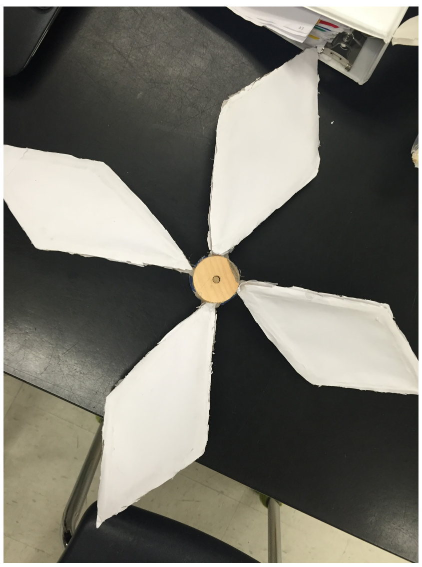
Power in the Wind - Wind Turbines

Team: Masters of Physics

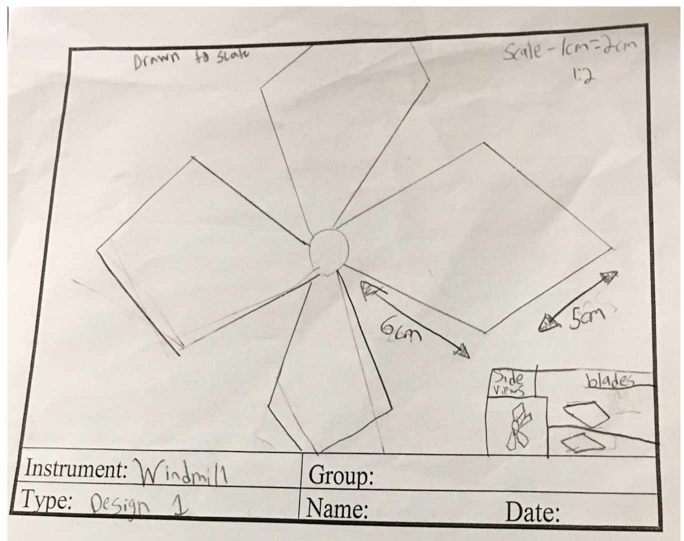
Design One: Wooden Frame & Paper

Design Goals (1)

Our goal for this design was to create a fast and efficient turbine that would produce lots of power. It was required that this turbine be made out of the recyclable items provided for us, without any dangerous items like metal or glass.



First Design



First Design Scale Drawing

Blades

For our first design we hot glued 5” and 6” wooden sticks together to create a diamond frame for each of the four blades we used. The long parts of the diamond were 12 cm when attached. While the short ends were 10 cm when attached. We then glued the frame to two pieces of paper, cut out the diamond shape and glued each blade to the hub tilted at about a 35° angle, we decided to use this angle because we looked at some different angles and decided that 35 would be perfect to catch the wind. These blades were efficient and did generate power. The highest power they generated was 0.0033 watts.

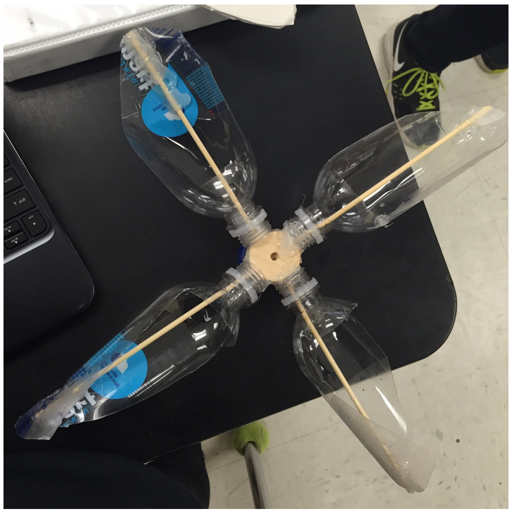
Aesthetic Appeal

The first model of our turbine had diamond shaped turbine blades made from a wood frame with paper on either side covering the gap in the frame. We made the turbine blades diamonds because one example we saw had four blades all the shape of a diamond. So we decided to do that.

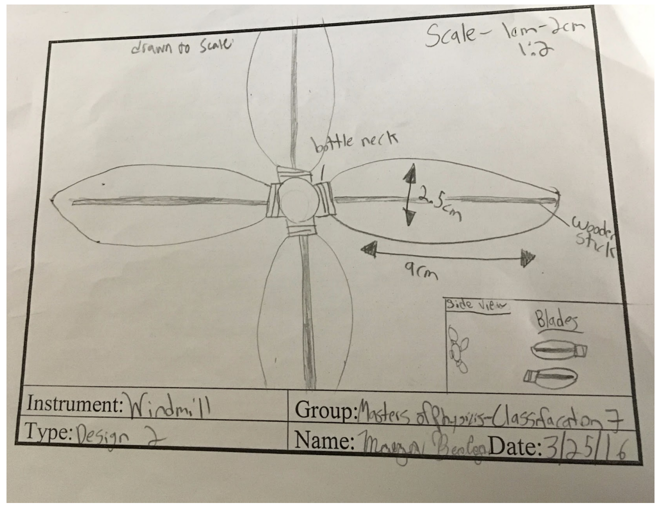
Design Two: Smart Water Bottles

Design Goals (2)

Our goal for this design was to create a fast and efficient turbine that would produce lots of power by catching the wind in its blades. For this design, we used four plastic smart water bottles. Our original plan was to cut the bottles in half but leave the bottoms and necks of the bottles attached. We used more wooden sticks, hot gluing one end into the holes of the hub, and putting the other end through the neck of the bottle and gluing it down to attach them.



Second Design



Second Design Scale Drawing

Blades

Our second design consisted of four blades made from smart water bottles. We glued the neck of the bottle to the center piece with a long wooden stick running through the bottle. We cut of one side of the bottle but left the bottom on. We tested this design but it wasn't sufficient because it wasn't generating power so we made a slight modification. The modification that we made was to cut off the bottom of the bottles. We did this because we thought it would allow the wind to go right through the bottles, while it pushed them at the same time. The length of the blade was 18 cm and the width was 5 cm. These blades were not efficient and did not generate power. This design had a 0% efficiency rating and produced 0 milliamps and 0.23 volts on average.

Aesthetic Appeal

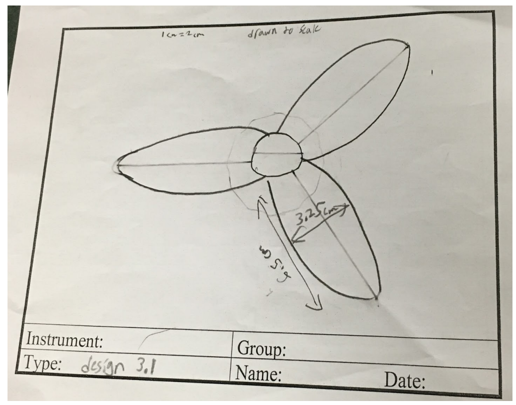
Our second model of our turbine has blades made from plastic bottles cut to a shape where they can catch wind. We made this design out of bottles because we thought the bottle would catch the wind allowing the turbine to spin.

Design Three: Foam Board Ovals

Design Goals (3)

Our goal for our third design was to make this turbine faster and more efficient than the previous two. We also wanted a third design to perform well after the second one failed to do so. This design was made of foam board for its light and airy material. We used three 13cm x 6.5cm ovals of this material. To attach the blades to the center piece, we glued wooden sticks into the holes in the center piece and glued the sticks to the blades. We then tilted the blades at 35° angles.


Third Design



Third Design Scale Drawing

Blades

Our third design was our most efficient design and generated the most power. It was made of three sunflower shaped blades. They are 18 cm long and 8cm wide and are tilted at 35-degree angles. These blades were made of a foam board material. This blade was fast but our group decided to make another because we wanted it to go to its full potential speed. We decided to make the same blade, only a smaller version of it to decrease weight and increase efficiency. We decided to make this design smaller because we wanted to test out a theory developed by the second design, we thought that less weight would make it so the force required to spin the turbine would be less due to the equation of Newton's Second Law of Motion, force/mass = acceleration. The dimensions are 13 cm, and a width of 6.5 cm. This smaller fan was way more efficient than the larger fan. Our third design was our most efficient design with an efficiency rating of 0.04% and producing 0.0006 amps along with 1.24 volts, which means it produced 0.0008 watts.

Aesthetic Appeal

Our third model is white, has 3 blades, and looks similar to design one, using wood for support and a white base. We chose to make the blade ovals because turbines in the real world have blades like this. We decided to make a smaller, lighter model of design three. It was colored to add some sense of creativity. We decided to make this turbine smaller because the larger model was too heavy so we decreased the size hoping to decrease the weight as well (modified).

Effect of the Varying of some Variables

By varying variables such as shape of blades, size of blades, total weight, and angle of blades on all our designs, we produced our most efficient design: design three. Between the first and second design, we knew that we needed something light that would not warp and that we needed to make sure we had a good angle on the blades. When we modified the second design to try to make it produce power, we learned that decreasing the weight would increase the power. While it was not enough increase to cause it to produce a milliamp, it was still increasing voltage significantly from the change. In design three we learned that the curvature and angle of the blades was good but we wanted to test out a theory developed by the second design, we made a smaller, lighter version of design three that was a replica but decreased to about half the size of the original and it was twice as good at producing power, so by testing and learning from our other designs, we created the most efficient design, a smaller design three that was much more powerful in both volts (2.01 V average) and milliamps.

Efficiency of the Best Design

The best design was decent in terms of efficiency and power output. While it was not successful in having more than 1% efficiency, compared to other blade designs that were created, it was the most effective and efficient. The efficiency rating of this design was 0.0369652% and it would take less than 200,000 (about 194,056) of these models to power a single house for a day which is a strong showing compared to some designs built by other groups that take millions of models to power a house.

Energy Transfers

The winds thermal energy starts to turn the blades of our turbine, which then produces mechanical energy, this energy starts to turn the high axle, which produces more mechanical energy, then the energy is transferred to a gearbox, which also produces mechanical energy. After the gearbox, the energy is transferred to a low axle, which also produces energy, and finally the energy is transferred to a generator, which then produces electrical energy.

Conclusion

In conclusion, design three was our most efficient model with 0.04% efficiency which we worked hard to produce out of our failed design two and our working first design, it had 2.01 Volts and 3.41 milliamps and producing 0.007 watts, this was one of the highest power and efficiency among our colleagues so by working off of our previous designs we created a strong, producing wind turbine. We chose to make our final design have 3 blades and have them be ovals because this is common in the real world. We also colored it with team colors to add some detail.

Source

Mogielnicki, J., D. Harmon, J. Kramer, D. Lyons, D. Lentine, D. Taylor, and MC Baker. *Power in the Wind*. *Create It Lab*. N.p., n.d. Web. Mar.-Apr. 2016. <http://createitlab.org/static/pdf/PinWind_V29Sb_L.pdf>.