SAE Aero #04 Midpoint Presentation

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Project Description

- SAE Aero Regular
  - Design a real-world aircraft to carry a payload
  - Payload soccer ball
- The Regular Class
  - Is an all-electric class intended to develop a fundamental understanding of aircraft design.
- Client Changed from Dr.Oman to Dr. Willy

Figure 1: SAE logo [1]

Function

- Aircraft is designed to take flight
- Complete the following course
- Carry payload

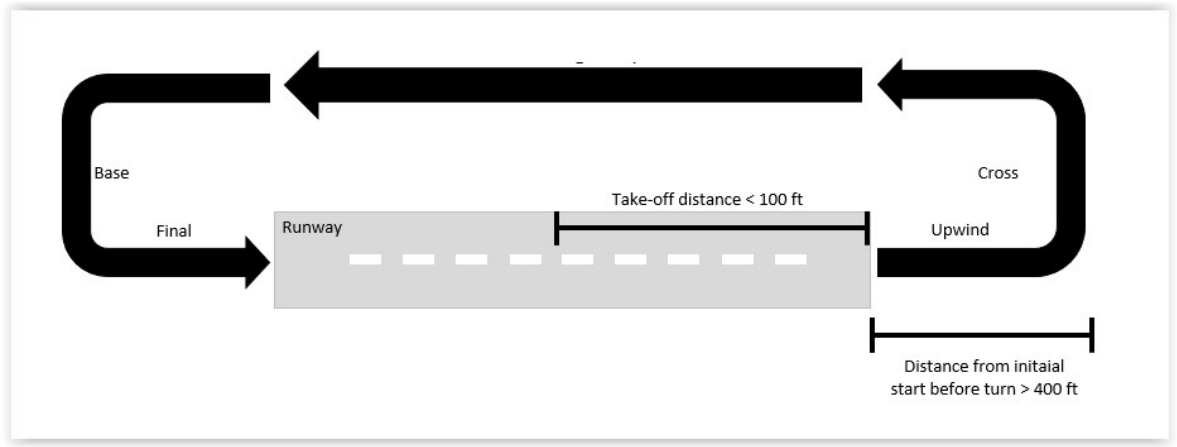

Figure 1: Flight path of aircraft

Iteration Process

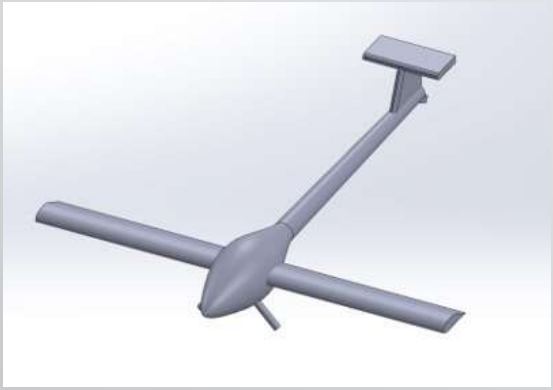

Figure 2: First CAD model

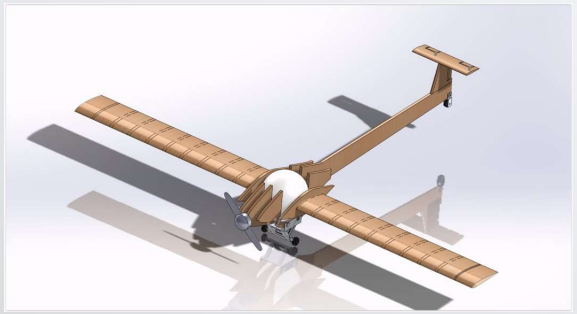

Figure 3: Second CAD model

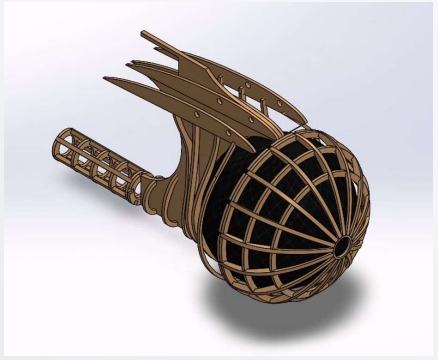

Figure 4: Third CAD model

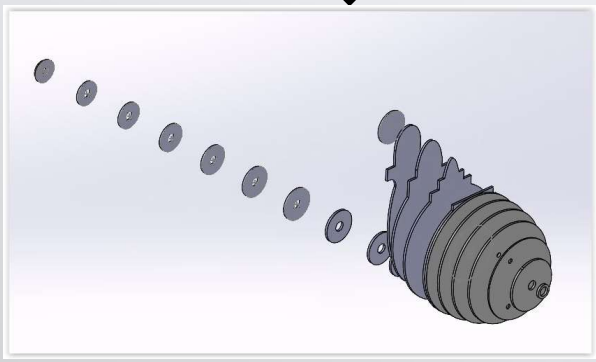

Figure 5: Fourth CAD model

- One thing that is interesting is how the plane has morphed over this project

?

Financials – Orders – More

Table 1: Purchased Products

Vendor Name	Item or Catalog #	Size/Color	Quantity	Cost	Tax	Shipping	Total Cost		
Horizon Hobby	SPMAR620	n/a	1	$49.99	$-	$-	$49.99	Order 1	Received
Horizon Hobby	SPMX32006S30C	n/a	1	$84.99	$-	$-	$84.99	$409.45	
Horizon Hobby	HRC57417	n/a	1	$15.97	$-	$-	$15.97		
Horizon Hobby	SPMXC1080	n/a	1	$99.99	$-	$-	$99.99		
Horizon Hobby	EFLM4060B	n/a	1	$126.99	$-	$-	$126.99		
Amazon		Size 5	1	$12.00	$-	$-	$12.00		
Amazon		n/a	1	$10.99	$2.54	$5.99	$19.52		
FibreGlast	241	yards	25	$5.75			$143.75	Order 2	Submitted
FibreGlast	90/69-A	Gallons	1	$83.95			$83.95	$358.46	
FibreGlast	582-C	5 yards	1	$59.95	$20.86	$49.95	$130.76		
Horizon Hobby	MAS1610TP	n/a	2	$18.98	$-	$3.99	$41.95	Order 3	
Amazon		n/a	1	$10.38	$1.43	$5.99	$17.80	$135.76	
Adafruit	169	n/a	9	$5.95	$4.33	$18.13	$76.01		
McMaster-Carr	9314A831	25	1	$8.94	$-	$-	$8.94		
McMaster-Carr	93181A411	100	1	$4.50	$1.40	$9.72	$15.62		
							$-		
						Subtotal	$928.23		

Still need to get purchased

Table 2: Products that need to be obtained

Home depot			$275.16
Foam sheets	2	$25.06	$50.1
Bondo	1	$16.47	$16.5
Spreaders	2	$4.27	$8.5
Primmer paint	2	$5.28	$10.6
120 grit	1	$12.97	$13.0
220 grit	1	$12.97	$13.0
400 grit	2	$4.97	$9.9
800 grit	3	$6.97	$20.9
1000 grit	3	$6.97	$20.9
Surform	2	$7.75	$15.5
6 mil plastic	1	$31.98	$32.0
Lauan	1	$24.88	$24.9
wax	1	$6.47	$6.5
tape	1	$21.97	$22.0
Glue	1	$10.97	$11.0

Consumables for building still need to be purchased

Remaining budget
$295

Current state of System

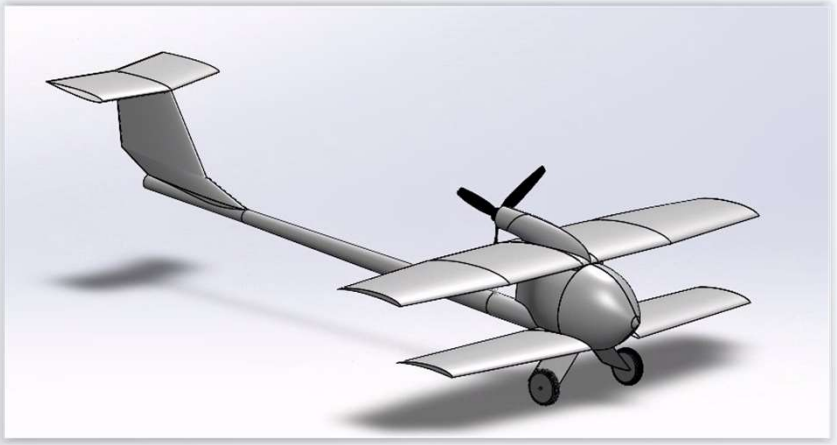

Figure 7: Current CAD model iso view [2]

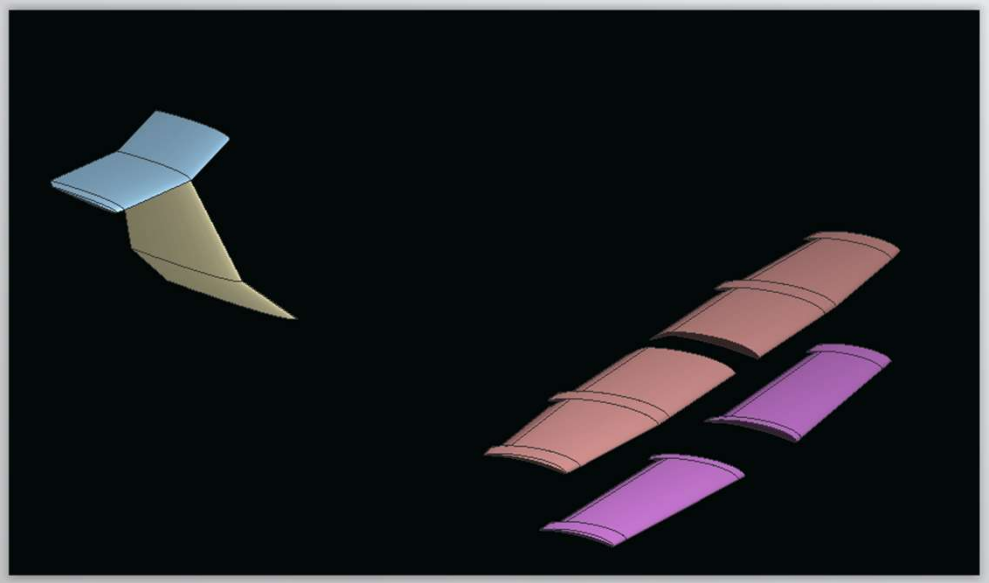

Figure 9: Current XFLR5 model

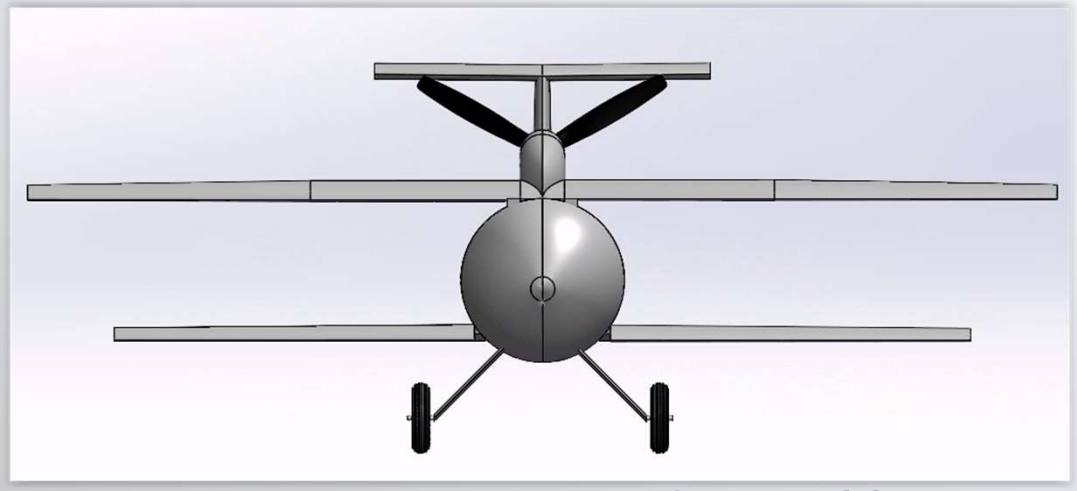

Figure 8: Current CAD model front view [2]

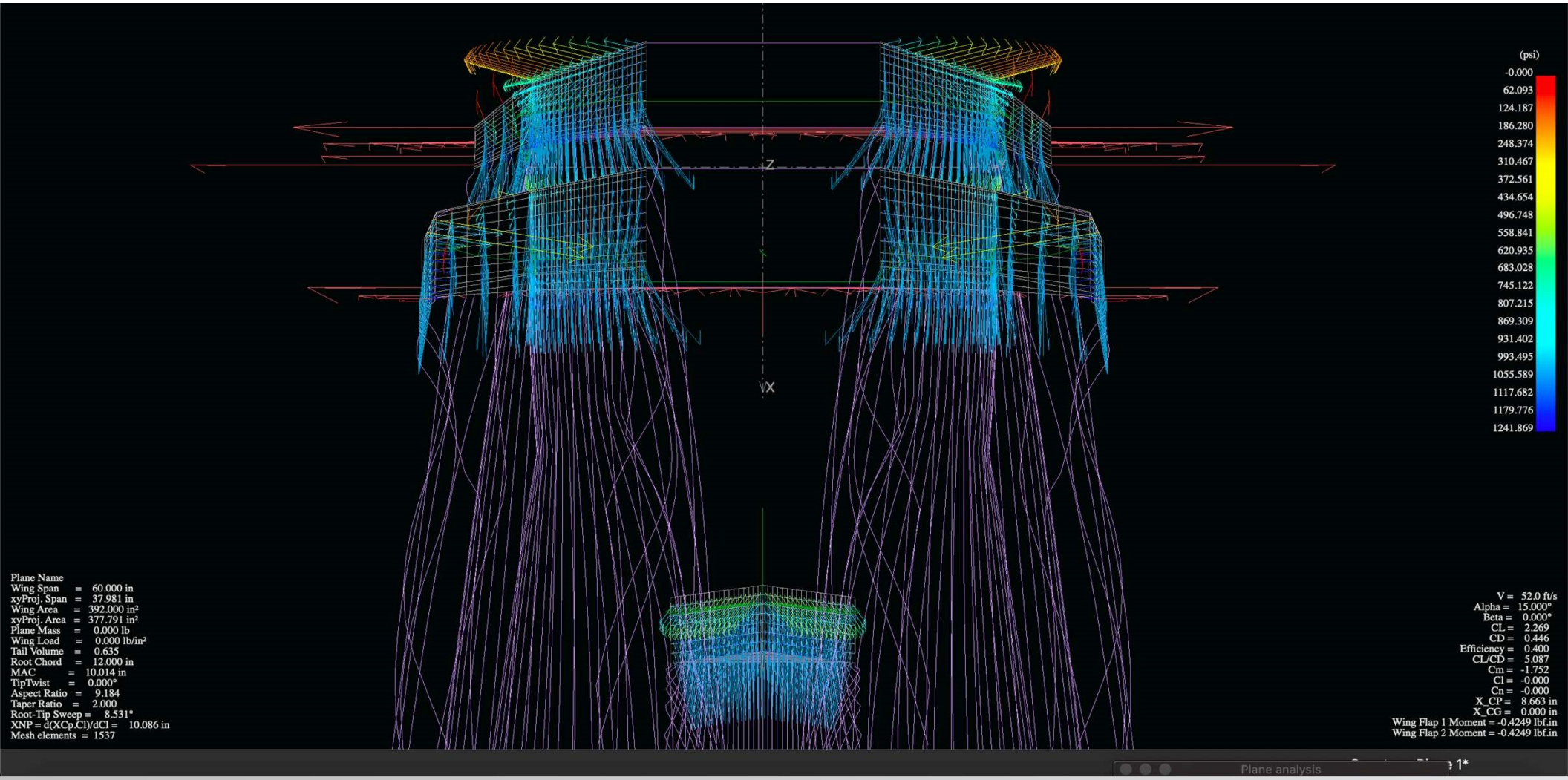

Figure 10: Downstream, F/s , Surface Velocities

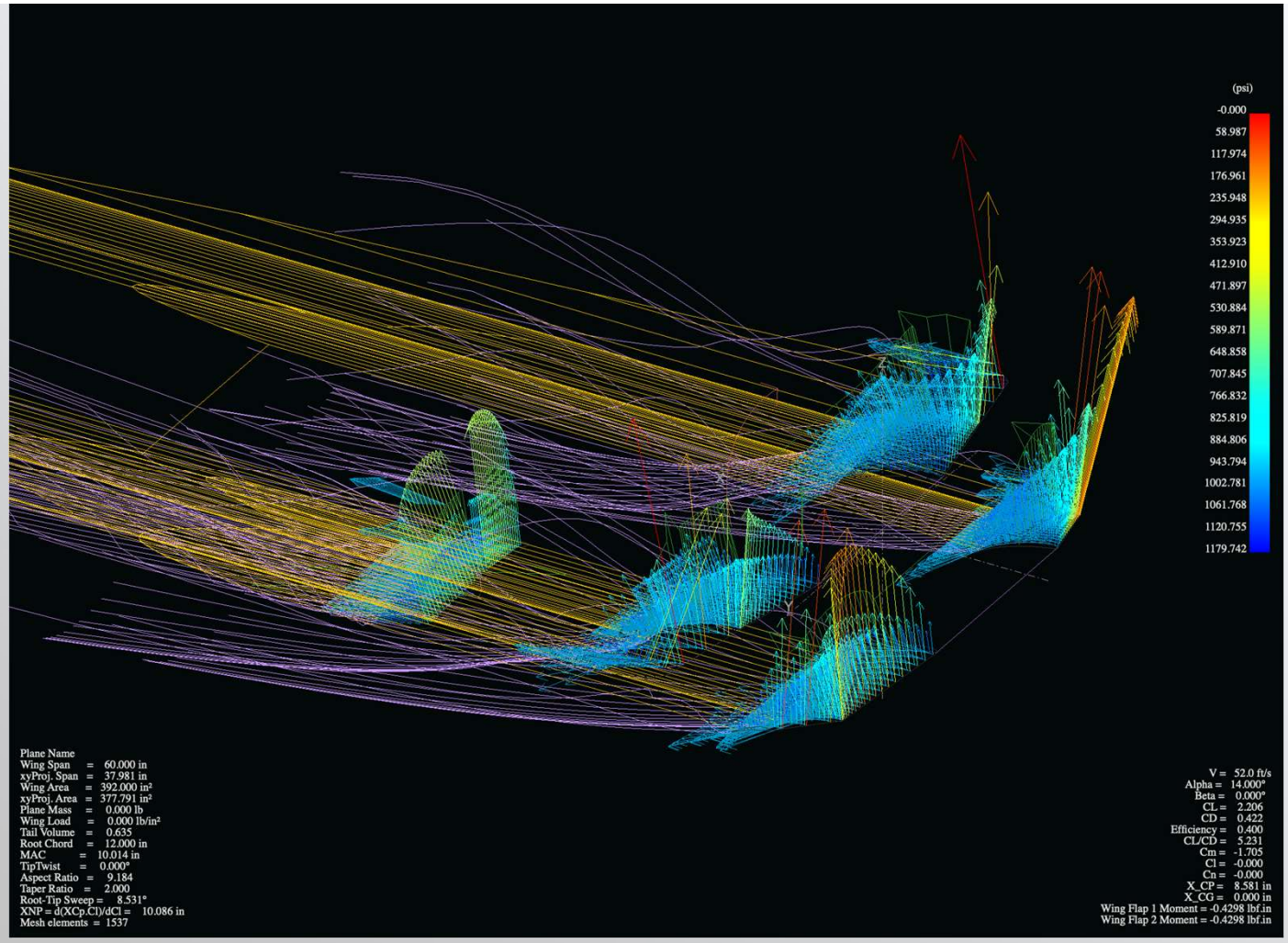

Figure 11: Alternate View

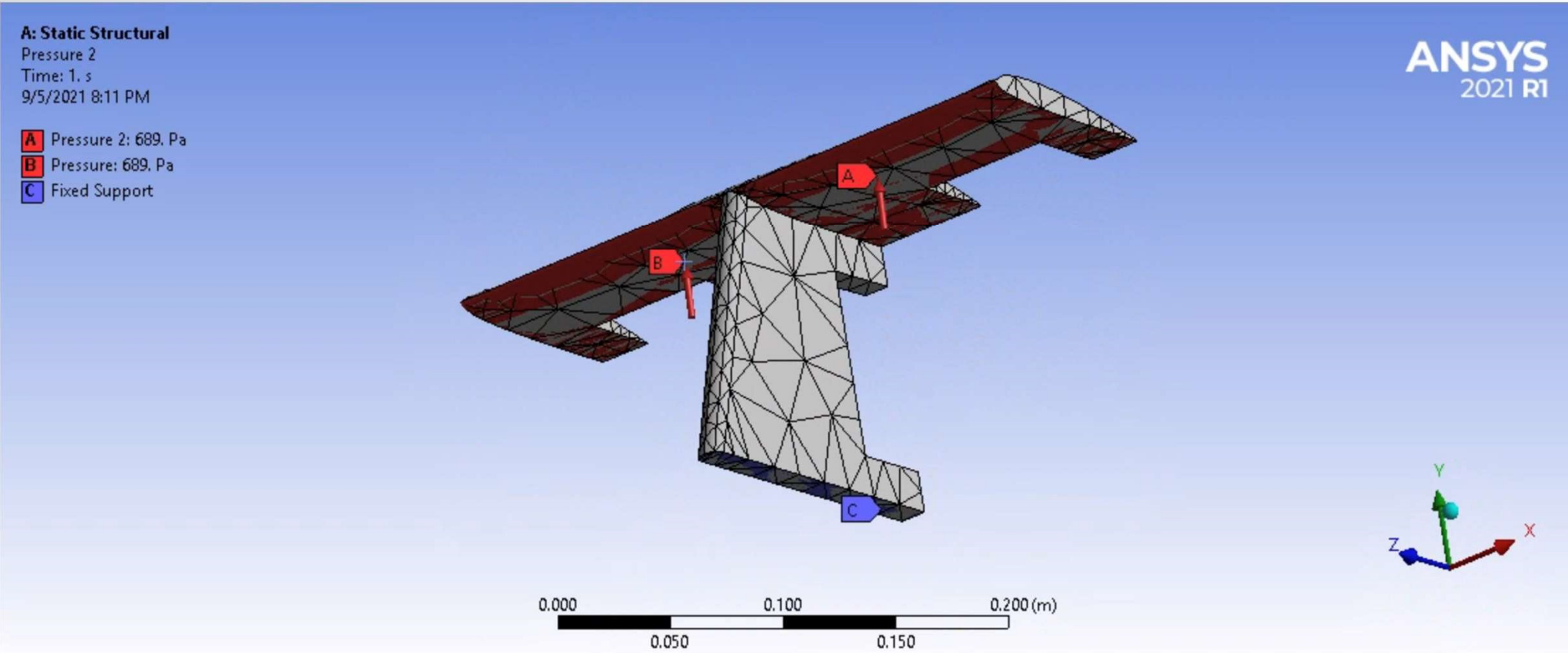

Figure 12: Working Static Structural (MAPDL-FEA) model on ANSYS 2021

Completed Action Items

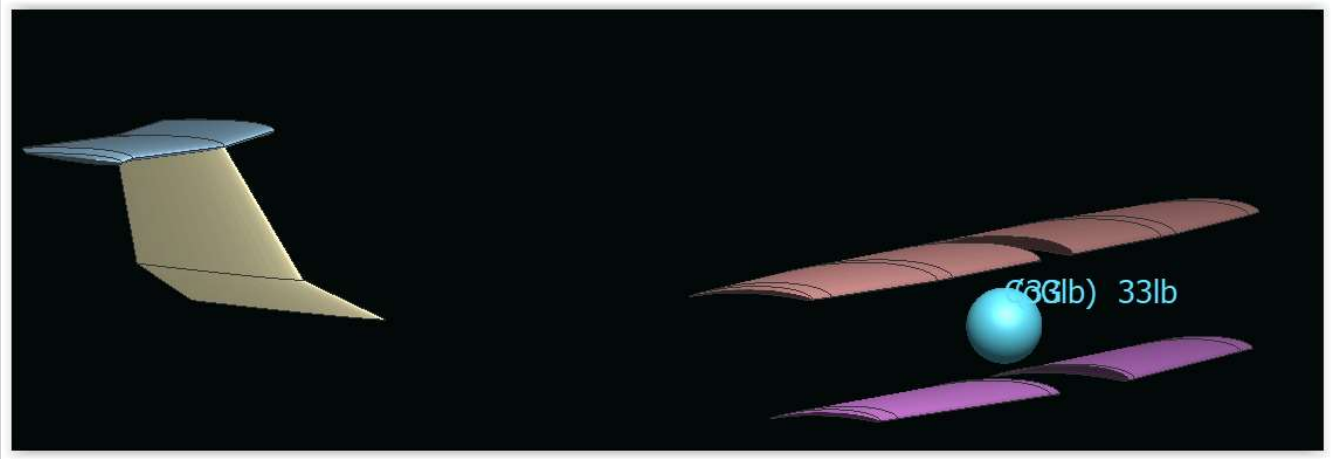

Figure 13: Current XFLR5 model with CG

- Aiden
  - Purchasing
  - CAD
- Ryan
  - CAD
  - XLFR5
  - Website
  - Calculation
- Gajaba
  - CAD
  - XLFR5
  - Engineering Analysis
- Dylan
  - Fabrication
  - Documentation

Implementation Plan

Due to limited time the current CAD will most likely be our final iteration

Future tasks – BUILD

- All hands on deck building
- Aiden – electronics
- Dylan & Ryan – mold – fiberglass layup
- Gajaba – continue analyzing fluid models

Figure 14: Lego man [3]

Manufacturing

Figure 16: Fiberglassed mold [4]

Figure 15: Plug mold [4]

- The team will use a plug mold approach
- Surface finish will be an issue with this method
- But with a little sanding and a gloss paint it should be good enough

Source - https://www.youtube.com/watch?v=EB3_7Zow2ec

Separate Parts

- Main wing
- Secondary wing
- Nose cone
- Fuselage
- Tail section
- Horizontal stabilizer
- Vertical stabilizer

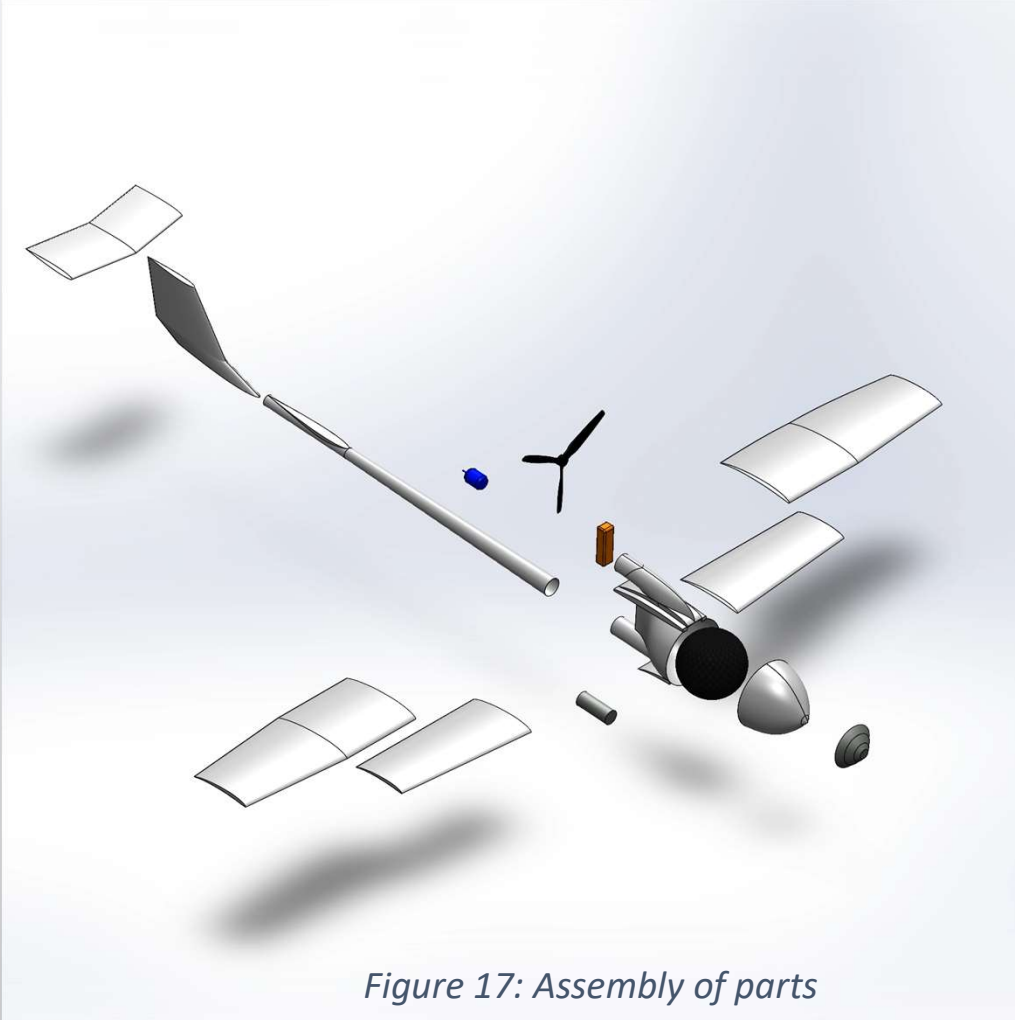

Figure 17: Assembly of parts

Engineering Requirements, WHYS

- Engineering requirements come form competition
- Because of this our score matters more then anything else except crashing

$$Flight\ Score = 120 * \frac{3 * S + W_{Payload}}{b + L_{Cargo}}$$

S = Number of Soccer balls

$W_{Payload} = Weighted\ Paylod\ (lbs)$

$L_{cargo} = Length\ of\ Cargo\ Bay\ (inches)$

b = Aircraft Wingspan (inches)

Table 3: Calculation for flight score

Mass of payload		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Wing Span	60	21.0	26.2	31.4	36.7	41.9	47.2	52.4	57.6	62.9	68.1	73.4	78.6	83.8	89.1	94.3	99.6	104.8	110.0	115.3	120.5

Engineering Requirements

Table 4: Engineering requirements yes or nos

Cargo bay carrying standard size 5 soccer ball	Yes, the ball fits
Weight < 55 lbs	Estimated 30 lbs
Drag < Lift	When it takes moves, we will know
Lift > weight	> 30 lbs
1:1 Prop to motor gear ratios	Yes, motor is direct drive
Power <1000 watts	Yes, due to the power limiter
Wingspan 120 inches	Current design 60 inches

Testing Plan

Table 5: Engineering requirements testing

Engineering Requirement	Testing procedure
Cargo bay carrying standard size 5 soccer ball	Put the ball in plane make sure it fits
Weight	High speed taxiing, lift off
Drag < Lift	Hard to test and isn't important for competition (not testing)
Lift > weight	Test the plane at different weights and take it off (hopefully, we don't crash and raise the weight limit)
1:1 Prop to motor gear ratios	N/A
Power <1000 watts	N/A
Wingspan 120 inches	N/A

Questions

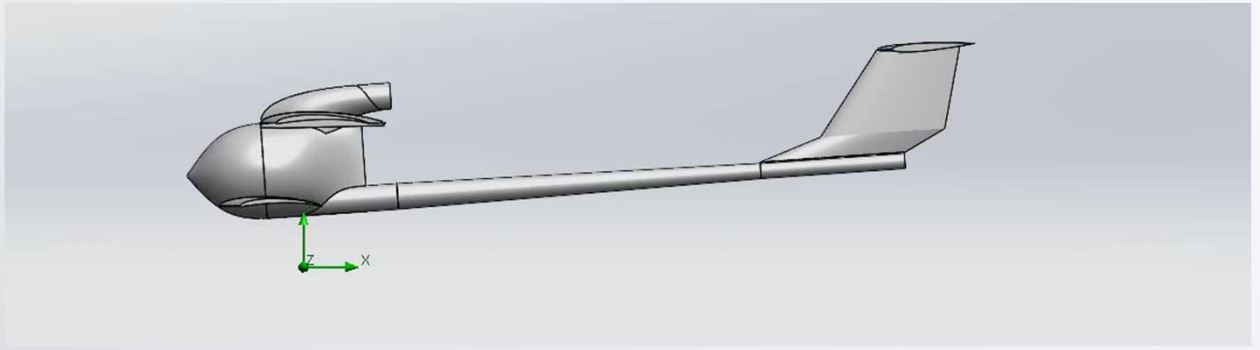

Figure 18: Pressure difference in the Z direction

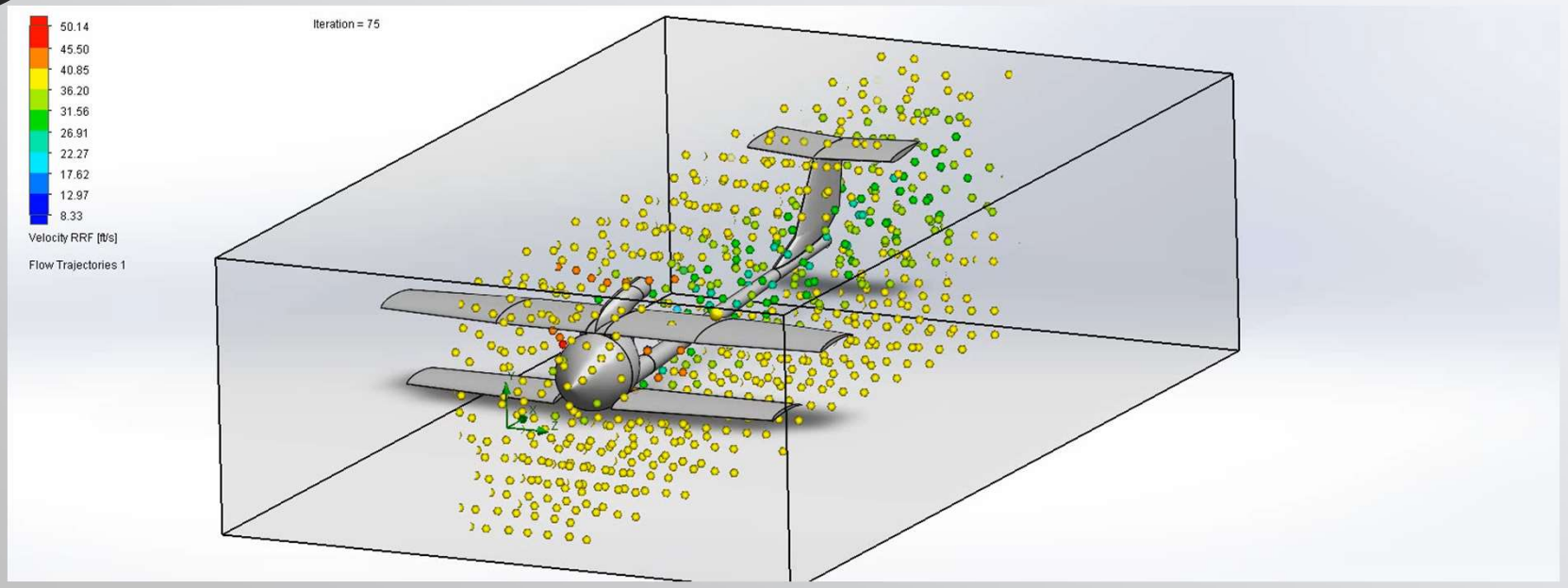

Figure 19: Velocity demonstration

Extra Information

- Main wing
- Secondary wing
- Nose cone
- Fuselage
- Tail section
- Horizontal stabilizer
- Vertical stabilizer

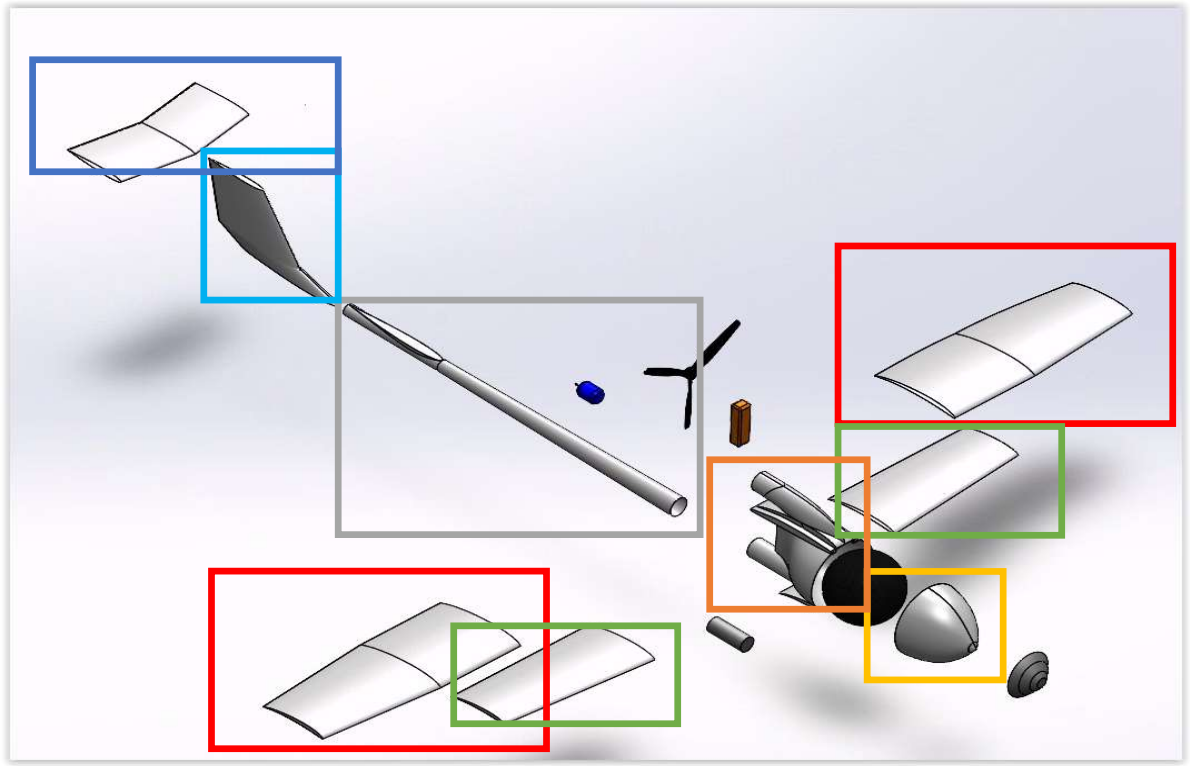

Figure 20: Graphicly showing the different part names

Plane numbers

- AOA = 11°
- Mass = 15.00
- Cl = 2.209
- Cd = 0.350
- Cl/Cd = 6.320
- Cm = -0.764
- AR = 5.720

- AOA = 11°
- Mass = 24.83
- Cl = 2.209
- Cd = 0.350
- Cl/Cd = 6.320
- Cm = -0.764
- AR = 5.720

- AOA = 11°
- Mass = 33.00
- Cl = 2.209
- Cd = 0.350
- Cl/Cd = 6.320
- Cm = -0.764
- AR = 5.720

Table 5: Flight score possibilities

Wingspan/payload mass	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Area	CL	LIFT
20																					138	0.94	3
22																					162	1.00	3
24																					186	1.06	4
26																					210	1.11	5
28	39.2																				234	1.17	6
30	37.2	46.5																			258	1.23	6
32	35.4	44.2																			282	1.28	7
34	33.7	42.2	50.6																		306	1.34	8
36	32.2	40.3	48.3	56.4																	330	1.39	9
38	30.8	38.5	46.3	54.0	61.7																354	1.45	10
40	29.6	37.0	44.4	51.7	59.1	66.5															378	1.51	12
42	28.4	35.5	42.6	49.7	56.8	63.9	71.0														402	1.56	13
44	27.3	34.2	41.0	47.8	54.6	61.5	68.3	75.1	82.0												426	1.62	14
46	26.3	32.9	39.5	46.1	52.7	59.2	65.8	72.4	79.0	85.6											450	1.67	15
48	25.4	31.7	38.1	44.4	50.8	57.1	63.5	69.8	76.2	82.5	88.9										474	1.73	17
50	24.5	30.7	36.8	42.9	49.1	55.2	61.3	67.5	73.6	79.7	85.9	92.0									498	1.79	18
52	23.7	29.7	35.6	41.5	47.4	53.4	59.3	65.2	71.2	77.1	83.0	89.0	94.9								522	1.84	19
54	23.0	28.7	34.4	40.2	45.9	51.7	57.4	63.2	68.9	74.6	80.4	86.1	91.9	97.6							546	1.90	21
56	22.3	27.8	33.4	38.9	44.5	50.1	55.6	61.2	66.8	72.3	77.9	83.5	89.0	94.6	100.2						570	1.96	23
58	21.6	27.0	32.4	37.8	43.2	48.6	54.0	59.4	64.8	70.2	75.6	81.0	86.4	91.8	97.2	102.5	107.9	113.3			594	2.01	24
60	21.0	26.2	31.4	36.7	41.9	47.2	52.4	57.6	62.9	68.1	73.4	78.6	83.8	89.1	94.3	99.6	104.8	110.0	115.3	120.5	618	2.07	26
62	20.4	25.5	30.6	35.6	40.7	45.8	50.9	56.0	61.1	66.2	71.3	76.4	81.5	86.6	91.7	96.7	101.8	106.9	112.0	117.1	642	2.12	28
64	19.8	24.8	29.7	34.7	39.6	44.6	49.5	54.5	59.4	64.4	69.3	74.3	79.2	84.2	89.1	94.1	99.0	104.0	108.9	113.9	666	2.18	29
66	19.3	24.1	28.9	33.7	38.6	43.4	48.2	53.0	57.8	62.7	67.5	72.3	77.1	81.9	86.7	91.6	96.4	101.2	106.0	110.8	690	2.24	31
68	18.8	23.5	28.2	32.9	37.5	42.2	46.9	51.6	56.3	61.0	65.7	70.4	75.1	79.8	84.5	89.2	93.9	98.6	103.3	108.0	714	2.29	33
70	18.3	22.9	27.4	32.0	36.6	41.2	45.7	50.3	54.9	59.5	64.0	68.6	73.2	77.8	82.3	86.9	91.5	96.1	100.6	105.2	738	2.35	35

Reference

[1] "SAE," Wikipidea, [Online]. Available: https://en.wikipedia.org/wiki/SAE_International. [Accessed 14 10 21].

[2] G. Gress, Artist, *Propeller 16x10in Master Airscrew 3-bladed.* [Art]. Grab Cad, 2014.

[3] Unknown, Artist, *https://m.media-amazon.com/images/I/618oKcmW2DL._AC_SS350_.jpg.* [Art].

[4] wilmracer, "RC Scratch Building - Fiberglass Fuselage Without a Mold / https://www.youtube.com/watch?v=EB3_7Zow2ec," Youtube, 2016.