Analysis

Section III: Results

10 trials of data were collected for each different type of wing/blade, being the penguin wing, bat wing, pterodactyl wing, and control. This was replicated for a total of 3 different wind speeds, yielding 120 sound power measurements (dB) and 120 average kinetic energy measurements (joules).

Proof of Concept Test #1

Testing an older prototype with the penguin wing didn't execute as expected. Based on the results, a new model was implemented to acquire data.

Proof of Concept Test #2

The second proof of concept test used the standard wind turbine blade which served as the control with the current design. Qualitative data proved the apparatus worked, effectively spinning the hub.

Wind Tunnel Test 1

The first wind tunnel test wasn't functional, resulting in no data being recorded.

Main Test for Angular Velocity

The average angular velocity of the penguin and control groups was recorded for each of the three different fan speeds, as shown in Figure 1. The control capped off its speed at around the second fan setting for wind speed. There was only a fragment increase from the angular acceleration of the control for the second wind speed to the third. The penguin wing didn't hit its terminal angular velocity at wind speed 2 and overall was steadier under wind speeds 2 and 3. While spinning, the control would occasionally lose control for a couple of seconds,

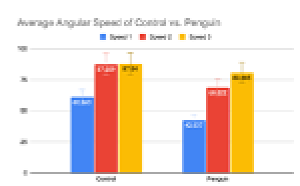

Figure 1: Average Angular Velocity (W) of the Standard Wind Turbine Blade and Penguin Wing over 3 Wind Speeds. *The Control had an average angular velocity of 60.8 rad/s for wind speed 1 or 87.6 rad/s for wind speed 2, and 87.8 rad/s for wind speed 3. The penguin wing design had an average angular velocity of 42. 5 rad/s for wind speed 1, 68.8 rad/s for windspeed 2, and 80.9 rad/s for wind speed 3. Overall, the control was faster, however, reached its optimal wind speed at wind speed 2, only seeing a minor improvement for wind speed 3. The penguin wing design was on average slower, however more consistent, and had a greater amount of improvement for each wind speed compared to the control.*

slowing it down. After testing the control with wind speed two, part of the inside hole was melted, resulting in a decrease in speed after gathering data for wind speed 2. No T-Test has been conducted, yet, as it will be conducted for the power calculation.

Final Test for Power (Per Second)

Speed 1

For the first wind speed, the penguin wing generated the most power by a considerable amount. It had a greater acceleration, and a greater mass (increasing its moment of inertia), contributing to its higher power levels. The bat was the overall fastest, enabling it to generate the second most amount of power, followed by the control and pterodactyl. The results were influenced by their acceleration to terminal velocity within the first 20 seconds of operation.

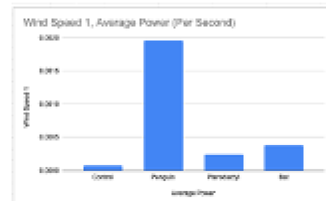

Figure 2: Average Power (Joules) of each blade for wind speed 1. The penguin had the greatest overall power production, followed by the bat, pterodactyl, then control. The penguin's high energy output is a result of its greater mass.

Speed 2

For the second wind speed, the penguin once again generated the most power, with the bat and pterodactyl producing relatively similar power levels in comparison. However, the control was by far the fastest, allowing it to come in a much closer second in overall power generation to the penguin wing. The acceleration for the control increased significantly, combined with the greater overall angular velocity enabled its higher power generation.

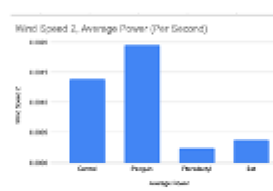

Figure 3: Average Power (Joules) of each blade for wind speed 2. The penguin had the greatest power output, followed by the control, both of which produced over twice the bat, followed by the pterodactyl.

Speed 3

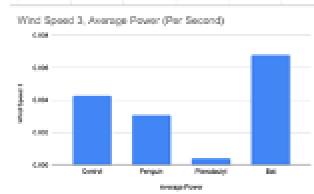

Figure 4: Average Power (Joules) of each blade for wind speed 3. The bat had the greatest power, followed by the control, Penguin and pterodactyl.

For the third wind speed, the bat was shown to have generated the most amount of power. While the control maintained the higher angular velocity, the bat accelerated to terminal velocity rapidly, enabling for its higher amount of power generation. The control surpassed the penguin wing in power generation, and for all wings except the bat, the angular acceleration decreased.

Main Test for Sound

The sound measurements collected were insignificant as a result of the noise from the fan and mechanical components of the wind turbine.