Analysis Subteam

9/6-9/13

:D

Aero S&C

Jennah

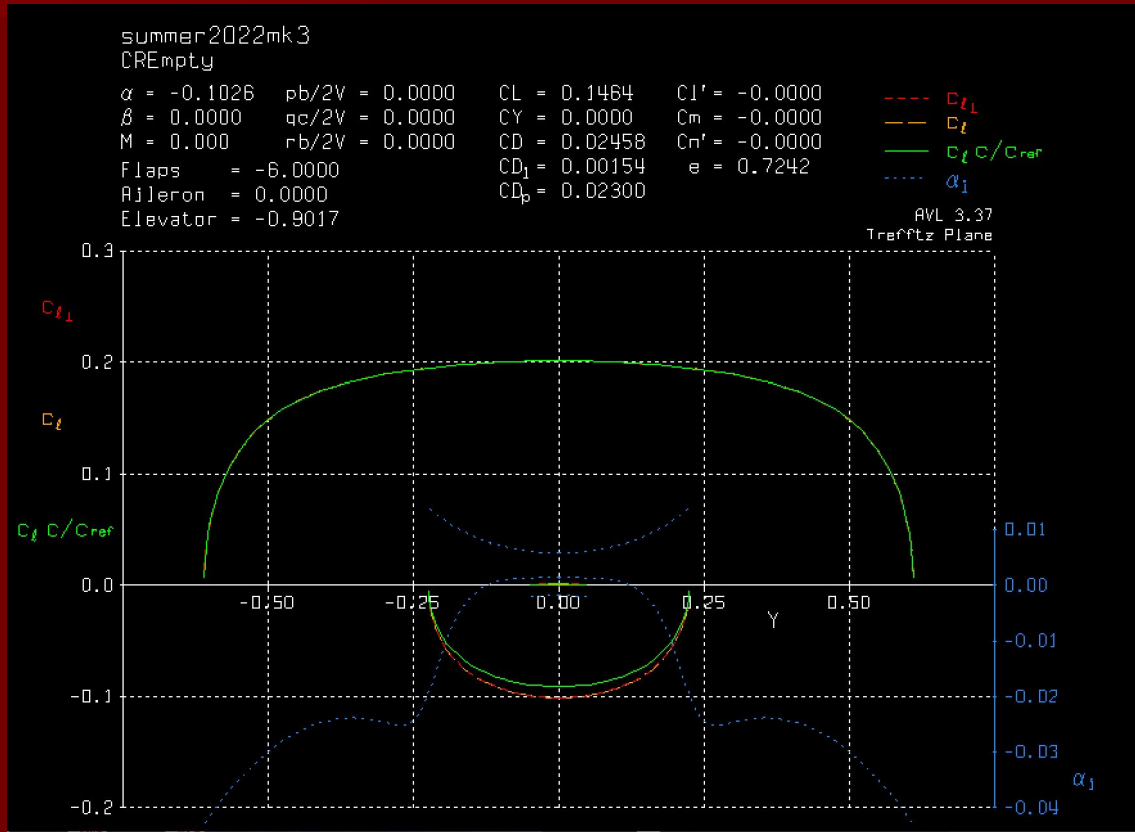
Aero Updates

- We were (I was) silly
- goe226 airfoil has a higher pitching moment coefficient -> requires a higher tail force for trim

Aero Updates

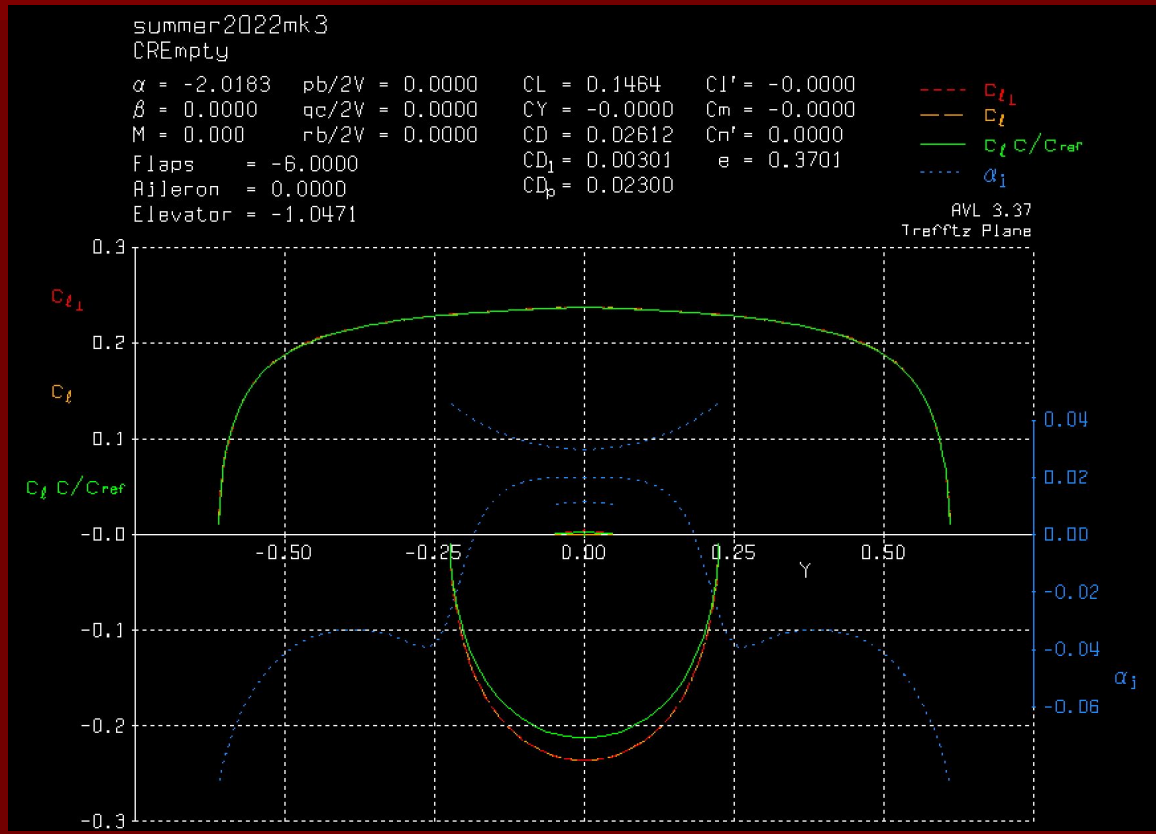
Aero Updates

- Trefftz plot of e422



Aero Updates

- Trefftz plot goe226



Next Steps

- Help build team get Summer Plane ready to fly
- Work on control surfaces Wednesday/Thursday
- Transmitter set up so we can fight some fires!

Performance

Jai

Overview

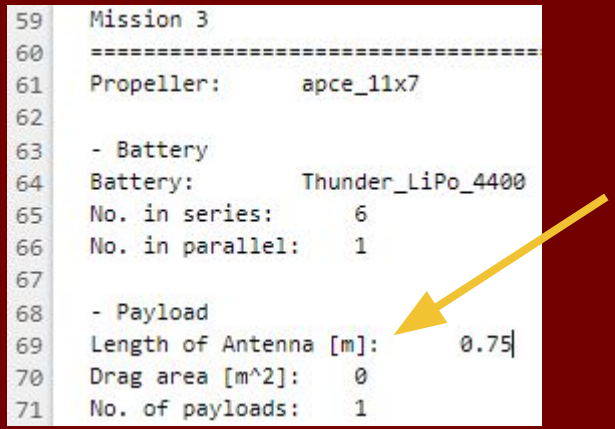
- Modifying PT to reflect DBF 2023
- Next steps for getting initial numbers & plots
- Mass Build-up “Mini Project”
  - Wiring (David)
  - Built-up Wing (Jai)

Modifying PT to reflect DBF 2023

- Created “2023” folder under Competitions
- Set mission parameters
  - M2: 10 min time limit
  - M3: 5 min time limit, 3 lap limit
- Updated lap simulation
  - Not taking off and landing each lap (2022)
  - Not changing mass halfway through course (2022S)

Modifying PT to reflect DBF 2023

- plane.txt previously took in a payload mass for M3, now the input is length of antenna
- How is that reflected in mass build-up?



Modifying PT to reflect DBF 2023

- ½ in. PVC → 0.16 lbs/ft → 0.238 kg/m
  - mPayloads = plane.lengthPayload3 * 0.238;
- More on mass build-up soon…

Size (in.)	Wall Thickness (in.)	Inner Diameter (in.)	Outer Diameter (in.)	Weight / Foot (lbs/ft.)	
				PVC	CPVC
1/2	0.109	0.622	0.840	0.16	N/A
3/4	0.113	0.824	1.050	0.21	N/A
1	0.133	1.049	1.315	0.32	N/A
1 1/4	0.140	1.380	1.660	0.43	N/A
1 1/2	0.145	1.610	1.900	0.51	N/A

Modifying PT to reflect DBF 2023

- Updated scoring equation

```
if missionNo == 2
    missionResults.score = plane.mPayload2 * nLaps;
elseif missionNo == 3
    missionResults.score = plane.lengthPayload3 / missionTime;
end

if TOFL > 60
    missionResults.score = 0;
end
```

Next steps for getting initial numbers

- Run Jack’s energyAnalysis script for ballpark estimate
- Input into PT and begin trades

Mass Build-up “Mini Project”

- Model built-up wing
  - Integrate spar sizer
  - Rib sizing/spacing functionality
- Wiring
- Servos
- ESCs
- Landing gear
- Payload (M2, M3)
- Packaging box weight

Gauges Weight Table.xlsx

	A	B
	GaugesWeightTable1	
	VarName1	VarName2
	Number	Number
1		
2	1	0.4070
3	2	0.3440
4	3	0.2870
5	4	0.2430
6	5	0.2030
7	6	0.1670
8	7	0.1400
9	8	0.1160
10	9	0.0937
11	10	0.0741
12	11	0.0608
13	12	0.0489
14	13	0.0383
15	14	0.0289
16	15	0.0234
17	16	0.0185
18	17	0.0142
19	18	0.0104
20	19	0.0072
21	20	0.0059
22	21	0.0046
23	22	0.0035
24	23	0.0026
25	24	0.0022
26	25	0.0018
27	26	0.0015
28	27	0.0012

Sheet1 Sheet2

Import variables and parameters

Imported Parameters

```
%IMPORT PARAMS FROM TXT FILE
%To be implemented, hard coded below

%Wing Span
b = 1.2;

%Tail-to-Nose Fuselage Distance
fuseTailNoseDist = 1.5;

%Motor Count
motorCount = 1;

%Motor Location, "n" or "w"
motorLoc = "n";

%If wing mount, percent of half span
if motorLoc == "w"
    motorHalfSpanPerc = 0.3;
end

%Motor Current
motorPeakCurrent = 200;
```

```
%ESC Count
escCount = 1;

%Flap Servos Half Span Percentage
flapServosHalfSpanPerc = 0.2;

%Ailerons Servos Half Span Percentage
ailerServosHalfSpanPerc = 0.4;
```

Import Gauge/Weight Table

```
GaugesWeightTable = readtable('Gauges Weight Table.xlsx');
```

Calculating Lengths

Calculating Gauges

```
%Gauges
%TO BE IMPLEMENTED, HARD CODED BELOW
motorWireGauge = 10;
servosWireGauge = 26;
escWireGauge = 10;
```

Creating Lengths Arrays

A length array holds every individual calculated length and has as the first element the gauge for those calculated lengths.

This is to facilitate the weight calculation later on, where one can simply add up values from xWireLen(2:end), look up the weight/length ratio for the specific gauge with xWireLen(1) and an external table, and then multiply that by the sum of lengths.

```
%Empty Lengths Arrays
motorWireLen = motorWireGauge;
servosWireLen = servosWireGauge;
escWireLen = escWireGauge;
```

Motor wiring (ESC-motor) calculations

```
%Motor
if motorLoc == "n" %Nose mount, assume 30% of fuse
    motorWireLen = [motorWireLen 3*(0.3*fuseTailNoseDist)];
    %multiply by three because three leads
    %assume 30%, talked to nick, need a little to allow CG adj.
elseif motorLoc == "w" %Wing mount
    motorWireLen = [motorWireLen 3*(motorCount*motorHalfSpanPerc*b/2)]
else
    error("Invalid motor location input")
end
```

Servos wiring (battery-servos) calculations

```
%Servos

%Tail and rudder
servosWireLen = [servosWireLen 3*(2*(0.5*fuseTailNoseDist))]
```

```
servosWireLen = 1×2
  26.000000000000000   4.500000000000000
```

```
%multiply by three because three leads

%Ailerons
servosWireLen = [servosWireLen 3*(2*(ailerServosHalfSpanPerc*b/2))]
```

```
servosWireLen = 1×3
  26.000000000000000   4.500000000000000   1.440000000000000
```

```
%Flaps
servosWireLen = [servosWireLen 3*(2*(flapServosHalfSpanPerc*b/2))]
```

```
servosWireLen = 1×4
  26.000000000000000   4.500000000000000   1.440000000000000   0.720000000000000
```

ESC wiring (battery-ESC) calculations

```
%Ask Nick about ESC gauges and rest

escWireLen = [escWireLen 2*(escCount*(0.07))]
```

```
escWireLen = 1×2
  10.000000000000000   0.140000000000000
```

```
%two leads, 7cm each lead
```

Weight Estimation

```
format long
motorWireWeight = sum(table2array(GaugesWeightTable(motorWireLen(1), 2)) .* motorWireLen(2:end
```

```
motorWireWeight =
   0.100035000000000
```

```
servosWireWeight = sum(table2array(GaugesWeightTable(servosWireLen(1), 2)) .* servosWireLen(2:
```

```
servosWireWeight =
   0.009723600000000
```

```
escWireWeight = sum(table2array(GaugesWeightTable(escWireLen(1), 2)) .* escWireLen(2:end))
```

```
escWireWeight =
   0.010374000000000
```

```
finalWeight = motorWireWeight + servosWireWeight + escWireWeight
```

```
finalWeight =
   0.120132600000000
```

THINGS TO DO NEXT

1. Implement dynamic gauge determination and txt file reading

Determine the gauge by the amount of current that is drawn. Read txt instead of hard coding parameters.

2. Test, troubleshoot, and improve the model

Many assumptions are made.

Also problem with parameters. For instance, I need the motor half span percentage. But if we have this value, and the wing span, than we have the distance to the motor, which is much more simple. Asking for percent is redundant.

3. Refractor

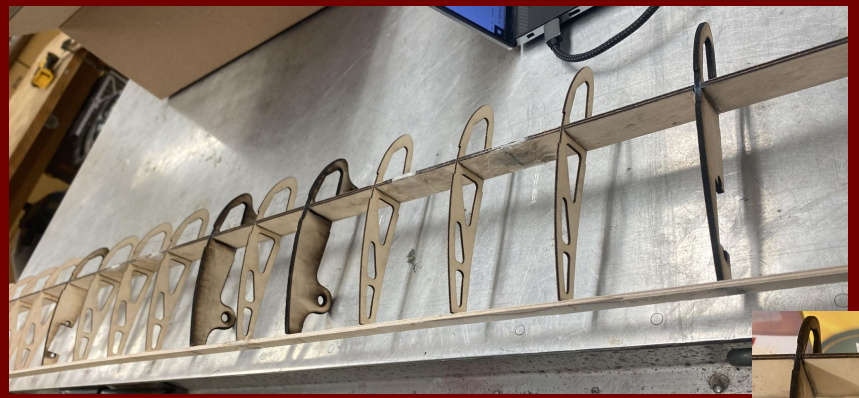
```
3*(2*(0.5*fuseTailNoseDist))]
```

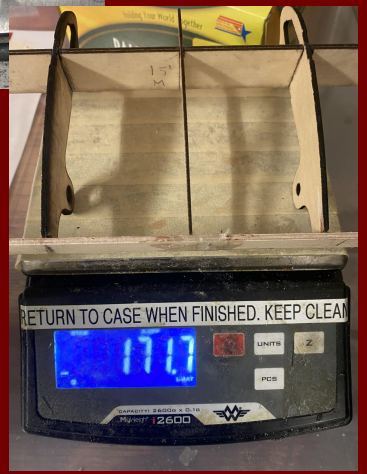
```
3*(0.3*fuseTailNoseDist)];
```

Tried not multiplying these out now because the separate numbers do mean separate things, and it might be an option to make them into variables in the future (however, these are very fixed things. Hard to switch to a motor that has more than 3 leads, for instance. That's a constant.)

Summer plane built-up wing

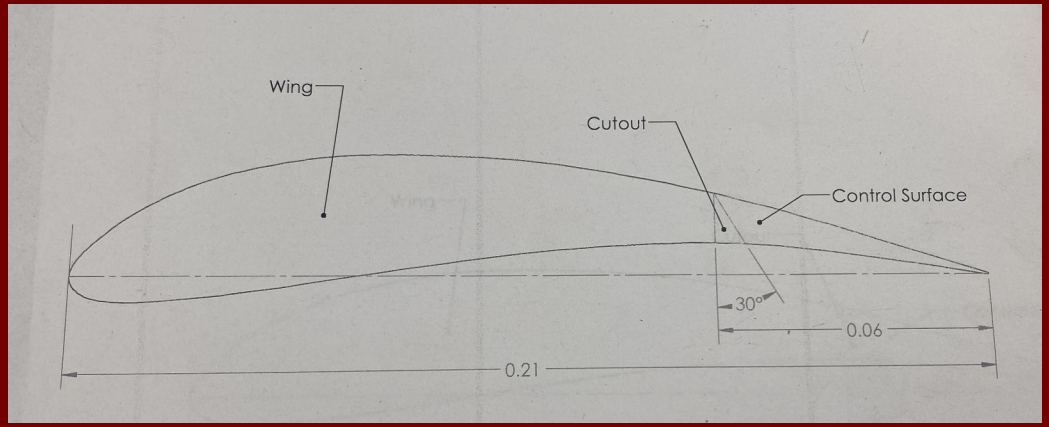
- Ribs
  - 1/8” ply (x4)
  - 1/16” ply (x7)
  - 1/8” balsa (x8)
- Front/Aft spars 1/8” ply (entire span)
- m = 0.172 kg





How to estimate weight?

- Cross-sectional areas



This Week’s Focus

- MASS BUILD UP

Propulsion

Nick

Next Steps

- Static thrust stand
- Fuse characterization
- What else?

New Rules!!! Observations:

- Mass buildup is critical
- PVC will be draggy…
- GM driving lower span
  - Brace the wing?
- M2, M3 driving higher span
- Very little fuselage volume needed…
  - We can build a heavy 3 x 3 x 6 inch block

New Rule Observations cont.

- Structural interfaces are critical
  - FEA needed?
- Want to be as light as possible
- What else?

2023 Competition Rules

- Electronic Warfare and Recon Aircraft
- Box to store disassembled aircraft
  - (length + width + height) < 62 in.
  - Holds fuselage, tails, two left + right wing sections (L + R sections > 80% total span)
  - Gross weight for each mission < 50 lb w/ box
- 100 Wh propulsion energy limit
  - fuse: lesser of 100 Amps or C rating * capacity

Mission 1 - Typical

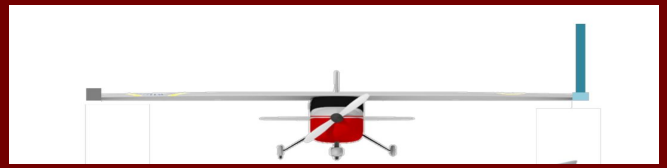
- Completion, score 0 or 1
- 3 laps
- 5 minute window
- 60 ft TOFL
- No payload

Mission 2 - Surveillance Flight

- 10 minute window
- 60 ft TOFL
- Payload: (1) electronics package
  - Payload mass fraction > 30% for M2
  - At least 3 x 3 x 6 inches, team-supplied
  - Entirely internal
- Score = 1 + $(\text{payload mass} * \#\ \text{laps})_{USC}$ /
  $(\text{payload mass} * \#\ \text{laps})_{\text{Max}}$

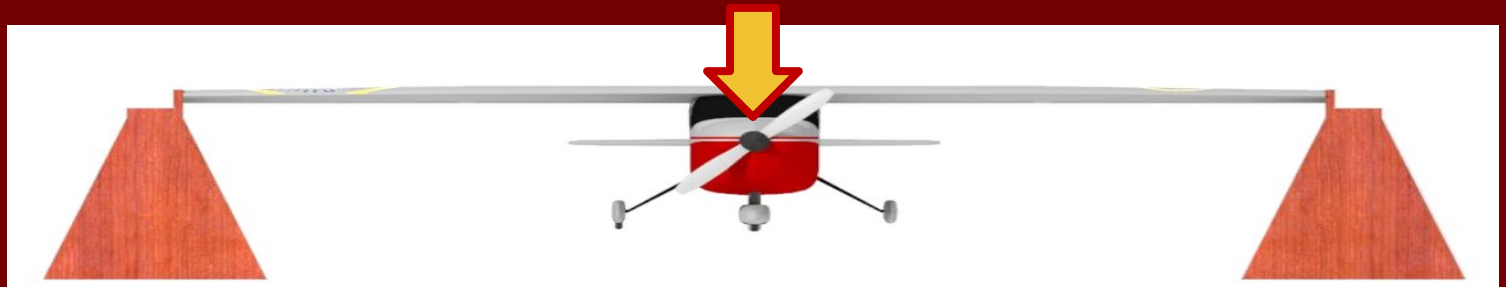
Mission 3 - Jamming Flight

- 3 laps
- 5 minute window
- 60 ft TOFL
- Payload: Jamming Antenna
  - ½ inch PVC pipe on wingtip
  - 3 lengths tech-inspected
- Score = 2 + (antenna length / time)$_{USC}$ / (antenna length / time)



Ground Mission - Structural Margin Demonstration

- 10 minute window
- Aircraft in heaviest-teched configuration
- Continually load weight onto centerline, supported at the wingtips
- Score = (test weight/max weight)$_{USC}$ /



Competition Total Scoring

- Total Mission Score = M1 + M2 + M3 + GM
- Design Report Score: 0 to 100
- Participation factor P:
  - P = 1 for attending the fly-off
  - P = 2 for completing tech inspection
  - P = 3 for attempting a flight mission
- Competition Score = Design Report Score * Total Mission Score + P