AEROVEC

Syracuse University
College of Engineering
& Computer Science

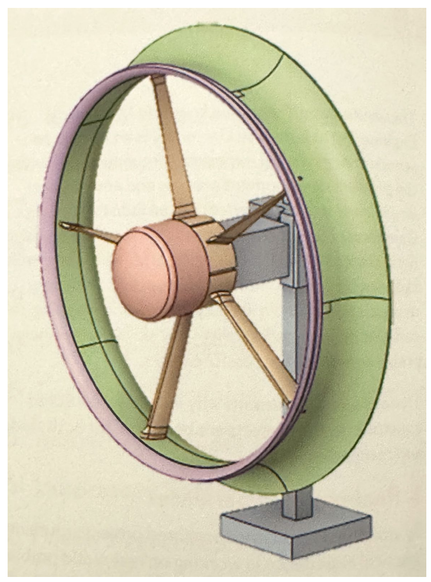
Aerovec Wind Turbine Optimization Project

Project Description:

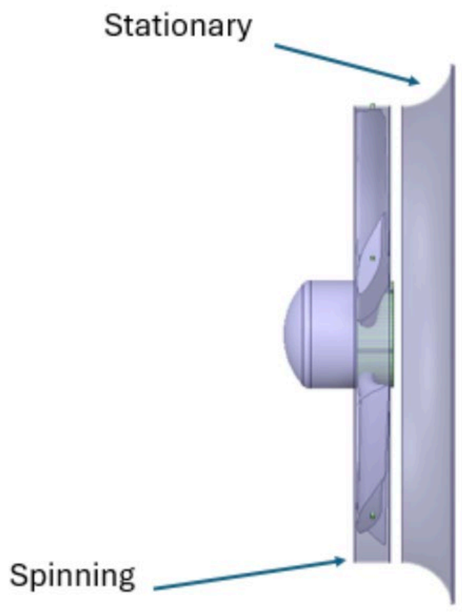
We have been tasked with improving and upgrading the Wind Turbine design from last year's Aerovec team. **Our main aim has been to design a split cowling with a moving shroud and stationary diffuser that maintains its alignment.** This stationary diffuser will help us achieve a higher efficiency and power output. Another goal for our team is to conduct CFD and FEA analysis on our designs to quantify the performance of our current and updated component designs. Additionally, we have started to perform Market Research on the Small to Medium sized Wind Turbine Industry to be on par with the designs and advancements made by our competitors. The Market Research will help us identify our target customers, helping us in modifying our design accordingly.

Background:

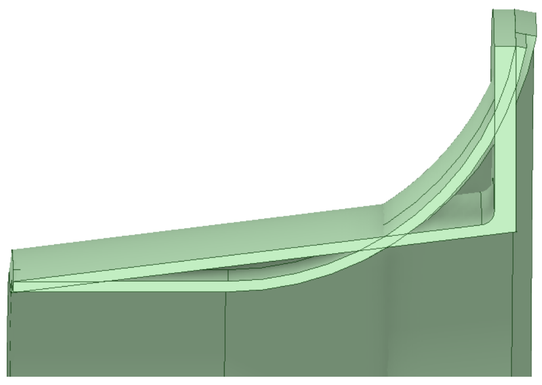
The 2023-24 Senior Cohort created a design featuring 5 blades attached to a shroud/cowling that rotated all together. (seen to the right) Through testing we confirmed that the diffuser design was not as effective as possible and needed to be improved.



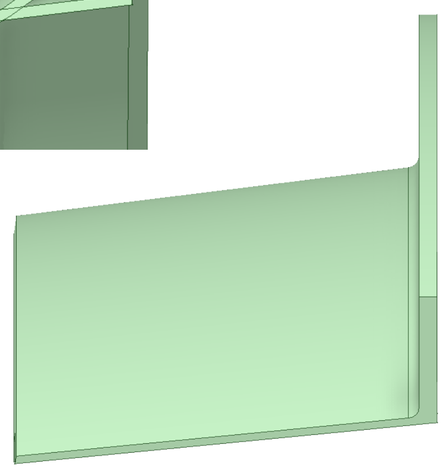
Early Design Concepts:



The first preliminary stationary diffuser design. This design used the same expansion angle and curve as last year's design but separated the cowling from the shroud.

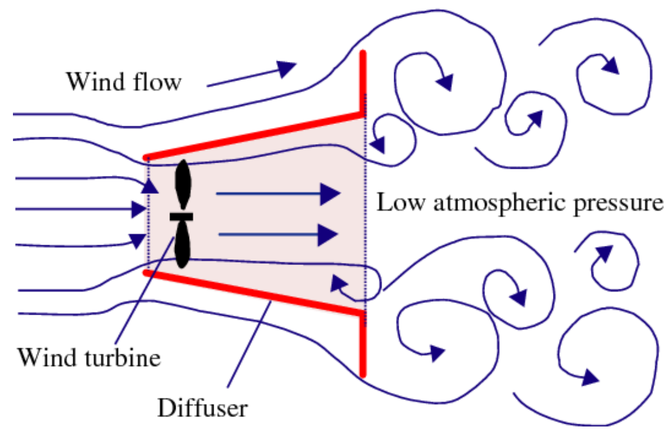


Cross Sectional View of Last Year's Curved Design vs New "Cone" Design with a brim/flange



Improved Diffuser Design: Created a "Cone" shape that expands with a brim/flange rather than a large curve. This design decreases the expansion angle and promotes better flow through the turbine.

Key Concept:



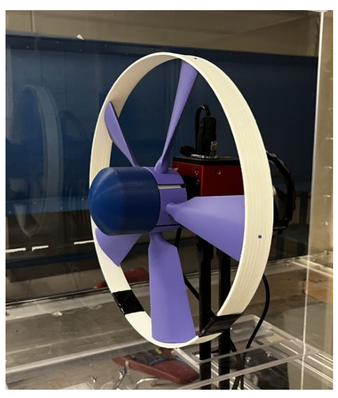
"Design and flow velocity simulation of diffuser augmented wind turbine using CFD" Research Paper

Diffuser Augmented Wind Turbine (DAWT)
Although testing has shown that the shroud performed better than last year's design, if done correctly, a diffuser is beneficial. A correctly designed diffuser leverages the Venturi Effect: a fluid's velocity increases as it passes through a constricted section, causing a drop in pressure. Lower pressure behind the rotor increases flow velocity and pulls more air through the turbine.

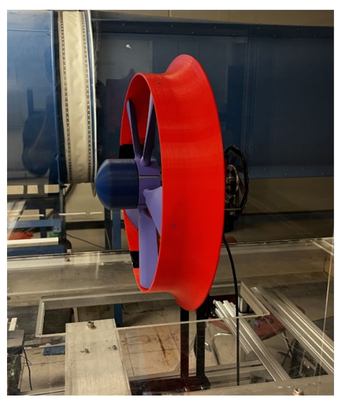
Wind Tunnel Testing:

Testing of small-scale prototypes will be completed in the wind tunnel to estimate power output in varying conditions

- Full Cowling
- Shroud
- Stationary Diffuser Iterations
- Final Design

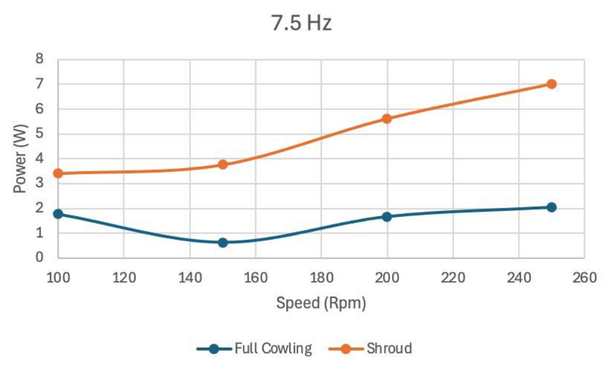


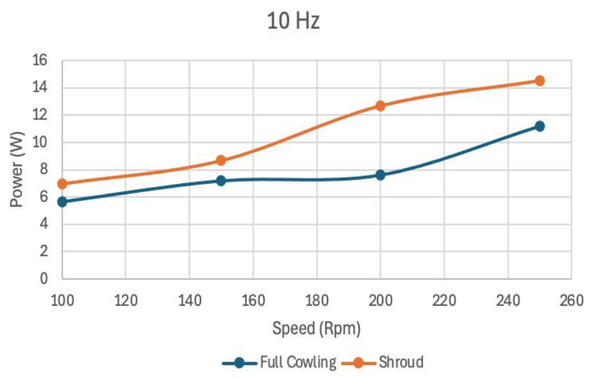
Shroud

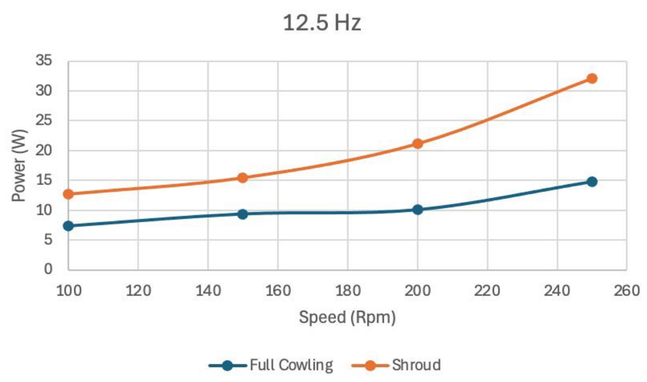


Full Cowling

Wind Tunnel Testing Results:





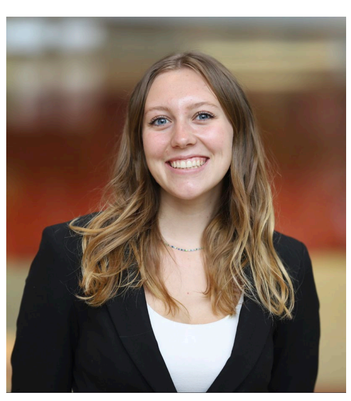


Due to the old diffuser's design, the shroud (no diffuser) performed better during all tests. The improved stationary diffuser is projected to perform even better than the shroud.

Semester Deliverables:

1. Design, 3-D print and assemble the new Diffuser
2. Test the new Wind Turbine Assembly at wind speeds of 7.5 Hz, 10 Hz, 12 Hz
3. Complete CFD (Computational Fluid Dynamics) analysis for the new Diffuser design
4. Complete FEA (Finite Element Analysis) for the new Wind Turbine Assembly
5. Continue Market Research and Competitor Analysis

Faculty Mentor:
Dr. Jackie Anderson



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