EML4551-2

VDR 2
Team 518:
Light-Weight UAV

November 17, 2020

Department of Mechanical Engineering

FAMU-FSU Engineering

Team Introductions

Ethan Hale
Manufacturing and Systems Engineer

Jackson Dixon
Supply Chain Engineer

Maxwell Sirianni
Flight Dynamics Engineer

John Storms
Test Engineer

Joseph Ledo-Massey
Design Engineer and Project Manager

Sponsor and Advisor

NORTHROP GRUMMAN

Jennifer Tecson

Manager of Engineering

FSU Electrical Engineering Graduate

Lance Cooley, Ph.D.

Professor of Mechanical Engineering

Research interests in superconducting materials

Joseph Ledo-Massey

Objective

The objective of this project is to reduce the weight of a UAV and directly increase the flight time while maintaining surveillance capabilities.

Joseph Ledo-Massey

Previous Work

Joseph Ledo-Massey

Previously...

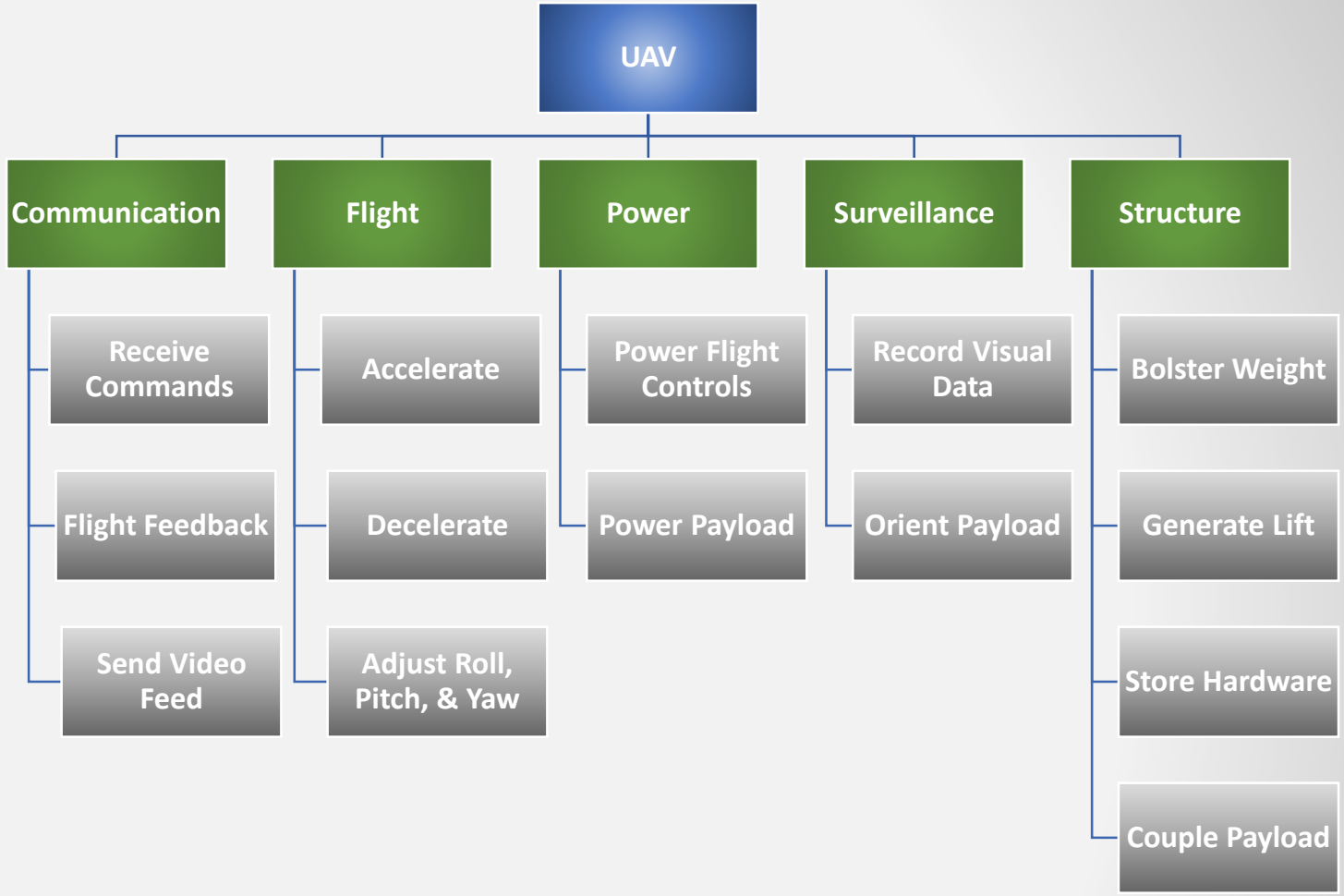
- Primary Market:
  Farming and Agriculture

- Key Goals
  - Easy to transport and operate
  - Competitive with similar UAVs on the market
  - Use multiple light weighting techniques

Joseph Ledo-Massey

Previously...

- Functional Decomposition
  - Communication
  - Flight
  - Power
  - Surveillance
  - Structure



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Analysis of UAV

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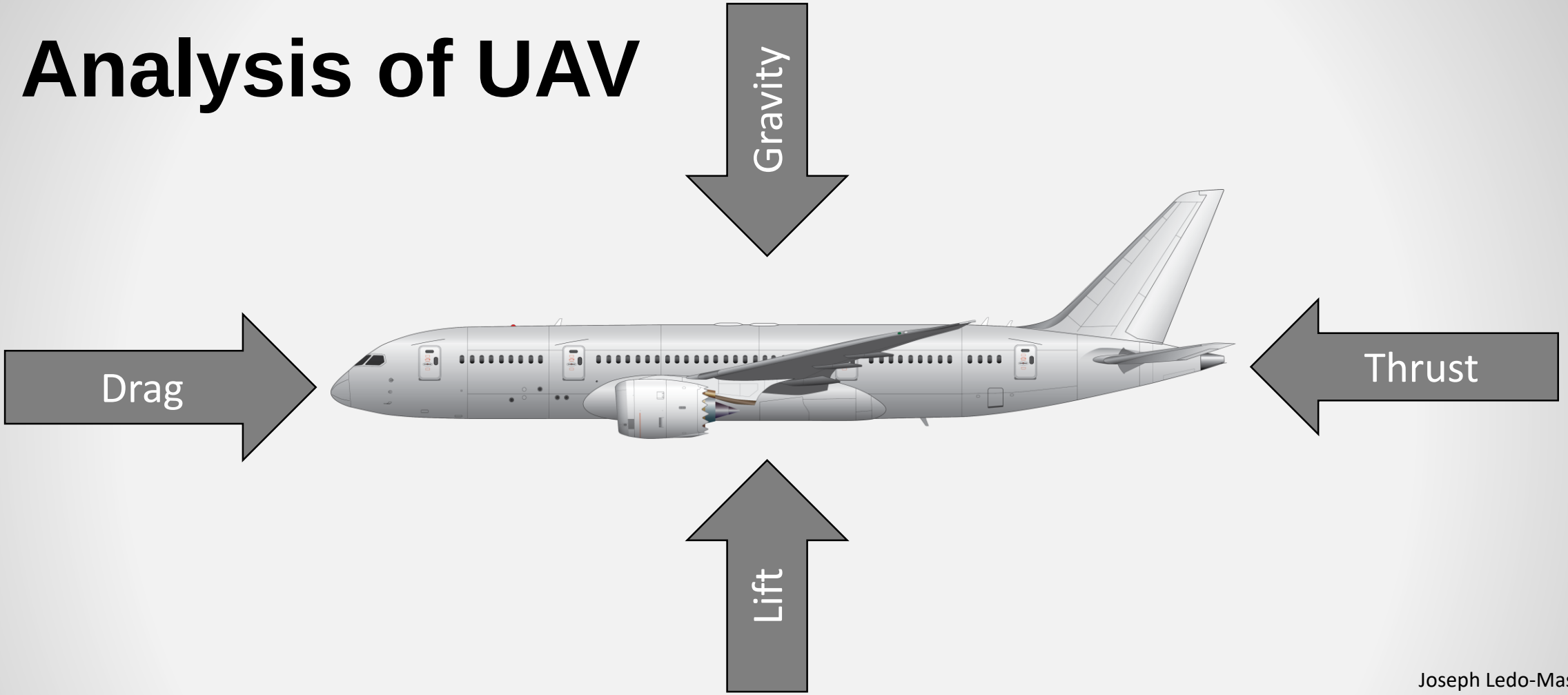
Analysis of UAV



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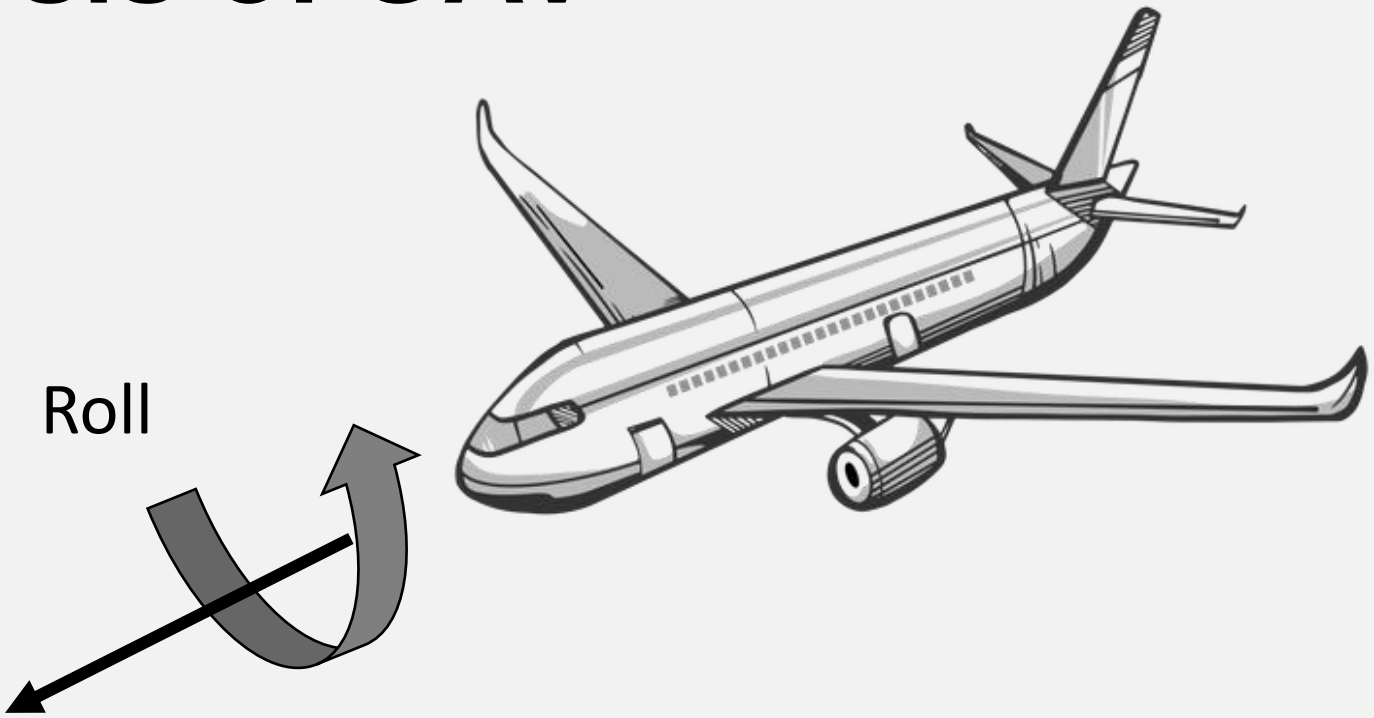

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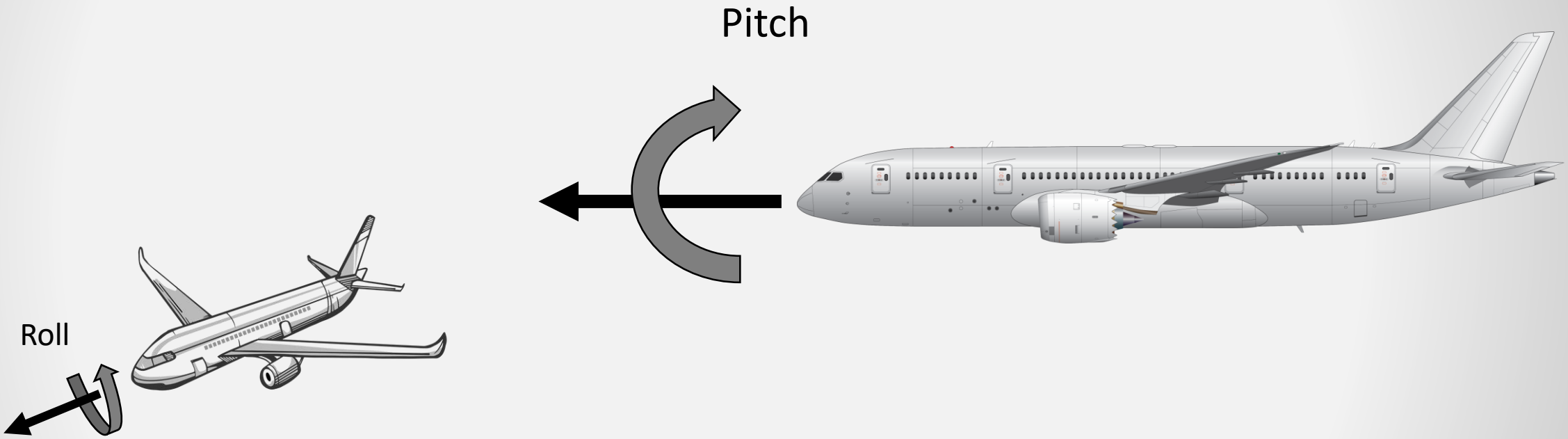
Analysis of UAV



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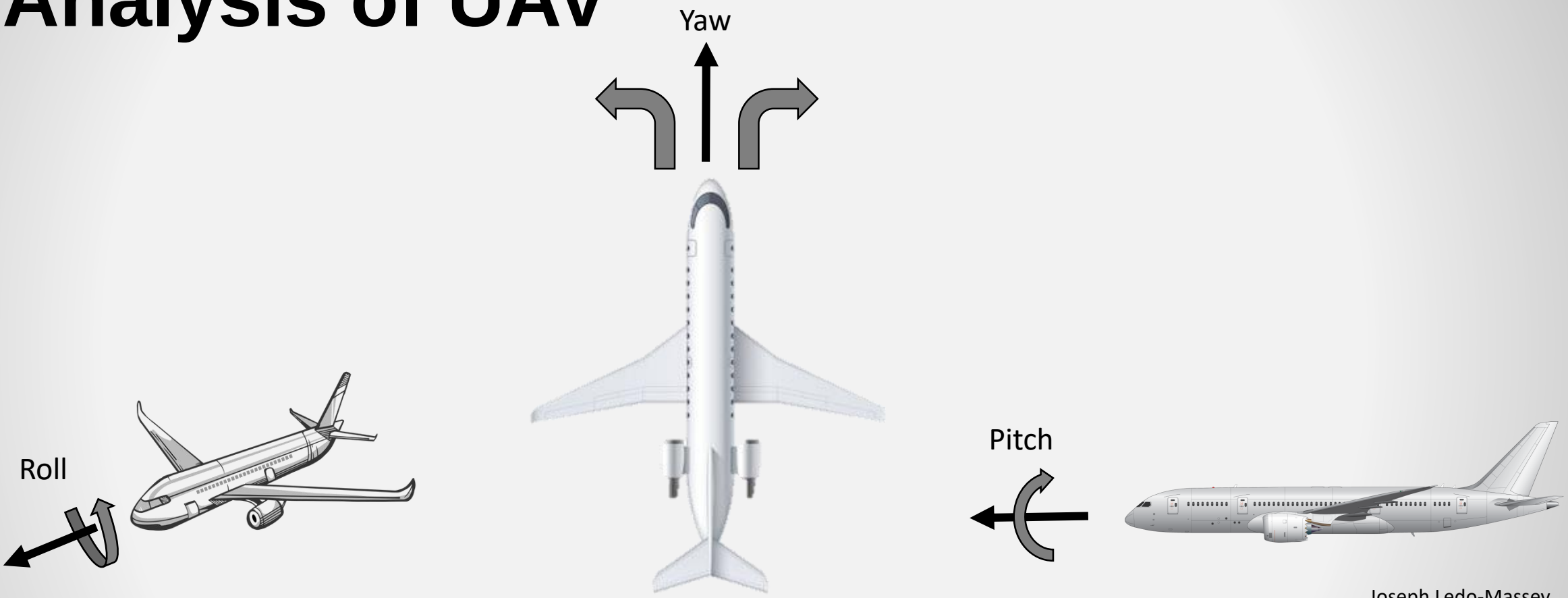
Analysis of UAV



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Analysis of UAV

= Center of Pressure(CP)

= Center of Gravity (CG)

Joseph Ledo-Massey

Targets and Metrics

Joseph Ledo-Massey

Critical Targets and Metrics

Functions	Metrics	Targets
1) Bolster weight	1) Support moment due to wing	1) 1.128 N/m
2) Generate Lift	2) Airfoil produces greater lift force than gross weight	2) 54 N
3) Couple Payload	3) Mass of payload supported	3) 600 g
4) Endurance	4) Overall flight time	4) 60 mins

Joseph Ledo-Massey

Concept Generation

Concept Generation

Anti-Problem

Biomimicry

Brainstorming

Systematic Approach

John Storms

Concept Generation

100 Concepts

Medium Fidelity Concepts

Regenerative Power Source

Generative Design

Honeycomb Structures

Electric Components used as support

Complete wing Design

High Fidelity Concepts

LW-PLA Constructed Parts

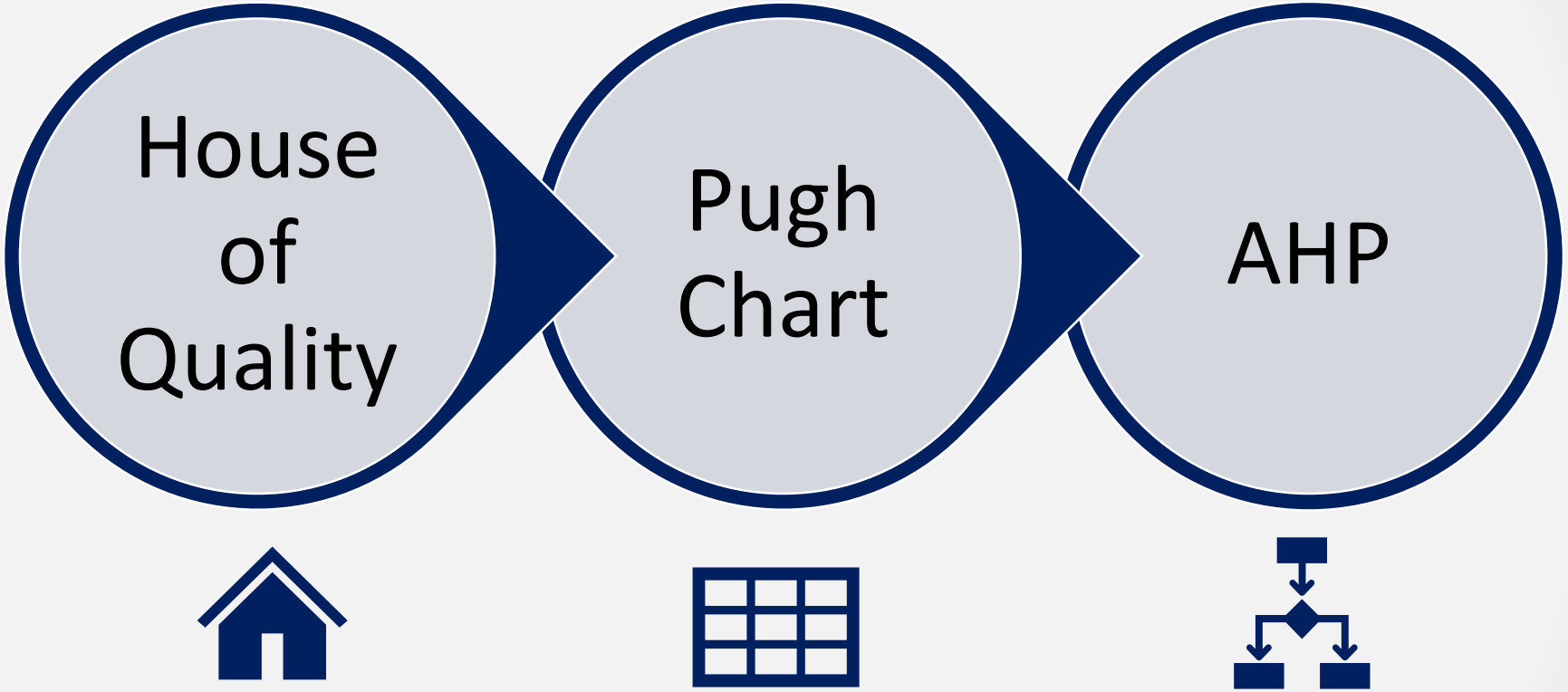
Lighter Electrical Components

Improve Propeller Design

John Storms

Concept Selection

Concept Selection



John Storms

Concept Selection – House of Quality

House of Quality		Engineering Characteristics										
Improve Direction		↓	↑	↑	-	↓	↑	↑	↑	-	↑	↑
Units		Kg	Sec	m	m	g	N	n/a	m/s	m	m	deg
Customer Requirements	Importance Weight Factor	Overall Weight	Endurance	Wingspan	Length	Payload Weight	Wing rigidity	Material Durability	Velocity Control	Altitude	Signal Range	Payload Control
UAV constructed of lightweight materials	7	9	7	5	7		7	7	3	3	1	1
UAV implements previously purchased components	3	1				5					1	3
UAV takes off and lands assisted or unassisted	1				3			5	7	1		
The UAV is of the fixed wing style	3	3	9	9	1		9		3	5		3
The UAV has a payload	6	5	5		3	9	1		5	1	1	7
The UAV uses outsourced components	1					9					3	3
The UAV is smaller than double the reference drone	3	7	1	3			1		1		1	
The UAV is category 1	4	7				7			3	9		
Raw Score	905	154	109	71	73	106	85	54	82	79	22	70
Relative Weight %		17.02	12.04	7.85	8.07	11.71	9.39	5.97	9.06	8.73	2.43	7.73
Rank Order		1	2	8	7	3	4	10	5	6	11	9

John Storms

Concept Selection – House of Quality

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Units		Kg	Sec	m	m	g	N	n/a	m/s	m	m	deg
Customer Requirements	Importance Weight Factor	Overall Weight	Endurance	Wingspan	Length	Payload Weight	Wing rigidity	Material Durability	Velocity Control	Altitude	Signal Range	Payload Control
…	…	…	…	…	…	…	…	…	…	…	…	…
Raw Score	905	154	109	71	73	106	85	54	82	79	22	70
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Rank Order		1	2	8	7	3	4	10	5	6	11	9

John Storms

Previous Work | Analysis of UAV | Targets and Metrics | Concept Generation | Concept Selection | Selected Concept

Concept Selection – Pugh Charts

Pugh Chart Iteration One	Datum	Concepts				
Selection Criteria	Styrofoam	LW-PLA constructed parts	Lighter Electrical Components	Improve Propeller design	Generative Design	Regenerative Power Source
Overall Weight	Datum	S	-	-	+	-
Endurance		+	+	+	+	+
Payload Weight		S	S	-	S	-
Wing Rigidity		+	+	S	S	S
Velocity Control		+	+	+	S	S
# of pluses		**3**	**3**	**2**	**2**	**1**
# of minuses		**0**	**1**	**2**	**0**	**2**

John Storms

Concept Selection – Pugh Charts

Pugh Chart Iteration Two	Datum	Concepts			
Selection Criteria	Improve Propeller design	LW-PLA constructed parts	Lighter Electrical Components	Generative Design	Regenerative Power Source
Overall Weight	Datum	-	-	+	-
Endurance		+	S	+	+
Payload Weight		S	S	S	-
Wing Rigidity		+	S	S	S
Velocity Control		-	+	S	-
# of pluses		**2**	**1**	**2**	**1**
# of minuses		**2**	**1**	**0**	**3**

John Storms

Concept Selection – Pugh Charts

Pugh Chart Iteration Three	Datum	Concepts		
Selection Criteria	Lighter Electrical Components	LW-PLA constructed parts	Improve Propeller design	Generative Design
Overall Weight	Datum	+	+	+
Endurance		S	S	S
Payload Weight		-	S	S
Wing Rigidity		+	S	S
Velocity Control		+	-	-
# of pluses		**3**	**1**	**1**
# of minuses		**1**	**1**	**1**

John Storms

Concept Selection – AHP

Matrix [c]					
	Overall Weight	Endurance	Payload Weight	Wing Rigidity	Velocity Control
Overall Weight	1.000	1.000	0.333	0.200	0.200
Endurance	1.000	1.000	0.333	0.200	0.143
Payload Weight	3.000	3.000	1.000	0.333	0.200
Wing Rigidity	5.000	5.000	3.000	1.000	1.000
Velocity Control	5.000	7.000	5.000	1.000	1.000
Sum	15.000	17.000	9.666	2.733	2.543

Jackson Dixon

Concept Selection – AHP

{Matrix [C]} → Normalize

Normalized Matrix [norm c]						
	Overall Weight	Endurance	Payload Weight	Wing Rigidity	Velocity Control	Criteria Weight {W}
Overall Weight	0.067	0.059	0.034	0.073	0.079	0.06
Endurance	0.067	0.059	0.034	0.073	0.056	0.06
Payload Weight	0.200	0.176	0.103	0.122	0.079	0.14
Wing Rigidity	0.333	0.294	0.310	0.366	0.393	0.34
Velocity Control	0.333	0.412	0.517	0.366	0.393	0.40
sum	1.00	1.00	1.00	1.00	1.00	

Jackson Dixon

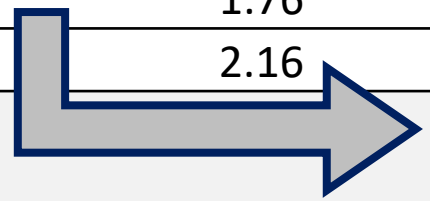
Concept Selection - AHP

Normalized Matrix [norm c]						
	Overall Weight	Endurance	Payload Weight	Wing Rigidity	Velocity Control	Criteria Weight {W}
Overall Weight	0.067	0.059	0.034	0.073	0.079	**0.06**
Endurance	0.067	0.059	0.034	0.073	0.056	**0.06**
Payload Weight	0.200	0.176	0.103	0.122	0.079	**0.14**
Wing Rigidity	0.333	0.294	0.310	0.366	0.393	**0.34**
Velocity Control	0.333	0.412	0.517	0.366	0.393	**0.40**
Sum	1.00	1.00	1.00	1.00	1.00	

Jackson Dixon

Concept Selection - AHP

Criteria Consistency Check		
{Ws}=[C]{W} Weighted Sum Vector	{W} Criteria Weights	{Ws}/{W} Consistency Vector
0.31	0.06	5.24
0.29	0.06	4.86
0.69	0.14	4.95
1.76		
2.16		



Consistency and Bias Check			
Average Consistency	Consistency Index	Consistency Ratio	Is Comparison Consistent
5.127	0.033	0.029	Yes

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Concept Selection – AHP

Final Rating Matrix			
	Lighter Electrical Components	LW-PLA constructed Parts	Improve Propeller Design
Overall Weight	0.20	0.60	0.20
Endurance	0.30	0.61	0.09
Payload Weight	0.11	0.63	0.26
Wing Rigidity	0.20	0.34	0.46
Velocity Control	0.72	0.19	0.08

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Concept Selection – AHP

Alternative Weight of Concepts	
Concepts	Alternative
Lighter Electrical Components	0.401
LW-PLA Constructed Parts	0.352
Improve Propeller Design	0.242

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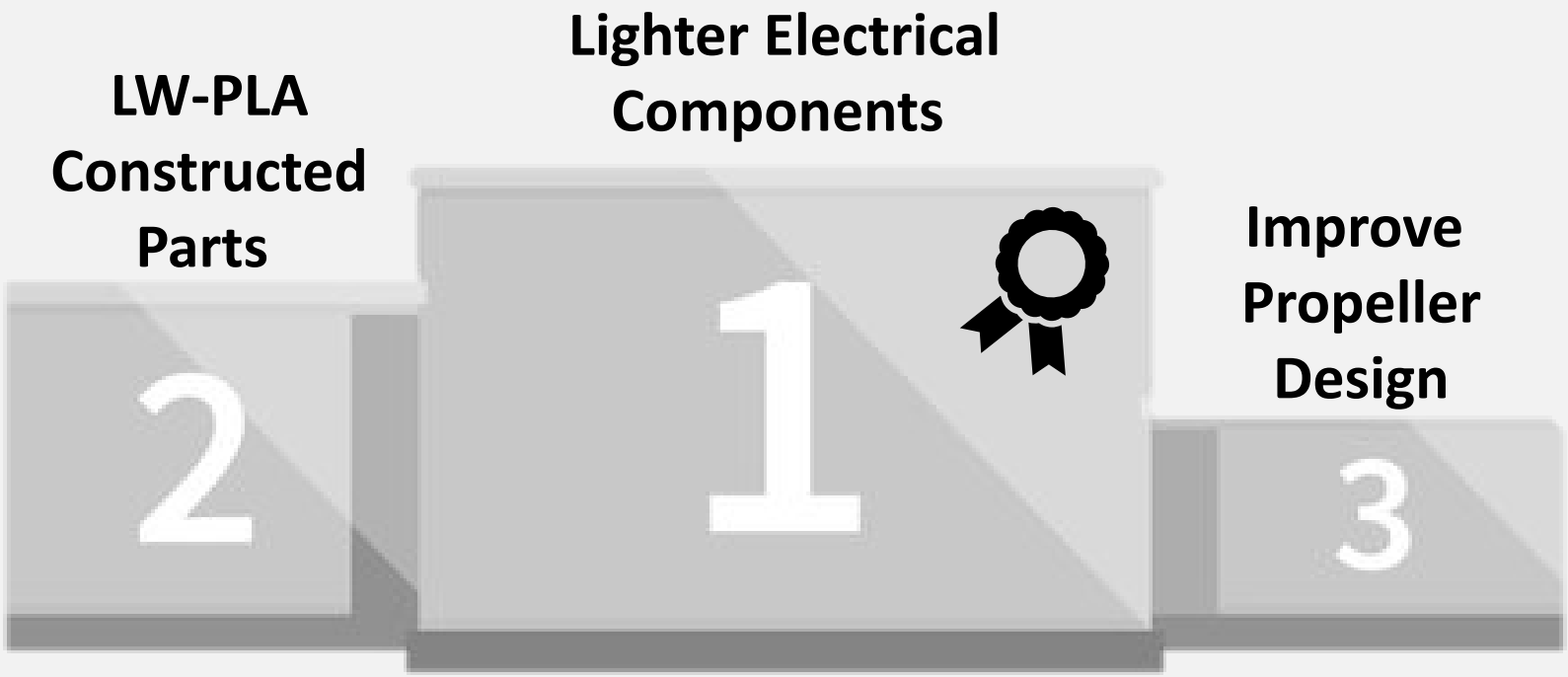
Selected Concept



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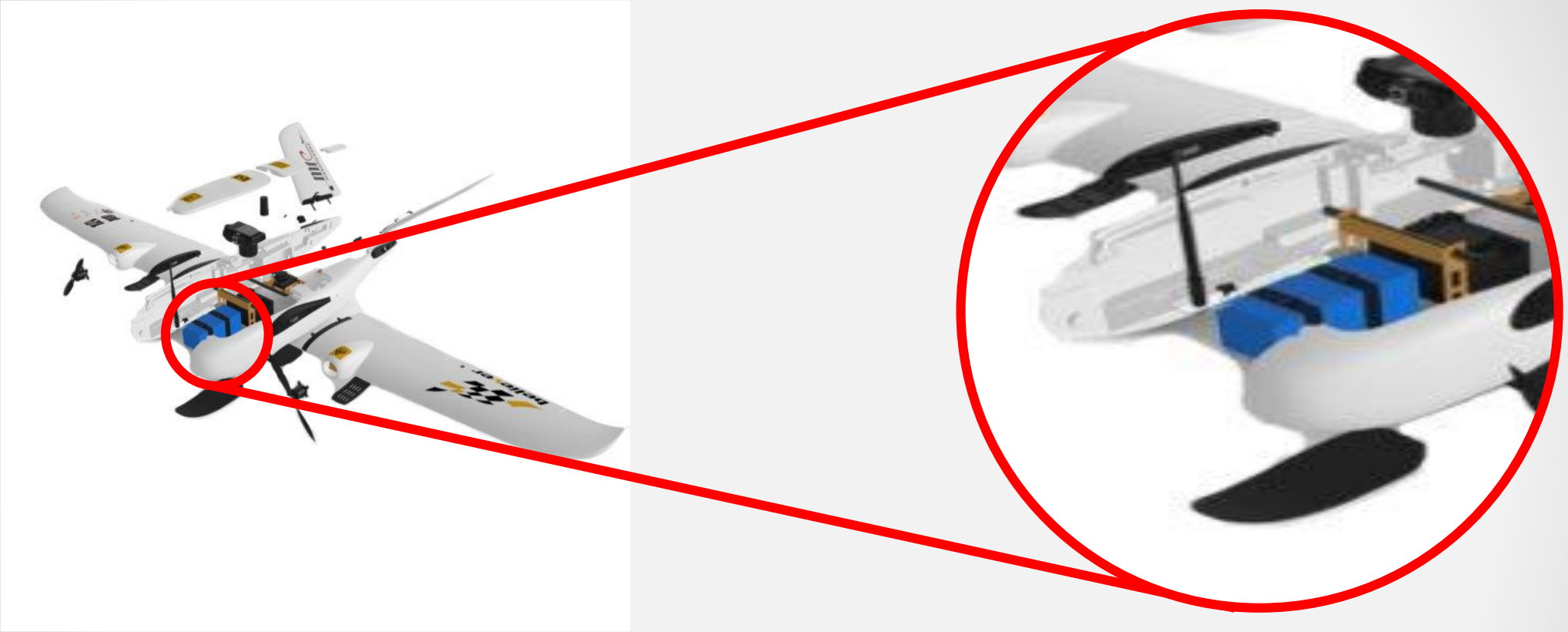
Selected Concept



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Selected Concept

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Selected Concept

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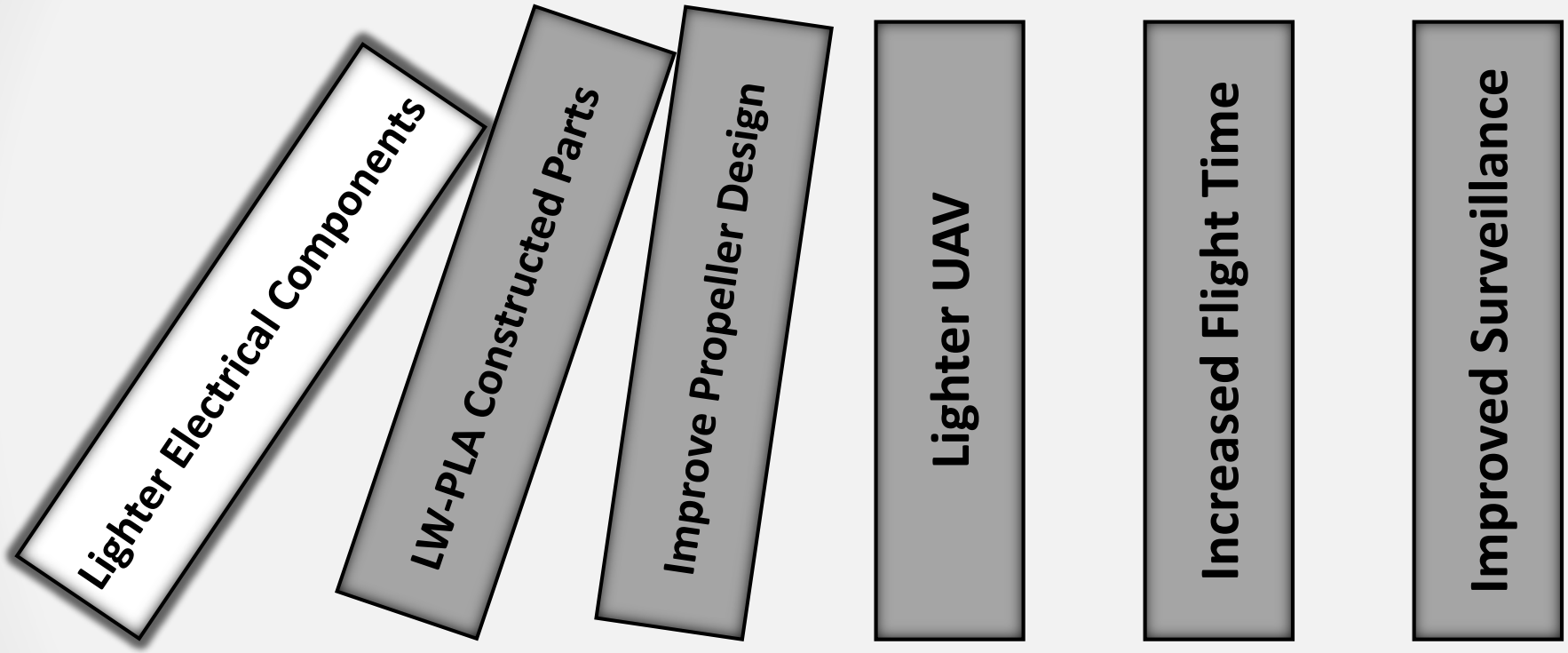
Selected Concept



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Questions

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