Will the addition of a *shield* increase the efficiency of a Vertical Axis Wind Turbine (VAWT)?

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Background

- A wind turbine is a complex machine used to convert mechanical energy into electricity through various concepts of mechanics.
- Figure 1 shows a Vertical Axis Wind Turbine, the type of turbine used for this project.

Figure 1: (below)
Example of a Vertical Axis Wind Turbine (VAWT).

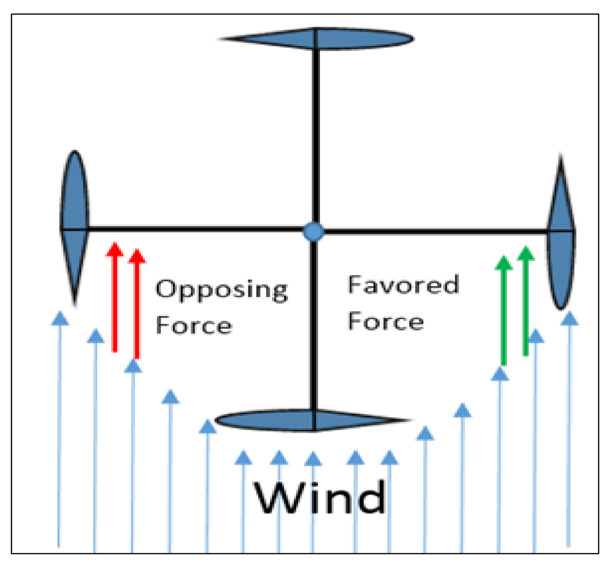

Figure 2: (above)
Forces that act on a Vertical Axis Wind Turbine (VAWT).

Physics

- A VAWT can be driven by lift or driven by drag: the air flowing around the blades will either pull or push the turbine to rotate.
- A major conflict in the function of a VAWT is that when the wind blows, one set of blades sees incoming air while the other set of blades sees opposing airflow to the overall rotation, causing counteracting forces and inefficiency in the performance of the turbine (Figure 2).
- With the shield in place, there will not be an opposing force since the set of blades that produce the opposing force will be blocked; theoretically making the function of the turbine more efficient.

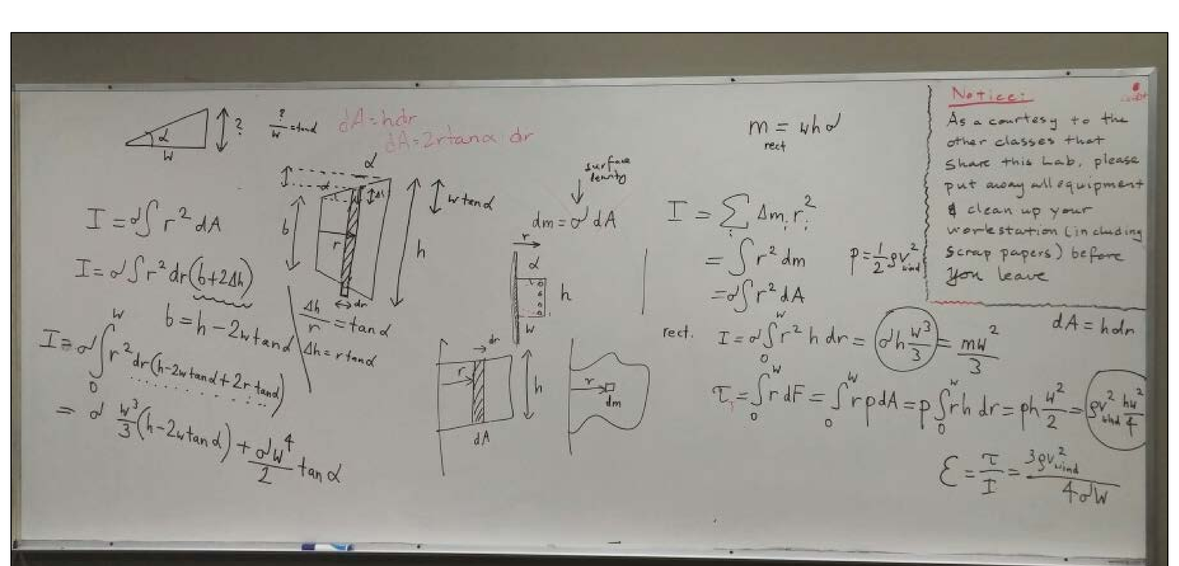

Figure 3: Example of a few theoretical calculations using Mechanics. Because of complexity, we resort to experimentation.

Methodology

- The work was carried out in four phases:
  1. Explore theoretical models
  2. CAD designs of individual parts and assemblies
  3. Fabrication of prototype (turbine and shield)
  4. Experimental testing of turbine and shield.
- The theoretical models were constructed using calculations of Mechanics and Fluid Dynamics to understand the flow about the turbine and it's rotational movement (Figure 3).
- Designs were developed using CAD software: SolidWorks™ and Autodesk Inventor® (Figure 4).
- The fabrication of the turbine and shield were divided into phases:
  1. Surrounding stand
  2. Aluminum blades
  3. Post & Bearing Mounts
  4. Motor/generator (work in progress)
  5. Shield

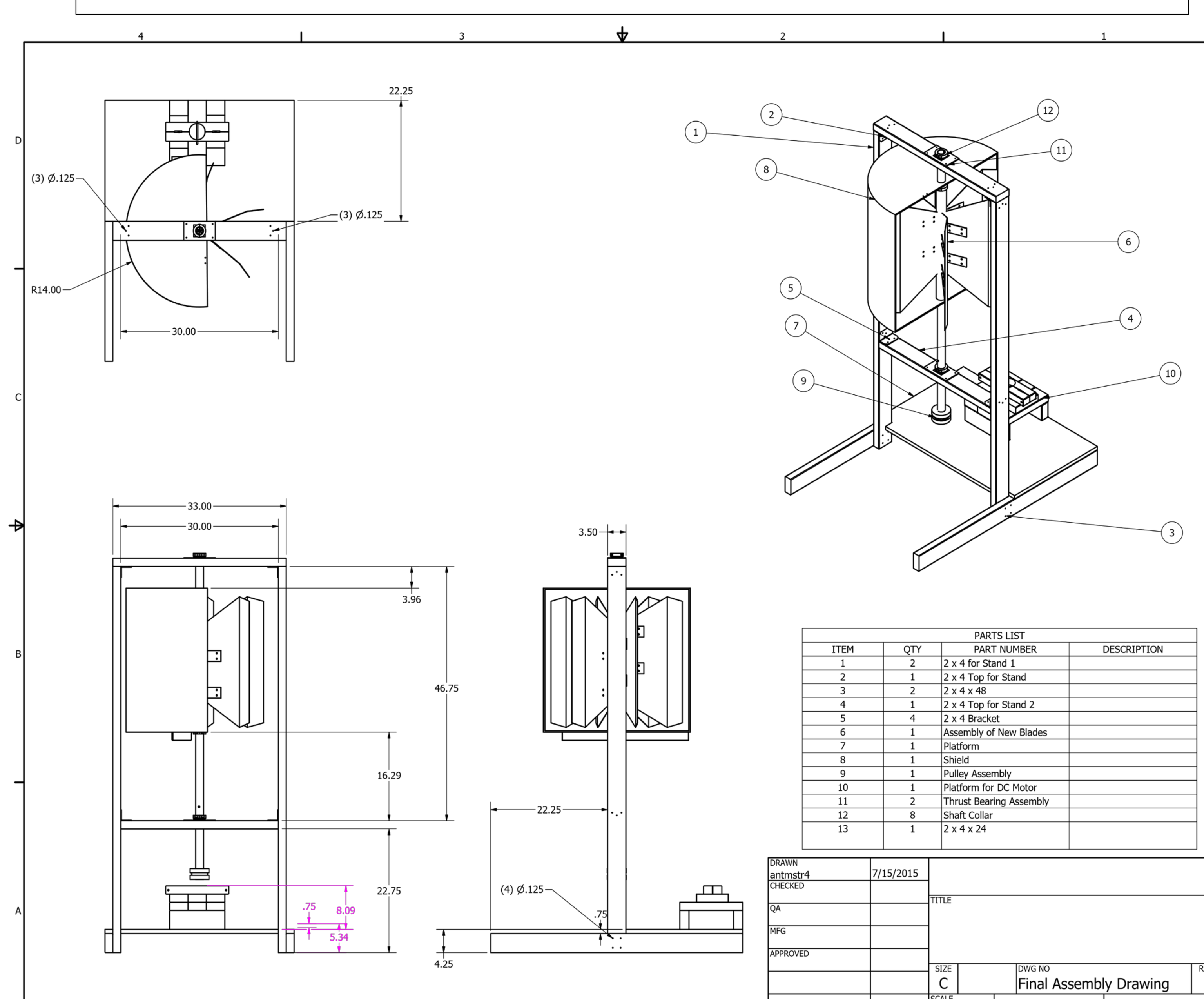

Figure 4:
Mechanical Drawing of the Final Assembly of the Turbine and Shield; all dimensions are in inches.

Results

- Testing was done with and without the shield at various wind speeds.
- The *wind* was generated by the exhaust of the wind tunnel located in the Mechanical Engineering Lab. Power of the wind tunnel was varied to obtain wind speeds of 10-30 mph.
- Due to resistance of the brushed DC motor used, the turbine was tested solely for RPM; the turbine could not overcome static friction or rotate at sufficiently high RPM.
- The chart summarizes the data collected showing revolutions per minute (RPM) that the turbine achieved, at various wind speeds, with and without the shield.

			RPM's	
Power	Wind Speed (MPH)	Trials	Without Shield	With Shield
20%	13.1	1	0	62
		2	0	62
		3	0	60
22%	15.3	1	31	72
		2	28	74
		3	30	73
28%	19.5	1	47	100
		2	43	101
		3	44	98
35%	28.7	1	61	132
		2	64	133
		3	65	135

Future Work

- A permanent magnet alternator will be built to provide a more suitable application for the prototype and to achieve a wider range of voltages and current.
- Various types of blades will be used and tested to observe which type of blade performs better in terms of efficiency (voltage and current from alternator).
- Instrumentation will be integrated to collect data which can then be used for analysis and comparison to other setups.

Acknowledgements

Mr. John H. Kelley - Mechanical Engineering
Mr. Mark Morton - Electrical Engineering