ensure rotation

Steps:

1) Calculate lift of horizontal stabilizer using lift equation and Prandtl lifting line theory
2) Calculate moment produced by CG ahead of main gear
3) Calculate moment produced by tail down force

Horizontal Stabilizer CL v Alpha Curve



Optimization & Flight Score

Carlo

Symbolic Variable	Physical Quantity	Optimized Value- 1st Iteration	Optimized Value- Final Iteration	Units
P_full	Filled payload weight	1.06E-06	4.53E-06	[lb]
X_p	Payload X location	0.1016	0.4625	[m]
X_w	Wing X location	0.0969	0.380	[m]
b_ht	Horz. tail half span	0.0508	0.2832	[m]
b_vt	Vert. tail half span	0.021	0.1017	[m]
b_w	Wing half span	0.047	0.6477	[m]
c_ht	Horz. tail chord	0.07	0.2238	[m]
c_vt	Vert. tail chord	0.07	0.1300	[m]
cr_w	Wing root chord	0.1663	1.0603	[m]
f_weight	Fuselage weight	14.7884	6.8921	[lb]
l_f	Fuselage length	0.4064	1.1615	[m]
lambda_w	Wing taper ratio	0.9	0.9944	
FS	Flight Score	16.8907	12.7511	Points

- MATLAB small scale aircraft optimization code used
  - Based on flight score parameters, flight stability, and Prandtl lift line theory
  - Modified for 2026 SAE Aero competition rules
- First iteration completed for rough dimensioning and initial design choices
- Final iteration completed from testing and sizing for flight stability

Optimization & Flight Score

Carlo

$$Flight\ Score = FS = 3 * W_{Payload} * M + Z$$

$$M = \frac{11}{(W_{Empty} - 1)^4 + 8.9}$$

$$Z = B_{Takeoff} - S^{1.5}$$

$W_{Payload} = Payload\ Weight\ (lbs)$

$W_{Empty} = Empty\ Weight\ (lbs)$

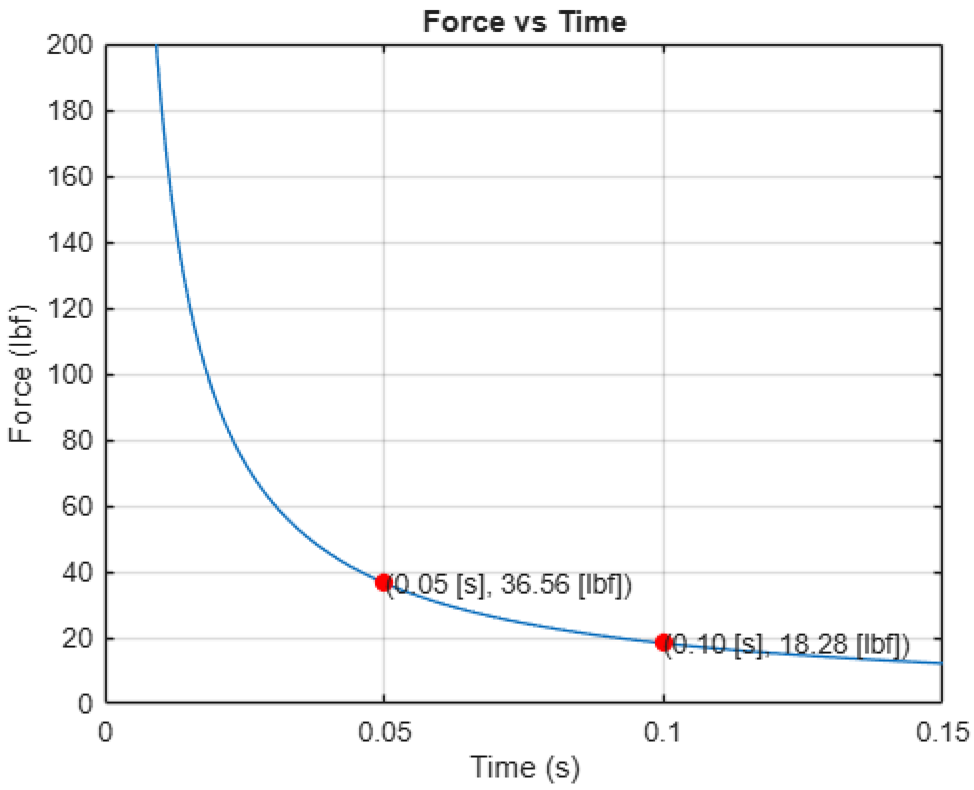
$S = Wingspan\ (ft)$

$$B_{Takeoff} = \begin{cases} 20 & 0 \le x \le 10\ ft \\ 15 & 10 < x \le 25\ ft \\ 9 & 25 < x \le 50\ ft \\ 0 & 50 < x \le 100\ ft \end{cases}$$

Most dependance on wingspan, empty weight, and takeoff distance

Cale

Nose Gear Force Analysis



$$F = \frac{m * \Delta V_y}{t}$$

$$m = 6.8\ [lbs] = 3.08\ [kg]$$

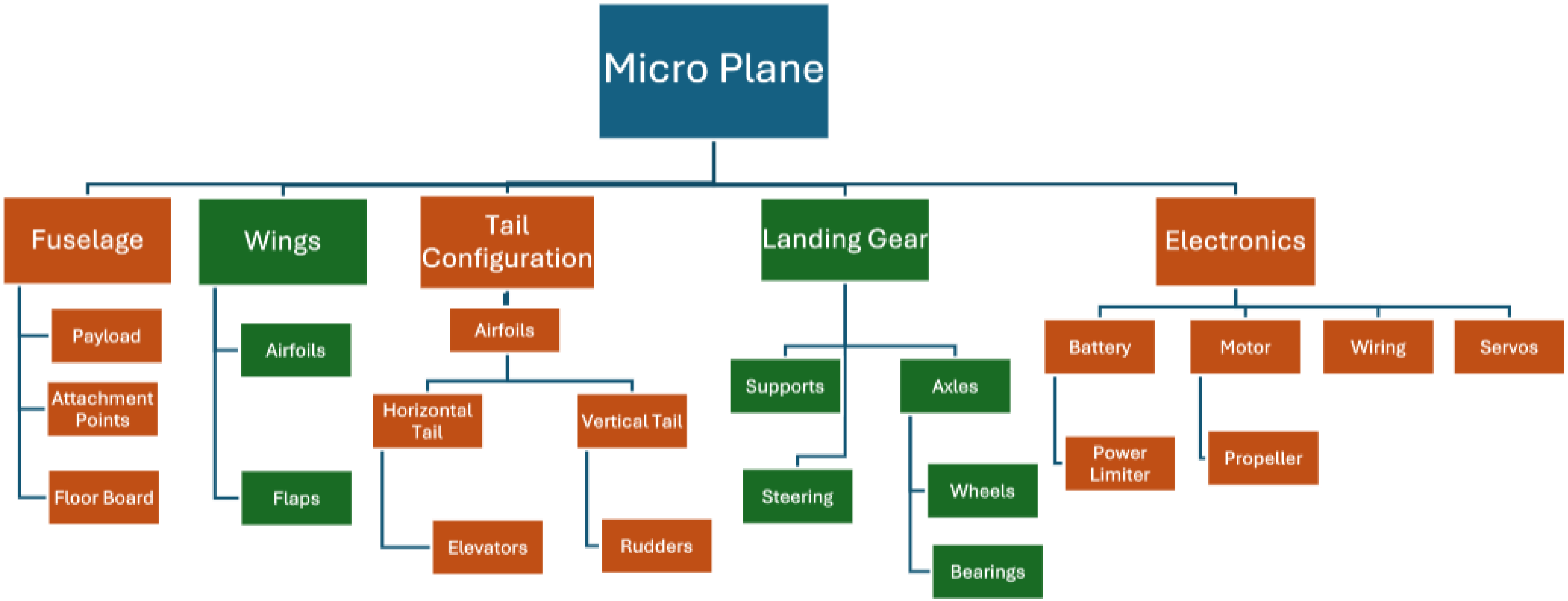
$$V_y = 8.68 \left[\frac{ft}{s}\right] = 2.64 \left[\frac{m}{s}\right]$$

$$t = 0:0.001:1\ [s]$$

Force @ t=0.05: 36.56 [lbf]
Force @ t=0.1: 18.28 [lbf]

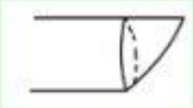
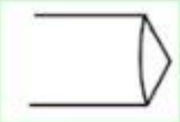
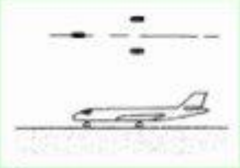
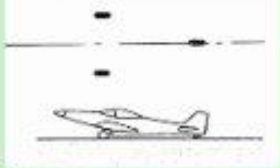
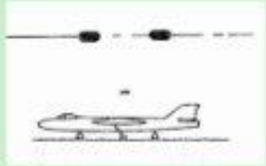
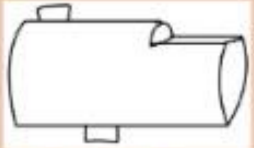
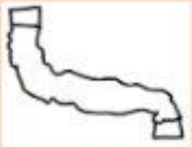
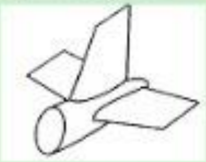
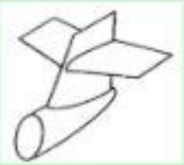
Functional Decomposition

Carlo



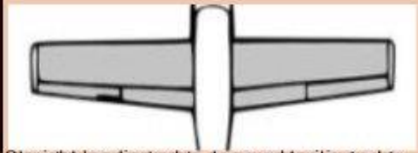
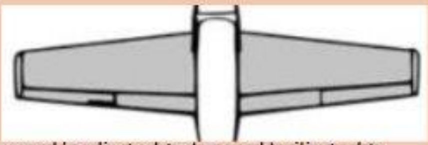
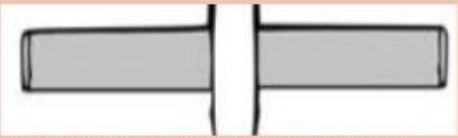
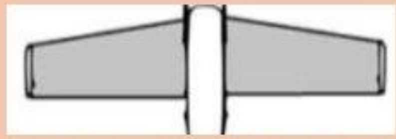
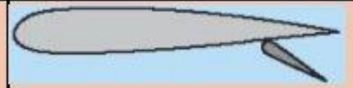
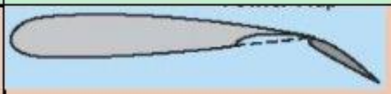
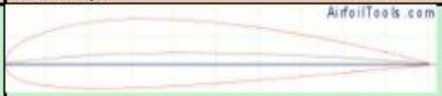
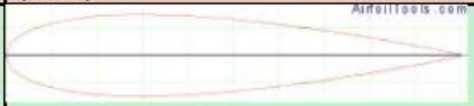
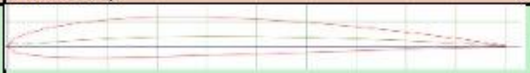
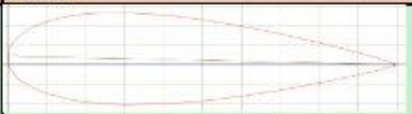
Cale

Morphological Chart

Subfunctions:	Concept Variants			
Fuselage Shape	 1	 2	 3	 4
Fuselage Design	Hollow Structural Tube (Carbon Fiber)	Wrapped Stringers and Chords (Balsa)	Wrapped Stringers and Chords (Carbon Fiber)	Tail end carbon fiber rod
Fuselage Inner Diameter	6"	5"	4"	3"
Nose Cone	 Dome Shaped	 Lift up	 Sharp Point	
Nose Cone Attachmemt	Screw in through fuselage	Twist and Lock	Glued	Hook and Post
Landing Gear Configuration	 tricycle	 tail dragger	 bicycle	Quadricycle
Payload Container	 3D printed cylinder	 Plastic 2L bladder		
Tail Shapes	 Conventional	 T-tail	 Cruciform	 Dual Tail

Cale

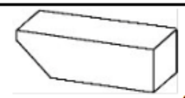
Morphological Chart Cont.

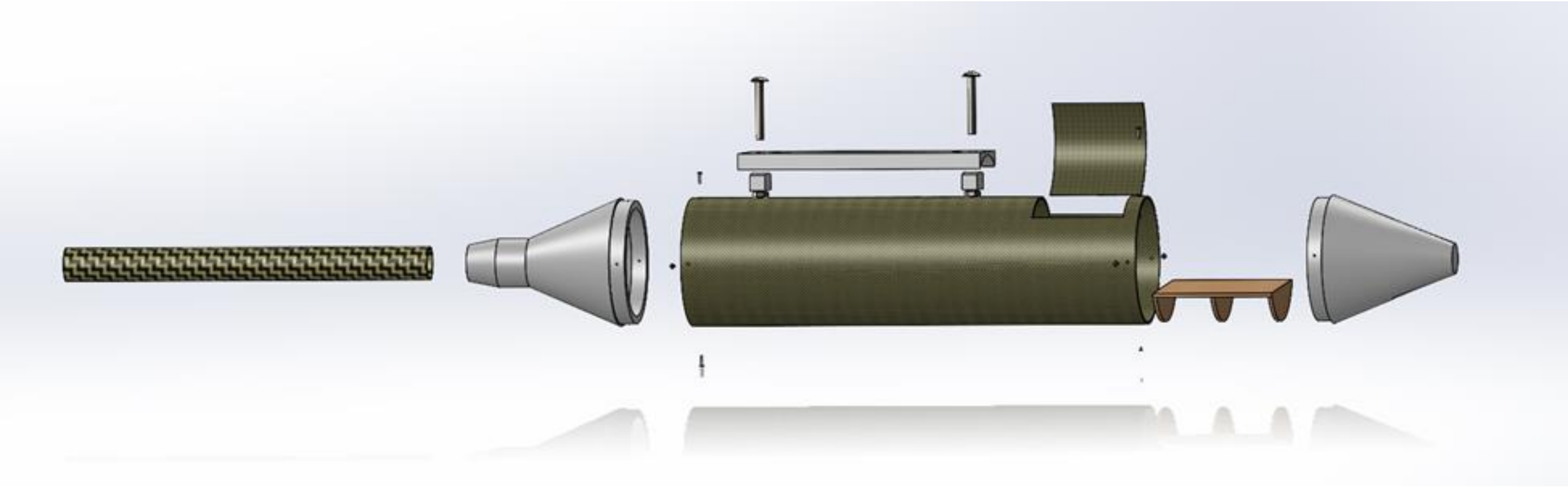
Wing Shapes:	 Straight leading edge, tapered trailing edge	 Tapered leading edge, tapered trailing edge	 Straight leading edge, straight trailing edge	 Tapered leading edge, straight trailing edge
Wing Materials:	Balsa Wood sheets with Balsa wood sticks	Ultrakote shell with balsa wood sticks	EPP Foam (flexible, durable, lightweight)	Ultrakote shell with Carbon fiber sitcks
Flap Design:	 Plain Flap	 Split Flap	 Slotted Flap	 Fowler
Airfoil Shapes:	 NACA 2412	 NACA 0015	 NACA 2408	 NACA 23024

Carlo

Fuselage Selection

Fuselage Decision Matrix			Options			
			1	2	3	4
Selection Criteria	Weight	Multiply	(1-5)			
Ease of Manufacturability	5	x	5	5	2	2
Cost	3	x	3	3	2	5
Surface Drag	5	x	4	4	4	2
Weight	4	x	4	2	3	4
		Total Score	70	62	48	51

Options	Shape	Design	Diameter	Nose Cone	Attachment
1	 1	Structural Tube	4"	Sharp Point	Screw in
2	 2	Structural Tube	4"	Sharp Point	Screw in
3	 3	Structural Tube	4"	Sharp Point	Screw in
4	 4	Wrapped Stringers and chords	3"	Sharp Point	Screw in

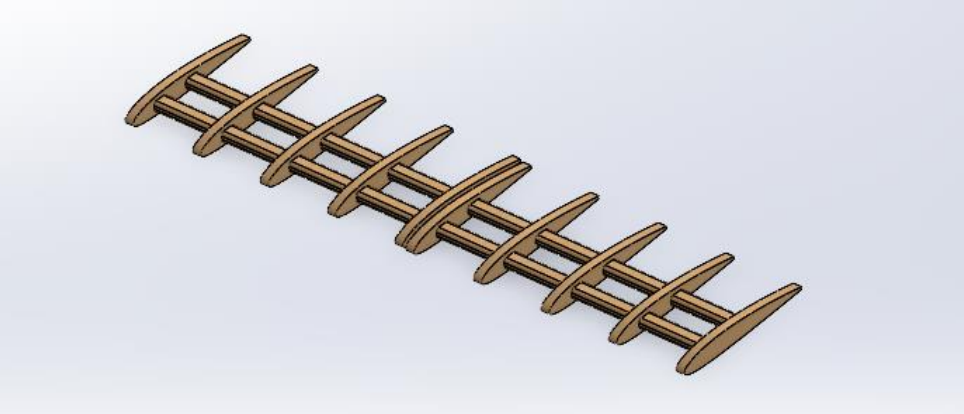


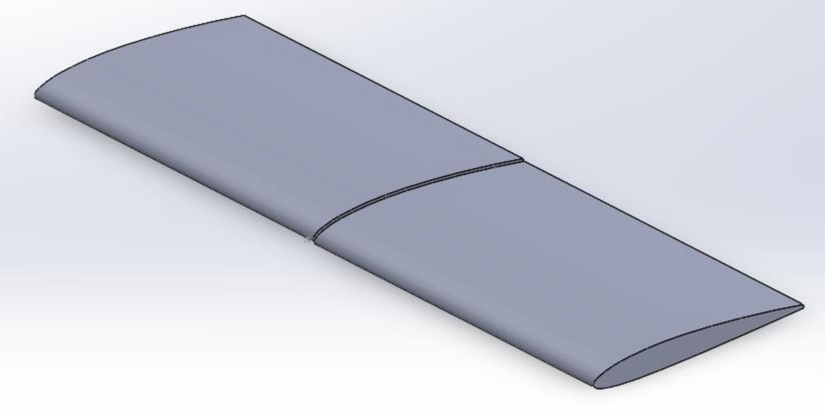
Wing Selection

Ryan

Decision Matrix Main Wing		Design Options:			
		1	2	3	4
Criteria:	Weight (1-5)	Weight (1-5)			
Lift/Drag	5	5	3	4	2
Ease of Manufacturing	3	4	3	2	3
Cost	4	4	5	4	2
Stall Characteristics	5	4	3	3	2
Stability	5	4	4	3	2
Air Resistance	3	3	2	4	3
Weight	3	3	4	3	4
Compatibility	4	4	2	4	4
	Total Score:	127	102	109	84

Design Options				
Options	Wing Shape	Wing Material	Flap Type	Foil Type
1	Straight leading edge, straight trailing edge	Balsa wood wing Ultrakote sheet	plain flap	NACA 2412
2	straight leading edge, straight trailing	EPP foam wing	split flap	NACA 0015
3	tapered leading edge, straight trailing	Balsa wood wing Ultrakote sheet	Slotted Flap	NACA 2408
4	Tapered leading edge, tapered trailing edge	Carbon fiber sticks with Balsa wood sheet	plain flap	NACA 23024



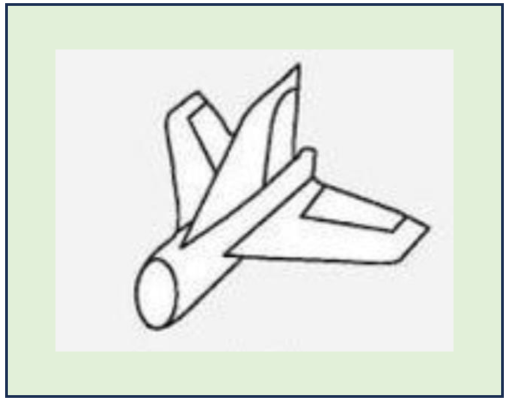


Tail Wing Selection

Luke

Criteria	Weight		1	2	3	4	5	6	7	8
Lift and Drag	2	x	2	3	3	4	2.5	3.5	3	4
Ease of Manufracturing	3	x	5	4	3	2	3	2	2.5	2
Stability	5	x	3	2	4	3	3	2	4	3
Weight	3	x	4	4	2	2	3	3	3	3
Final Scores			46	40	41	35	38	32	43	38

Design Options		
Options	Tail Type	Airfoil
1	conventional	Symmetrical
2	conventional	Cambered
3	T-tail	Symmetrical
4	T-tail	Cambered
5	Cruciform	Symmetrical
6	Cruciform	Cambered
7	Dual Tail	Symmetrical
8	Dual Tail	Cambered


Conventional


T-Tail

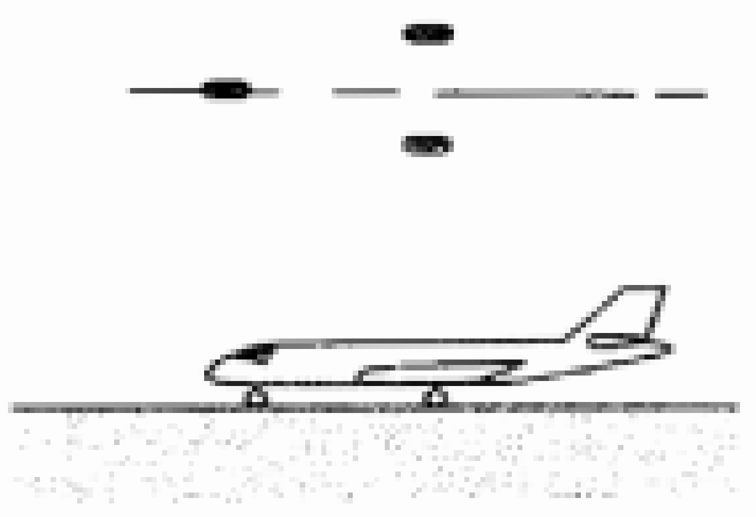

Cruciform


Dual Tail

Landing Gear Selection

Cale

Landing Gear configurations		Bicycle	Tricycle	Quadricycle	Taildragger
Characteristics	**Weight (1-5)**	Score (1-5)			
Stability on landing	5	1	4	3	1
Ease of manufacturing	2	3	3	1	3
ground control (taxiing)	4	1	5	3	2
Ease of take off	3	2	3	2	5
	Score	21	55	35	34



Propulsion Selection

Trey

Decision Matrix Motor		Design Options:		
		1	2	3
Criteria:	Weight (1-3)	Scoring (1-3)		
Hp/W	3	3	2	1
KV	2	2	1	3
Cost	1	1	3	2
	Total Score:	14	11	11

Option	Hp/W	KV	Cost
1)D3536 Brushless Outrunner Motor	(739.1)/(102)=7.24	1450	19.99
2)FLASH HOBBY 2826 RC Brushless Motor	(342)/(50) =6.84	1000	17.99
3)FLASH HOBBY D2830 Brushless Motor	(275)/(52) = 5.28	1300	18.99

Decision Matrix Battery		Design Options:		
		1	2	3
Criteria:	Weight (1-3)	Scoring (1-3)		
Weight	3	3	2	1
C-Rating	2	1	3	2
Cost	1	3	2	1
	Total Score:	14	14	8

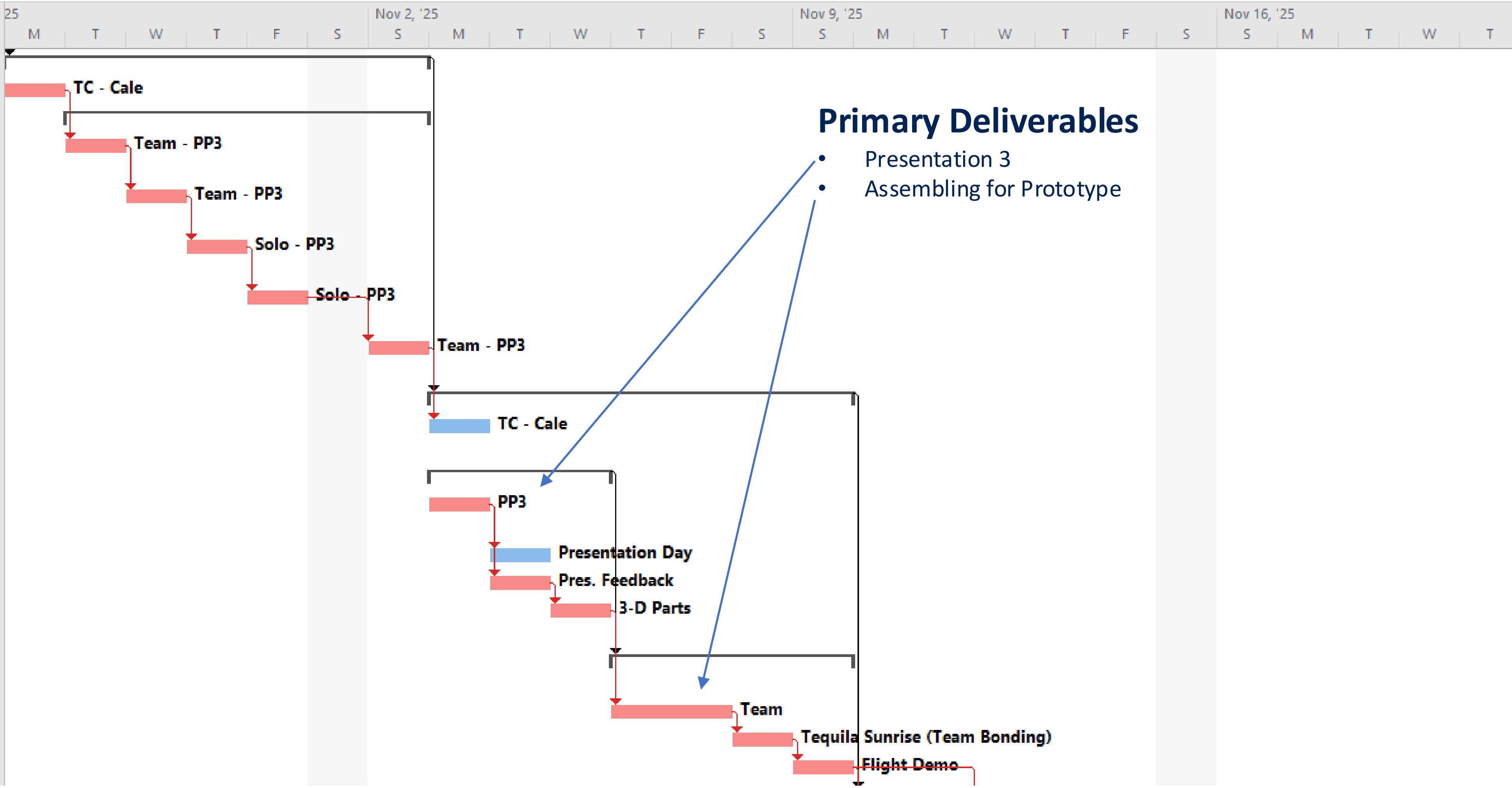
Option	Weight	C Rating	Cost
1) Goldbat 5000mah	0.61 lbs	50	$11
2) HRB 5000mah	0.831 lbs	120	$51
3) Ovonic 5000mah	1.79 lbs	100	$55

- Manufacturer Recommended Propeller Size: 9-inch diameter
- Planned Prop Size: 9 X 4.5 in
- Updated to 12 X 6 in after testing

Schedule Fall 1

Cale

Task Name	Duration	Start
Timecard Wk10	**6 days?**	**Mon 10/27/25**
Turn in Timecard Wk9	1 day?	Mon 10/27/25
Presentation 3	**5 days?**	**Tue 10/28/25**
Team meeting 2:30-4:30	1 day?	Tue 10/28/25
Team meeting 2:30-4:30	1 day?	Wed 10/29/25
Do respective parts for presentation	1 day?	Thu 10/30/25
Do respective parts for presentation	1 day?	Fri 10/31/25
Finalize Presnentation	1 day?	Sun 11/2/25
Timecard Wk11	**7 days?**	**Mon 11/3/25**
Turn in Timecard Wk10	1 day?	Mon 11/3/25
Presentation 3	**3 days?**	**Mon 11/3/25**
Practice Presentation 3	1 day?	Mon 11/3/25
Give Presentation	1 day?	Tue 11/4/25
Give feedback	1 day?	Tue 11/4/25
Finalize 3-D printed parts	1 day	Wed 11/5/25
Begin assembling prototype 2	**4 days**	**Thu 11/6/25**
Finish Assembly	2 days	Thu 11/6/25
TEQUILA SUNRISE!	1 day	Sat 11/8/25
Fly the Damn Thing	1 day	Sun 11/9/25

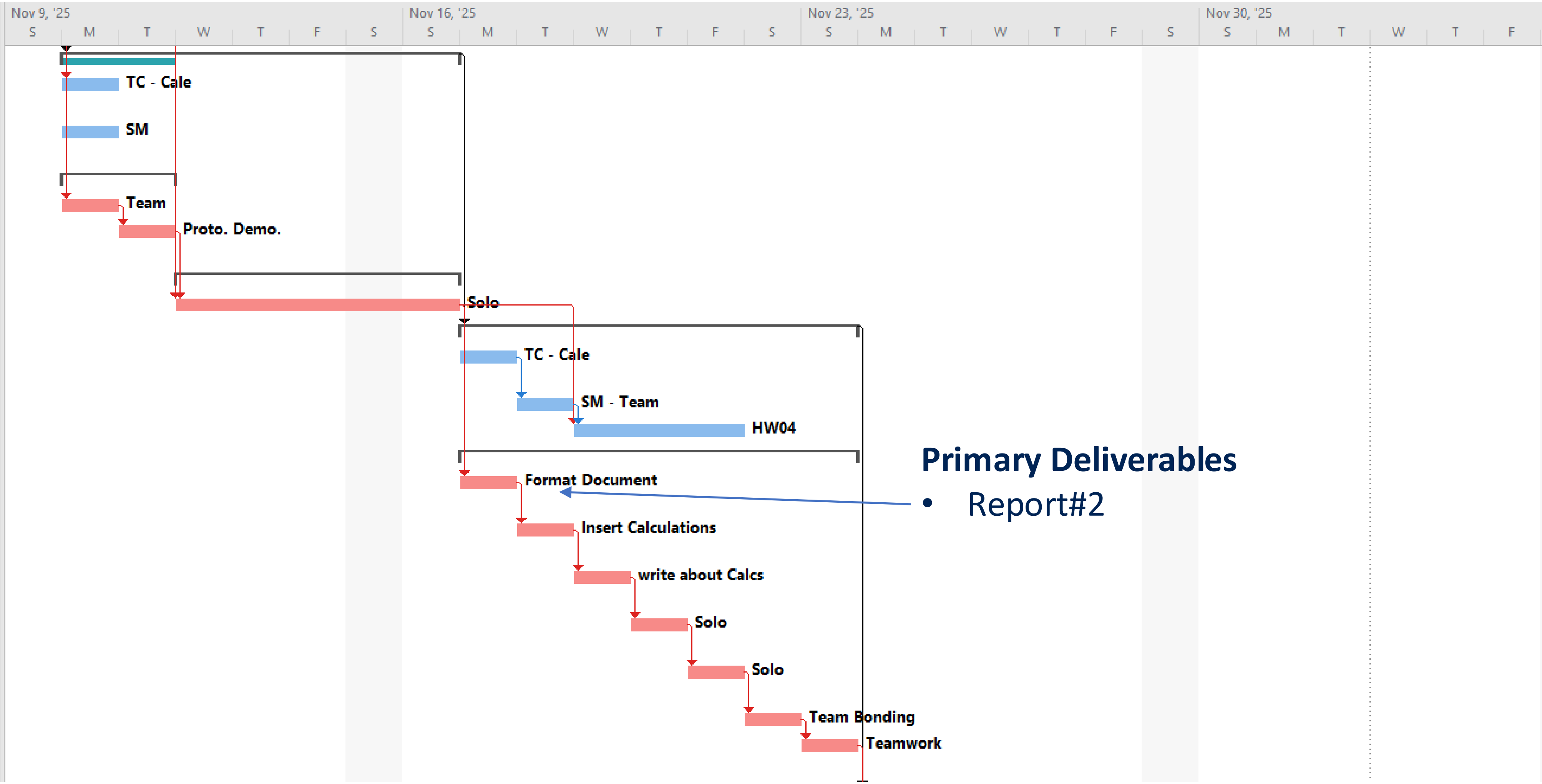


Primary Deliverables

- Presentation 3
- Assembling for Prototype

Schedule Fall 2

Task Name	Duration	Start
Timecard Wk12	**6 days?**	**Mon 11/10/25**
Turn in Timecard Wk11	1 day?	Mon 11/10/25
Staff Meeting #9 (wk13)	1 day	Mon 11/10/25
Prototype #1	**2 days**	**Mon 11/10/25**
Finalize Prototype	1 day	Mon 11/10/25
Prototype Presentation	1 day	Tue 11/11/25
Start Homework 4	**4 days**	**Wed 11/12/25**
Start HW04	4 days	Wed 11/12/25
Timecard Wk13	**7 days?**	**Mon 11/17/25**
Turn in Timecard Wk12	1 day	Mon 11/17/25
Staff Meeting #9	1 day	Tue 11/18/25
Finish HW04	3 days	Wed 11/19/25
Report #2	**7 days?**	**Mon 11/17/25**
Team meeting 2:30-4:30	1 day?	Mon 11/17/25
Capstone Meeting 5:30-8	1 day?	Tue 11/18/25
Team Meeting 2:30-4:30	1 day	Wed 11/19/25
Do respective parts for presentation	1 day?	Thu 11/20/25
Do respective parts for presentation	1 day?	Fri 11/21/25
Drink in Excess	1 day	Sat 11/22/25
Finalize Presnentation	1 day?	Sun 11/23/25



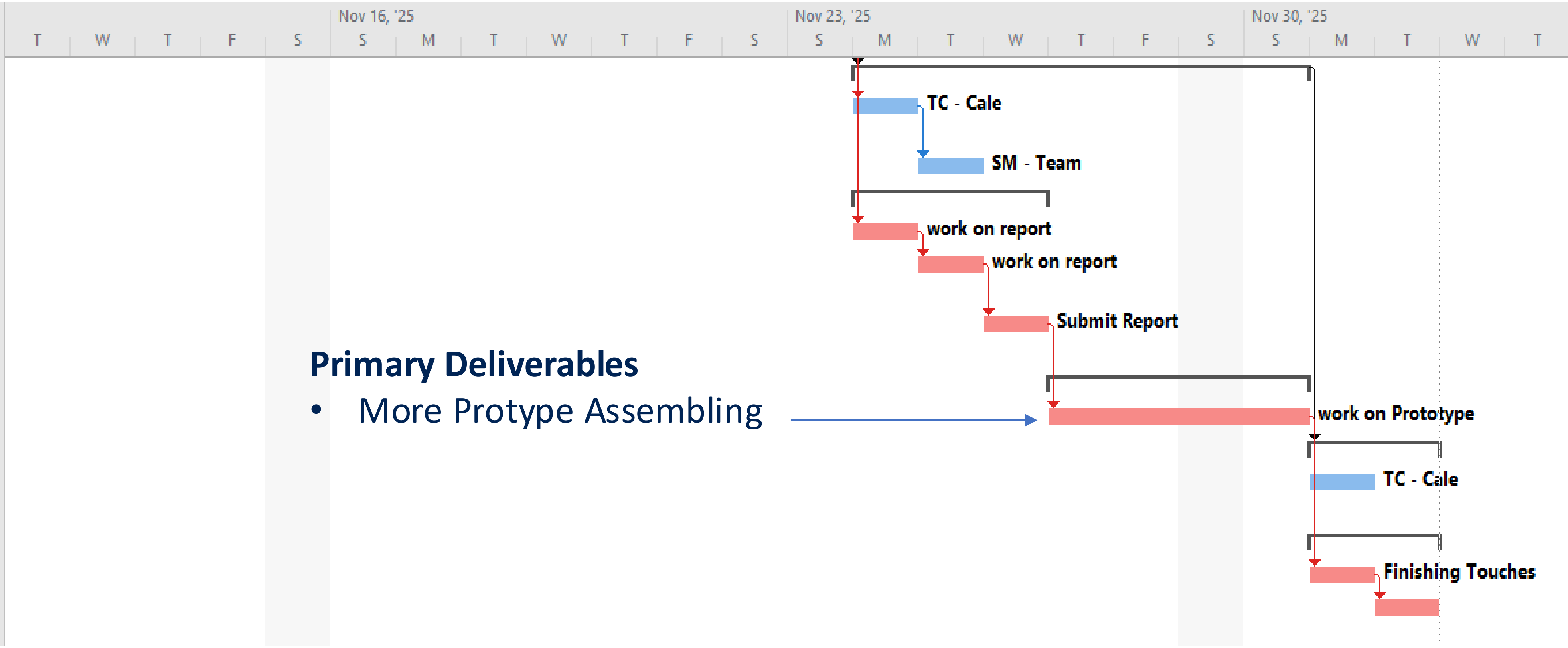
Primary Deliverables

- Report#2

Schedule Fall 3

Cale

Task Name	Duration	Start
Timecard Wk14	**6 days?**	**Mon 11/24/25**
Turn in Timecard Wk13	1 day	**Mon 11/24/25**
Staff Meeting #10	1 day	Tue 11/25/25
Report #2	**3 days?**	**Mon 11/24/25**
Team Meeting	1 day	Mon 11/24/25
Capstone Team meeting	1 day?	Tue 11/25/25
Finish Report and submit	1 day?	Wed 11/26/25
Prototype 2	**3 days**	**Thu 11/27/25**
Work on Prototype	3 days	Thu 11/27/25
Timecard Wk15	**2 days**	**Mon 12/1/25**
Turn in Timecard Wk14	1 day	Mon 12/1/25
Prototype 2	**2 days**	**Mon 12/1/25**
Finalize prototype	1 day	Mon 12/1/25
Complete Proto 2 Demo	1 day	Tue 12/2/25



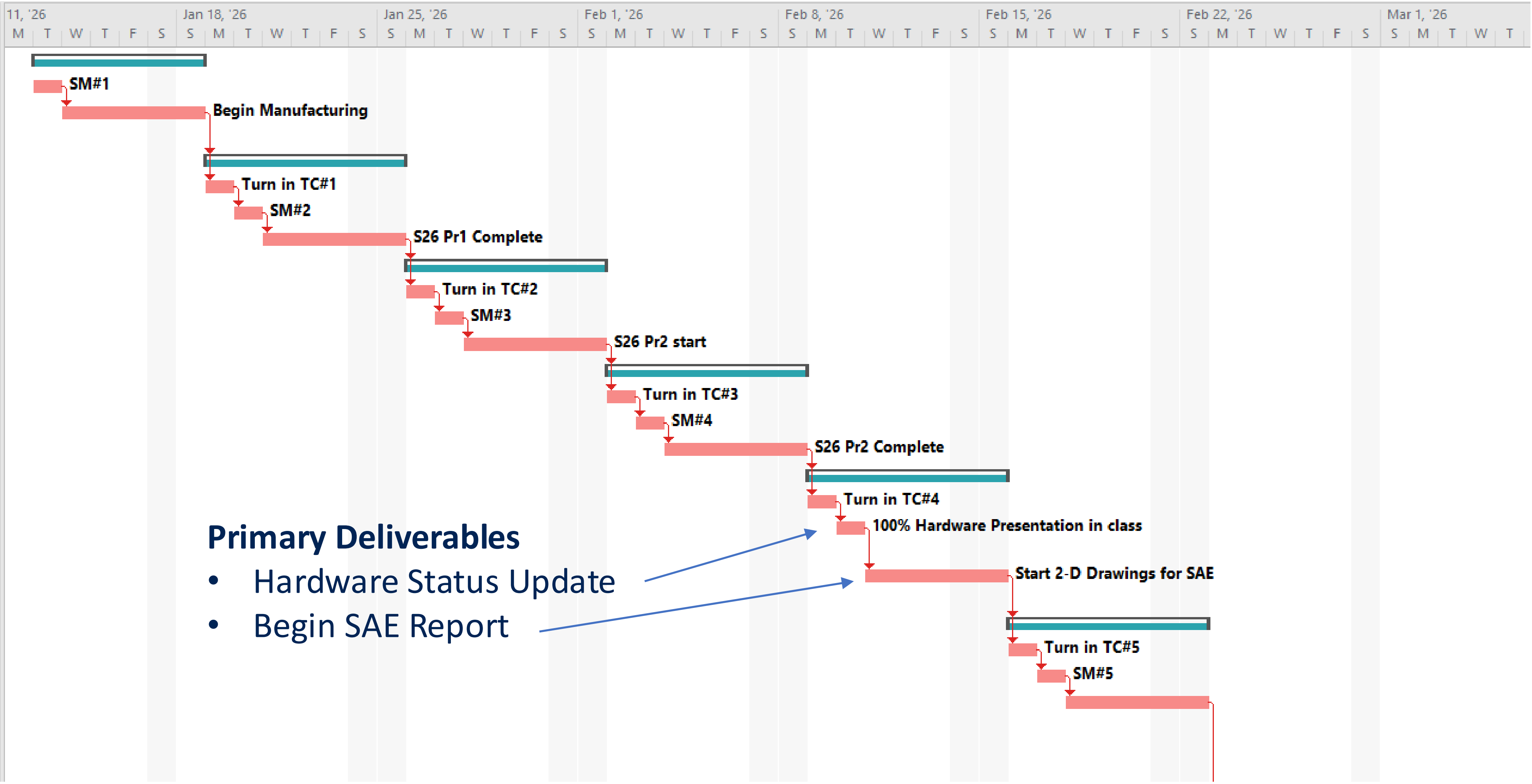
Primary Deliverables

- More Protype Assembling

Cale

Schedule Spring 1

Task Name	Duration	Start
Week 1	**5 days**	**Tue 1/13/26**
Staff meeting #1	1 day	Tue 1/13/26
Get started on prototype 4	4 days	Wed 1/14/26
Week 2	**6 days?**	**Mon 1/19/26**
Timecard Wk 1	1 day	Mon 1/19/26
Staff meeting #2	1 day	Tue 1/20/26
Finish Proto 4	4 days	Wed 1/21/26
Week 3	**6 days?**	**Mon 1/26/26**
TimeCard Wk 1	1 day	Mon 1/26/26
Staff Meeting #3	1 day	Tue 1/27/26
Start Proto 5	4 days	Wed 1/28/26
Week 4	**6 days?**	**Mon 2/2/26**
Timecard Wk 3	1 day	Mon 2/2/26
Staff Meeting #4	1 day	Tue 2/3/26
Finish Proto 5	4 days	Wed 2/4/26
Week 5	**6 days?**	**Mon 2/9/26**
Timecard Wk 4	1 day	Mon 2/9/26
100% Hardware Status Update	1 day	Tue 2/10/26
Begin 2-D drawings for SAE	4 days	Wed 2/11/26
Week 6	**6 days?**	**Mon 2/16/26**
Timecard Wk 5	1 day	Mon 2/16/26
Staff Meeting #5	1 day	Tue 2/17/26
Make any adjustments needed to Proto 5 and drawings	4 days	Wed 2/18/26



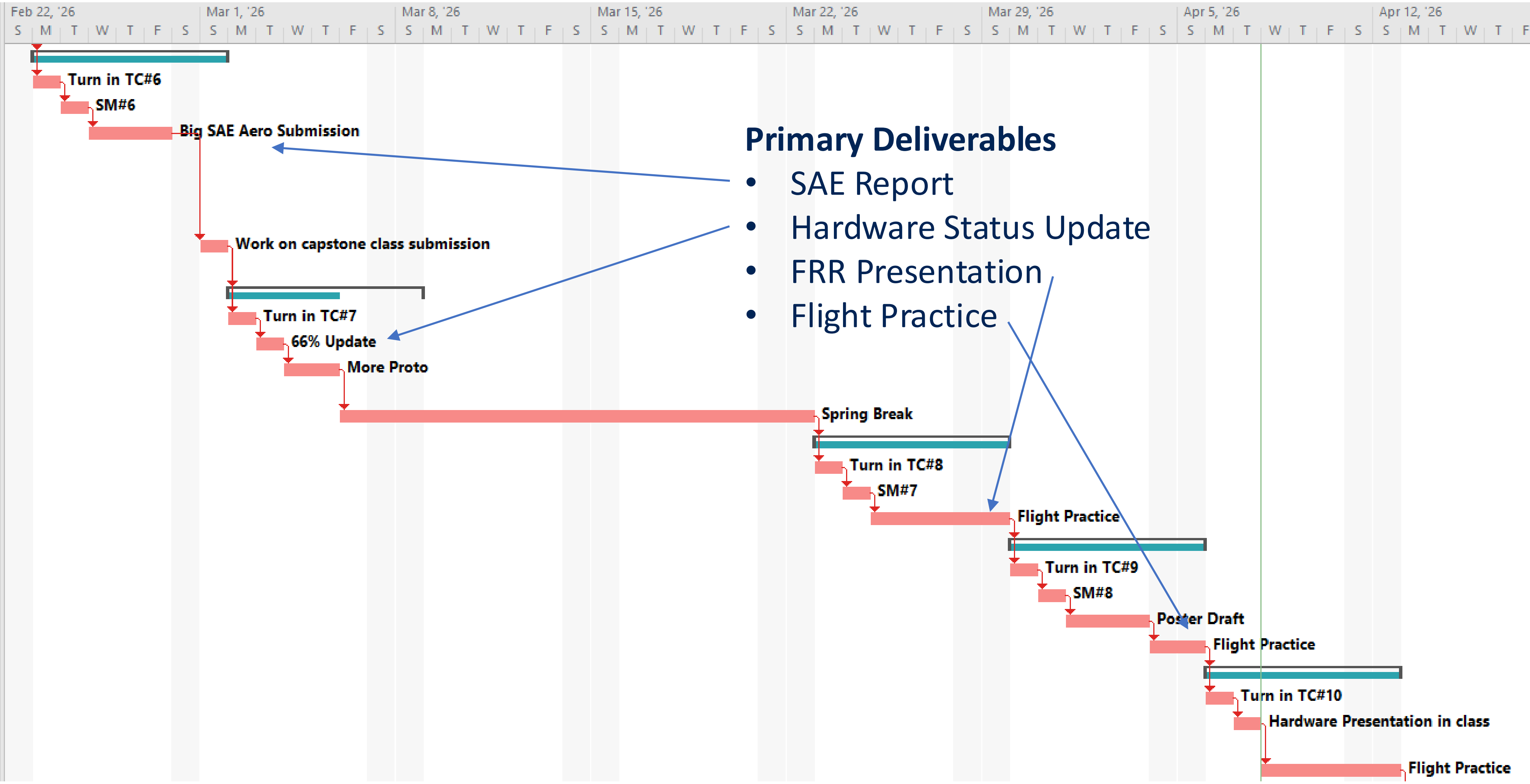
Primary Deliverables

- Hardware Status Update
- Begin SAE Report

Schedule Spring 2

Cale

Task Name	Duration	Start
Week 7	**6 days?**	**Mon 2/23/26**
Timecard Wk 6	1 day	Mon 2/23/26
Staff Meeting #6	1 day	Tue 2/24/26
Submit SAE 2D drawings, Technical Data Sheet and Technical Design Report	3 days	Wed 2/25/26
Begin work on 66%+ Hardware update	1 day	Sun 3/1/26
Week 8	**6 days?**	**Mon 3/2/26**
Timecard Wk 7	1 day	Mon 3/2/26
Give 66% update	1 day	Tue 3/3/26
Continue workin on Prototype	2 days	Wed 3/4/26
Spring Break	12 days	Fri 3/6/26
Week 9	**6 days?**	**Mon 3/23/26**
Timecard Wk 8	1 day	Mon 3/23/26
Staff meeting #7	1 day	Tue 3/24/26
Practice Flying	4 days	Wed 3/25/26
Week 10	**6 days?**	**Mon 3/30/26**
Timecard Wk 9	1 day	Mon 3/30/26
Staff meeting #8	1 day	Tue 3/31/26
Poster draft	3 days	Wed 4/1/26
Flight Practice	2 days	Sat 4/4/26
Week 11	**6 days?**	**Mon 4/6/26**
Timecard Wk 10	1 day	Mon 4/6/26
100% Hardware Presentation	1 day	Tue 4/7/26
Flying!!!!	4 days	Wed 4/8/26



Primary Deliverables

- SAE Report
- Hardware Status Update
- FRR Presentation
- Flight Practice

Purchasing

Luke

Purchase Date	Vendor	Description	Quantity	Cost
10/30/2025 (Registration)	SAE International	REG-AEROWEST-2026	-	$ 1,650.00
11/6/2025 (RR #1)	HomCo Lumber & Hardware	3006178 WIRE MUSIC	1	$ 8.03
		4411468 DOWEL HARDWOOD ROUND	1	
		999 BOLT, NUT AND SCREW	4	
		999 BOLT, NUT AND SCREW	2	
		999 BOLT, NUT AND SCREW	2	
11/6/2025 (RR #2)	HomCo Lumber & Hardware	999 BOLT, NUT AND SCREW	4	$ 22.97
		999 BOLT, NUT AND SCREW	4	
		999 BOLT, NUT AND SCREW	4	
		1798883 33400 GLUE	1	
	HomCo Lumber & Hardware	999 BOLT, NUT AND SCREW	4	
		999 BOLT, NUT AND SCREW	8	
		999 BOLT, NUT AND SCREW	4	
		999 BOLT, NUT AND SCREW	1	
		999 BOLT, NUT AND SCREW	2	
		999 BOLT, NUT AND SCREW	2	
		999 BOLT, NUT AND SCREW	2	
		999 BOLT, NUT AND SCREW	4	
		999 BOLT, NUT AND SCREW	4	
		999 BOLT, NUT AND SCREW	8	
11/6/2025 (RR #3)	Michael's	Guillow's 1/2" x 36"	1	$ 225.42
		Loctite Gel Control	1	
	HomCo Lumber & Hardware	6331987 3/4X10' PVC PIPE	1	
		9155789 4X10 THINWALL PVC SOLID PIP	1	
	Amazon	FLASH HOBBY Brushless Motor	1	
		Polymaker PLA PRO Filament	1	
		Beffkkip [8-Pack] MG90S 9g	1	
		Flycolor 80A ESC 3-6S	1	
		9 Pieces Y Connector 3 Pin	1	
		1 Set Aluminum Main Landing	1	
		uxcell RC Propellers CW	1	
11/18/2025 (RR #4)	HomCo Lumber & Hardware	2420768 SHEET ALUMINUM MILL 6X24	1	$ 27.31
		999 BOLT, NUT AND SCREW MISC BOX&	23	
12/9/2025 (PO #1)	DragonPlate	Kevlar Core Carbon Fiber Round Tube ~	1	$ 725.07
		Braided Carbon/Yellow Kevlar Round Tu	1	
		Kevlar Core Carbon Fiber Round Tube ~ 4"	1	

12/9/2025 (RR #5)	Amazon	Jienk 4PCS 40mm Aluminum Heat Sink w	1	$ 42.62
		Jienk 4PCS Black Aluminum Heat Sink w	1	
		Jienk 4PCS Black Aluminum Heat Sink w	1	
	HomCo Lumber & Hardware	999 BOLT, NUT AND SCREW MISC BOX&	4	
		999 BOLT, NUT AND SCREW MISC BOX&	4	
		3116829 ALUMINUM TUBE RND 3/16OD	2	
	The Home Depot	WOOD SCRW BRSS PHL FLT #4 X 3/4	2	
		FLAT WASHER ZINC 5/16 (ABB)	10	
	Michaels	Cindoco Wood Prod... 00715998180367	1	
12/9/2025 (RR #6)	Michaels	20" x 30" Dry Erase... 00769125997939	1	$ 56.18
		X-ACTO Cut All Li... 00079946369007	1	
		Cindoco Wood Prod... 00715998383867	1	
	The Home Depot	GREAT STUFF BIG GAP FILLER 12OZ	1	
		2IN DBLWIDE CORN BRACE SS 2PK	3	
12/9/2025 (RR #7)	Walmart	PG LUG SCALE 670223740010	1	$ 220.06
	Michaels	Gorilla Tape 10yd... 00052427601001	1	
		1/2" x 36" Balsa Wo... 00195158927542	1	
		22" x 28" Poster Bo... 00400100998588	1	
		Guillow's 1/8" x 3/8"... 00072365051263	1	
		Cindoco Wood Prod... 00715998141467	1	
	HomCo Lumber & Hardware	3400199 48-89-2304 DRILL BIT BIT 7/64II	1	
	Harbor Freight	69657 DIAMOND ROTARY CUTTING DI	1	
		63244 .94IN X 60YD PAINTER'S TA	1	
		69030 25 x 1IN TAPE MEASURE W/A	1	
		62440 276PC ROTARY TOOL ACCESSO	1	
	Amazon	OVERTURE Air PLA Filament, Pre-Foame	1	
		OVERTURE Air PLA Filament, Pre-Foame	1	
		Tecunite 20 Pieces 3-pin Servo Extensior	1	
		uxcell Control Horn, 16x17mm Plastic Hc	1	
		Hangar 9 Digital Sealing Iron HAN1017 T	1	
1/15/2026 (PO #2)	Amazon	NOBRIM Carbon Fiber Landing Gear YAK5	2	$ 56.86
		Hangar 9 UltraCote Deep Blue HANU873	1	$ 27.33
		(10) KARBXON – 4mm x 4mm x 1000mm F	1	$ 71.61

Purchasing

Luke

		FLASH HOBBY D3542 1250KV Brushless I	3	$ 19.35
		20 PCS Professional 545 Diamond Cuttin	1	
		uxcell RC Propellers CW 11x5.5 Inch 2-Va	1	
		Zeee 3S Lipo Battery 2200mAh 11.1V 50C	1	$ 285.79
		MECCANIXITY Propeller Adapter RC Plane	1	
		Master Airscrew GF Series 11x5 Performa	1	
		uxcell Control Horn, 16x17mm Plastic Ho	1	
		Flycolor 80A ESC 3-6S Electric Speed Cor	1	
		Beffkkip 12PCS MG90S 9g Micro Servo M	1	
		OVONIC 3s Lipo Battery 50C 5000mAh 1	1	
		OVERTURE Air PLA Filament, Pre-Foamed	1	
		Master Airscrew GF Series 11x5 Performa	1	$ 9.83
	Innov8tive Designs	ArmingPlug Cablewith XT60Connectors	1	$ 16.98
	Bambu Lab	PLA Basic Gold (10401)/Refill/1kg	3	$ 122.44
		PLA Basic Blue (10601)/Refill/1kg	1	
		PLA Basic Black (10101)/Refill/1kg	4	
1/16/2026	Master Airscrew	GF Series 11x5 Propeller	1	$ 10.26
	Horizon Hobby	UltraCote, Deep Blue HANU873	1	$ 48.72
			3	
2/10/2026 (PO #3)	Bambu Lab	PLA Basic Black (10101) / Refill / 1kg	5	$ 122.46
		PLA Basic Blue (10601) / Refill / 1kg	1	
		PLA Basic Gold (10401) / Refill / 1kg	2	
	Amazon	(10) KARBXON – 4mm x 4mm x 1000mm F	2	$ 138.53
2/18/2026 (PO #4)	Amazon	Hangar 9 UltraCote Silver HANU881 Airpla	2	$ 125.72
		Hangar 9 UltraCote Silver HANU881 Airpla	2	-
		Hangar 9 UltraCote ParkLite - Blue HANU(	1	-
		uxcell Control Horn, 16x17mm Plastic Ho	1	-
		FLASH HOBBY D3542 1250KV Brushless I	2	$ 45.92

2/22/2026 (PO #5)	RCDepron	2mm | 10 Sheets | ~23.5" x ~17.2" | Whit	1	$ 54.95
	Amazon	Spektrum 2200mAh 2S 6.6V Li-Fe Receiv	2	$ 108.25
		OliRC 4pcs No Wires Connector: XT60 XT	1	
3/16/2026 (PO #6)	Amazon	OVONIC Battery 5000 mAh	1	
		10 PCS Control horns	2	
		80A ESC	1	
				$ 104.40
3/23/2026 (PO #7)	Amazon	10 Count Servos	1	$ 28.99
	Innov8tive Designs	Red arming plug	1	$ 9.99
	Neutronics Enterprise Inc	450 W power limiter	1	$ 85.00
Balsa wood 11/24/25	NAU IDEA Lab			$ 24.18
1/27/2026				$ 31.45
2/3/2026				$ 36.04
3/17/2026				$ 25.23

Luke

Itemized Bill of Materials

Part	Quantity(inches or number)	$/unit	Total cost
Spinner Nut	1	4.995	4.995
Propellor	1	8.595	8.595
D3542 Motor	1	21.99	21.99
M3x12mm	4	0.36	1.44
M3x washers	6	0.4	2.4
Nose Cone	1	4.616	4.616
M4x12mm	3	0.43	1.29
N.G. mount	1	0.42999	0.42999
6-32x2" bolt	4	0.29	1.16
6-32 Lock Nut	4	0.26	1.04
M3x10mm	2	0.32	0.64
Nose Gear	1	29.66	29.66
NG Control Arm	1	0.0158	0.0158
Servo	1	2.5	2.5
M3x16mm	1	0.37	0.37
M3 washer	1	0.4	0.4
M3 nut	1	0.39	0.39
Fuselage	20	6.5	130
Bladder caps	1	1.3495	1.3495
Bladder body	1	0.6785	0.6785
Bladder Bolts	2	0.1282	0.2564
11/16 ID O-Rings	2	0.61	1.22
Main Gear mount	1	0.14013	0.14013
Main Gear	1	20.99	20.99
8-32x3/4	2	0.25	0.5
8-32 Lock Nut	2	0.27	0.54
Big Ahh	1	1.65271	1.65271
Mounting Bracket	1	1.15422	1.15422
Couplers	4	0.077213	0.30885
Spars	96	0.155	14.88
Main Wing Foils	8	1.4	11.2
10-24x2"	1	0.35	0.35
10-24x2.5	1	0.38	0.38
10-24 Lock Nuts	2	0.28	0.56
Aileron Rod (1/4")	4	0.0275	0.11

Ailerons	2	1.109	2.218
M3x16mm	2	0.37	0.74
M3 nut	2	0.39	0.78
M3 washer	2	0.4	0.8
Linkage rods	2	0.86	1.72
Servo Mounts	2	0.06969	0.13938
Endcaps	2	1.2166	2.4332
Servos	2	2.5	5
Boom Connector	1	2.9262	2.9262
M4x12mm	3	0.43	1.29
Boom	16	3.15	50.4
Connecting device	1	2.1927	2.1927
Vertical Tail	1	0.9853	0.9853
Tail Foils	6	1.4	8.4
Spars	52	0.155	8.06
Rudder	1	0.5951	0.5951
Servo Mount	1	0.06969	0.06969
Servo	2	2.5	5
Linkage rods	2	0.86	1.72
M3x16mm	2	0.37	0.74
M3 nut	2	0.39	0.78
M3 washer	2	0.4	0.8
Control Horns	4	0.79	3.16
Depron	352.53	0.0136	4.794408
Aluminum Shaft	22.5	0.0877	1.97325
Rudder Shaft	3	0.06	0.18
Battery	1	30.99	30.99
ESC	1	37.49	37.49
Reciever	1	18.99	18.99
On/Off	1	6.5	6.5
Red arming	1	9.99	9.99
Splitter	2	1.65	3.3
Gyro	1	43.99	43.99
Reciever Battery	1	11.5	11.5
Extension cables	6	0.484	2.904
Power Limiter	1	97.5	97.5
Final Cost			625.6633

Financials

Luke

Primary Budget	
$5000	
$4587.94	Total Spent
$412.04	Remaining Balance

Income	
$5000	Initial Donation
$2105	Go Fund Me
$2000	ASNAU

Overview			
	Projected	Actual	Difference
Total income	**$ 10,000**	**$ 9105**	**-$ 845**
Expenses	**$ 7,325**	**$ 7405.49**	**$ 80.49**
Balance	**$ 2,675**	**$ 1649.51**	

Trey

FMEA

Part # and Functions	Potential Failure Mode	Potential Effect(s) of Failure	Severity (S)	Potential Causes and Mechanisms of Failure	Occurrence (O)	Current Design Controls Test	Detection (D)	RPN	Recommended Action
3. Nose Cone/Motor Mount	Motor could come loose	Loss of thrust, Flying Debris	9	*Infill of motor mount could be too low * Mount is not properly fastened to fuselage	2	Measure distance between bracket and mount	1	18	Use higher infill percentage (currently 30%, use 35%)
1. Fuselage	Yield under load	Disassembly of aircraft	10	Stress concentration within fuselage	2	Load Test	1	20	Simulate loads in Ansys, Eliminate stress concentration points such as sharp corners in fuselage
2. Boom Adapter	Could come loose, shear in bolts	Total loss of control	10	Infill near nuts too low, too much force from tail wing	2	Load test	1	18	Slicing software for thicker infill near nuts
5. Boom	Yield under load	Disassembly of aircraft	10	Stress concentration within boom	2	Load Test	1	20	Eliminate stress concentrat ion points such as sharp corners in boom
24. Stabilizer Connector	Fasteners could become loose	Disassembly of aircraft	5	Loads could exceed strength of fasteners	5	Load Test using weight hanging from tail vertically	1	25	Use additional fasteners
23. Vertical Stabilizer	Ribs could slide along stringer	Unstable flight	9	Insufficient force to keep ribs in place	5	Measure distance between outboard rib and end of stringer	1	45	Screw outboard ribs in place

FMEA (part 2)

Trey

25. Rudder	Control surface could fail to return to neutral	Yaw to one direction	3	Servo arm moves upon activation Linkage stopper becomes loose	5	Measure distance between control surface end point and neutral point	8	120	Examine control surface prior to flight
20. Horizontal Stabilizer	Structure could cant due to being improperly fastened	Unstable flight	9	Insufficient force to keep ribs in place	5	Determine if stabilizer is level using spirit level	1	45	Examine stabilizer prior to flight
22. Elevators	Control surface could fail to return to neutral	Pitch in one direction	3	Servo arm moves upon activation Linkage stopper becomes loose	5	Measure distance between control surface end point and neutral point	8	120	Examine control surface prior to flight
8-13. Wing	Tear in wrap, struts braking	Flight instability and high likelihood of crash	8	*wrapping too tight *large gaps in airfoils on wing skeleton *Crashing	7	Load test Experimenting with wrap	3	168	strong leading edge, eliminate wrap fludder through experimentation
6. Wing Connector Bolts	Bolts could shear or come loose in the infill	Complete loss of wings or wings becoming loosly mounted	10	*Too low of infill on 3D print *Shear force on bolts	5	Testing forces on wings before flight	2	100	Higher infill percentage or redesign
9. Ailerons	Control arm disconnecting Connection rod breaking	Loss of control surfaces on main wings, airplane only controlled from tail	8	*loose connections Servo arm moves upon activation Linkage stopper becomes loose	3	Shear Calculations, strong control arm mounts	7	168	Stronger materials for connection rod and control arm

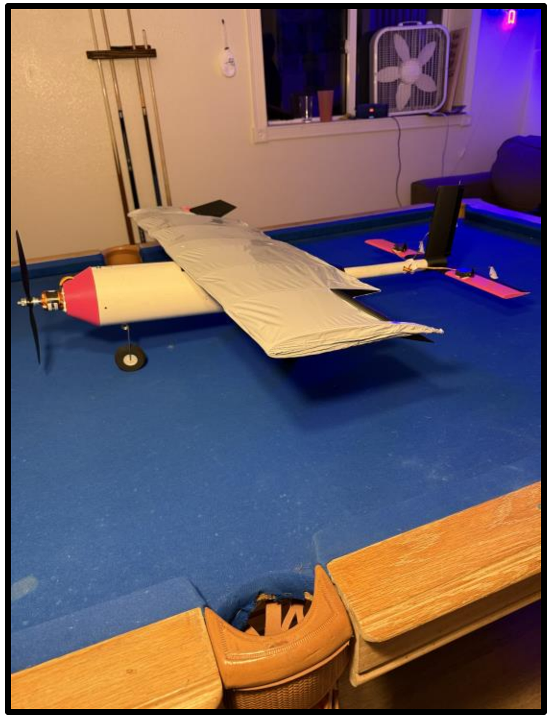
Trey

FMEA (part 3)

29. Motor	Thermal Fatigue Leads could break	Loss of Thrust	7	Sustained operation at high RPM	2	Measure temperature at high throttle settings using infrared thermometer	2	28	Reduce the amount of time operating at high throttle. Reduce Tension on motor leads.
30. Servos	Wire could break Servo arm could become loose Servo could dismount from tray	Loss of control	9	Tension on servo wire	3	Functionality Test prior to flight	1	27	Nail servos to servo tray
31. ESC	Thermal Fatigue Leads could break	Loss of Thrust	7	Sustained operation at high RPM	2	Measure temperature at high throttle settings using infrared thermometer	2	28	Reduce the amount of time operating at high throttle settings Reduce Tension on ESC leads
32. Battery	Charge could run out during flight Battery could overheat	Loss of control	10	High current draw Reduced battery capacity from wear	2	Measure battery voltage prior to flight	2	40	Introduce cooling vents into nose cone to allow airflow through fuselage
33. Receiver	Loss of signal	Loss of control	9	Physical damage	2	Functionality Test prior to flight	1	18	Store receiver away from other components
34. Propeller	Yield under load Brittle Fracture	Loss of Thrust	10	Physical damage	4	Functionality Test prior to flight	1	40	Examine propeller prior to flight
3b, 2b. Nose Cone and Boom Adapter bolts	Bolts could shear or come loose in the infill	Complete loss of power and stability	10	*low infill on 3D print *Bolts not tightened	2	Shear Calculations	3	60	*Higher infill near the nut holders
14-19. Landing Gear	Yield under load	Damage to aircraft Flying debris	9	*Improper fastening * Material defects or damage	2	Drop test	2	36	Use strong materials such as carbon fiber

Engineering Iterations

Can we build to competition specs?



October ‘25-
November ‘25

- Stubby Nose Cone
- NACA 2412
- Straight Tail

Can we make something fly?

November ‘25-
December ‘25

- Foam Assembly
- Wings Modeled from Proto1

Can we taxi and takeoff on our own weight?

- Longer Nose Cone
- NACA 2412
- 3° Tail

Engineering Iterations

Carlo

December ‘25-
February ‘26

Can we have stable flight?

- Heavier Nose Cone
- Eppler 423
- 10° Tail
- Hatched Fuselage

February ‘26-
April ‘26

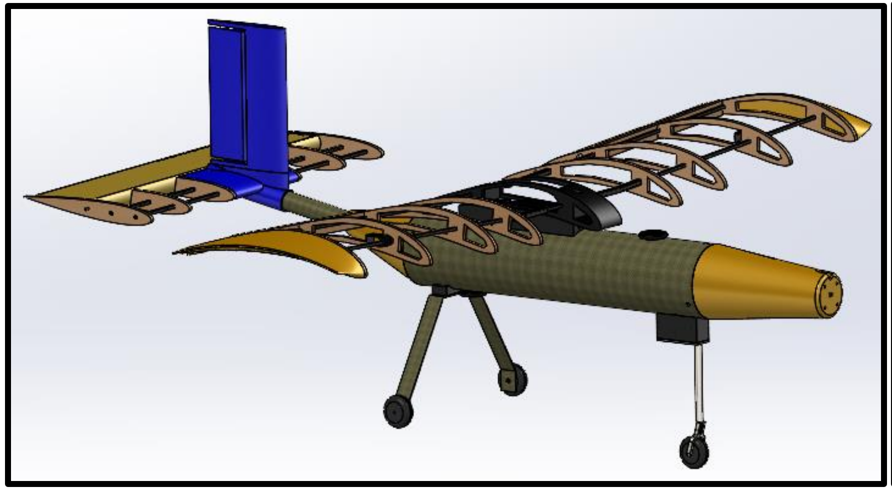
Can we meet all competition requirements?

- Eppler 423
- 10° Tail
- Solid Fuselage
- 3° Dihedral

Final Overall Design

Cale

CAD Assembly



Manufacturing

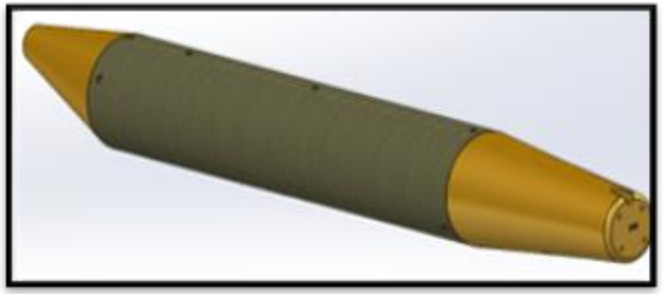
Key Aspects

- Total Weight = 6.5lbs
- Static Thrust to Weight Ratio = 0.615
- Wingspan = 51"
- Aspect Ratio = 4

Fuselage Sub Assembly

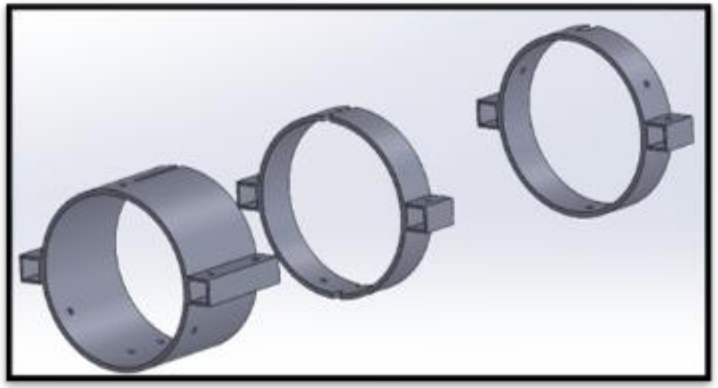
Carlo

CAD Assembly



Manufacturing

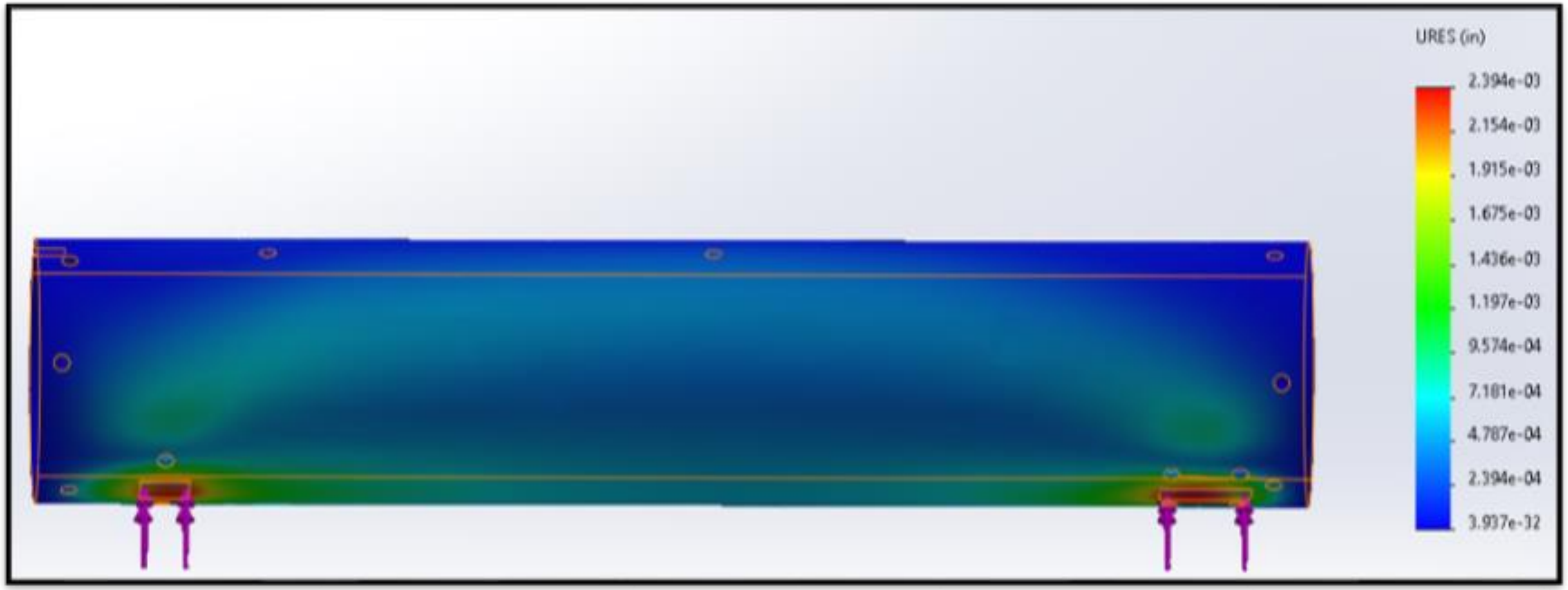
Jig



- Carbon Fiber Body (4" ID) 20" long
  - Lightweight, structurally sound
  - 3D Printed Jig for repeatability in manufacturing
- 3D Printed Nose Cone
  - Nut inserts for ease of assembling
  - Weighted to correct C.G.
  - Flat plates for battery and ESC mount
- 3D Printed Boom Connector
  - Nut inserts for ease of assembling
  - 10° boom-sleeve for tail angle (eliminate tail strike)

Fuselage Analysis

Carlo



SolidWorks FEA

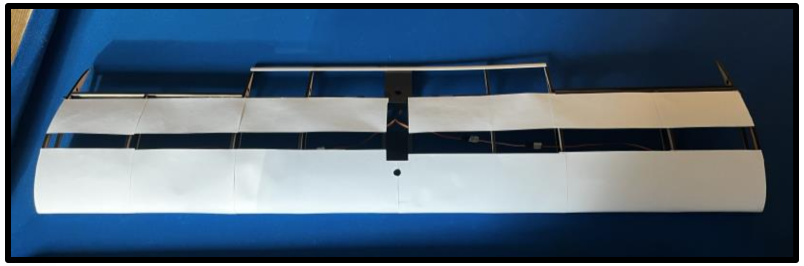
- 250 lbf on each landing gear
- Maximum deflection 0.0024"

Main Wing Sub Assembly

CAD Assembly

- **51" Wingspan**
- **12.6" Chord Length**
- **3.75" x 12" Ailerons**
- **3° Dihedral**

Manufacturing

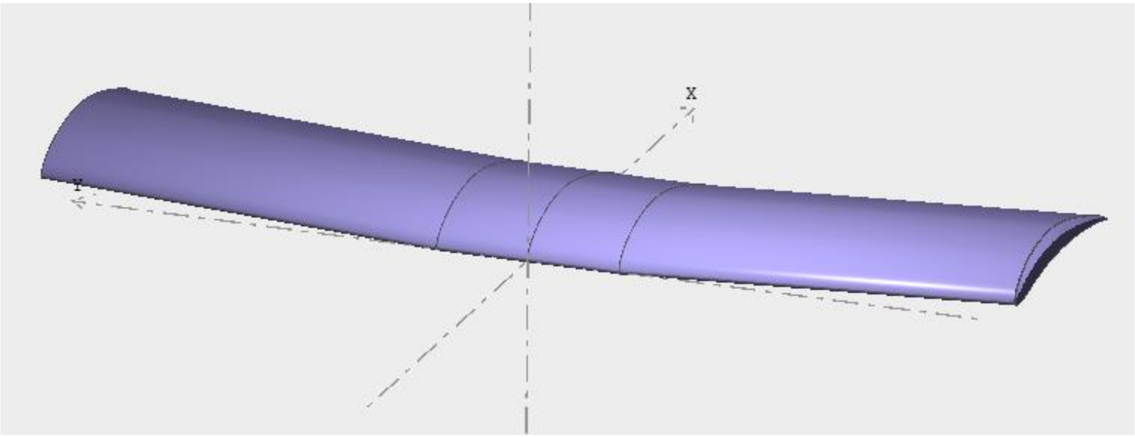


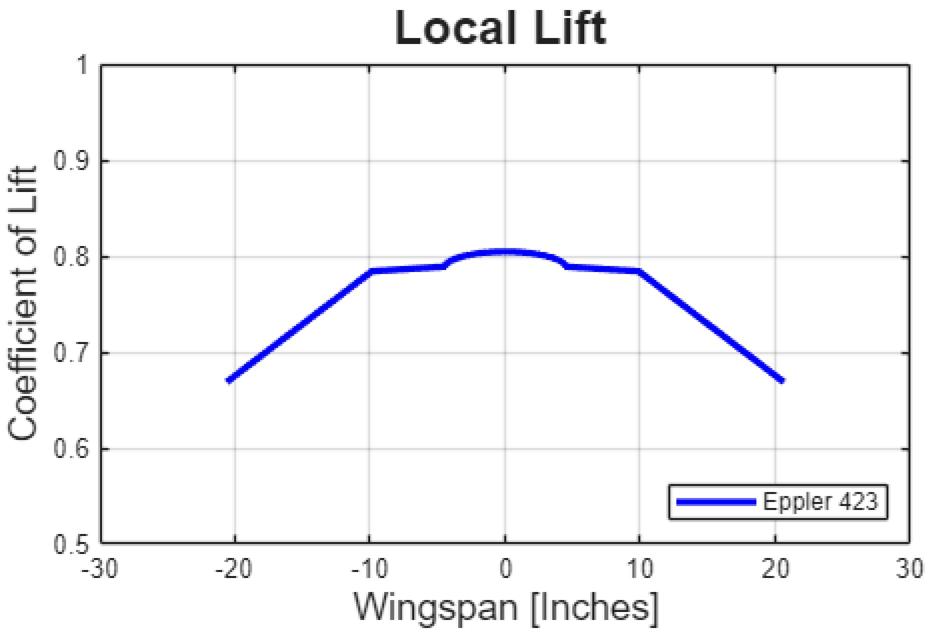
- 8 Maple veneer laser cut Eppler 423 airfoils
  - Two are ~¾ chord, with the trailing edge cut off for aileron fitting
- One 2" wide 3D printed mounting airfoil at the root
- Connected with two 4mm x 4mm carbon fiber spars and four 3° 3D printed PLA couplers
  - Couplers are inserted near the root of the wing, gives the wing its dihedral shape
- Wrapped in UltraCote
- 3D printed Ailerons, Endcaps, Servo mounts, Wing mount
- Cardstock leading edge, balsa wood trailing edge

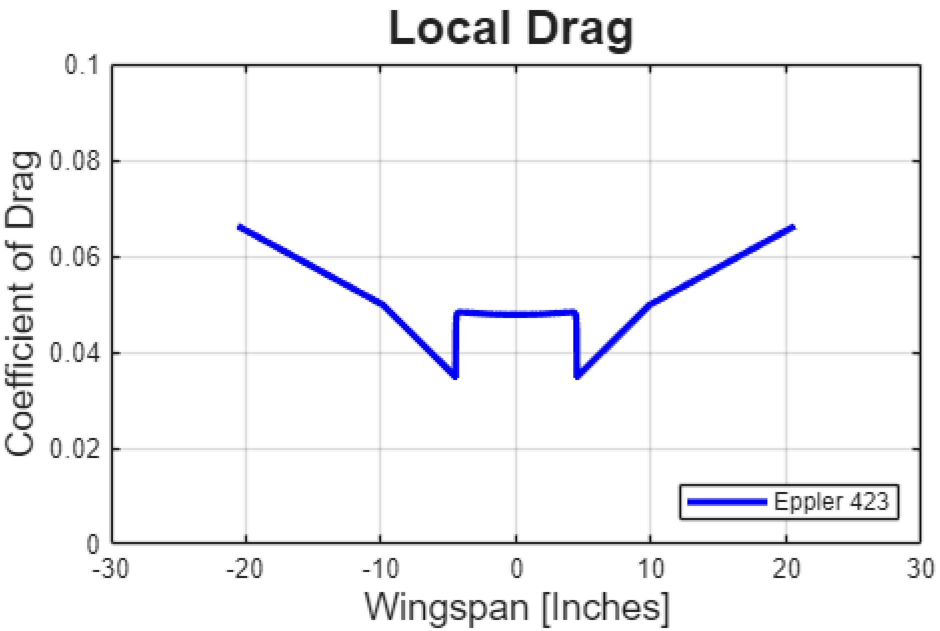
Main Wing Analysis

Ryan

- Local Lift and Local Drag graphs ~ 300,000 Re
- Ideal Local Lift Graph:
  - Highest at root of wing
  - Smooth curves down towards wing tip
- Ideal Local Drag Graph
  - Increased drag due to 3° dihedral shape
  - Does not overcome the local drag at rest of wing



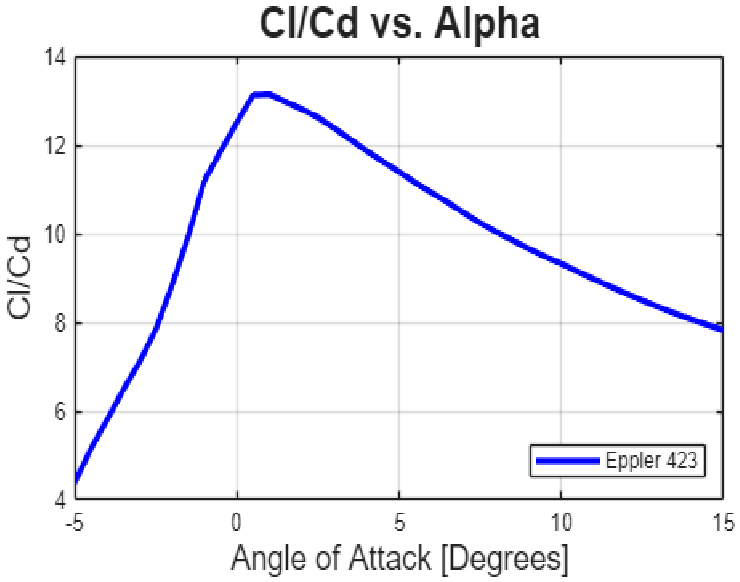


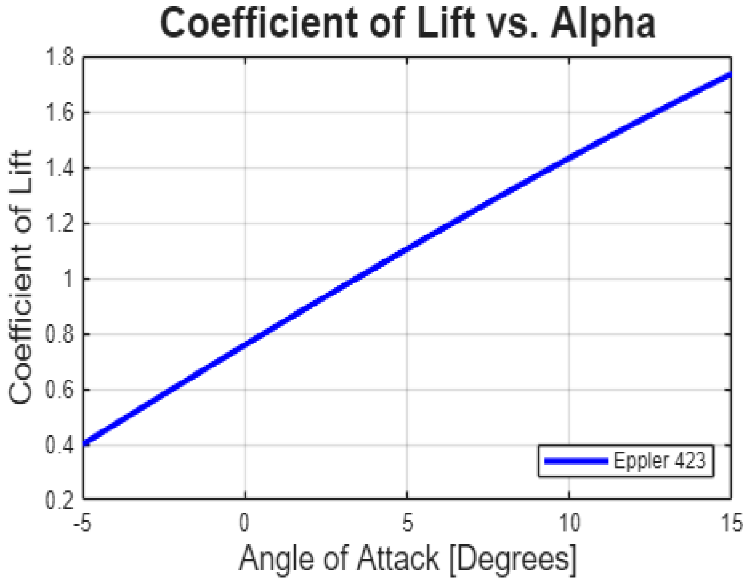


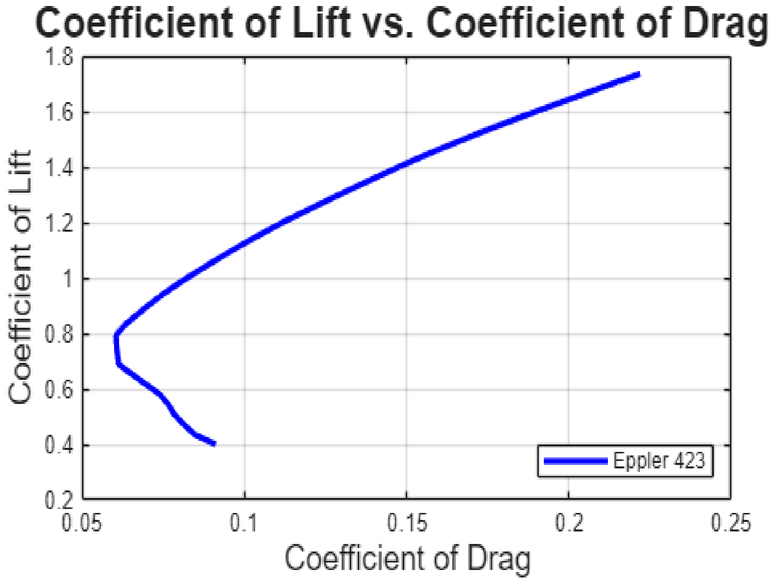
Main Wing Analysis

Ryan

- Operating at 60 ft/s Re ~ 300,000
- Cl vs Cd Graph
  - Smooth line, no sharp drops of local lift when drag increases
- Cl vs Alpha
  - Positive lift at 0-degree AOA
- Cm vs Alpha
  - Negative moment at positive AOA
  - Counter-acting down force at leading edge as lift increases the AOA
- Cl/Cd vs Alpha
  - Smooth curve
  - Positive Cl/Cd at zero-degree AOA







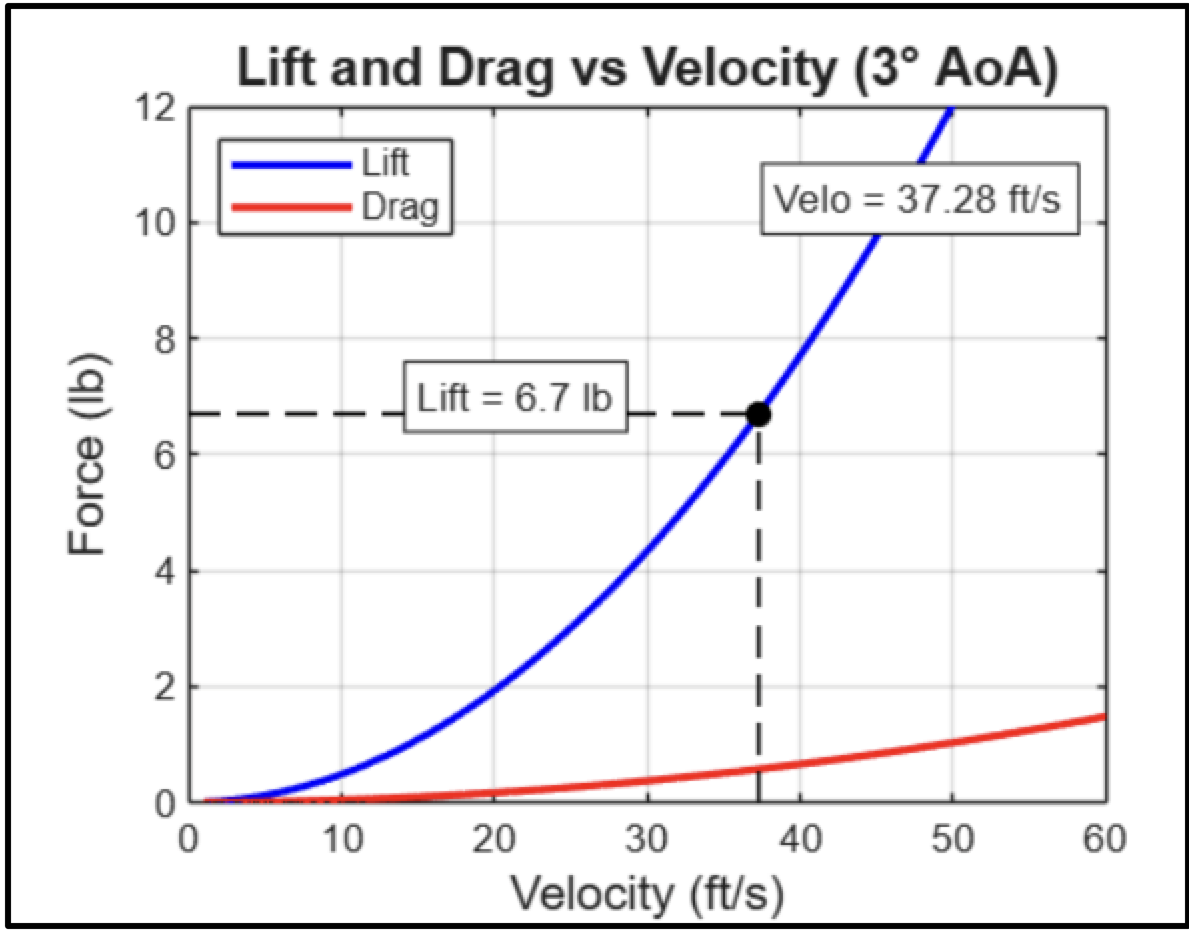
Main Wing Analysis

Ryan

- Using XFLR5, a 3D model of the wing was created for efficiency analysis
- **How fast does our plane need to travel for the main wing to overcome the weight of the plane purely due to lift force?**
  - Our landing gear is configured such that a natural 3° AOA is present. Calculations were done with respective coefficients at 3° AOA

$$L = \frac{1}{2}\rho \cdot v^2 \cdot C_L \cdot S \qquad D = \frac{1}{2}\rho \cdot v^2 \cdot C_D \cdot S$$

- Using the equations for lift and drag force, a plot was made in MATLAB displaying Velocity (ft/s) vs. Force (lb)
- **As the plane weighs 6.8 lbs, it takes a velocity of 37.28 ft/s to achieve takeoff purely due to lift**



Main Wing Analysis (cont.)

Ryan

- **Do our Ailerons produce enough roll?**
- Using a relative speed of ~40 ft/s and a lift coefficient of 0.74
  - 0° AOA because we will be rolling when stable in the air
  - Due to landing gear configuration, wings have an initial AOA of 3°
- Small deflection angles (±3, ±5, ±7)°
- Producing efficient dynamic moments of ±14.7, ±24.5, ±34.3 [lb×in/s]

- **Therefore, throw on the servos was lowered and made sensitive**

Variable:	Description:	Value:
$C_{l\varepsilon}$	Aileron lift increase with deflection angle (ε)	0.03837
$C_{l\alpha}$	Lift coefficient at 0° AOA	0.74
γ	Aileron chord length	3.75 [in]
$S_{aileron}$	Surface area of aileron	45 [in^2]
S_{ref}	Wing area	642.6 [in^2]
$y_{aileron}$	Spanwise center of aileron (center of aileron → wing root)	19.5 [in]
b	Wingspan	51 [in]
ε	Deflection angle	(±3, ±5, ±7)° [convert to rad]
q_∞	Dynamic pressure	0.223 [$\frac{lb}{in^2 \times s}$]
M	Dynamic moment	(±14.7, ±24.5, ±34.3) [$\frac{lb \times in}{s}$]

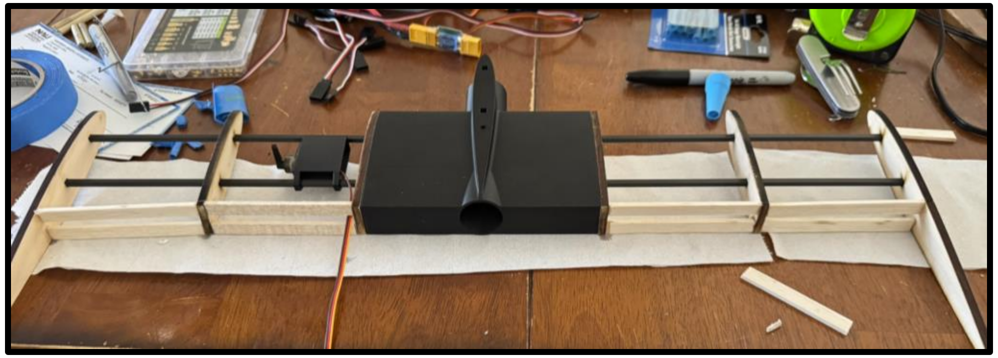
$$C_{l\varepsilon} = C_{l\alpha} \times \sqrt{\gamma} \times \frac{S_{aileron}}{S_{ref}} \times \frac{y_{aileron}}{b}$$

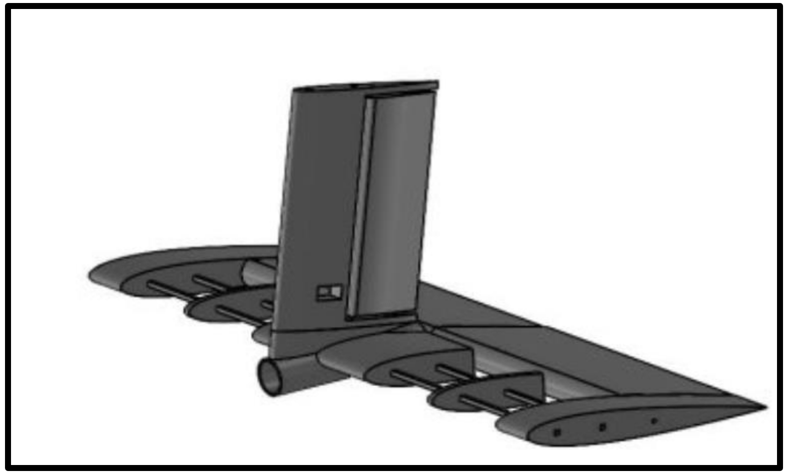
$$M = C_{l\varepsilon} \times \varepsilon \times S_{ref} \times b \times q_\infty$$

NORTHERN ARIZONA UNIVERSITY

Tail Wing Sub Assembly

Luke



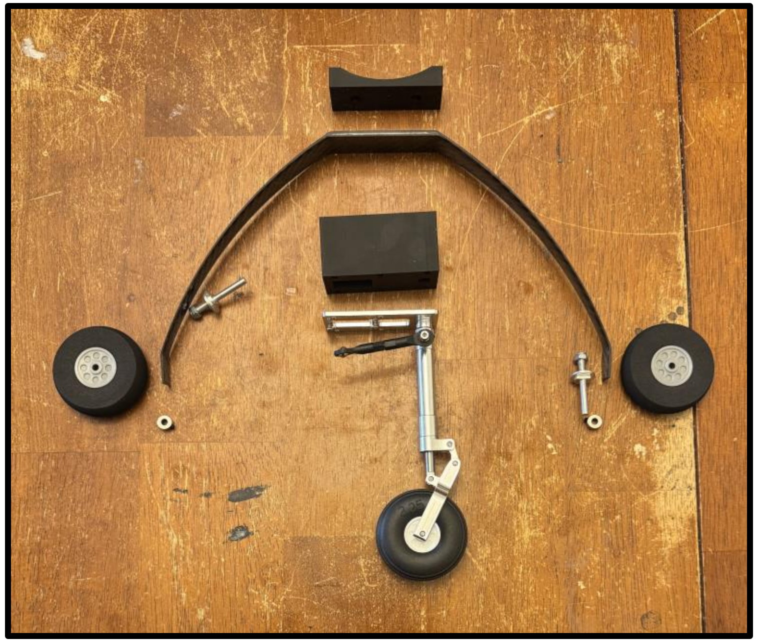


- 6 laser-cut maple veneer airfoils are used to construct horizontal stabilizer.
  - 4 are cut in line with the connecting device to allow room for elevator.
  - 22.3" Span, 8.81" Chord
- Center piece is a 3D printed connecting device that connects the tail-wing to the boom.
  - 10° angle from the boom connecting device to bring level with main wing.
  - Airfoil shape has a -3°geometric angle of attack to allow for more down force to bring nose level easier.
- Elevator made from depron foam then reinforced with duct tape.
  - 21.5" Span, 4.5" Chord
- Vertical Stabilizer and rudder both are 3D printed and connected with the carbon fiber spars.
  - 8" Span, 5.33" Chord

Cale

Landing Gear Sub Assembly

- Nose Gear purchased from AliExpress, Aluminum – "Piston" absorbs landing impulse
- Main Gear purchased from Amazon, Carbon Fiber



- MG - 70x275x150

Electronics

Trey

Specifications

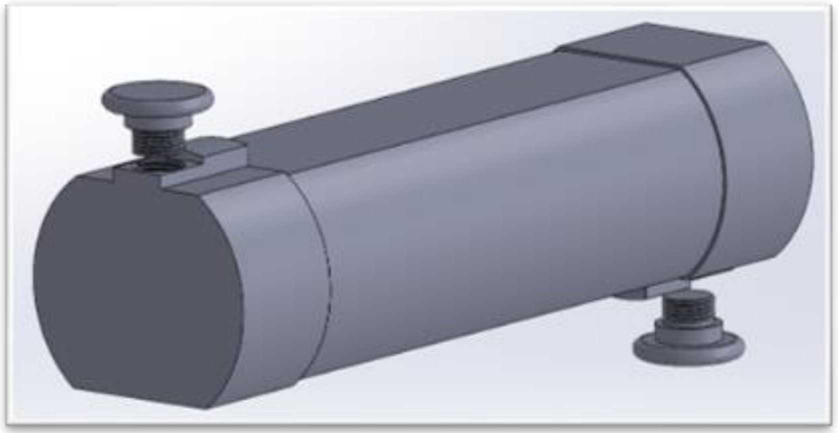
- 1250 KV brushless motor
  * Produces 4lbs of static thrust with 12 x 6 propeller
- 80 Amp ESC–BEC
- 3S 5000 mAh 30C Lithium Polymer Battery
- 2S 1000 mAh 35C Lithium Polymer Receiver Battery
- Neutronics 450W Power Limiter
- MG90s Metal Geared Servo

Payload Container

Carlo

Manufacturing

CAD Assembly

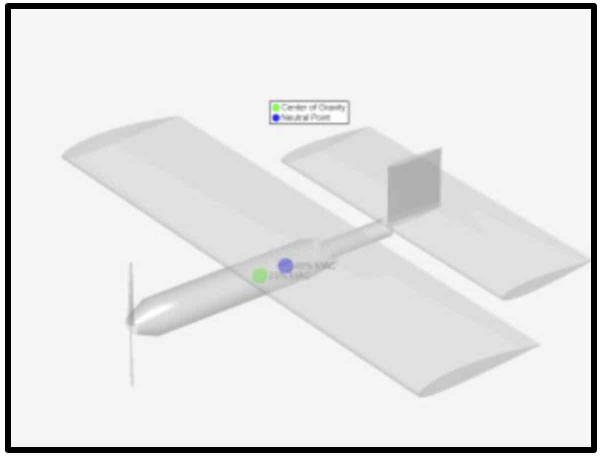


- 3D printed with PLA in a three-piece assembly
  - All pieces assembled with JB Weld plastic bonder
- Bolts 3D printed with ¾" diameter
  - O-Ring added for water-tight seal
- Overall volume of 71.4 fl oz > competition requirement
- Flat channels designed to slide past pre-existing hardware in fuselage

Trey

Flight Stability Optimization

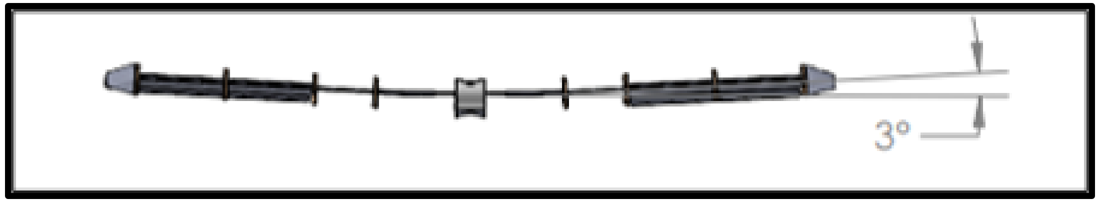
Pitch Stability



Aircraft Intuitive Design Tool

- Center of Gravity Placement: 25% of Mean Aerodynamic Chord
- Aircraft Neutral Point: 46% of Mean Aerodynamic Chord
- Static Margin = 21%

Roll Stability



- A dihedral of 3° was implemented in order to improve stability along the longitudinal axis while minimizing a reduction in lift

Competition Predictions

Cale

Flight Predictions

- If windy (>12mph) takeoff <10ft
- If calm conditions takeoff <40ft
- Landing distance within 200ft

Density Altitude - The altitude in the standard atmosphere at which the air density is equal to the current air density. How high does the air *behave* based on its density?

Expected Environmental Conditions

- 12+ mph winds
- ~80 F

Weather Conditions

	Temp (K)	Altimeter Pressure (Pa)	Station Pressure (Pa)	Vapor pressure (Pa)	Dry Air Pressure (Pa)	Density (kg/m^3)	Pressure Altitude (ft)	Standard Temp @ alt (°C)	Change in Temp (°C)	Density Altitude (ft)
Fort Worth	299.82	101325	99243.6	2430.2	96813.4	1.1584	650	13.7	12.97	2206.4
Flagstaff	289.82	103224.4	79680.6	595.5	79085.1	0.96002	6390	2.22	14.45	8124

Testing Summary

Ryan

Experiment/ Test	Relevant DRs	Testing Equipment	Other Resources
EXP1- TakeOff Test	CR1- Safely Taxi ER1- Weight Limit ER2- Thrust to Weight Ratio ER4- Takeoff Distance ER8- Wingspan	Cones, Measuring Tape, StopWatch, Camera	Access to RC Field, Low wind speeds
EXP2- Landing Test	CR1- Safely Taxi ER5- Landing Distance	Cones, Measuring Tape, Camera	Access to RC Field, Low wind speeds
EXP3- Static Thrust Test	ER2- Thrust to Weight Ratio ER3- Combined Power ER4- Takeoff Distance	Dynomometer, motor, propellor, battery, remote, voltometer	Lab/Outdoor Space
EXP4- Payload Test	CR2- Carry Payload ER6- Payload Release ER7- Payload Capacity	Measuring Device, Stopwatch, Water, Bucket	
EXP5- Controls Test	CR1- Safely Taxi CR4- Stable Flight ER4- Tekeoff Distance ER5- Landing Distance	Servos, Remote, Battery	
EXP6 - Flight Stability Test	CR4 - Stable Flight ER2 - Thrust to Weight Ratio ER3 - Combined Power ER8 - Wingspan	Final Assembly	Access to RC Field, Low wind speeds
EXP7- High Wind Test	CR3 - Fixed Wing Design CR4 - Stable Flight ER8 - Wingspan	Final Assembly	Access to RC Field, High wind speeds
EXP8 – Tolerance Check	ER9- Total Length ER10- Total Height ER11- CG Distance	Final Assembly, measuring tape	

Testing Procedure

Ryan

Experiment/ Test	Testing Procedure	Questions Being Answered
EXP1- TakeOff Test	1. Setup cones 10ft apart 2. Record Video 3. Takeoff 4. Review Video	1. Is our takeoff distance acceptable for competition requirements?
EXP2- Landing Test	Same as EXP1	1. Can we successfully land?
EXP3- Static Thrust Test	1. Secure motor/prop to dynamometer 2. Plug in all electrical 3. Turn on dynamometer 4. Full engine run up	1. Do we have a sufficient set-up to achieve sufficient thrust?
EXP4- Payload Test	1. Fill up bladder with 67 fl oz 2. Start Timer 3. Remove bladder bolts and drain bladder	1. Do we have the capability of carrying a payload?
EXP5- Controls Test	1. Plug in all servos and electronics 2. Turn on transmitter 3. Check all controls	1. Can we effectively actuate components?
EXP6 - Flight Stability Test	1. Fly 2. Observe	1. Do we have stable, effective flight?
EXP7- High Wind Test	1. Fly in high winds 2. Observe	1. Can the plane remain stable at high wind speeds?
EXP8 – Tolerance Check	1. Measure all vital dimensions	1. Can we remain in spec (1">)

Testing Results

Ryan

Engineering Requirements		Competition Target	Team Target	Tolerance	Measured Value	ER Met?	Client Acceptable?
ER1	Weight Limit	<55lbs	<10 lbs	0	6.5 lb	Yes	Yes
ER2	Static Thrust to Weight Ratio	>0.23		0	0.615	Yes	Yes
ER3	Combined Power	≤ 450 W		0	432.66 W	Yes	Yes
ER4	Takeoff Distance	<100ft	<25ft	0	>25 ft	Yes	Yes
ER5	Landing Distance	<200ft		0	50-60 ft	Yes	Yes
ER6	Payload Release	<60s		0	~43s	Yes	Yes
ER7	Payload Capacity	67 fl oz	≥ 67 fl oz	0	71.9 fl oz	Yes	Yes
ER8	Wingspan	N/A	51 in	± 0.125 in	51.0625 in	Yes	Yes
ER9	Total Length	N/A	48.64 in	± 0.0625 in	48.625 in	Yes	Yes
ER10	Total Height	N/A	13.78 in	± 0.1875 in	13.625 in	Yes	Yes

Testing Results- Payload Release

Carlo

Results

- Fully unloaded in 43 seconds, capable of carrying 71.93 fl oz > competition requirement of 67 fluid oz

Trey

Testing Results- Taxi

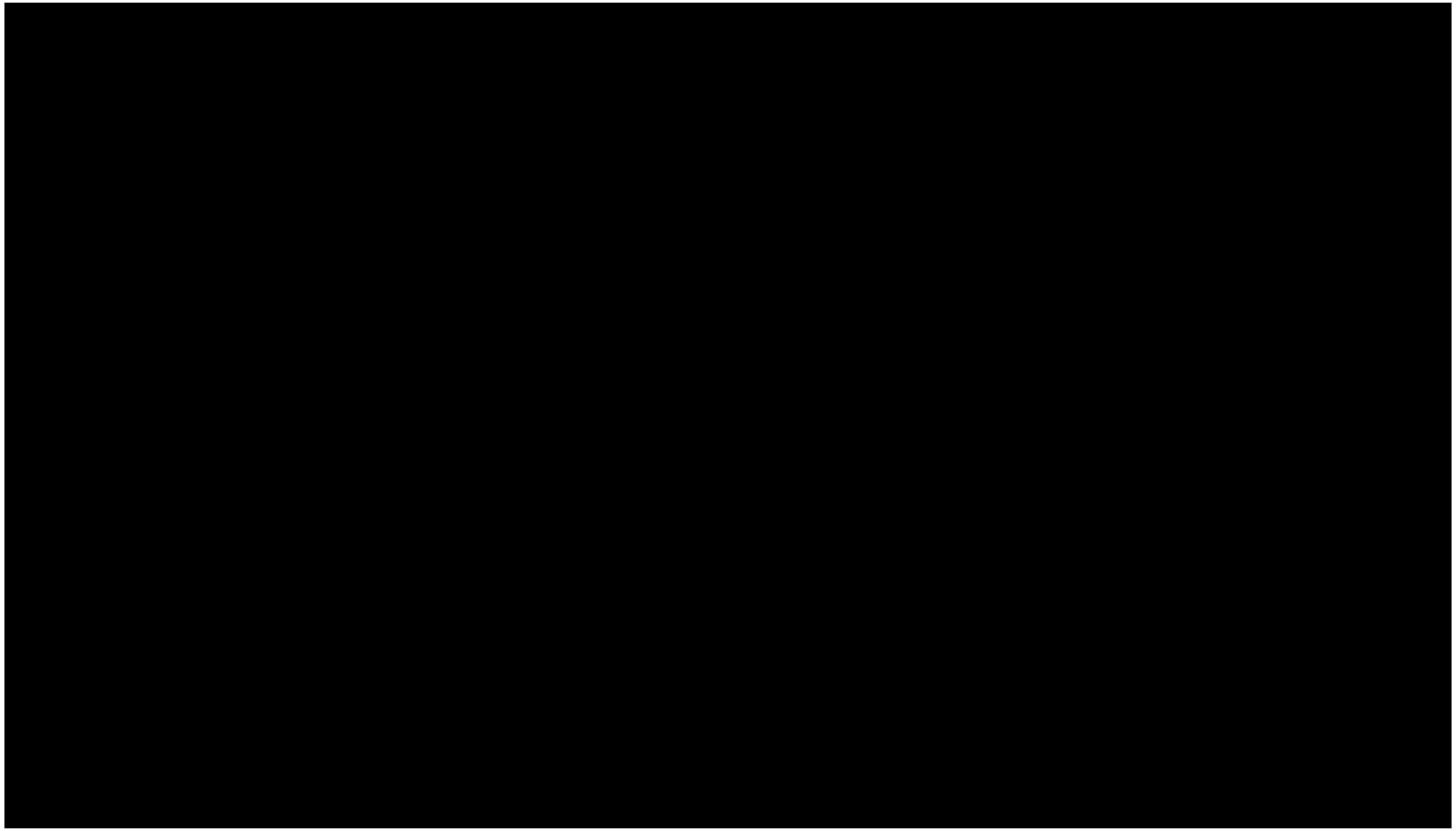
Results

Aircraft is successfully able to taxi on the ground.

Trey

Testing Results- Takeoff, Flight, Landing

Results



Competition Takeaways

Luke

Competition Results:

- First time an NAU team has successfully completed a full flight in the last 9 years.
  - Achieved a flight score of 6.1739
    - Lower end due to long wingspan, heavier design, and flight without payload.

Project Revisions:

- Flaps
- Drooped Tips or End Plates
- Delta wing design
- More light weight
- Design around bladder

Future Work:

- Create a document of useful tips for next year's team
- Hand-off plane to the college for display and for future teams to reference

References

[1] SAE, *2026 Collegiate Design Series SAE Aero Design Rules,* SAE, 2026.

[2] MATLAB, "Aircraft Design Optimization with Fixed Wing Object," MATLAB, 2025. [Online]. Available: https://www.mathworks.com/help/aerotbx/ug/aircraft-design-optimization-with-the-fixed-wing-object.html. [Accessed 16 October 2025].

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Thank You!