UAV Design Tutorial II

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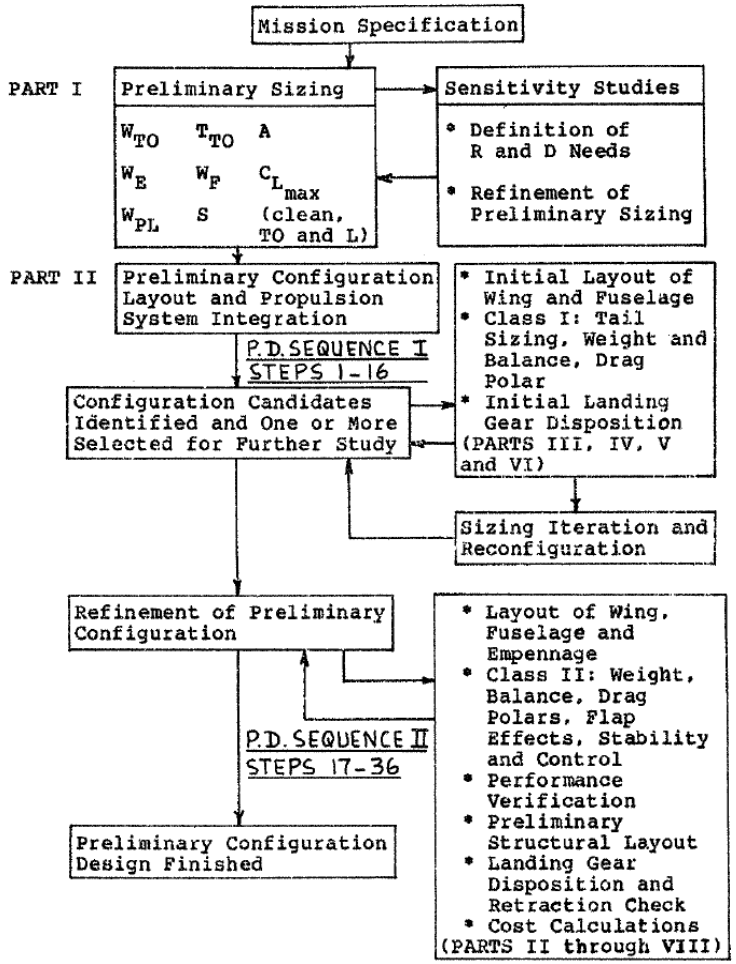
Overview

- Overview of Design Process
- Configuration Selection

Overview of Design Process



Ref: Roskam, Jan, *Airplane Design: Part II*

Overview of Design Process

1. Review Mission Spec
2. Perform Study of Similar Aircraft
3. Select Type of Configuration
4. Prepare a Preliminary Drawing of Fuselage
5. Decide on Propulsion System
6. Decide on Wing Planform Parameters

Overview of Design Process

7. Decide on Type, Size, and Disp of High Lift Devices
8. Decide on the Layout of the Empennage
9. Decide on Type and Disposition of Landing Gear
10. Prepare a Scaled Preliminary Arrangement
11. Perform a Class I Stability and Control Analysis
12. Perform a Class I Drag Analysis

Overview of Design Process

13. Analyze the Results of Steps 10 and 11
14. Compute the L/D for Each Mission Segment
15. Determine Impact of Changes in L/D on W_{TO}, W_E, and W_F
16. Prepare a Dimensioned 3-View

Configuration Selection

Configuration Selection

	B-47H	AVRO Vulcan
•WTO(lbs):	202,000	200,000
•S (ft2):	1,400	3,964
•W/S(psf):	144	50.5
AR	9.6	3.1
f (ft2)	34	29
L/D max	15.8	16.4
CL, max	0.77	0.24

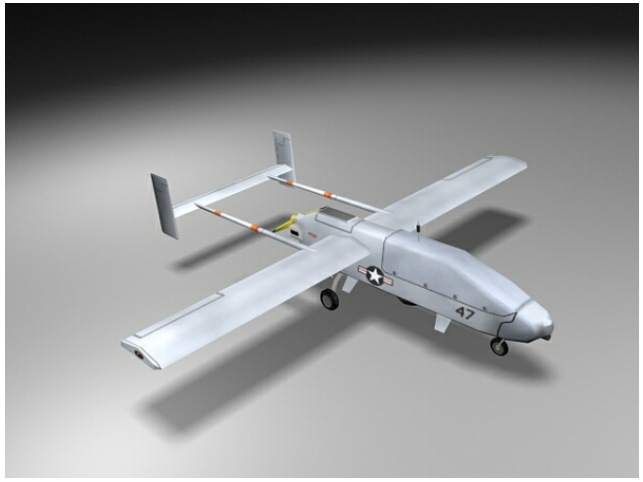
Configuration Selection

- Name these airplanes

Configuration Selection

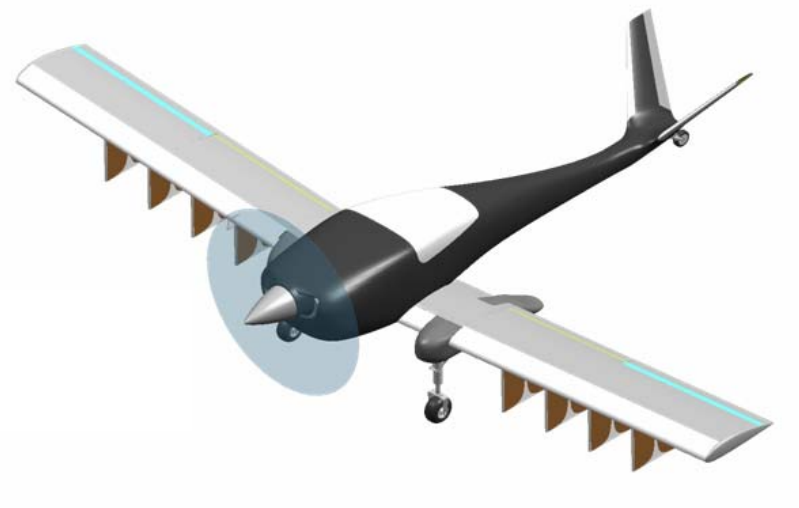
- Predator A and Predator B
- Why are the tails different?
  - Control
  - Stability
  - Aesthetics

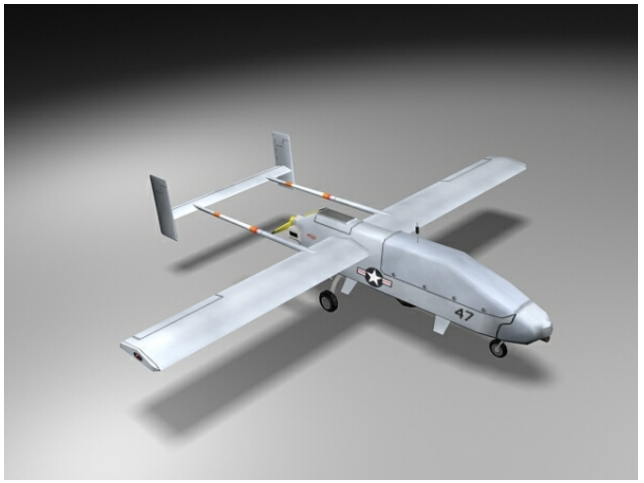
Configuration Selection - Engine



- Pusher – Propeller in the rear
- Tractor – Propeller in the front
- Pros, Cons?

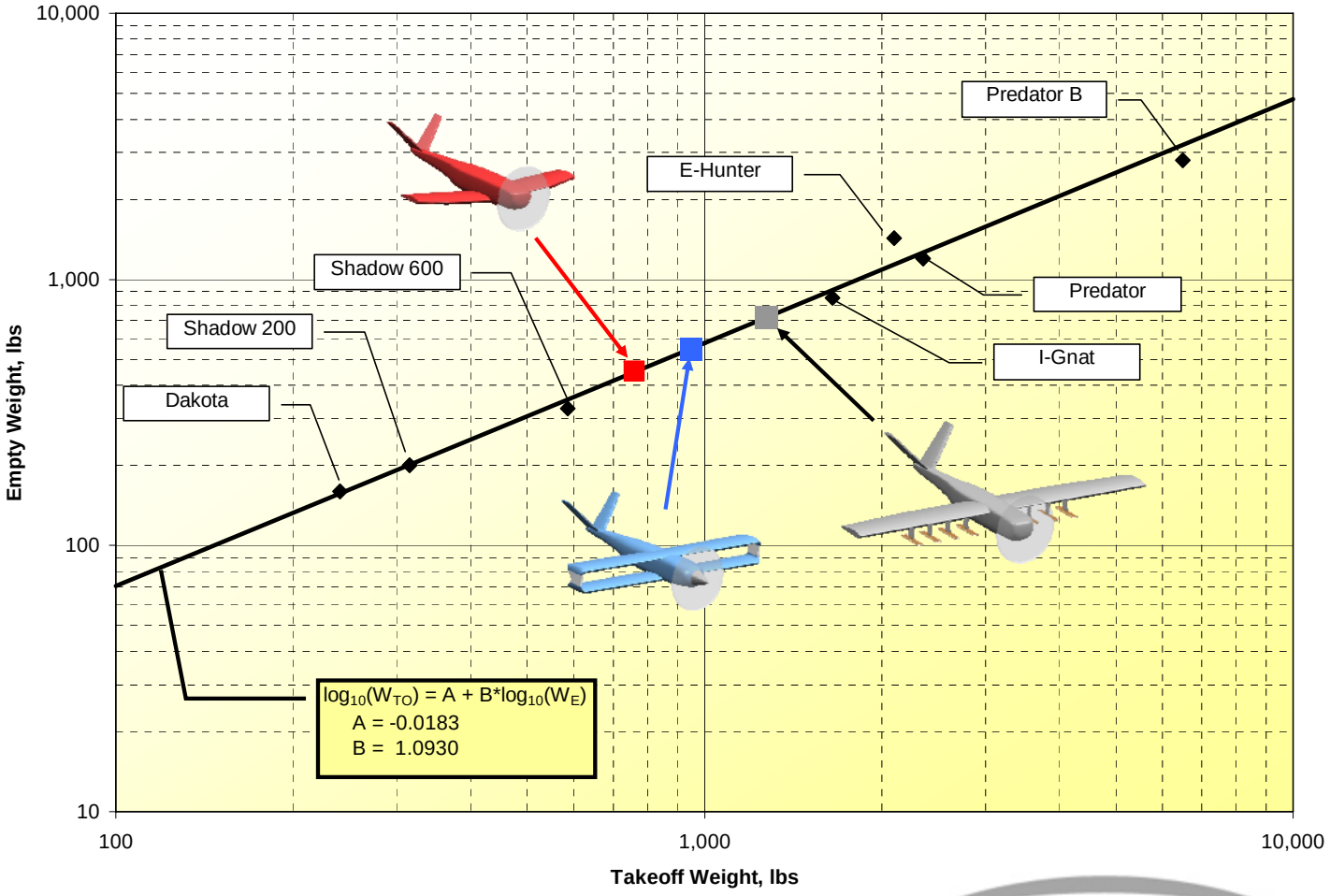
Configuration Selection - Empennage



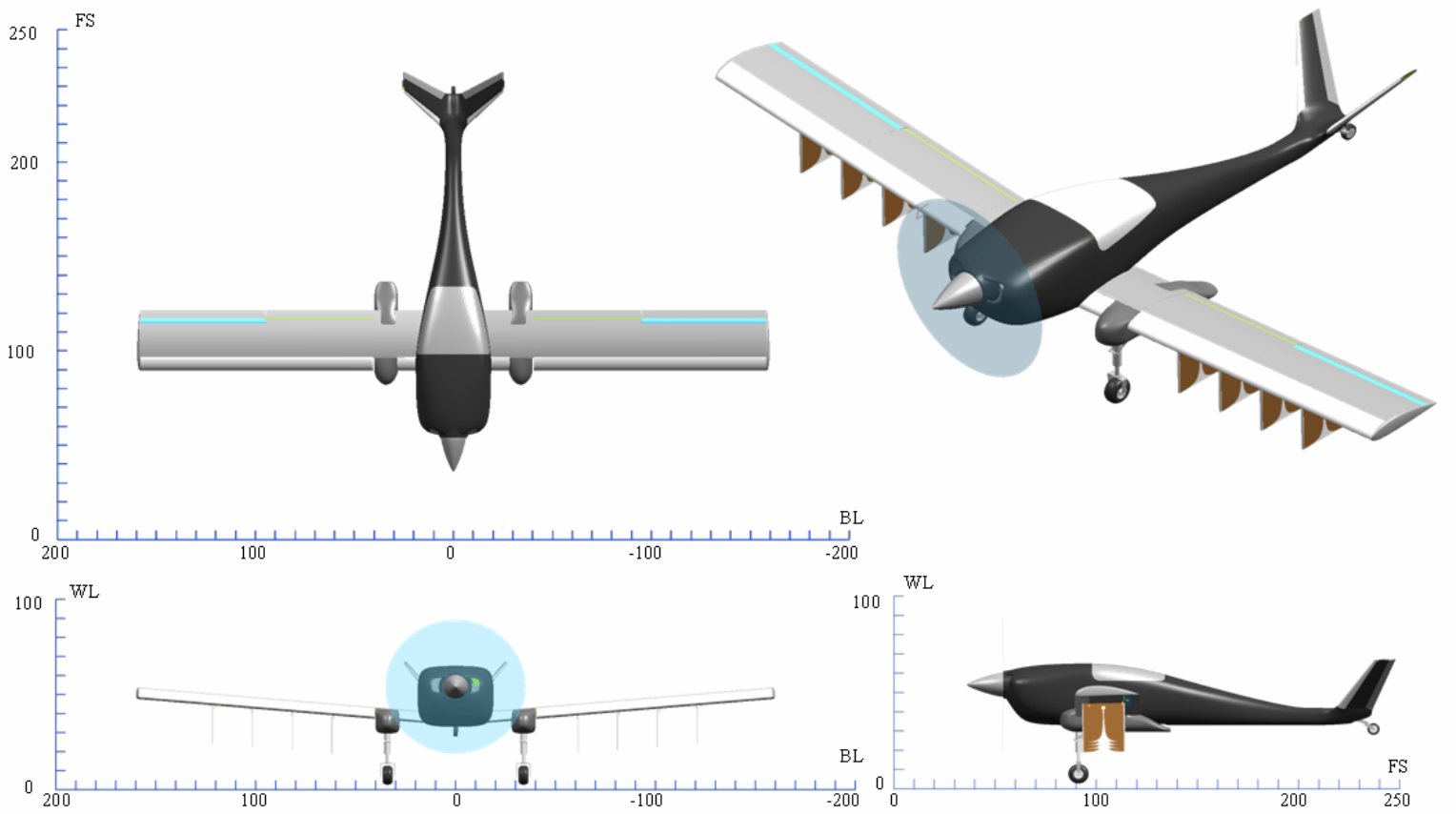


- Twin boom
- V-Tail
- Y-Tail
- Conventional Tail

Configuration Selection – The Meridian

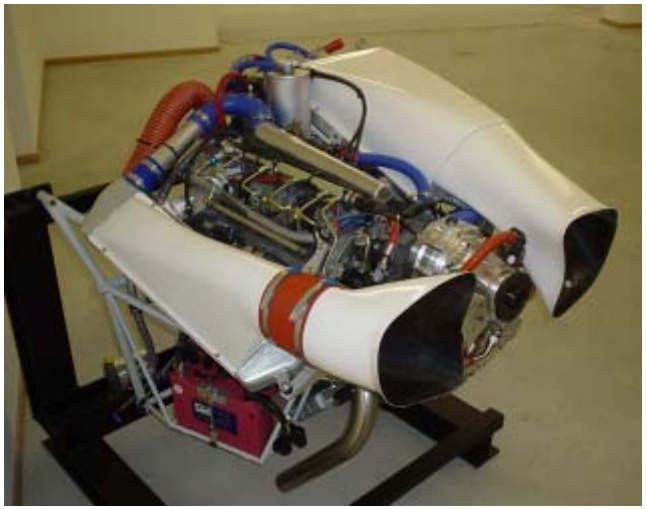


Configuration Selection – The Meridian



Engine Selection

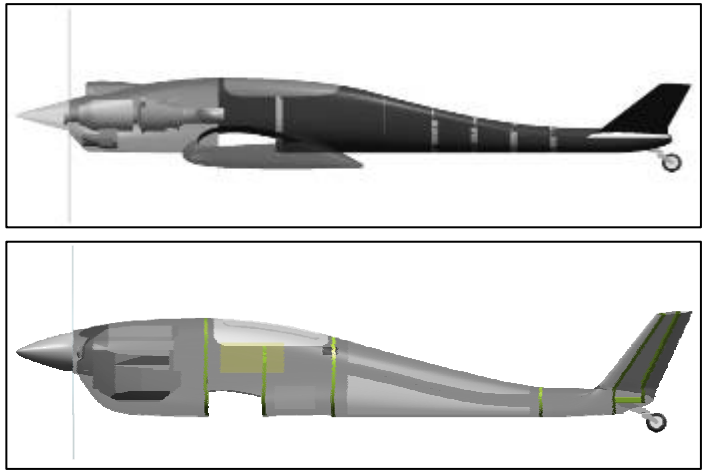
Innodyn 165TE



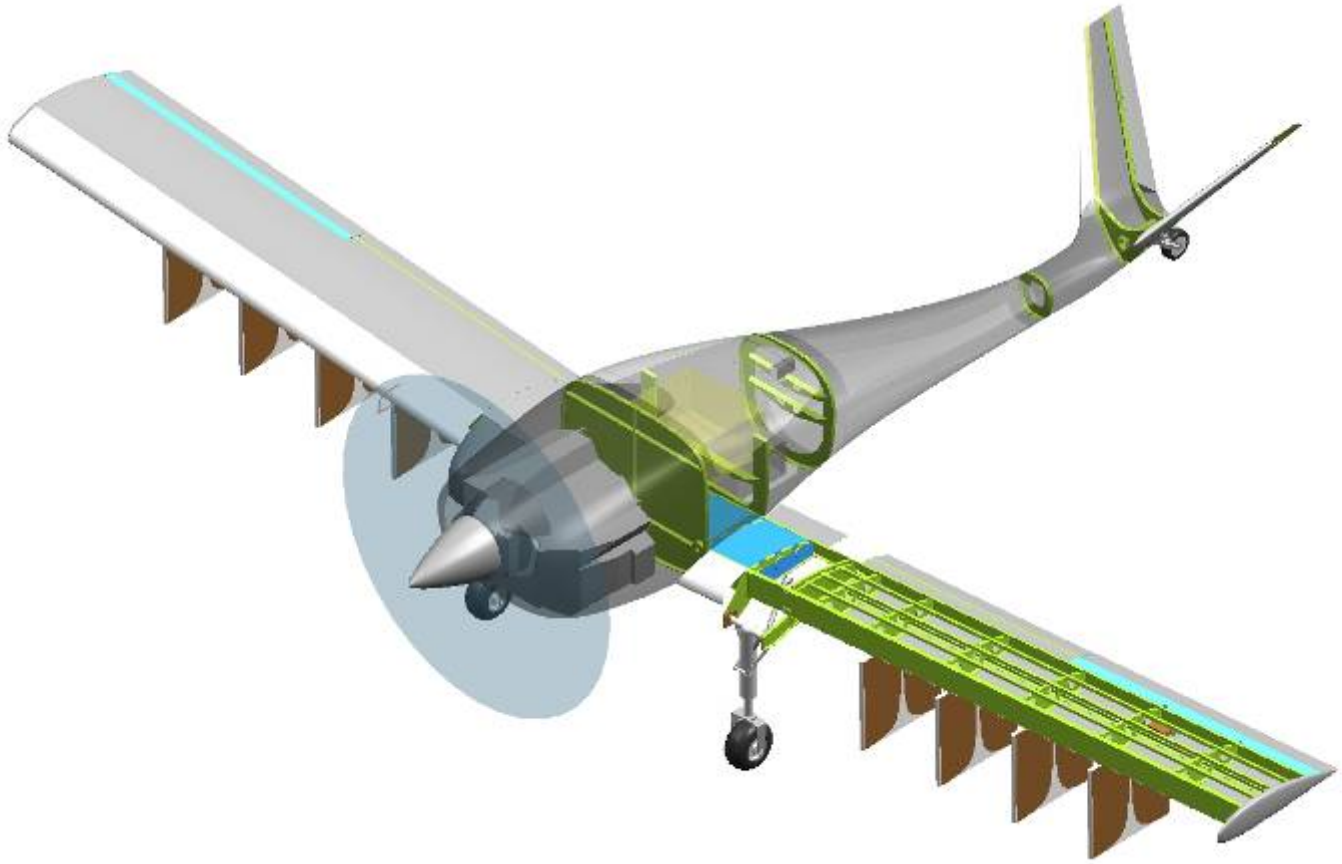
Centurion 1.7

Engine Selection

- Primary Engine Changed from Innodyn 165TE to Thielert Centurion 2.0



Aircraft Structural Design

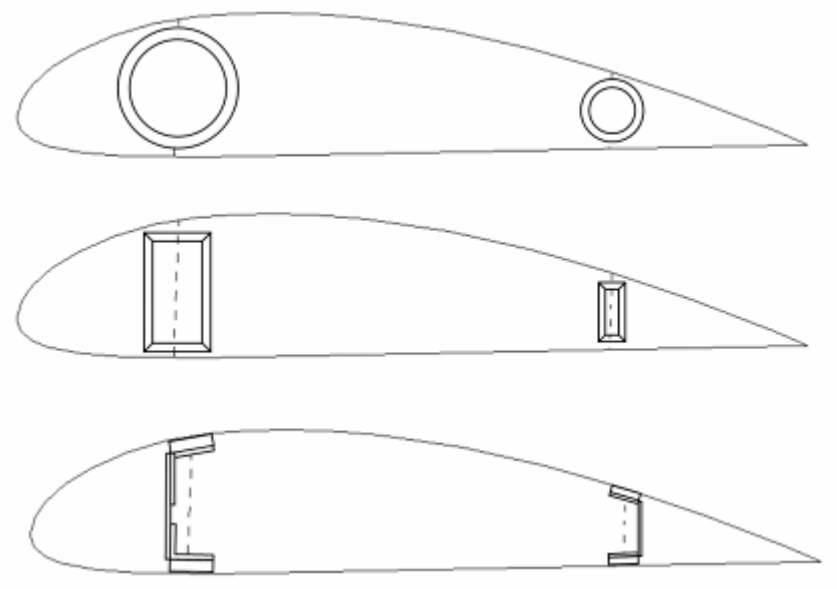


Structural Design Constraints

- Strength/stiffness at various load cases
- Weight
- Transportation requirements (wing splice)
- Manufacturability
- Cost
- Elastic stability (buckling)
- Aerodynamic stability (flutter)

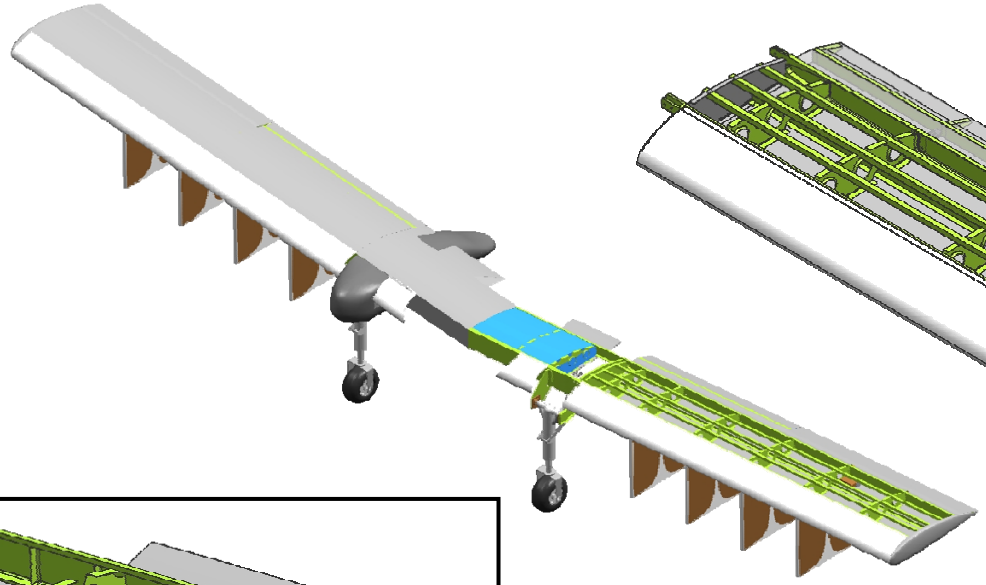
Wing: Structural Trade Studies

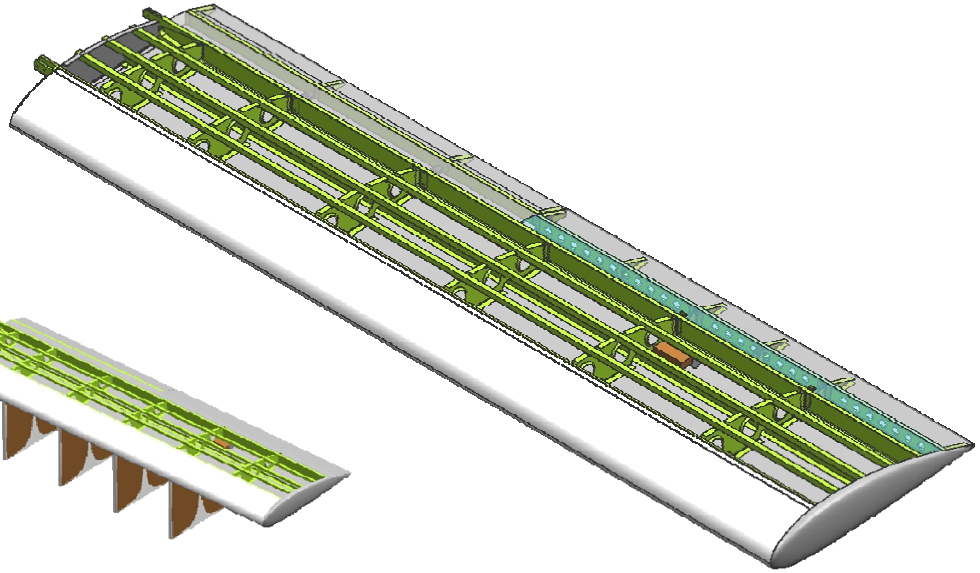
- Wing spars: Tubes vs built-up C beams; Alum vs CFRP
- Outboard wing skin: Alum vs Composites

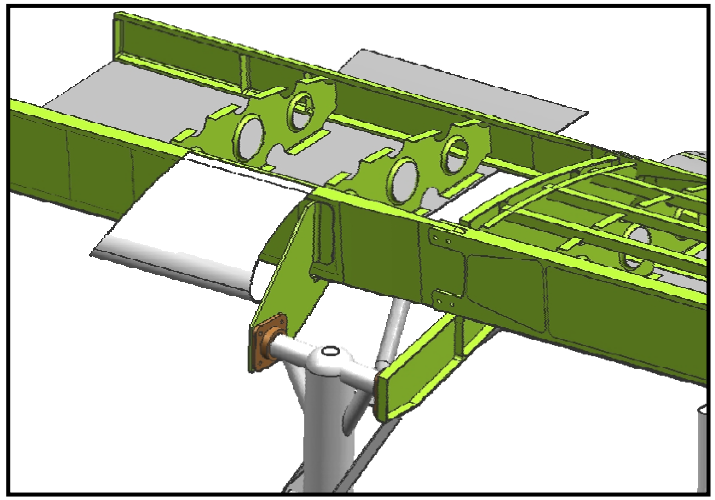


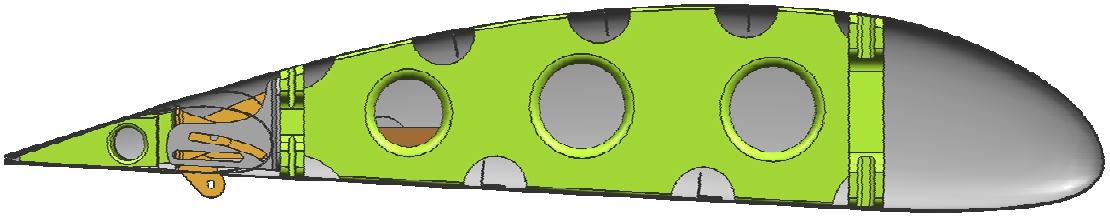
- Weight?
- Cost (including tooling)?
- Ease of landing gear integration?
- Ease of splice assembly?

Wing Structural Arrangement









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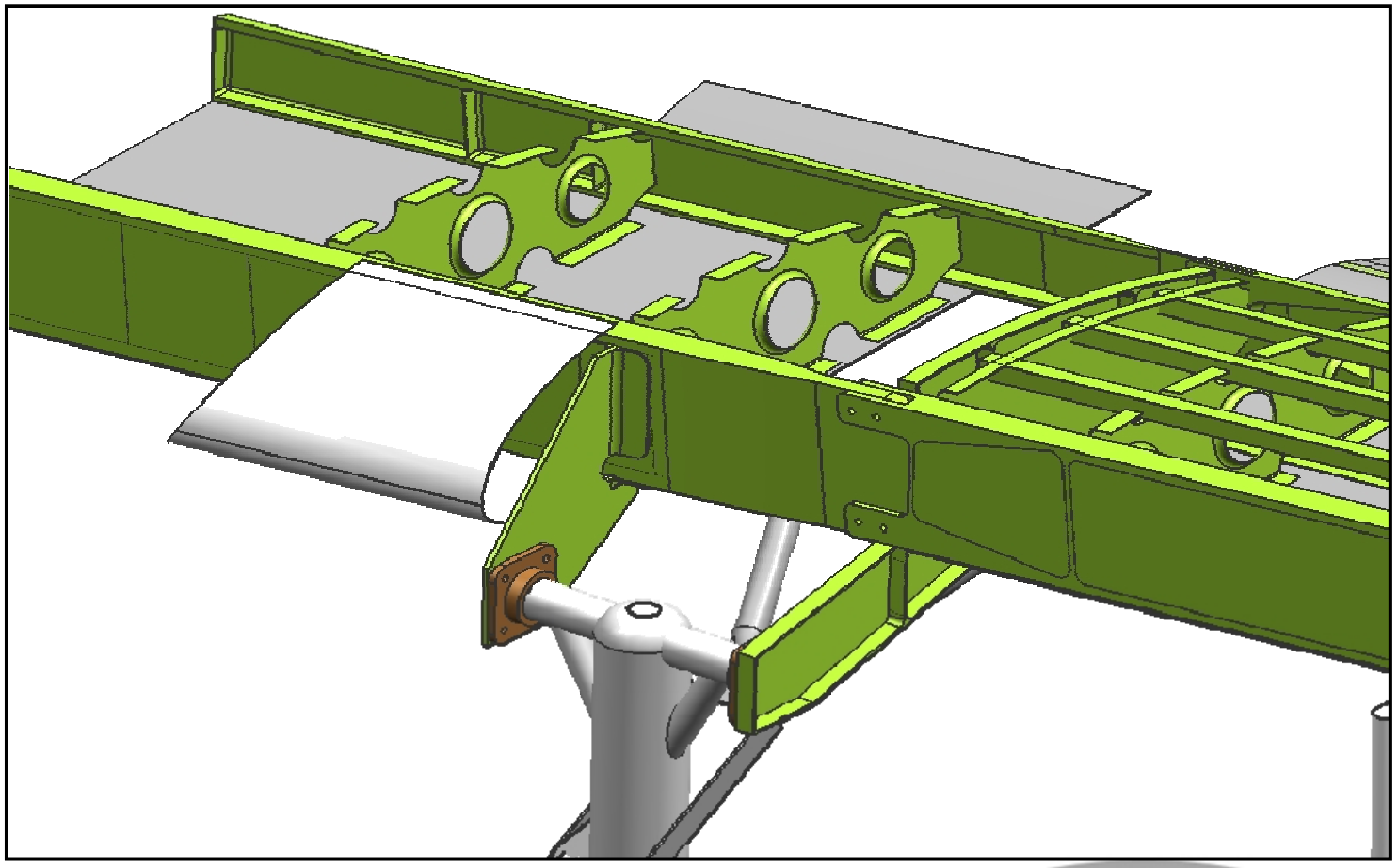
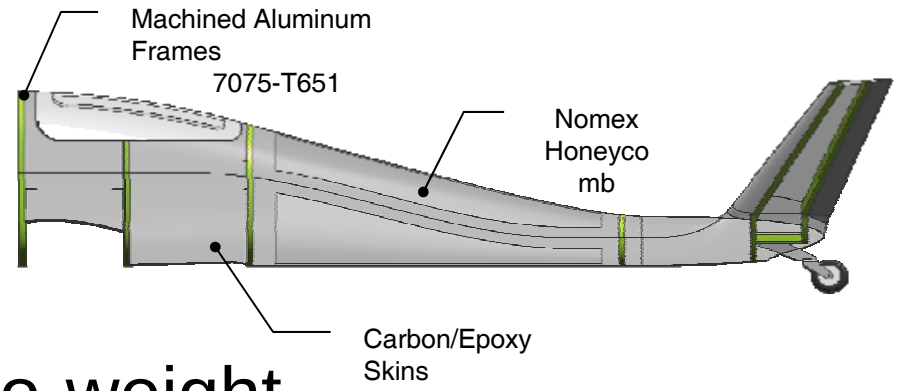
Wing Attachment



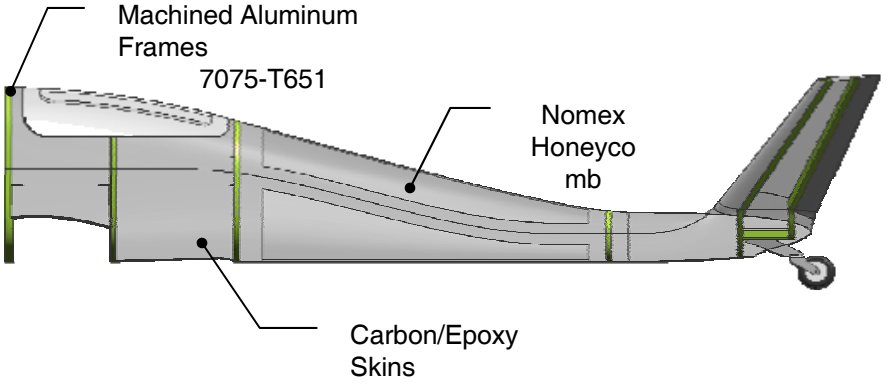
Material Selection

- Carbon Fiber
  - High stiffness-to-weight
  - Expensive
  - Difficult to inspect
- Aluminum
  - Moderate stiffness-to-weight
  - “Nice” failure modes
  - Easy to inspect



Material Selection

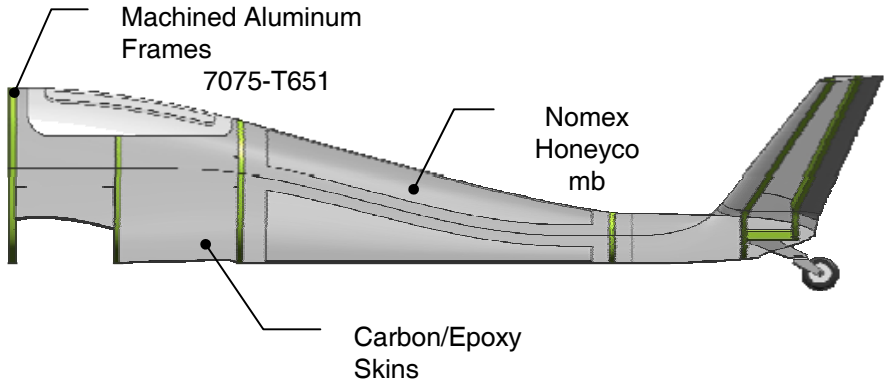
- Carbon Fiber
  - Good for complex shapes where stiffness is key



- Aluminum
  - Good in areas where you will bolt things together

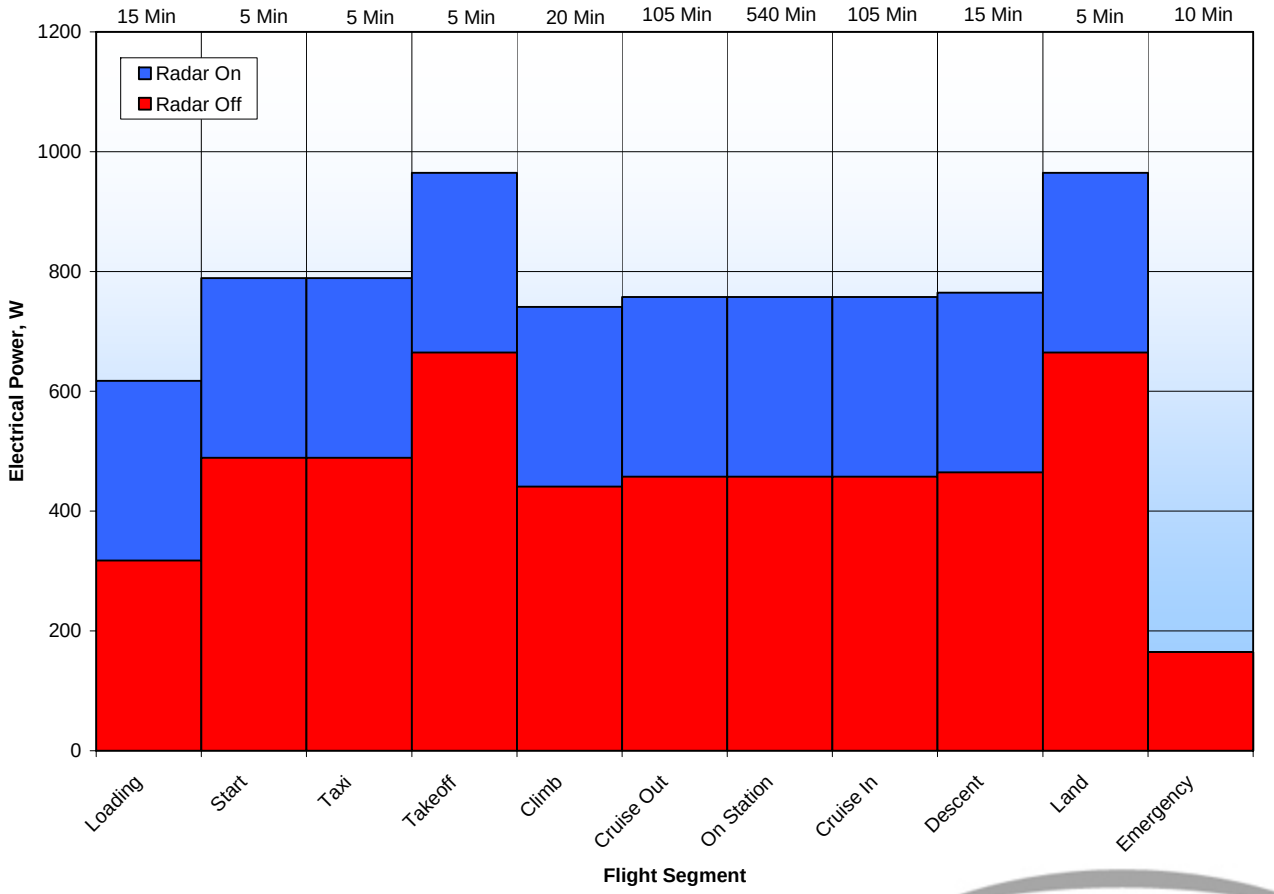
Material Selection

- Fiberglass
  - Inexpensive
  - Low stiffness-to-weight ratio

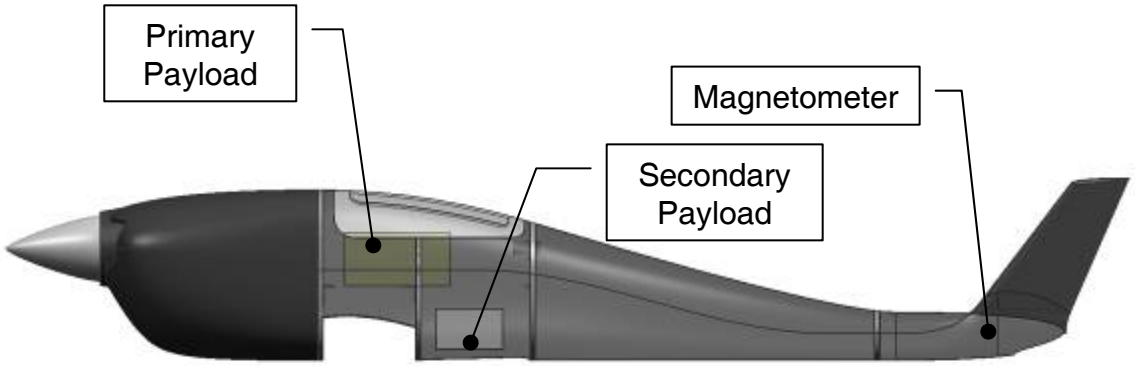


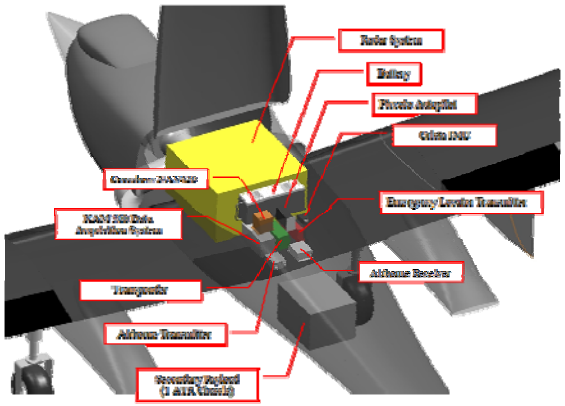
- Steel
  - Very high strength
  - Good for impact loads (Landing Gear, Hinges)

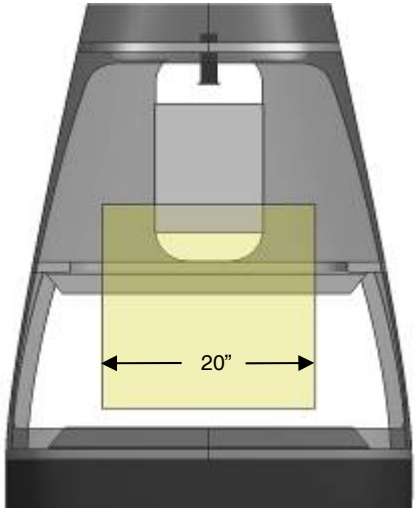
Electrical Power Sizing



Payload Integration

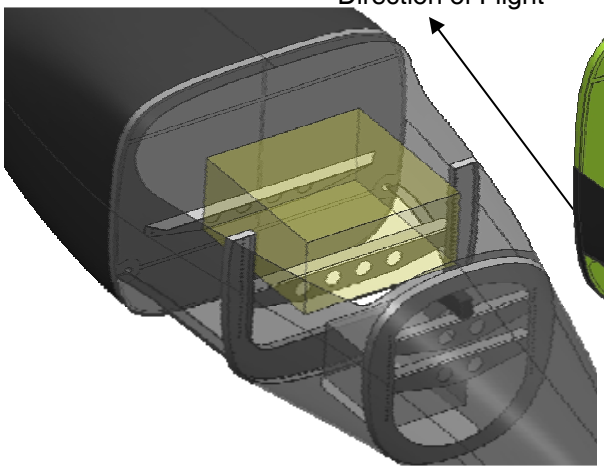


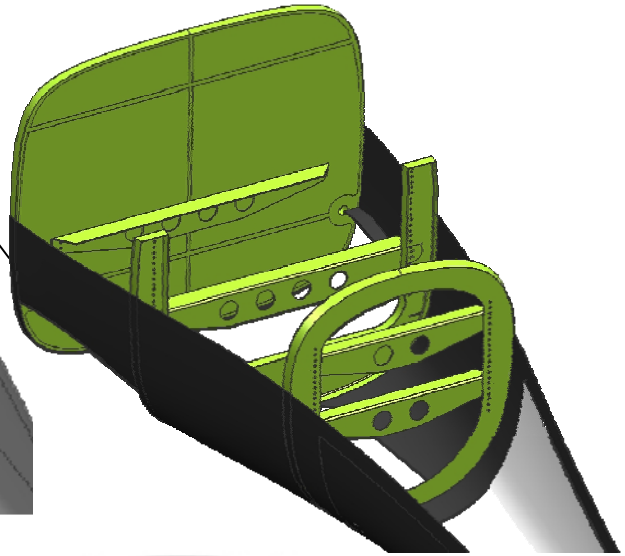




Direction of Flight

Direction of Flight





Top View (a)

Payload Integration

Summary

- “Aircraft Design is a highly iterative, non-unique process.”
  - Dr. Jan Roskam
- “In aircraft design, everything depends on everything else.”
  - Dr. Jan Roskam

Questions?

National Science Foundation
WHERE DISCOVERIES BEGIN

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