DRACO

Executive Summary
University of Maryland, College Park
Undergraduate Team

42nd Annual Vertical Flight Society
Student Design Competition
Pioneering Hydrogen-Electric VTOL

Sponsored by AIRBUS HELICOPTERS

Alfred Gessow Rotorcraft Center
Department of Aerospace Engineering
University of Maryland
College Park, MD 20742 U.S.A.

Draco: A Dragon Without Flames

Draco is an advanced helicopter powered by novel zero-emission Proton Exchange Membrane Fuel Cells, revolutionizing the world of manned VTOL. These use hydrogen to generate electrical power with minimal environmental risk.

Our design philosophy: Minimize technological risk by using ***proven and safe*** VTOL technology, with the PEMFC system as the only new variable.

Draco's streamlined design combines performance and environmental ethics in the pursuit of exploration.

Draco: An Overview

Optimized rotor blades and compounded wings for maximum loiter endurance

Articulated main rotor hub with Spherical Elastomeric Bearings

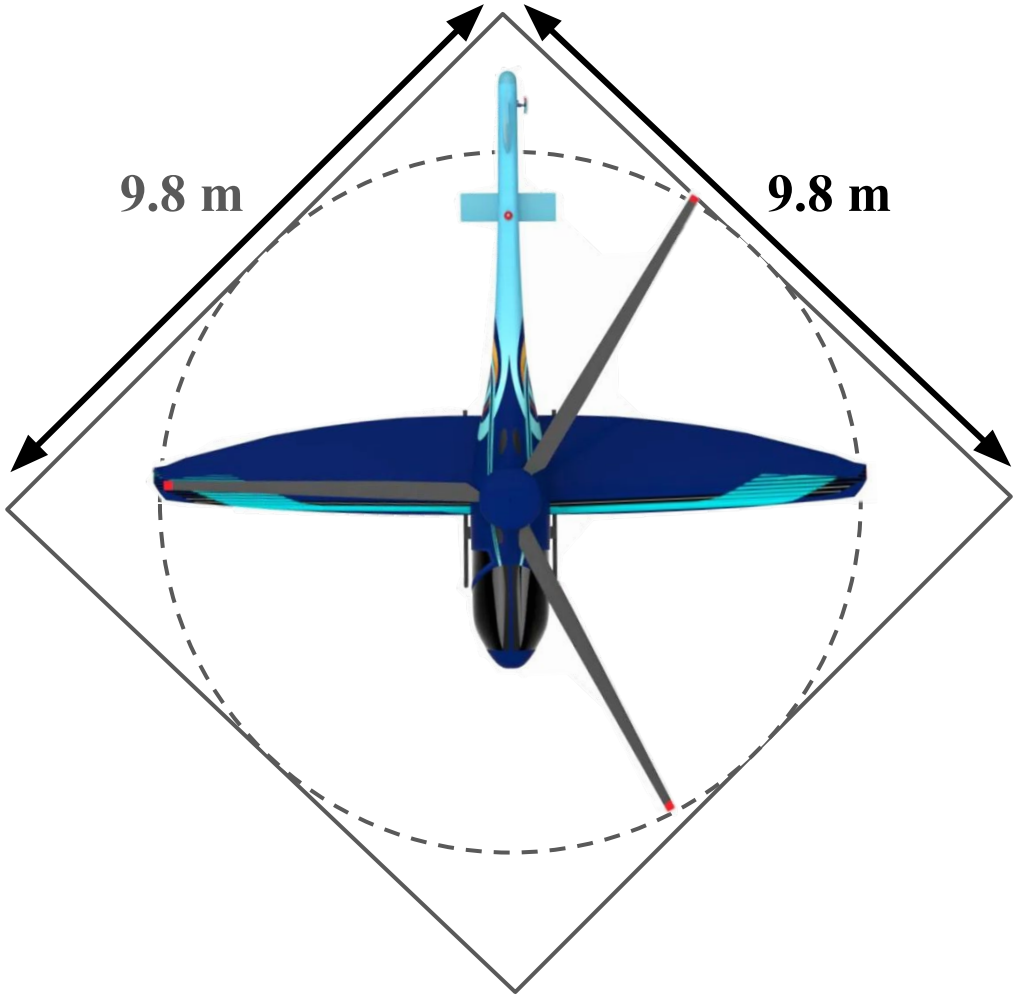
Simple, efficient bevel-gear transmission

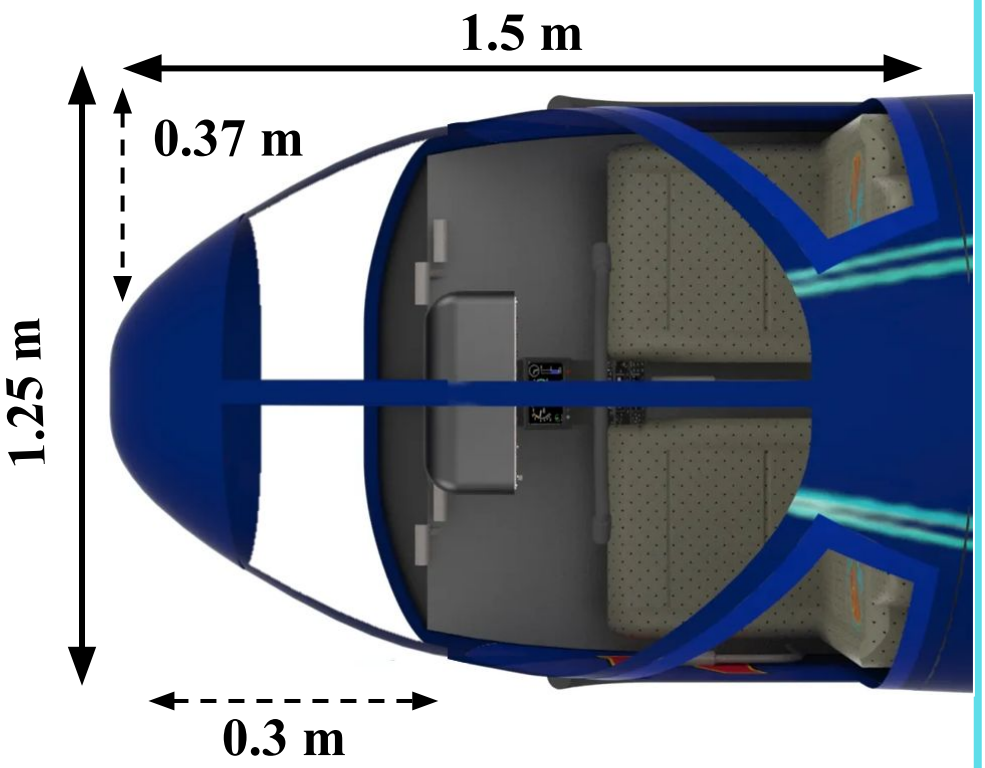
196-kW PEMFC with rechargeable 58-kW battery

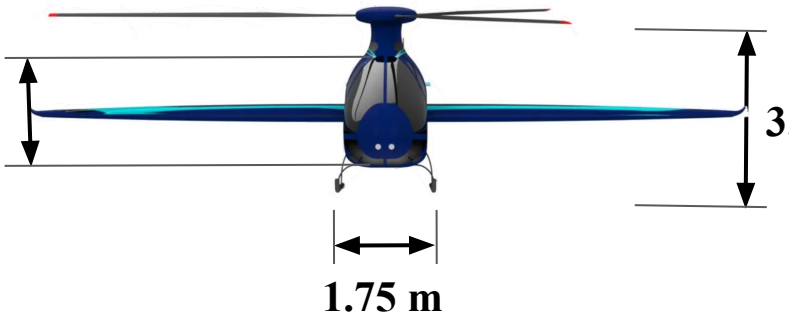
Superior aerodynamic performance and a guarantee for passenger safety

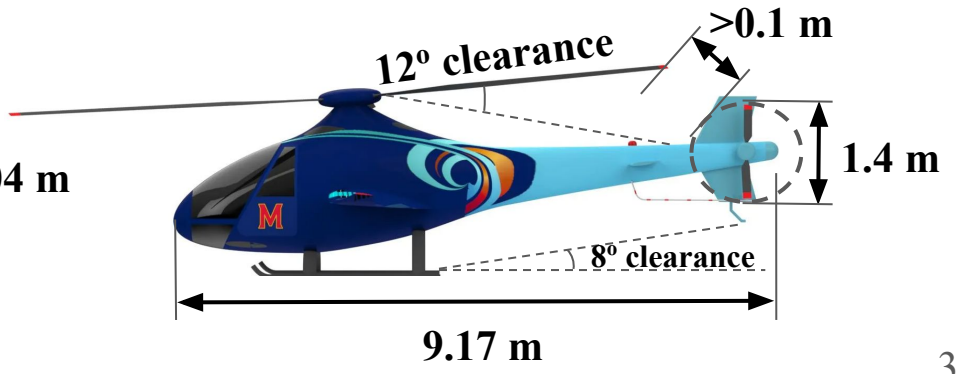
GTOW	1417 kg (3124 lb)
Installed Power	254 kW (341 hp)
Loiter Endurance	190.3 minutes
Rotor radius	4.9 m (16.1 ft)
Disk Loading	206 N/m^2 (4.3 lb/ft^2)
Wingspan	9.4 m (30.8 ft)

Size Specifications



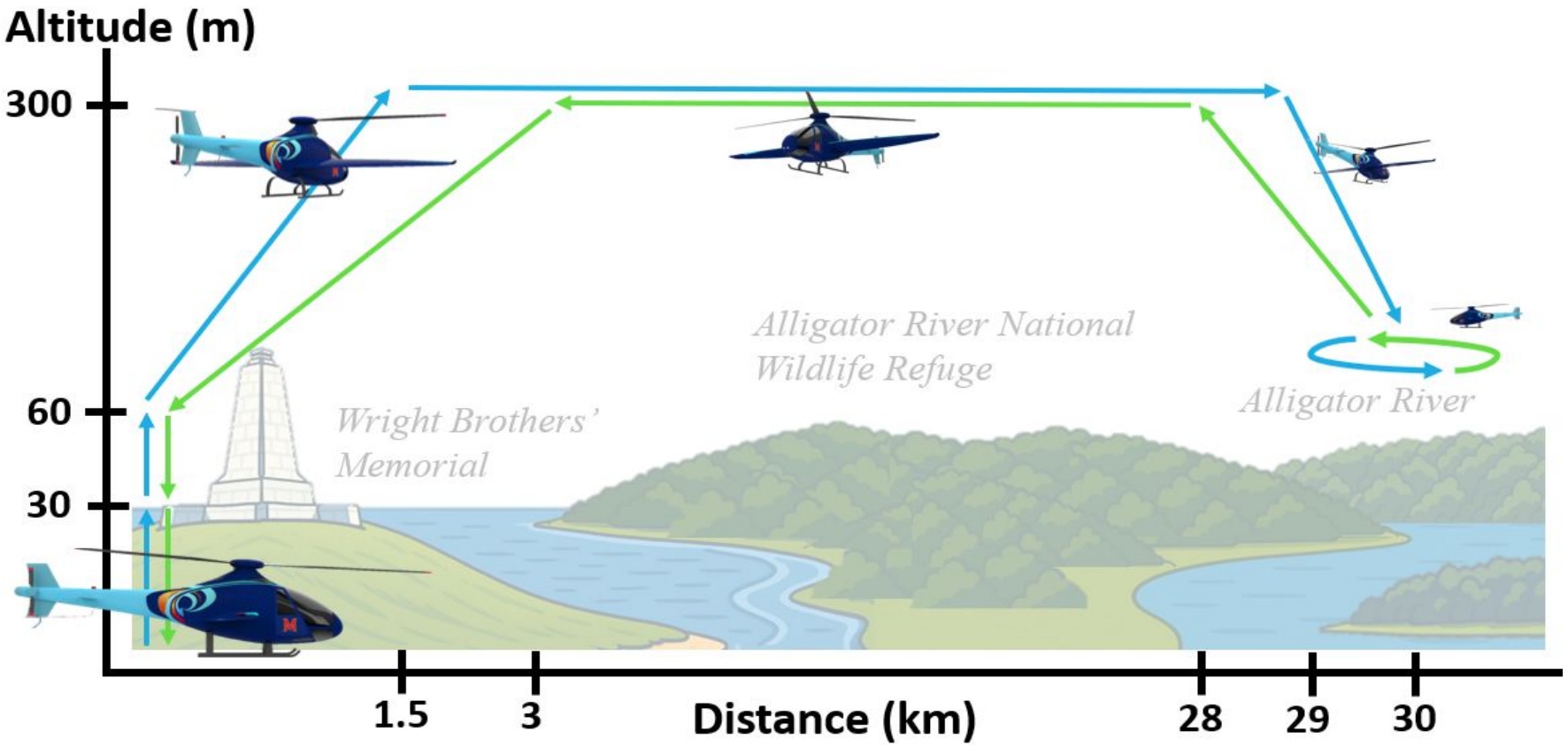






Mission Summary

Starting from Wright Brothers National Memorial in Kitty Hawk, NC, *Draco* follows the prescribed mission profile over to Alligator Lake, where it loiters for 127 minutes before returning along the rest of the mission profile, landing normally at its starting point. During the mission, at 300m above MSL, *Draco* flies at its best-range speed of 33.9 m/s, and during the loiter, it flies at its best-endurance speed of 26.8 m/s. Cruising above the lake at this low speed, the passenger can comfortably observe local wildlife.



Configuration Selection

SMR: Reduced empty weight fraction

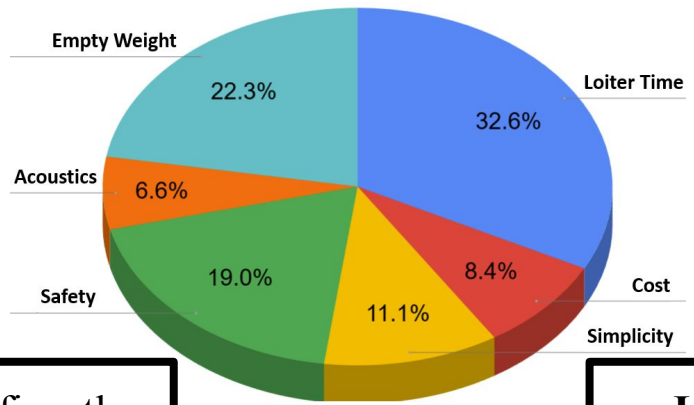
Lift Compound
Reduced mechanical complexity and weight for similar loiter time

Tiltrotor: Improved versatility

Lift Compound: Reduced mechanical complexity

Lift Compound: Significantly improved loiter time

Design Priorities



Lift + Thrust Compound: Improved reliability

Lift + Thrust Compound: Reduced mechanical complexity

PEMFC System

Proton Exchange Membrane Fuel Cell (PEMFC)

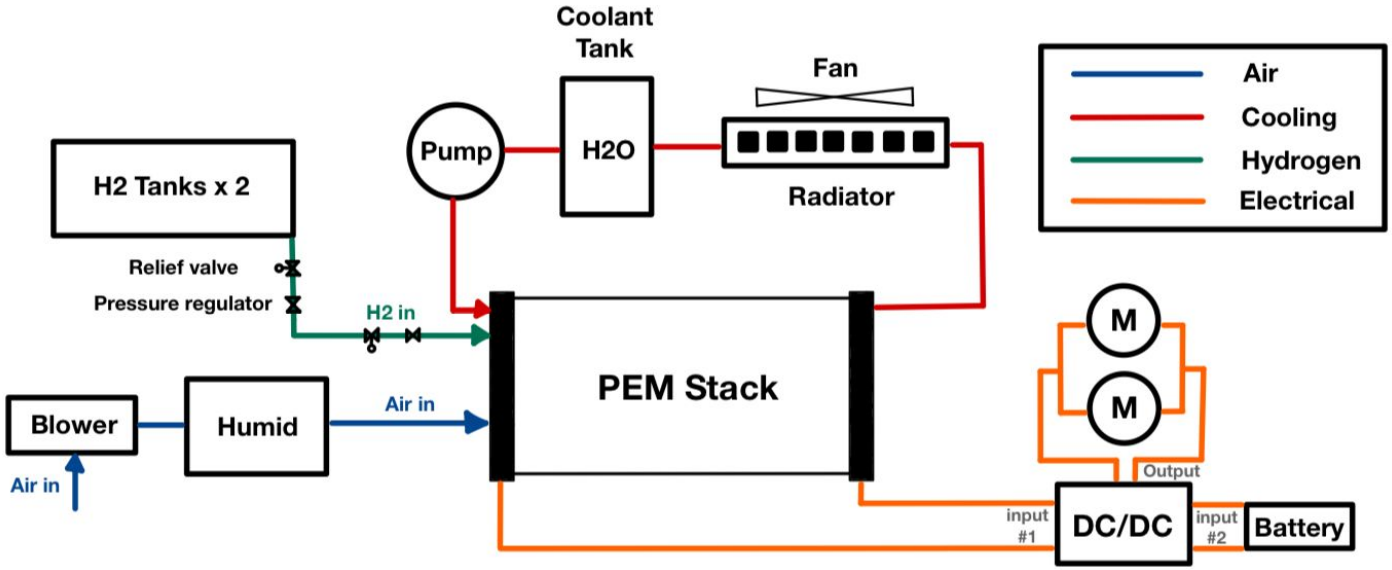
Installed power: 196.58 kW (263.6 hp)

Maximum operating temperature: 85°C

Hydrogen Tanks

2x Type 4 Cylinder

14.8 kg (16.31 lb) fuel capacity



Air system

Requires no compressor or low-temperature cooling system

Battery (Samsung 40T)

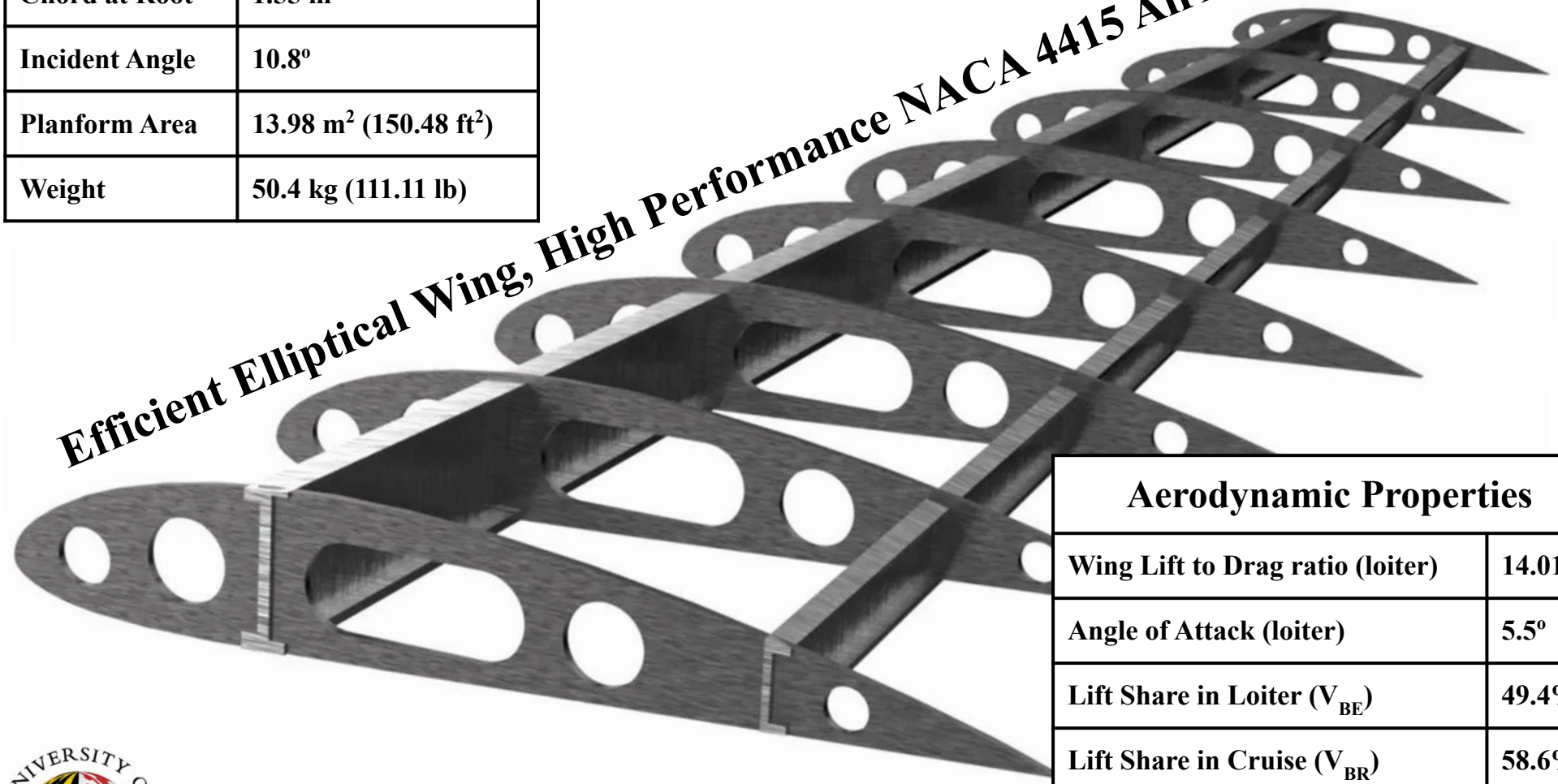
Installed Power: 57.9 kW (77.6 hp)

Enhances safety & reduces system weight by 7.4%

Sized and validated with proven market-ready components

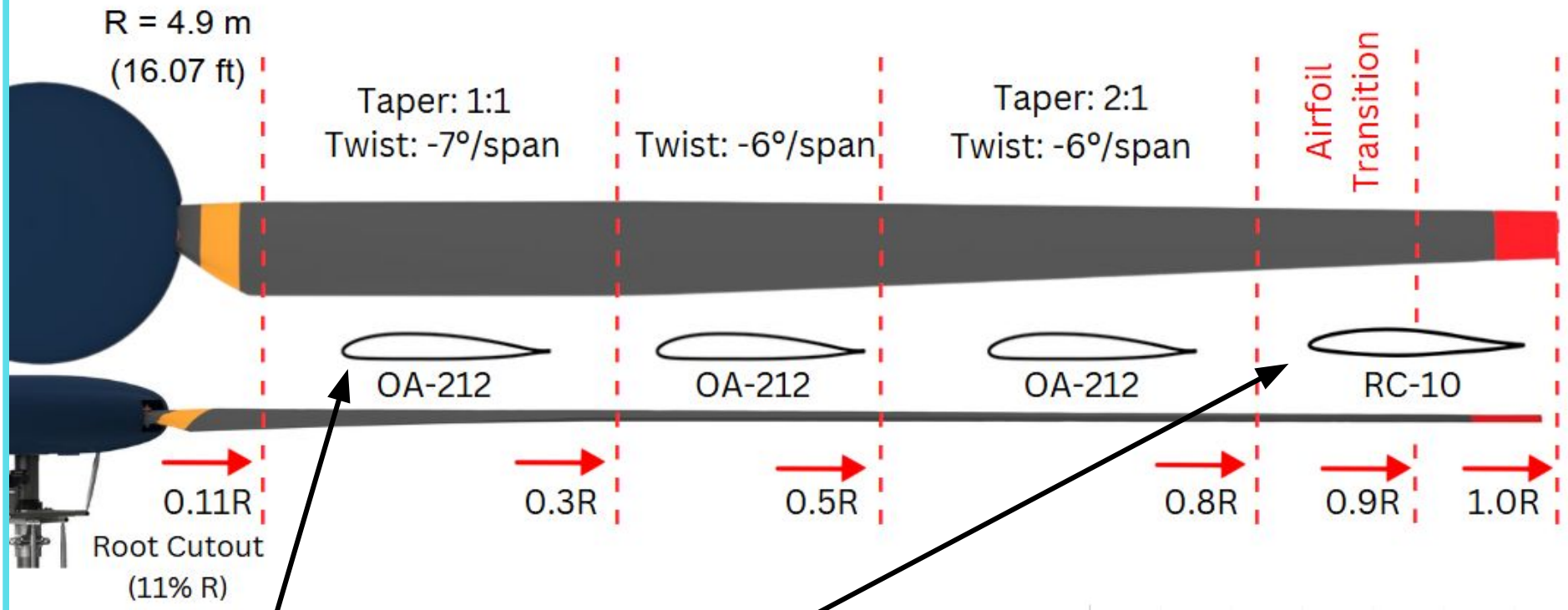
Wing Design

Geometric Properties	
Wingspan	11.25 m (36.9 ft)
Chord at Root	1.55 m
Incident Angle	10.8°
Planform Area	13.98 m^2 (150.48 ft^2)
Weight	50.4 kg (111.11 lb)



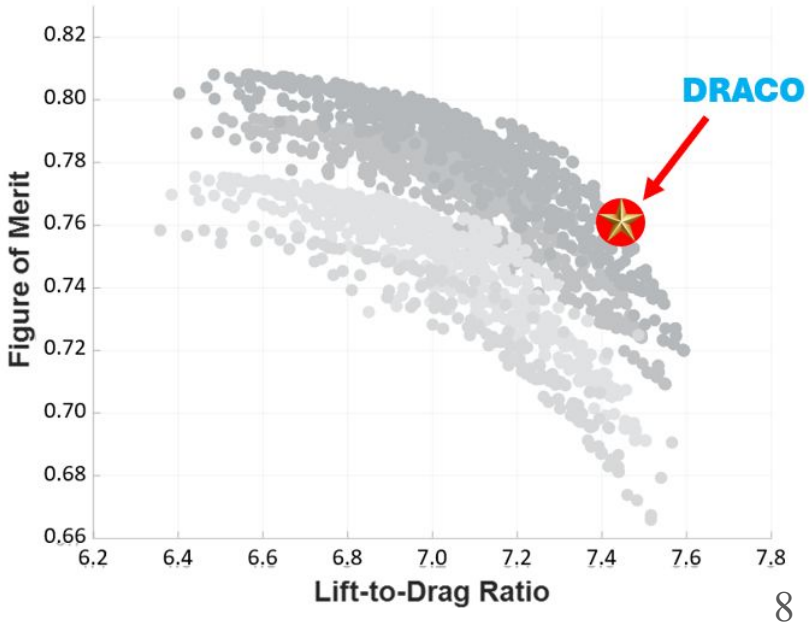
Aerodynamic Properties	
Wing Lift to Drag ratio (loiter)	14.01
Angle of Attack (loiter)	5.5°
Lift Share in Loiter (V_{BE})	49.4%
Lift Share in Cruise (V_{BR})	58.6%
Wing Hover Download	7%

Main Rotor Blade Design



High L/D airfoil at root

High Mach divergence airfoil at tip



4,251 Tested Designs

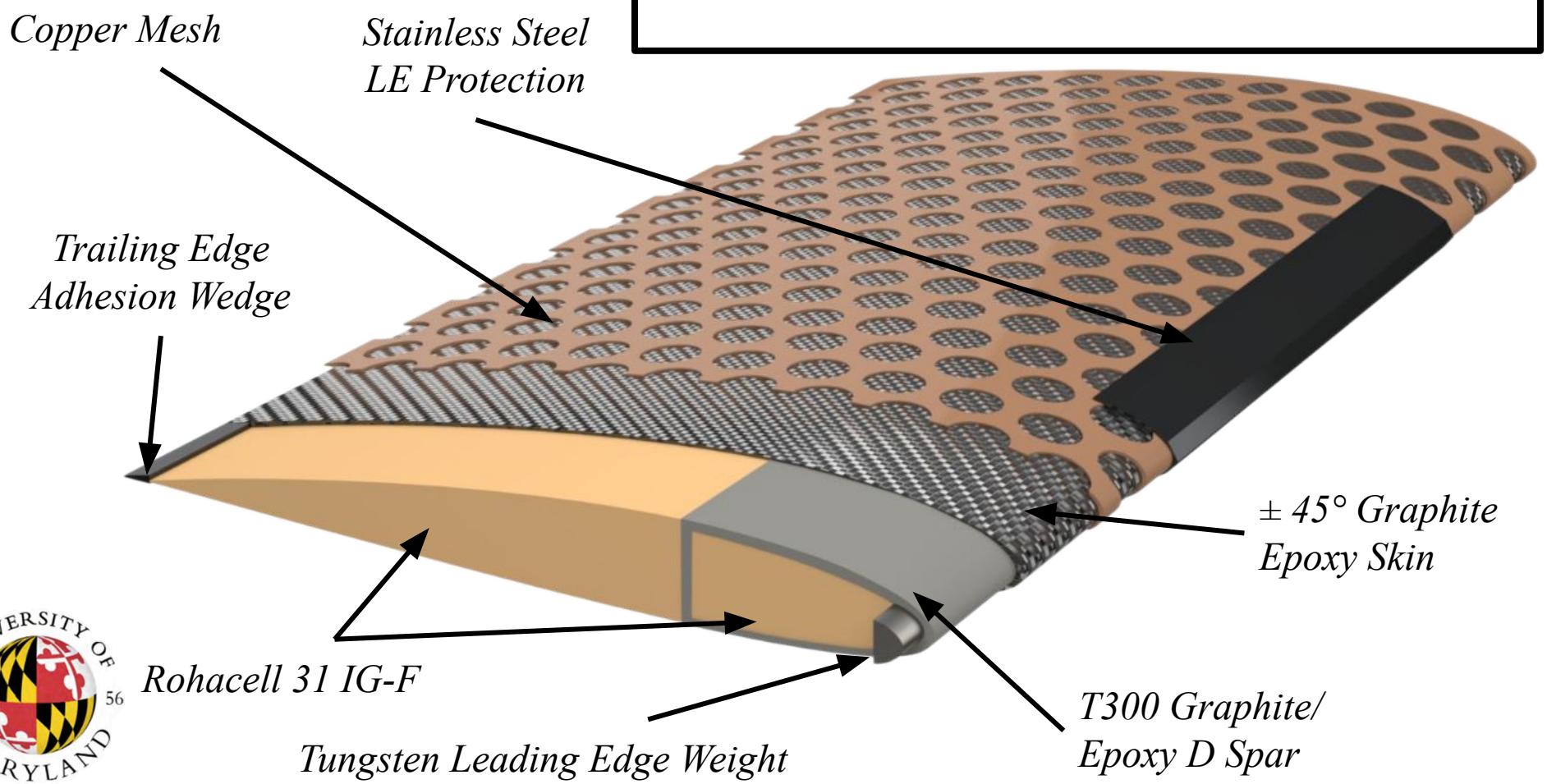
1 Optimal Solution

Main Rotor Blade: Internal Structure

Reliable design with common practices

Key Features:

- D-spar and Rohacell 31 supports loads with high strength-to-weight ratio
- Tungsten leading edge weight for C.G. balance
- Stainless steel leading edge protects from debris

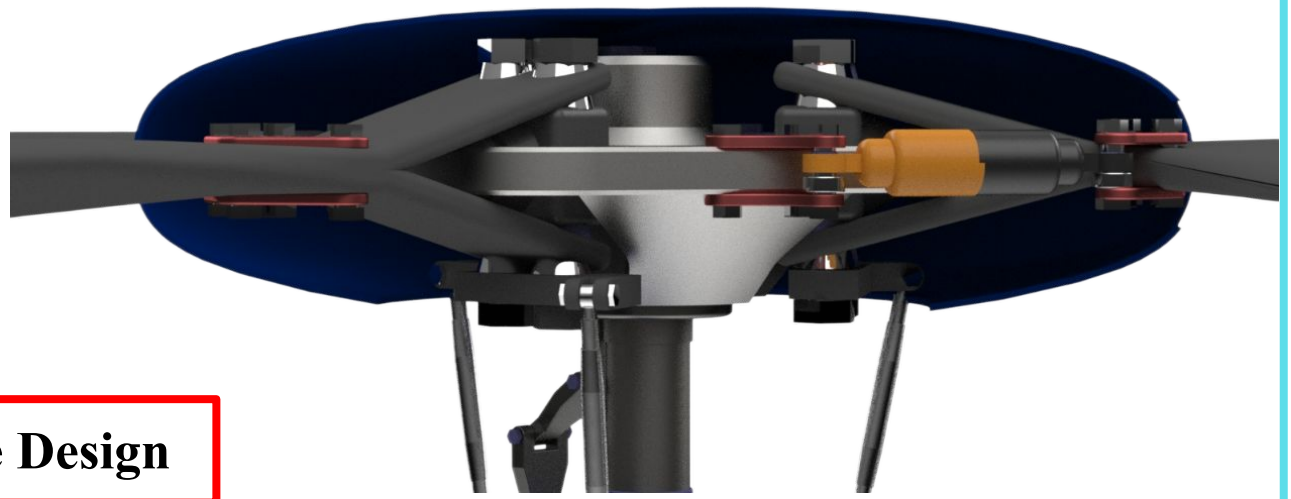


Main Rotor Hub

Articulated Rotor Hub

Maintenance-free spherical elastomeric bearings

Elliptical hub cap reduces drag



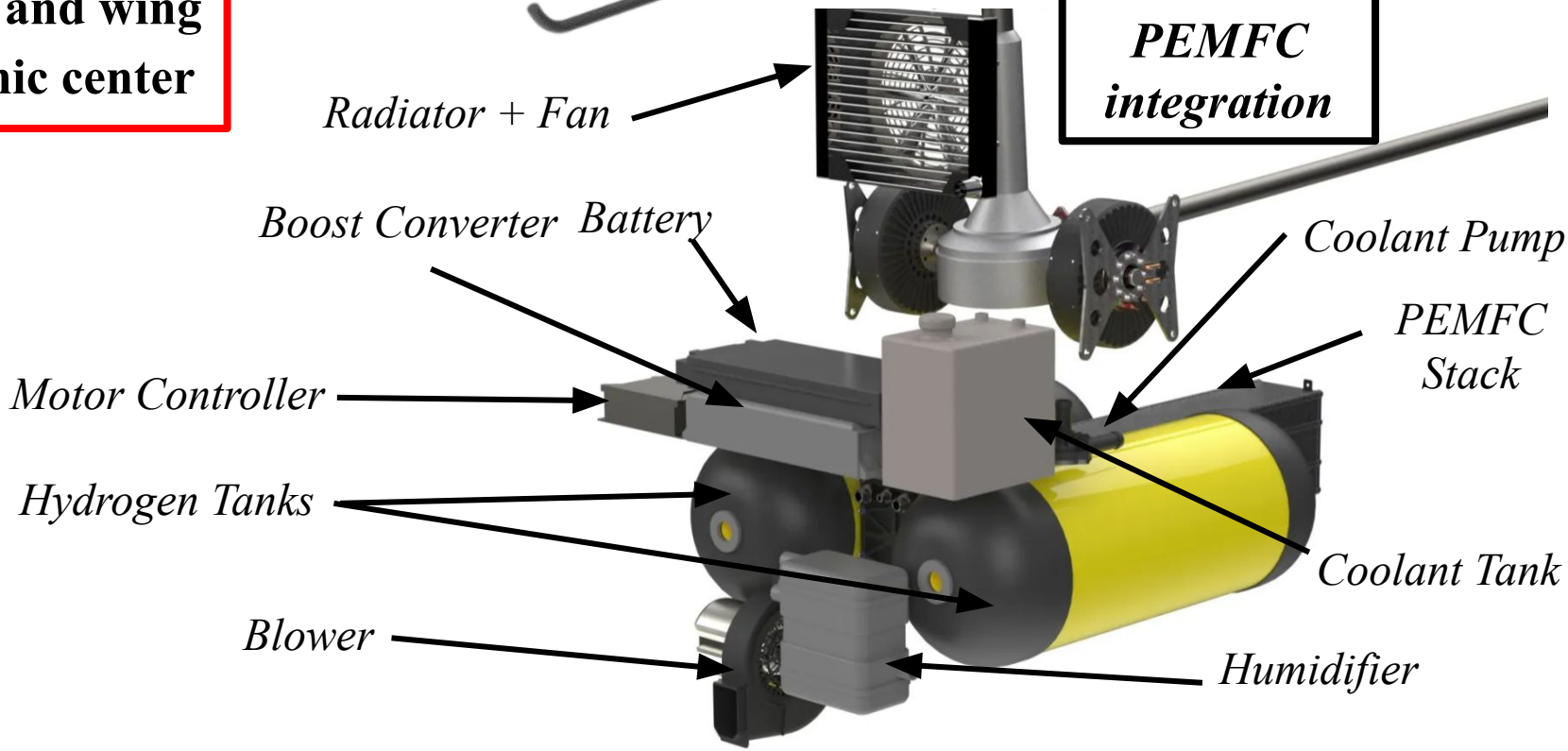
Proven, Reliable Design

Draco's Internal Layout

Balanced weight distribution: C.G. aligned with main rotor shaft and wing aerodynamic center

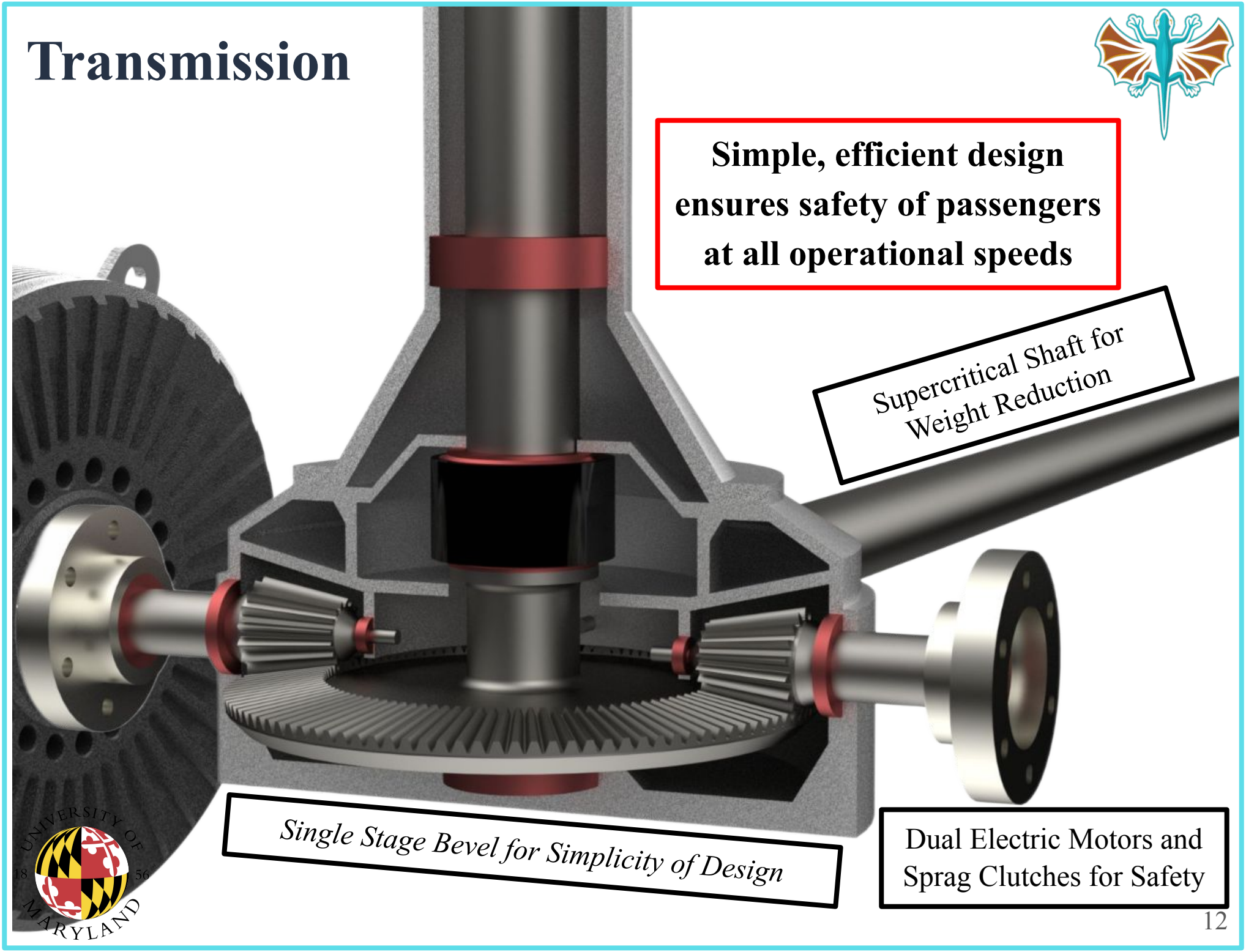
Compact volume allocation

PEMFC integration



Transmission

Simple, efficient design ensures safety of passengers at all operational speeds

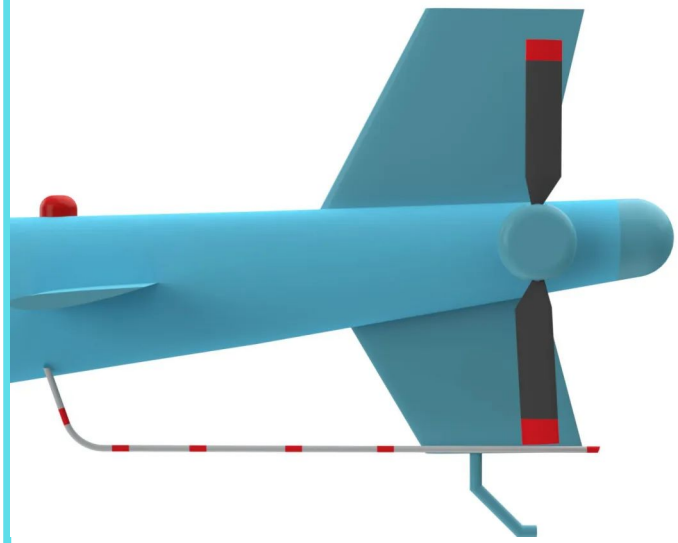


Supercritical Shaft for Weight Reduction

Single Stage Bevel for Simplicity of Design

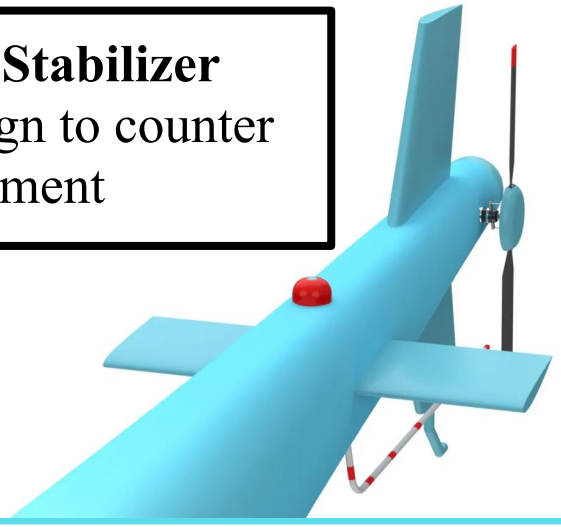
Dual Electric Motors and Sprag Clutches for Safety

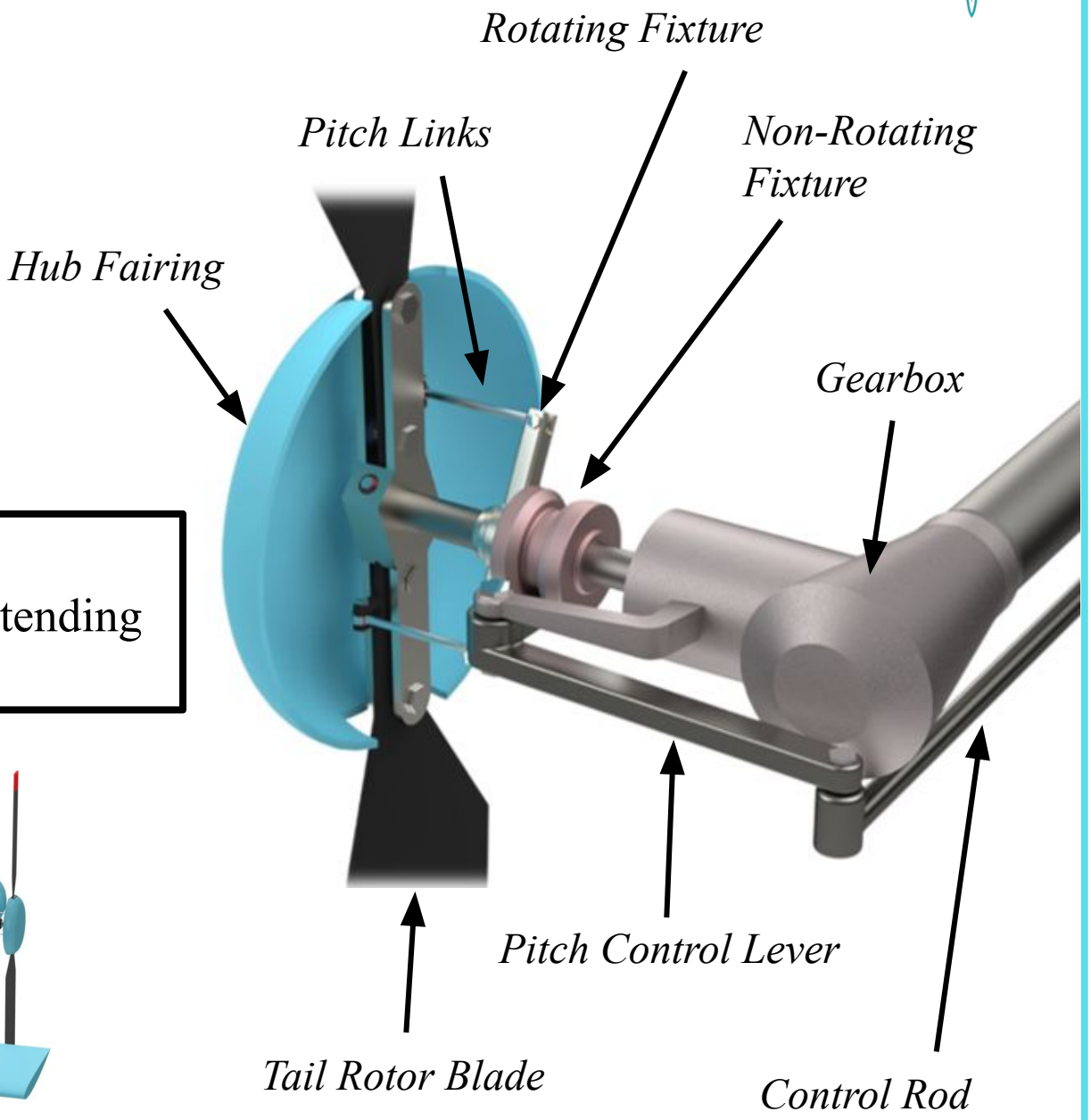
Tail Rotor and Empennage Design



Vertical Stabilizer
Fully offloads tail rotor in loiter, extending endurance

Horizontal Stabilizer
Proven design to counter pitching moment





Fuselage Shape and Aerodynamics

Hub and mast fairings for main rotor hub drag reduction

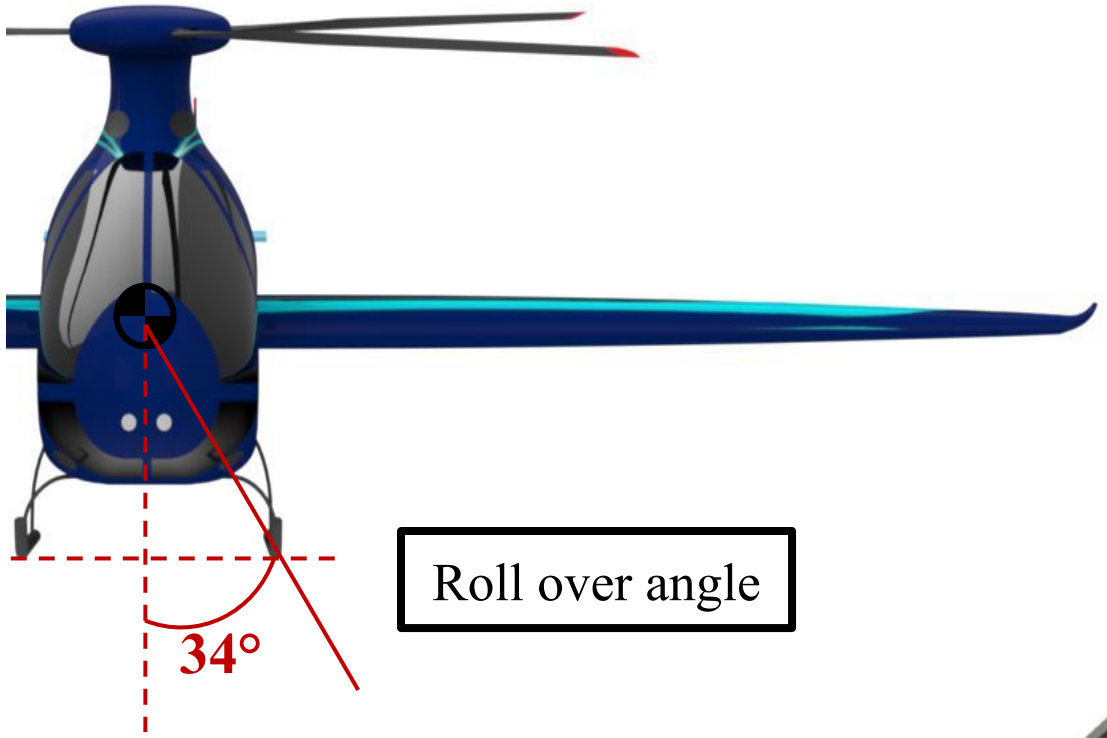
Vehicle equivalent flat plate area:
0.422 m^2 (4.542 ft^2)

Narrow front profile reduces drag and hover download

Smooth transition from main body to tail boom reduces flow separation and drag

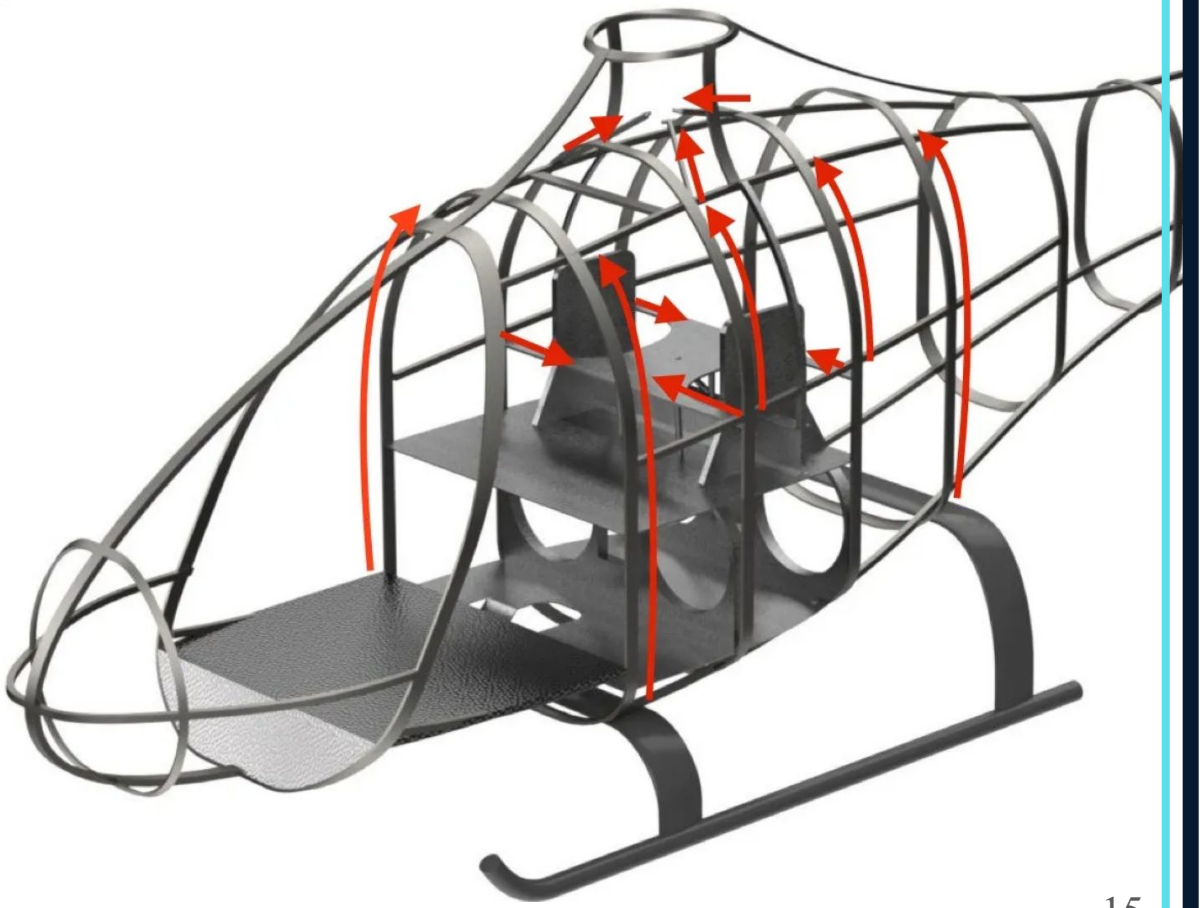
Airfoil-shaped landing gear casings for drag reduction

Airframe Structure and Landing Gear



Roll over angle

Load paths of reaction frame in hover



Geometry designed for efficient load distribution

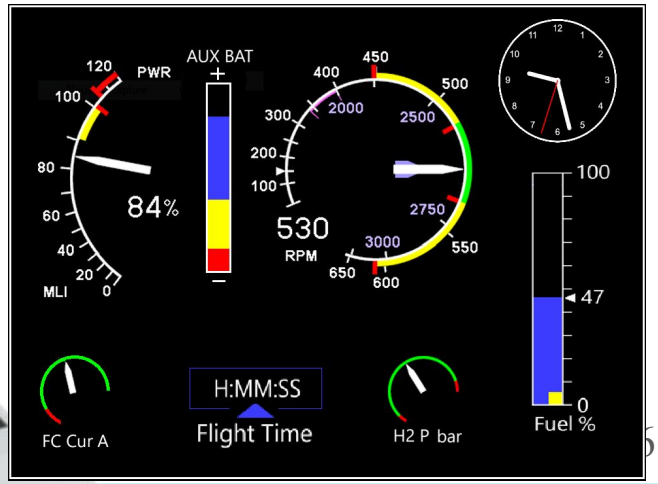
Glass Cockpit

14 CFR 27 and CS-27 Compliant

Industry Standard Garmin GI 275 for Navigation

Modifiable
3 extra slots available for expansion or for lower cost steam gauge configuration

Custom Engine Panel designed to address hydrogen supply and PEMFC performance



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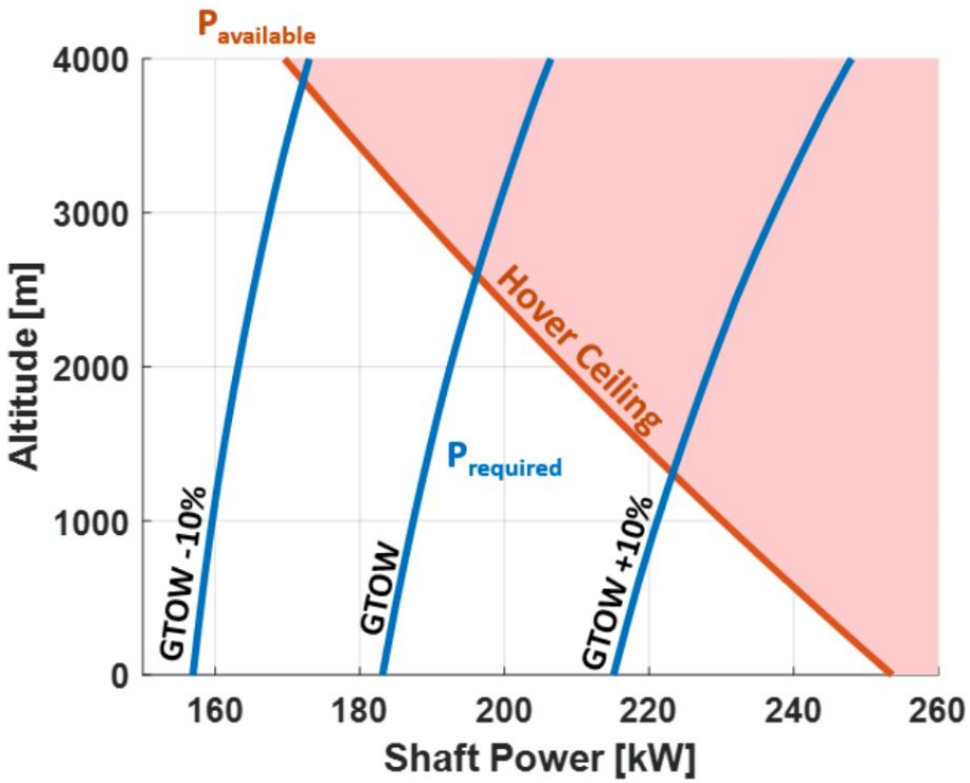
Vehicle Performance

Cruise Speeds	
Best Endurance Velocity (V_{BE})	26.8 m/s (52 kts)
Best Range Velocity (V_{BR})	33.9 m/s (66 kts)
Maximum Velocity (V_{MAX})	46.8 m/s (91 kts)



Vehicle calibrated for <u>MAXIMUM</u> loitering performance

Up to <u>2,600 meter</u> hover with mission payload

Max Vehicle L/D ⟶ 8.21

…A Revolutionary Flight Forward

The University of Maryland Undergraduate Team is proud to present *Draco* as our response to the RFP of the 42nd Annual VFS Student Design Competition.

- Proven, safe, and mechanically simple technology, minimizing technological risk while implementing the novel PEMFC system
- Compounded wings provide additional lift to offload the main rotor, reducing power requirements by 49.4% during loiter and 58.6% during cruise, significantly extending *Draco*'s loiter endurance.
- PEMFC, transmission, avionics, and structures designed for pilot and passenger safety
- Fully-articulated rotor hub with elastomeric bearings for easy control of flight and hover, and transition to different flight states
- Aerodynamically designed landing gear, rotor hubs, and airframe for minimum drag and power requirements
- Extra motor provides enough power for steady descent
- Battery supplies extra power for high-intensity, short-duration mission mission segments and allow for a 7.4% PEMFC system weight reduction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