DEPARTMENT OF AEROSPACE ENGINEERING

Design Build Fly Team

AIAA DBF

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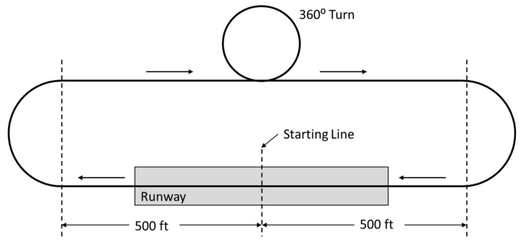
A. JAMES CLARK SCHOOL OF ENGINEERING

Introduction

DBF is an AIAA hosted international collegiate competition



Goal: Create a plane able to perform the following missions

Mission 1: Delivery Mission
- 3 laps in under 5 minutes
- Crew Only

$$M1 = 1$$

Mission 2: Medical Transport
- 3 timed laps, under 5 minutes
- Crew, 2 EMTs, 1 Patient, and Medical Cabinet

$$M2 = 1 + \frac{(\frac{\text{Payload Weight}}{\text{Time}})_{\text{UMD}}}{(\frac{\text{Payload Weight}}{\text{Time}})_{\text{MAX}}}$$

Mission 3: Urban Taxi Flight
- Maximum number of laps under 5 minutes
- Crew, and max number of passengers

$$M3 = 2 + \frac{(\frac{\#\text{ Laps} \times \#\text{ Passengers}}{\text{battery capacity}})_{\text{UMD}}}{(\frac{\#\text{ Laps} \times \#\text{ Passengers}}{\text{battery capacity}})_{\text{MAX}}}$$

Ground Mission: Configuration Demonstration
- Timed set up of each mission listed

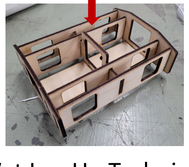
$$GM = \frac{(\text{Mission Time})_{\text{MIN}}}{(\text{Mission Time})_{\text{UMD}}}$$

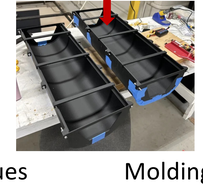
Manufacturing

Different processes used to create the plane chosen based on weight, manufacturability, availability, and cost

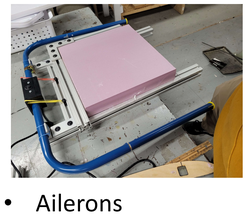
Laser Cutting

3D Printing





Foam Cutting



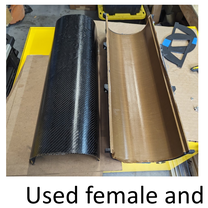
- Ailerons
- Rudder
- Flaps
- Elevator
- Horizontal Stabilizer
- Vertical Stabilizer
- Wings

Wet Lay-Up Techniques

All foam cut parts are composite lay-ups using epoxy resin with either:
- Carbon Fiber

or
- Fiber Glass

Molding

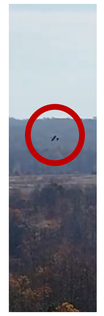


Used female and male molds, with carbon fiber and fiber glass
- Fuselage
- Tail Cone

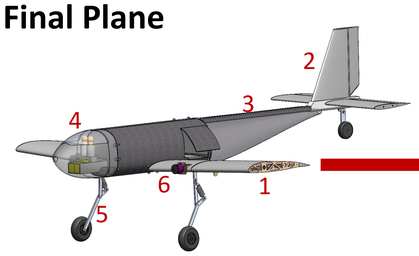
Prototype

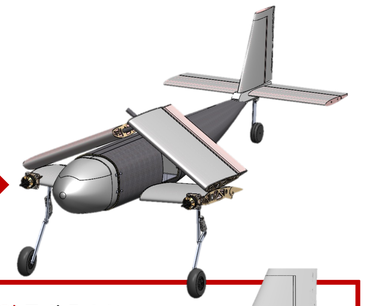
Lessons Learned:
- Keel beam was strong but too heavy
- Foam wings can be hollowed out to save weight
- Vertical Stabilizer needs to be tapered more
- Landing gear need to stronger

Flight Tests:
- Able to take off and land safely

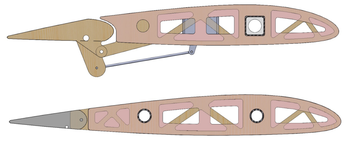


Final Plane

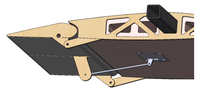




1) Wing Design

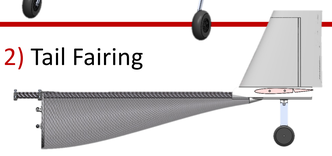


- NACA 25012
- Dihedral 3°



Flap Design:
- Deflection (0°,40°)
- ZOSKAY 35kg Servo

2) Tail Fairing

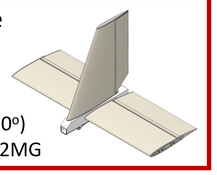


- Keel Beam Design
- Carbon Fiber Skin

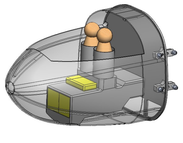
3) Empennage

Stabilizers: NACA 0009

Deflection: (30°,30°)
Servo: Hitec HS-82MG



4) Nose Cone

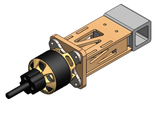


- Houses Electronics and Receiver
- Holds the Crew

5) Landing Gear

- Custom Waterjet 3/16” Aluminum Leg
- Spring for Landing Absorption

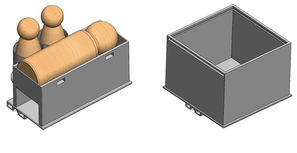
6) Motor Mount + Motor



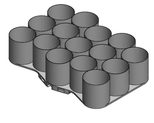
- Plywood Cut Forward Thrust Structure
- Scorpion SII-4020-540KV

Rail System

Mission 2 Pallets



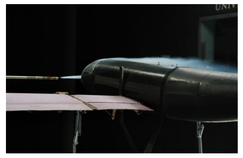
Mission 3 Pallets

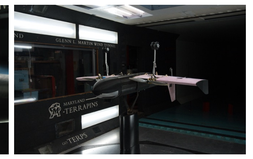


Flight Testing and Wind Tunnel Testing

Wind Tunnel Testing – Glen L Martin Wind Tunnel

Three tests for the tare and inference method:
1) Plane mounted upside down
2) Plane upside down with strut on top
3) Plane upright

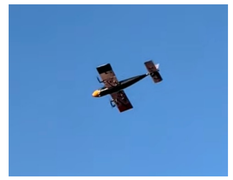




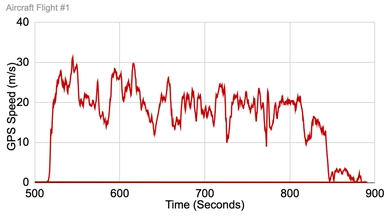
Scenario	Freestream (m/s)	AOA (deg)	Lift (kgf)	% Difference	Drag (kgf)	% Difference
Theoretical Takeoff with flaperons	15.5	13	5.6	26.79	N/A	N/A
Wind Tunnel Takeoff with flaperons	13.4	14	7.1		2.19	
CFD Takeoff with flaps	13.4	13	8.4	-26.19	0.81	129.63
Wind Tunnel Takeoff with flaps	13.4	14	6.2		1.86	
CFD Cruise	30	3	4	-5.00	0.46	421.74
Wind Tunnel Cruise	29	3	3.8		2.4	

Flight Testing

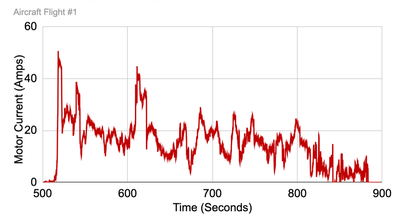
- Left: Flight Speed vs. Time
- Right: Power Drawn vs. Time
- Performed three flight test before competition



GPS Speed vs. Time



Motor Current vs Time



Competition – Wichita Kansas

- Competed in AIAA Design Build Fly Competition
- Completed Missions

Thank You to our Sponsors and our Advisor Dr. Lee

BOEING NORTHROP GRUMMAN hilink