Design & Optimization of Motor & Fan Assembly For an eVTOL Aircraft

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OntarioTech Engineering & Applied Science

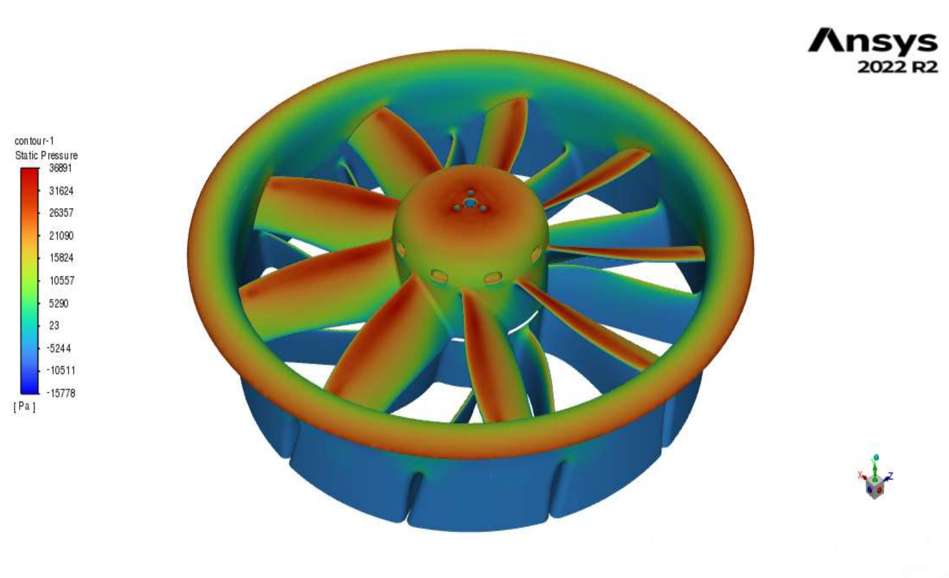
Horizon Aircraft

MRL

FLEMING

Introduction & Objective

eVTOL (electric vertical take-off and landing) aircraft requires an efficient propulsion system that can deliver an optimal lift to torque balance. The majority of lift is produced by the rotor component, significantly at the tip of each blade.



Static Pressure Contour of the Propulsion system

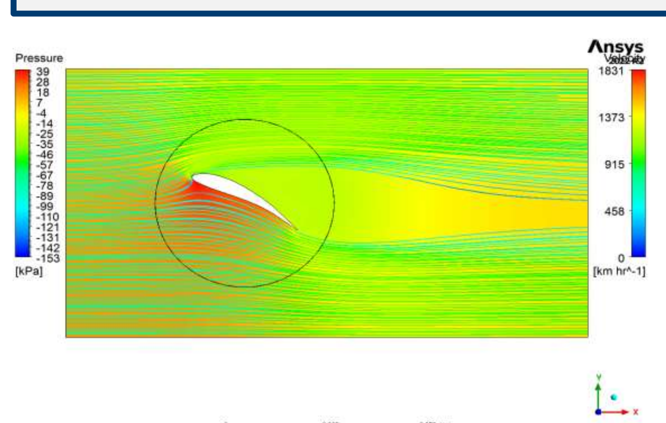
Project Goals

- Increase overall lift of the vertical propulsion system
- Increase efficiency of the system
- Focus in rotor design

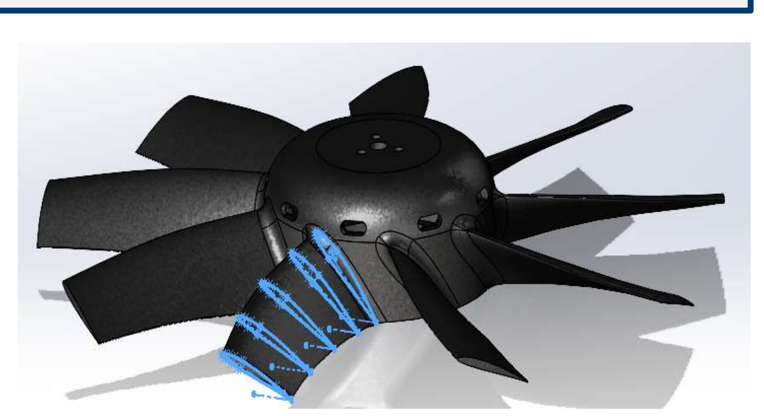
Airfoil Candidate Research

Conducted analyses of online airfoil indexes to select optimal airfoils for the rotor blades, crucial for maximizing lift performance. Extensive research across various airfoil families led to the identification of 30 potential candidates.

2D Simulations & Segment Analysis



GOE255 Airfoil Candidate Streamline Graph @ 30 [deg]

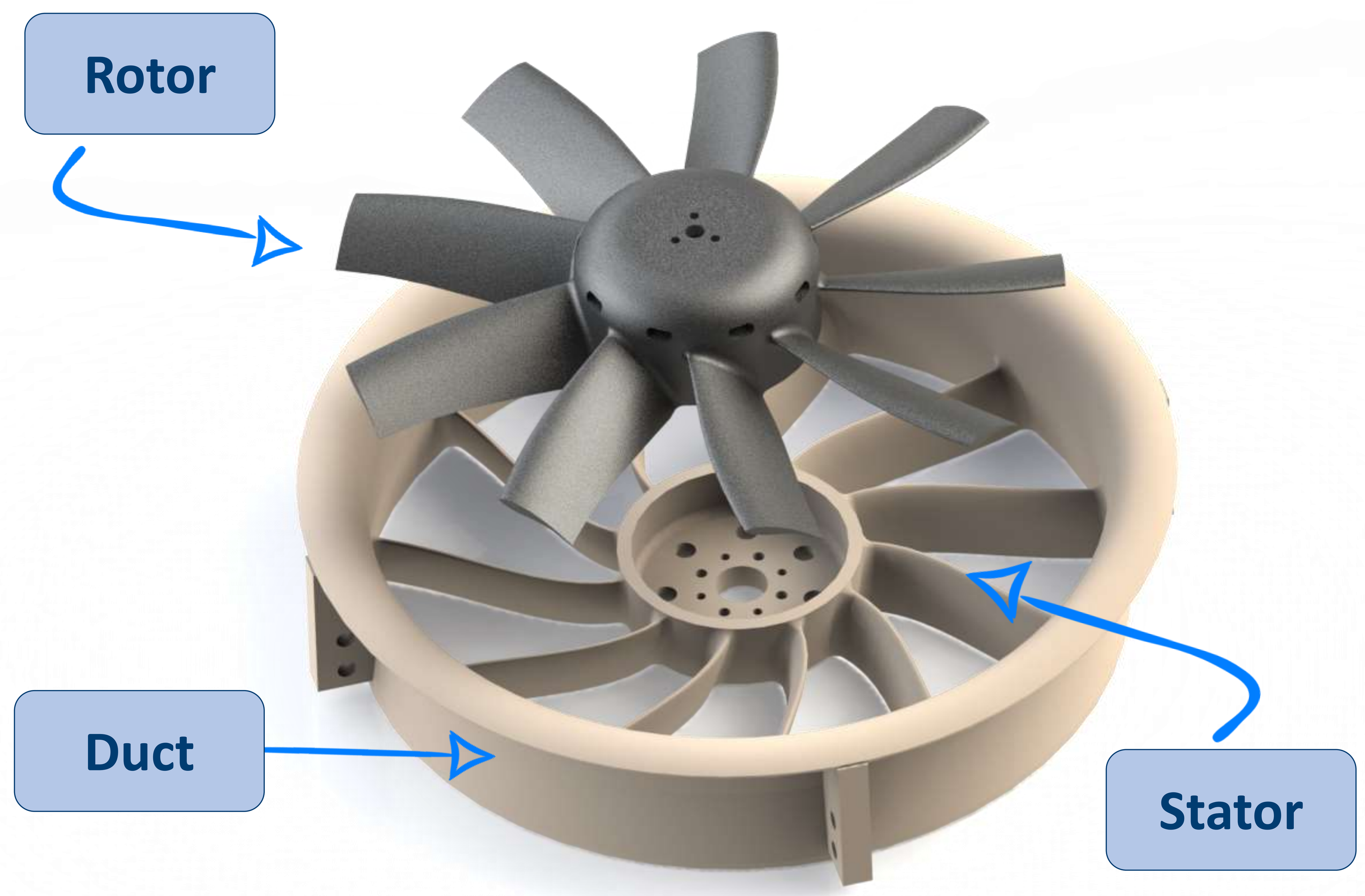


Example of Segment Analysis on the Rotor

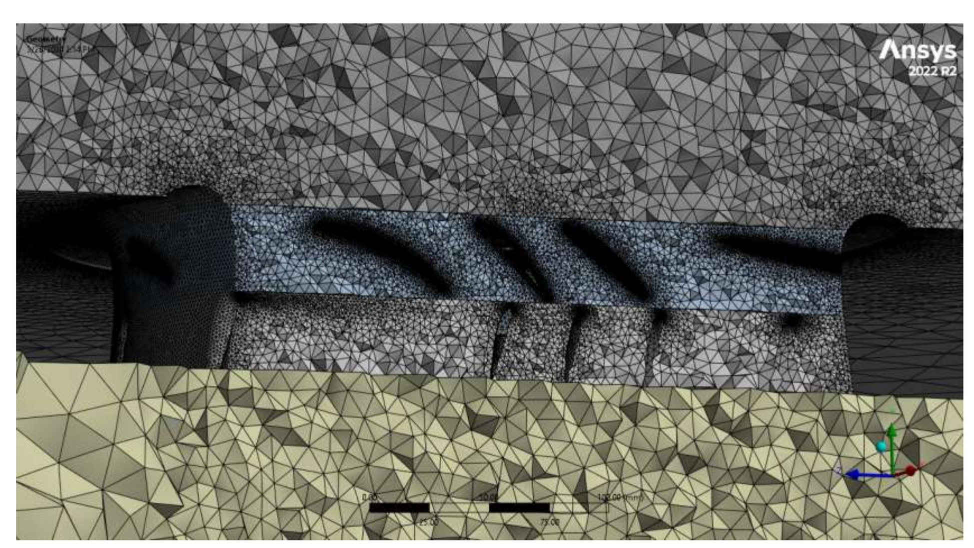
- Final selection comprised of 18 candidates
- Simulated & analyzed wake regions in Ansys Fluent
- Compared the lift to drag ratios and lift force
- Implemented segment analysis to identify the optimal angle of attack at each section of the blade

Top 5 Airfoil Candidates	
1	SG6043
2	DAE31
3	DAE21
4	GOE233
5	CHEN

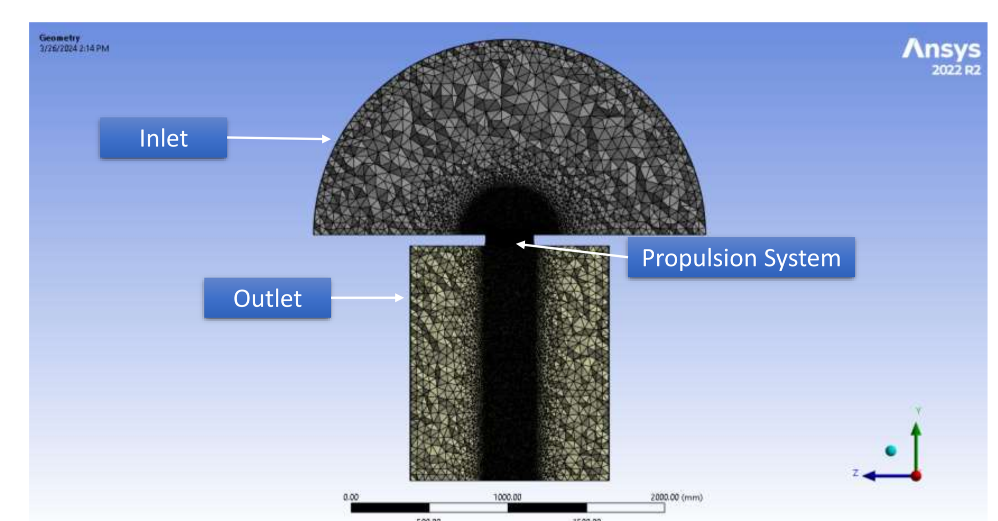
3D Model of the Propulsion System



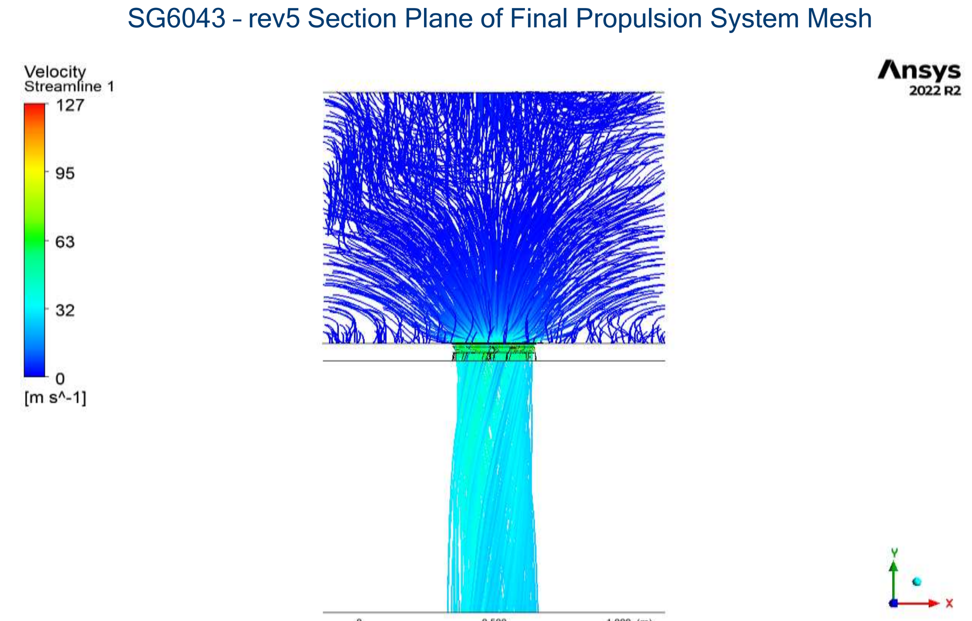
3D Simulations



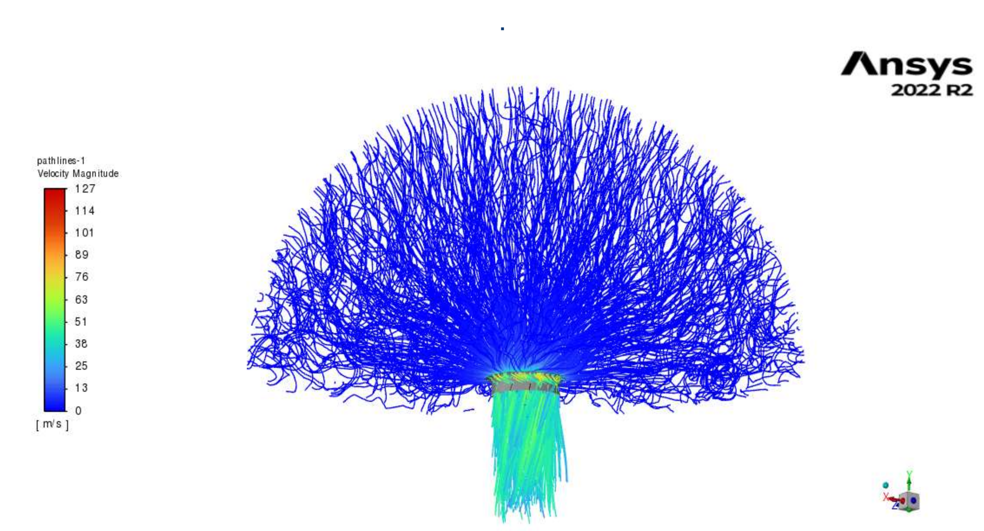
SG6043 - rev5 Section Plane of Final Propulsion System Mesh



SG6043 - rev5 Section Plane of Final Mesh



SG6043 - rev5 CFD-Post Streamline Without Boundary Layer



SG6043 - rev5 CFD-Post Streamline With Boundary Layer

- Applied structured meshing
- Prioritized boundary layer configuration
- Modelled the turbulence effects over the rotor blades

- Simulated at 7800 RPM
- Set convergence conditions to minimize processing time

Final Results

Simulation Results

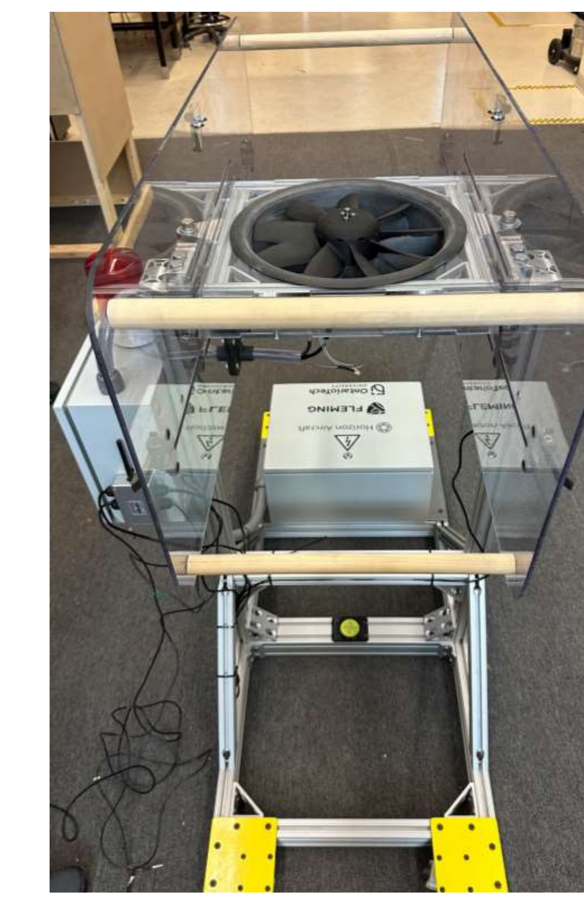
- Compared Rotor Lift, Overall Lift, and Rotor Torque
- Rotor Torque maintained near 3.8 lb.ft for accurate simulation

Testing Results

- Additive Manufactured with ABS Material
- Testing rig and system model scaled to 40% of actual design

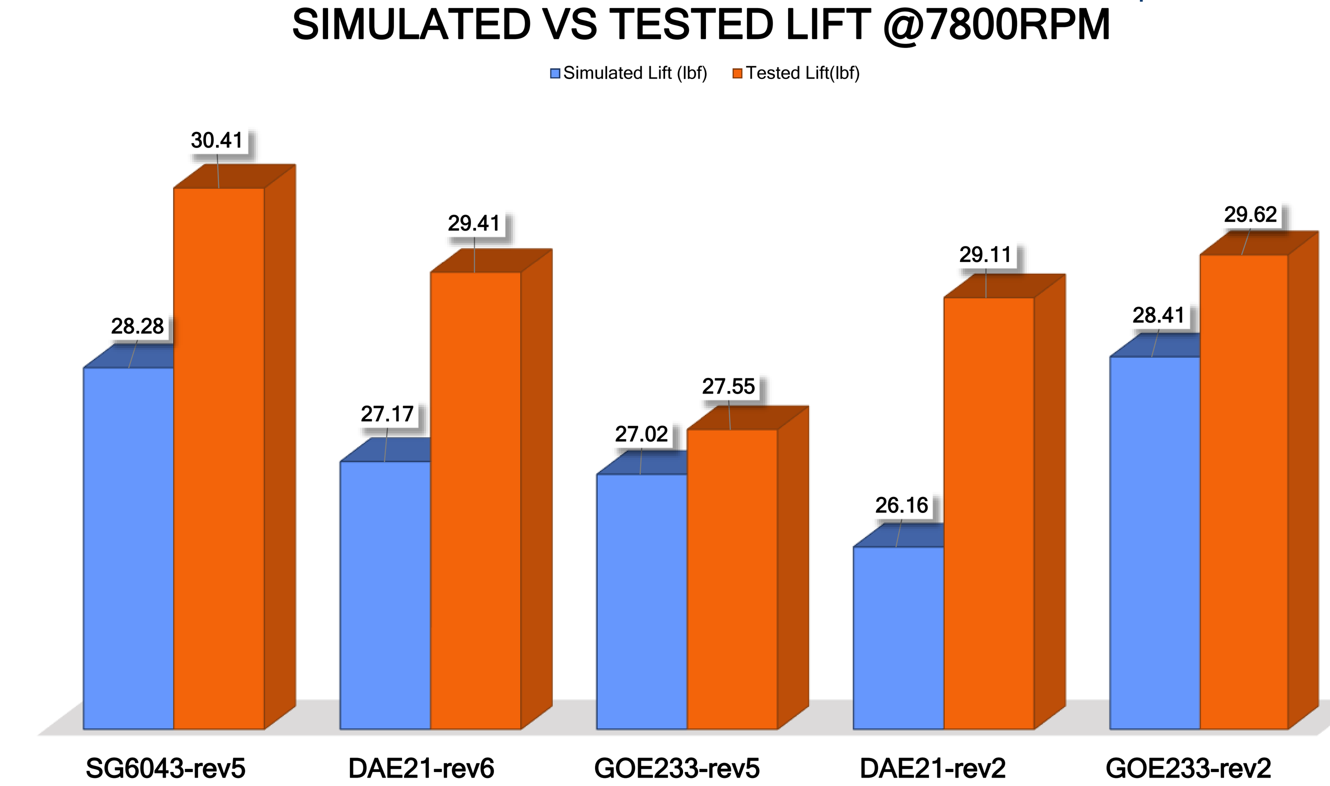
Testing Process

- Rotors were mounted onto the Test rig
- Tested at various RPM (4250, 6025, 7800)



Testing Rig Setup

SIMULATED VS TESTED LIFT @7800RPM



Main Findings

- SG6043-rev5 had the highest overall lift
- DAE21-rev6 had the highest average Figure of Merit (F.O.M)
- Further modifications in segment analysis could increase the lift further

Acknowledgements

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