Draco: The Hydrogen-Powered eVTOL

(AHS) 42nd Annual Vertical Flight Society Student Design Competition

Ishmael Agui, Ron Berlin, Colby Cotoia, Joshua Katz, Billy Lee, Isaiah Lee, Samuel Renz

Problem Definition

This year's challenge:
Design a passenger-carrying electric VTOL powered by gaseous hydrogen via Proton Exchange Membrane Fuel Cells (PEMFC).

Major Challenges of PEMFC:

- Brand new technology–many unknowns
- Realism and practicality
- Safety and reliability
- Higher cost, weight, and volume of components versus conventional engines

Our design philosophy:

Use reliable, proven VTOL design concepts, with hydrogen power as the only unknown variable.

Mission Requirements

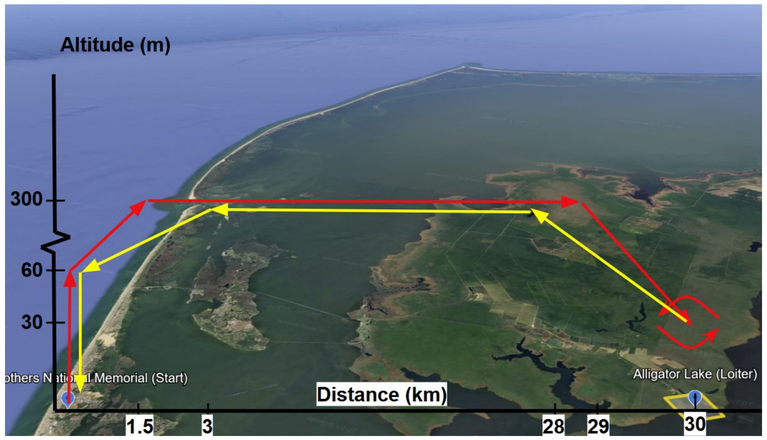

Figure 1. Mission Profile

Final Design

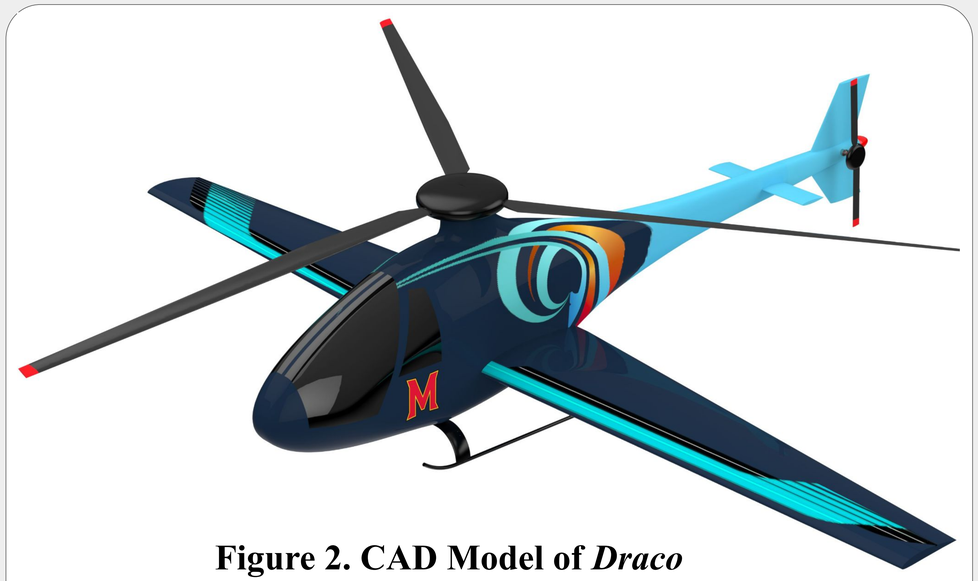

Figure 2. CAD Model of *Draco*

Inspired by our mission to observe wildlife in Alligator Lake, we named our design **Draco** — after the flying reptiles known for their efficient flight. Designed for agile, long-endurance observation, **Draco** is powered by zero-emission hydrogen fuel cells. Its streamlined design combines performance and environmental responsibility in the pursuit of exploration.

Figure 3. 3D Drawing of Internal Views

Design and Configuration

Mechanical simplicity and **minimal power** requirements were major drivers in our design choices.

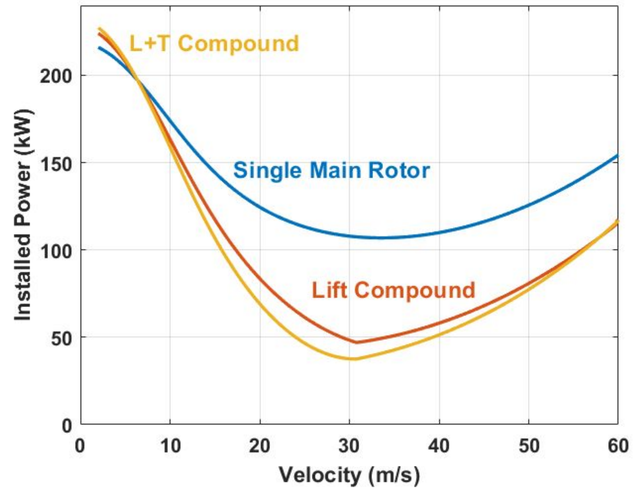

Figure 4. Power Velocity Curve by Configuration

Parameters	Lift Compounded SMR	Lift-Thrust Compounded SMR
Cruise Power [kW, (hp)]	47 (63)	38 (51)
Fuel Weight [kg, (lb)]	11.7 (25.8)	9.66 (21.3)
Loiter Time	**166**	**166**

Lift Compounded Single Main Rotor:

- Low power in loiter compared to SMR
- Simplicity: no pusher propellers, lighter than Lift+Thrust Compound
- Best choice to meet the customer's needs and maximize our loiter endurance

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Hydrogen System

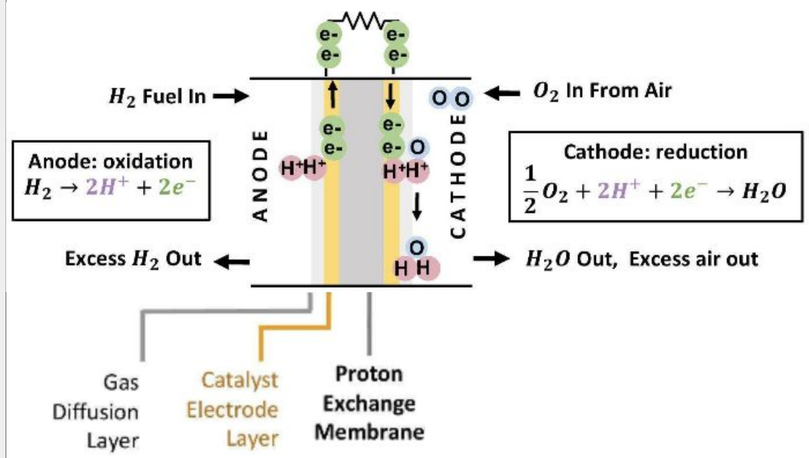

Figure 5. PEM Fuel Cell Overview [1]

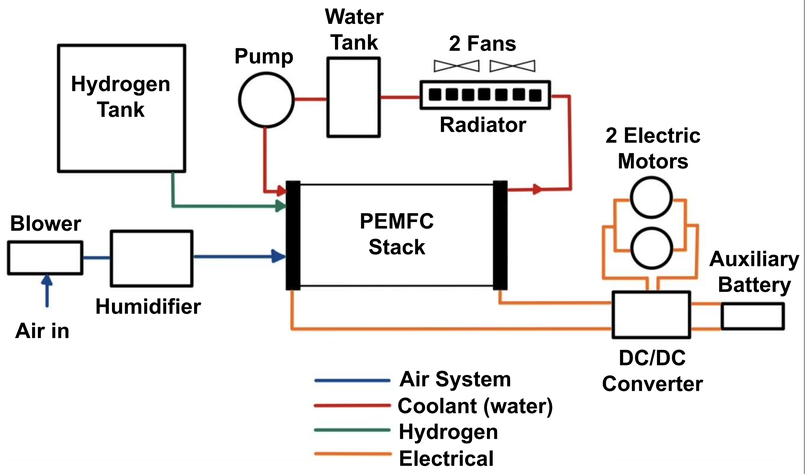

Figure 6. *Draco*'s Hydrogen System Schematic

Transmission Design

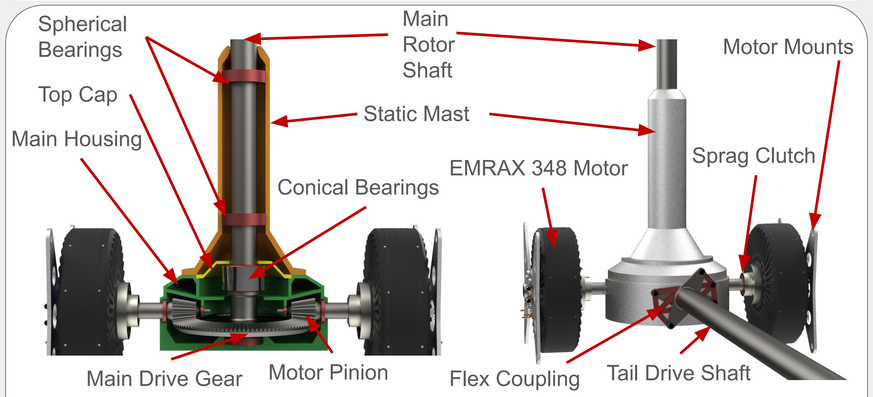

Figure 7. Gearbox and Shafting

- Key goals: Weight reduction and simplicity
- Single-stage reduction bevel gearbox: 2500 RPM motors stepped down to 389.9 RPM for the main rotor
- Supercritical tail rotor shaft
- Self-centering tendency stabilizes the shaft

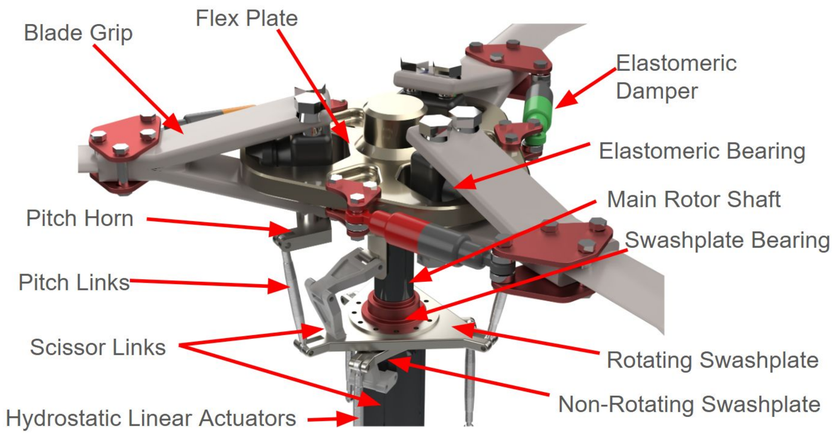

Figure 8. Main Rotor Hub

Aerodynamics

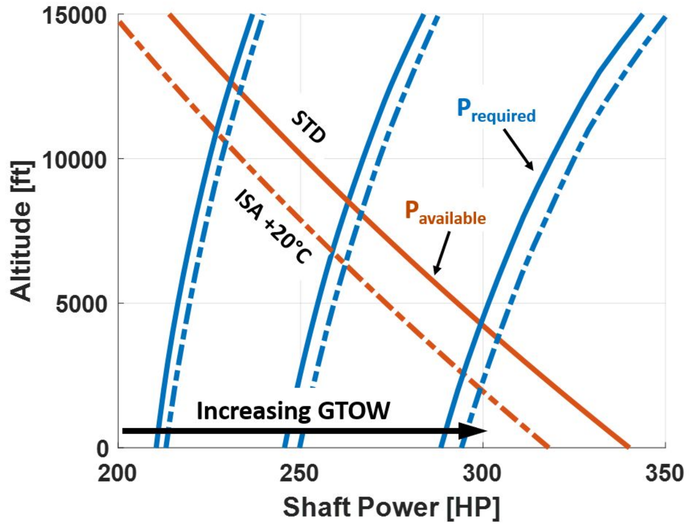

Figure 9. HOGE Service Ceiling

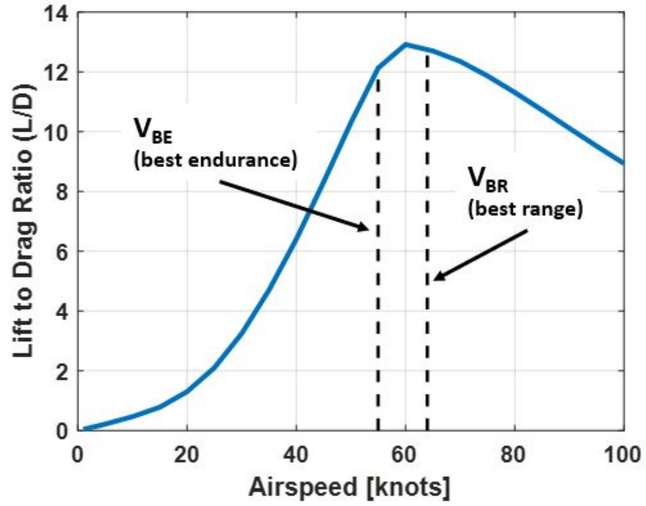

Figure 10. Forward Flight Performance

Blade Structural Design

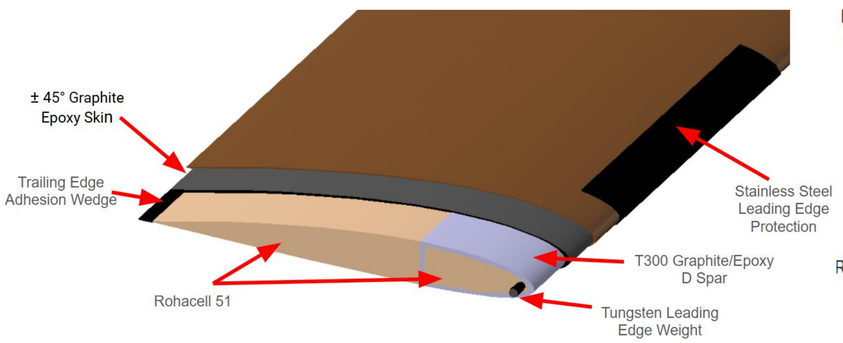

Figure 11. Blade Cross Section

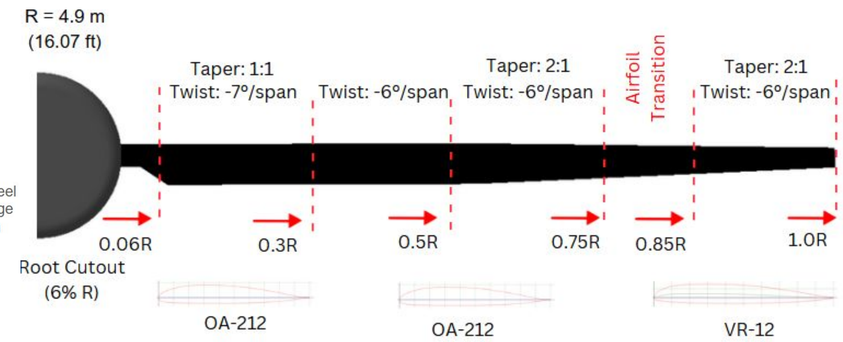

Figure 12: Blade Shape

Acknowledgements and References

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[1] Datta, Anubhav. 2021. "PEM Fuel Cell Model for Conceptual Design of Hydrogen eVTOL Aircraft." NASA Technical Reports. https://ntrs.nasa.gov/citations/20210000284.

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