Science Fair Log Book
By Rajveer and Khushi Gr.6A

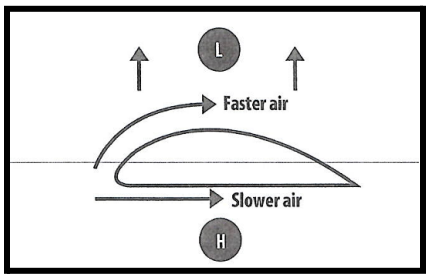
Dates	Things to do:
Thursday, Dec. 7, 2023	Choose a topic and write a project question
Friday, Dec 8, 2023	Get approval from our teacher
Sunday, Dec 10 to Tuesday, Dec12, 2023	Research our topic and write out background research
Wed. Dec13th, 2023	Write a hypothesis
Monday, Dec 18 to Monday, Dec 25, 2023	Design an experiment; list variables and write the procedure
Sunday, Jan 7, 2024	List and gather your materials
Saturday, Jan. 13 to Sunday, Jan 14, 2024	Conduct experiments and record data and observations
Saturday, Jan. 13 to Monday, Jan 15, 2024	Create a table, chart, or graph of the data
Saturday, Jan 20, 2024	Conclusion and results
Monday, Jan 22, 2024	Complete the slides (online project)
Wednesday, Jan 24, 2024	Write the Abstract
Thursday, Jan 25, 2204	Finish the log book
Monday, Jan 29, 2024	Submit the completed project to the teacher

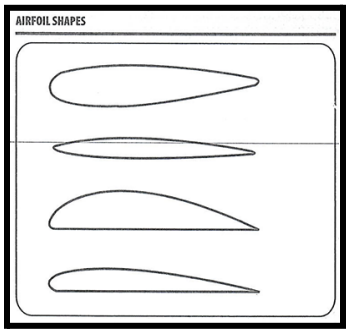
Choose a topic: Does the shape of the blades affect the wind turbine's performance?

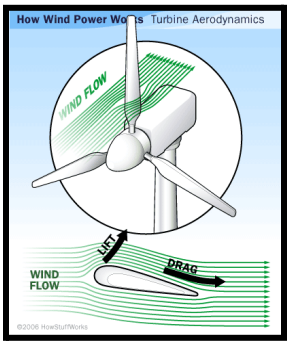
This topic interests us because we recently finished our aerodynamics unit and we found that planes have curved wings similar to wind turbine blades. Curved wings with the Bernoulli principle help planes fly and we wonder if the Bernoulli principle also works on wind turbine blades and how wind turbines rotate to make electricity.
In our experiment, we will use weight to see how different shapes of blades lift the weight faster. We want to find out which type of blade shape will be most effective in pulling up weight.

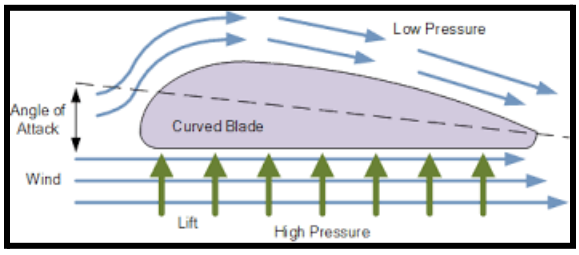
Background Research:

Wind power is one of the best and most sustainable forms of renewable energy and we use wind turbines to harvest the energy from the wind to power our homes. Wind turbines are machines that convert the wind's mechanical energy into electrical energy. Wind turbines rely on two main principles. Newton's third law states that "for every action, there is an equal and opposite reaction". This is true for the wind turbine's blade. The action is the wind which projects air towards the blade and the reaction is the blade being pushed causing the wind turbine to spin. The wind is not the only force acting on the wind turbine there are many forces including drag (the force that is opposite to the way the blades are spinning), life (with the direction of motion of the blades), and gravity (the force that pusses things down). Bernoulli's principle and Newton's third law. Bernoulli's principle states that "faster-moving air has lower pressure". This is true for the wind turbine blade because the blade is an "*airfoil shape.*" Wind turbines usually have a curved airfoil-shaped blade. This causes the wind to move faster over the curved side increasing the overall speed of the wind turbine. Wind turbines work on a principle, instead of using electricity like a house fan, wind turbines use the wind moving through it to make electricity. The motor will turn the blades that also spin a strong generator, producing electrical energy. This is called renewable energy, renewable energy is energy that does not run out. The first ever electricity-generating wind turbine was made in 1887 by a Scottish professor James Blyth in Glasgow, Scotland. We researched different types of blades of the wind turbine and that's how our project will work with the help and power of the fan, winds will travel through the turbine resulting in it spinning like you would see in the countryside.









Testable question: **Does the shape of the blades affect the wind turbine's performance?**

Key words: Displayed in the table below

Key Word	Definition
Surface Area	The outside part or uppermost layer of something
Turbine	A device that harnesses the kinetic energy of a fluid
Kinetic Energy	A form of energy that an object or particle has because of its motion
Rotary motion	The act of rotating as if on an axis
Electrical energy	The energy derived from potential energy or kinetic energy of the charged particles.

Hypothesis: We believe that the rectangular blades will pull the weights the fastest because of more surface area to capture the wind.

Materials: Displayed in the table below

Materials		Ruler
Drill	Washers X10	Tape
Straws X5	Marbles (25-40)	Glue
Paper Clips	Papers	Mini Fan
Scissors	500 Milliliter bottle	1 Liter Bottle

Procedure:

1. Gather the materials.
2. Cut the top of the 1-liter bottle and create flaps on either side of the bottle. Fill the bottom of the bottle with marbles.
3. With the help of an adult we drilled a hole on each side of the 500-ml bottle and inserted a straw through it.
4. Attach the 500-ml bottle between the flaps of the 1-liter bottle as shown.
5. Then we cut the paper into 3 different shapes. We made a rectangle, square, and triangle. We then folded each paper in half and taped the two longer edges forming a teardrop shape and curved them in the opposite direction.
6. We glued each paper on the ends of a straw just enough for a blade to be secured. Glue a blade on either side of the straw.
7. Repeat step six with the other blades.
8. Grab some paper clips and straighten them out. Twist the paperclip in the middle to form a “T” shape.
9. Put the “T” shaped paperclip in between the blades. Creating something

that looks like a handle. Add a straw to the bottom of the paperclip.
10. Take another paperclip and hang it from a string. Then attach the string to the end of the straw and put one flat washer for weight.
11. Put it all together and you have got yourself a wind turbine.

Variables:

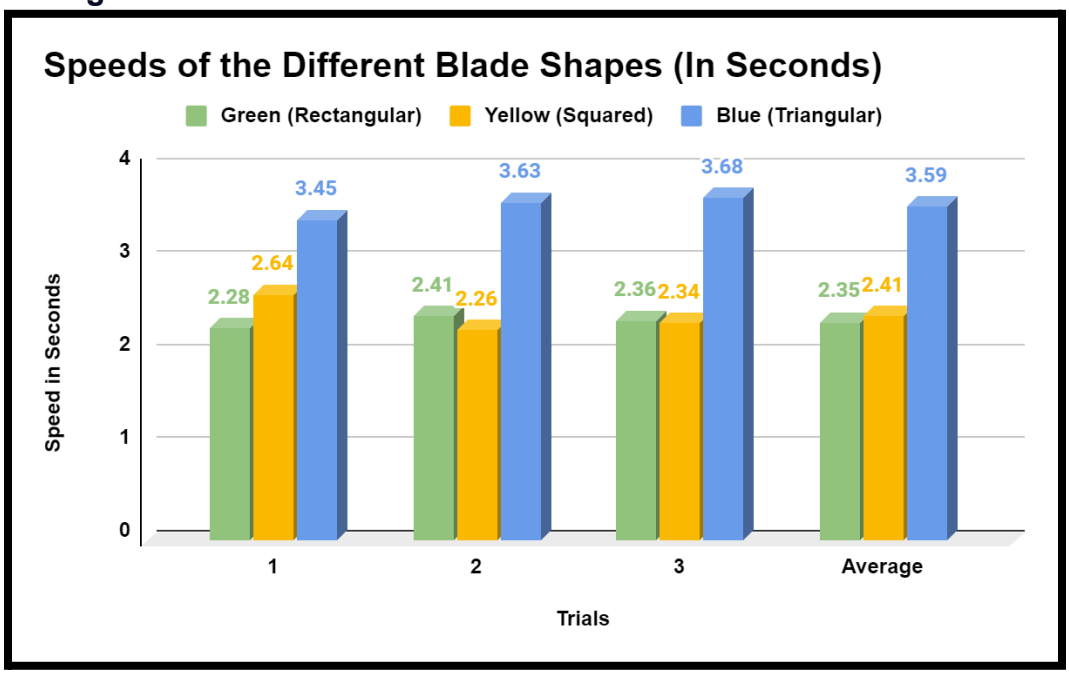
Variable	
Dependent	The time the different blade types take to spin around.
Controlled	- The amount of weight - The speed of the fan - The distance of the fan from the bottle - 2 blades for each shape
Independent	The shape of the blades
Uncontrolled	Fan's Power We had no way of measuring the speed of the wind coming from the fan so the power of the fan might not have been constant which wouldn't give us accurate results.

Data: Shows our final results from the projects

Blade Shape	Trials (seconds and milliseconds)			
	1	2	3	Average
Green (Rectangular)	2.28	2.41	2.36	2.35
Yellow (Square)	2.64	2.26	2.34	2.41
Blue (Triangular)	3.45	3.63	3.68	3.59

Observations: From this table you can see that the rectangular blades (green) did the best with an average of 2.35 seconds. In second place was the squared blade (yellow) with an average of 2.41 seconds. The blade with the longest time was the triangular blade (blue) with an average of 3.59 seconds.

Results: The question was ‘’Does the shape of the blades affect the wind turbine's performance?” we made a whole wind turbine and tested it out. We found that the Green Rectangular blades rotated fast by pulling the weight up to the top in a record-setting time of 2.35 seconds as it smoothly ran with the fast wind coming from the fan.



Conclusions: We hypothesized that the Rectangular blade (Green) would spin the fastest. After experimenting we found that our hypothesis was correct because the Rectangular blades (Green) took the least time to rotate and took an average of 2.35 seconds.

Abstract: The question of this project is “Does the shape of the blades affect the wind turbine's performance?", using three different curved blades on a homemade structure of a wind turbine. The reason for this experiment was that we learned about the types of wings that an airplane has, so we thought about a wind turbine as it also works with curved and long blades. We wondered if the shape of the blades would affect the performance of the wind turbine. We experimented by setting up a mini fan at the highest setting and setting up the wind turbine 30 cm away from the fan. We kept the speed and distance constant in all the trials. Then we use the stopwatch to record the time of each of the blades to get the weight (flat washer) to touch the top of the straw. We did three trials with each shape and found that the Rectangular blades (Green blades) took the least time with an average time of 2.35 seconds. The Yellow (Square blades) recorded an average of 2.41 seconds and the Blue (Triangular blades) with a recording of average 3.59 seconds. So we concluded that the Rectangular blades with the largest surface area that could hold enough air make the blades spin faster. We also found that the square blades were very close to the rectangular

blades with a difference of only 0.06 seconds. The triangular blades were spinning slowly because of the shape and capturing less air and took 1.24 more seconds to rotate as compared to the green blades. We also concluded that the shape of the blades does affect the performance of the wind turbine.

Who will this be useful for?

Wind turbines are found in rural communities and areas so the best example of "who would use this information", is farmers, as they usually live in large fields away from the urban cities and towns. Since farmers live in rural communities they would need electricity from somewhere. So one of the most popular ways is wind turbines to generate electricity. The wind turbine principle is very simple."Instead of using electricity like a house fan, wind turbines use the wind moving through it to make electricity. They generate electricity by using 2 or 3 blades connecting to the rotor and forming a propeller. The rotor is also connected to the main shaft. The main shaft is a device that transfers the revolution from the rotor into the gearbox with a typical rotation of 20 rpm (revolution per minute). The main shaft creates electricity by spinning a generator.

Sources of error and how will we prevent this in the future?

1. **The blades got stuck on the tap of the 500-ml bottle**
    - **We made sure that the hole in the bottle was smooth and big enough for a straw to spin freely.**
2. **The size of the fan, first we experimented with the smaller fan but it did not work due to less speed to pull the flat washer up.**
    - **We used a bigger fan with adjustable speed for our experiment.**
3. **The straws**
    - **The plastic straws we used before were too lightweight and were not working so we switched to paper straws to give strength to our fan.**

Application: After doing this experiment, we started to wonder if we were to change anything else on the wind turbine to make spin faster. We noticed that wind turbines only have three blades. We want to know if wind turbines will spin faster or slower if they have more blades.

Future Question: Does The Number of Blades a Wind Turbine Has Affect its Speed?

References:

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- chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.nmmesa.org/wp-content/uploads/2019/10/Aerodynamics-of-Wind-Turbine-Blades.pdf

Final Project Video: https://www.youtube.com/watch?v=DOCSJv9nR3k