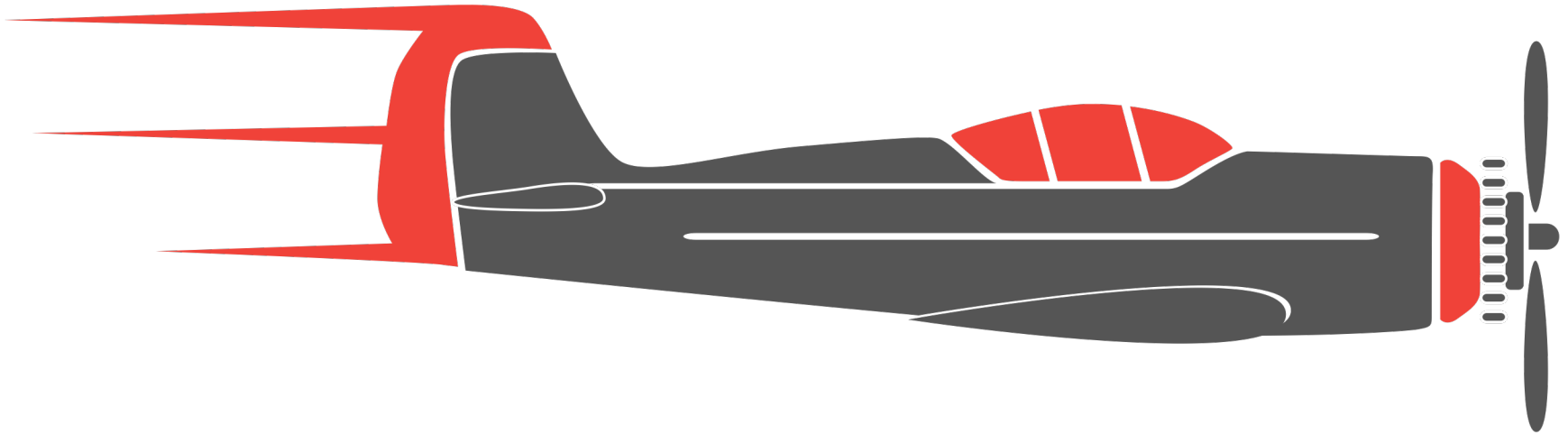


Team 508
SAE Aero Design: Geometric Integration

EML 4551C

Team Members

Jacob Pifer
Project Manager
Materials Engineer
CAD Engineer

Lauren Chin
Controls Engineer
Meeting Coordinator
CAD Engineer

Joseph Figari
Manufacturing Engineer
Financial Coordinator
CAD Engineer

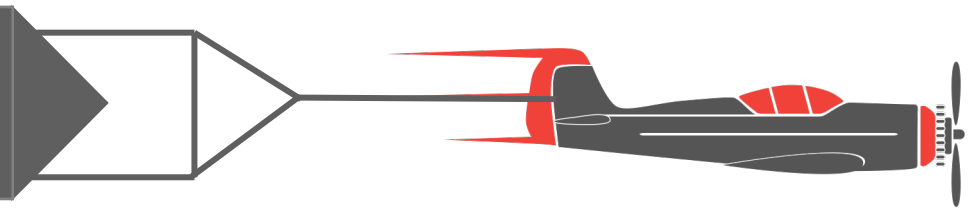
Sponsor & Advisor

Florida Space Grand Consortium
Financial Sponsor

Simone Hruda, PhD
Faculty Advisor

Jacob Pifer

Project Objective

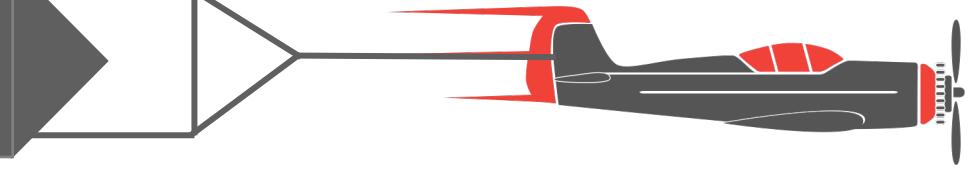


- The objective of this project is to design and manufacture a 3D printed remote control airplane within the rules of the SAE Aero Design Competition

- It will be able to take off, complete the needed flight path, and land while carrying the required cargo

Jacob Pifer

Project Brief Summary



- Structure of the plane is primarily 3D printed
- Innovative construction methods will be used
- Two team are assigned to this project
  - Team 507 is in charge of aero propulsions
  - Team 508 oversees geometrics

Jacob Pifer

Background

- SAE hosts an annual RC airplane competition
- The team will compete in the Regular Class Competition
- Scoring is based on the plane's uniqueness and ability to complete the standardized flight pattern

Jacob Pifer

Background

- The college has entered the competition for multiple years
- Teams in the past have been the only ones with a plane made using additive manufacturing

Jacob Pifer

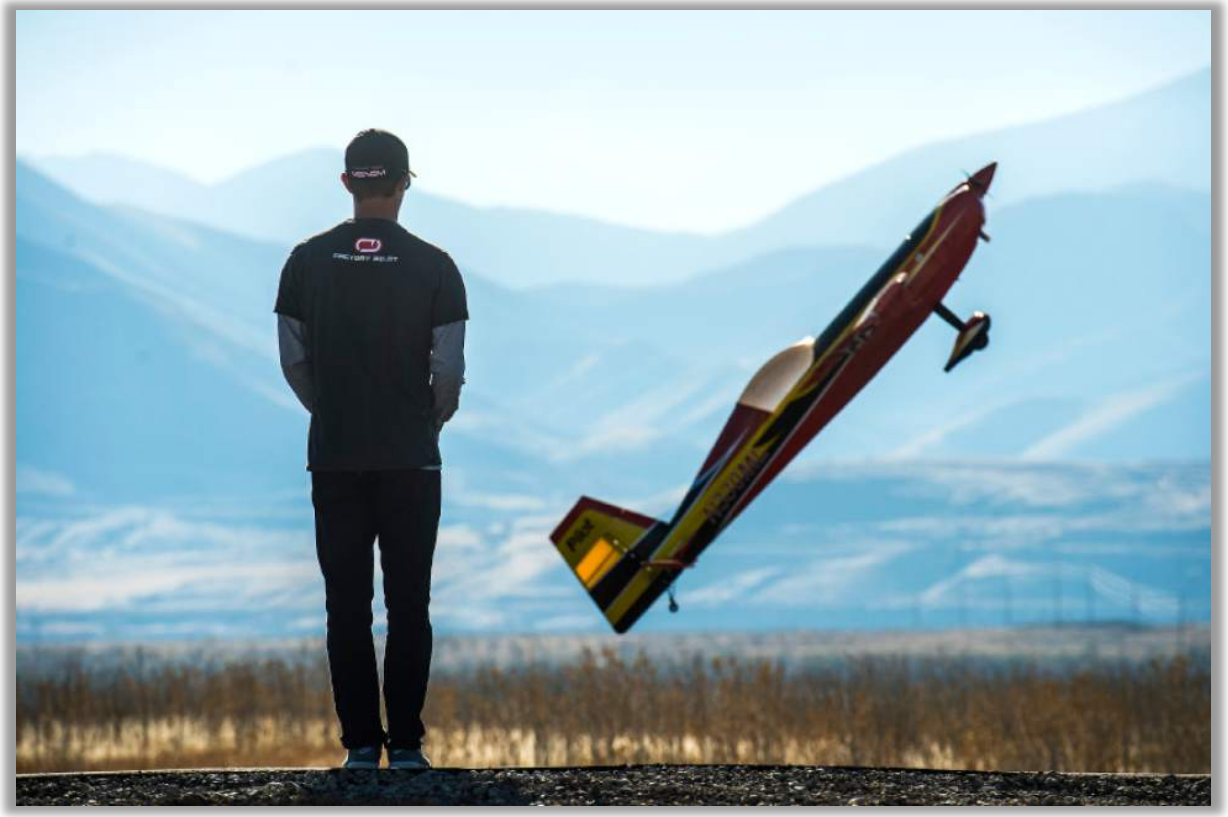
Key Goals: Structure

- The plane passes competition inspection
- Project costs stay within the given budget
- At least 80% of the plane's weight is from 3D printed material
- The plane can securely hold a size 5 soccer ball and a one pound box weight
- The plane can be firmly assembled and easily taken apart

Joseph Figari

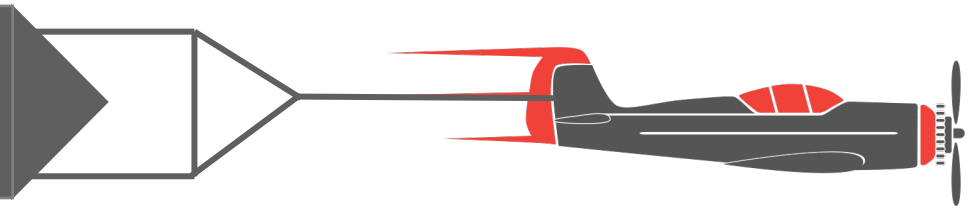
Key Goals: Flight Mission

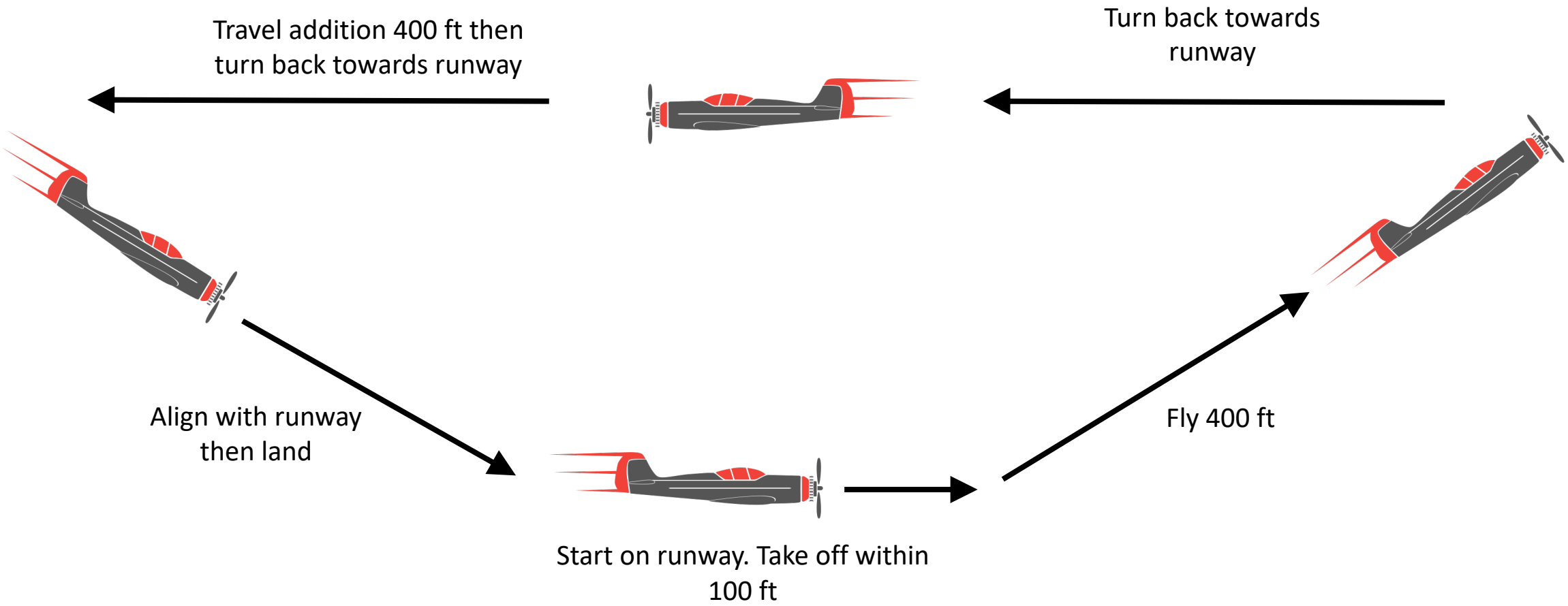
- An appointed RC pilot can fly the plane without issue
- The plane can fly in wind speeds of 45 knots
- The cargo can be unloaded in under one minute
- The plane can complete the required flight path



Joseph Figari

Key Goals: Flight Mission





Joseph Figari

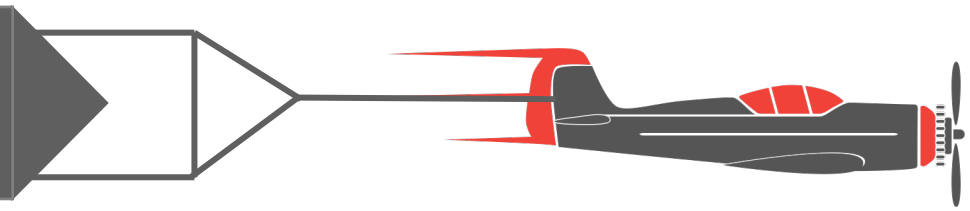
Key Goals: Flight Mission

- The team can have multiple flight attempts if:
  - The team's time hasn't expired (two minutes)
  - Bouncing occurred within the 100 ft take-off distance

- Second attempt is not allowed if bouncing happens past 100 ft

Joseph Figari

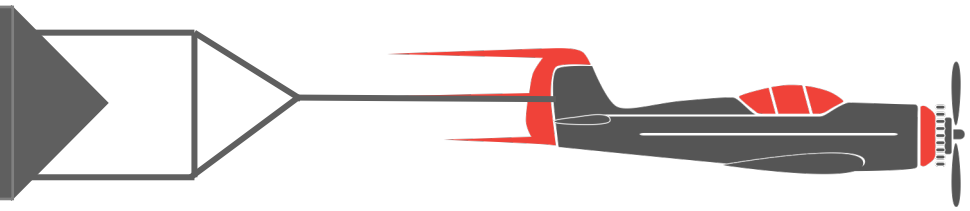
Assumptions



- The plane will fly under spring inland Florida weather conditions
- Some parts of the plane must be purchased or borrowed
- The plane will be printed in multiple parts
- The plane must fly while carrying the cargo

Joseph Figari

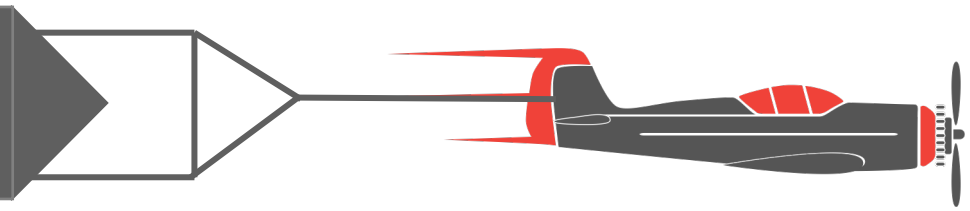
Customer Needs



- Customer Needs were pulled from two sources:
  - Dr. McConomy
    - Construction Requirements
  - SAE Aero Design Competition Rule Book
    - General Aircraft Requirements
    - Geometric Design Requirements
    - Materials Requirements
    - Flight mission Requirements

Lauren Chin

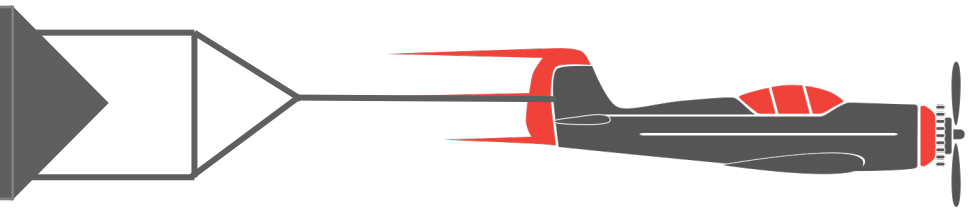
Sponsor Requirements



Question/Prompt:	Statement:	Need Interpretation:
Are the rules the only things we should see as customer needs?	The rules should be seen as the bare minimum. This is a contest so we are trying to impress the judges	Find innovative ways to build the plane that will stand out at the competition.
How much of the plane must be 3D printed? Meaning where are the other materials allowed?	3D printing material must be the primary material used. Other materials must only be used where deemed necessary.	The plane's main building material is 3D printing fillament. Other materials are only used when needed.
If possible, is sponsorship from other companies and organizations outside of the college allowed?	Sponsorship is allowed. It will help in funding aspects like material and transportation.	Pursuing outside sponsorhip is okay.
Are there any specifications we need to follow in regard to electric components?	Reduce wires as much as possible as electrical components are dead weight	Use as few wires as possible.

Lauren Chin

Sponsor Requirements



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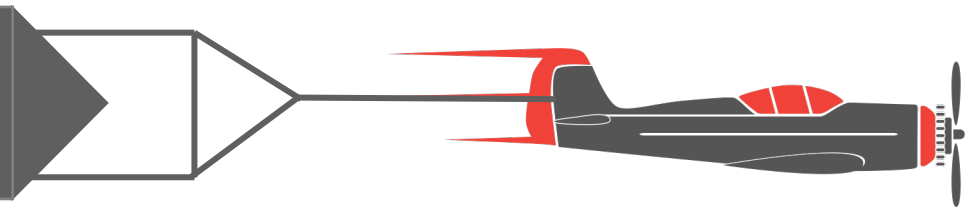

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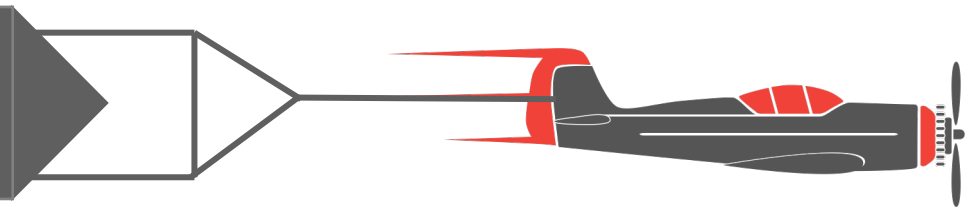
Lauren Chin

Sponsor Requirements



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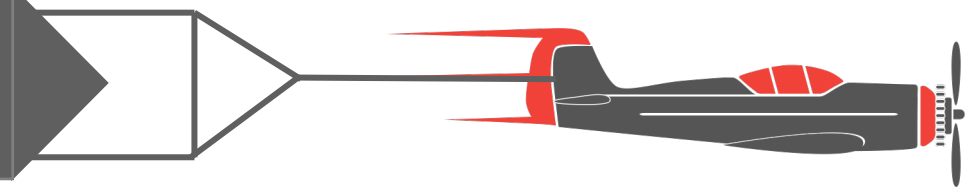
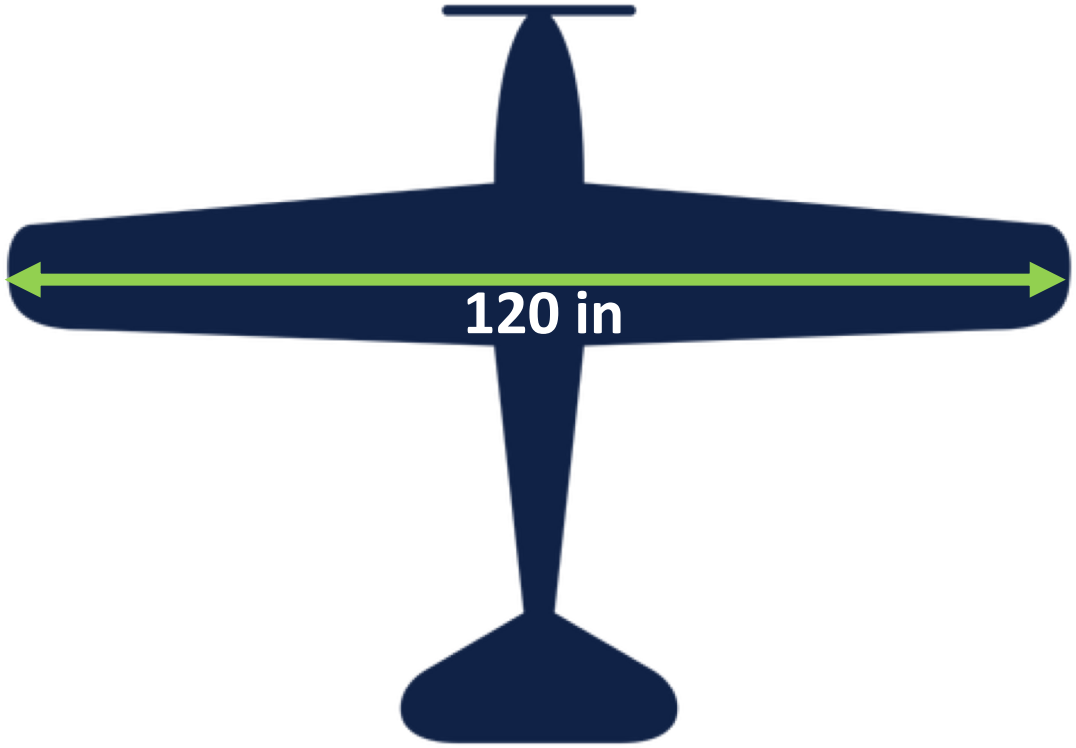
Lauren Chin

General Aircraft Requirements



- Identification
  - Team and aircraft identification is visible from all angles
- Dimensional requirements
  - Must not exceed 55 pounds
  - Wingspan of no larger than 120 inches
- Safety requirements
  - There will be a safety nut for the propeller



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Geometric Design Requirements

- The aircraft must have a ground steering mechanism
  - Not dependent on flight control mechanism
- The cargo must be fully enclosed within the aircraft
- The aircraft must be functioning with or without cargo
  - Must account for a change in the center of gravity

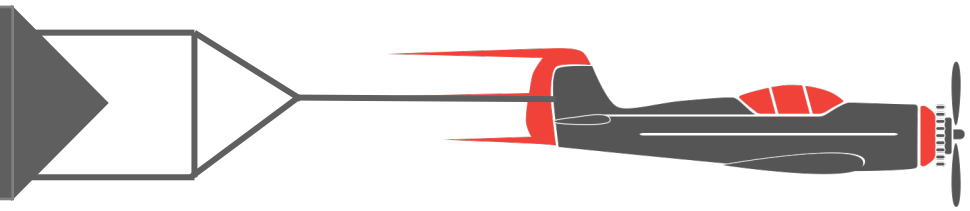
Lauren Chin

Materials Requirements

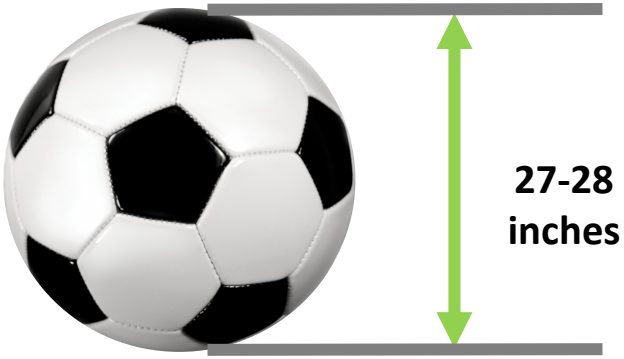
- Propeller
  - The propeller cannot be made of metal
- Aircraft construction
  - FRP composites and lead are prohibited.
  - Rubber bands may not be used
- Cargo
  - Must be secured by means other than:
    - Rubber bands, tape, Velcro, strictly friction

Lauren Chin

Flight Mission Requirements



- Take off
  - The plane has two minutes and a 100 ft runway to achieve flight
  - One team member can assist the pilot



- A predetermined flight path must be completed

- Cargo
  - A size 5 soccer ball and a one pound box cargo will be loaded into the aircraft
  - The cargo must be unloaded within a minute

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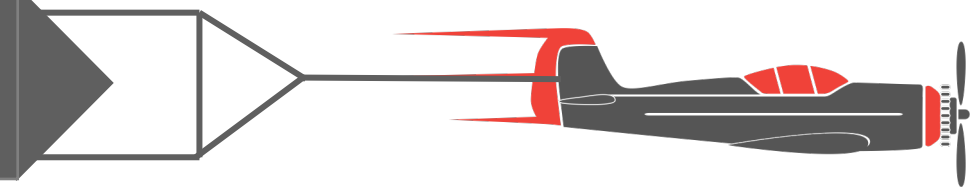
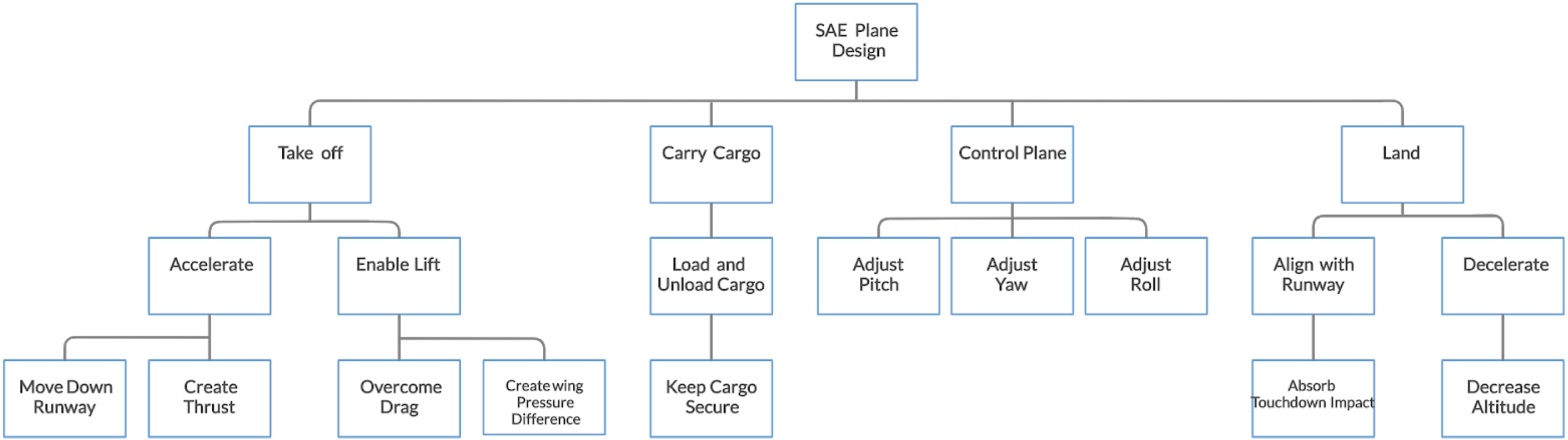
Functional Decomposition





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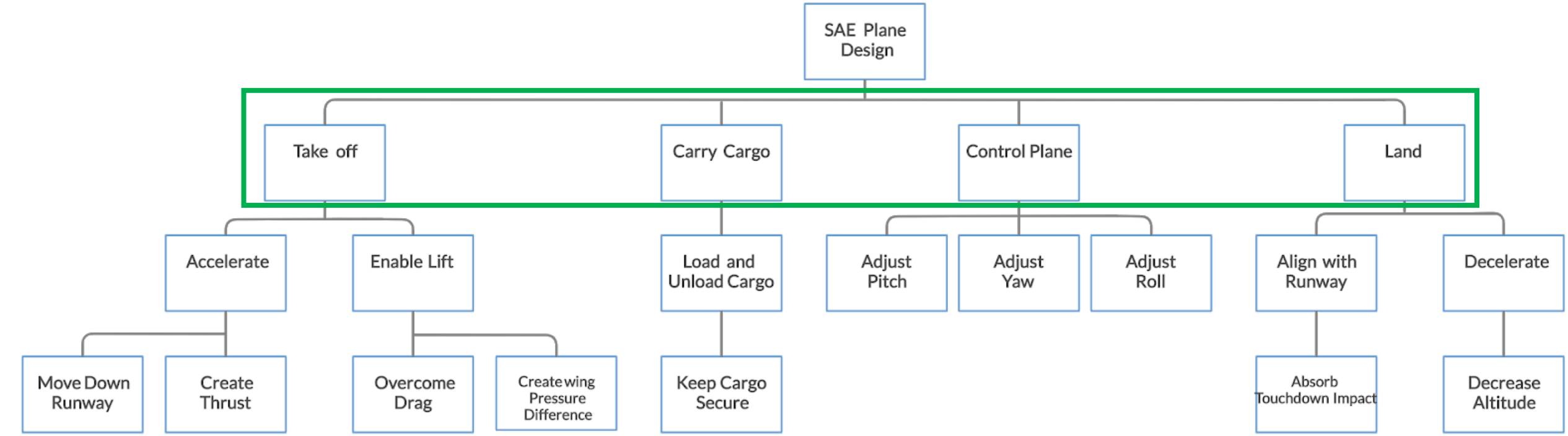
Functional Decomposition



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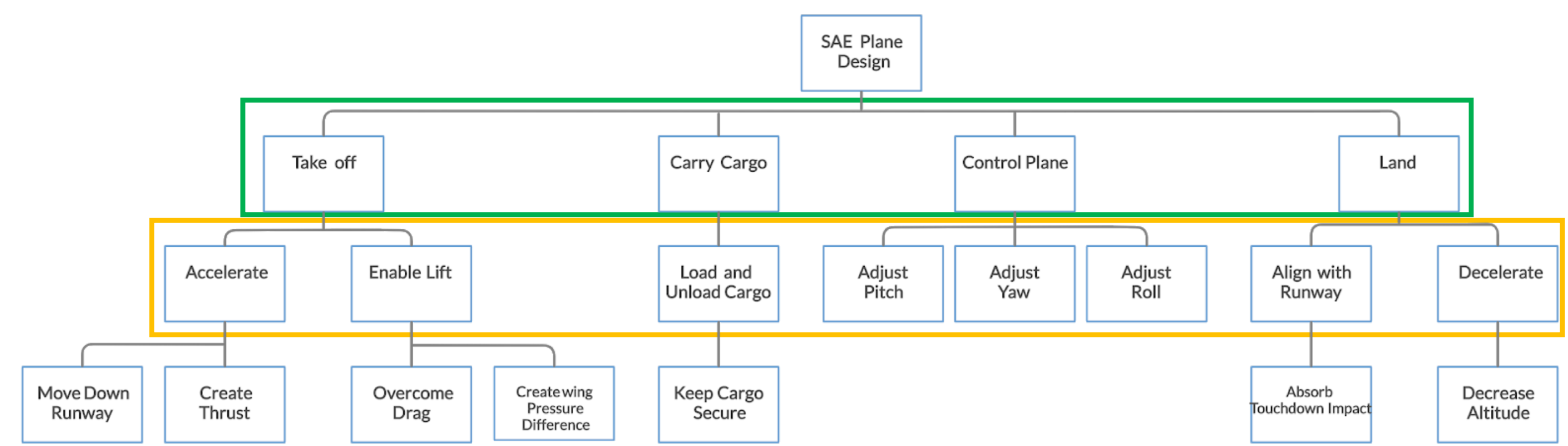

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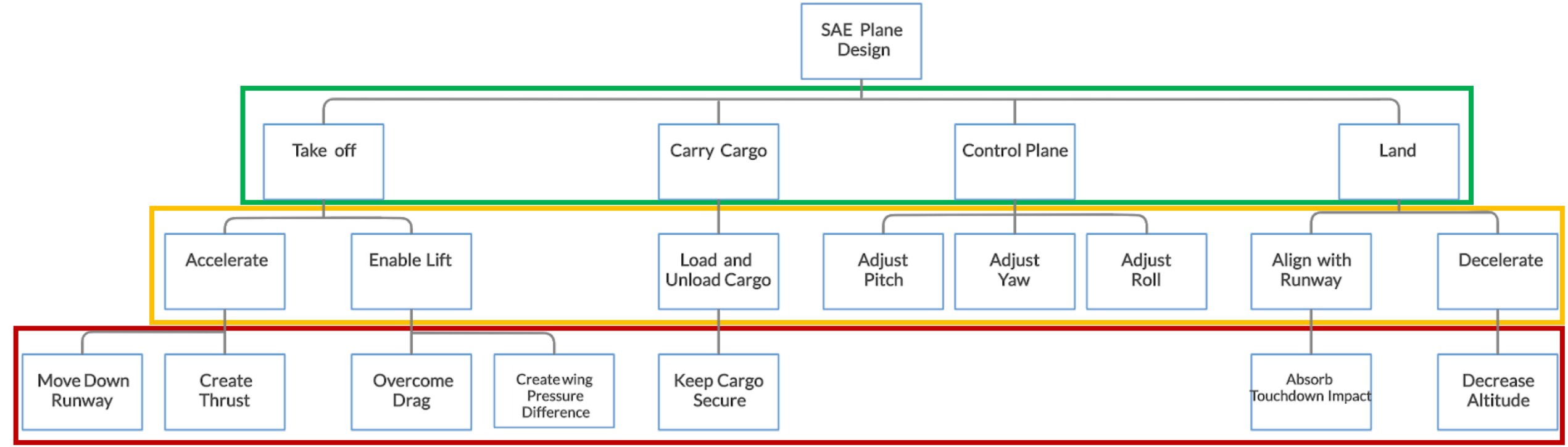
Functional Decomposition



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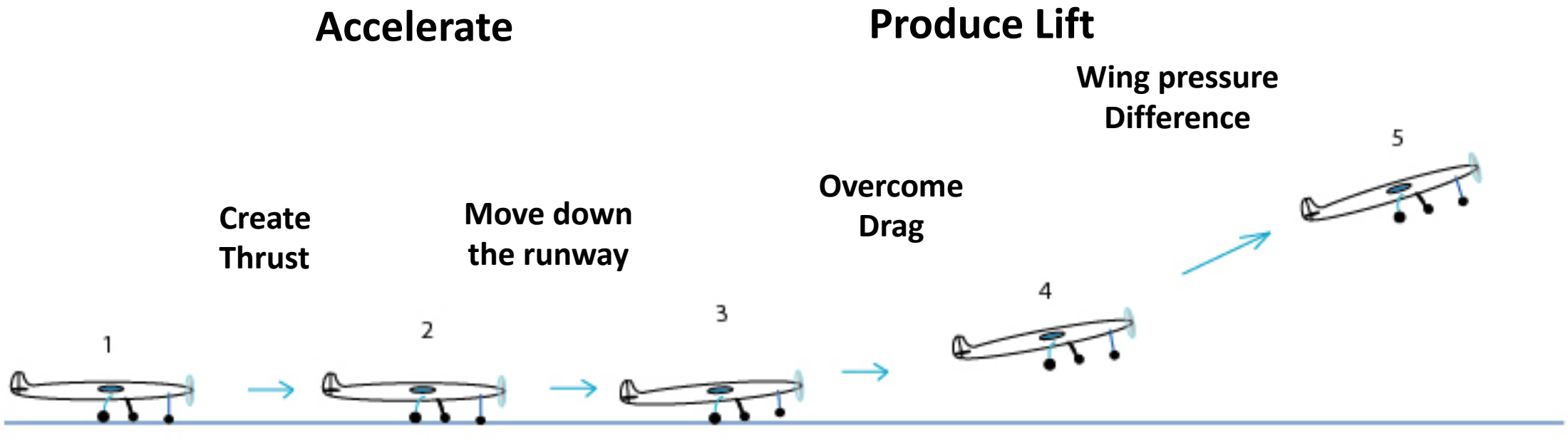
Take-Off



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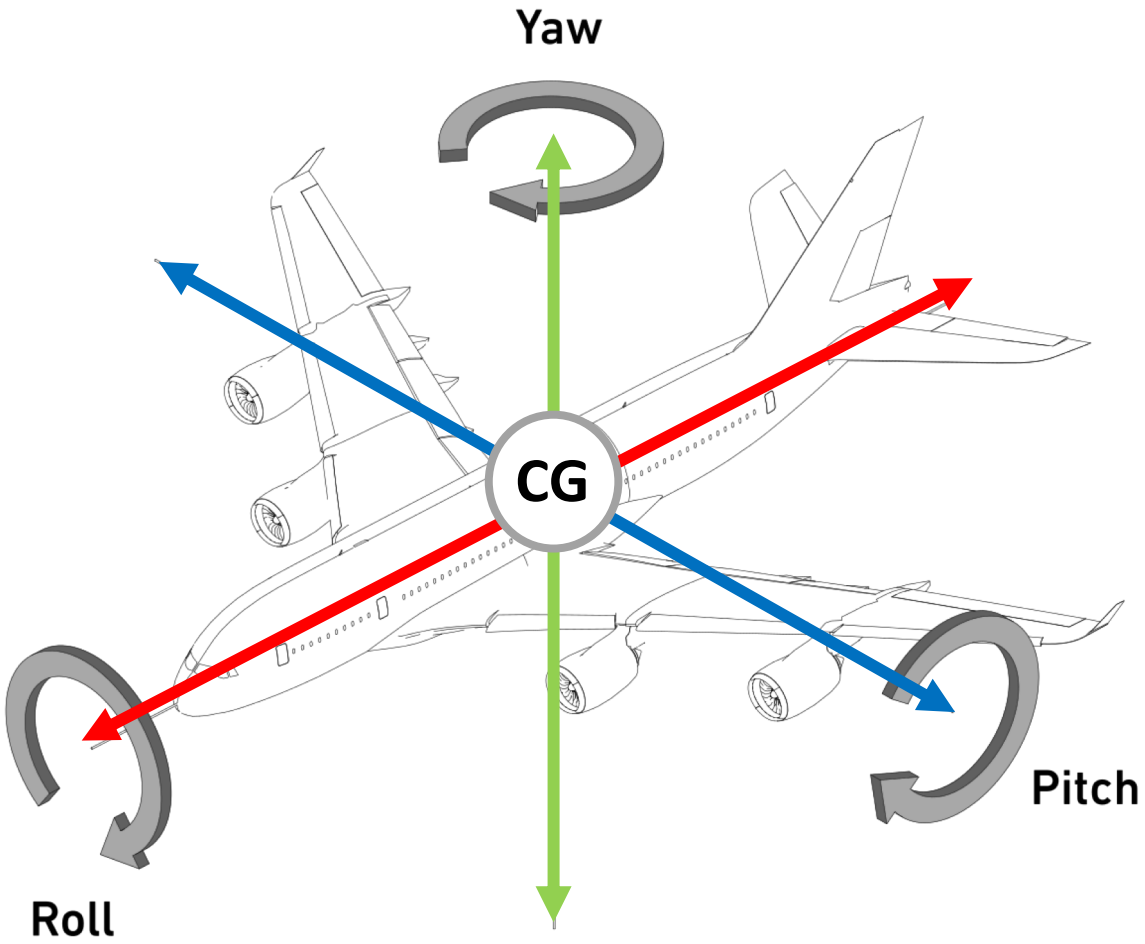
Aircraft Control



- Control of the aircraft is governed rotation about 3 axes:
  - **Roll axis:** Orients aircraft's horizontal position in the air
  - **Pitch axis:** Orients aircraft's vertical position in the air
  - **Yaw axis:** Orients aircraft's horizontal position in the air

Lauren Chin

Carrying Cargo

- Load Cargo
  - 1 Size 5 soccer ball
  - 1 pound box cargo
- Secure Cargo
  - Easily accessible
- Unload all cargo in under one minute

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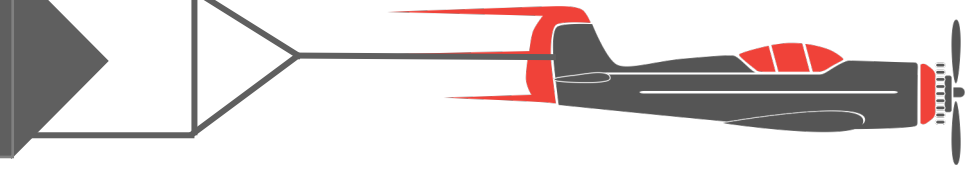
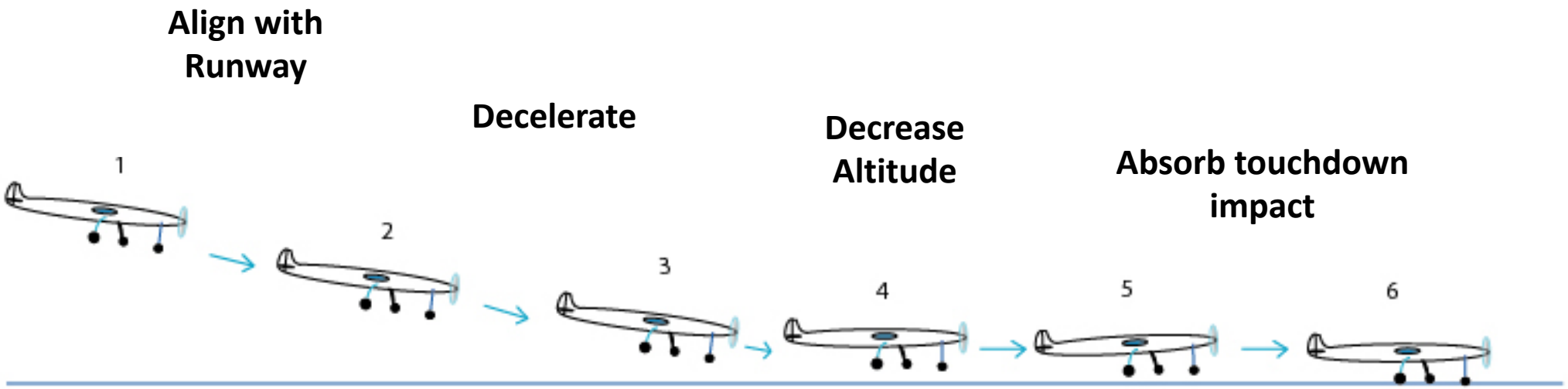
Landing





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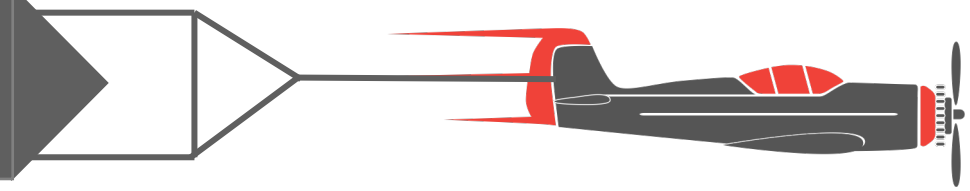
Analytical Hierarchy Chart



- Each major function was ranked against a minor function

- Major Function rankings
  - Take-off - 4
  - Control Plane -1
  - Transport Cargo -3
  - Land -2

		Major Functions:				
Minor Functions:	Customer Needs:	Take off	Control Plane	Transport Cargo	Land	**Minor Function Ranking:**
Enable Lift	1, 2, 3, 4, 6	X	X		X	1
Overcome Drag	1, 2, 3, 4, 6	X	X			2
Create Wing Pressure Difference	1, 2, 3, 4, 6	X	X		X	1
Accelerate	2, 3, 4, 6, 8	X	X	X		1
Move Down Runway	2, 3, 4, 6, 8	X	X	X		1
Create Thrust	2, 3, 4, 6, 8	X	X	X		1
Adjust Roll	6, 8		X	X	X	4
Adjust Yaw	2, 6, 8		X	X	X	3
Adjust Pitch	4, 6, 8	X	X	X	X	2
Load and Unload Payload	1, 2, 3, 4, 6			X		3
Keep Payload Secure	1, 2, 3, 4, 6	X		X	X	1
Decelerate	2, 6, 8		X		X	4
Decrease Altitude	2, 6, 8		X		X	4
Align with Runway	4, 6, 8		X		X	4
Absorb Touchdown Impact	4, 6		X	X	X	4
Major Function Ranking:		4	1	3	2	

Lauren Chin

Analytical Hierarchy Chart

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Create Wing Pressure Difference	1, 2, 3, 4, 6	X	X		X	1
Accelerate	2, 3, 4, 6, 8	X	X	X		1
Move Down Runway	2, 3, 4, 6, 8	X	X	X		1
Create Thrust	2, 3, 4, 6, 8	X	X	X		1
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Adjust Pitch	4, 6, 8	X	X	X	X	2
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Keep Payload Secure	1, 2, 3, 4, 6	X		X	X	1
Decelerate	2, 6, 8		X		X	4
Decrease Altitude	2, 6, 8		X		X	4
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Lauren Chin

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Create Wing Pressure Difference	1, 2, 3, 4, 6	X	X		X	1
Accelerate	2, 3, 4, 6, 8	X	X	X		1
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Create Thrust	2, 3, 4, 6, 8	X	X	X		1
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Adjust Pitch	4, 6, 8	X	X	X	X	2
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Decelerate	2, 6, 8		X		X	4
Decrease Altitude	2, 6, 8		X		X	4
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Lauren Chin

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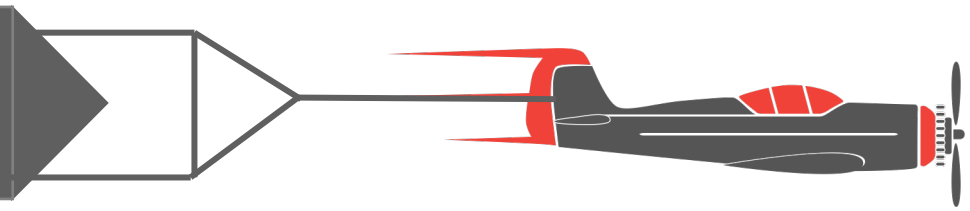

- Each Minor Function was rated against each major function

- Highest ranking minor functions:
  - Adjust Roll
  - Decelerate
  - Decrease altitude
  - Align with runway
  - Absorb touchdown impact

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Accelerate	2, 3, 4, 6, 8	X	X	X		1
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Lauren Chin

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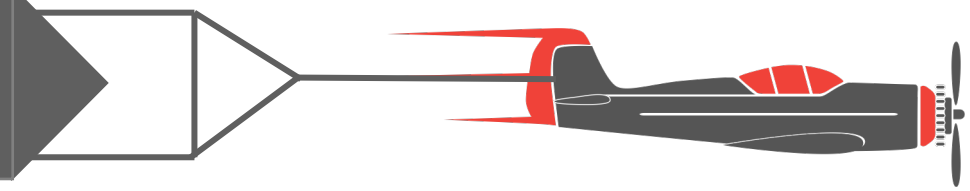

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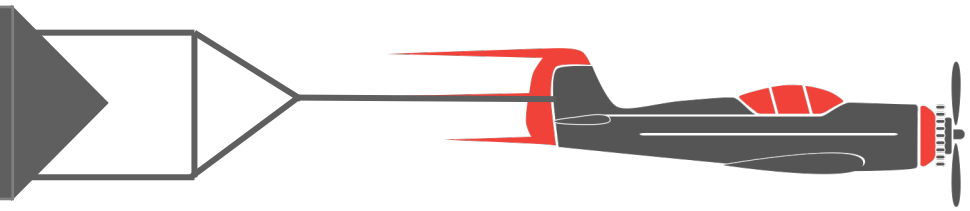
Keep Payload Secure	1, 2, 3, 4, 6	X		X	X	1
Decelerate	2, 6, 8		X		X	4
Decrease Altitude	2, 6, 8		X		X	4
Align with Runway	4, 6, 8		X		X	4
Absorb Touchdown Impact	4, 6		X	X	X	4
Major Function Ranking:		4	1	3	2	

Lauren Chin

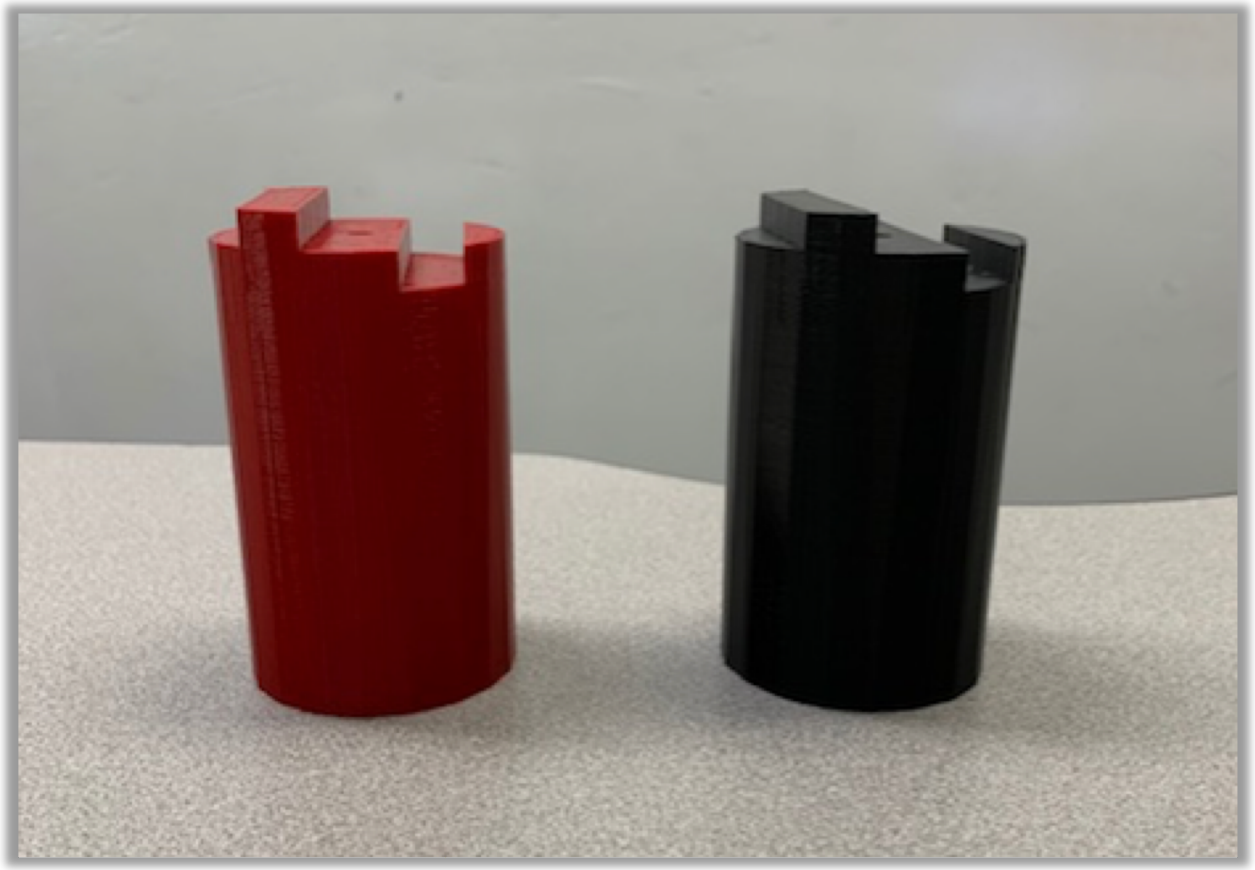
Accomplishments



- Read and understand the SAE rulebook
- Studied last year's plane to see its pros and cons
- Holding meetings with Team 507 to discuss design concepts
- Contacted different filament companies for sponsorship
- Created plans for testing filament strengths
- Started a professional relationship with Seminole RC Club
- Analyzing innovate connection methods for modular parts

Jacob Pifer

Accomplishments



- Different woodworking techniques are being studied for connecting parts
- This will help reduce or eliminate the need for adhesives

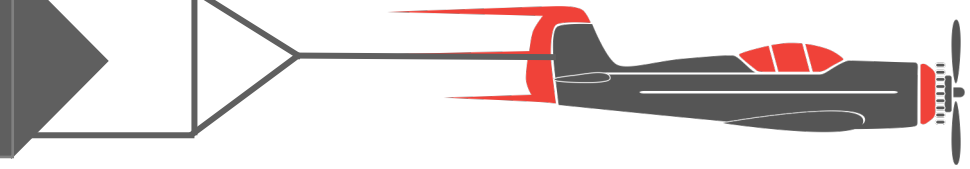
Jacob Pifer

Accomplishments

- Finger Joint
- Consists of complementing shafts and gaps that are pressed together
- Pins can be used
- Connects parallel and perpendicular parts

Jacob Pifer

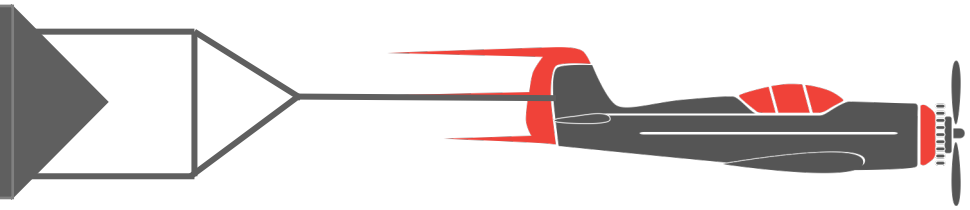
Future Work



- Test filaments and choose the best one
- Determine the empty aircraft weight
- Pick the best modular connecting method(s)
- Learn any needed simulation software
- Work with Team 507 to finalize airfoil shape and size

Jacob Pifer

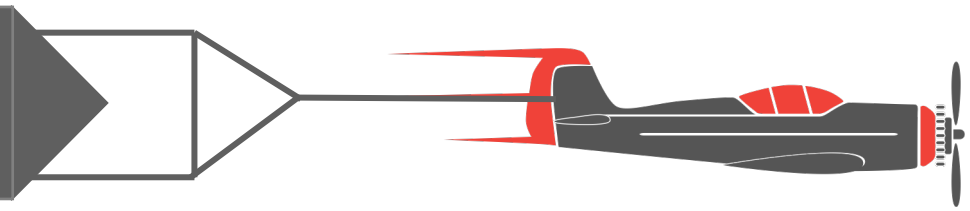
Key Takeaways



1. The objective of the project is to design and 3D print an RC airplane to compete in the SAE Aero Design Competition
2. Sponsorship outside of FSGC is being pursued
3. Studies in material strength and connection methods are underway
4. Meetings with Team 507 are taking place to make design decisions
5. Last year's plane is being studied but not rebuilt

Jacob Pifer

References



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