



# SAE Aero #04 Midpoint Presentation

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# Intro/Project Problem

- Redesign previous team's plane
- Meet all SAE Aero Designations
  - Design plane according to Flight Score Formula
  - Follow given runway loop with payload



Figure 2: Ponderosa Pilots' Final Plane [2]

$$FS = \text{Flight Score} = 120 * \frac{3 * S + W_{\text{payload}}}{b + L_{\text{cargo}}}$$

Figure 1: Flight Score Formula [1]

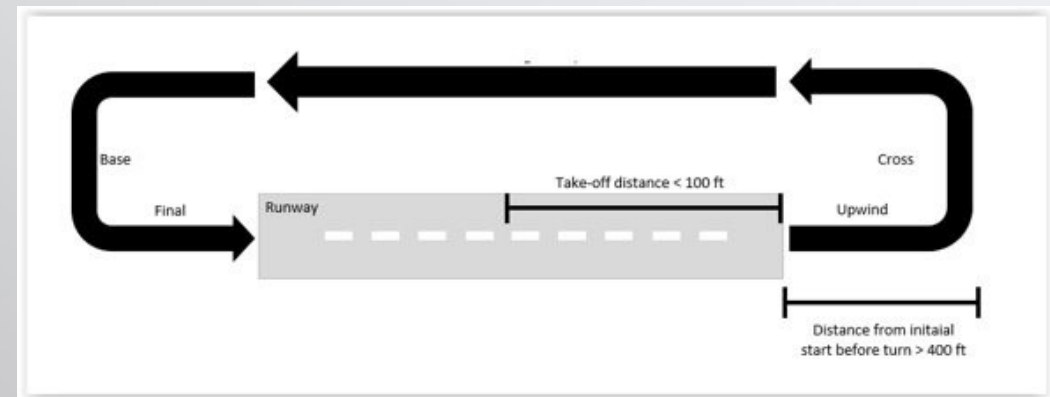


Figure 3: SAE Flight Loop [1]

# Project Requirements

- SAE Rule Requirements
  - 120 inch wingspan maximum
  - 6 Cell (22.5 Volt) 3000 mAh battery minimum
  - 1000W power limiter
  - Cargo bay carrying standard size 5 soccer ball
  - 1:1 Prop to motor gear ratios
  - Weigh 55 pounds or less

# Design Solution

- Pusher Propeller
  - Master Airscrew 16x10 three blade propeller
- Airfoil
  - Althaus' Low Reynolds Number Airfoil
  - Althaus AH 7-47-6
- Wingspan
  - 60 inches
- Length
  - 78 inches

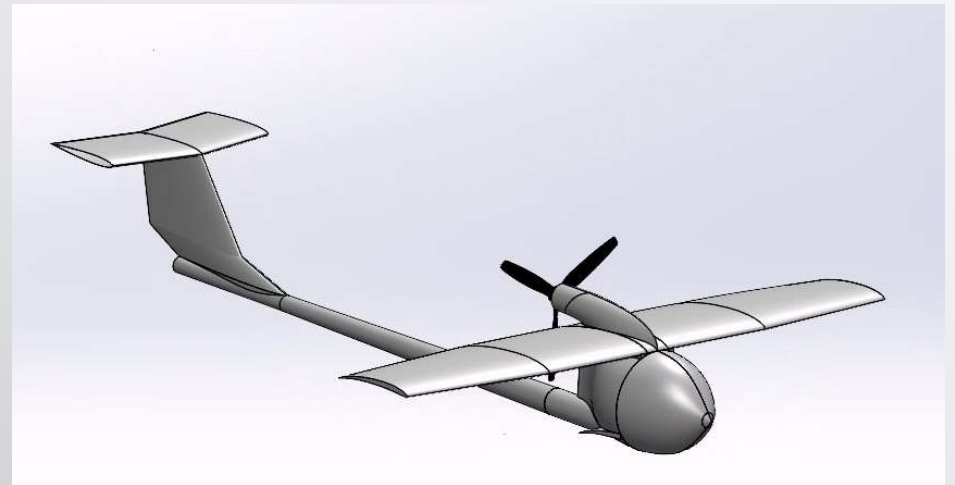


Figure 4: Finalized Product Design

# Design Process

- Airfoil analysis
- Change in propeller location
- Fiberglass instead of balsa wood
- Enlarge propeller

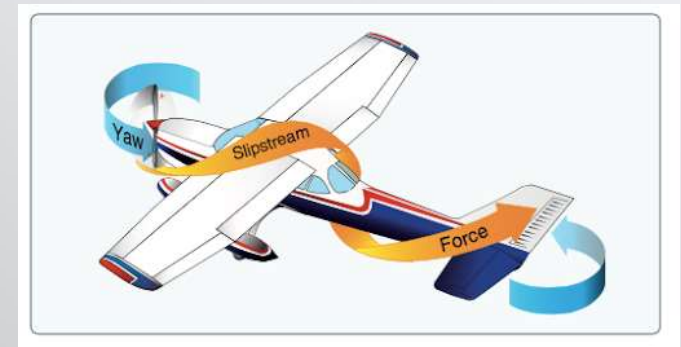
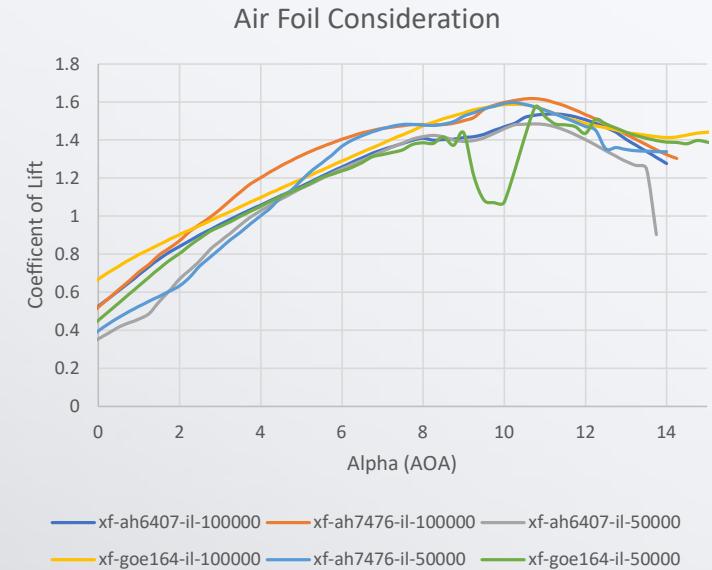


Figure 5: Slipstream Visualization

# Model analysis

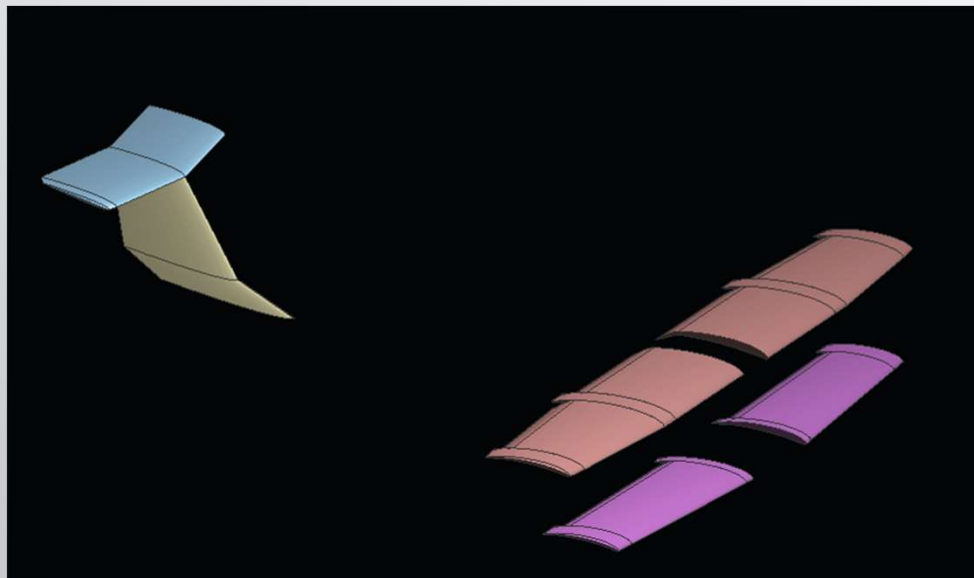


Figure 5: XFLR5 model

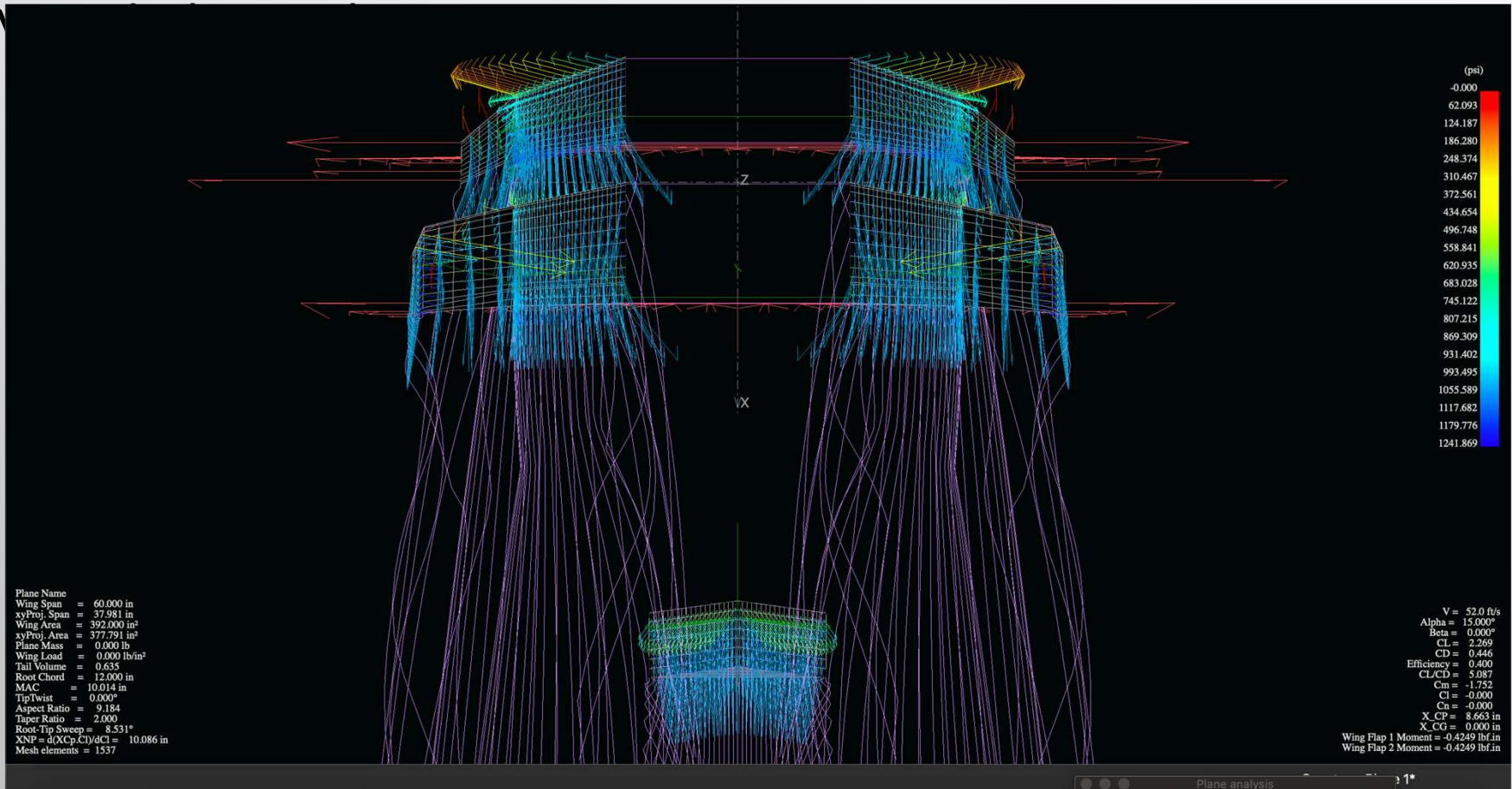


Figure 5: XFLR5 visualization



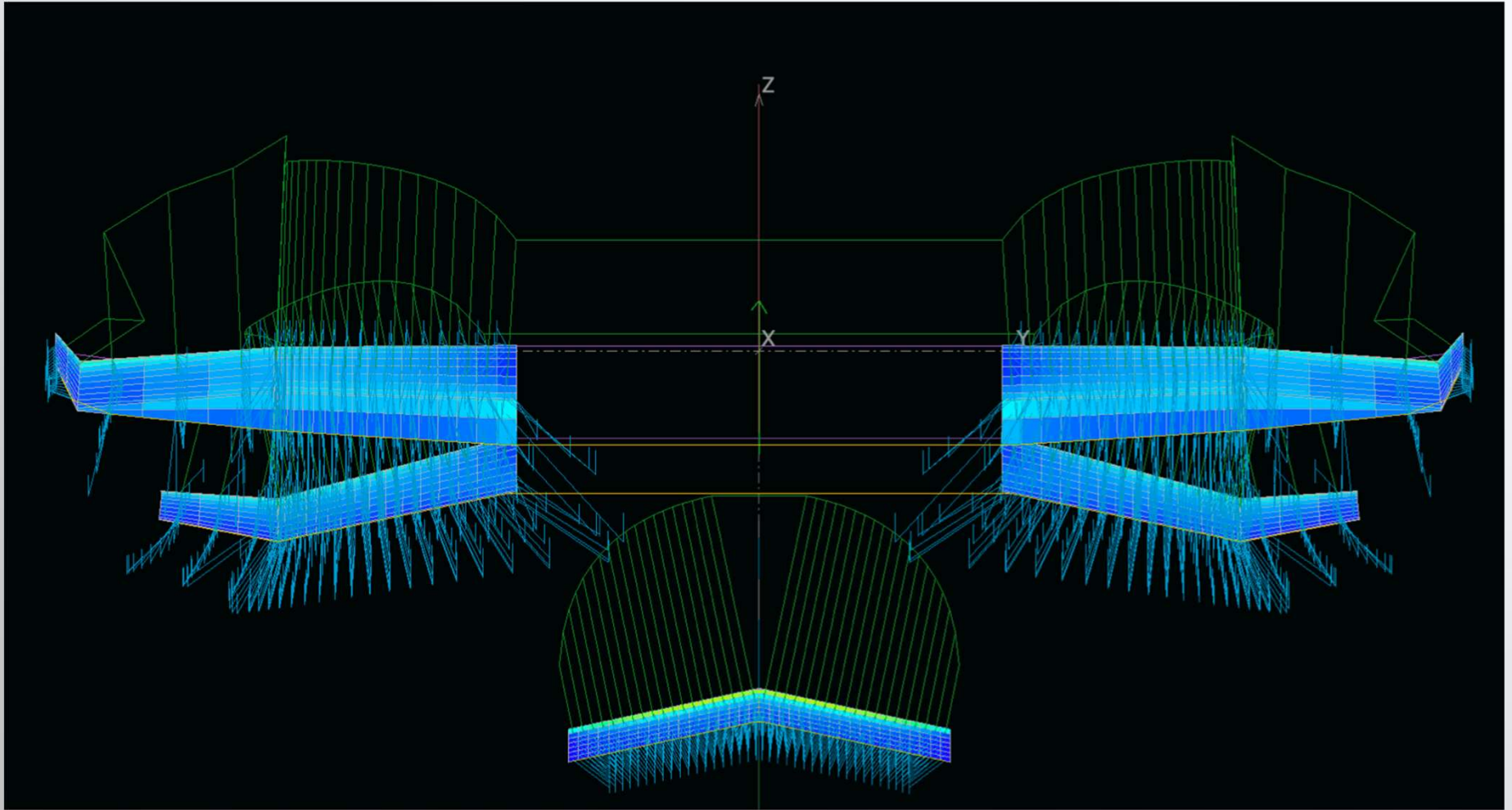


Figure 5: Forces acting on the airframe at maximum a.o.a



# Manufacturing



Figure 6: Product being assembled



Figure 7: Cut parts

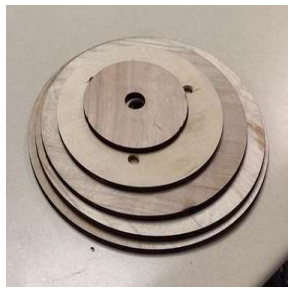


Figure 9: Laser cut parts

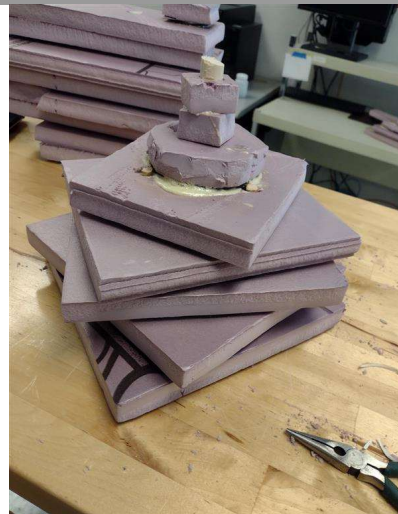


Figure 8: Glued up puck

- Start with cut out plywood
- Cut foam to dimension of the plywood
- Laminate the foam and plywood together to create a plug
- Finish the plug to a smoother surface finish in preparation for fiberglass

# Manufacturing Continued

- Once plugs were made, they are fiber glassed in preparation for making the parts.



# Budget

Table 1: Full Budget Breakdown

Vendor Name	Description of Item	Item or Catalog #	Size/Color	Quantity	Discount Code	Cost	Tax	Shipping	Total Cost			
Horizon Hobby	<a href="https://www.horizonhobby.com/p/SPMAR620">https://www.horizonhobby.com/p/SPMAR620</a>	SPMAR620	n/a	1		\$ 49.99	\$ -	\$ -	\$ 49.99	Order 1	Received	Actual Value
Horizon Hobby	<a href="https://www.horizonhobby.com/p/SPMX32006530C">https://www.horizonhobby.com/p/SPMX32006530C</a>	SPMX32006530C	n/a	1		\$ 84.99	\$ -	\$ -	\$ 84.99	\$ 409.45		\$ 437.73
Horizon Hobby	<a href="https://www.horizonhobby.com/p/HRC57417">https://www.horizonhobby.com/p/HRC57417</a>	HRC57417	n/a	1		\$ 15.97	\$ -	\$ -	\$ 15.97			
Horizon Hobby	<a href="https://www.horizonhobby.com/p/SPMXC1080">https://www.horizonhobby.com/p/SPMXC1080</a>	SPMXC1080	n/a	1		\$ 99.99	\$ -	\$ -	\$ 99.99			
Horizon Hobby	<a href="https://www.horizonhobby.com/p/EFLM4060B">https://www.horizonhobby.com/p/EFLM4060B</a>	EFLM4060B	n/a	1		\$ 126.99	\$ -	\$ -	\$ 126.99			
Amazon	<a href="https://www.amazon.com/Champion-5p">https://www.amazon.com/Champion-5p</a>		Size 5	1		\$ 12.00	\$ -	\$ -	\$ 12.00			
Amazon	<a href="https://www.amazon.com/dp/B07PK2V">https://www.amazon.com/dp/B07PK2V</a>		n/a	1		\$ 10.99	\$ 2.54	\$ 5.99	\$ 19.52			
FibreGlast	<a href="https://www.fibreglast.com/p/241">https://www.fibreglast.com/p/241</a>	241	yards	25		\$ 5.75			\$ 143.75	Order 2	Received	
FibreGlast	<a href="https://www.fibreglast.com/p/9069-A">https://www.fibreglast.com/p/9069-A</a>	9069-A	Gallons	1		\$ 83.95			\$ 83.95	\$ 358.46		\$ 358.46
FibreGlast	<a href="https://www.fibreglast.com/p/582-C">https://www.fibreglast.com/p/582-C</a>	582-C	5 yards	1		\$ 59.95	\$ 20.86	\$ 49.95	\$ 130.76			
Horizon Hobby	<a href="https://www.horizonhobby.com/p/MAS1610TP">https://www.horizonhobby.com/p/MAS1610TP</a>	MAS1610TP	n/a	2		\$ 18.98	\$ -	\$ 3.99	\$ 41.95	Order 3	Received	
Amazon	<a href="https://www.amazon.com/0-047x10-24">https://www.amazon.com/0-047x10-24</a>		n/a	1		\$ 10.38	\$ 1.43	\$ 5.99	\$ 17.80	\$ 135.76		
Adafruit	<a href="https://www.adafruit.com/p/169">https://www.adafruit.com/p/169</a>	169	n/a	9		\$ 5.95	\$ 4.33	\$ 18.13	\$ 76.01			
McMaster-Carr	<a href="https://www.mcmaster.com/p/9314A831">https://www.mcmaster.com/p/9314A831</a>	9314A831	25	1		\$ 8.94	\$ -	\$ -	\$ 8.94			
McMaster-Carr	<a href="https://www.mcmaster.com/p/93181A411">https://www.mcmaster.com/p/93181A411</a>	93181A411	100	1		\$ 4.50	\$ 1.40	\$ 9.72	\$ 15.62			
Reimbursements												
Home Depot	<a href="https://www.homedepot.com/p/Owens-Corning-FC">https://www.homedepot.com/p/Owens-Corning-FC</a>			2		\$ 25.06			\$ 50.12	Home Depot 1	Approved	
Home Depot	<a href="https://www.homedepot.com/p/HDX-Plastic-Sprea">https://www.homedepot.com/p/HDX-Plastic-Sprea</a>			2		\$ 4.27			\$ 8.54	\$ 252.40		\$ 252.40
Home Depot	<a href="https://www.homedepot.com/p/Rust-Oleum-Auton">https://www.homedepot.com/p/Rust-Oleum-Auton</a>			2		\$ 5.28			\$ 10.56			
Home Depot	<a href="https://www.homedepot.com/p/3M-Pro-Grade-Pre">https://www.homedepot.com/p/3M-Pro-Grade-Pre</a>			1		\$ 12.97			\$ 12.97			
Home Depot	<a href="https://www.homedepot.com/p/3M-Pro-Grade-Pre">https://www.homedepot.com/p/3M-Pro-Grade-Pre</a>			1		\$ 12.97			\$ 12.97			
Home Depot	<a href="https://www.homedepot.com/p/3M-Pro-Grade-Pre">https://www.homedepot.com/p/3M-Pro-Grade-Pre</a>			2		\$ 4.97			\$ 9.94			
Home Depot	<a href="https://www.homedepot.com/p/3M-Imperial-Wete">https://www.homedepot.com/p/3M-Imperial-Wete</a>			3		\$ 6.97			\$ 20.91			
Home Depot	<a href="https://www.homedepot.com/p/3M-3-2-3-in-x-9-in">https://www.homedepot.com/p/3M-3-2-3-in-x-9-in</a>			3		\$ 6.97			\$ 20.91			
Home Depot	<a href="https://www.homedepot.com/p/Stanley-15-3-4-in-x-3">https://www.homedepot.com/p/Stanley-15-3-4-in-x-3</a>			2		\$ 7.75			\$ 15.50			
Home Depot	<a href="https://www.homedepot.com/p/HUSKY-10-ft-x-25-ft">https://www.homedepot.com/p/HUSKY-10-ft-x-25-ft</a>			1		\$ 31.98			\$ 31.98			
Home Depot	<a href="https://www.homedepot.com/p/1-5-in-x-4-ft-x-8-ft">https://www.homedepot.com/p/1-5-in-x-4-ft-x-8-ft</a>			1		\$ 24.88			\$ 24.88			
Home Depot	<a href="https://www.homedepot.com/p/SC-Johnson-1-lb-F">https://www.homedepot.com/p/SC-Johnson-1-lb-F</a>			1		\$ 6.47			\$ 6.47			
Home Depot	<a href="https://www.homedepot.com/p/Gorilla-8-oz-Origin">https://www.homedepot.com/p/Gorilla-8-oz-Origin</a>			1		\$ 10.97	\$ 15.68		\$ 26.65			
Amazon	<a href="https://www.amazon.com/5pack-Battery-2-1mm-A">https://www.amazon.com/5pack-Battery-2-1mm-A</a>			1		\$ 5.99	\$ 0.62		\$ 6.61	Amazon	Approved	
Amazon	<a href="https://www.amazon.com/Pressure-Transducer-0-5">https://www.amazon.com/Pressure-Transducer-0-5</a>			3		\$ 24.92			\$ 74.76	\$ 102.10		\$ 102.10
Amazon	<a href="https://www.amazon.com/Readytosky-Ardupilot-Ar">https://www.amazon.com/Readytosky-Ardupilot-Ar</a>			1	2.24	\$ 13.99	\$ 8.98		\$ 22.97			
9 volts batteries				1		\$ 13.99			\$ 13.99	Home Depot 2	Approved	
3/4 dowel	<a href="https://www.homedepot.com/p/6412U-3-4-in-x-3-4">https://www.homedepot.com/p/6412U-3-4-in-x-3-4</a>			4		\$ 3.64			\$ 14.56	\$ 43.21		\$ 43.21
3/8 dowel	<a href="https://www.homedepot.com/p/Waddell-3-8-in-x-3">https://www.homedepot.com/p/Waddell-3-8-in-x-3</a>			4		\$ 1.93			\$ 7.72	Autozone 1	Approved	
Bondo	<a href="https://www.homedepot.com/p/3M-Bondo-1-gal-L">https://www.homedepot.com/p/3M-Bondo-1-gal-L</a>			1		\$ 16.47			\$ 16.47	\$ 38.20		\$ 38.20
3/8 dowel	<a href="https://www.homedepot.com/p/Waddell-3-8-in-x-3">https://www.homedepot.com/p/Waddell-3-8-in-x-3</a>			4		\$ 1.93			\$ 7.72	Home Depot 3	Approved	
Home Depot	<a href="https://www.homedepot.com/p/Gorilla-8-oz-Origin">https://www.homedepot.com/p/Gorilla-8-oz-Origin</a>			1		\$ 10.97	\$ 15.68		\$ 26.65	\$ 18.48		\$ 18.48
	SENSOR PRESSURE DIFF									Digikey 1	Approved	
	MICROSD CARD BREAKOUT 5V OR 3V									\$ 48.87		\$ 48.87

Table 2: Overall Budget

Purchases	Expected Cost	Actual Cost	Projected Budget	
Horizon hobby	\$ 419.88	\$ 458.43	\$ 1,500.00	original
Amazon	\$ 49.32	\$ 36.43	\$ 302.50	compensation for error
	\$ 660.96	\$ 640.10	\$ 1,802.50	
Adafruit	\$ 76.01	\$ 70.14		
Mcmaster Carr	\$ 24.56	\$ 23.12		
Reimbursement 1	\$ 401.16	\$ 401.16		
Reimbursement 2	\$ 102.10	\$ 102.10		
<b>Total</b>	<b>\$ 1,733.99</b>	<b>\$ 1,731.48</b>	<b>\$ 1,802.50</b>	
	<b>Difference</b>	<b>\$ 2.51</b>	<b>Remaining</b>	<b>\$ 71.02</b>

# Future Work

- Testing
  - “Hot taxi” - using the following “black box” the real air speed of the airplane will be analyzed
- Finalize electronics system on plane
- Finish assembling airplane



Figure 10: Aircraft Black Box

# Reference

- [1] SAE International, 2021 Collegiate Design Series SAE Aero Design Rules, SAE International, 2021.
- [2] J. Cong, C. Galus, A. Klausenstock, and N. Valenzuela, "Manufacturing," *Pictures*, 10-Apr-2020. [Online]. Available: [https://ceias.nau.edu/capstone/projects/ME/2019/19F12\\_SAEAeroRegular/Pictures.html](https://ceias.nau.edu/capstone/projects/ME/2019/19F12_SAEAeroRegular/Pictures.html). [Accessed: 19-Nov-2021].