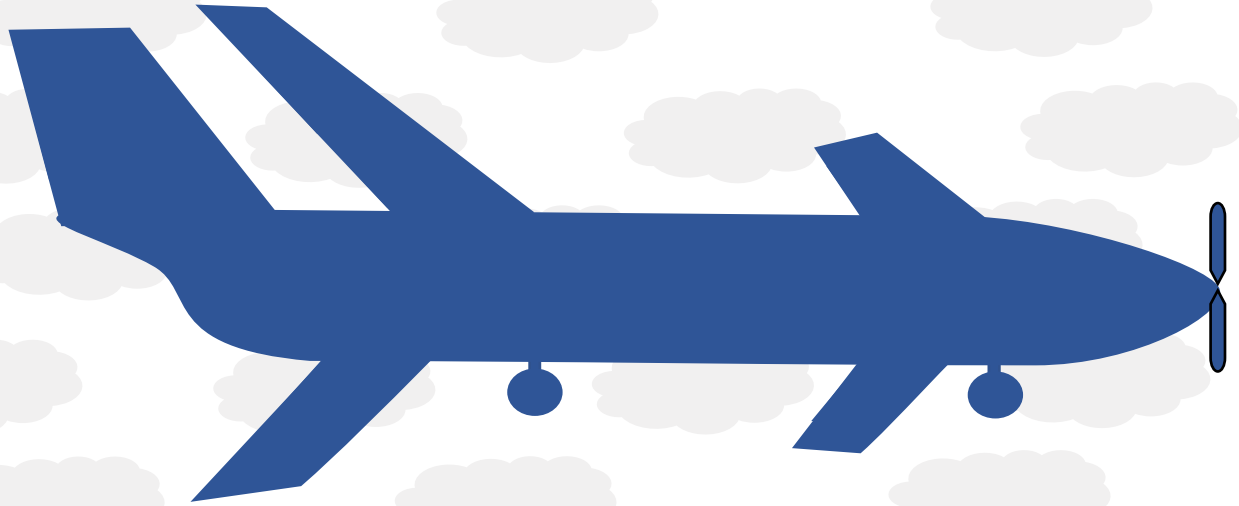
EML4551-2

Virtual Design Review 2



Team 507 - SAE Aero Design – Aero and Propulsion Team

Team Introductions

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

Sponsor and Advisors

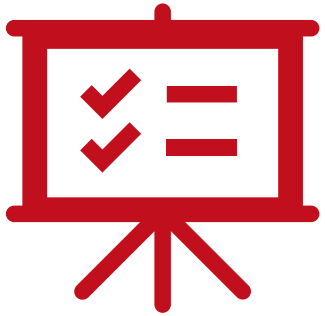
Florida Space Grant Consortium:
Funding Sponsor

Seminole RC Club:
Equipment/Personnel Sponsor

Dr. Chiang Shih:
Professor & AME Center Director Advisor

Presenter: CR

Team Objective

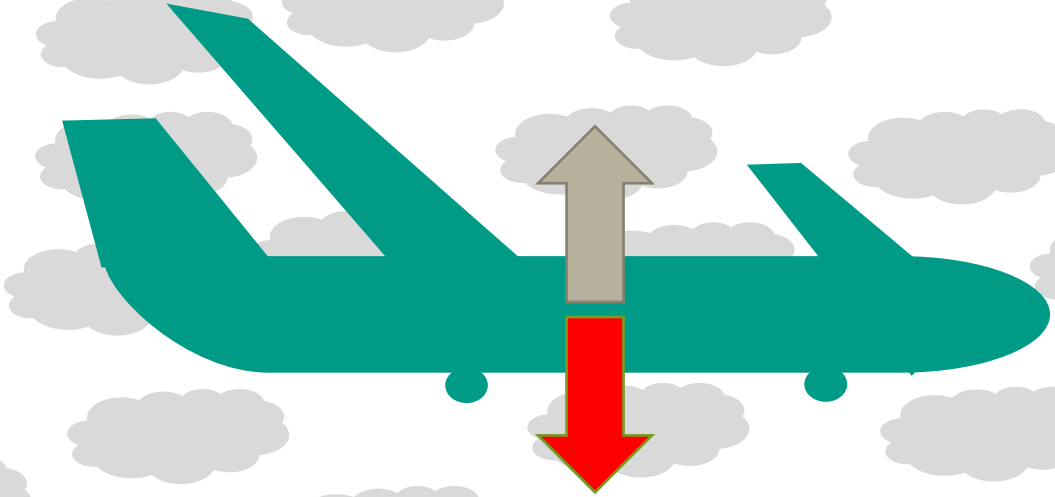


The objective of the aero-propulsion team is to ensure that the plane takes off and lands while carrying a payload while completing the flight path.

Presenter: CR

Key Definitions

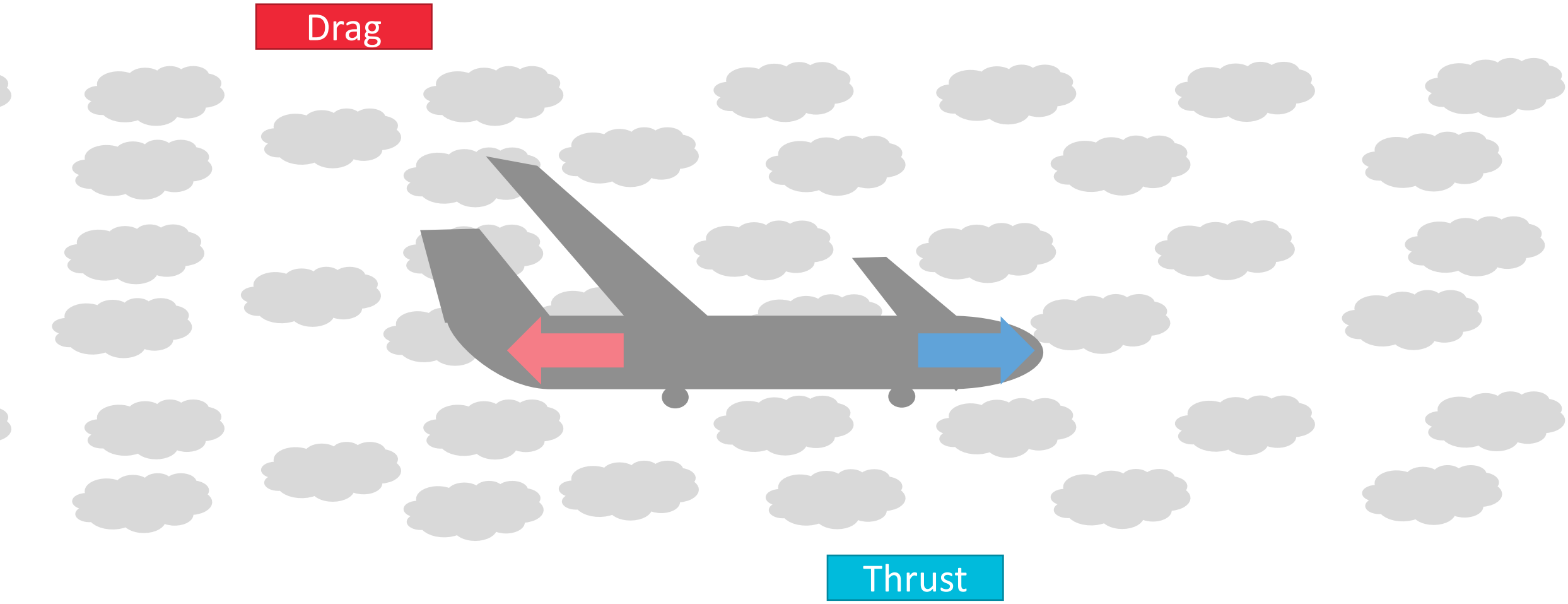
Lift



Weight

Presenter: CR

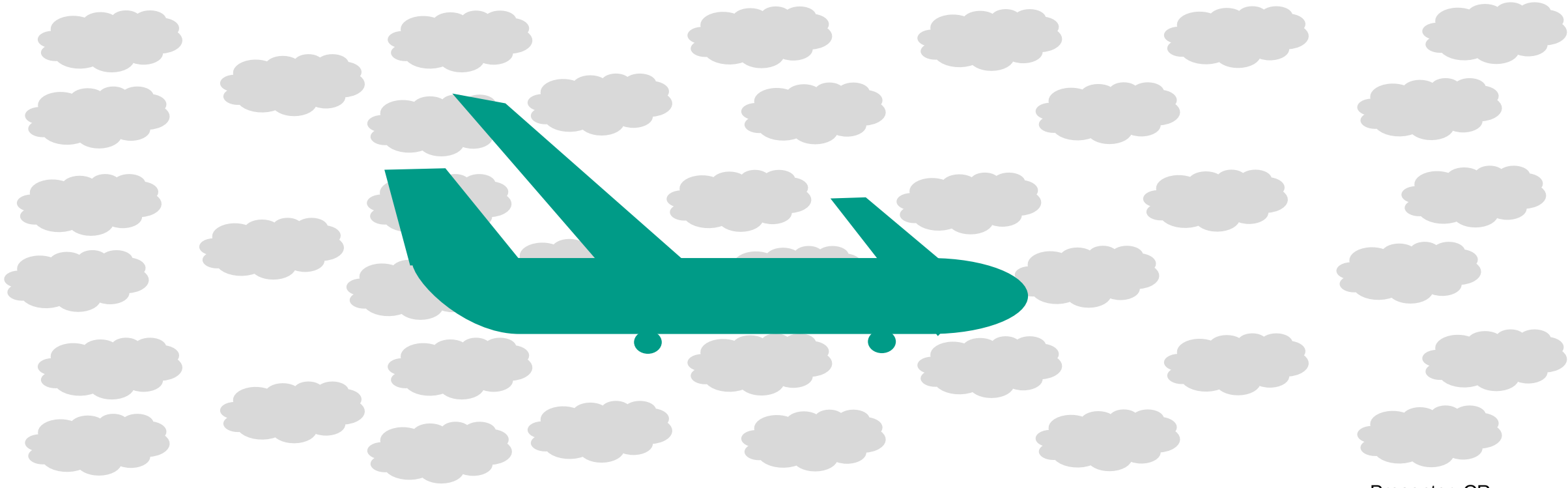
Key Definitions



Presenter: CR

Key Definitions

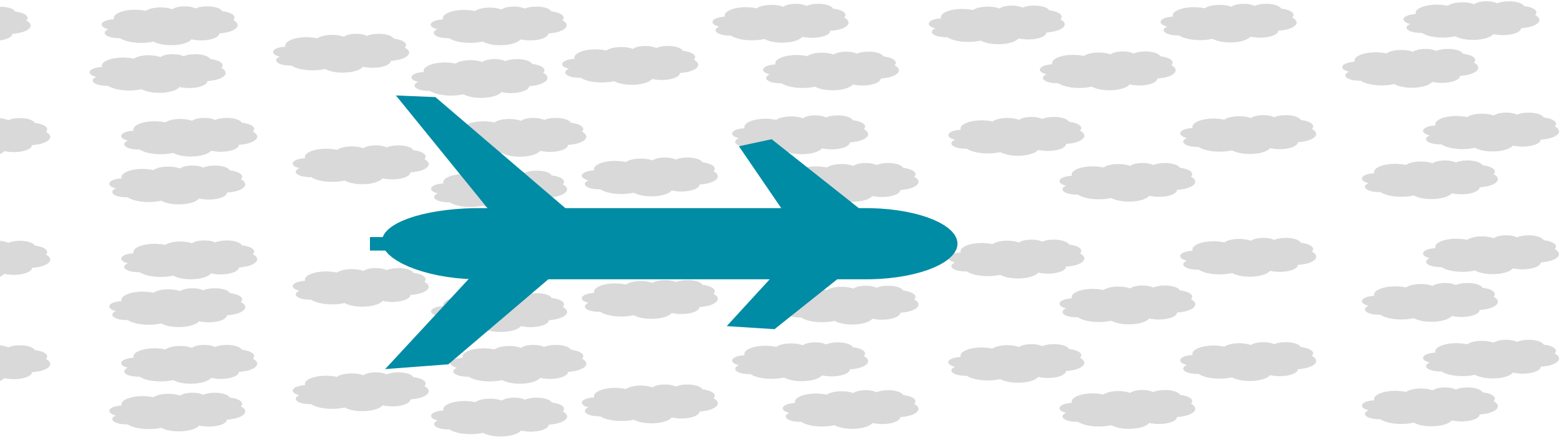
Pitch



Presenter: CR

Key Definitions

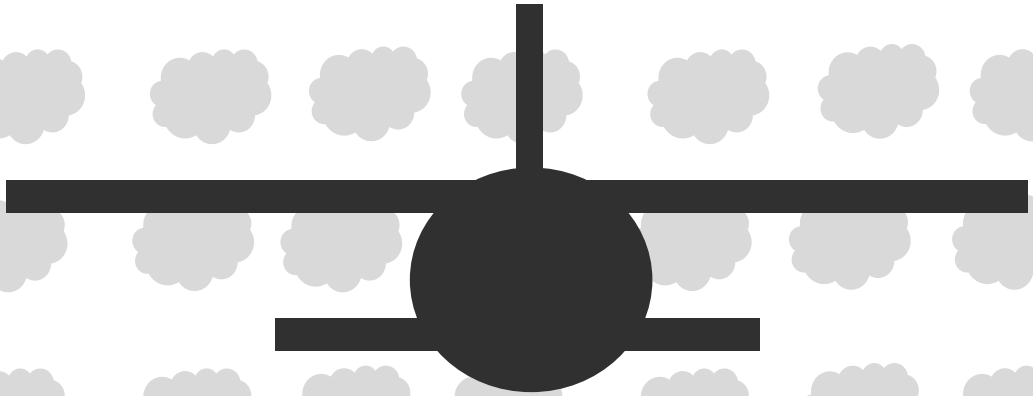
Yaw



Presenter: CR

Key Definitions

Roll



Presenter: CR

VDR 1 Review

Presenter – Cameron Riley

Project Background

- Plane to be entered in SAE Aero Design Competition East
- Certain elements from last year's design will be used

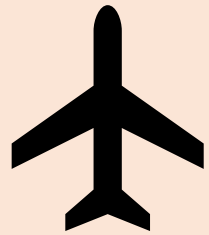
Presenter: CR

Key Goals

- The plane takeoff, cruise, and land while carrying a cargo load
- The plane carries a minimum of one soccer ball as the cargo load

Assumptions

- Will be flown in atmospheric conditions at sea level
- Motors and electronics will be store bought and not custom-made



Presenter: CR

Markets and Stakeholders

Markets

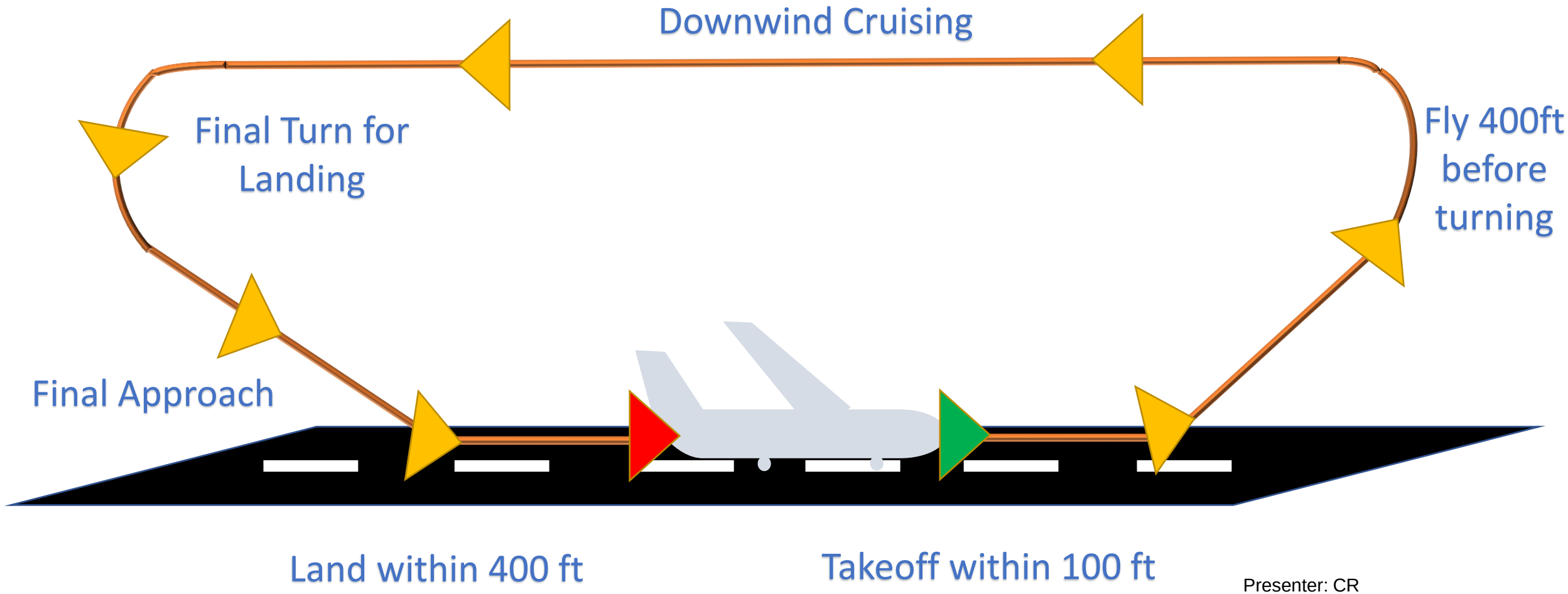
- Primary
  - SAE Aero Design Competition
  - Advisors
  - Sponsors
- Secondary
  - Professionals in the Aviation field
  - Aviation Companies
  - RC Hobbyists
  - Scholars that reference this project

Stakeholders

- Dr. McConomy and Dr. Shih
- FAMU-FSU College of Engineering
- SAE Design Competition
- RC Pilots
- Senior Design Teams 507 &508

Presenter: CR

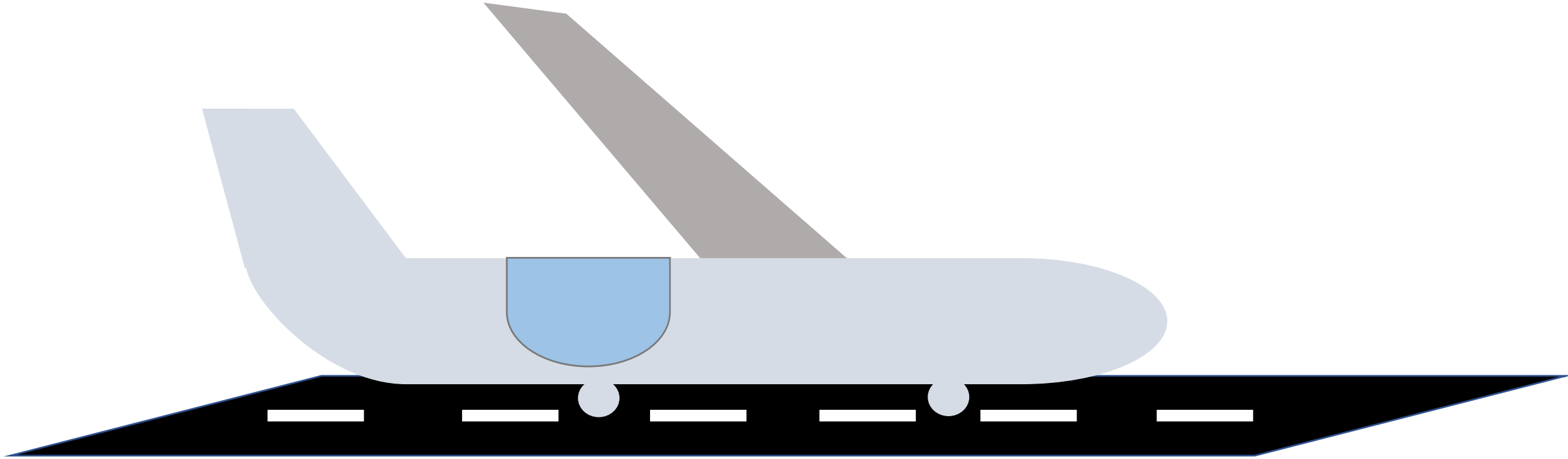
Customer Needs



Presenter: CR

Customer Needs

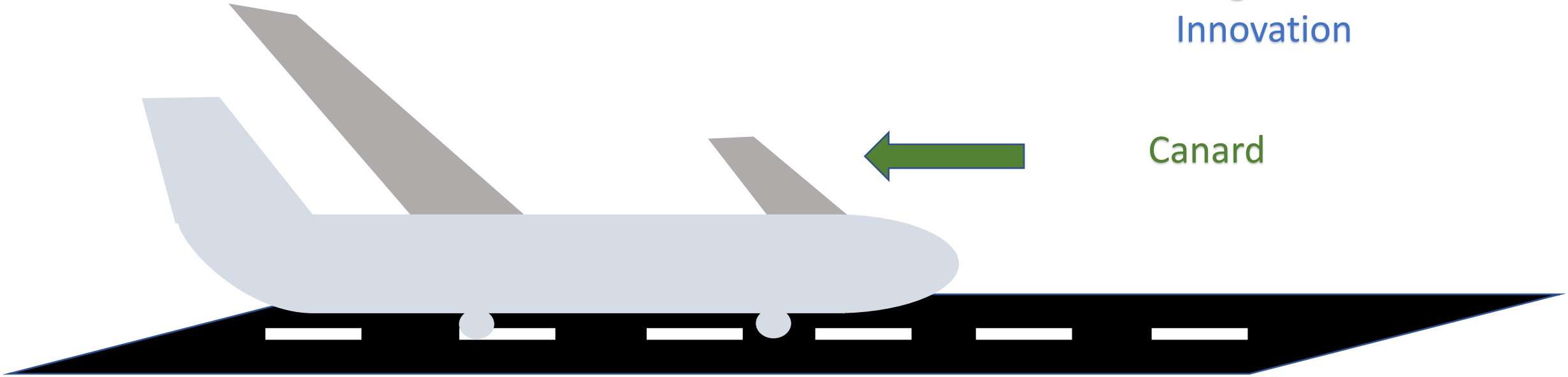
Loading/Unloading time – 1 min



Presenter: CR

Customer Needs

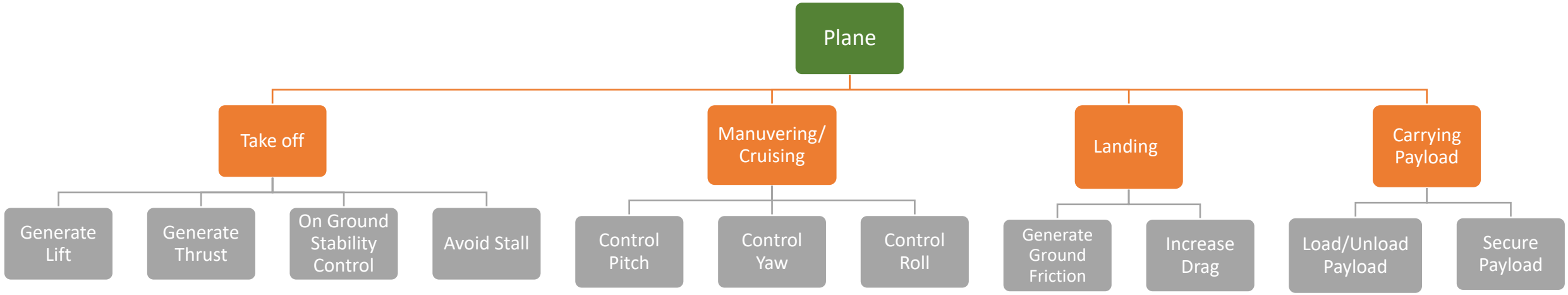
A signature
Innovation



Canard

Presenter: CR

Functional Decomposition



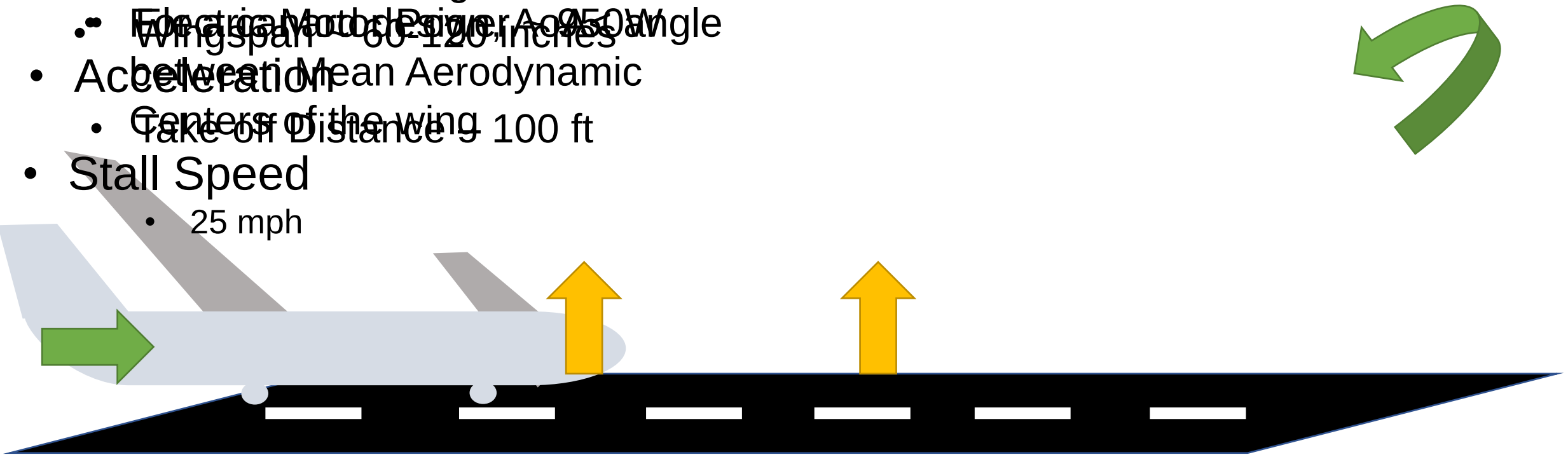
Presenter: CR

Targets and Metrics

Presenter – Cameron Riley

Targets and Metrics

- Maximum Angle Of Attack (AoA)
  - Coefficient of Lift Greater than 1
  - Coefficient of Drag ≈ Less than 1
  - Wingspan ~ 60-120 inches
- Acceleration
  - Take off Distance ~ 100 ft
- Stall Speed
  - 25 mph



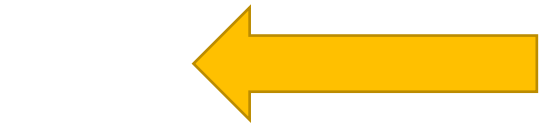
Presenter: CR

Targets and Metrics

- Control Surface Movement
  - Controlling pitch ~ angle about x-axis
    - Servo Motor Torque produced ~ Greater than 66 oz-in
  - Controlling yaw ~ angle about y – axis
    - Servo Motor Torque produced ~ Greater than 66 oz-in
  - Controlling roll ~ angle about z – axis
    - Servo Motor Torque produced ~ Greater than 66 oz-in
- Weight
  - Less than 55 lbs

Targets and Metrics

- Generating Drag (Air and Ground)
  - Coefficient of Drag ~ Greater than 1
  - Landing Velocity ~ 25 mph
- Deceleration
  - Air Brake Force ~ 2-5 lbf
  - Coefficient of Rolling Friction ~ 0.03-0.06
  - Landing Distance – 400 ft



Presenter: CR

Concept Generation

Presenter – Adrian Moya

Concept Generation

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

Presenter: AM

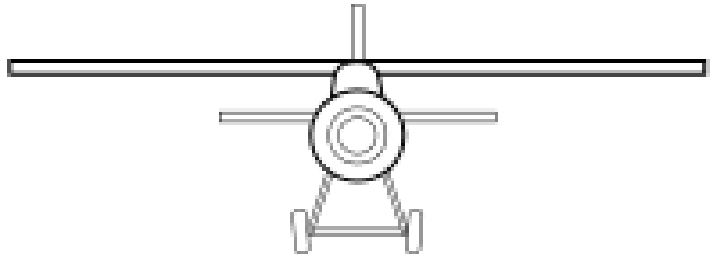
Design concepts

Rectangular

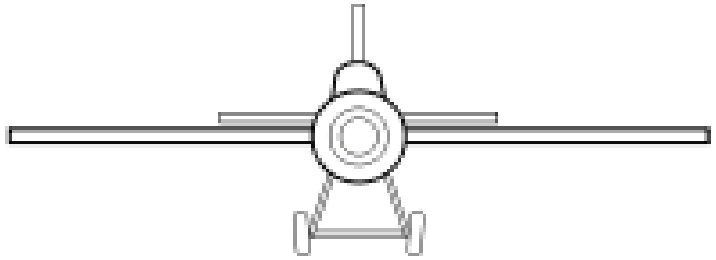
Rectangular Tapered

Rectangular
Elliptical

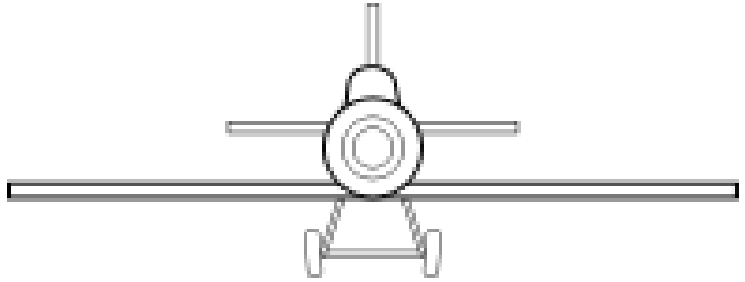
Elliptical



High-Wing



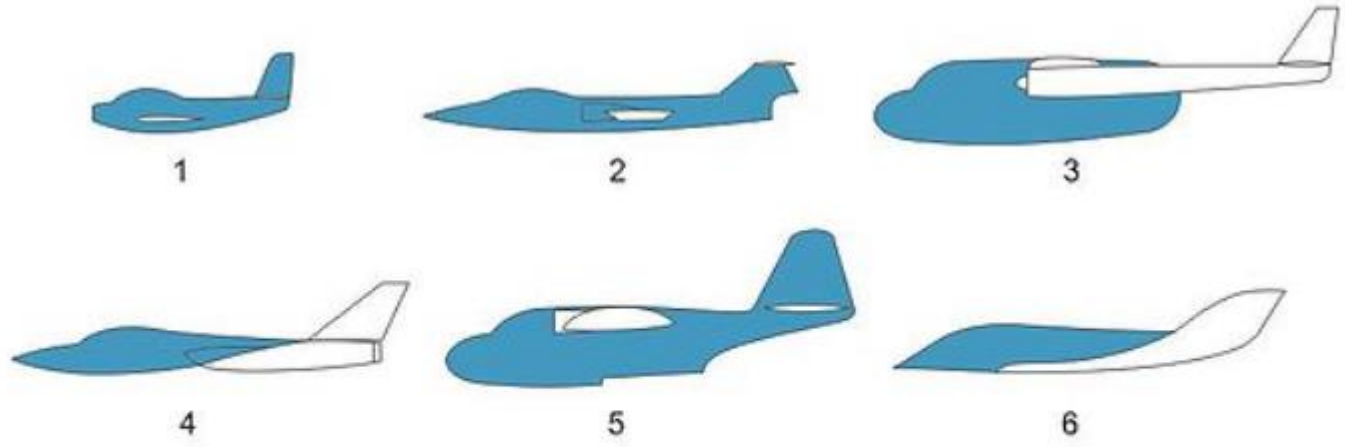
Mid-Wing



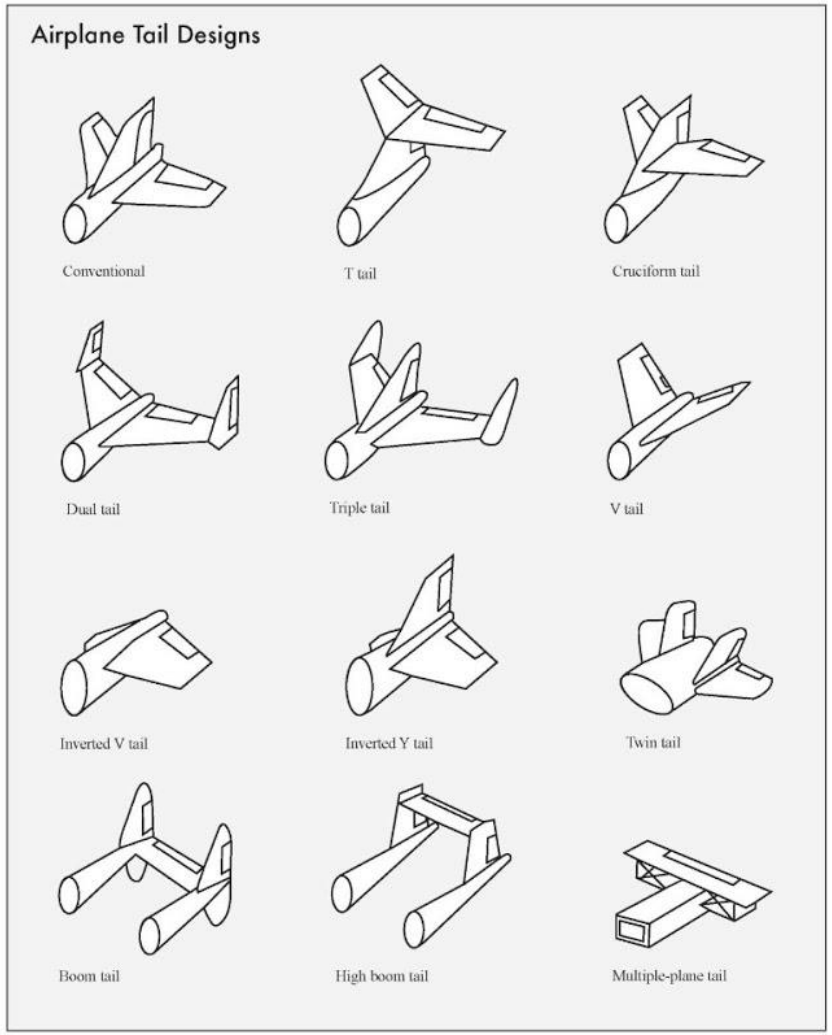
Low-Wing

Design Concepts

Fuselage Layouts



- 1: Subsonic
- 2: High-speed / supersonic
- 3: High-capacity subsonic
- 4: High-maneuverability supersonic
- 5: Flying boat
- 6: Hypersonic



Morphological Analysis

Morphological Analysis					
Wing Layout	Wing Type	Wing Position	Control Surfaces	Fuselage	Tail
Main-Tail	Main - Forward Swept Tail- Symmetric (x-29)	High Wing	Aileron	Bullet	Boom-Mounted Inverted V
Trapezoidal	Delta Wing	Mid Wing	Flaps	Flying Boat	H-Tail
Canard-Main	Main - Elliptical Tail - Symmetric	Low Wing	Elevators	Double Boom	Twin-Tail
	Main - Trapezoidal Tail - Symmetric				Tapered
					Triple-Tail
					Y-Tail

Competitive Benchmarking

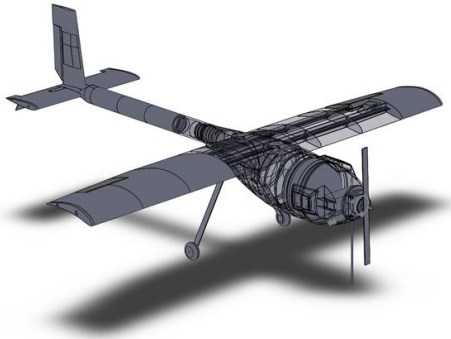
Rutan Long E-Z:
Small composite plane with canards & tip sails

Cessna 208 Grand Caravan:
Typical bush plane with extra cargo space

Kawasaki C-2:
Japanese military cargo plane

Medium and High Fidelity Concepts

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

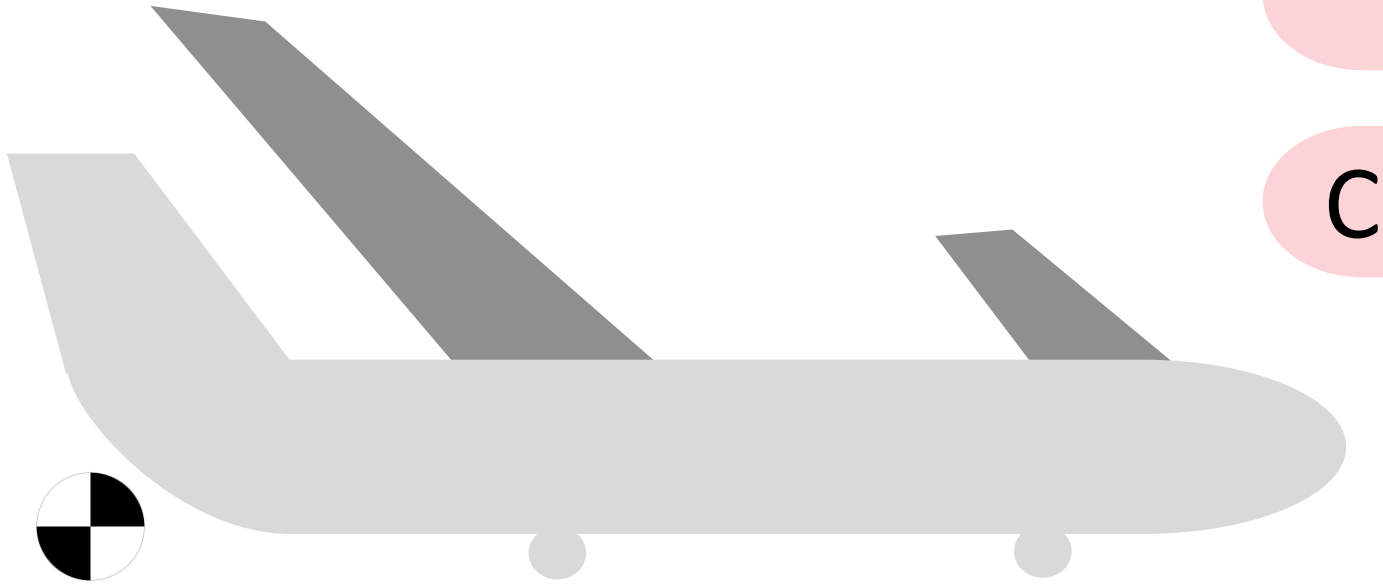
8. Kawasaki C-2

Presenter: AM

Concept Selection

Presenter – Adrian Moya

Customer Needs Considered



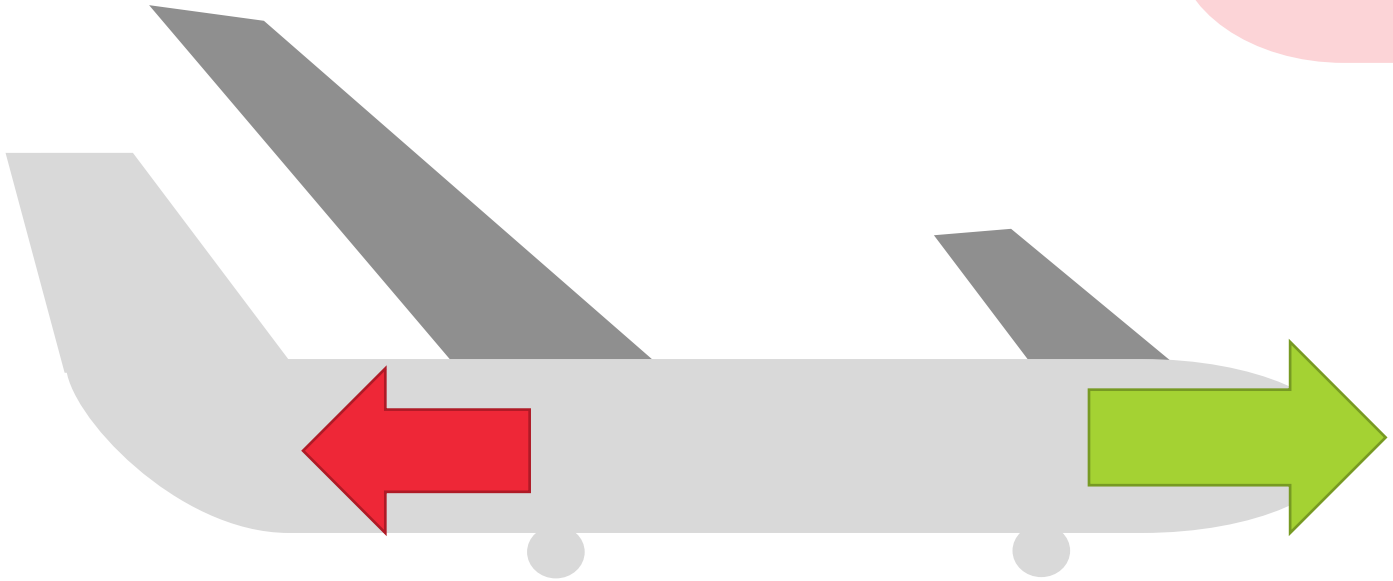
Stability

CG Position

Presenter: AM

Customer Needs Considered

Takeoff/Landing Requirements



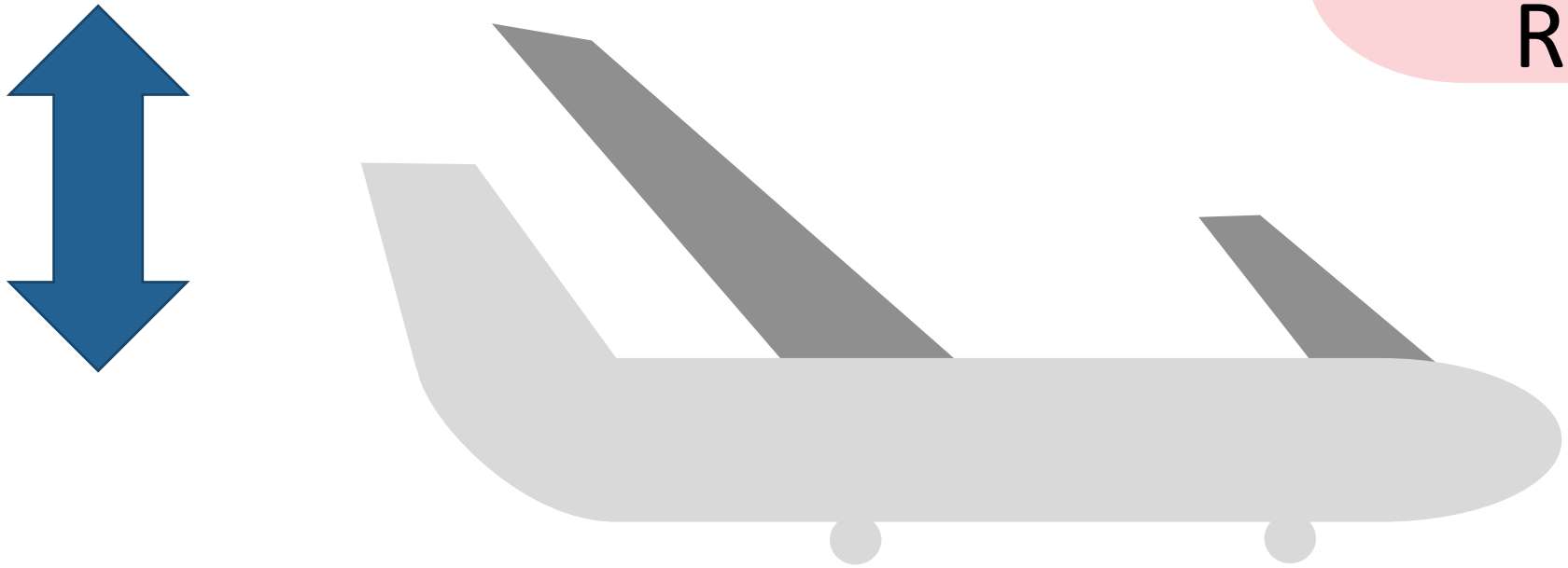
Land within 400 ft

Takeoff within 100 ft

Presenter: AM

Customer Needs Considered

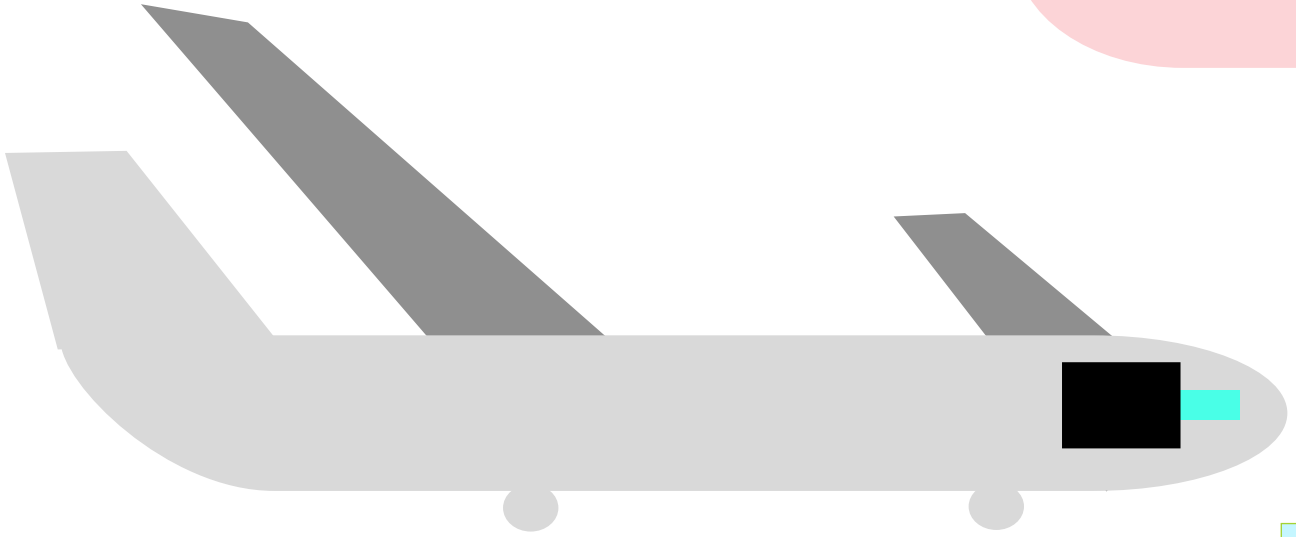
Wingspan Requirements



Presenter: AM

Customer Needs Considered

Sufficient Power



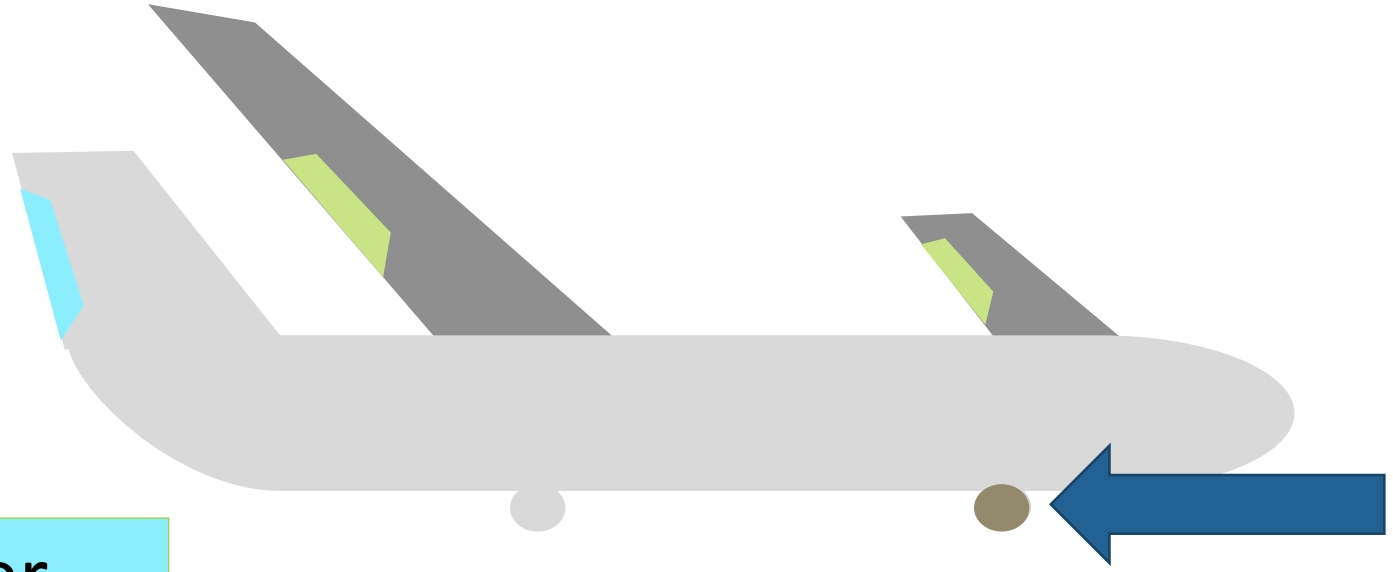
Servos

Motor

Presenter: AM

Customer Needs Considered

Ground Controls



Front Wheel Control

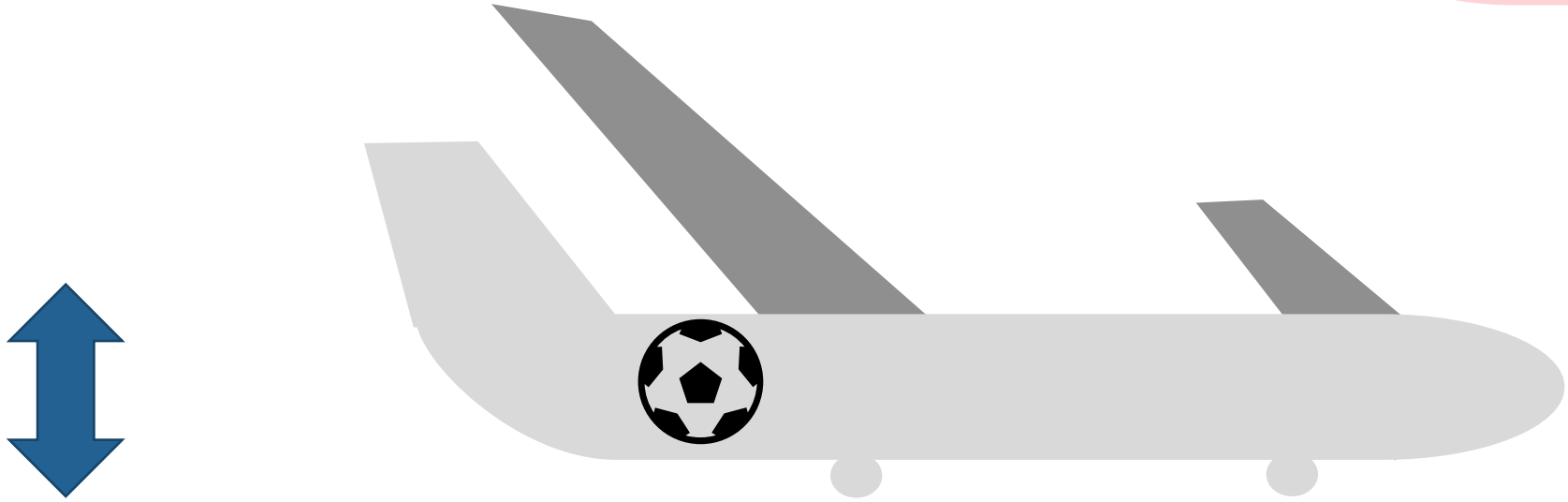
Rudder

Elevators/Ailerons

Presenter: AM

Customer Needs Considered

Carrying Cargo Load



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

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

Engineering Characteristics

- Lift
- Drag
- Thrust
- Max Angle of Attack
- Stall Speed
- Acceleration
- Control Surface Movement
- Deceleration
- Weight
- Loading/Unloading Time
- Joint Strength
- Material Strength

Presenter: AM

Concept Selection
House Of Quality

Presenter – Sasindu Pinto

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	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	12	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	

6.75

Presenter: SP

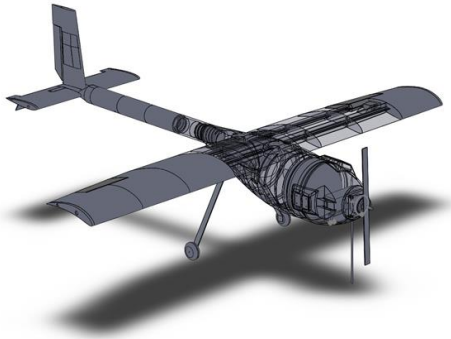
House of Quality

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

Concepts Considered

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

Presenter: SP

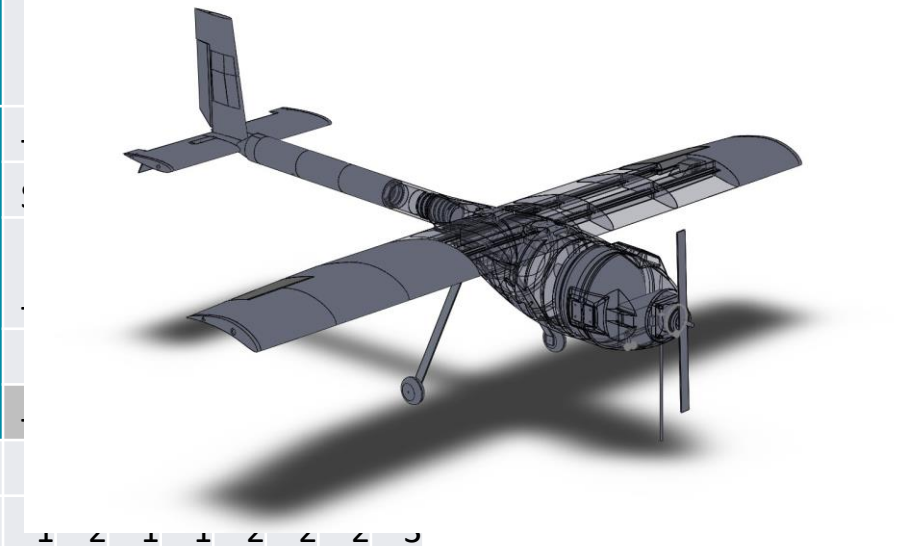
Pugh Chart 1

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									
Control Surface Movement									
Weight									
Joint Strength									
# of pluses									
# of S's									
# 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

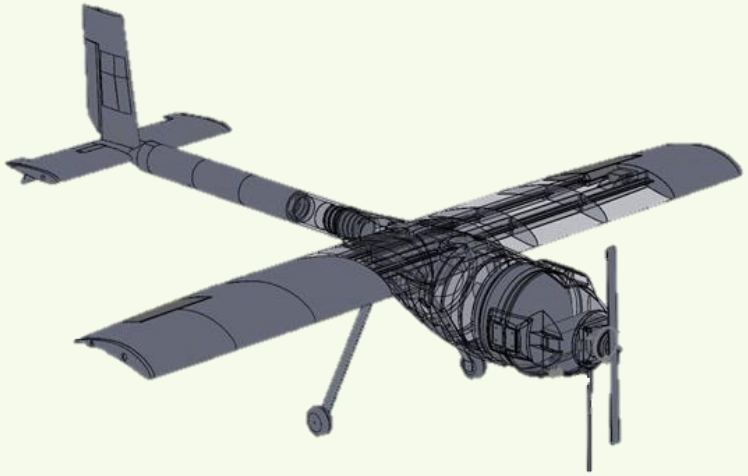
Pugh Chart 2		Concepts		
		High		Medium
Selection Criteria	Concept 2	1	3	6
Lift	Datum	-	+	-
Thrust		S	S	S
Control Surface Movement		+	+	+
Weight		-	-	-
Joint Strength		S	S	S
# of pluses		1	2	1
# of S's		2	2	2
# of Minuses		2	1	2

Presenter: SP

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



1. Boomtown

Concepts Considered for AHP

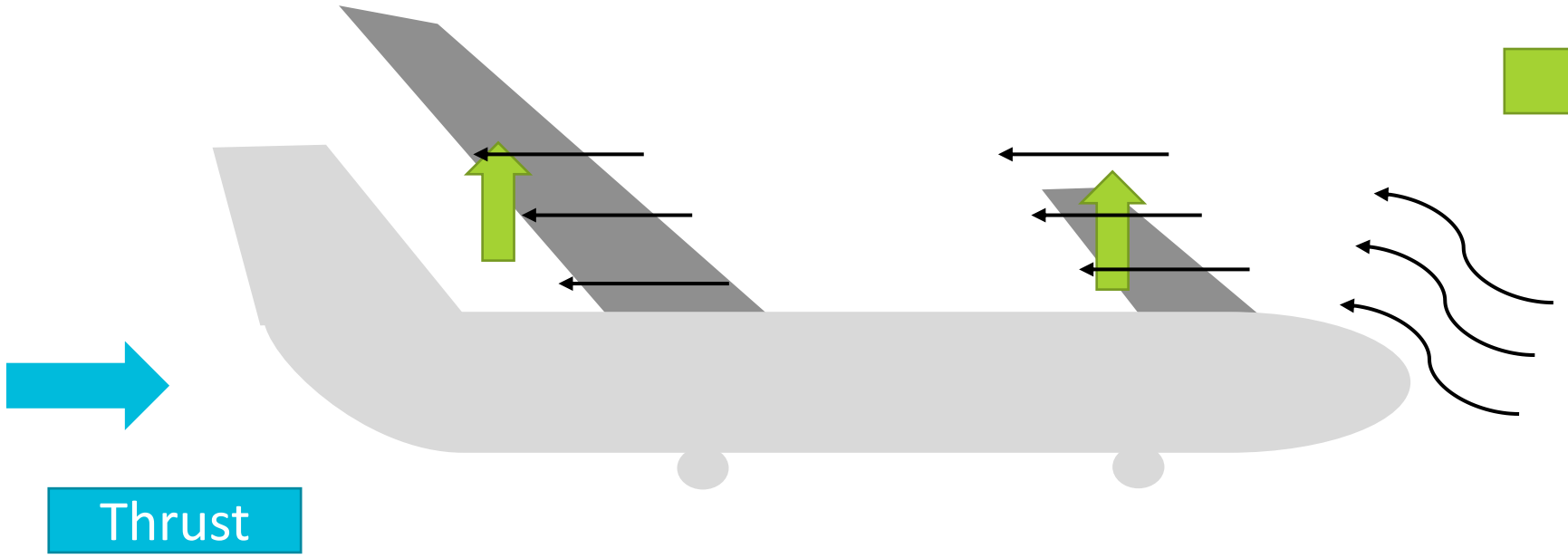
3. Rutan Quickie Q2

6. OMAC Laser 300

Presenter: SP

Criteria Comparison - AHP

Lift vs Thrust

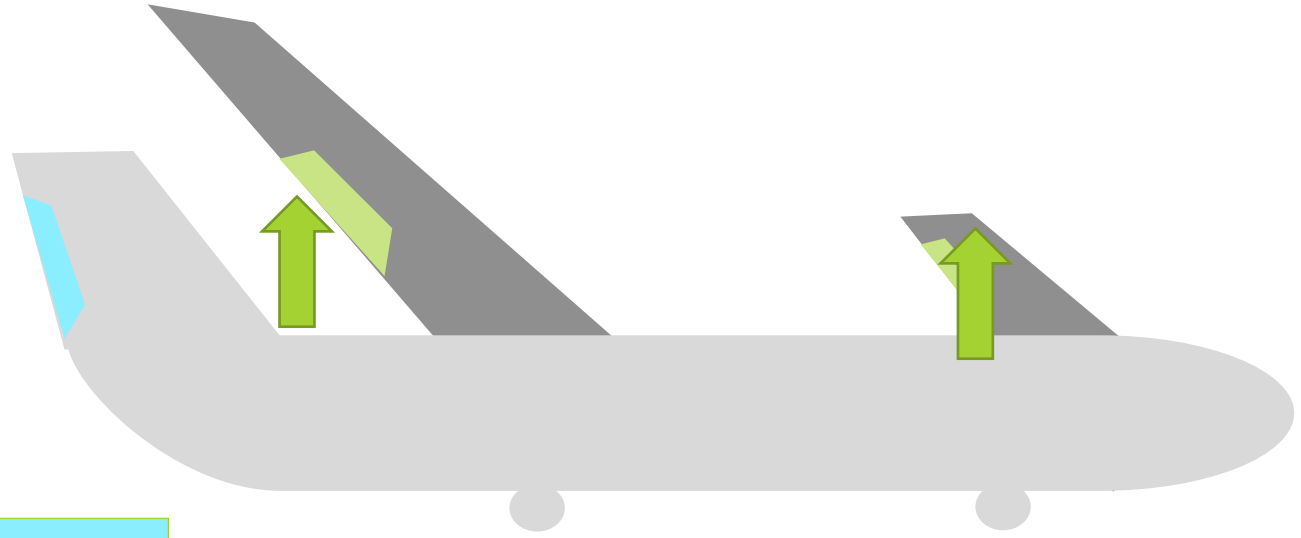


Thrust > Lift

Presenter: SP

Criteria Comparison - AHP

Lift vs Control Surface



Lift

Rudder

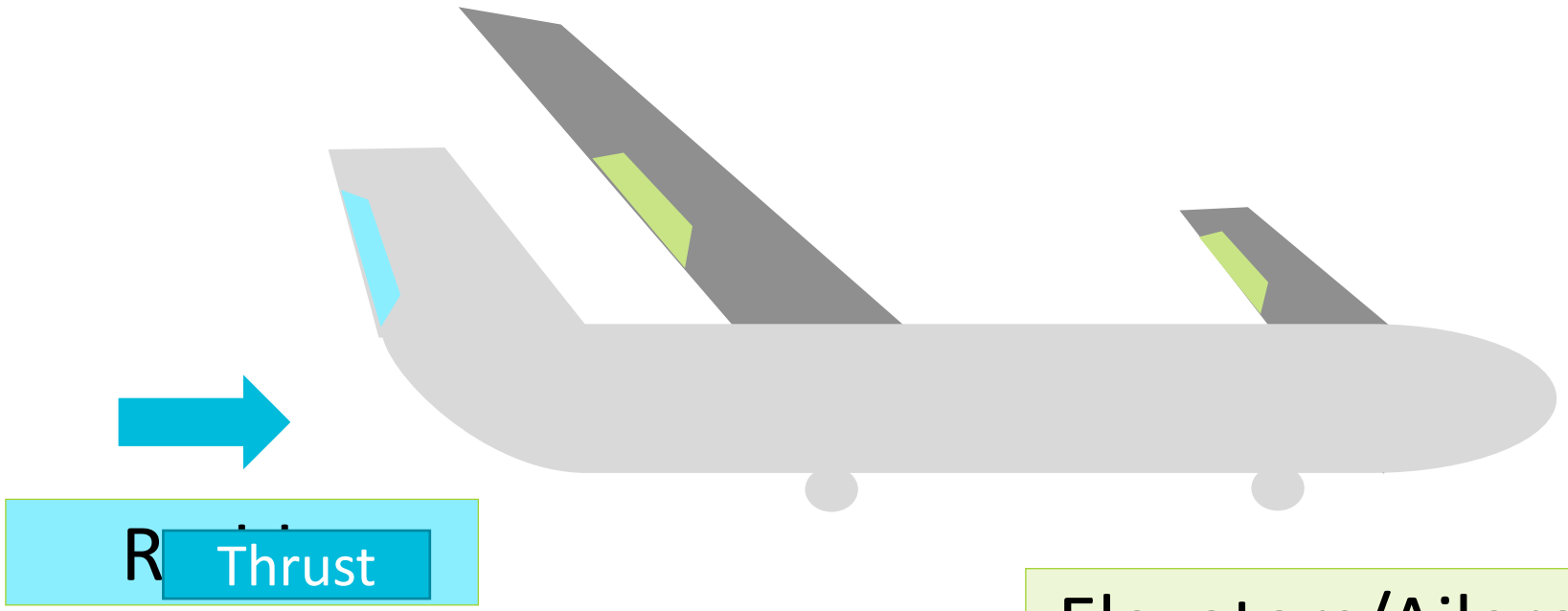
Elevators/Ailerons

Lift > Control Surface

Presenter: SP

Criteria Comparison - AHP

Thrust vs Control Surface



Elevators/Ailerons

Thrust > Control Surface

Presenter: SP

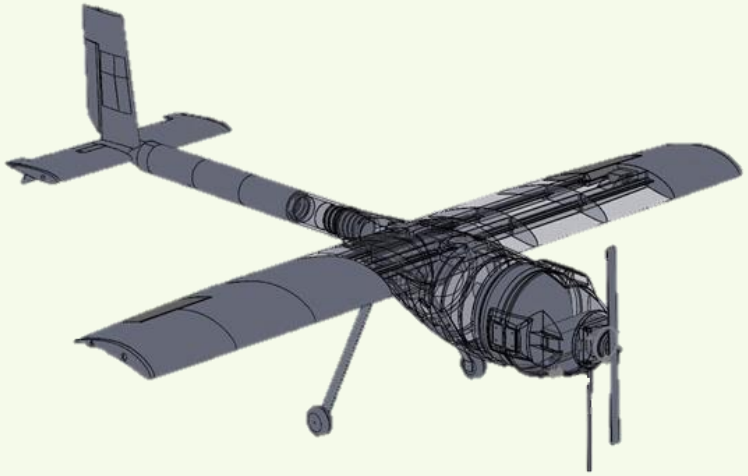
Criteria Comparison Matrix - AHP

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

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

CR<0.1

Presenter: SP



1. Boomtown

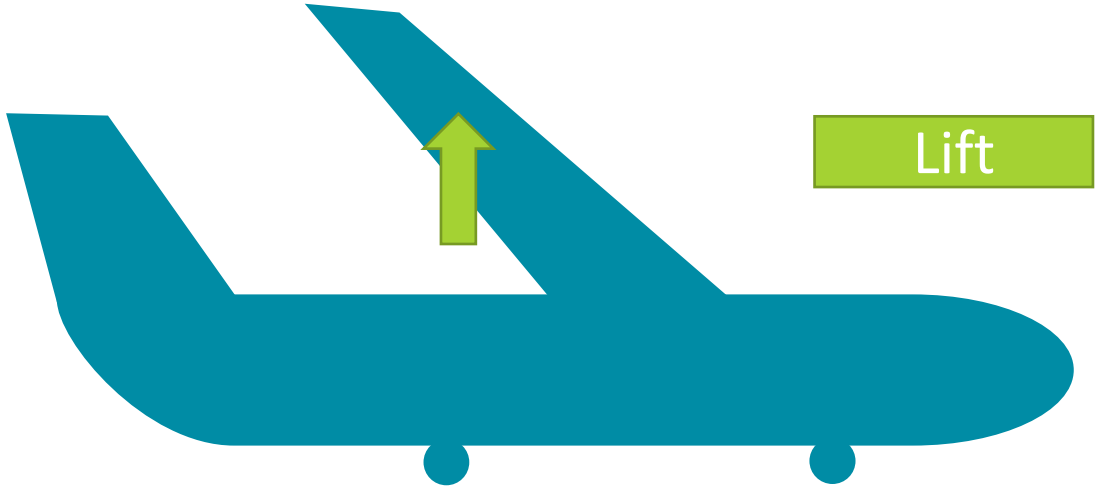
Concepts Considered for AHP

3. Rutan Quickie Q2

6. OMAC Laser 300

Presenter: SP

Lift Comparison for Concepts - AHP

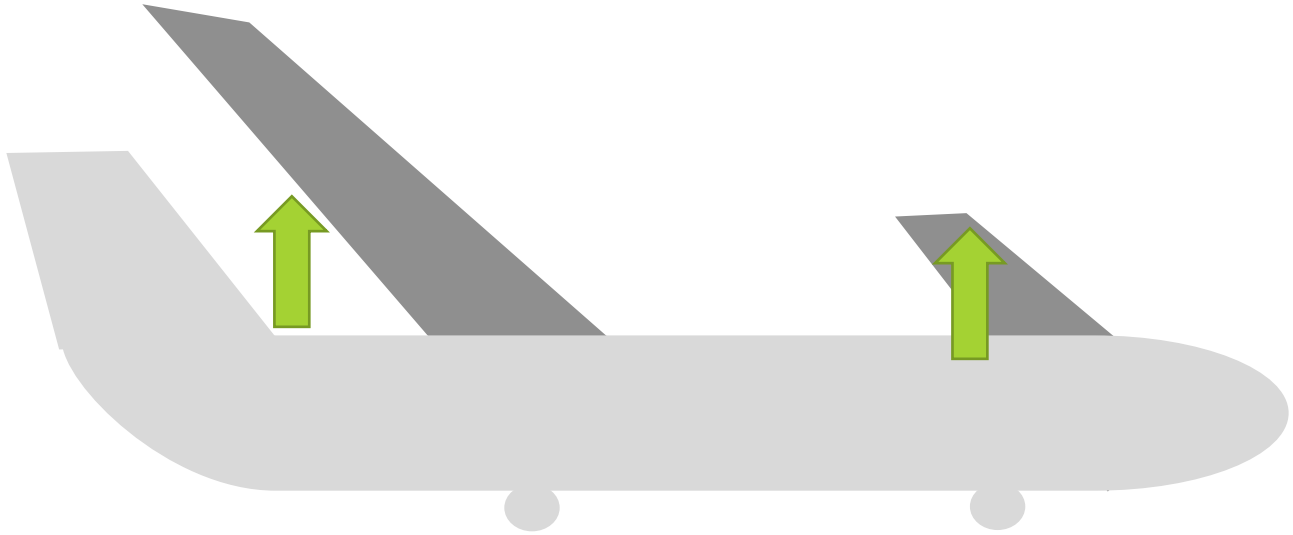


Just the main wing

Concept 1: Boomtown

Presenter: SP

Lift Comparison for Concepts - AHP



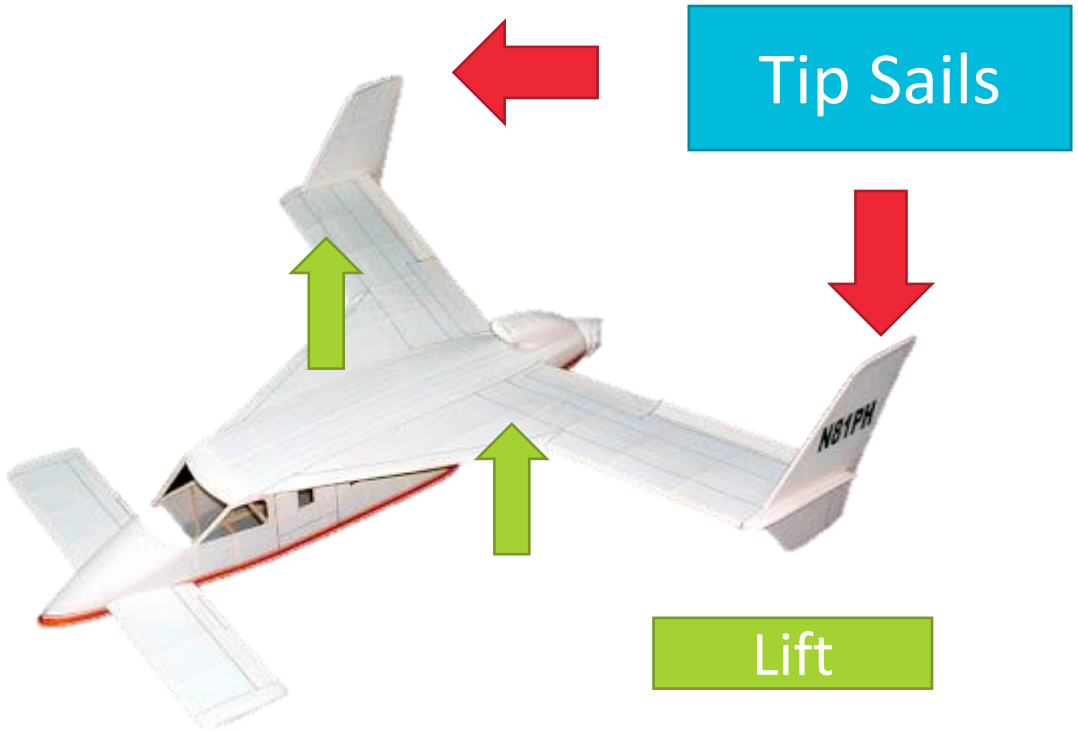
Lift

Canard + Main Wing

Concept 3: Rutan Quickie Q2

Presenter: SP

Lift Comparison for Concepts - AHP

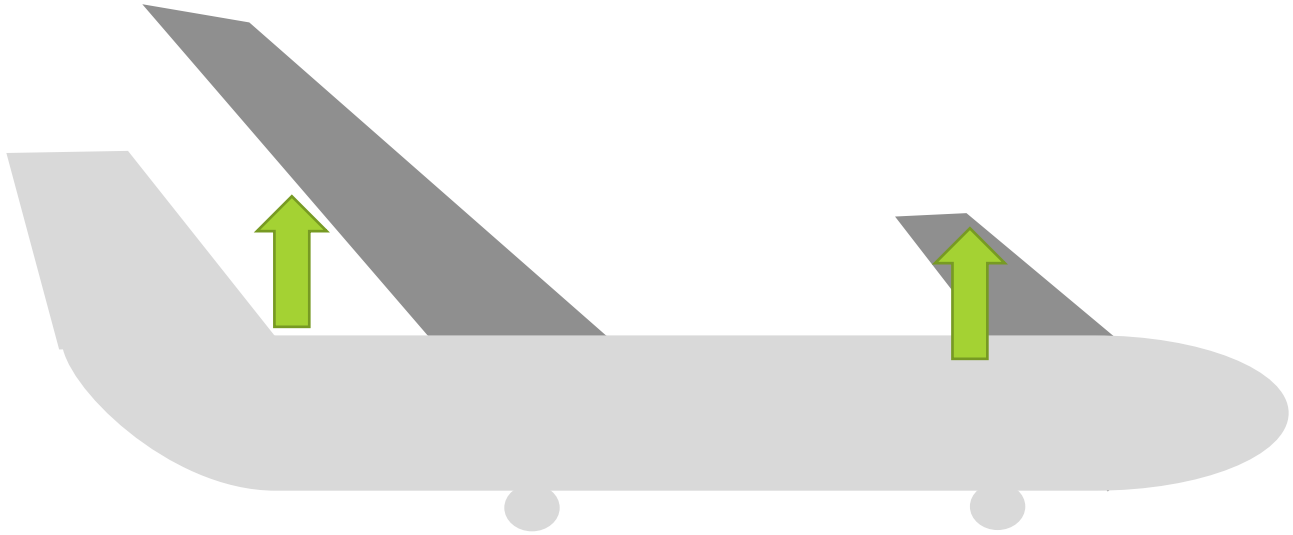


Concept 6: OMAC 300 Laser Plane

Lower Wingspan +
Delta Restriction

Presenter: SP

Lift Comparison for Concepts - AHP



Canard + Main Wing

Lift

Concept 3 > Concept 6 > Concept 1

Concept 3: Rutan Quickie Q2

Concept 6: OMAC 300 Laser Plane

Concept 1: Boomtown

Presenter: SP

Lift Comparison Matrix - AHP

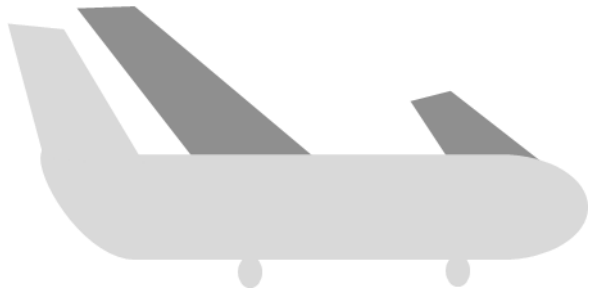
Comparison for All Criteria			
Thrust	CSM	Weight	Joint Strength

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

CR<0.1

1



3

6

Presenter: SP

Final Rating & Alternative Values - AHP

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

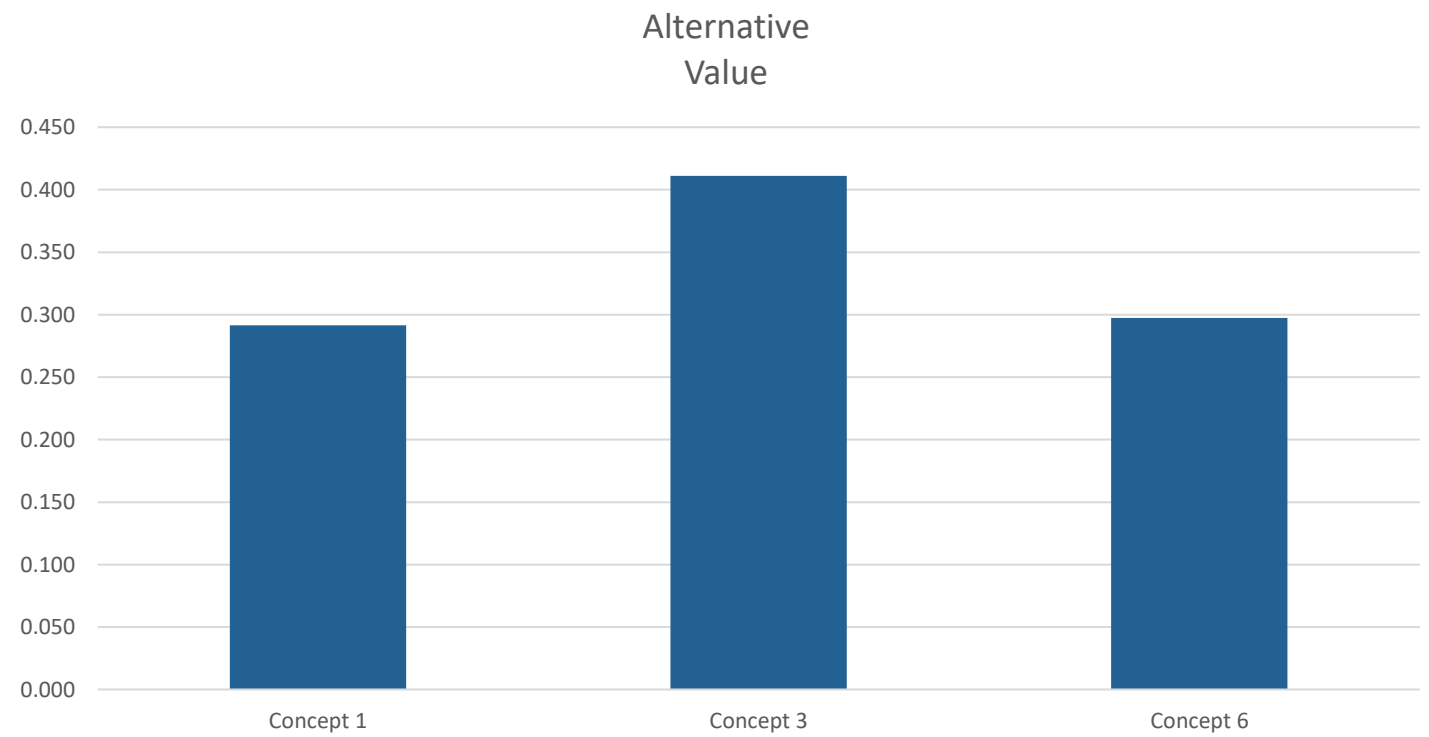
1

3

6

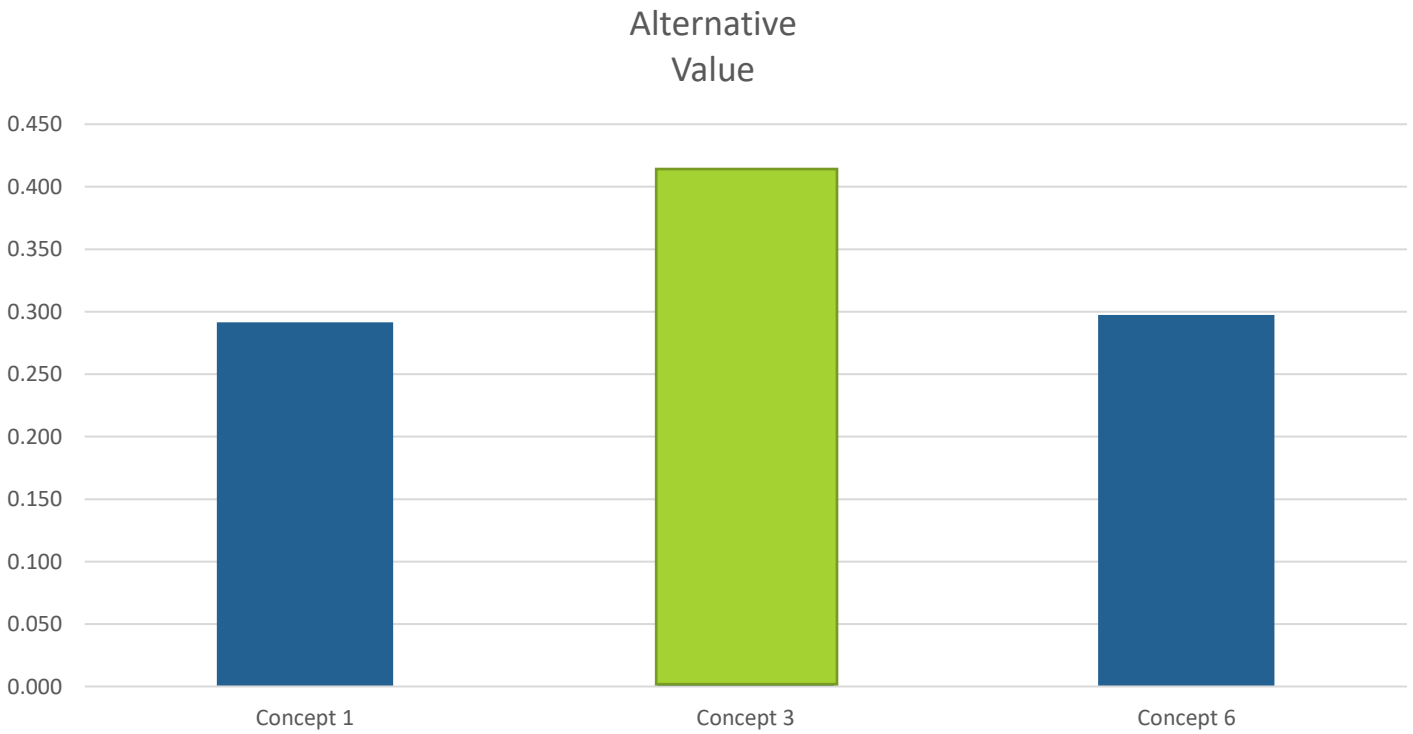
Presenter: SP

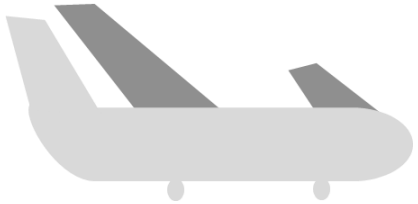
Concept Comparison- AHP



Presenter: SP

Concept Comparison- AHP





Presenter: SP

Concept Selection
The Chosen One

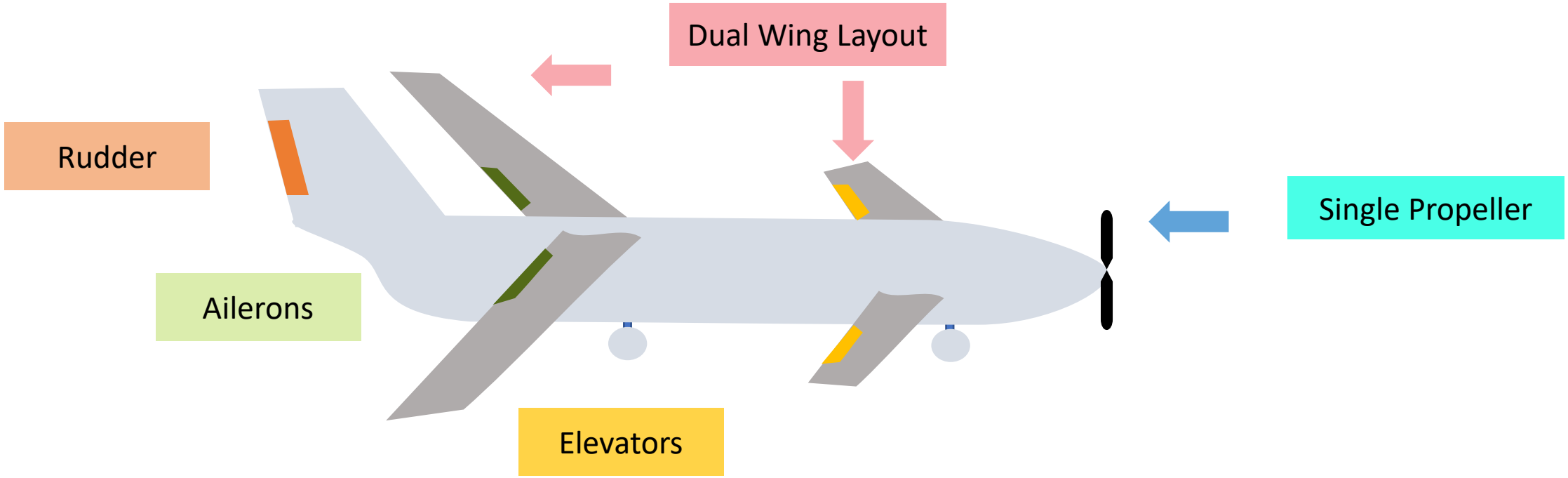
Presenter – Adrian Moya

Chosen Design

Concept 3: Rutan Quickie Q2

Presenter: AM

Chosen Design



Concept 3: Rutan Quickie Q2

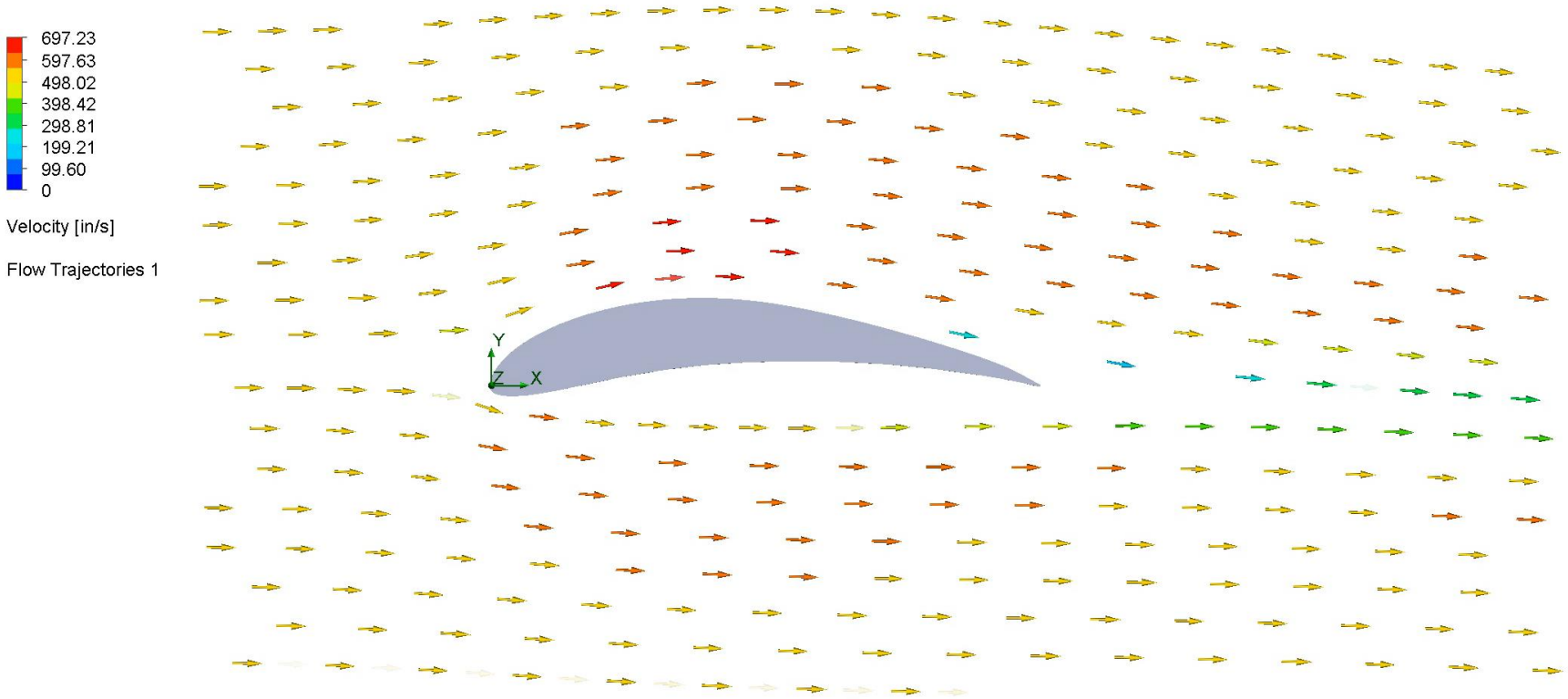
Presenter: AM

Current and Future Work

Presenter – Adrian Moya

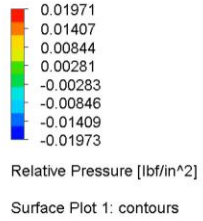
Current Work – Fluid Analysis

Eppler 423 Airfoil



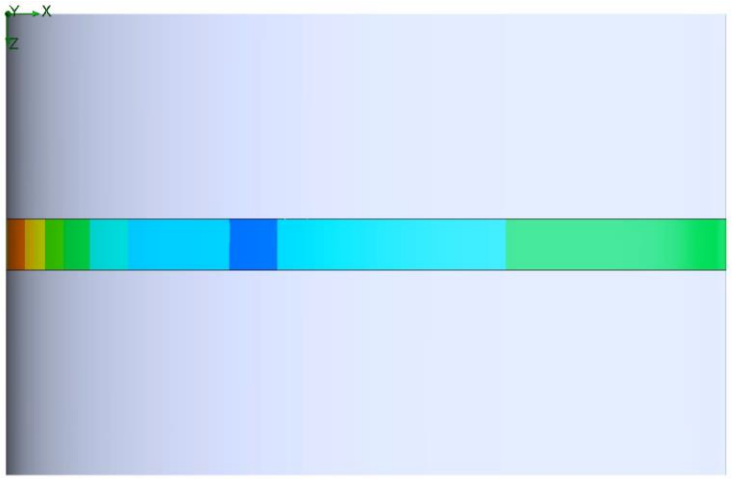
Presenter: AM

Current Work – Fluid Analysis



Drag Force	
X-component of Normal Force	0.017 lbf

Lift Force	
Y-component of Normal Force	0.036 lbf

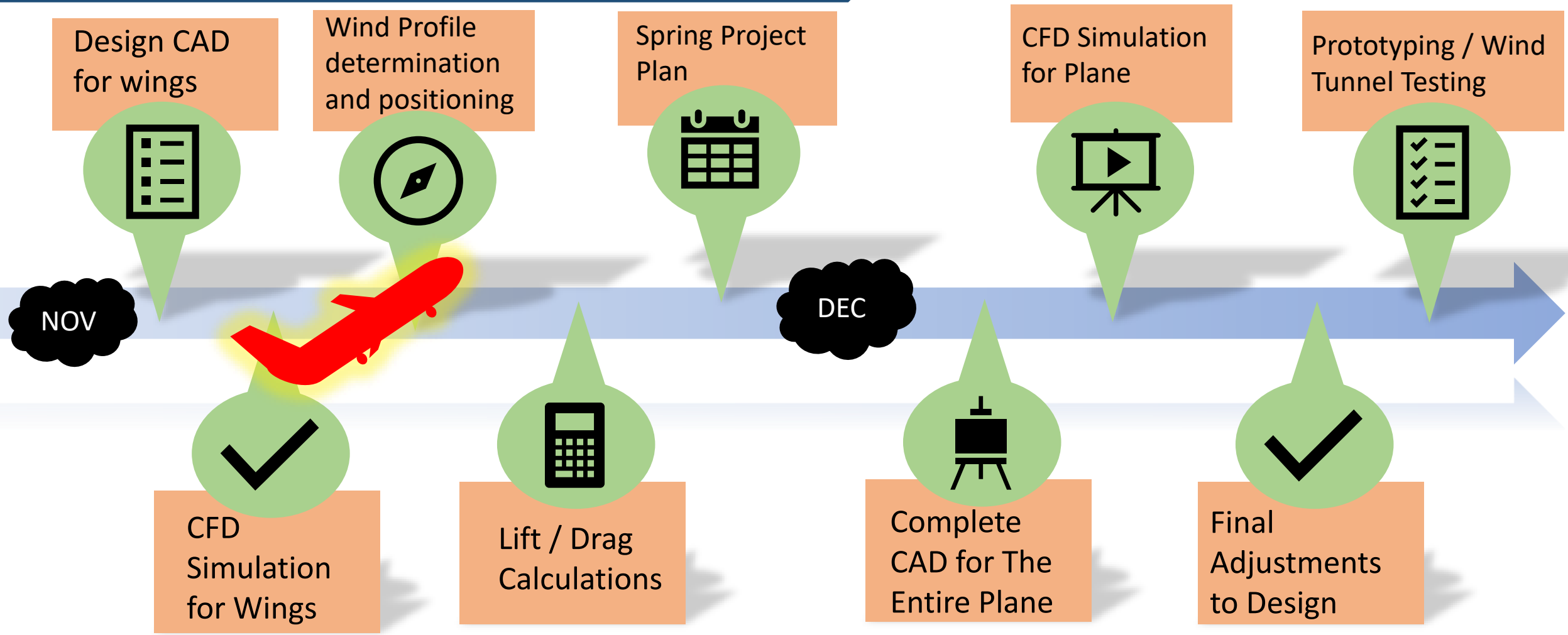


Top Surface

Bottom Surface

Presenter: AM

Project Timeline – FALL



Presenter: AM

References

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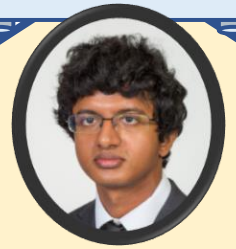
Tail Types. What-When-How. N.d. http://what-when-how.com/flight/tail-designs/

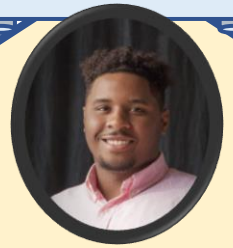
Presenter: AM

LinkedIn Information

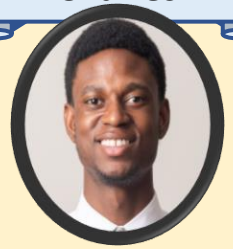
Sasindu Pinto



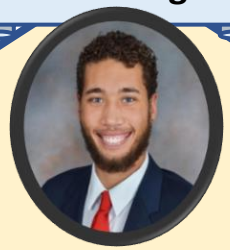
Cameron Riley



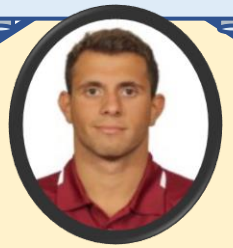
Michenell Louis-Charles



Noah Wright



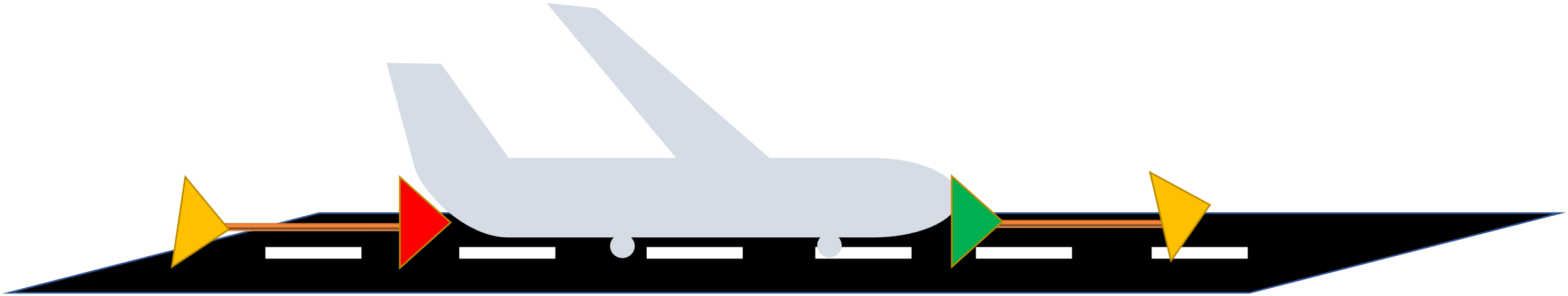
Adrian Moya



Criteria Comparison | Characteristic Comparison | Final Rating Matrix

Backup Slides

Customer Needs

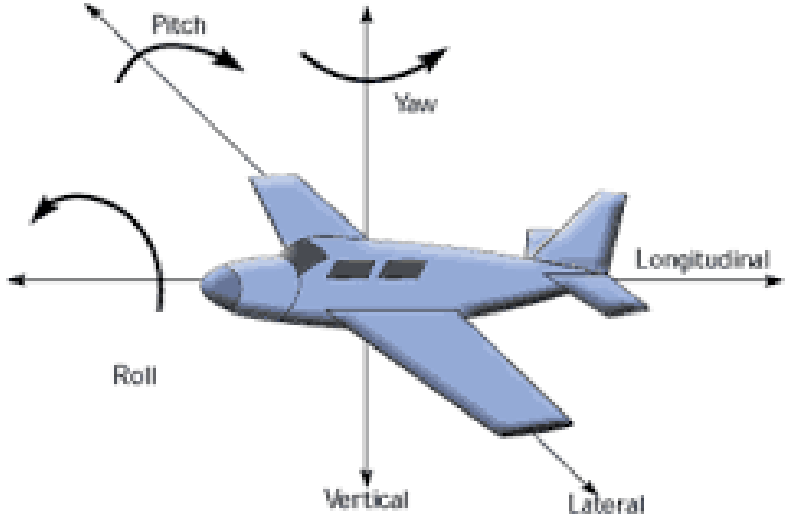


Land within 400 ft

Takeoff within 100 ft

Presenter: CR

Targets and Metrics



- Control Surface Movement
  - Controlling pitch ~ angle about x-axis
    - Servo Motor Torque produced ~ Greater than 66 oz-in
  - Controlling yaw ~ angle about y – axis
    - Servo Motor Torque produced ~ Greater than 66 oz-in
  - Controlling roll ~ angle about z – axis
    - Servo Motor Torque produced ~ Greater than 66 oz-in

Presenter: MLC

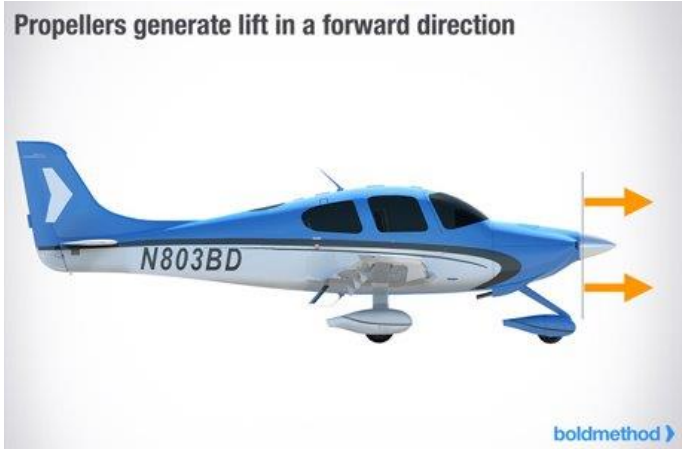
Targets and Metrics

- Generating Drag (Air and Ground)
  - Coefficient of Drag ~ Greater than 1
  - Air Brake Force ~ 2-5 lbf
  - Coefficient of Rolling Friction ~ 0.03-0.06
  - Landing Velocity ~ Less than 25 mph
  - Landing Gear Force absorption ~ Greater than 55 lbs

Presenter: MLC

Targets and Metrics

- Generate Thrust
  - Thrust Force ~ 15lbf
  - Propeller Diameter ~ 16in-20in
  - Electric Motor Power ~ 950W



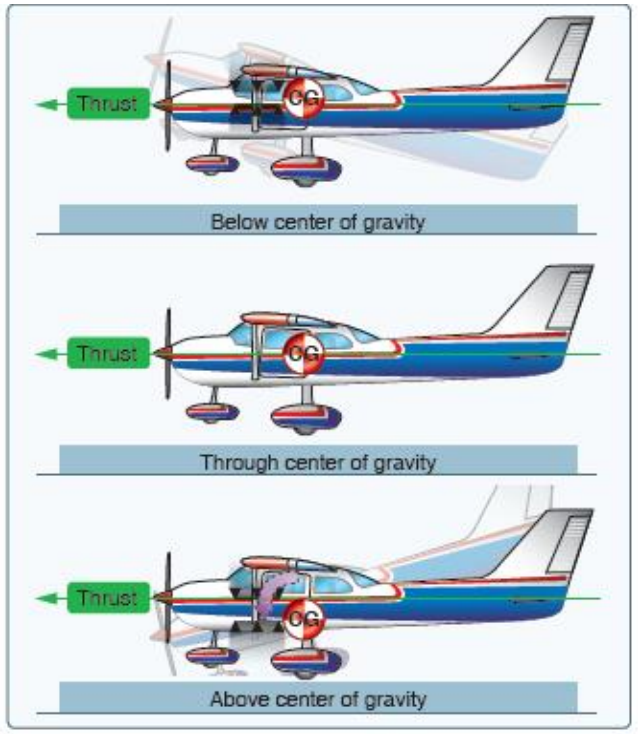


Figure 5-26. *Thrust line affects longitudinal stability.*

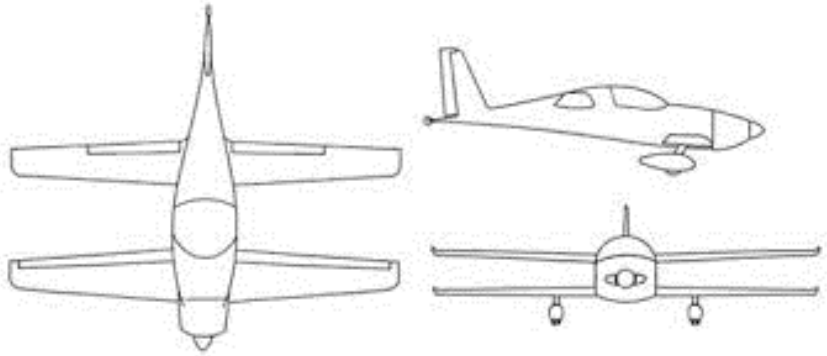
Presenter: MLC

- Deceleration
  - Coefficient of Drag ~ Greater than 1
  - Air Brake Force ~ 2-5 lbf
  - Coefficient of Rolling Friction ~ 0.03-0.06
  - Landing Velocity ~ Less than 25 mph
  - Landing Gear Force absorption ~ Greater than 55 lbs

Chosen Design

- The winner of the concept selection was…

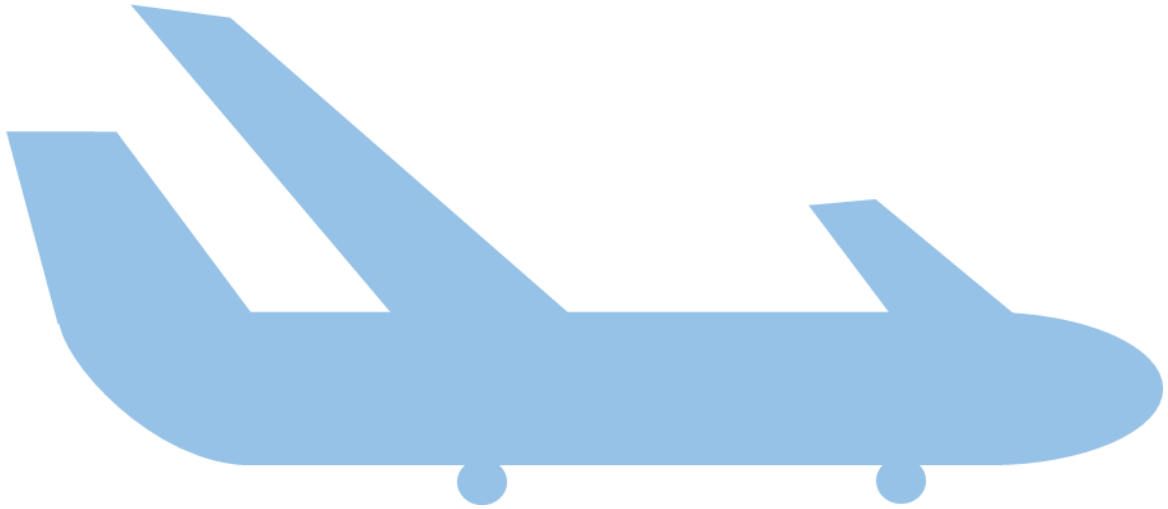
Rutan Quickie Q2!



Future Work

- Pinpointing our wing position and profile
- CAD Modeling (SolidWorks)
- Fluid Analysis (SolidWorks, Ansys)
- Verifying the accuracy of SolidWorks CFD with simple wind tunnel tests

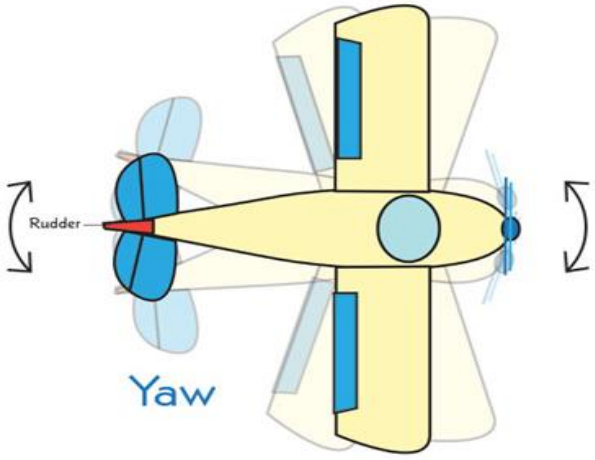
Customer Needs Considered



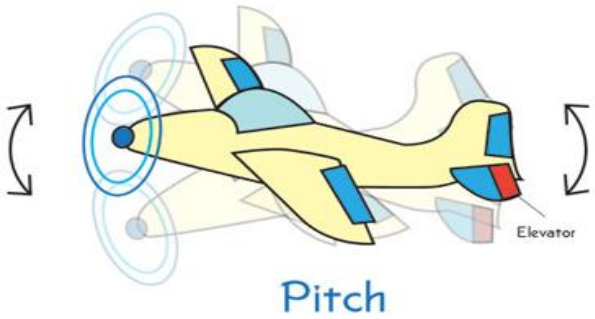
Material

Key Definitions

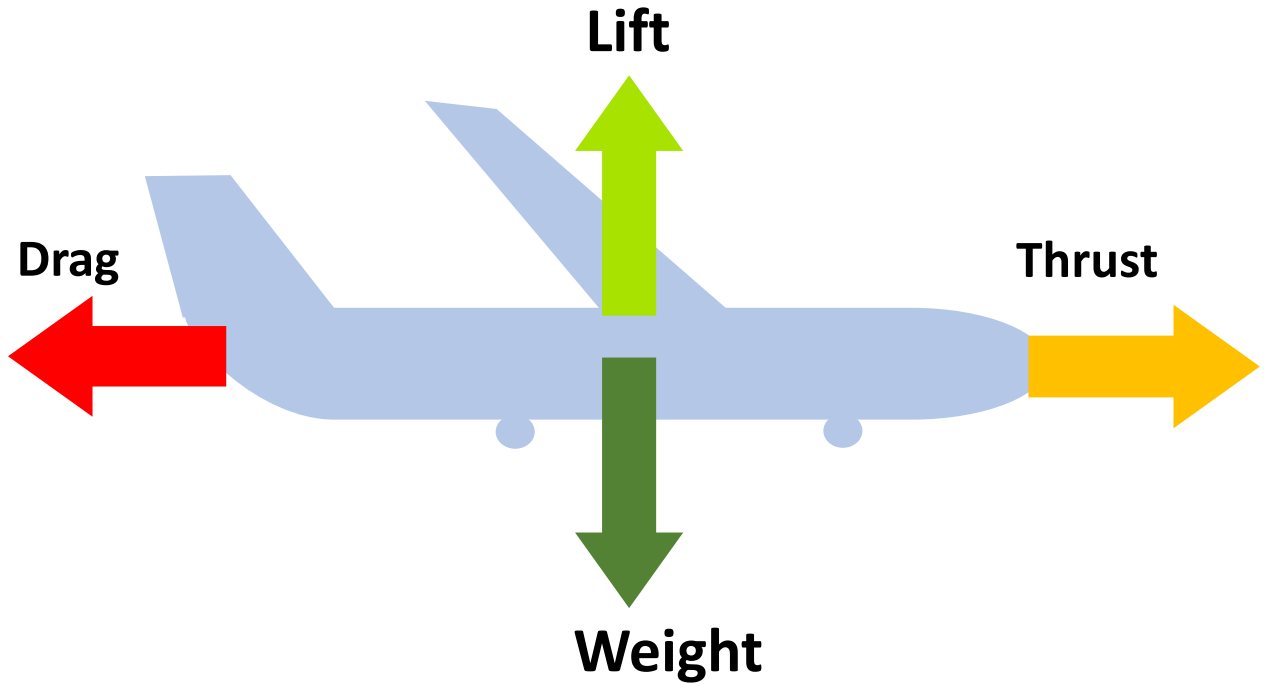
Use the ailerons to control
Roll



Use the rudder to control
Yaw



Use the elevators to control
Pitch



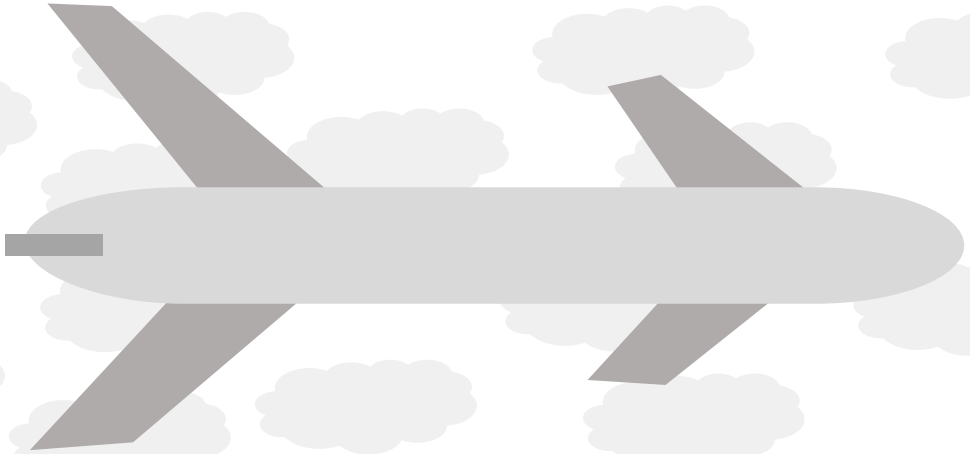
Targets and Metrics

- Control Surface Movement
  - Controlling pitch ~ angle about x-axis
    - Servo Motor Torque produced ~ Greater than 66 oz-in

Presenter: CR

Targets and Metrics

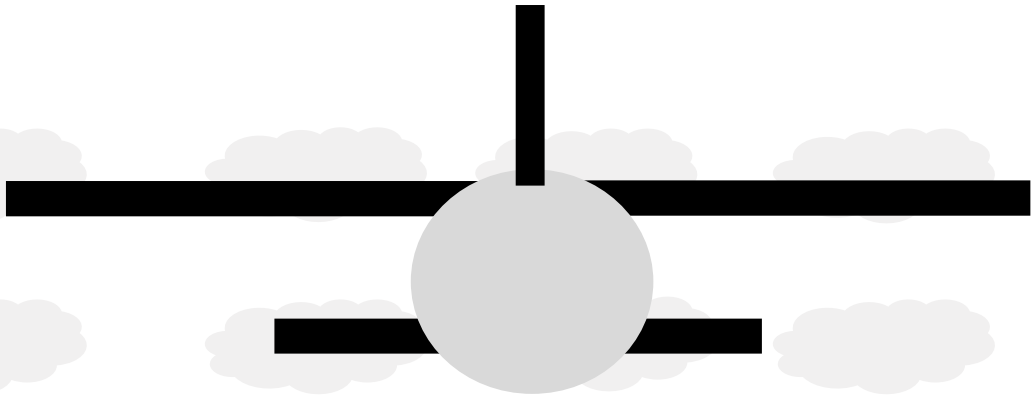
- Control Surface Movement
  - Controlling yaw ~ angle about y – axis
    - Servo Motor Torque produced ~ Greater than 66 oz-in



Presenter: CR

Targets and Metrics

- Control Surface Movement
  - Controlling roll ~ angle about z – axis
    - Servo Motor Torque produced ~ Greater than 66 oz-in



House of Quality

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	-

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

Pugh Charts

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

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

AHP Criteria Comparison

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