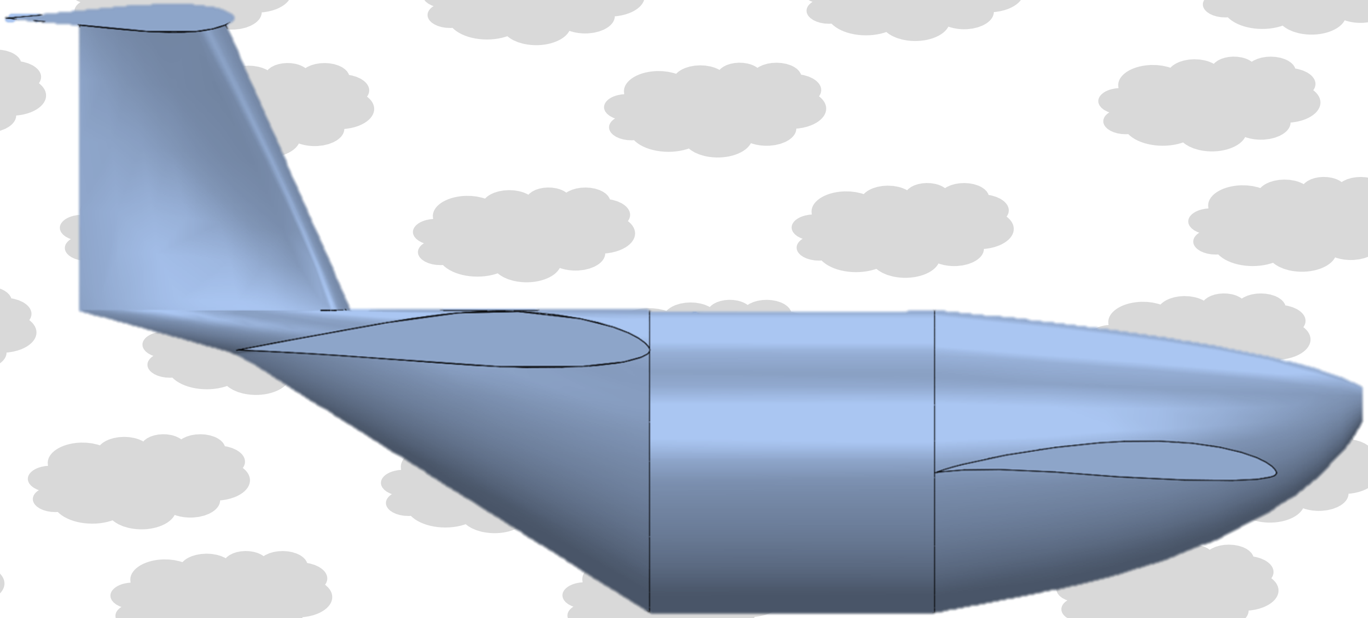
Engineering Design Day Presentation



Team 507 - SAE Aero Design – Aero and Propulsion Team

Team Introductions-507

Aerodynamics & Propulsion Team

Sasindu Pinto:
Project /Aeronautics/Propulsion Engineer

Noah Wright:
Aerodynamics Engineer

Michenell Louis-Charles:
Thermal Fluids Engineer/Financial Chair

Cameron Riley:
Materials/Hardware Engineer

Adrian Moya:
Systems/Hardware Engineer

Team Introductions-508

Lauren Chin

Lift and Control Surface Engineer/Meeting Coordinator

Joseph Figari

Fuselage and Payload Engineer/Financial Chair

Jacob Pifer

Project Engineer (Geometrics) and Manufacturing Engineer

Noah Wright

Sponsor and Advisors

Florida Space Grant Consortium:
Funding Sponsor

Seminole RC Club:
Equipment/Personnel Sponsor

Dr. Chiang Shih:
Professor & AME Center Director Advisor

Noah Wright

Project Background

- Plane designed to be entered in SAE Aero Design Competition East
- Only participating in the Design Knowledge Event and not the Validation Event due to financial constraints and health risks

Noah Wright

Team Objective

The objective of the aero-propulsion team is to ensure that the plane takes off, completes the flight path, and lands safely while carrying a payload.

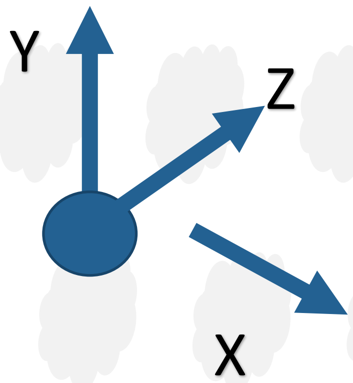
Noah Wright

Key Goals and Assumptions

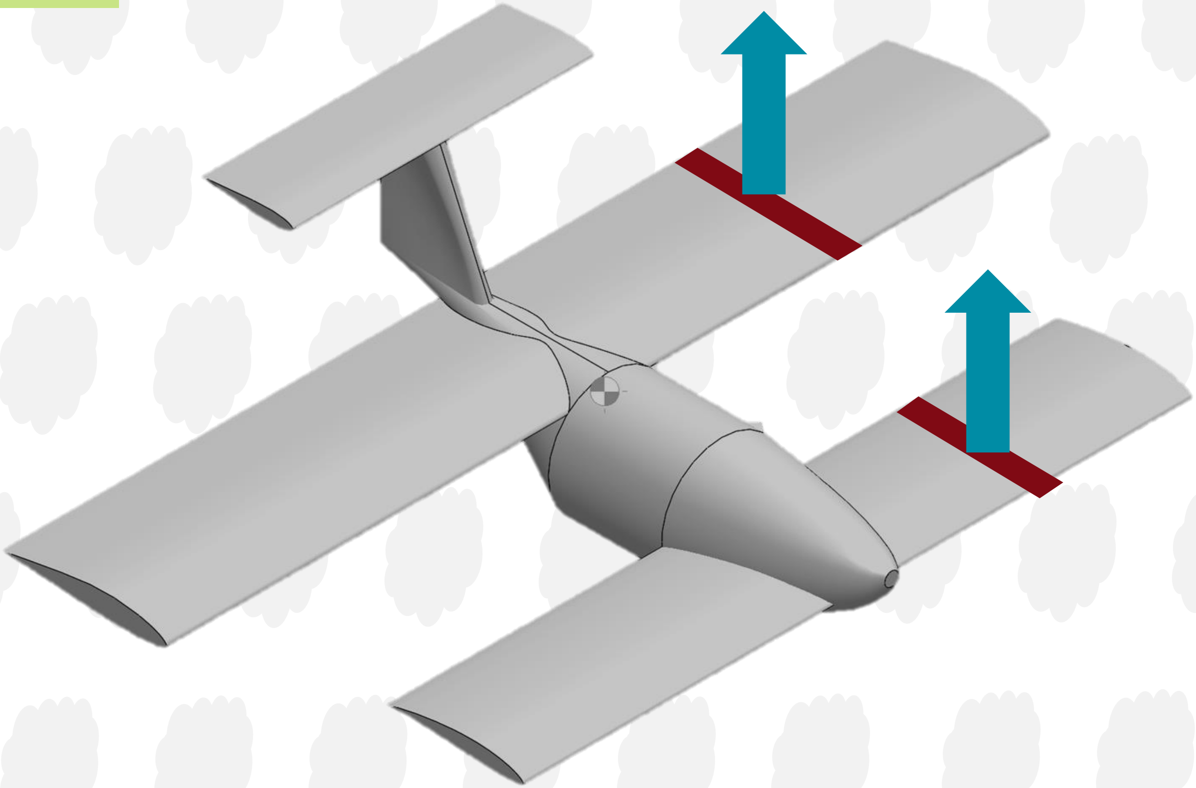
- Achieve lift
- Overcome drag
- Avoid stall
- Will be flown in atmospheric conditions at sea level

Noah Wright

Key Definitions

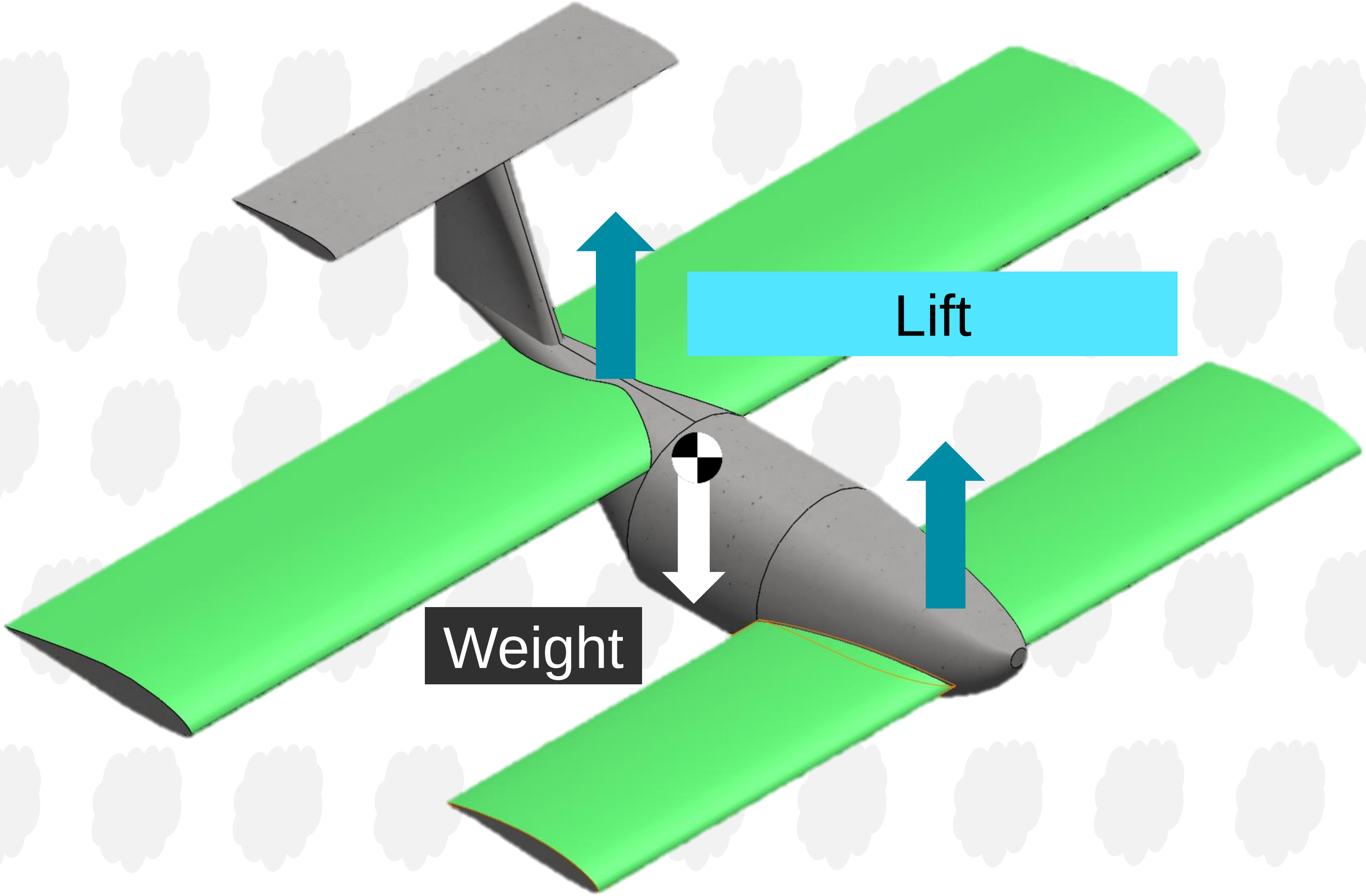


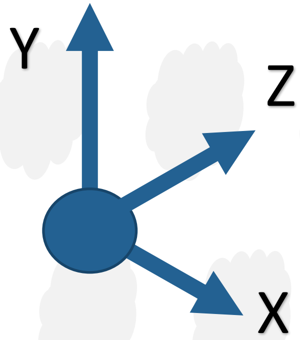
Coefficient of Lift



Noah Wright

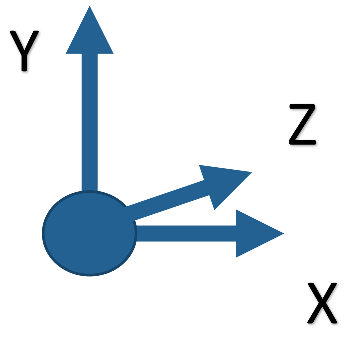
Key Definitions



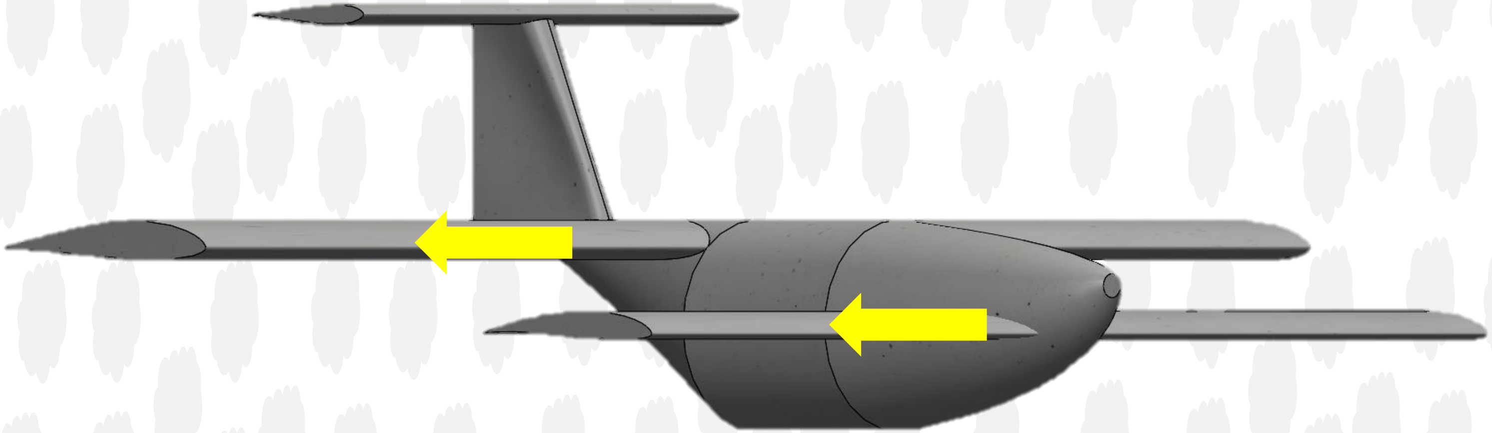


Noah Wright

Key Definitions

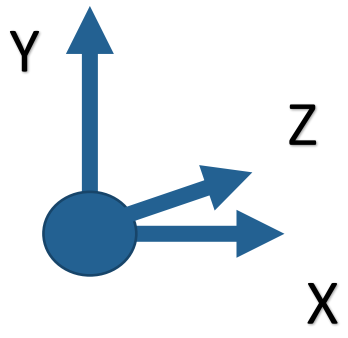


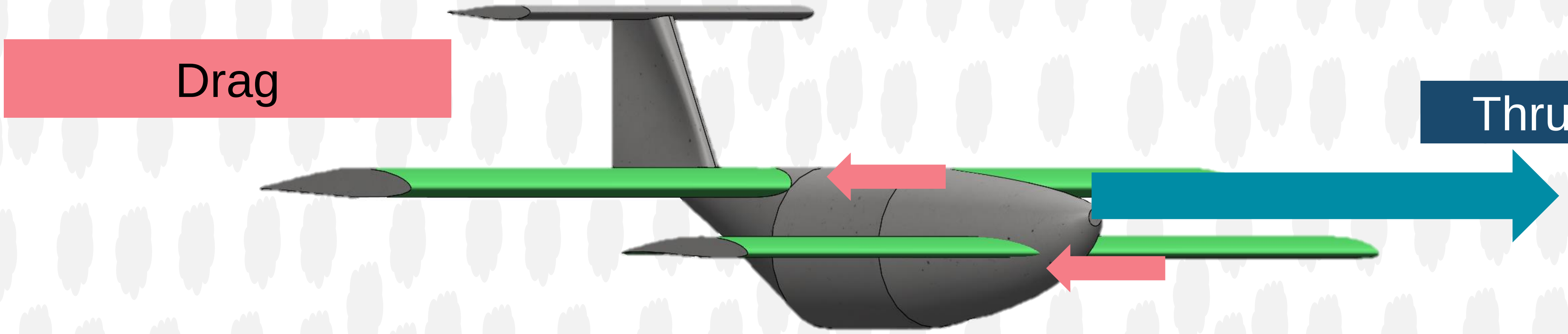
Coefficient of Drag



Noah Wright

Key Definitions

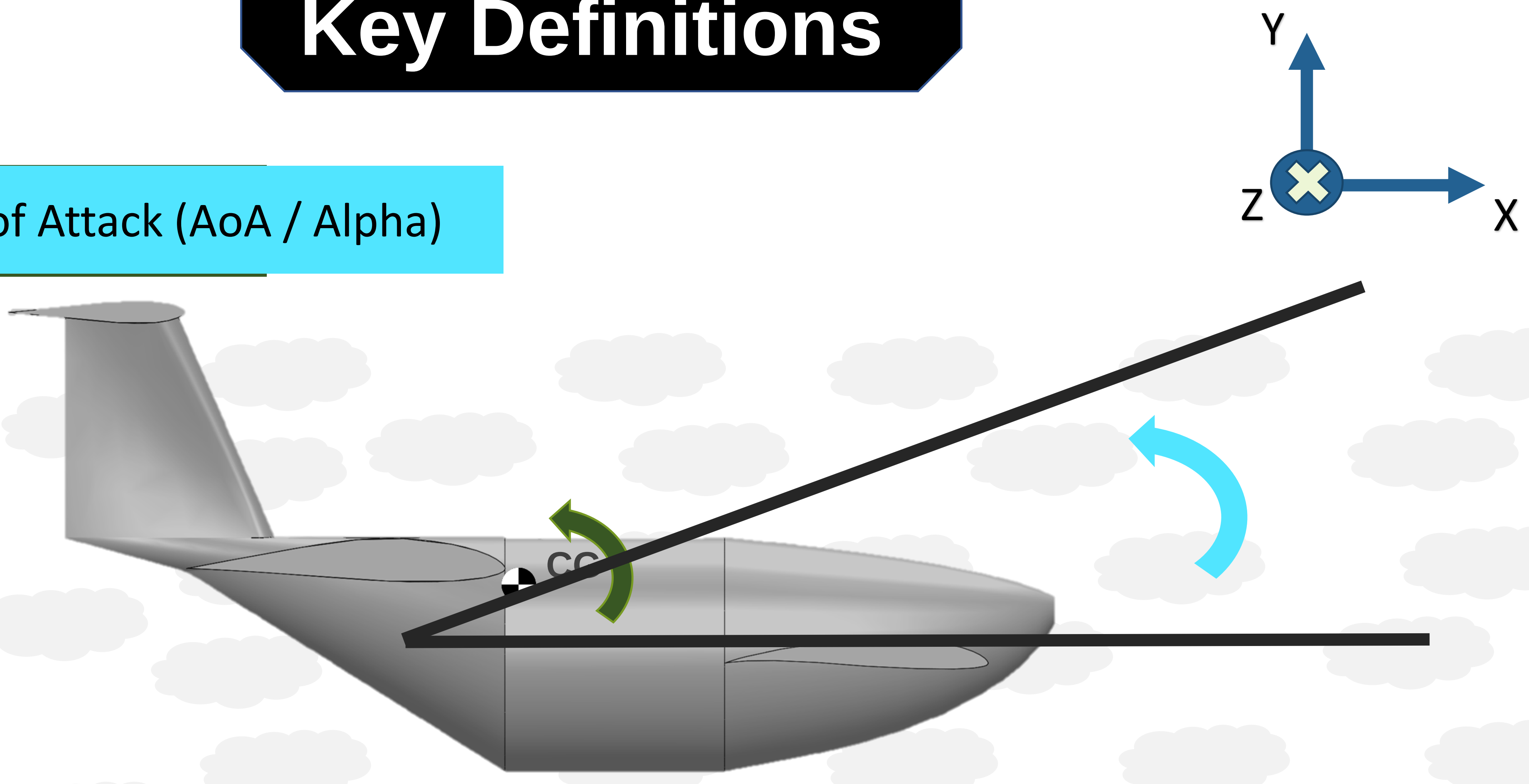




Noah Wright

Key Definitions

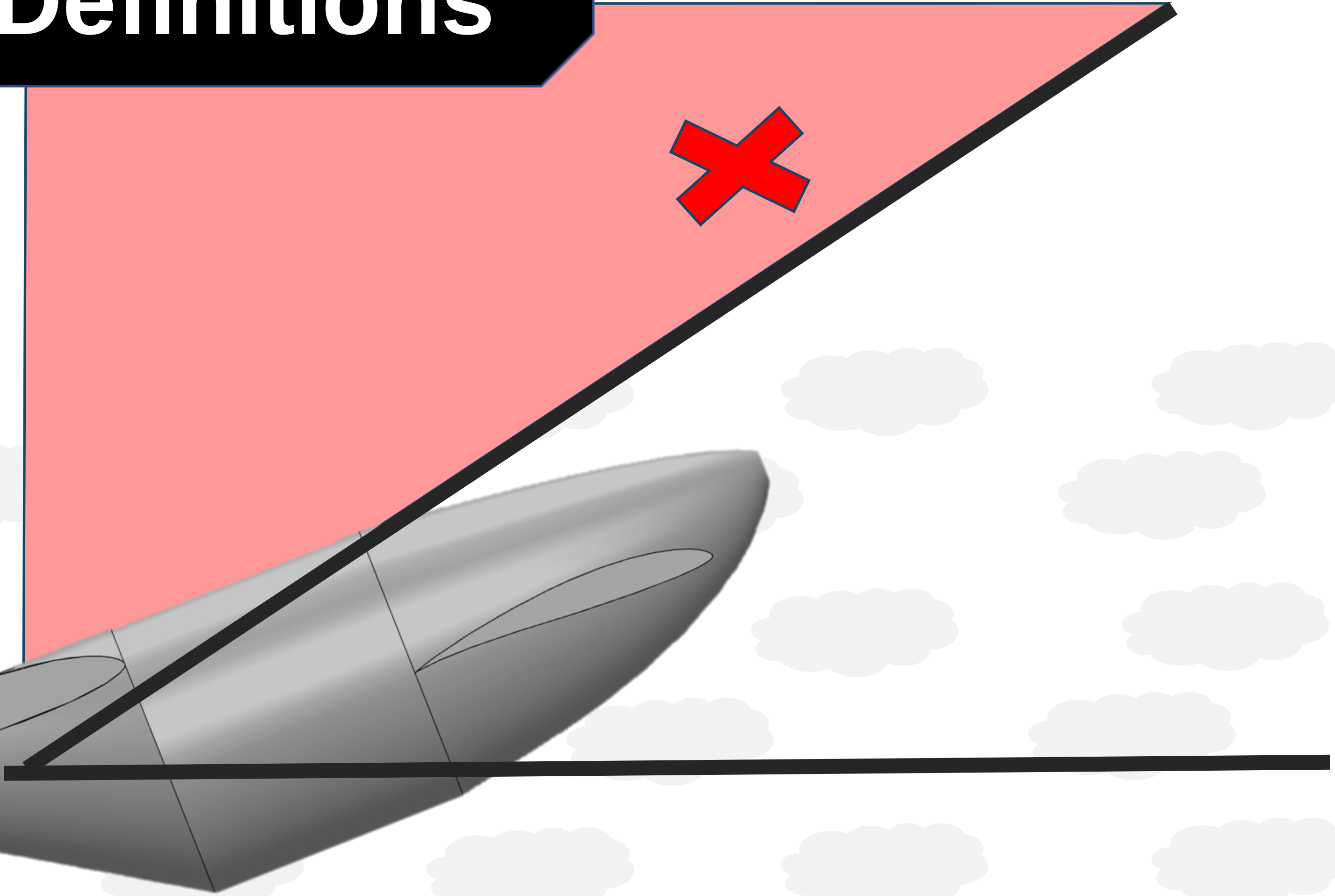
Angle of Attack (AoA / Alpha)



Noah Wright

Key Definitions

Stall: Net Lift = 0

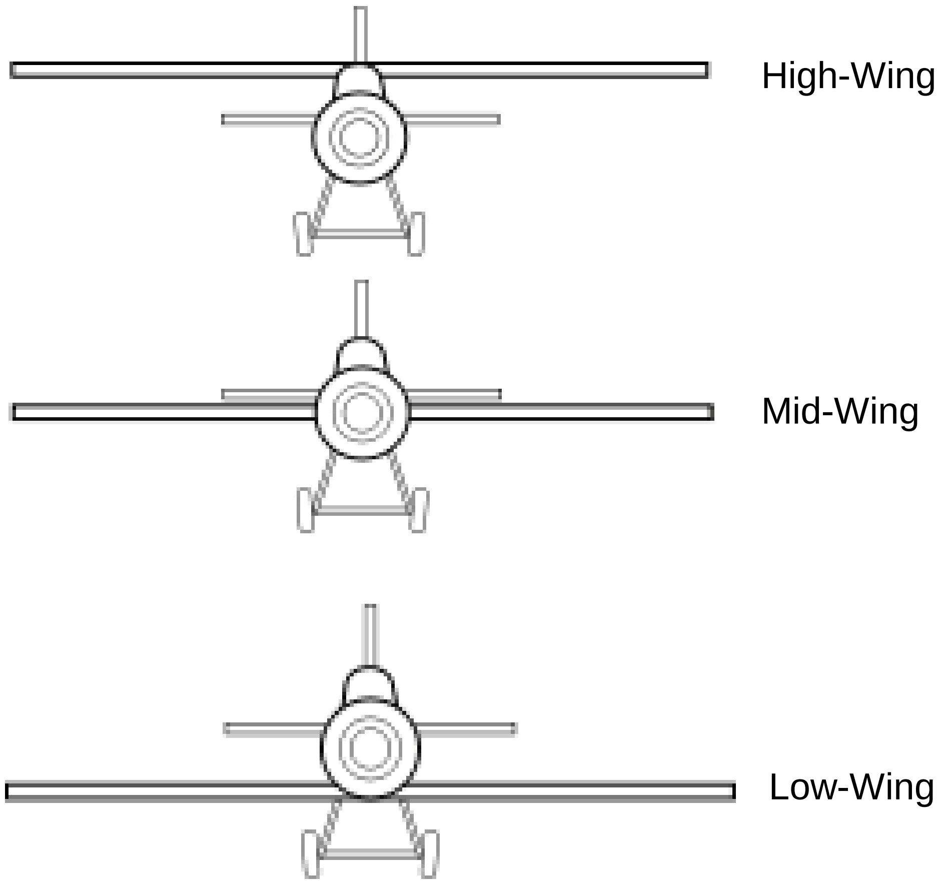


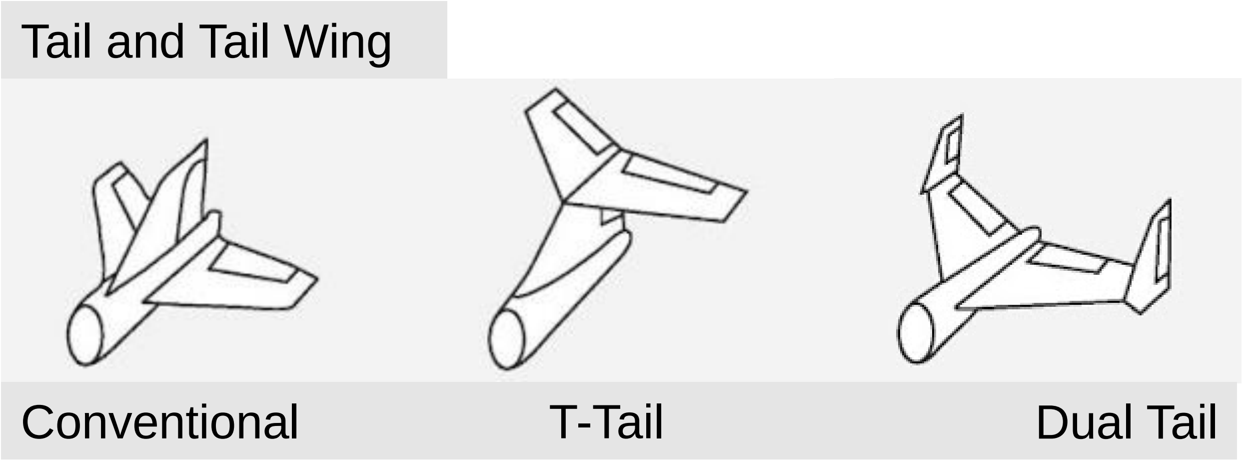
Noah Wright

Research and Concept Generation

Research and Concept Generation

Wing Positioning





Adrian Moya

Research And Concept Generation

Cargo Bay Location

Nose

Possible for traditional wing layout

Mid Plane

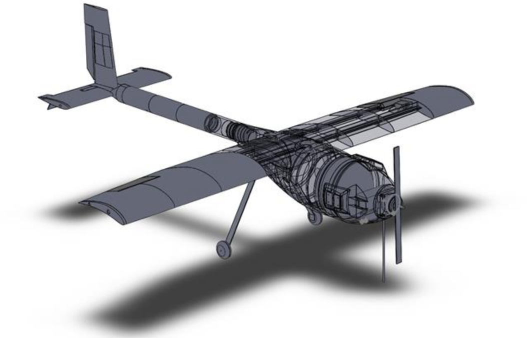
- Possible for simple canard and 3 wing layout

Adrian Moya

Research And Concept Generation

Possible Designs

Boomtown



OMAC Laser 300

Boeing 747 Dreamlifter

Rutan Quickie Q2

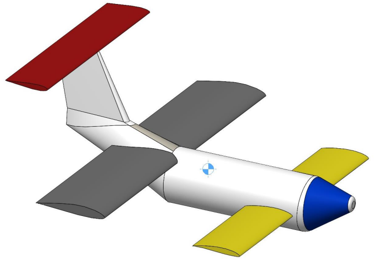
Kawasaki C-2

Cameron Riley

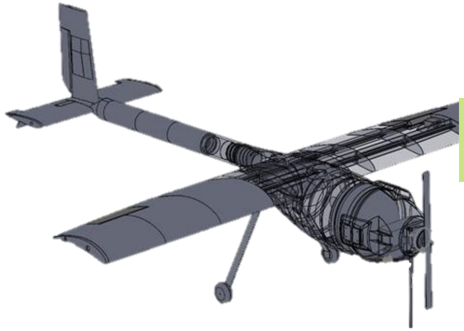
Research And Concept Generation

Possible Designs

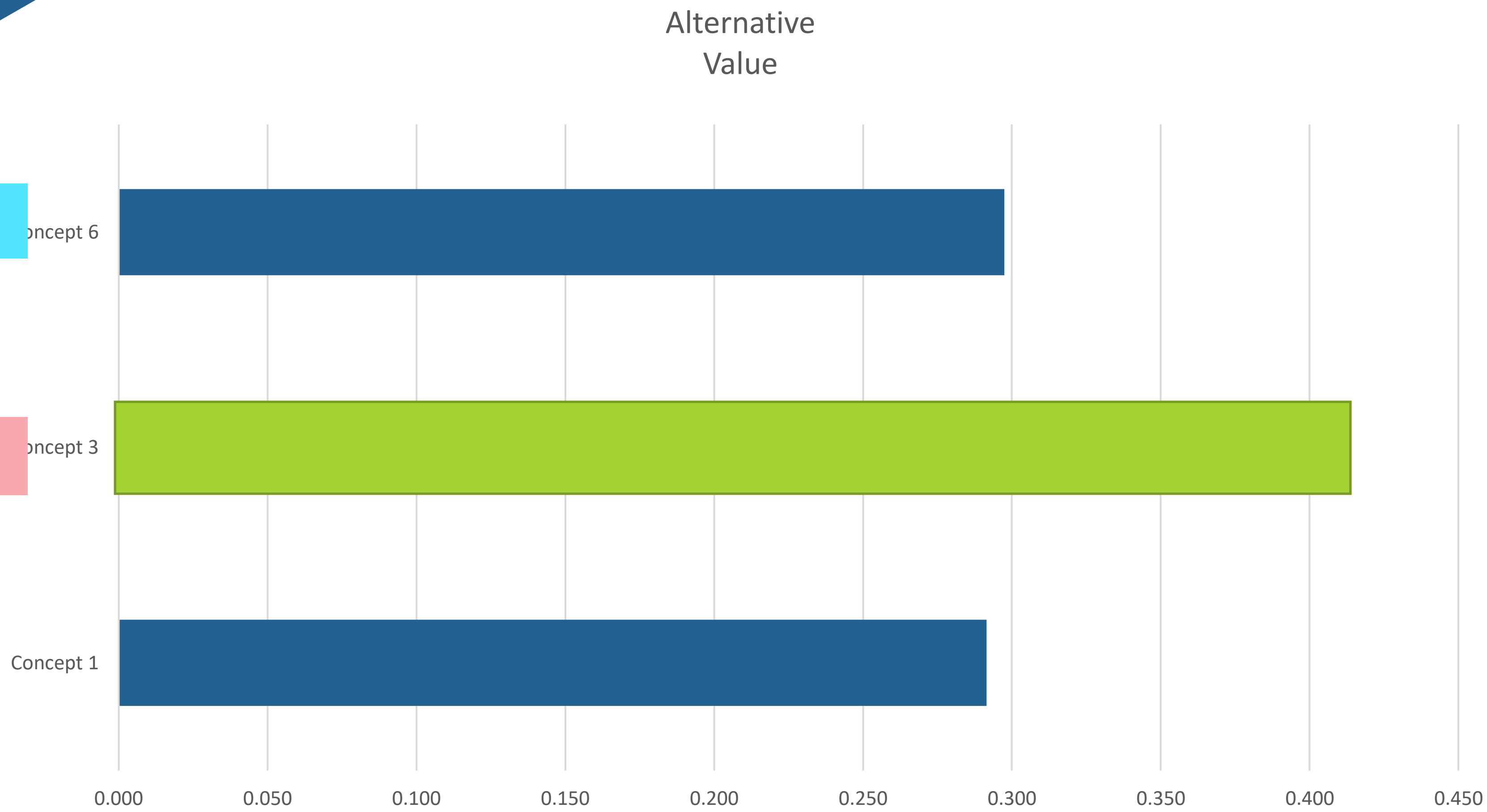
6. OMAC Laser 300



3. Rutan Quickie Q2



1. Boomtown



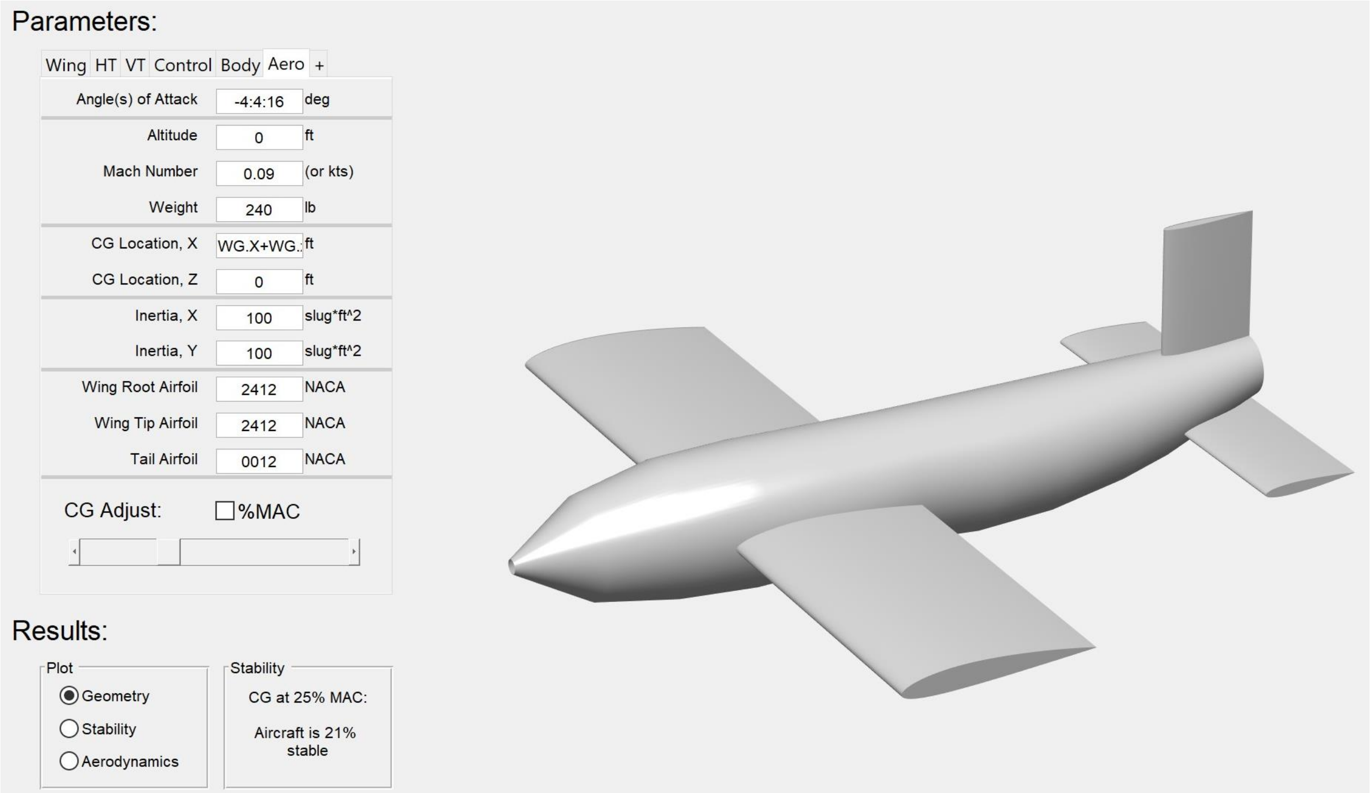
Cameron Riley

Design Development Procedure

Initial Design

DATCOM Data

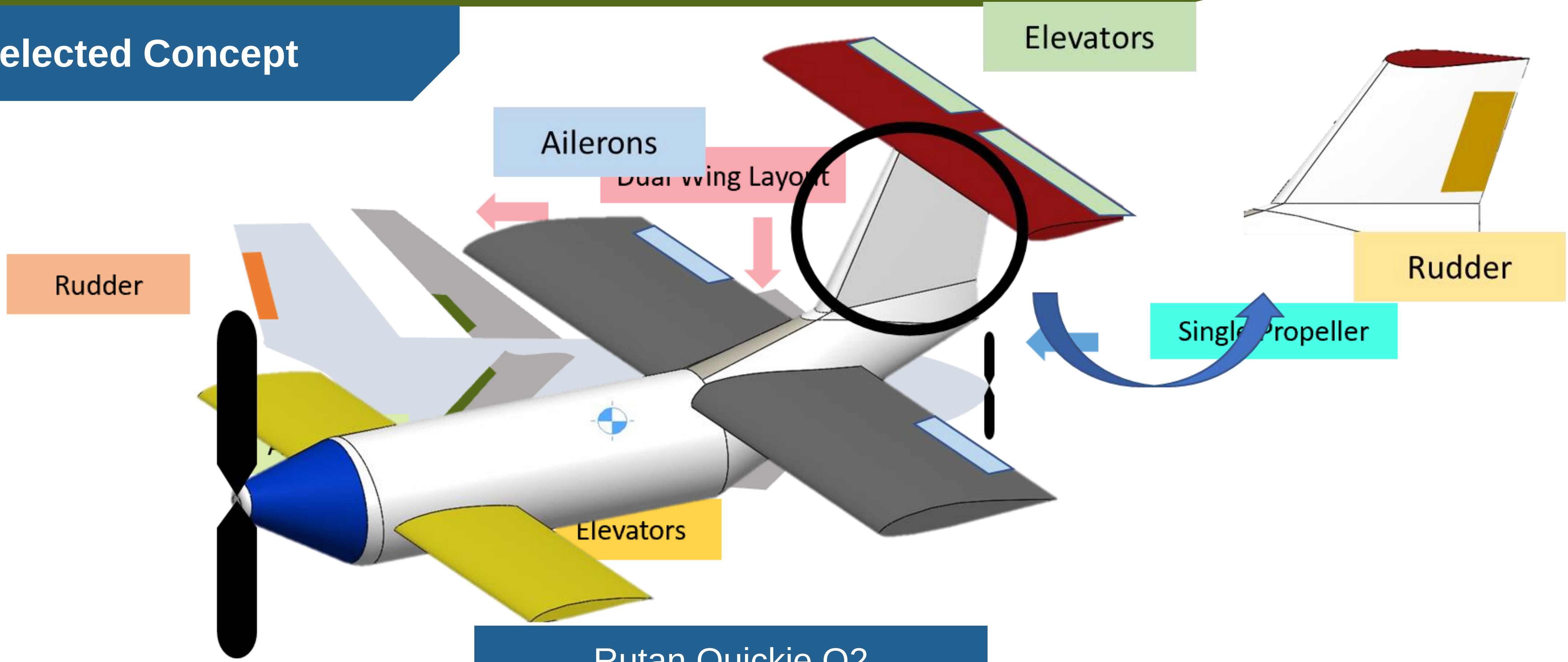
- Intuitive design tool on MATLAB
- Analyze DATCOM data to calculate stability and control
- Needs to use NACA Airfoils



Adrian Moya

Design Development Procedure

Selected Concept

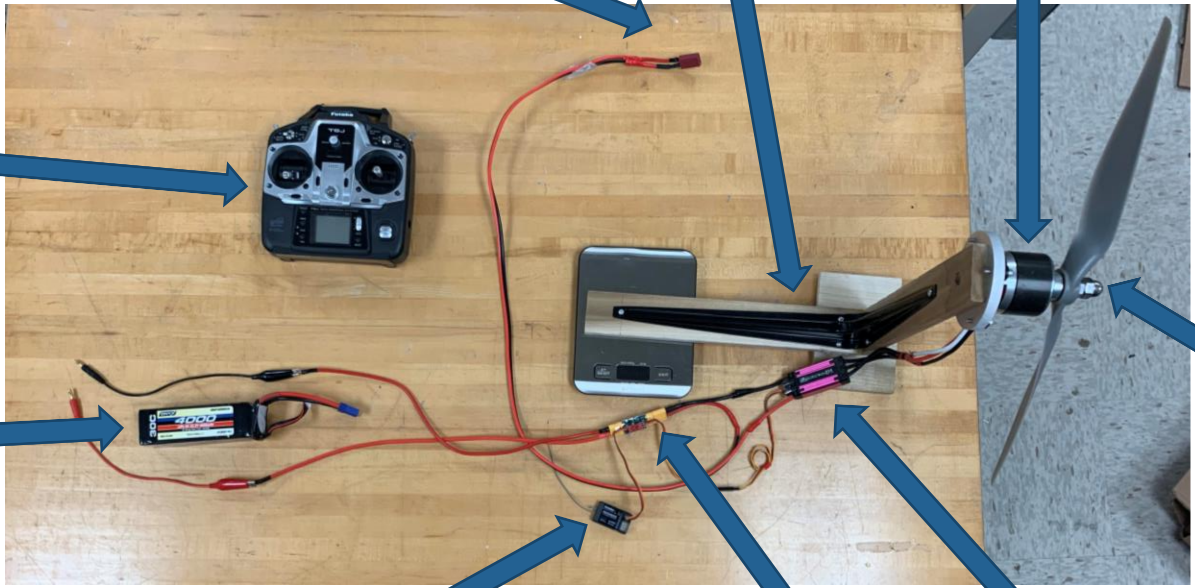


Rutan Quickie Q2

Sasindu Pinto

Design Development Procedure

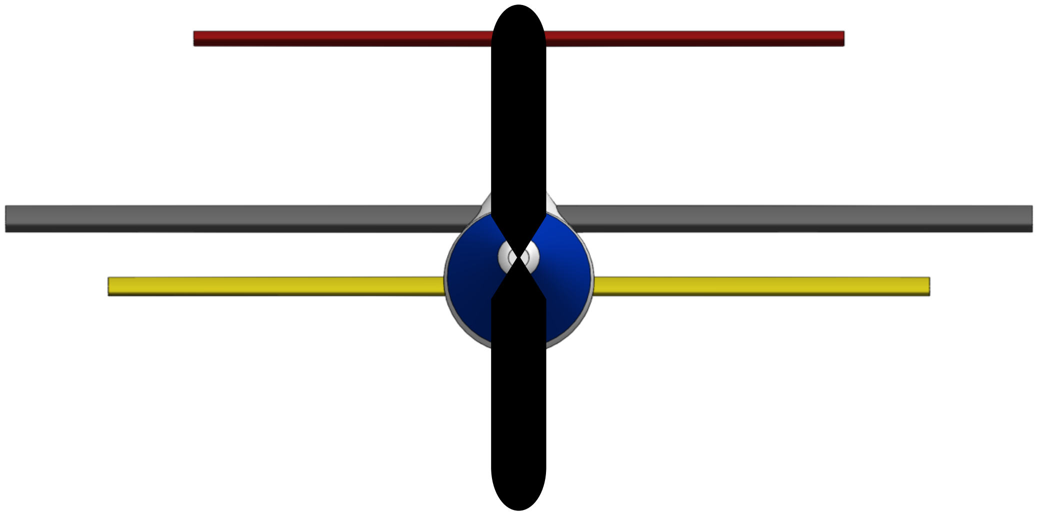
Thrust Test - Setup



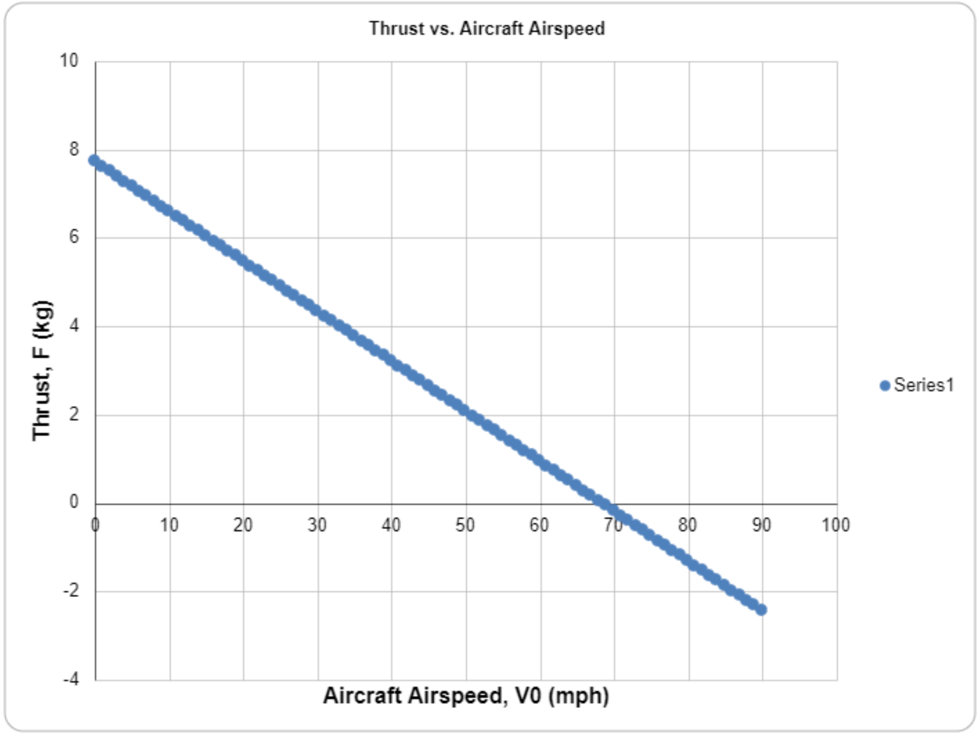
Cameron Riley

Design Development Procedure

Thrust Test



Experimental Thrust ~ 222 lbf

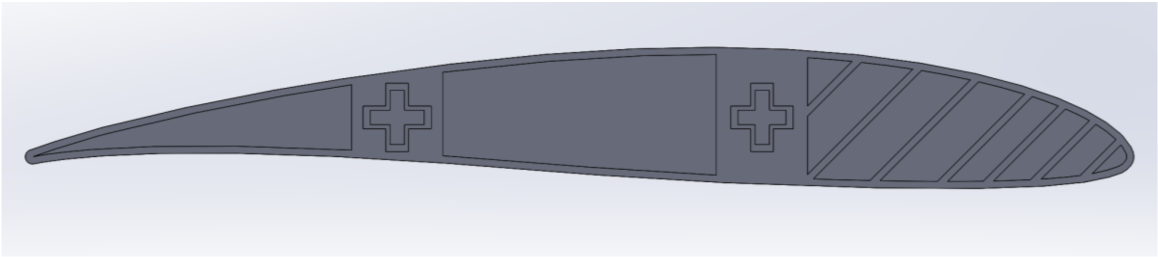


Calculated Static Thrust ~ 167 lbf

Cameron Riley

Design Development Procedure

Test Print Correlation Error



Projected Weight ~ 0.109 lbs.

Actual Weight – 0.211 lbs.

Initial density – 0.00245 lb./in^3 → → → **Adjusted density – 0.00474 lb./in^3**

Cameron Riley

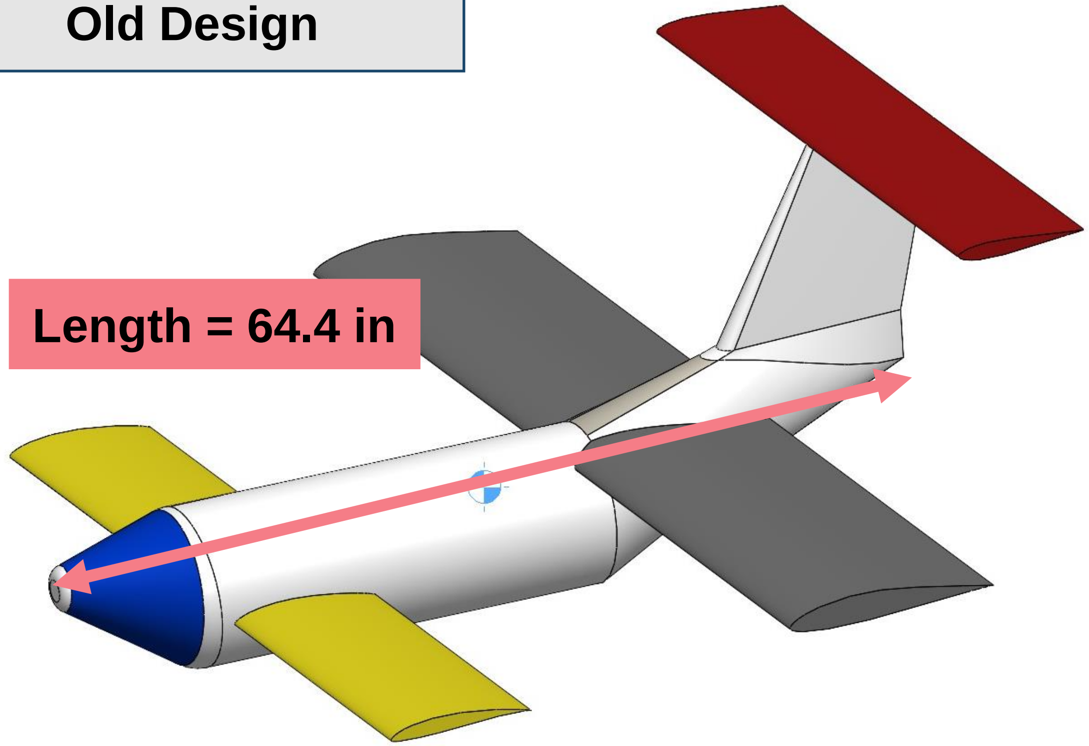
Redesigned Plane Analysis

Redesigned Plane Analysis

Comparison

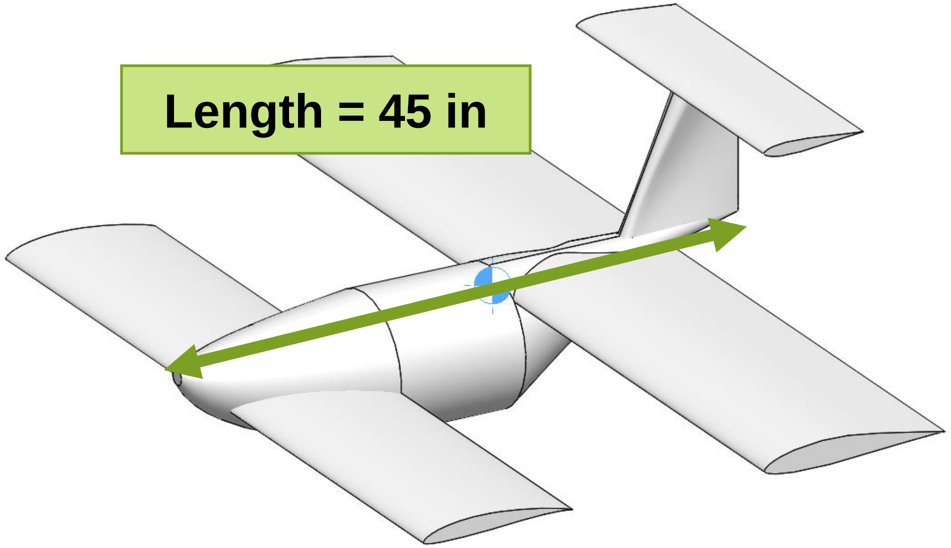
Reduction in Fuselage Length

Old Design



Vs

New Design

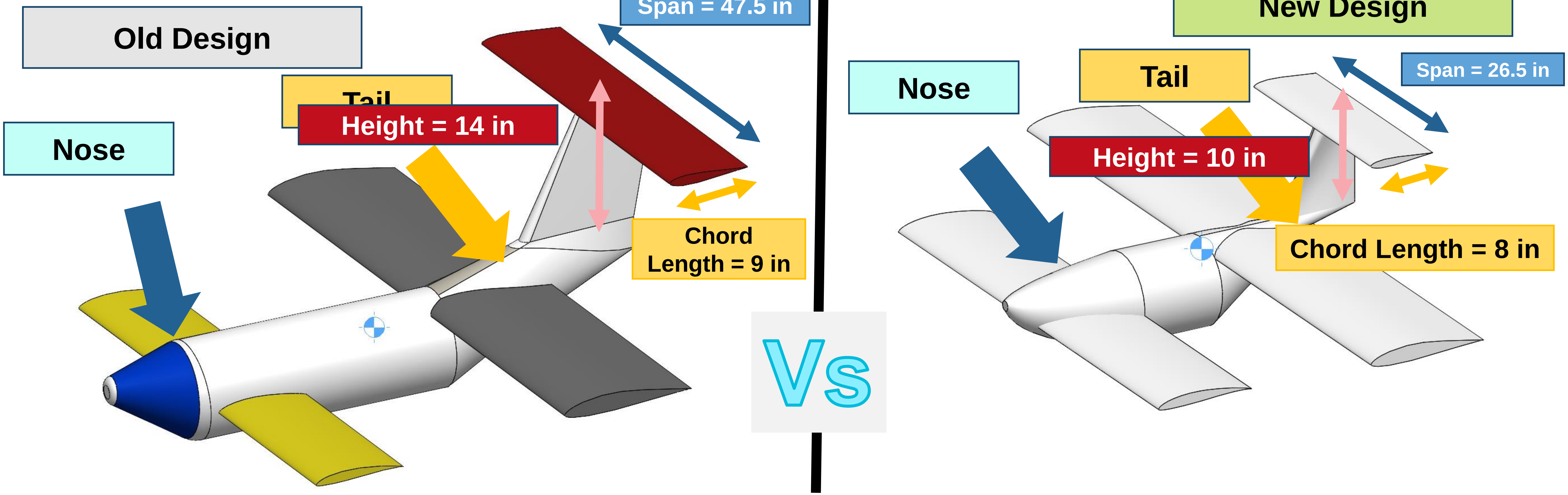


Cameron Riley

Redesigned Plane Analysis

Comparison

Smaller Fuselage and Tail Wing



Reduced Tail Wing Area

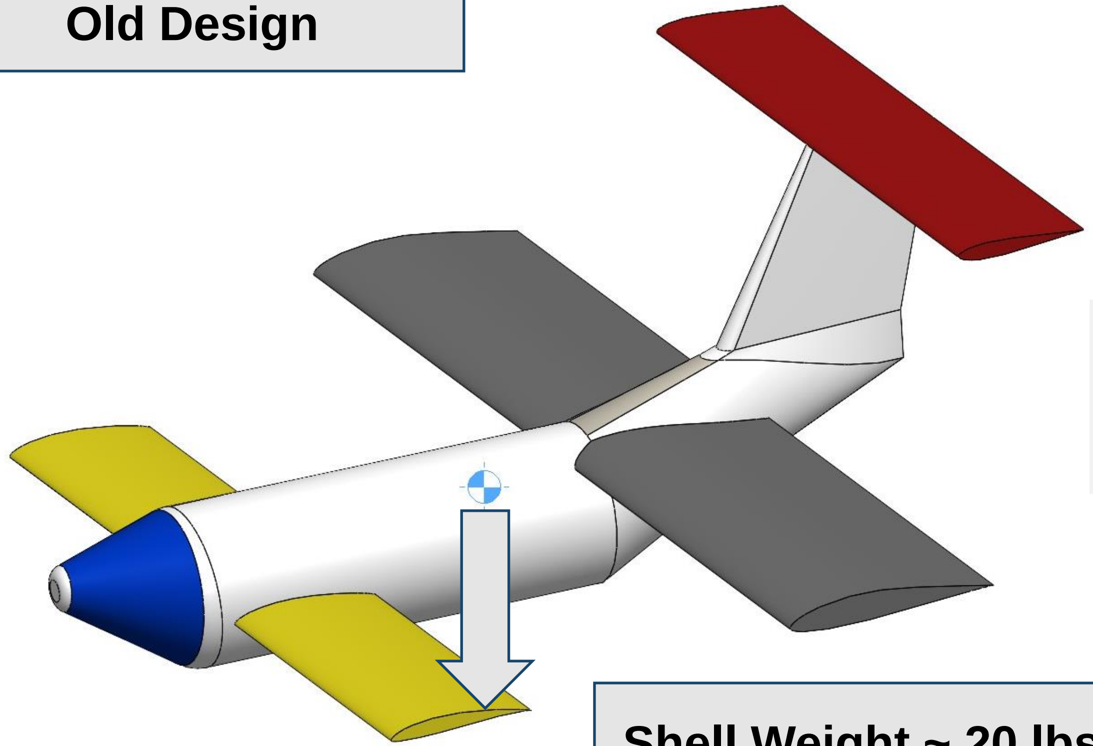
Cameron Riley

Redesigned Plane Analysis

Comparison

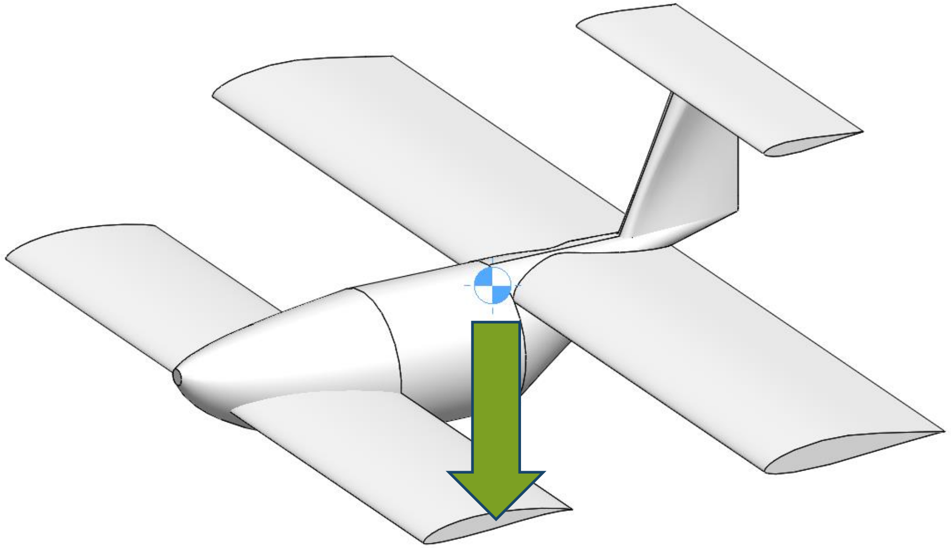
Smaller Fuselage and Tail Wing

Old Design



Shell Weight ~ 20 lbs.

Vs



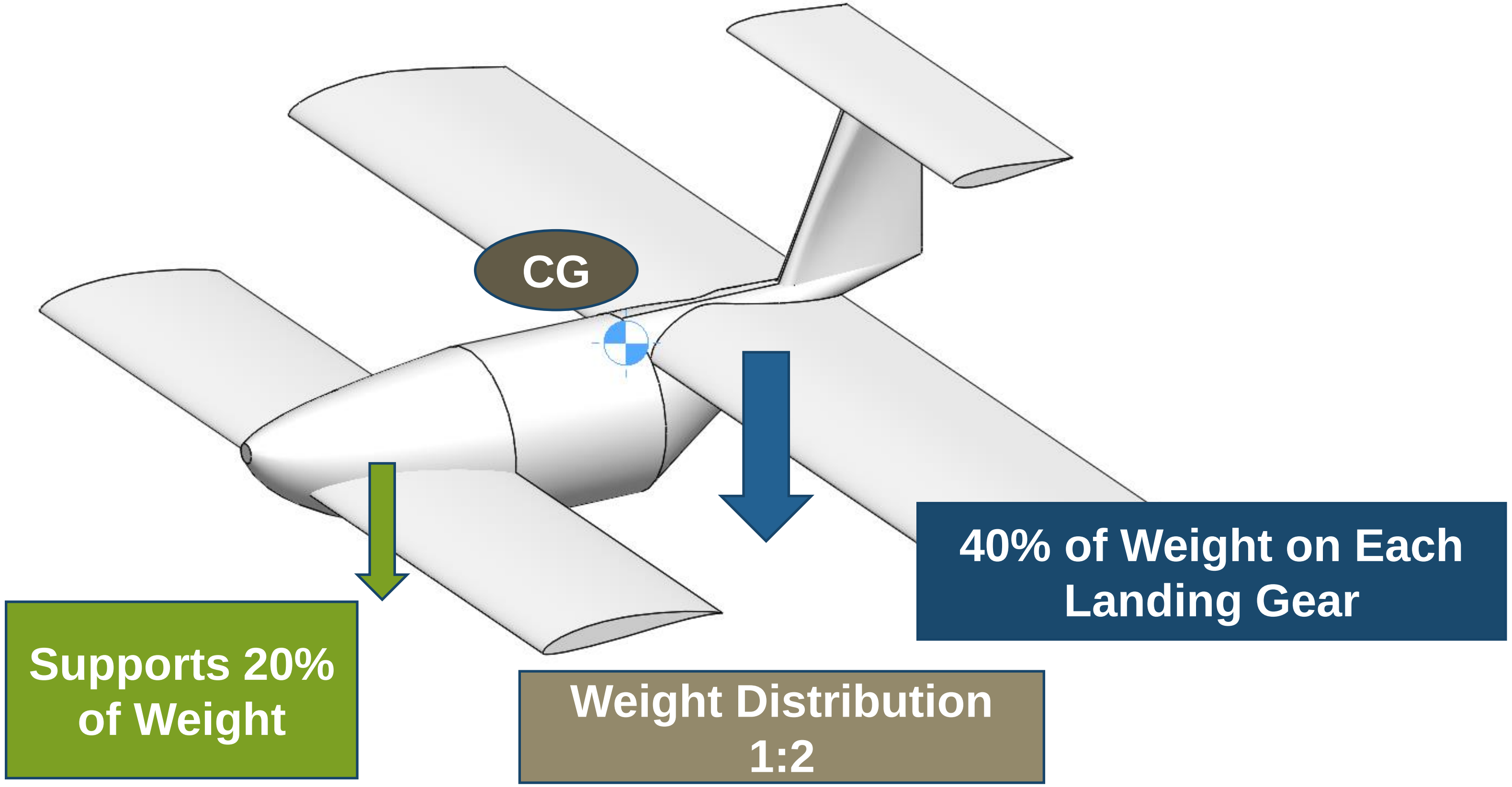
Shell Weight ~ 10.5 lbs.

Actual Shell Weight ~ 9 lbs.

Sasindu Pinto

Redesigned Plane Analysis

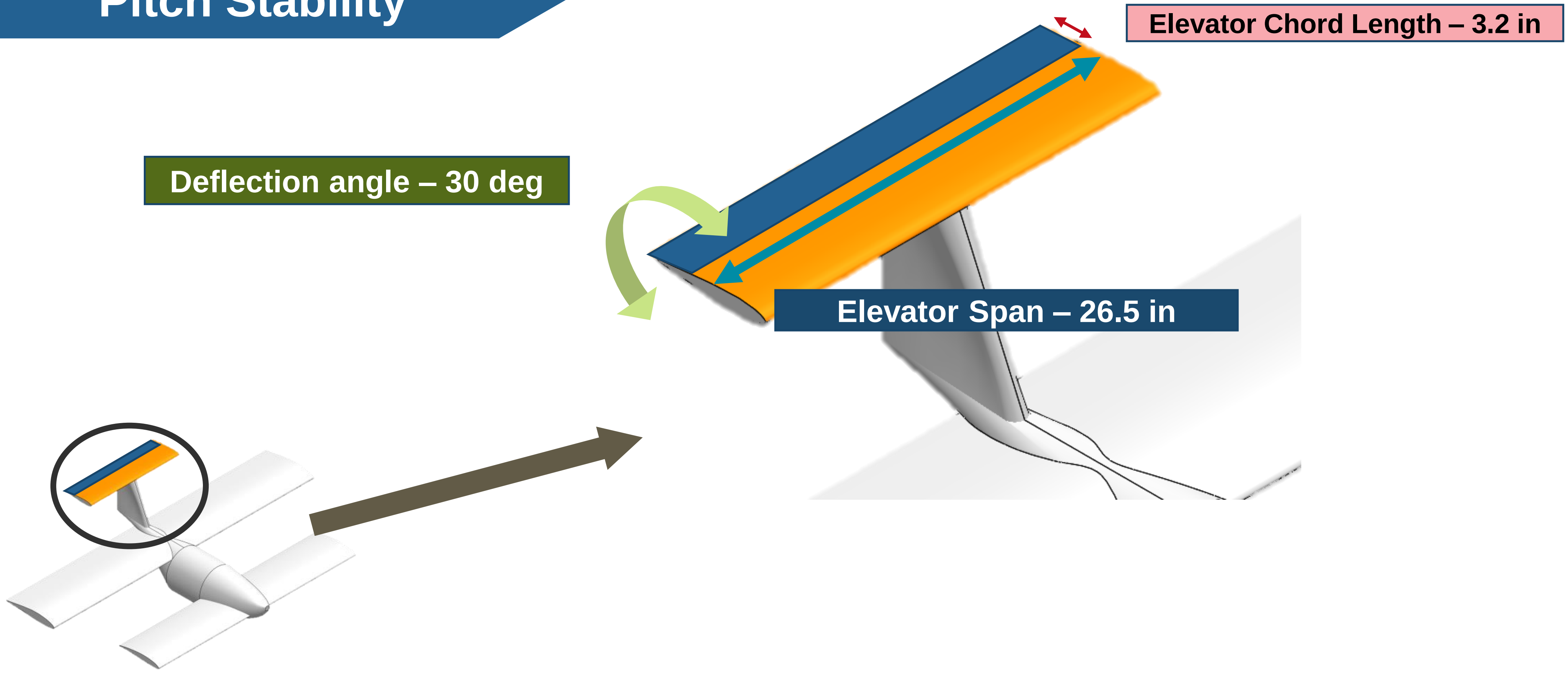
Landing Gear Weight Distribution



Sasindu Pinto

Redesigned Plane Analysis

Pitch Stability

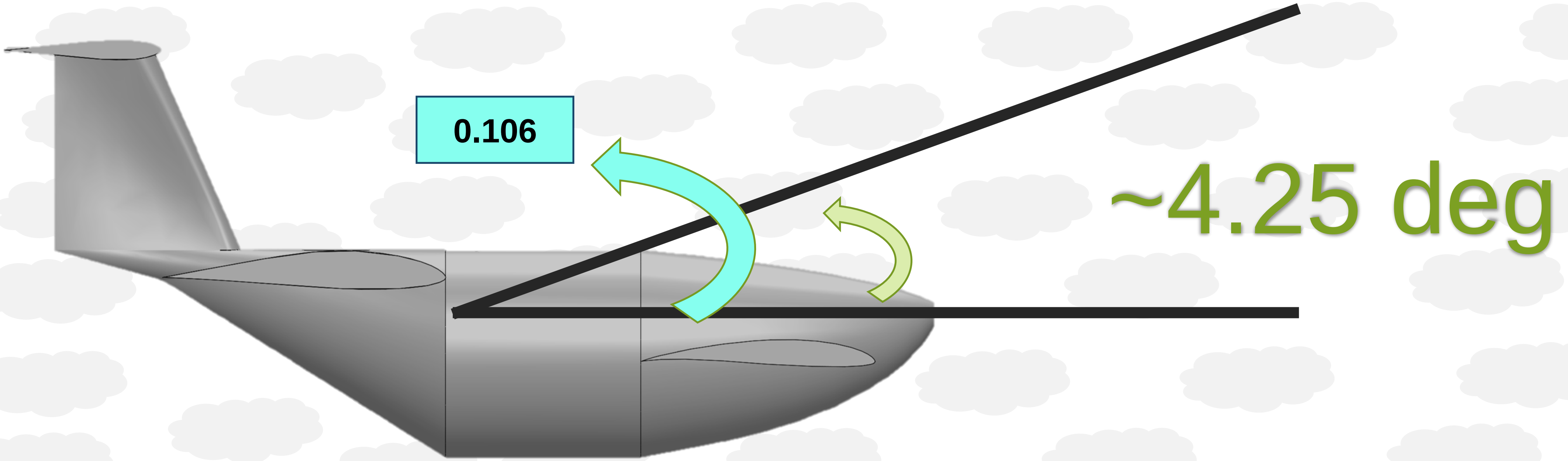


Sasindu Pinto

Redesigned Plane Analysis

Pitch Stability

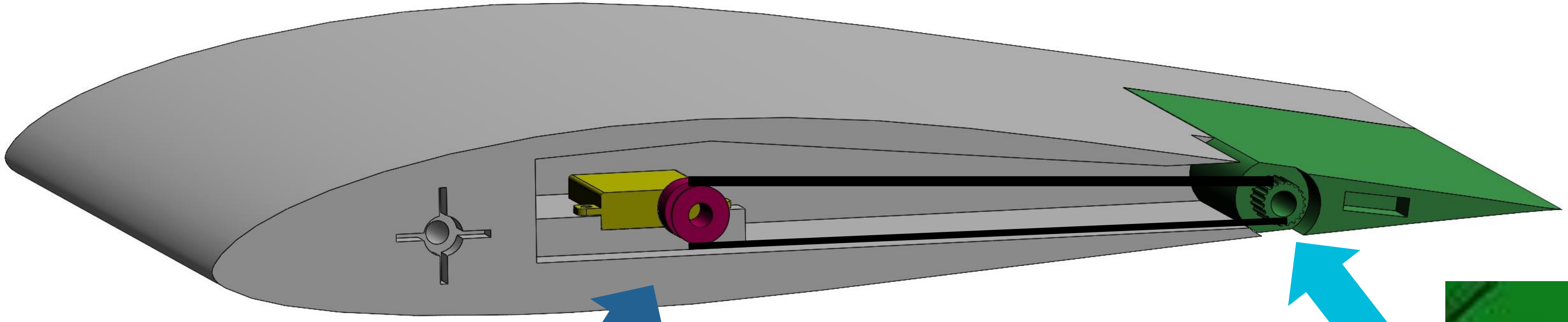
Equilibrium Angle of Attack



Sasindu Pinto

Redesigned Plane Analysis

Control Surface Motion



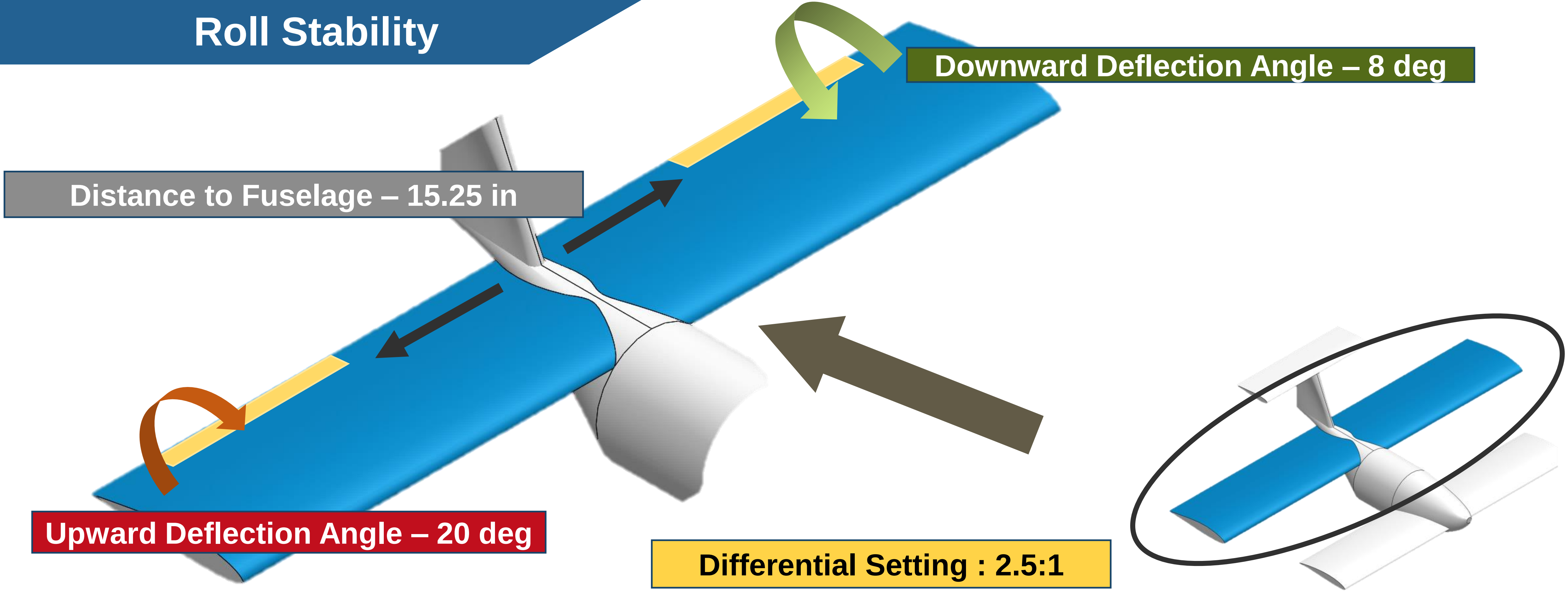
Belt

Control Surface Gears

Adrian Moya

Redesigned Plane Analysis

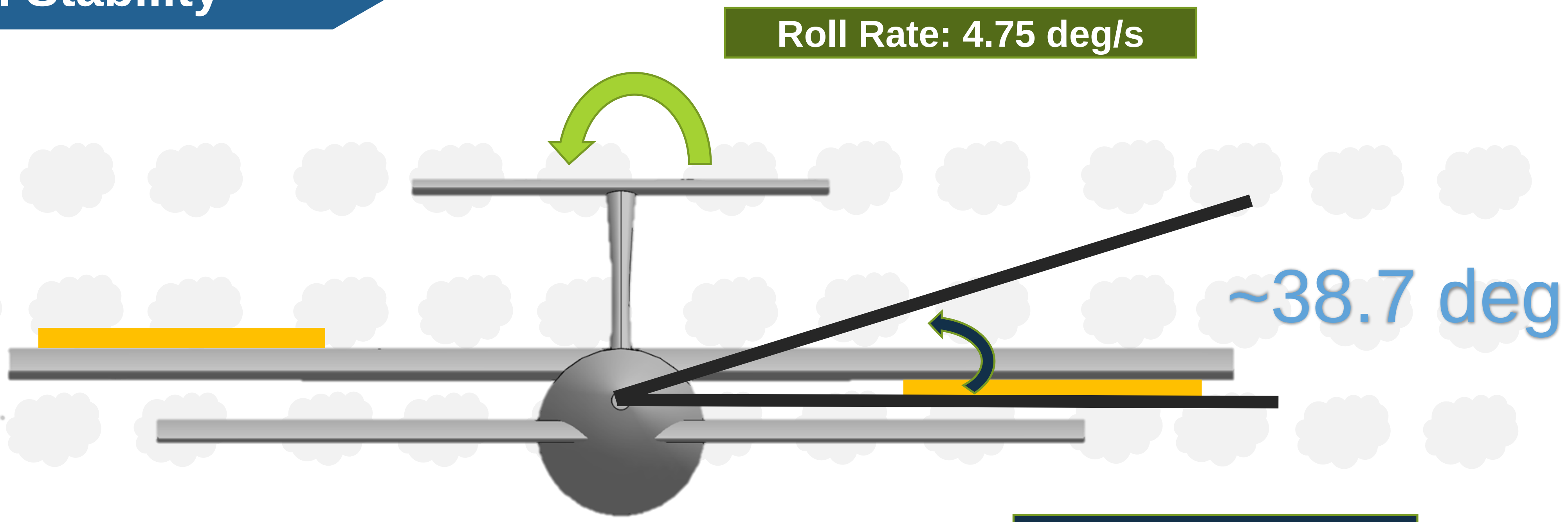
Roll Stability



Sasindu Pinto

Redesigned Plane Analysis

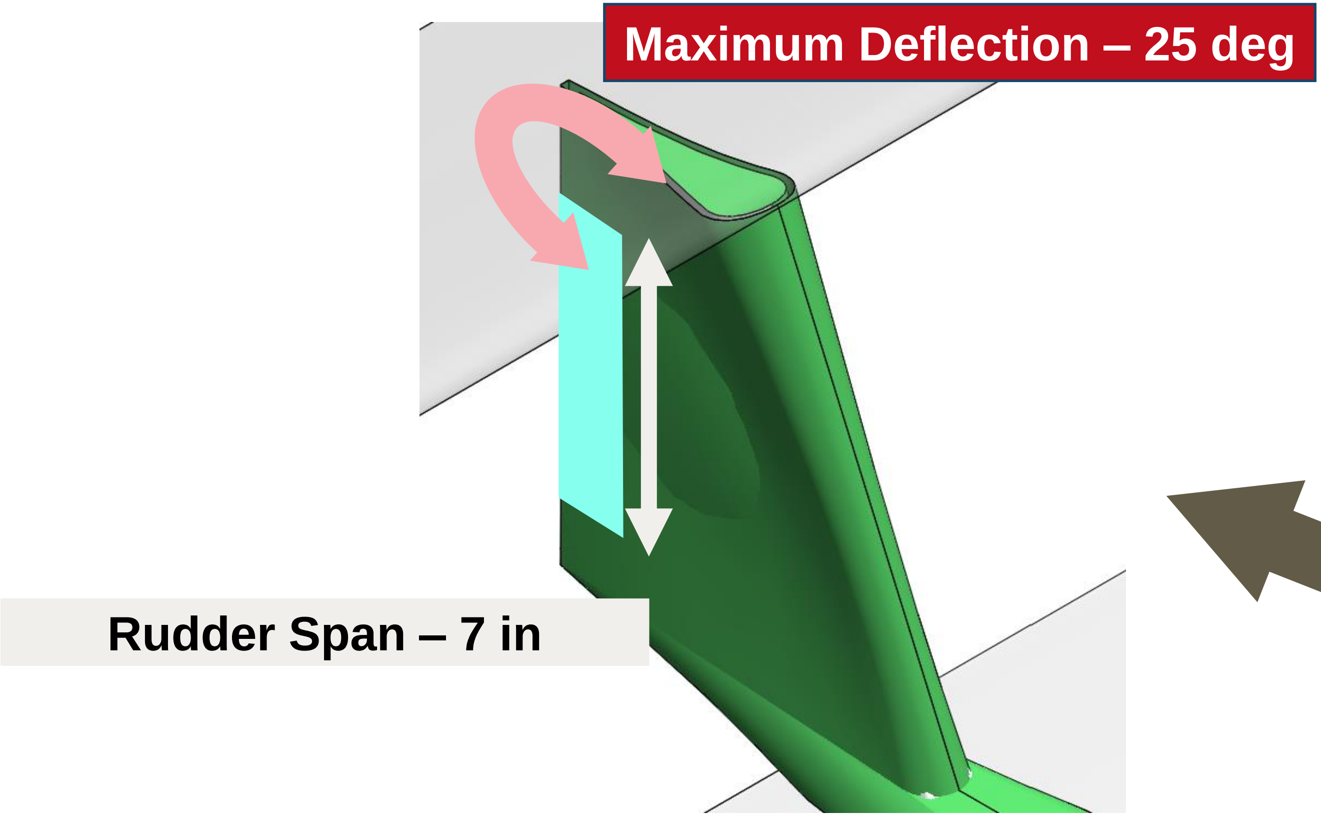
Roll Stability

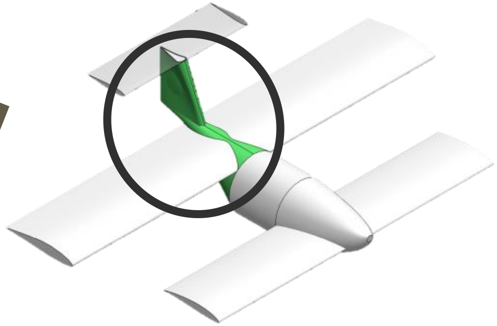


Sasindu Pinto

Redesigned Plane Analysis

Yaw Stability

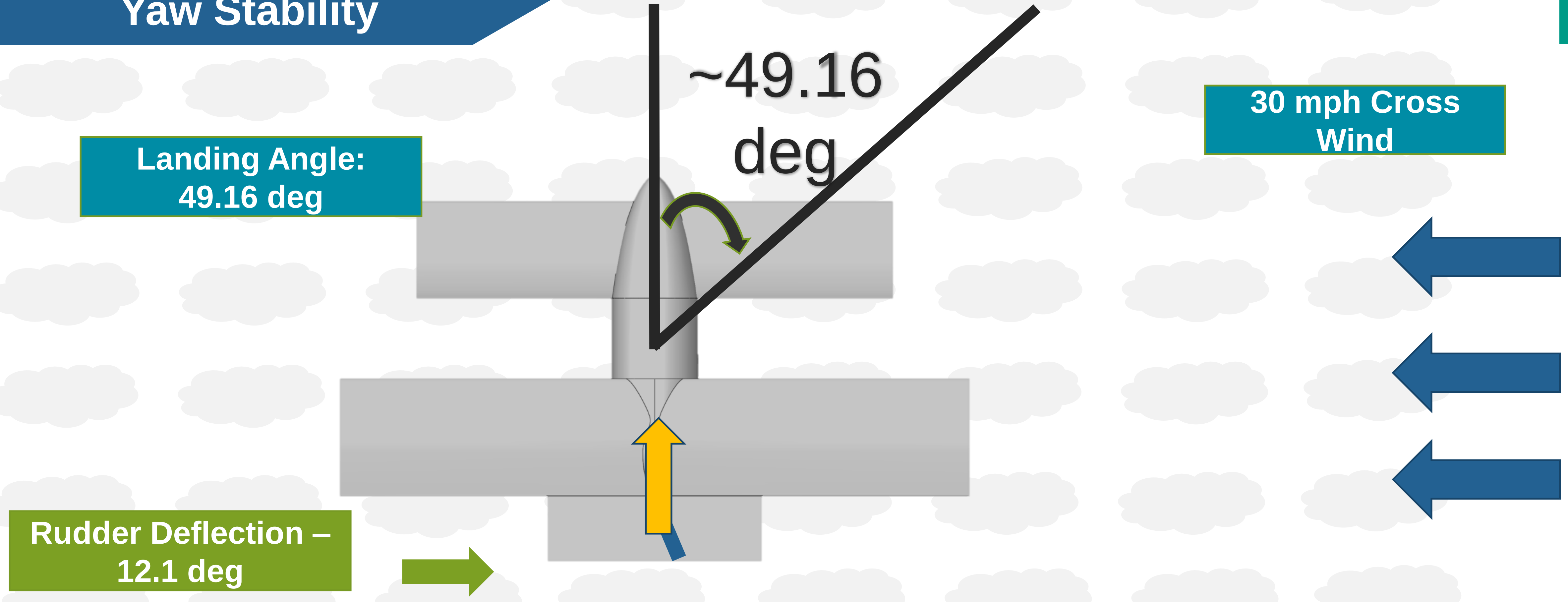




Sasindu Pinto

Redesigned Plane Analysis

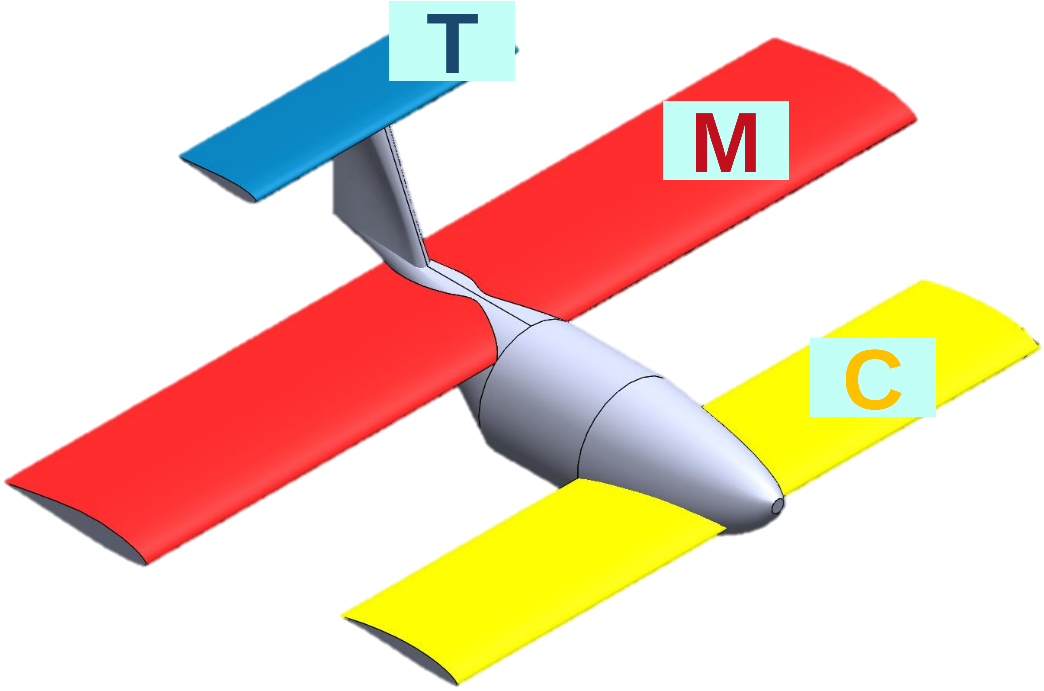
Yaw Stability

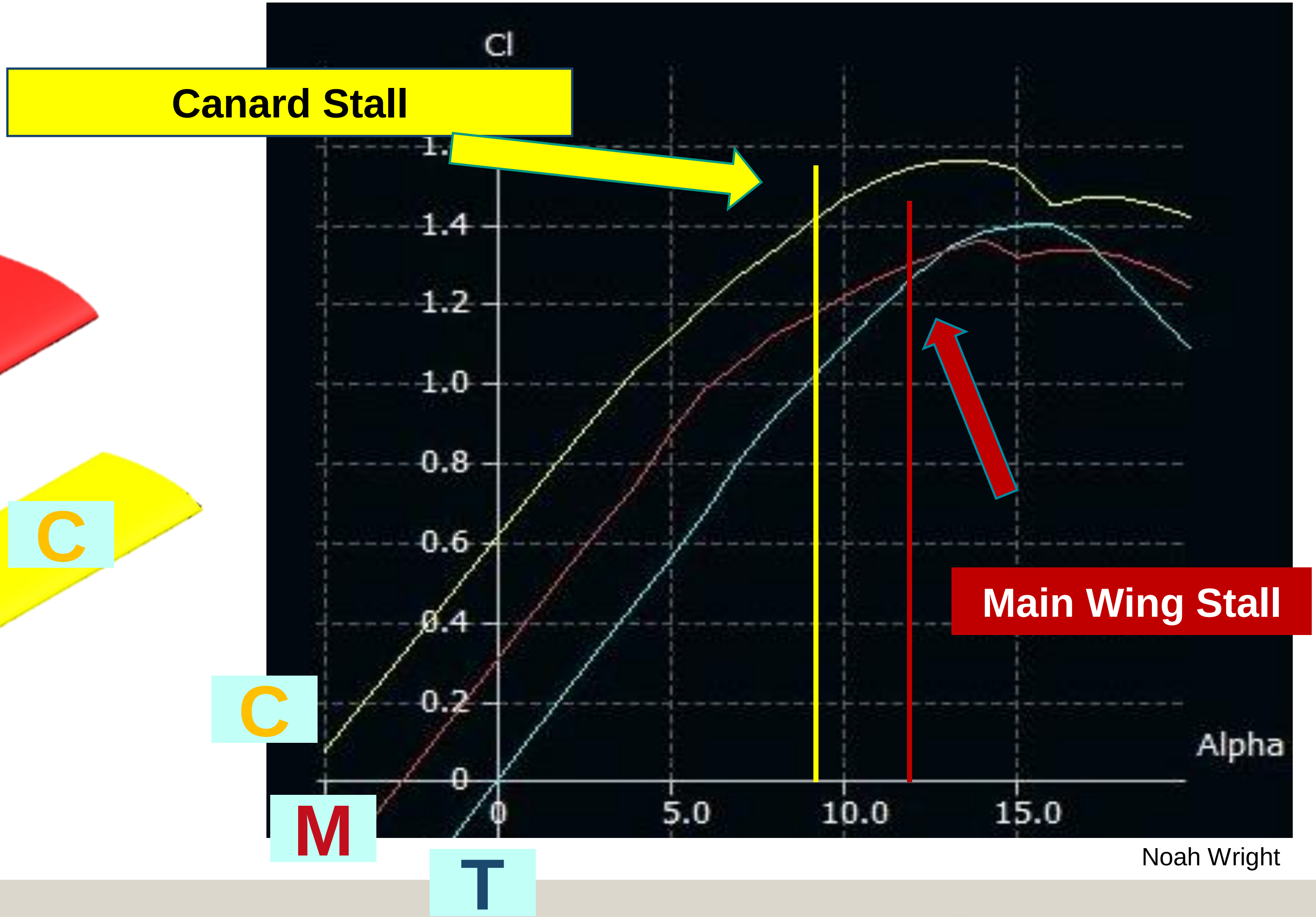


Sasindu Pinto

Redesigned Plane Analysis

Xfoil Analysis

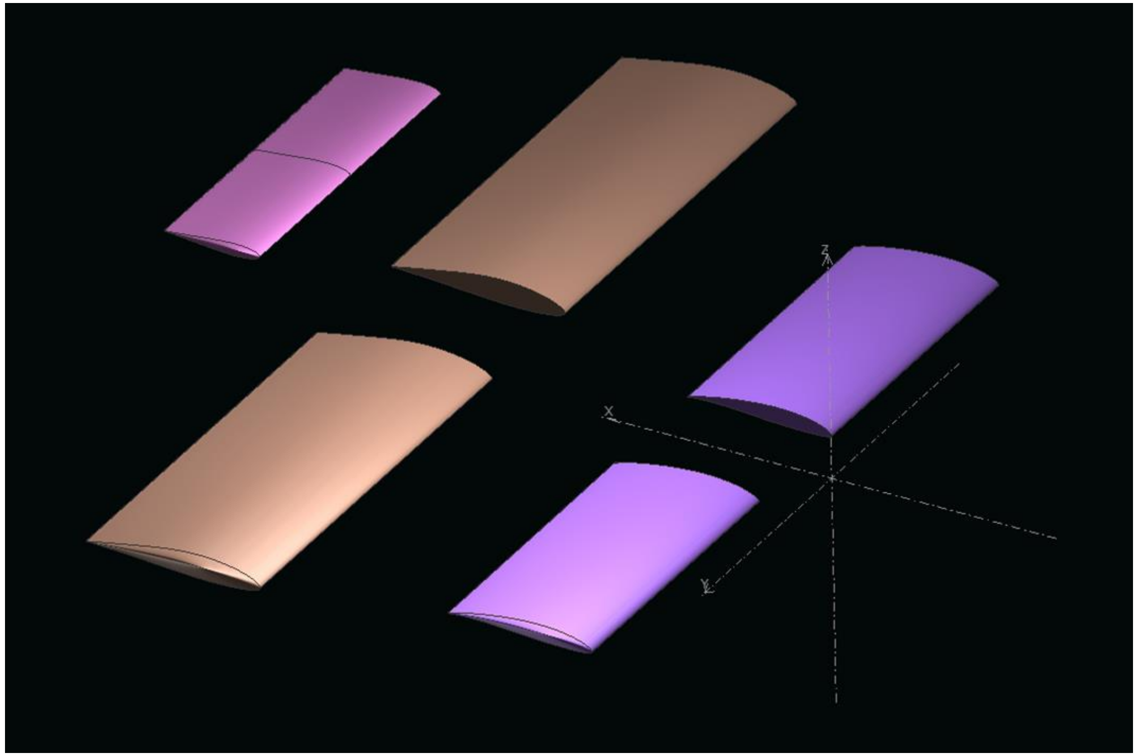




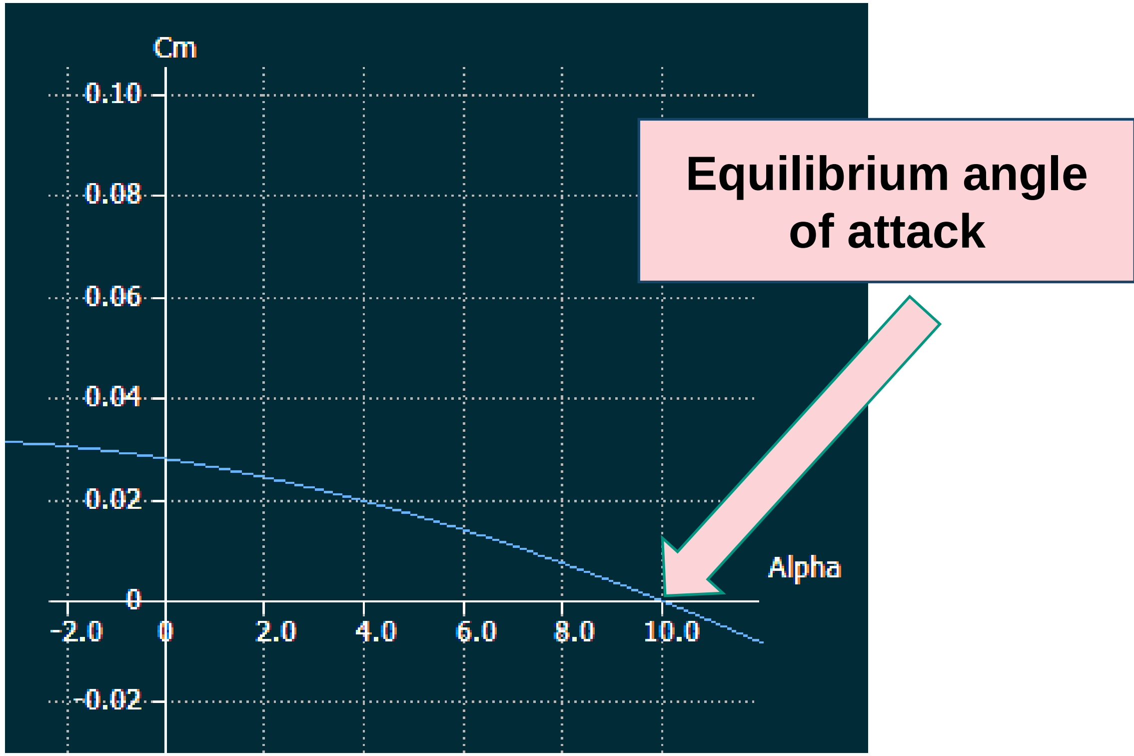
Noah Wright

Redesigned Plane Analysis

XFLR5 Analysis



Current Wing Layout in XFLR5

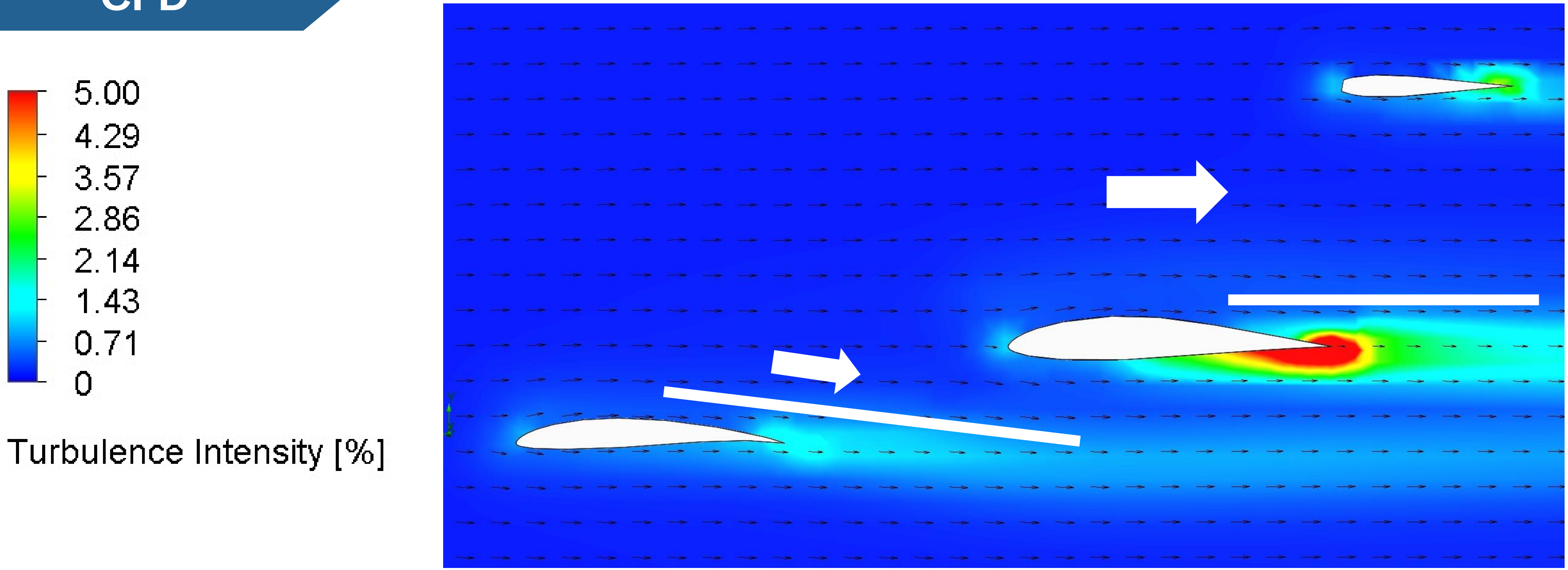


Coefficient of Moment Plot

Noah Wright

Redesigned Plane Analysis

CFD

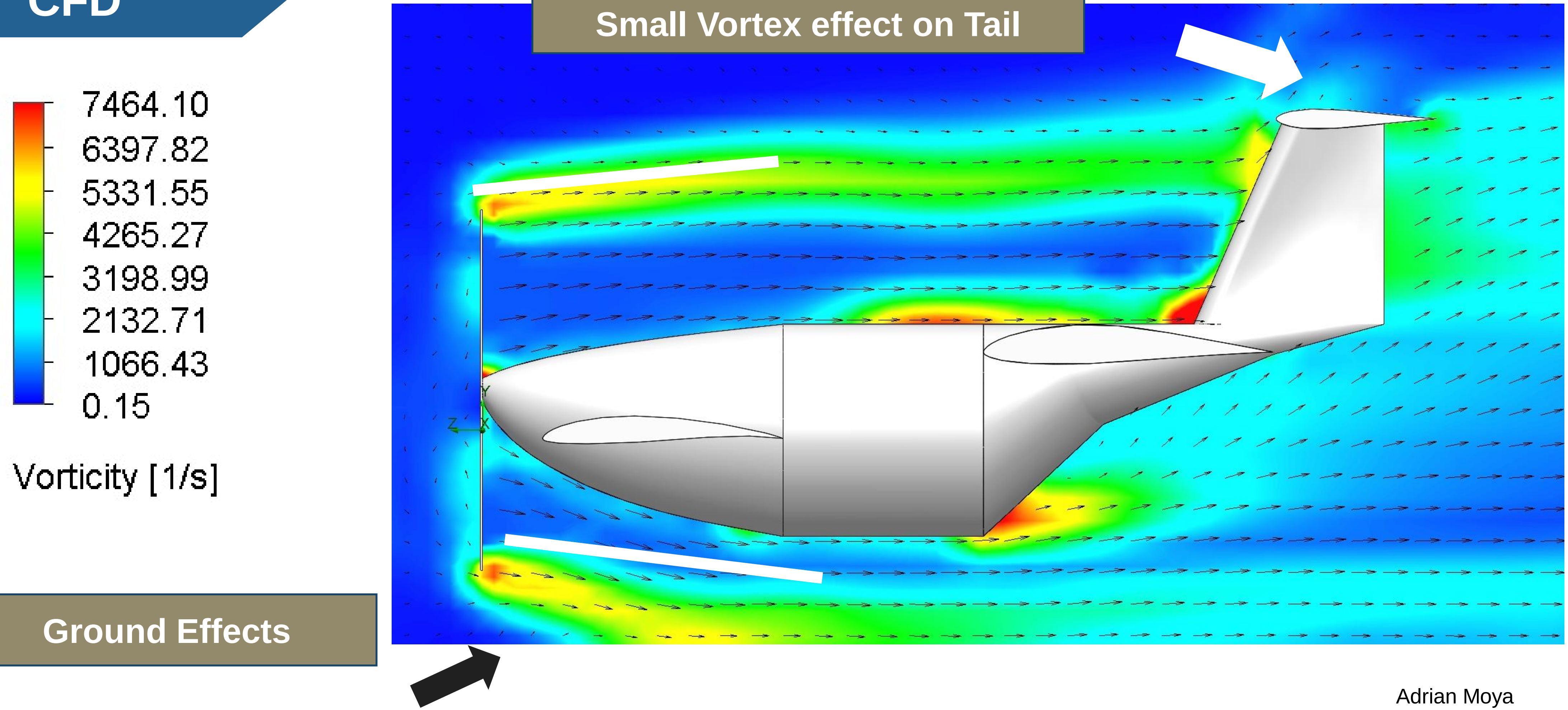


Negligible wake effects between wings

Adrian Moya

Redesigned Plane Analysis

CFD



Small Vortex effect on Tail

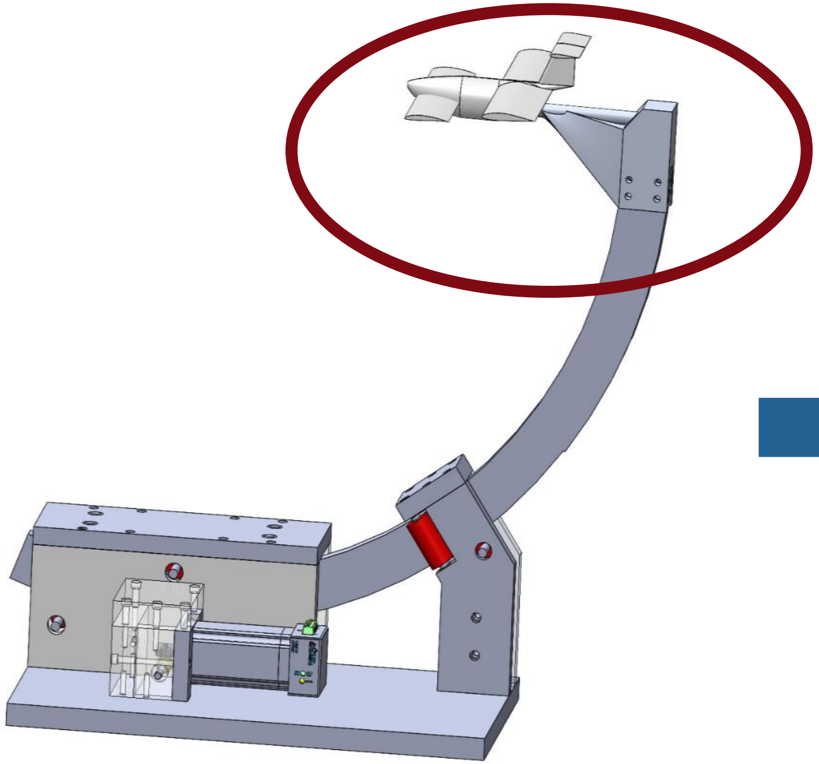
Ground Effects

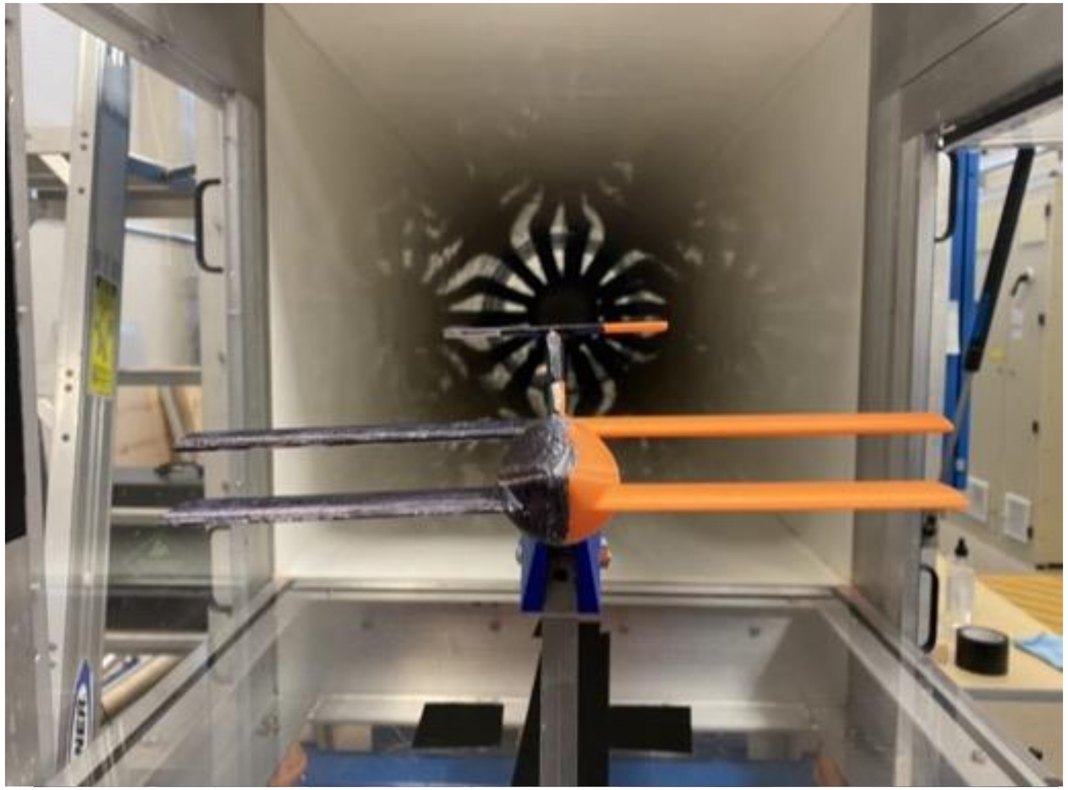
Adrian Moya

Validation and Electronics

Validation and Electronics

Wind Tunnel Test - Setup





Michenell Louis-Charles

Validation and Electronics

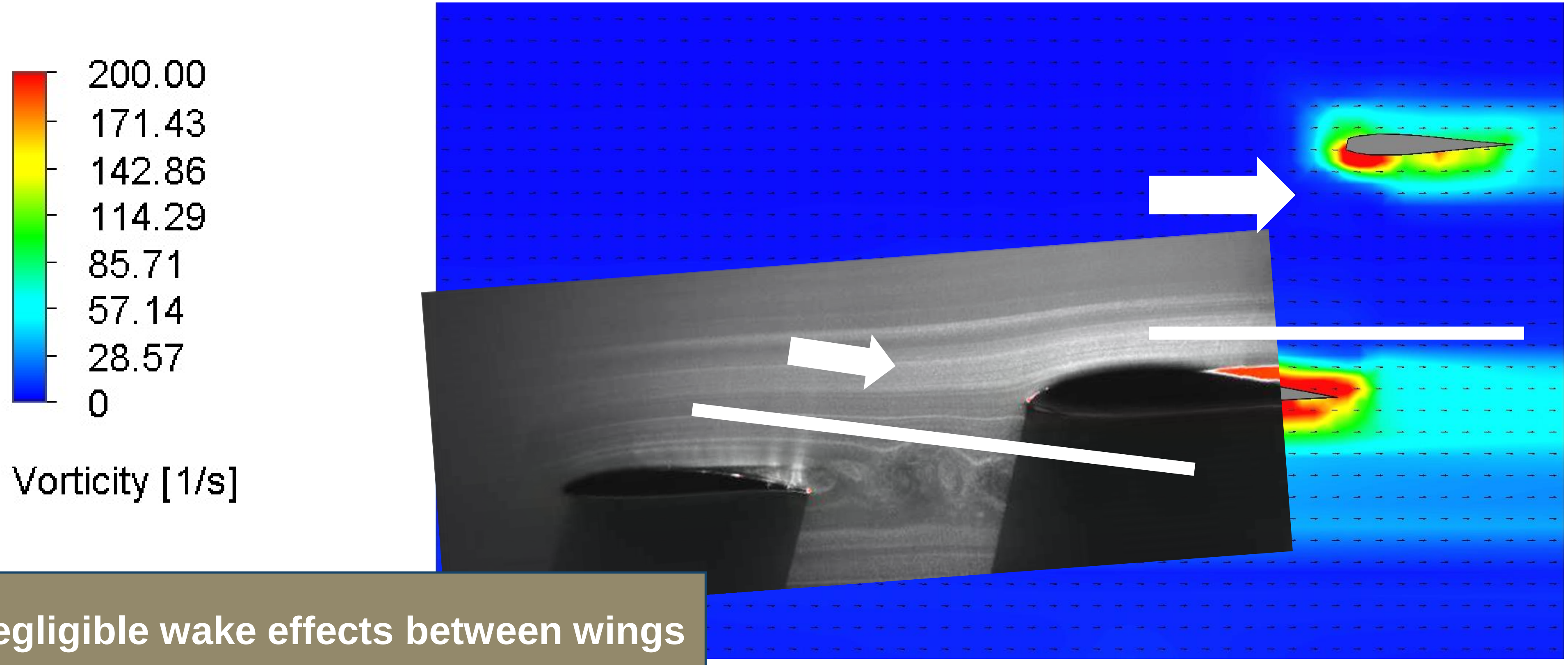
Wind Tunnel Test – Smoke Test

Michenell Louis-Charles

Validation and Electronics

Air Flow – 0 deg AoA

CFD | **Wind Tunnel Test**



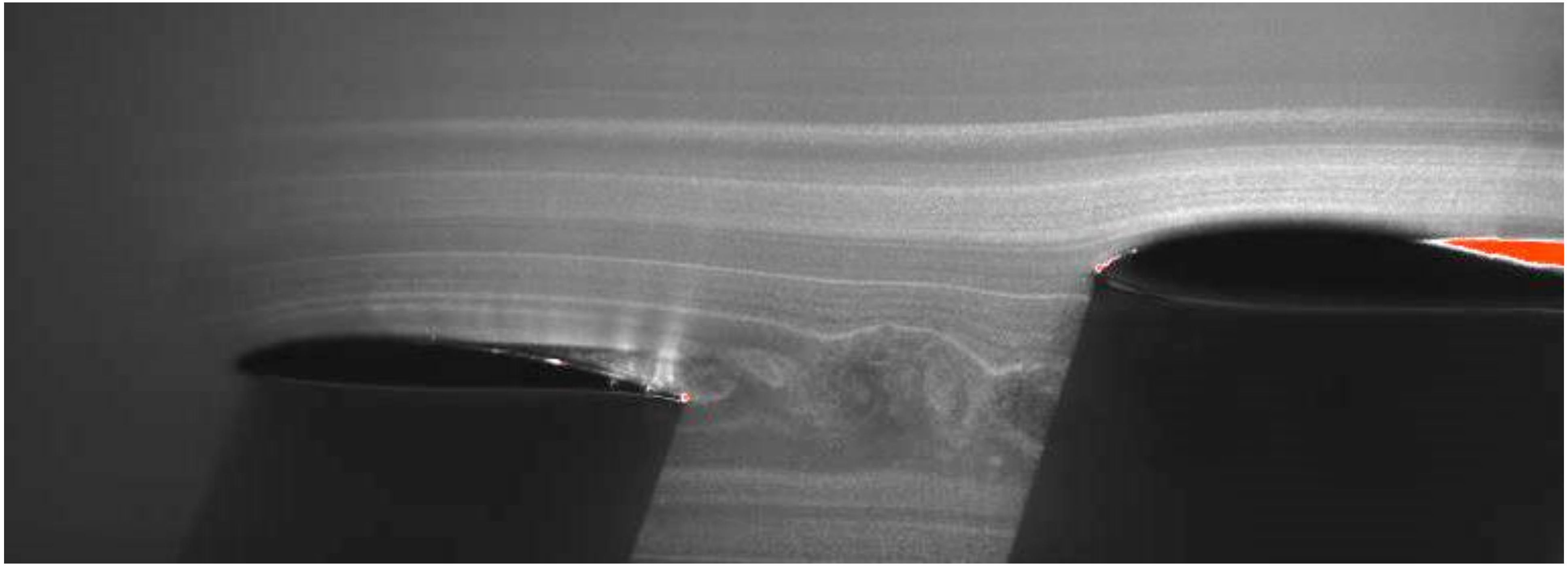
Negligible wake effects between wings

Michenell Louis-Charles

Validation and Electronics

Air Flow – 0 deg AoA

Wind Tunnel Test



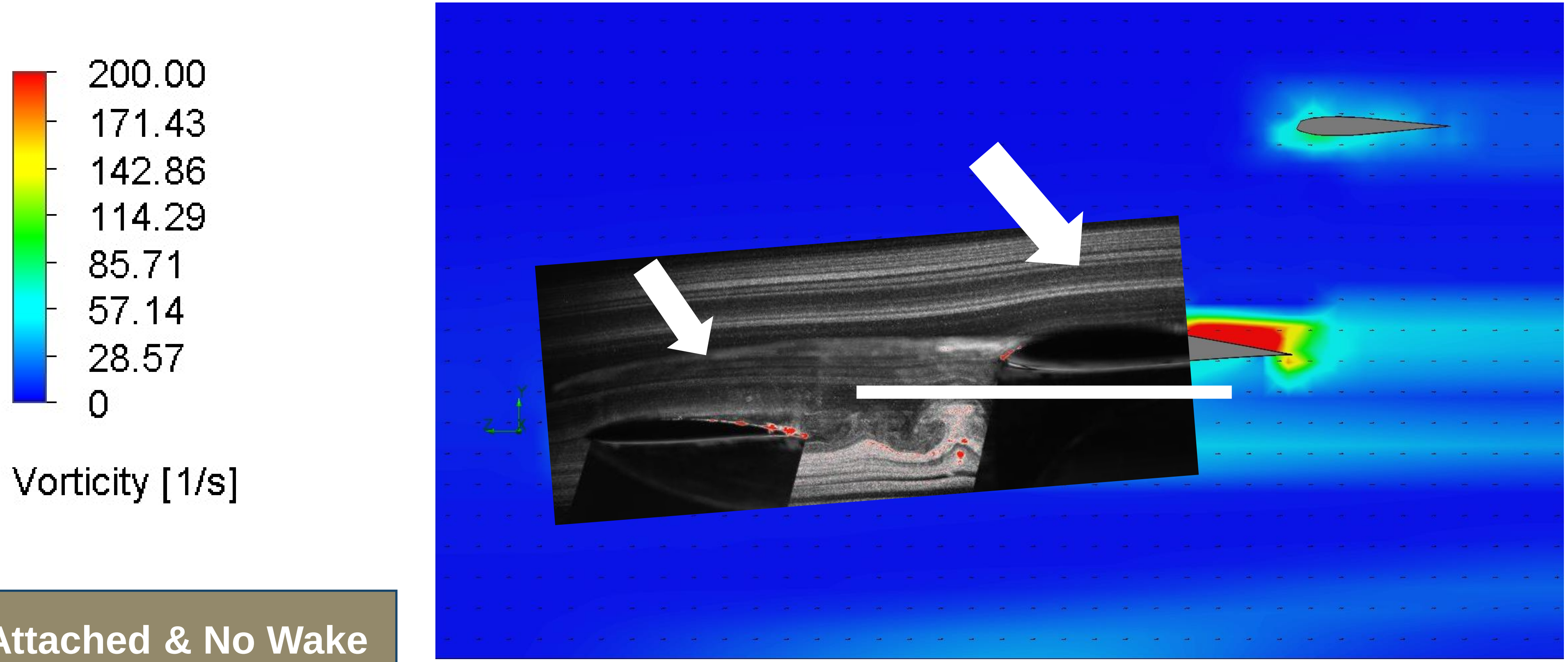
Negligible wake effects between wings

Michenell Louis-Charles

Validation and Electronics

Air Flow– 5 deg AoA

CFD **Wind Tunnel Test**



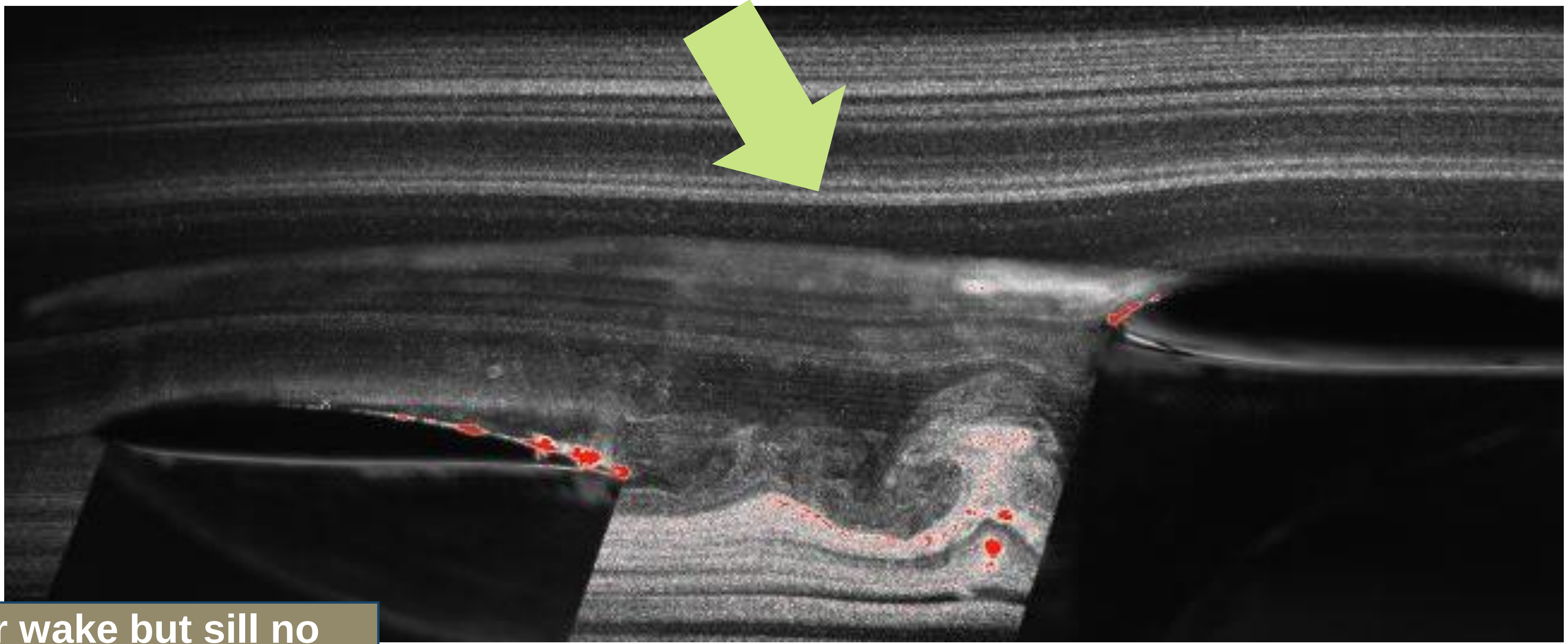
Flow Attached & No Wake

Michenell Louis-Charles

Validation and Electronics

Air Flow– 5 deg AoA

Wind Tunnel Test



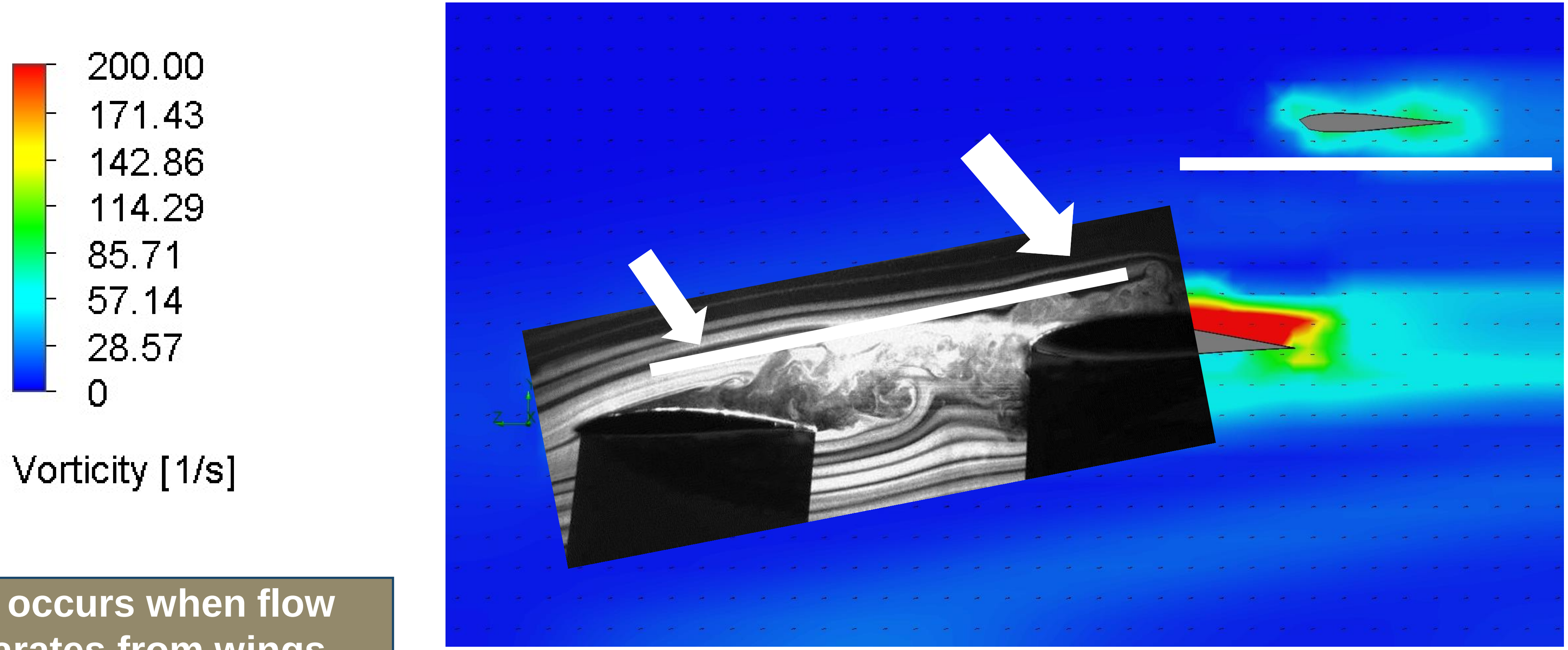
Larger wake but sill no interference

Michenell Louis-Charles

Validation and Electronics

Air Flow – 12 deg AoA

CFD **Wind Tunnel Test**



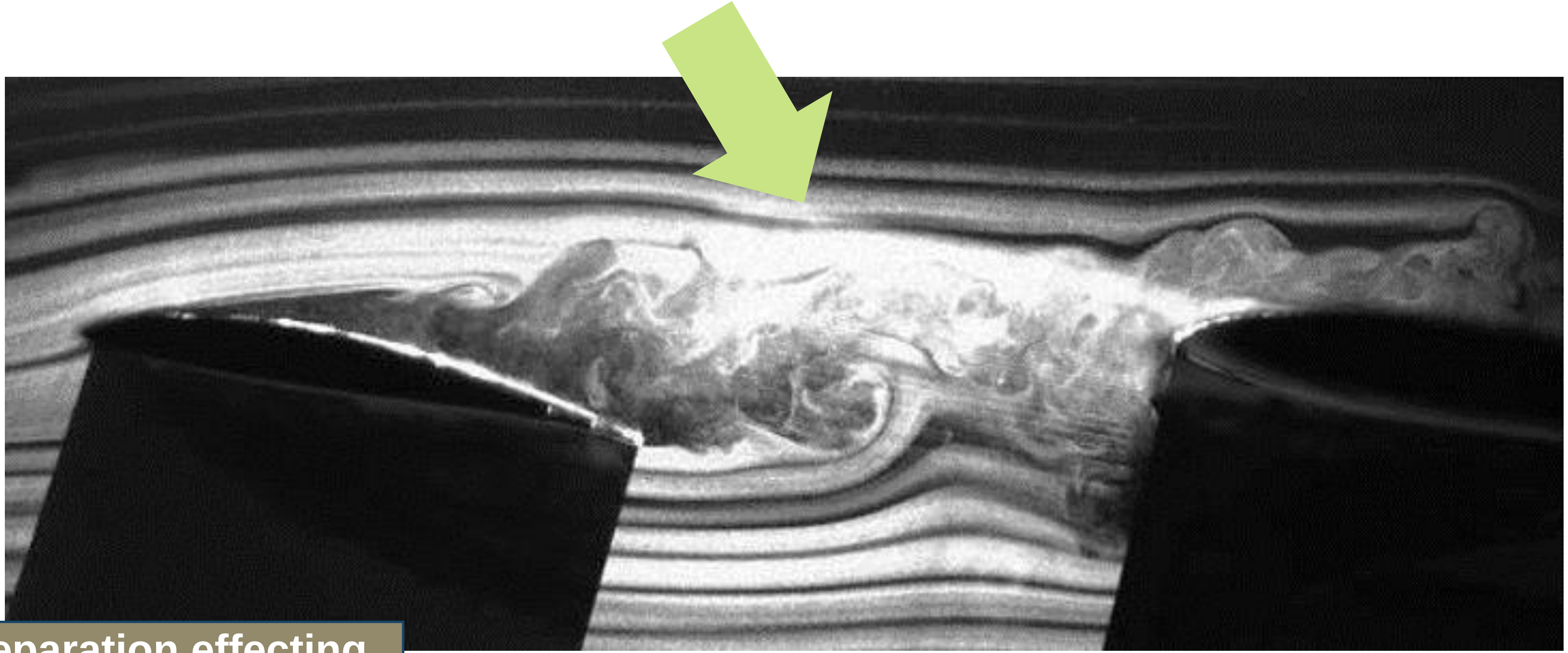
Stall occurs when flow separates from wings

Michenell Louis-Charles

Validation and Electronics

Air Flow – 12 deg AoA

Wind Tunnel Test



Flow separation effecting the main wing

Michenell Louis-Charles

Validation and Electronics

Controller Setup

Throttle (up/down)
Yaw (left/right)

Thrust-cut Button

Pitch (up/down)
Roll (left/right)

Programming the transmitter settings to favor our plane

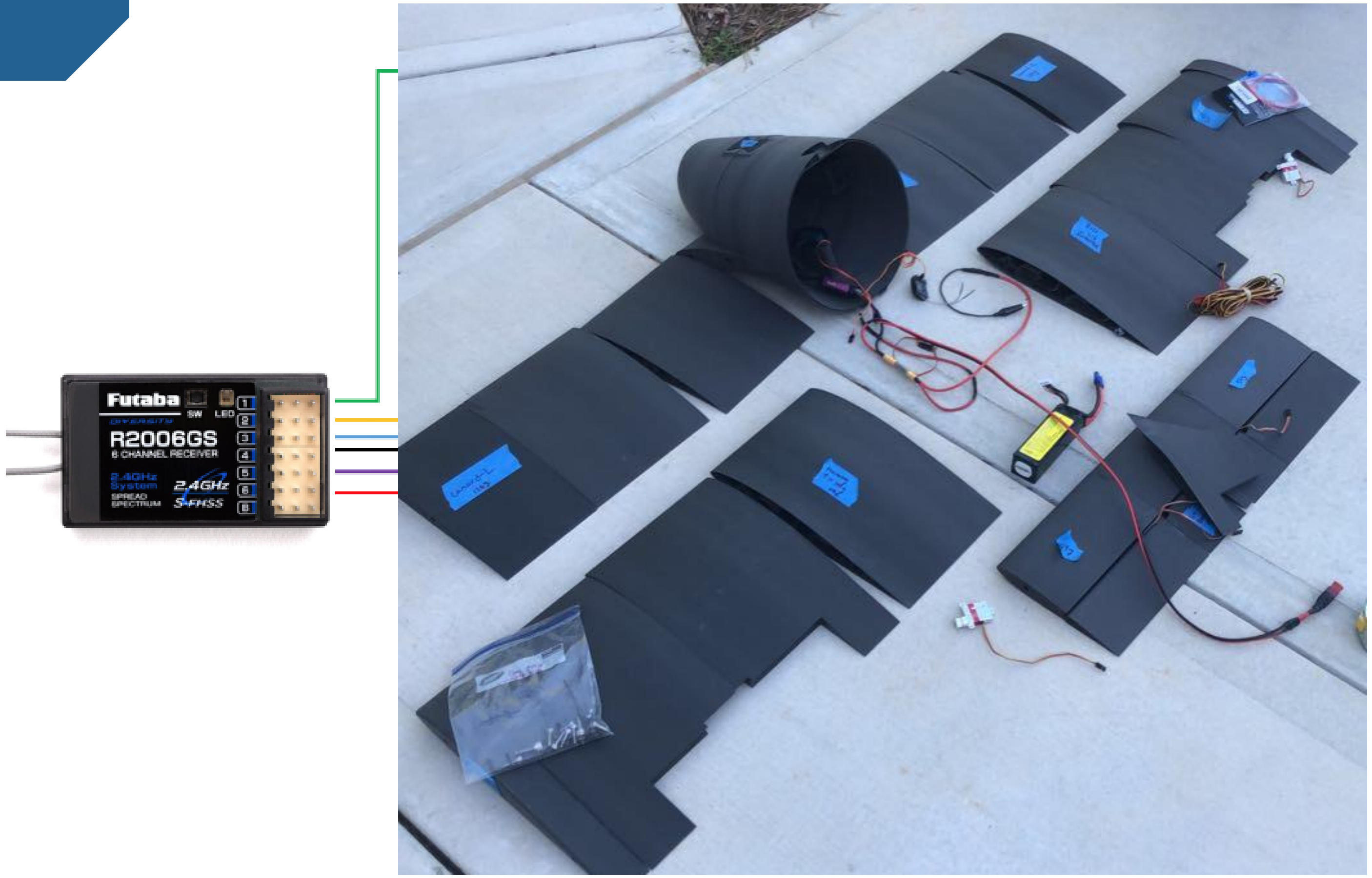
Cameron Riley

Validation and Electronics

Wiring

Method of splicing wires

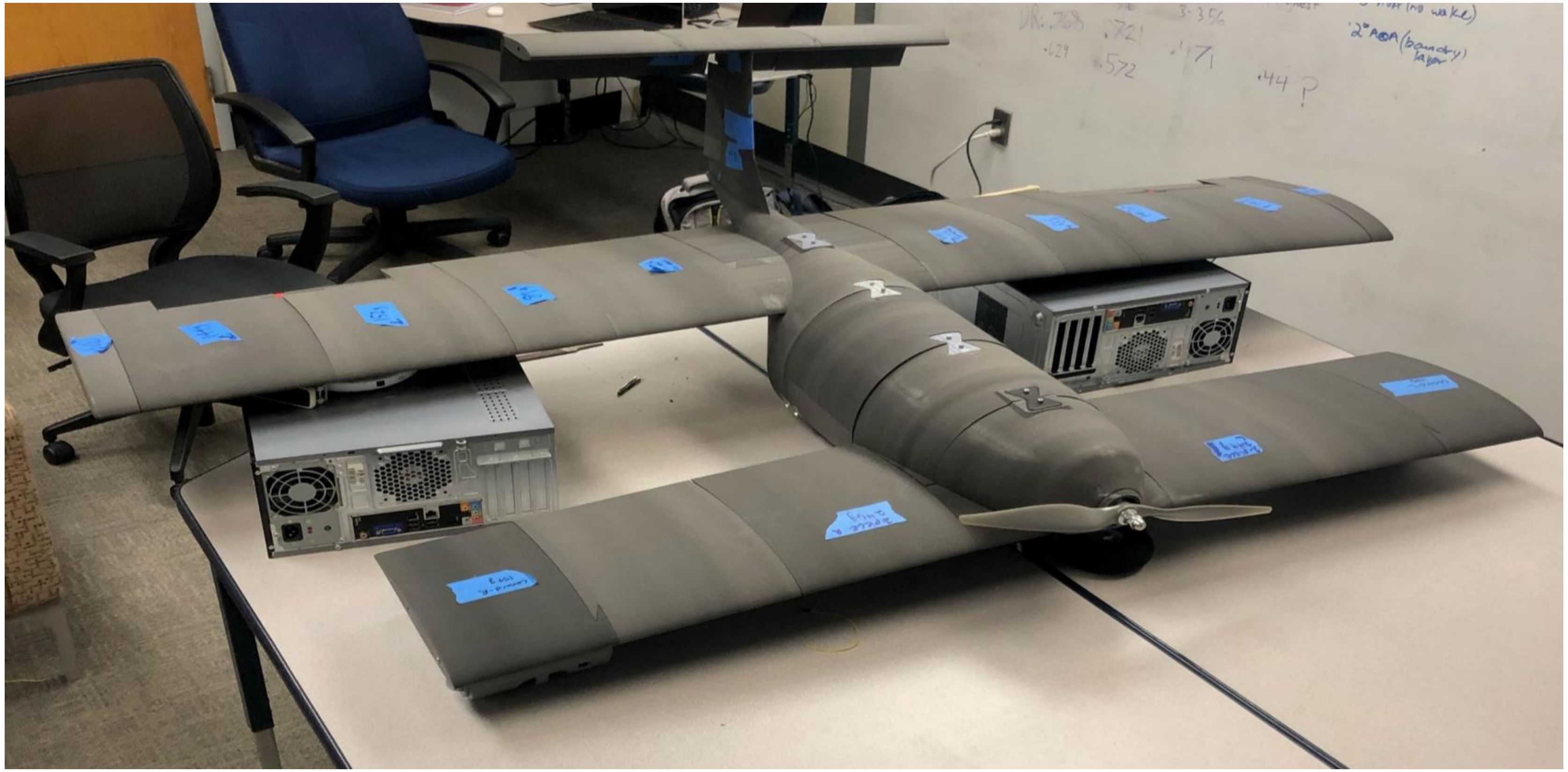
Servo Extension Wires



Cameron Riley

Validation and Electronics

Assembly



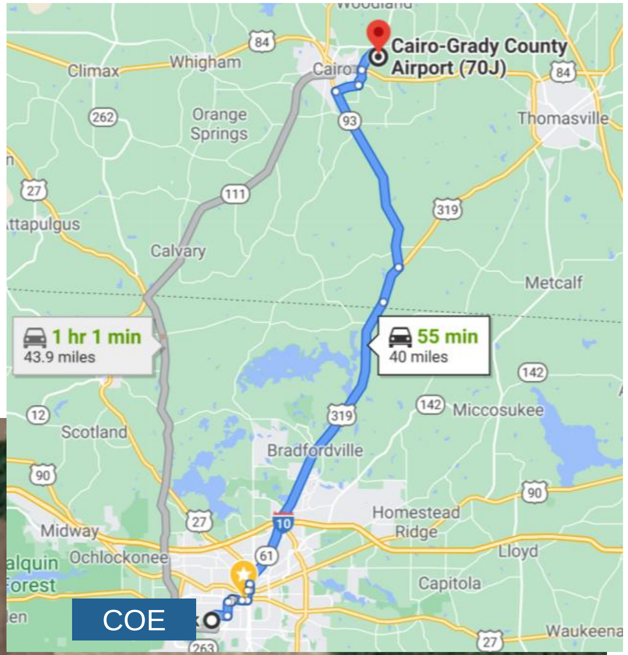
Cameron Riley

Current Work and Takeaways

Current Work and Takeaways

Assembly and Flight Info

- Tested control surface motion
- Tested Front wheel Motion
  - Needs connection print
- Wiring and Assembly
- Test Flight at Cairo County Airport (With R/C Club Assistance)

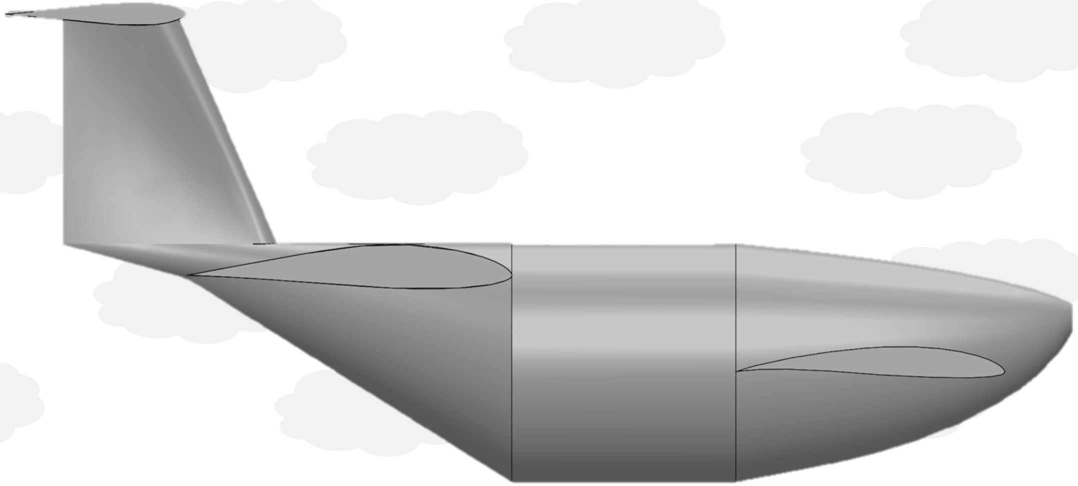


Michenell Louis-Charles

Current Work and Takeaways

Summary

- A Canard Design is possible
  - Tail wing needed for this layout
- Cargo bay between 2 major wings makes the plane stable
- Battery and cargo plate locations are adjustable to alter CG position
- Gear/belt mechanism used to operate control surfaces



Adrian Moya

Current Work and Takeaways

Recommendations

- **Finalize a design and finish calculations by early December**
  - **Test print to correlate density**
- **Use optimization to find the best wing placements**
- **Contact Dr. Kumar about Stability Calculation**
  - **Use Fund. Of Aero by J. Anderson for stability calculations**
  - **Use Systems Engineering Aircraft Design book by M. Sadraey**
- **Test control surface motion setup early**
- **Contact R/C Club about plane design and control**

Adrian Moya

References

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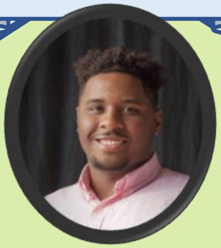
Tail Types. What-When-How. N.d. http://what-when-how.com/flight/tail-designs/

Cameron Riley

LinkedIn Information

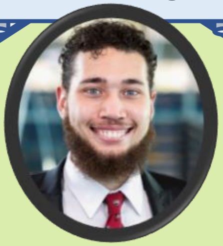
Sasindu Pinto

Cameron Riley



Michenell Louis-Charles

Noah Wright



Adrian Moya

Backup Slides

Old Design Info

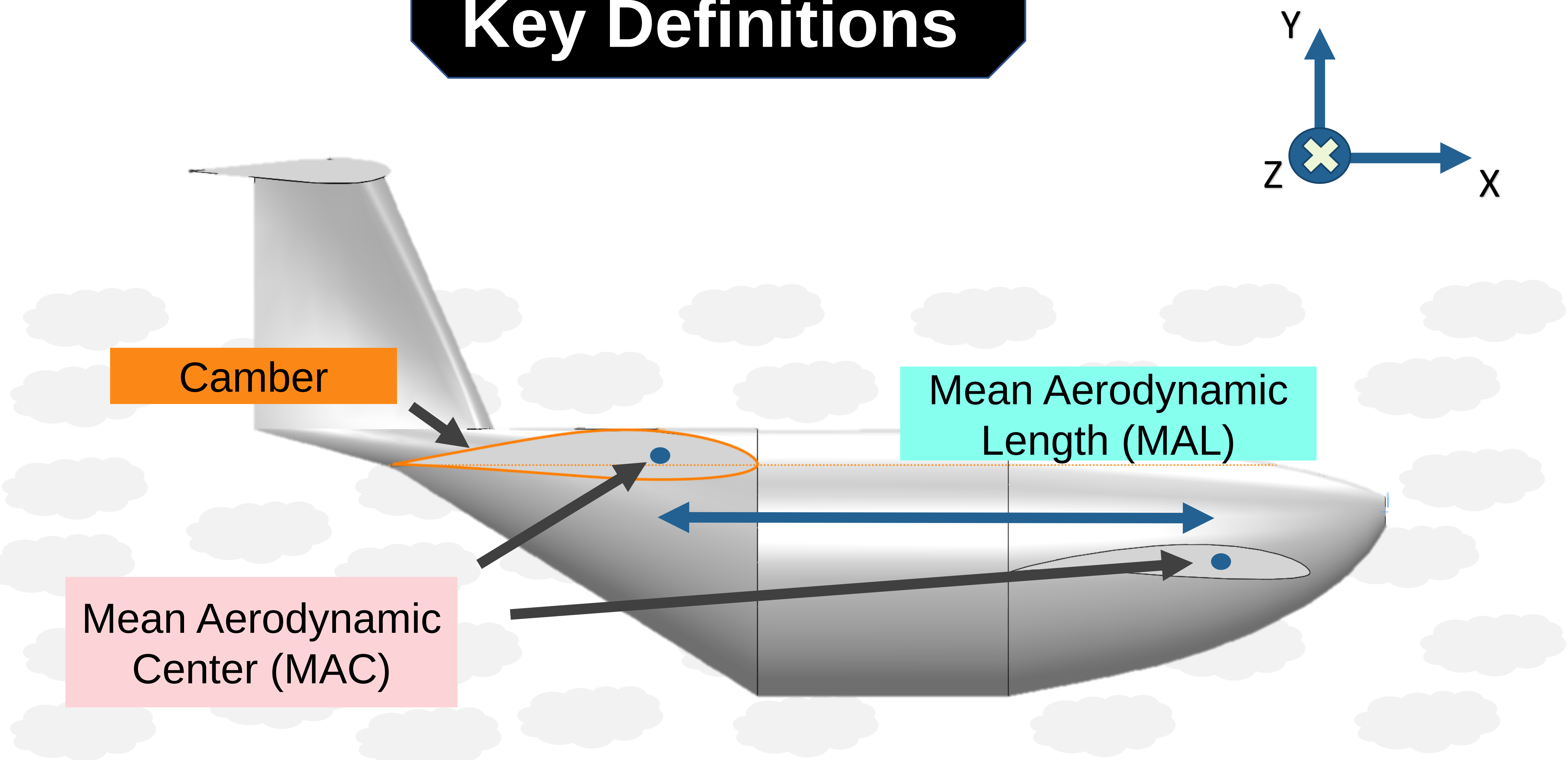
PIV

FD/BPC

AHP

Math

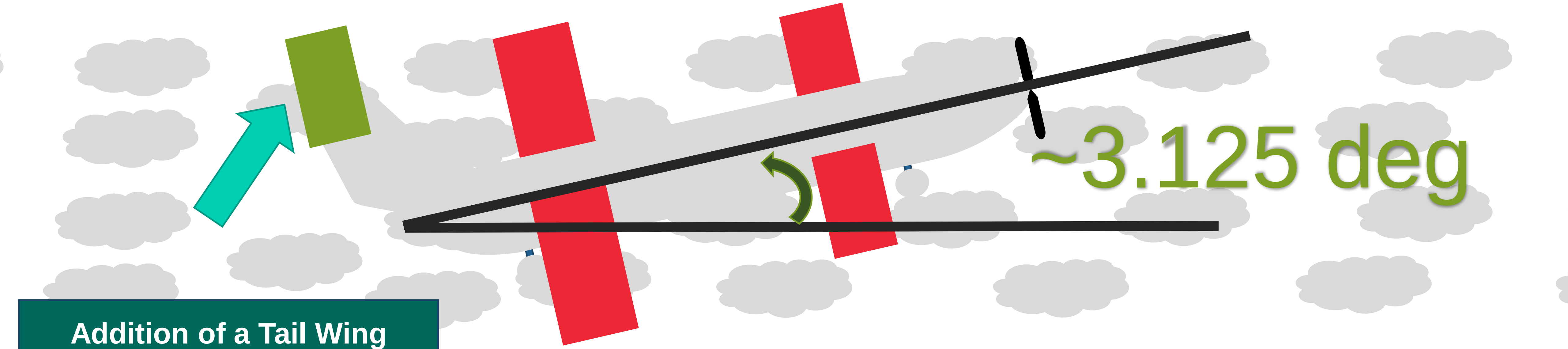
Key Definitions



Noah Wright

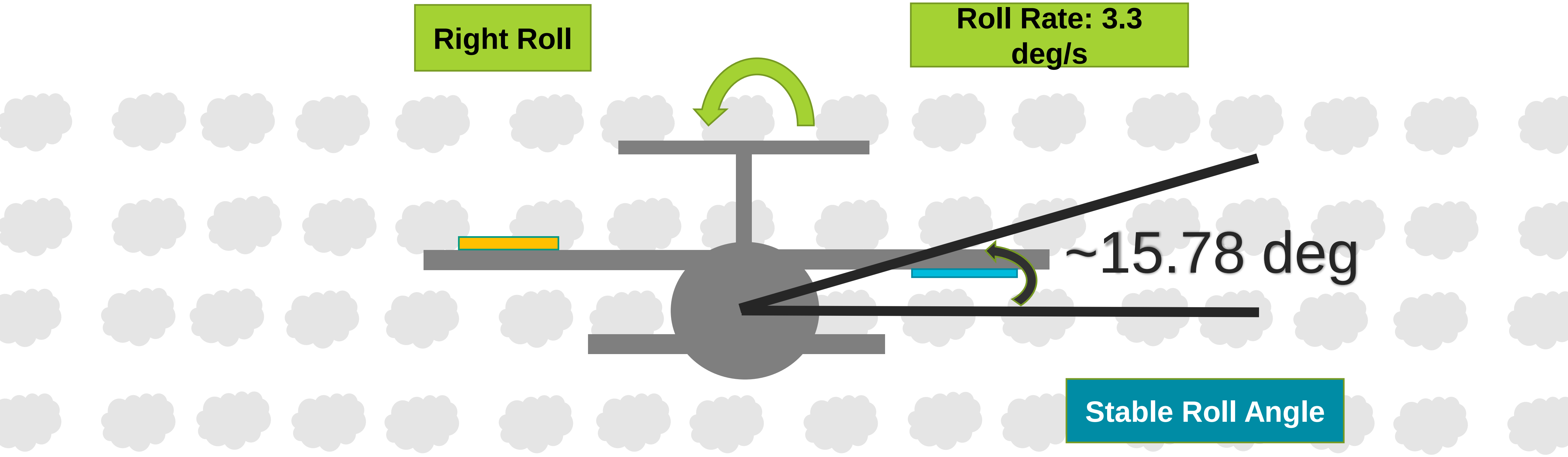
Initial Design - Pitch Stability

Equilibrium Angle of Attack



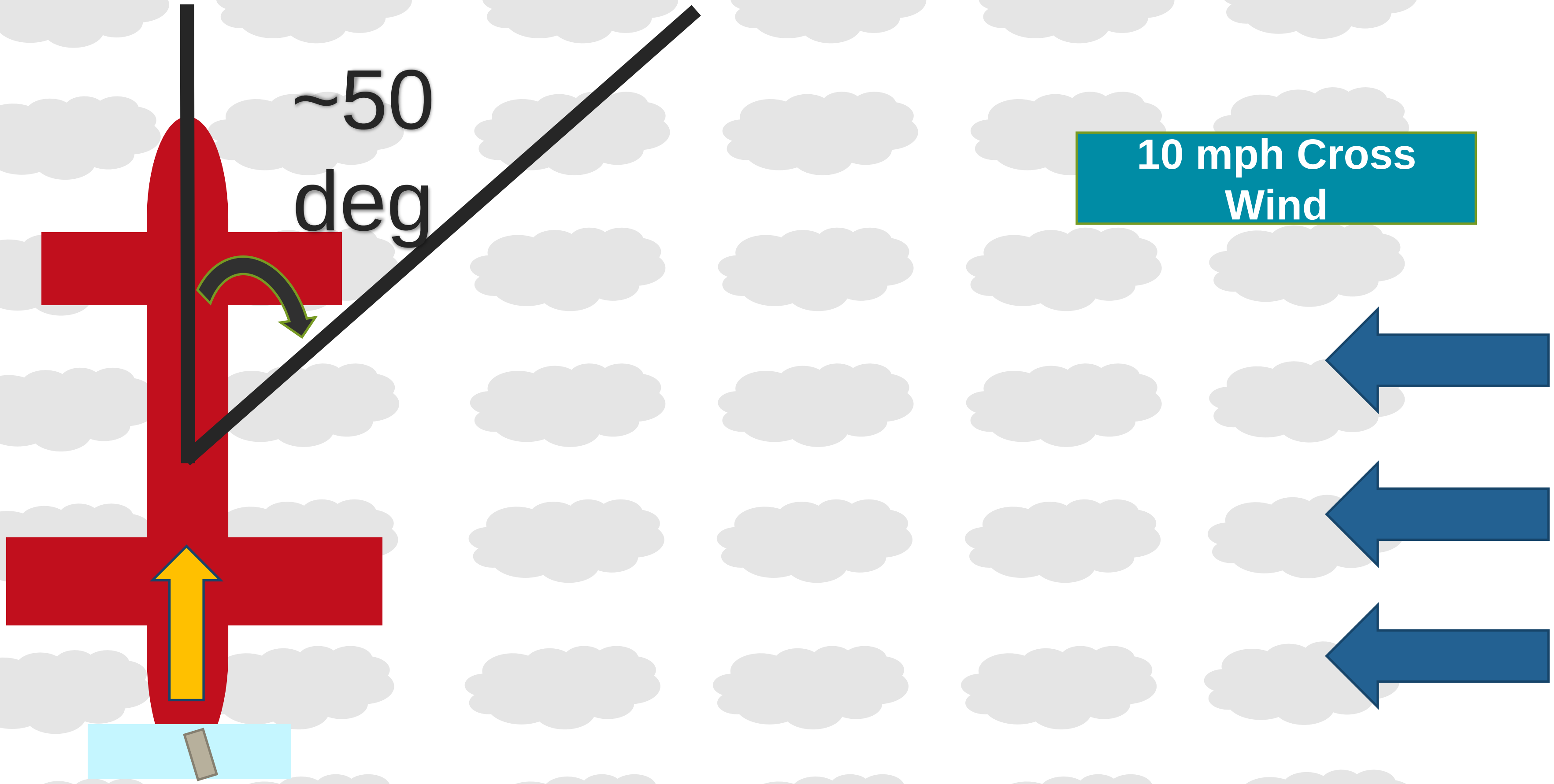
Addition of a Tail Wing

Initial Design - Roll Stability



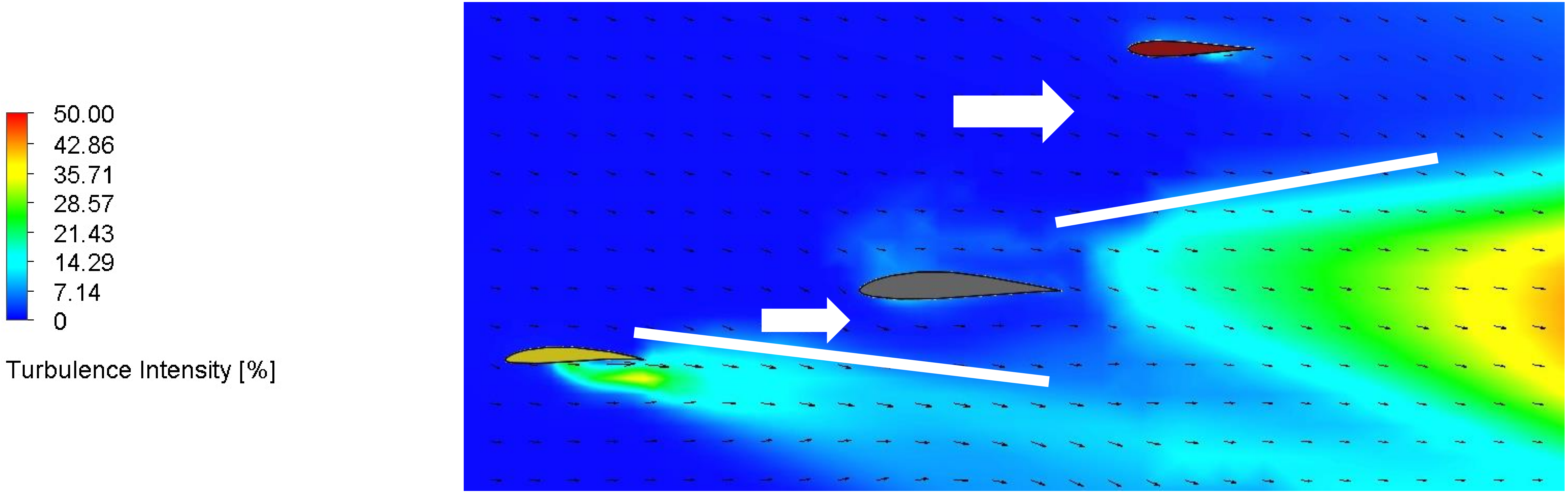
Yaw Stability – Operation

Landing Angle: 50 deg



Initial Design

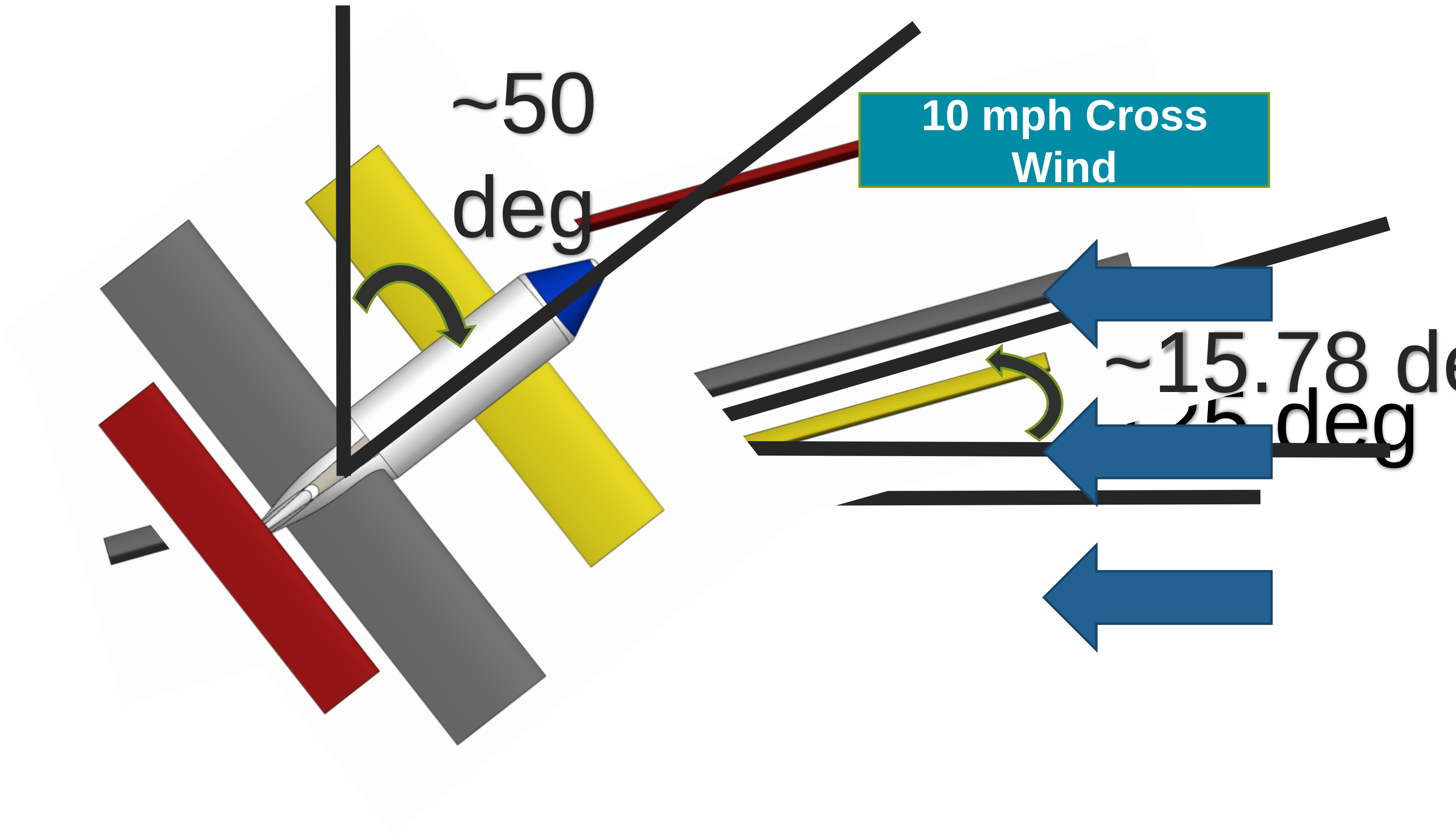
CFD – Wing Turbulence



Initial Design Summary

Preliminary Design Analysis

- Equilibrium Angle – 3.125 deg
- Roll Stability at 15.78 deg
- Yaw Stability for 30 mph wind at 50 deg



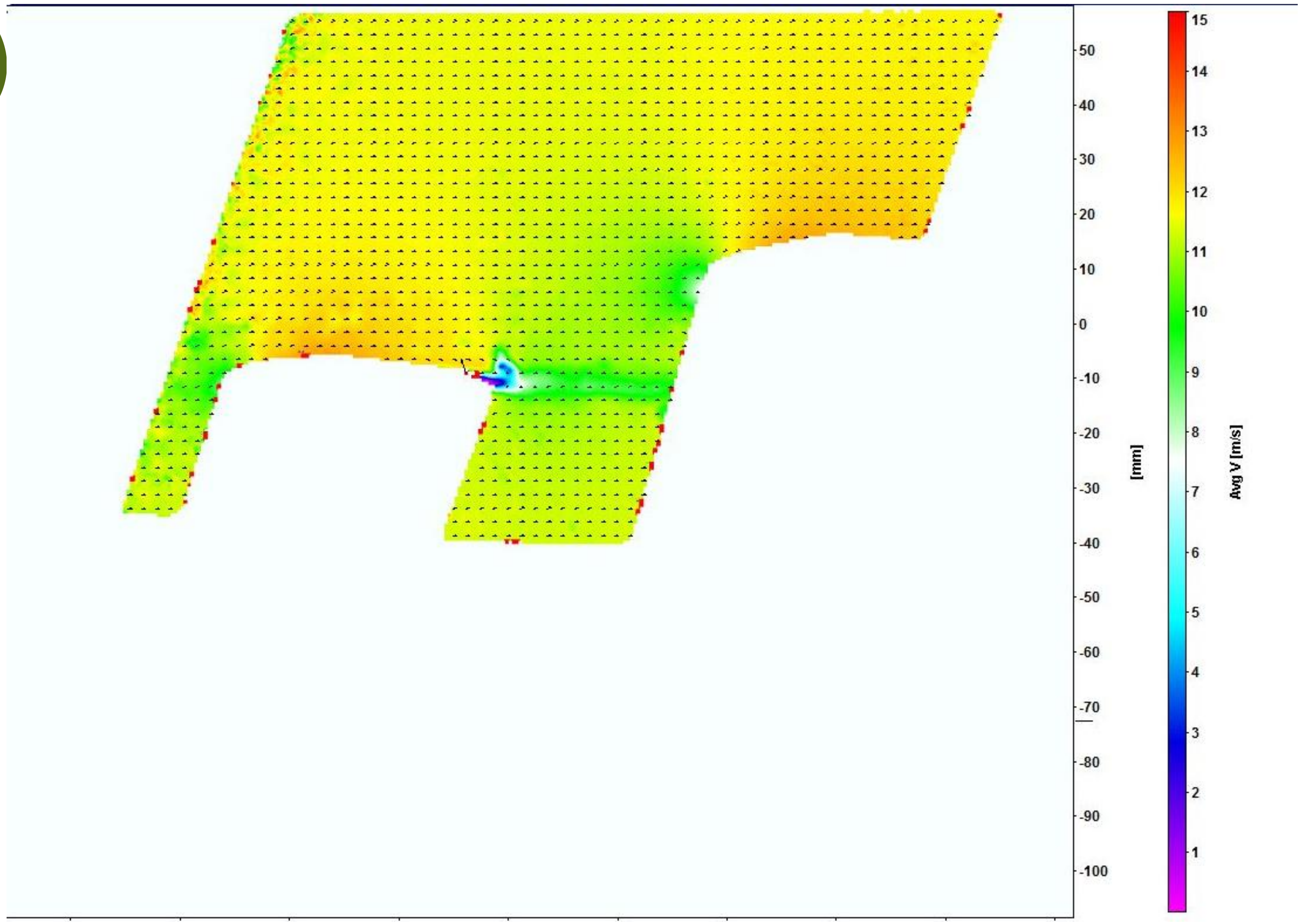
PIV Analysis

Wind Tunnel Test – PIV Test Video

Photosensitive Video

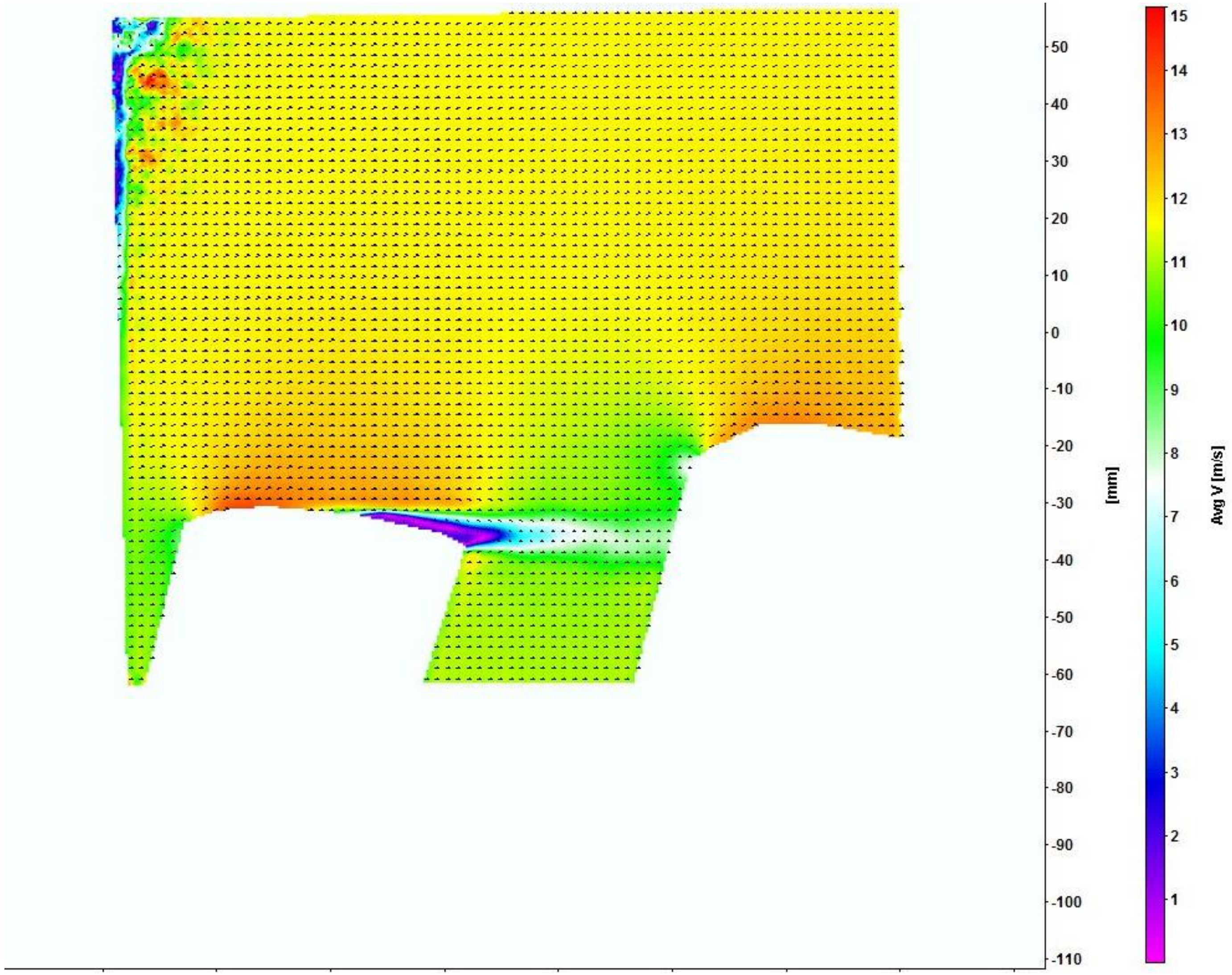
PIV Test

Wind Tunnel Test – PIV 0 deg



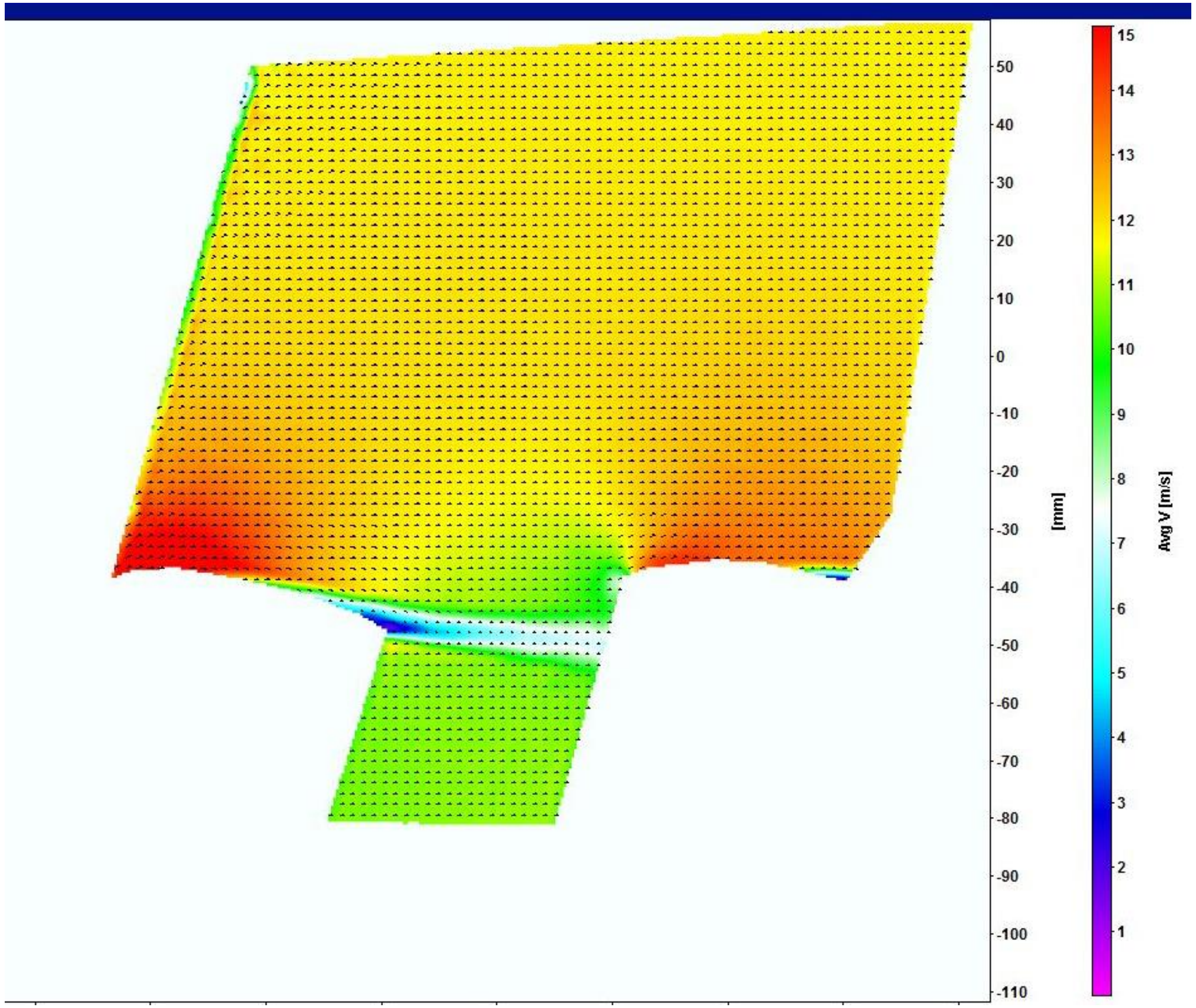
PIV Test

Wind Tunnel Test – PIV 5 deg



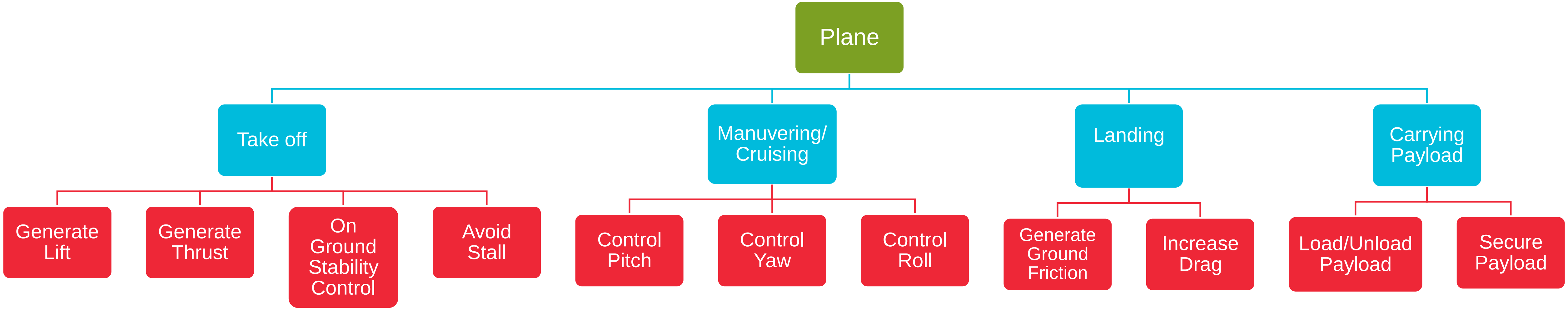
PIV Test

Wind Tunnel Test – PIV 12 deg



Functional Decomposition

Systems Chart



Concept Generation

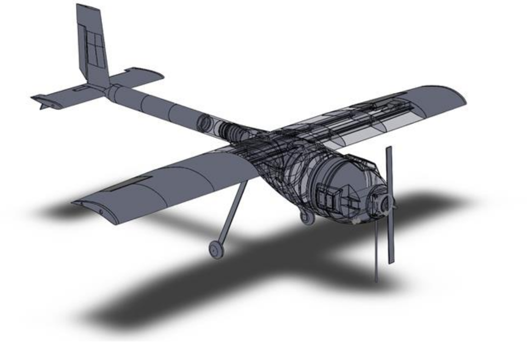
Medium and High Fidelity

- Methods used
  - Morphological Analysis
  - Biomimicry
  - Competitive Benchmarking
  - Crapshoot

Concept Generation

Medium and High Fidelity

1. Boomtown



2. Rutan Long EZ

3. Rutan Quickie Q2

4. Boeing 747 Dreamlifter

5. Cessna 208 Grand Caravan

6. OMAC Laser 300

7. Aero Spacelines Super Guppy

8. Kawasaki C-2

Binary Pairwise Comparison

Binary Pairwise Comparison													
	1	2	3	4	5	6	7	8	9	10	11	12	Total
1. Material	-	0	0	0	0	0	0	1	0	0	0	0	1
2. Stability	1	-	0	0	0	1	1	1	1	0	0	1	6
3. CG in front of CP	1	1	-	1	1	1	1	1	1	1	1	1	10
4. Meet takeoff/landing requirements	1	1	0	-	1	1	1	0	1	0	0	1	7
5. Wingspan meets restrictions	1	1	0	0	-	1	1	1	1	0	0	1	7
6. Sufficient Power	1	0	0	0	0	-	0	0	1	1	1	1	5
7. Maneuverability	1	0	0	0	0	1	-	0	1	0	0	1	4
8. Light Weight	0	0	0	1	0	1	1	-	1	1	0	1	6
9. Touch-down Impact	1	0	0	0	0	0	0	0	-	0	0	1	2
10. Ground Controls	1	1	0	1	1	0	1	0	1	-	1	1	7
11. Carry the Minimum Cargo Load Required	1	1	0	1	1	0	1	1	1	0	-	1	8
12. Easy to Load/Unload	1	0	0	0	0	0	0	0	0	0	0	-	1
Total	10	5	0	4	4	6	7	5	9	4	3	10	-

Presenter: AM

Binary Pairwise Comparison

Binary Pairwise Comparison													
	1	2	3	4	5	6	7	8	9	10	11	12	Total
1. Material	-	0	0	0	0	0	0	1	0	0	0	0	1
2. Stability	1	-	0	0	0	1	1	1	1	0	0	1	6
3. CG in front of CP	1	1	-	1	1	1	1	1	1	1	1	1	10
4. Meet takeoff/landing requirements	1	1	0	-	1	1	1	0	1	0	0	1	7
5. Wingspan meets restrictions	1	1	0	0	-	1	1	1	1	0	0	1	7
6. Sufficient Power	1	0	0	0	0	-	0	0	1	1	1	1	5
7. Maneuverability	1	0	0	0	0	1	-	0	1	0	0	1	4
8. Light Weight	0	0	0	1	0	1	1	-	1	1	0	1	6
9. Touch-down Impact	1	0	0	0	0	0	0	0	-	0	0	1	2
10. Ground Controls	1	1	0	1	1	0	1	0	1	-	1	1	7
11. Carry the Minimum Cargo Load Required	1	1	0	1	1	0	1	1	1	0	-	1	8
12. Easy to Load/Unload	1	0	0	0	0	0	0	0	0	0	0	-	1
Total	10	5	0	4	4	6	7	5	9	4	3	10	-

Presenter: AM

House of Quality

House of Quality													
		Engineering Characteristics (***From Main Targets***)											
Improvement Direction		↑	↓	↑	↑	↑	↑	↑	↓	↓	↑	↑	=
Units		lbf	lbf	lbf	degrees	ft/s	ft/s^2	degrees	seconds	lbs	ft/s^2	psi	psi
Customer Requirements	Importance Weight Factor	Lift	Drag	Thrust	Max Angle of Attack	Stall Speed	Acceleration	Control Surface Movement	Loading/ Unloading Time	Weight	Deceleration	Joint Strength	Material Strength
1. Material	1		1							9		9	9
2. Stability	6	9	3	3				9					
3. CG in front of CP	10	9	3	9	9	9		9		3			
4. Meet takeoff/landing requirements	7	9	3	9			9				9		
5. Wingspan meets restrictions	7	9	3		3	3		1				3	3
6. Sufficient Power	5	1	1	3			3	3		1	1		
7. Maneuverability	4				3	3		9		3		3	1
8. Light Weight	6	3		3			3			9	3		
9. Touch-down Impact	2							3		3	9	9	9
10. Ground Controls	7							1					
11. Carry the Minimum Cargo Load Required	8	9		3			3		9	9	3	9	9
12. Easy to Load/Unload	1								9	3		3	
Raw Score		365	96	228	123	123	120	215	81	191	128	135	124
Relative Weight %		18.92	4.98	11.82	6.38	6.38	6.22	11.15	4.20	9.90	6.64	7.00	6.43
Rank Order		1	11	2	6	6	10	3	12	4	8	5	9

Presenter: SP

House of Quality

House of Quality													
		Engineering Characteristics (***From Main Targets***)											
Improvement Direction		↑	↓	↑	↑	↑	↑	↑	↓	↓	↑	↑	=
Units		lbf	lbf	lbf	degrees	ft/s	ft/s^2	degrees	seconds	lbs	ft/s^2	psi	psi
Customer Requirements	Importance Weight Factor	Lift	Drag	Thrust	Max Angle of Attack	Stall Speed	Acceleration	Control Surface Movement	Loading/ Unloading Time	Weight	Deceleration	Joint Strength	Material Strength
1. Material	1		1							9		9	9
2. Stability	6	9	3	3				9					
3. CG in front of CP	10	9	3	9	9	9		9		3			
4. Meet takeoff/landing requirements	7	9	3	9			9				9		
5. Wingspan meets restrictions	7	9	3		3	3		1				3	3
6. Sufficient Power	5	1	1	3			3	3		1	1		
7. Maneuverability	4				3	3		9		3		3	1
8. Light Weight	6	3		3			3			9	3		
9. Touch-down Impact	2							3		3	9	9	9
10. Ground Controls	7							1					
11. Carry the Minimum Cargo Load Required	8	9		3			3		9	9	3	9	9
12. Easy to Load/Unload	1								9	3		3	
Raw Score		365	96	228	123	123	120	215	81	191	128	135	124
Relative Weight %		18.92	4.98	11.82	6.38	6.38	6.22	11.15	4.20	9.90	6.64	7.00	6.43
Rank Order		1	11	2	6	6	10	3	12	4	8	5	9

Presenter: SP

House of Quality

House of Quality													
		Engineering Characteristics (***From Main Targets***)											
Improvement Direction		Up	Down	Up	Up	Up	Up	Up	Down	Down	Up	Up	Equal
Units		lbf	lbf	lbf	degrees	ft/s	ft/s^2	degrees	seconds	lbs	ft/s^2	psi	psi
Customer Requirements	Importance Weight Factor	Lift	Drag	Thrust	Max Angle of Attack	Stall Speed	Acceleration	Control Surface Movement	Loading/ Unloading Time	Weight	Deceleration	Joint Strength	Material Strength
1. Material	1		1							9		9	9
2. Stability	6	9	3	3				9					
3. CG in front of CP	10	9	3	9	9	9		9		3			
4. Meet takeoff/landing requirements	7	9	3	9			9				9		
5. Wingspan meets restrictions	7	9	3		3	3		1				3	3
6. Sufficient Power	5	1	1	3			3	3		1	1		
7. Maneuverability	4				3	3		9		3		3	1
8. Light Weight	6	3		3			3			9	3		
9. Touch-down Impact	2							3		3	9	9	9
10. Ground Controls	7							1					
11. Carry the Minimum Cargo Load Required	8	9		3			3		9	9	3	9	9
12. Easy to Load/Unload	1								9	3		3	
Raw Score		365	96	228	123	123	120	215	81	191	128	135	124
Relative Weight %		18.92	4.98	11.82	6.38	6.38	6.22	11.15	4.20	9.90	6.64	7.00	6.43
Rank Order		1	11	2	6	6	10	3	12	4	8	5	9

Presenter: SP

House of Quality

House of Quality													
		Engineering Characteristics (***From Main Targets***)											
Improvement Direction		↑	↓	↑	↑	↑	↑	↑	↓	↓	↑	↑	=
Units		lbf	lbf	lbf	degrees	ft/s	ft/s^2	degrees	seconds	lbs	ft/s^2	psi	psi
Customer Requirements	Importance Weight Factor	Lift	Drag	Thrust	Max Angle of Attack	Stall Speed	Acceleration	Control Surface Movement	Loading/ Unloading Time	Weight	Deceleration	Joint Strength	Material Strength
1. Material	1		1							9		9	9
2. Stability	6	9	3	3				9					
3. CG in front of CP	10	9	3	9	9	9		9		3			
4. Meet takeoff/landing requirements	7	9	3	9			9				9		
5. Wingspan meets restrictions	7	9	3		3	3		1				3	3
6. Sufficient Power	5	1	1	3			3	3		1	1		
7. Maneuverability	4				3	3		9		3		3	1
8. Light Weight	6	3		3			3			9	3		
9. Touch-down Impact	2							3		3	9	9	9
10. Ground Controls	7							1					
11. Carry the Minimum Cargo Load Required	8	9		3			3		9	9	3	9	9
12. Easy to Load/Unload	1								9	3		3	
Raw Score		365	96	228	123	123	120	215	81	191	128	135	124
Relative Weight %		18.92	4.98	11.82	6.38	6.38	6.22	11.15	4.20	9.90	6.64	7.00	6.43
Rank Order		1	11	2	6	6	10	3	12	4	8	5	9

Presenter: SP

House of Quality

House of Quality													
		Engineering Characteristics (***From Main Targets***)											
Improvement Direction		↑	↓	↑	↑	↑	↑	↑	↓	↓	↑	↑	=
Units		lbf	lbf	lbf	degrees	ft/s	ft/s^2	degrees	seconds	lbs	ft/s^2	psi	psi
Customer Requirements	Importance Weight Factor	Lift	Drag	Thrust	Max Angle of Attack	Stall Speed	Acceleration	Control Surface Movement	Loading/ Unloading Time	Weight	Deceleration	Joint Strength	Material Strength
1. Material	1		1							9		9	9
2. Stability	6	9	3	3				9					
3. CG in front of CP	10	9	3	9	9	9		9		3			
4. Meet takeoff/landing requirements	7	9	3	9			9				9		
5. Wingspan meets restrictions	7	9	3		3	3		1				3	3
6. Sufficient Power	5	1	1	3			3	3		1	1		
7. Maneuverability	4				3	3		9		3		3	1
8. Light Weight	6	3		3			3			9	3		
9. Touch-down Impact	2							3		3	9	9	9
10. Ground Controls	7							1					
11. Carry the Minimum Cargo Load Required	8	9		3			3		9	9	3	9	9
12. Easy to Load/Unload	1								9	3		3	
Raw Score		365	96	228	123	123	120	215	81	191	128	135	124
Relative Weight %		18.92	4.98	11.82	6.38	6.38	6.22	11.15	4.20	9.90	6.64	7.00	6.43
Rank Order		1	11	2	6	6	10	3	12	4	8	5	9

Presenter: SP

House of Quality

House of Quality													
		Engineering Characteristics (***From Main Targets***)											
Improvement Direction		⬆	⬇	⬆	⬆	⬆	⬆	⬆	⬇	⬇	⬆	⬆	=
Units		lbf	lbf	lbf	degrees	ft/s	ft/s^2	degrees	seconds	lbs	ft/s^2	psi	psi
Customer Requirements	Importance Weight Factor	Lift	Drag	Thrust	Max Angle of Attack	Stall Speed	Acceleration	Control Surface Movement	Loading/ Unloading Time	Weight	Deceleration	Joint Strength	Material Strength
1. Material	1		1							9		9	9
2. Stability	6	9	3	3				9					
3. CG in front of CP	10	9	3	9	9	9		9		3			
4. Meet takeoff/landing requirements	7	9	3	9			9				9		
5. Wingspan meets restrictions	7	9	3		3	3		1				3	3
6. Sufficient Power	5	1	1	3			3	3		1	1		
7. Maneuverability	4				3	3		9		3		3	1
8. Light Weight	6	3		3			3			9	3		
9. Touch-down Impact	2							3		3	9	9	9
10. Ground Controls	7							1					
11. Carry the Minimum Cargo Load Required	8	9		3			3		9	9	3	9	9
12. Easy to Load/Unload	1								9	3		3	
Raw Score		365	96	228	123	123	[illegible]	215	81	191	128	135	124
Relative Weight %		18.92	4.98	11.82	6.38	[illegible]	6.22	11.15	4.20	9.90	6.64	7.00	6.43
Rank Order		1	11	2	6	[illegible]	10	3	12	4	8	5	9

6.75

Presenter: SP

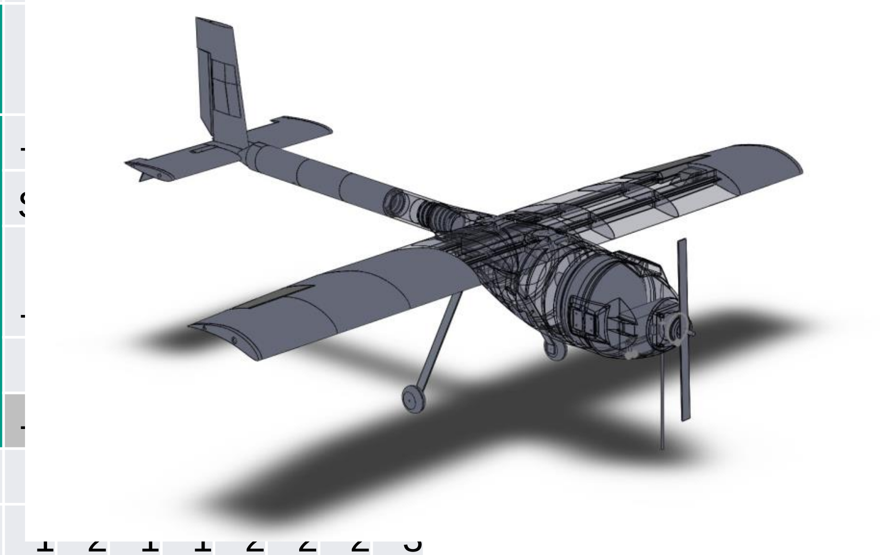
Pugh Chart 1

Pugh Chart 1		Concepts							
		High			Medium				
Selection Criteria	2020 Competition Entry	1	2	3	4	5	6	7	8
Lift	DATUM	+	+	+	-	-	+	-	-
Thrust		S	S	S	S	S	S	S	S
Control Surface Movement		+	+	+	+	S	+	S	S
Weight		-	S	-	-	-	S	-	S
Joint Strength		+	+	+	+	+	+	+	+
# of pluses		3	3	3	2	1	3	1	1
# of S's		1	2	1	1	2	2	2	3
# of Minuses		1	0	1	2	2	0	1	1

Presenter: SP

Pugh Chart 1

Pugh Chart 1		Concepts							
		High			Medium				
Selection Criteria	2020 Competition Entry								
Lift	DATUM	-							
Thrust		S							
Control Surface Movement		-							
Weight									
Joint Strength		-							
# of pluses									
# of S's		1	2	1	1	2	2	2	3
# of Minuses		1	0	1	2	2	0	1	1



Presenter: SP

Pugh Chart 1

Pugh Chart 1		Concepts							
		High			Medium				
Selection Criteria	2020 Competition Entry	1	2	3	4	5	6	7	8
Lift	DATUM	+	+	+	-	-	+	-	-
Thrust		S	S	S	S	S	S	S	S
Control Surface Movement		+	+	+	+	S	+	S	S
Weight		-	S	-	-	-	S	-	S
Joint Strength		+	+	+	+	+	+	+	+
# of pluses		3	3	3	2	1	3	1	1
# of S's		1	2	1	1	2	2	2	3
# of Minuses		1	0	1	2	2	0	1	1

Presenter: SP

Pugh Chart 2

Pugh Chart 2		Concepts		
		High		Medium
Selection Criteria	Concept 2	1	3	6
Lift	Datum	-	+	-
Thrust		S	S	S
Control Surface Movement		+	+	+
Weight		-	-	-
Joint Strength		S	S	S
# of pluses		1	2	1
# of S's		2	2	2
# of Minuses		2	1	2

Presenter: SP

Pugh Chart 2

Pugh Chart 2		Concepts		
		High		Medium
Selection Criteria	Concept 2	1	3	6
Lift	Datum	-	+	-
Thrust		S	S	S
Control Surface Movement		+	+	+
Weight		-	-	-
Joint Strength		S	S	S
# of pluses		1	2	1
# of S's		2	2	2
# of Minuses		2	1	2

Presenter: SP

AHP Slides

Comparison

Lift

Thrust

Control Surfaces

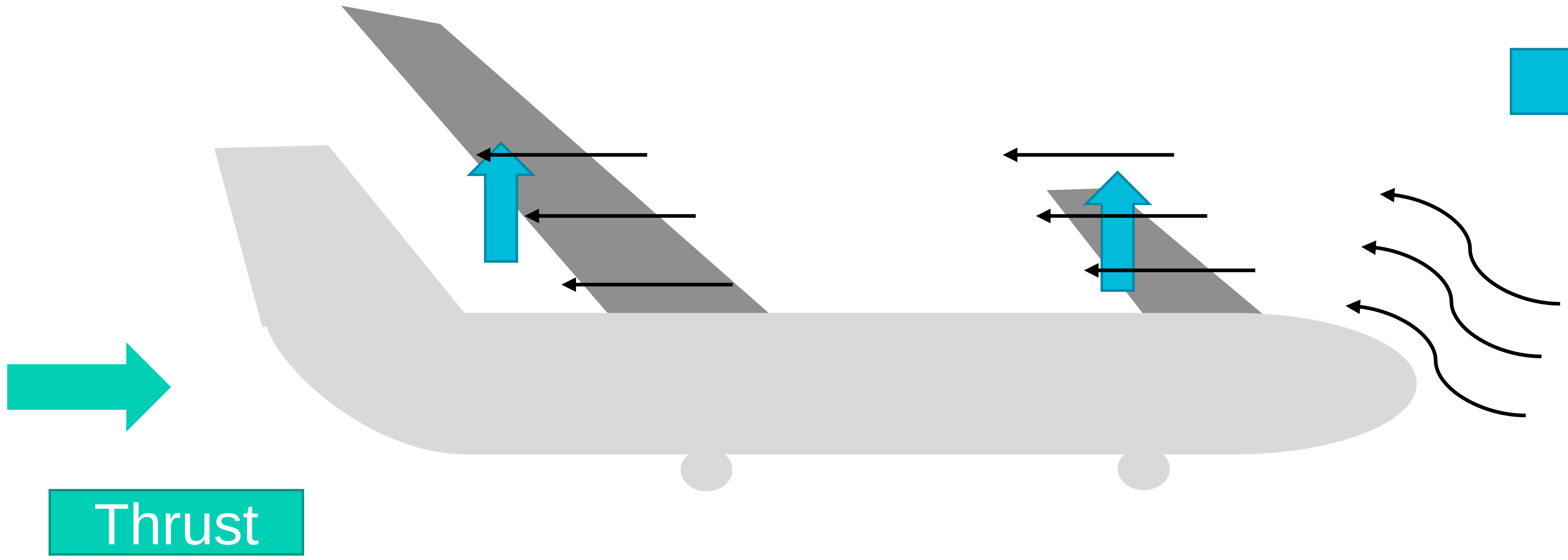
Weights

Joint Strength

AHP Criteria Comparison

Criteria Comparison - AHP

Lift vs Thrust

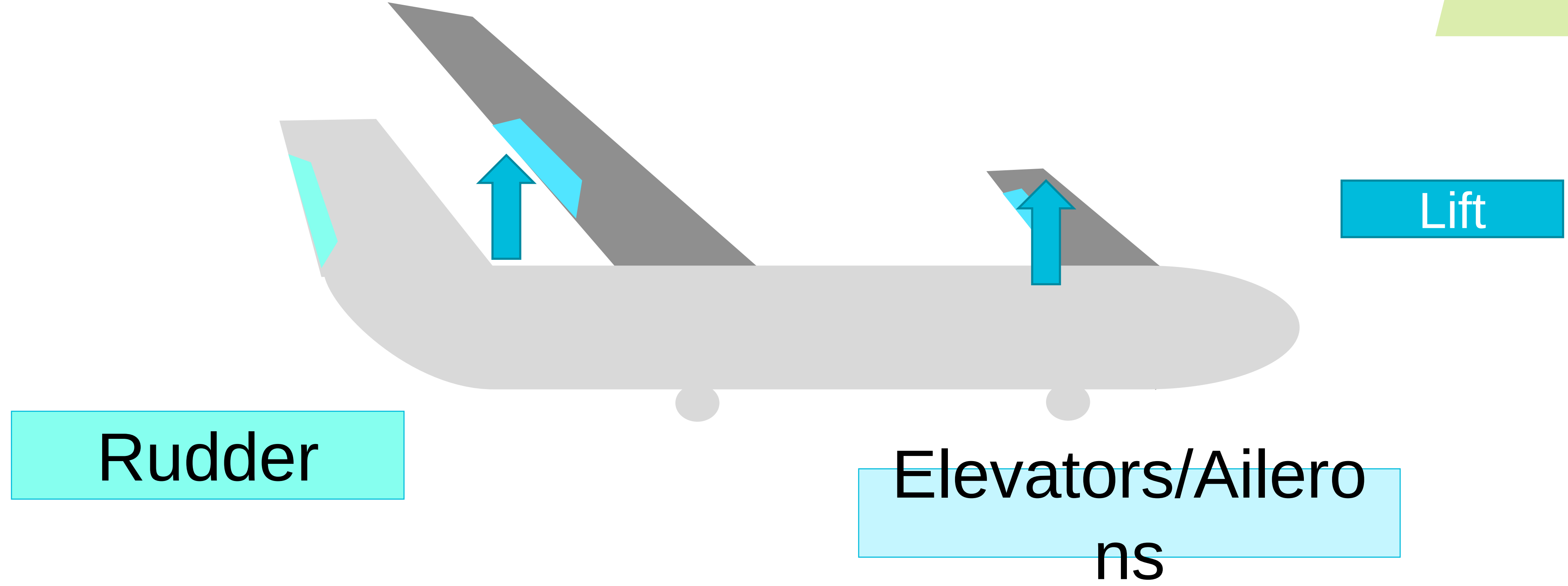


Thrust > Lift

Presenter: SP

Criteria Comparison - AHP

Lift vs Control Surface

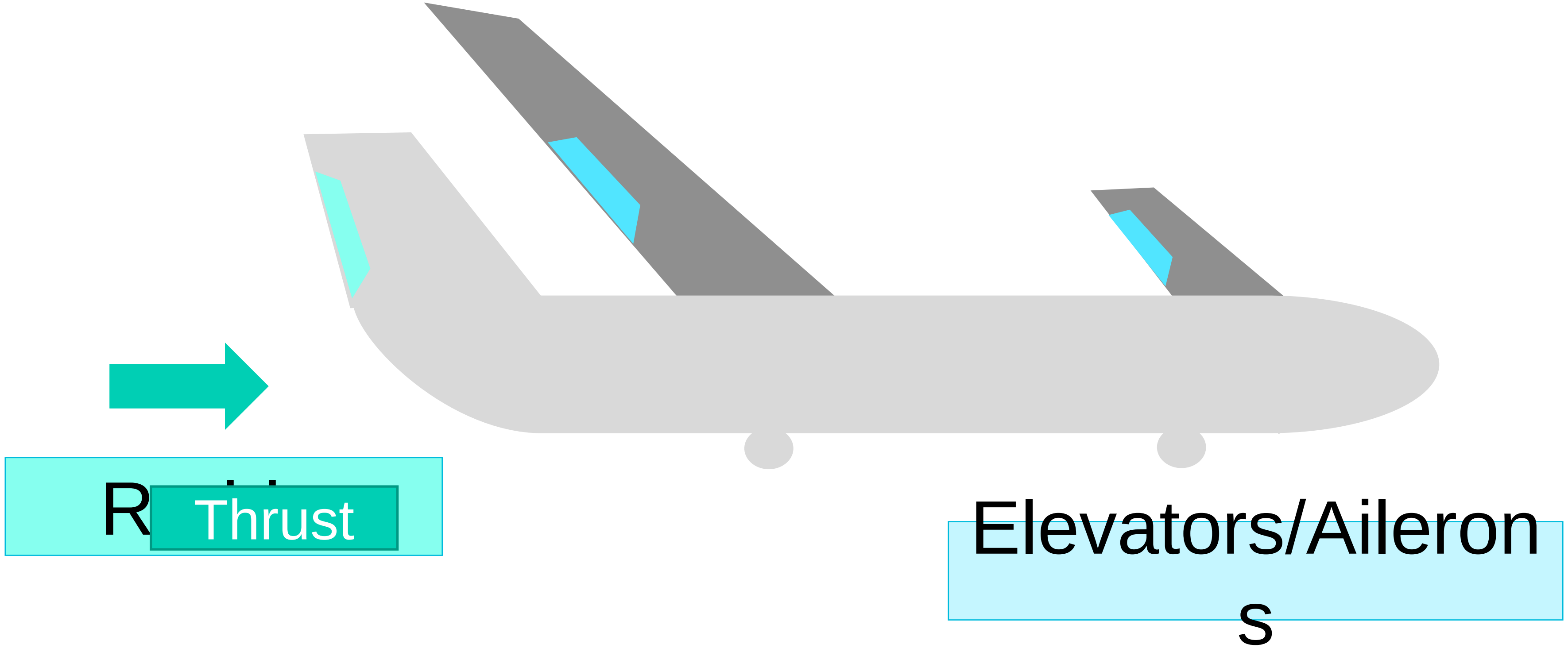


Lift > Control Surface

Presenter: SP

Criteria Comparison - AHP

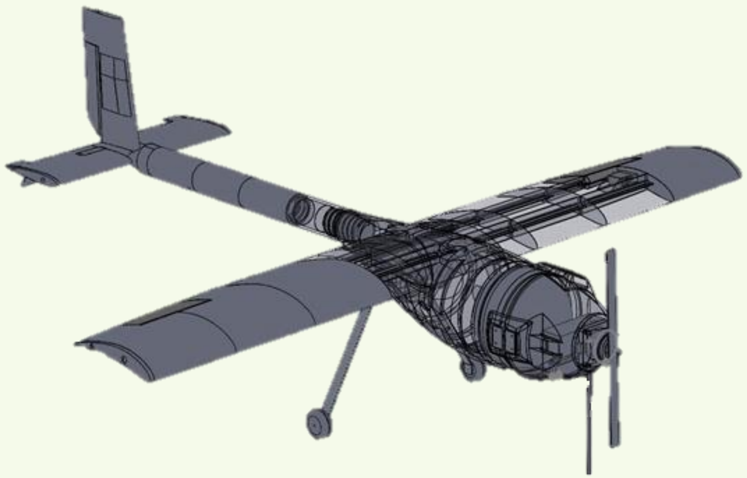
Thrust vs Control Surface



Thrust > Control Surfac

Presenter: SP

Concepts Considered for AHP



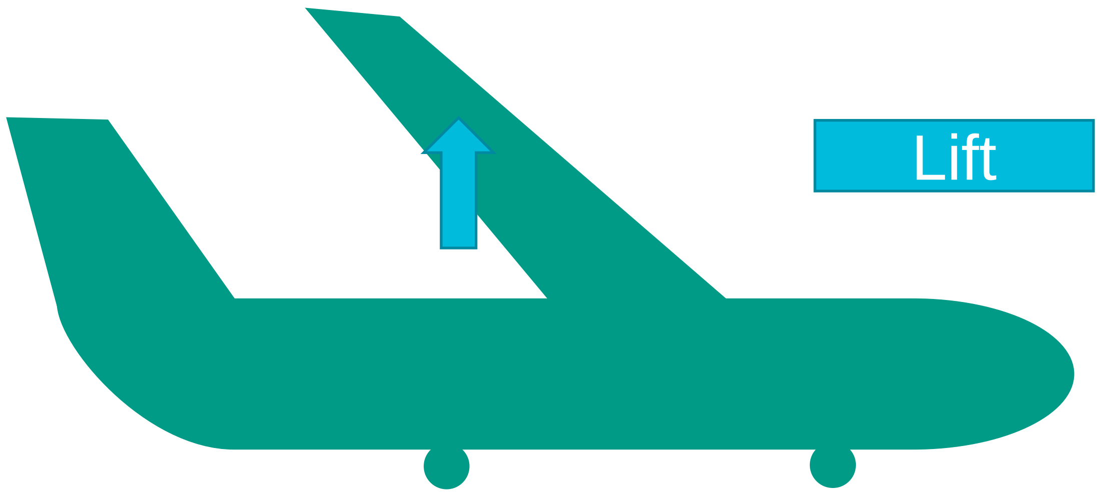
1. Boomtown

3. Rutan Quickie Q2

6. OMAC Laser 300

Presenter: SP

Lift Comparison for Concepts - AHP

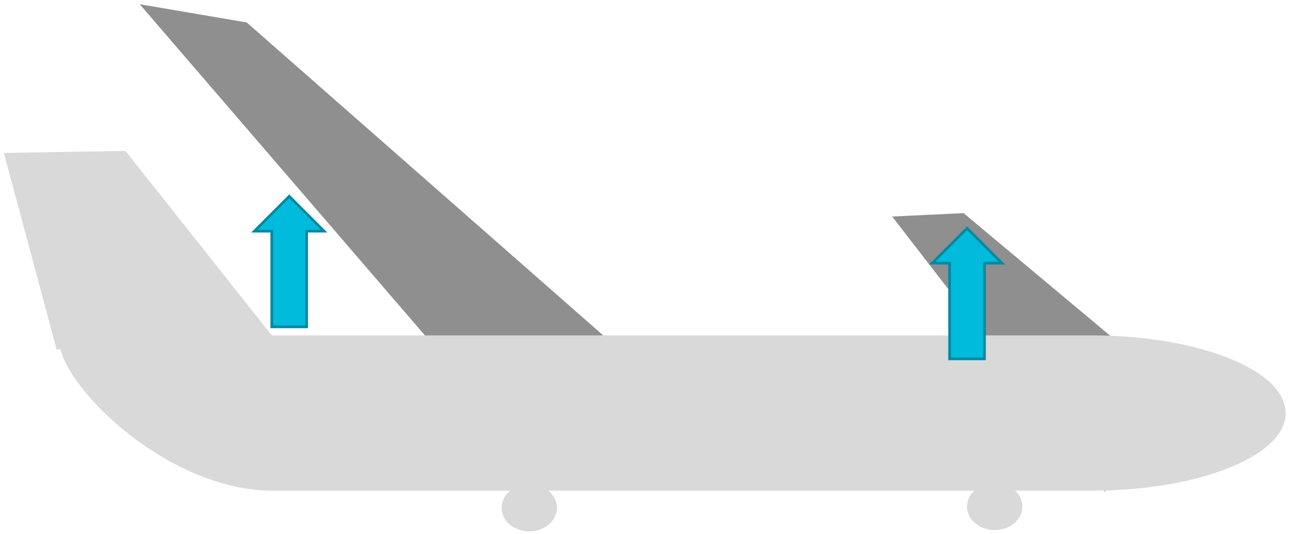


Concept 1: Boomtown

Just the main wing

Presenter: SP

Lift Comparison for Concepts - AHP



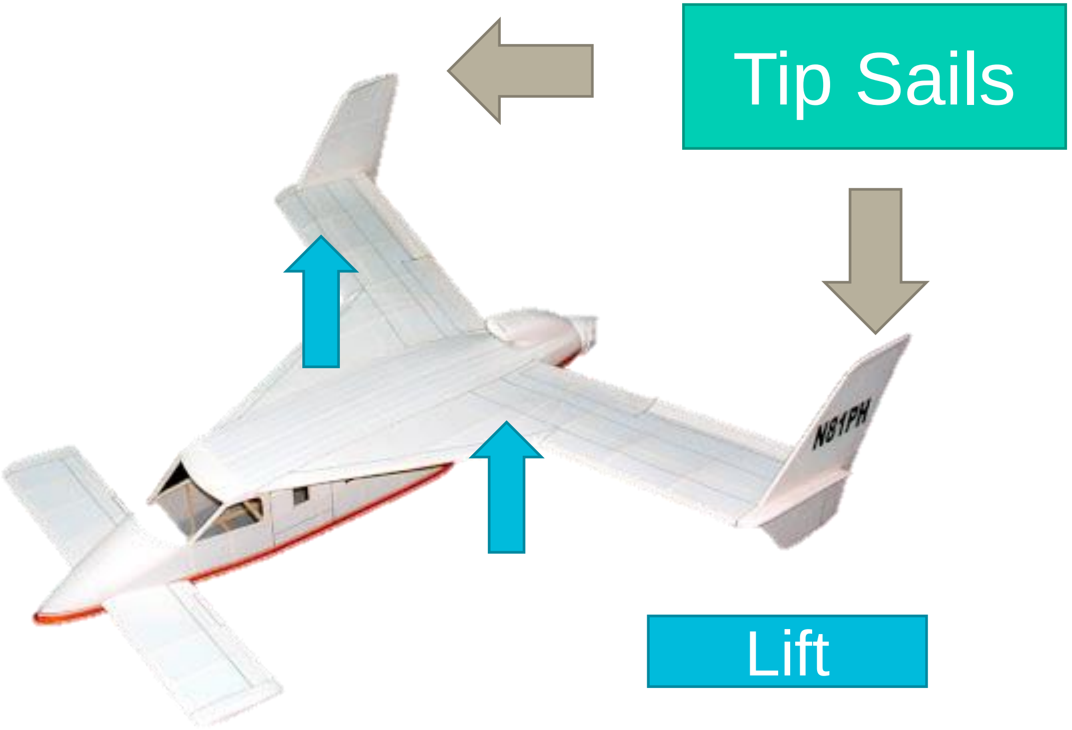
Lift

Canard + Main Wing

Concept 3: Rutan Quickie Q2

Presenter: SP

Lift Comparison for Concepts - AHP



Concept 6: OMAC 300 Laser Plane

Lower Wingspan
+ Delta Restriction

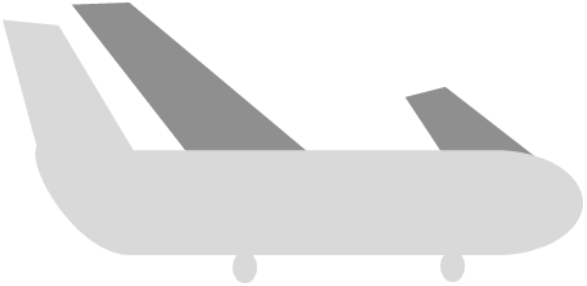
Presenter: SP

Lift Comparison Matrix - AHP

Lift Comparison			
	Concept 1	Concept 3	Concept 6
Concept 1	1.00	0.33	3.00
Concept 3	3.00	1.00	7.00
Concept 6	0.33	0.14	1.00
Sum	4.33	1.48	11.00

λ Average Consistency	CI Consistency Index	CR Consistency Ratio
3.00703	0.00352	0.00676

1



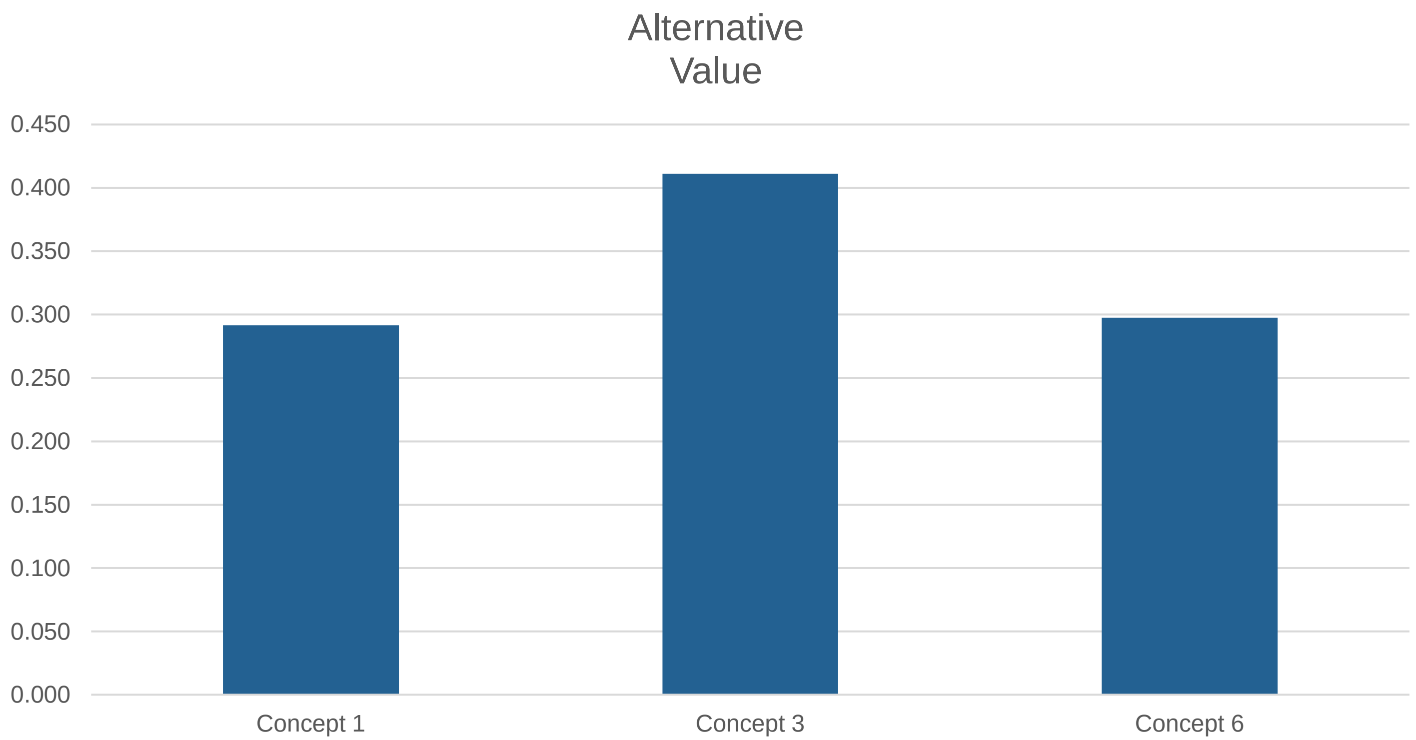
3

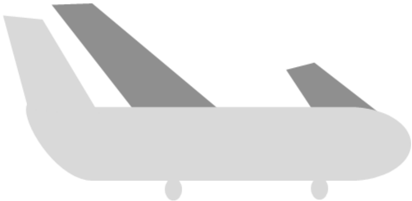
6

CR<0.1

Presenter: SP

Concept Comparison- AHP





Presenter: SP

Criteria Comparison Matrix

Development of a Candidate set of Criteria Weights {W}					
Criteria Comparison Matrix					
	Lift	Thrust	Control Surface Movement	Weight	Joint Strength
Lift	1.00	0.33	3.00	9.00	9.00
Thrust	3.00	1.00	3.00	9.00	9.00
Control Surface Movement	0.33	0.33	1.00	5.00	3.00
Weight	0.11	0.11	0.20	1.00	0.11
Joint Strength	0.11	0.11	0.33	9.00	1.00
Sum	4.56	1.89	7.53	33.00	22.11

Normalized Comparison Matrix

Normalized Criteria Comparison Matrix [NormC]						
Criteria Comparison Matrix						
	Lift	Thrust	Control Surface Movement	Weight	Joint Strength	Criteria Weight
Lift	0.22	0.18	0.40	0.27	0.41	0.295
Thrust	0.66	0.53	0.40	0.27	0.41	0.453
Control Surface Movement	0.07	0.18	0.13	0.15	0.14	0.134
Weight	0.02	0.06	0.03	0.03	0.01	0.029
Joint Strength	0.02	0.06	0.04	0.27	0.05	0.089
Sum	1.00	1.00	1.00	1.00	1.00	1.000

Criteria Comparison Consistency Check

Consistency Check		
{Ws}=[C]{W} Weighted Sum Vector	{W} Criteria Weights	Con={Ws}./{W} Consistency Vector
1.911	0.490	3.899
2.802	0.230	12.184
0.796	0.140	5.683
0.149	0.040	3.720
0.478	0.100	4.780

λ Average Consistency	CI Consistency Index	CR Consistency Ratio
6.053	0.027	0.051

AHP – Lift Tables

Lift Comparison Matrix

Lift Comparison			
	Concept 1	Concept 3	Concept 6
Concept 1	1.00	0.33	3.00
Concept 3	3.00	1.00	7.00
Concept 6	0.33	0.14	1.00
Sum	4.33	1.48	11.00

Normalized Lift Comparison Matrix

Normalized Criteria Comparison Matrix [NormC]				
	Concept 1	Concept 2	Concept 6	Criteria Weight
Concept 1	0.231	0.226	0.273	0.243
Concept 2	0.692	0.677	0.636	0.669
Concept 6	0.077	0.097	0.091	0.088
Sum	1.000	1.000	1.000	1.000

Lift Consistency Check

Consistency Check 1		
{Ws}=[C]{W} Weighted Sum Vector	{W} Criteria Weights	Con={Ws}./{W} Consistency Vector
0.731	0.243	3.005
2.015	0.669	3.014
0.265	0.088	3.002

λ Average Consistency	CI Consistency Index	CR Consistency Ratio
3.00703	0.00352	0.00676

AHP – Thrust Tables

Thrust Comparison

Thrust Comparison			
	Concept 1	Concept 3	Concept 6
Concept 1	1.00	1.00	1.00
Concept 3	1.00	1.00	1.00
Concept 6	1.00	1.00	1.00
Sum	3.00	3.00	3.00

Normalized Thrust Comparison Matrix

Normalized Criteria Comparison Matrix [NormC]				
	Concept 1	Concept 2	Concept 6	Criteria Weight
Concept 1	0.333	0.333	0.333	0.333
Concept 2	0.333	0.333	0.333	0.333
Concept 6	0.333	0.333	0.333	0.333
Sum	1.000	1.000	1.000	1.000

Thrust Consistency Check

Consistency Check 2		
{Ws}=[C]{W} Weighted Sum Vector	{W} Criteria Weights	Con={Ws}./{W} Consistency Vector
1.000	0.333	3.000
1.000	0.333	3.000
1.000	0.333	3.000

λ Average Consistency	CI Consistency Index	CR Consistency Ratio
3.00000	0.00000	0.00000

AHP – Control Surface Movement Tables

Control Surface Comparison Matrix

Control Surface Movement Comparison			
	Concept 1	Concept 3	Concept 6
Concept 1	1.00	3.00	0.20
Concept 3	0.33	1.00	0.20
Concept 6	3.00	5.00	1.00
Sum	4.33	9.00	1.40

Normalized Control Surface Comparison Matrix

Normalized Criteria Comparison Matrix [NormC]				
	Concept 1	Concept 2	Concept 6	Criteria Weight
Concept 1	0.231	0.333	0.143	0.236
Concept 2	0.077	0.111	0.143	0.110
Concept 6	0.692	0.556	0.714	0.654
Sum	1.000	1.000	1.000	1.000

Control Surface Consistency Check

Consistency Check 3		
{Ws}=[C]{W} Weighted Sum Vector	{W} Criteria Weights	Con={Ws}./{W} Consistency Vector
0.697	0.236	2.959
0.320	0.110	2.898
1.912	0.654	2.924

λ Average Consistency	CI Consistency Index	CR Consistency Ratio
2.92716	-0.03642	-0.07004

AHP – Weight Tables

Weight Comparison Matrix

Weight Comparison			
	Concept 1	Concept 3	Concept 6
Concept 1	1.00	0.33	3.00
Concept 3	3.00	1.00	5.00
Concept 6	0.33	0.20	1.00
Sum	4.33	1.53	9.00

Normalized Weight Comparison Matrix

Normalized Criteria Comparison Matrix [NormC]				
	Concept 1	Concept 2	Concept 6	Criteria Weight
Concept 1	0.231	0.217	0.333	0.260
Concept 2	0.692	0.652	0.556	0.633
Concept 6	0.077	0.130	0.111	0.106
Sum	1.000	1.000	1.000	1.000

Weight Consistency Check

Consistency Check 4		
{Ws}=[C]{W} Weighted Sum Vector	{W} Criteria Weights	Con={Ws}./{W} Consistency Vector
0.790	0.260	3.033
1.946	0.633	3.072
0.320	0.106	3.011

λ Average Consistency	CI Consistency Index	CR Consistency Ratio
3.03871	0.01936	0.03723

AHP – Joint Strength Tables

From Team 508

Joint Strength Comparison Matrix (508)

Joint Strength Comparison			
	Concept 1	Concept 3	Concept 6
Concept 1	1.00	1.00	1.00
Concept 3	1.00	1.00	1.00
Concept 6	1.00	1.00	1.00
Sum	3.00	3.00	3.00

Normalized Joint Comparison Matrix (508)

Normalized Criteria Comparison Matrix [NormC]				
	Concept 1	Concept 2	Concept 6	Criteria Weight
Concept 1	0.333	0.333	0.333	0.333
Concept 2	0.333	0.333	0.333	0.333
Concept 6	0.333	0.333	0.333	0.333
Sum	1.000	1.000	1.000	1.000

Joint Strength Consistency Check(508)

Consistency Check 5		
{Ws}=[C]{W} Weighted Sum Vector	{W} Criteria Weights	Con={Ws}./{W} Consistency Vector
1.000	0.333	3.000
1.000	0.333	3.000
1.000	0.333	3.000

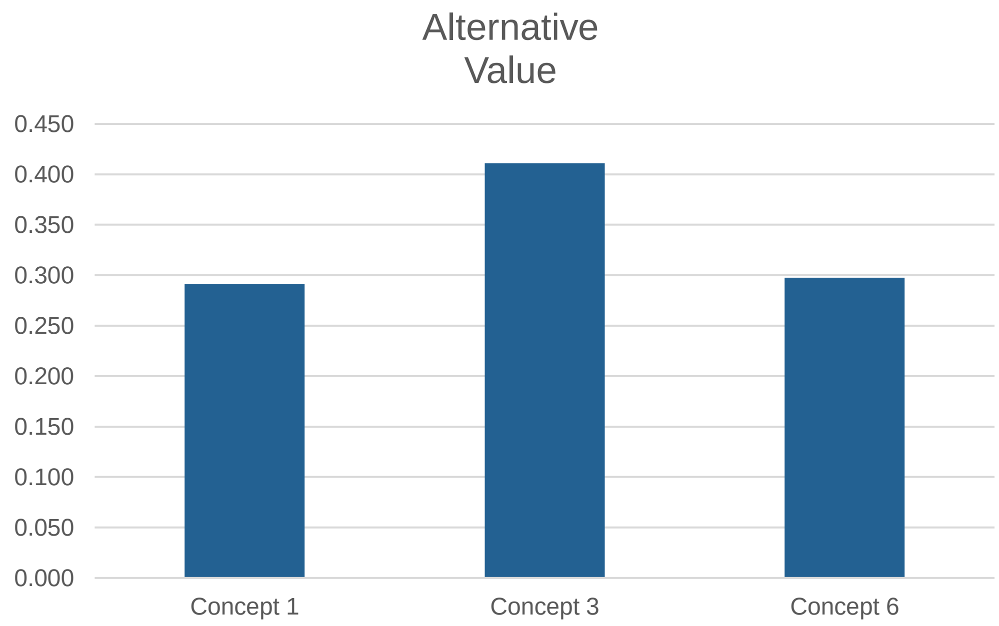
λ Average Consistency	CI Consistency Index	CR Consistency Ratio
3.00000	0.00000	0.00000

Final Rating

Final Rating Matrix

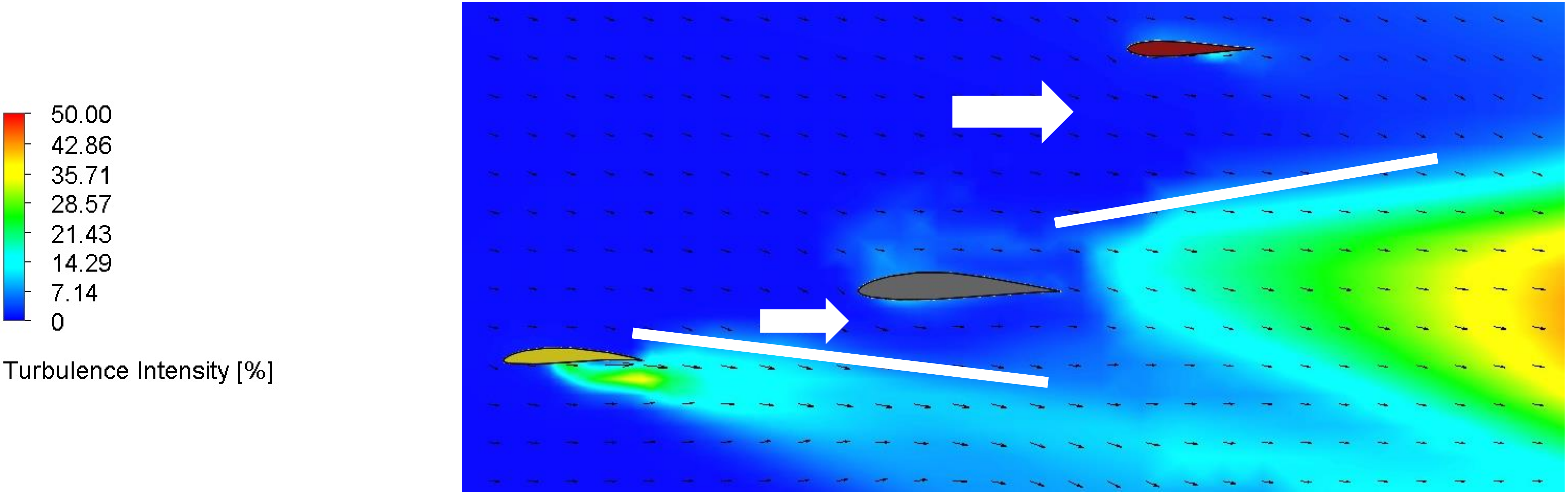
Final Rating Matrix			
Selection Criteria	Concept 1	Concept 2	Concept 6
Lift	0.243	0.669	0.088
Thrust	0.333	0.333	0.333
Control Surface Movement	0.236	0.110	0.654
Weight	0.260	0.633	0.106
Joint Strength	0.333	0.333	0.333

Concept	Alternative Value
Concept 1	0.292
Concept 3	0.411
Concept 6	0.297



Initial Design

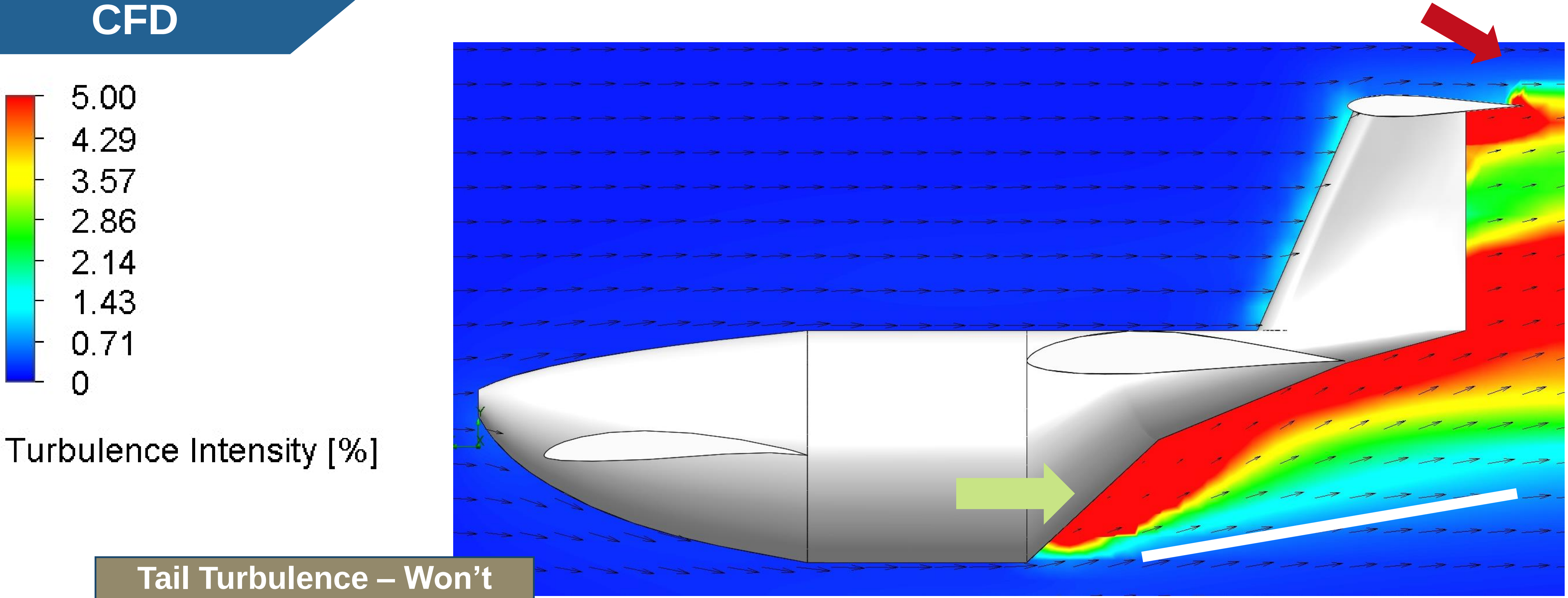
CFD – Wing Turbulence



Adrian Moya

Redesigned Plane Analysis

CFD

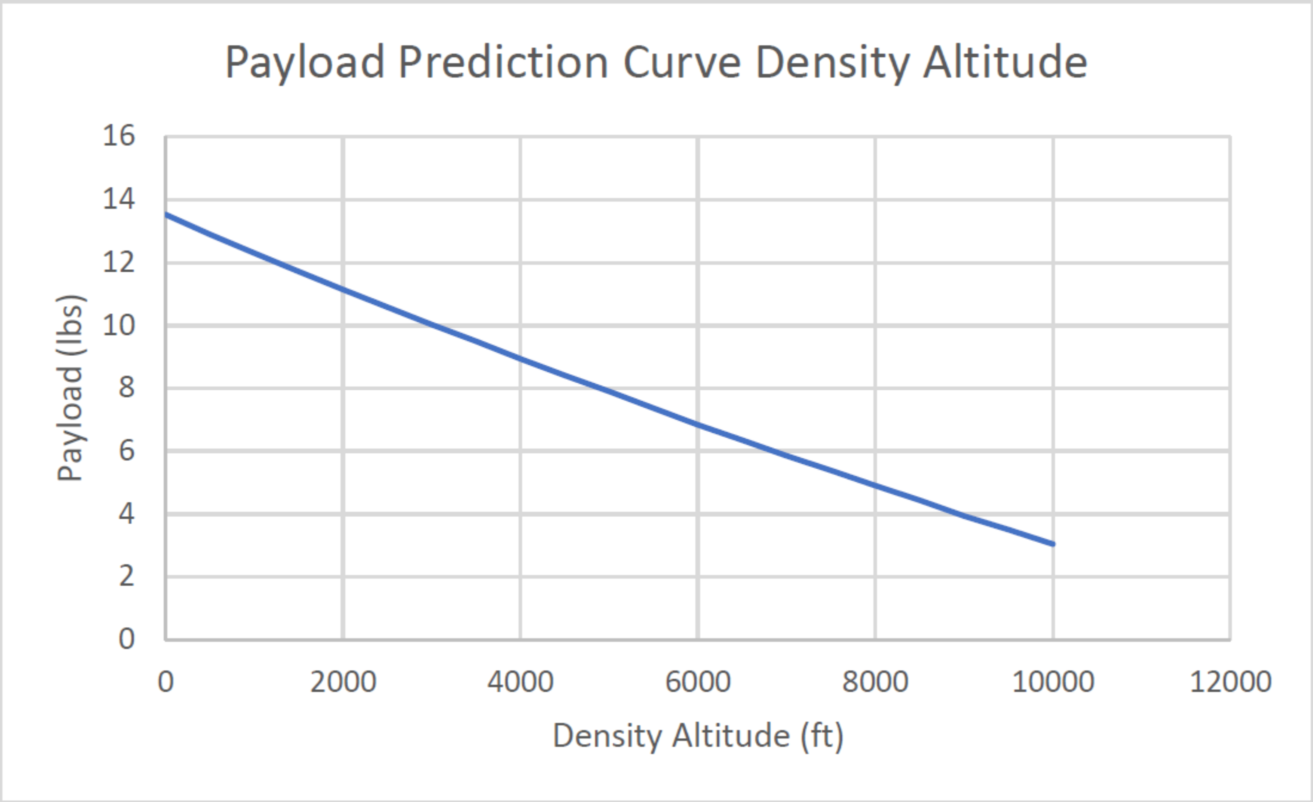


Tail Turbulence – Won't affect flight

Adrian Moya

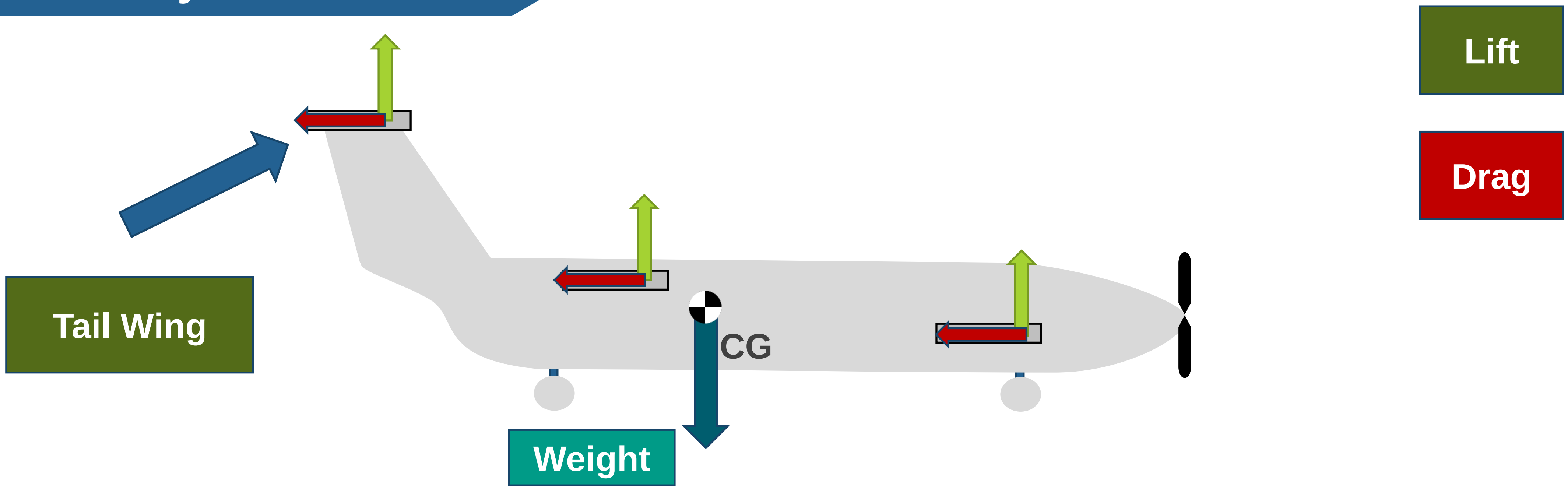
Payload Prediction

Assuming Constant Temperature



Stability

Stability Plot – No Tail

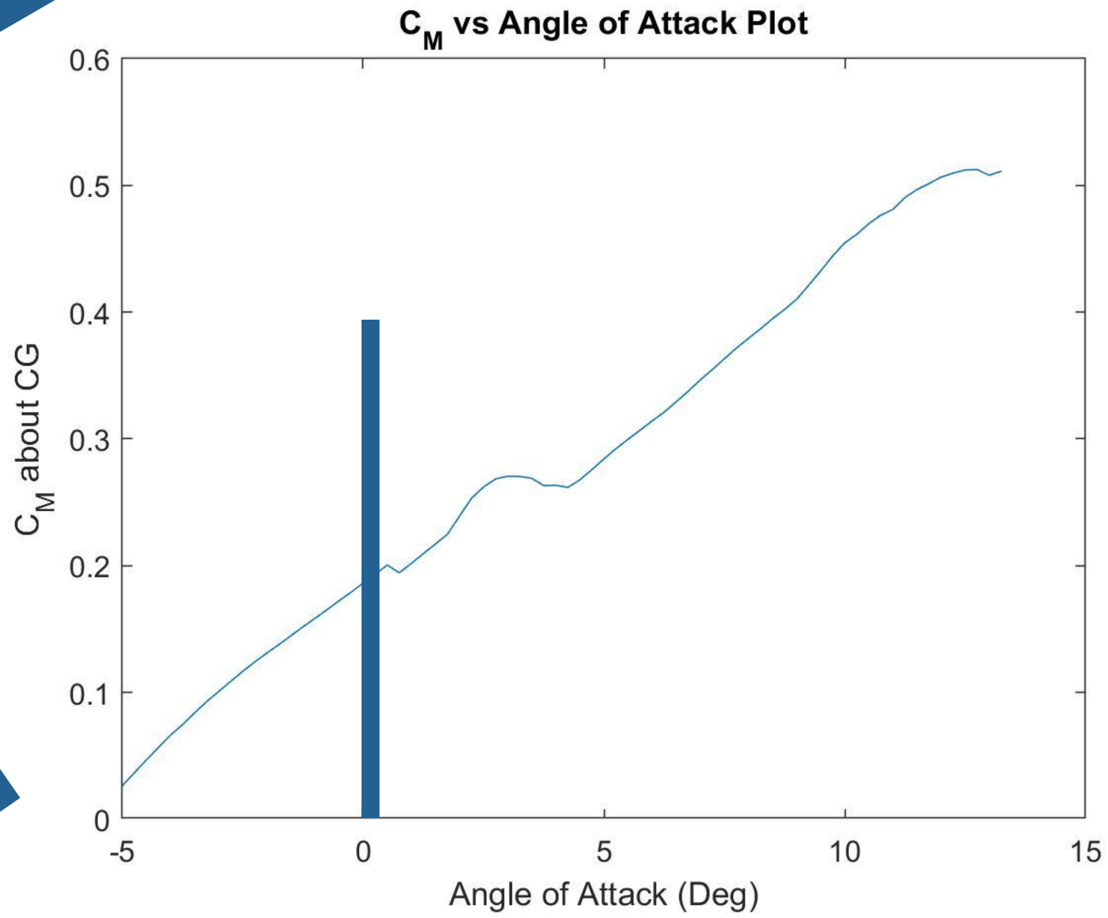



```
%Moment about CG
M_CG=L_c*x_c + L_c.*(alphaR).*y_c - D_c*y_c + D_c.*(alphaR).*x_c - L_a*x_a - L_a.*alphaR.*y_a...
    + D_a*y_a - D_a.*alphaR.*x_a - L_t*x_t - L_t.*alphaR.*y_t + D_t*y_t-D_t.*alphaR.*x_t...
    + M_AC_C + M_AC_M + M_AC_T;

%Coefficient of Moment about CG
C_M_CG = M_CG./(q*S_aft*Chord_aft);
```

Stability

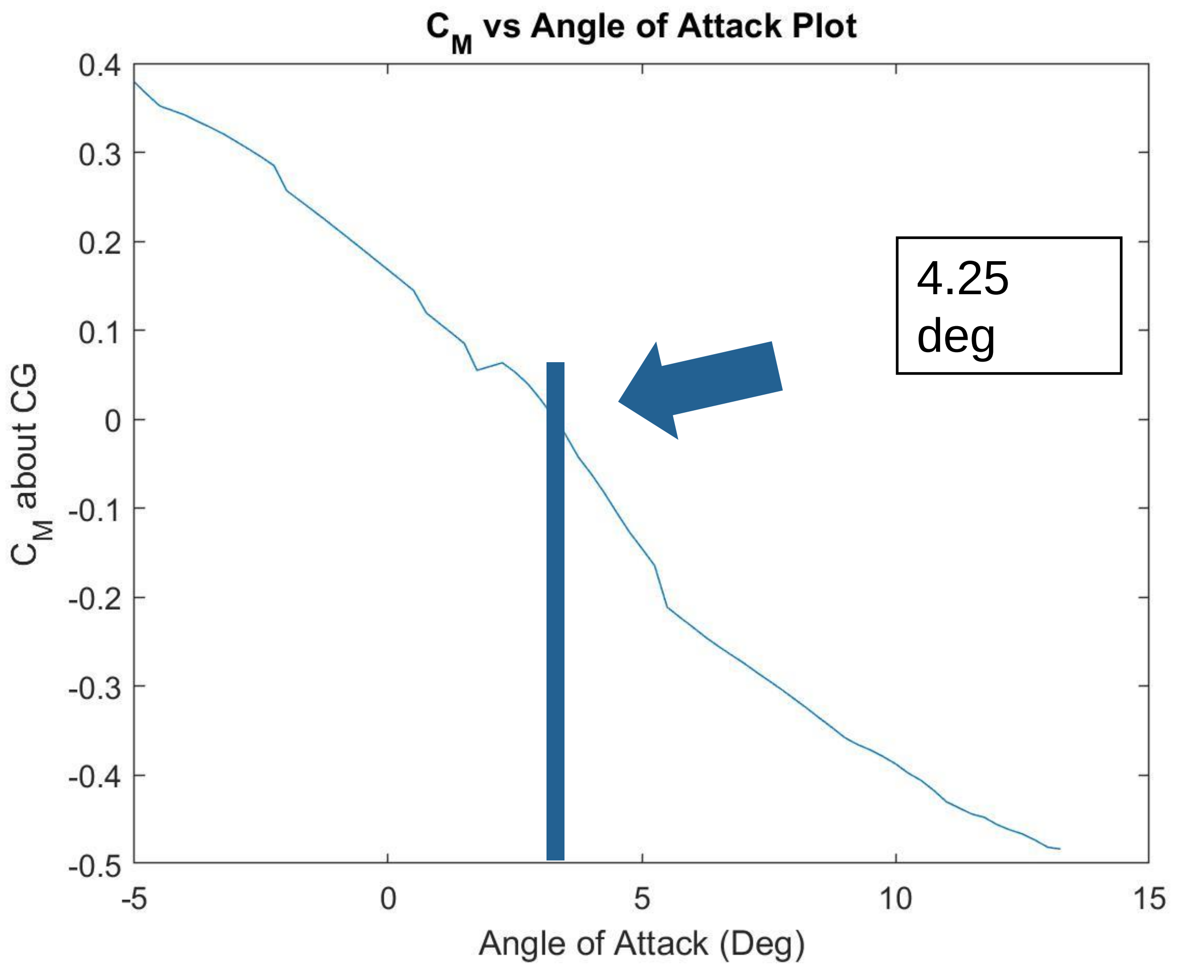
Stability Plot – No Tail



No positive Equilibrium

Stability

Stability Plot



Stability

Neutral Point