The Improved 6-blade Turbine

Team DEKA

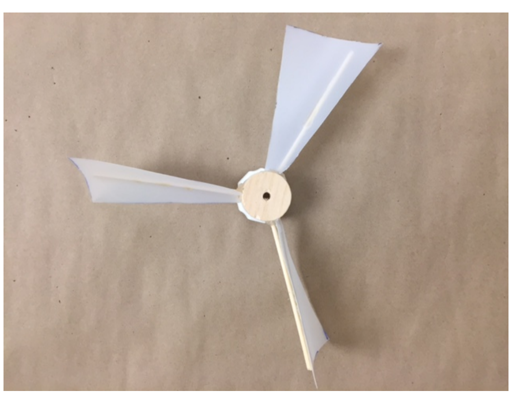
Goal

The goal of this project was to design and build a wind turbine that is efficient and can create power. The requirements for this project were to use recyclable materials only.

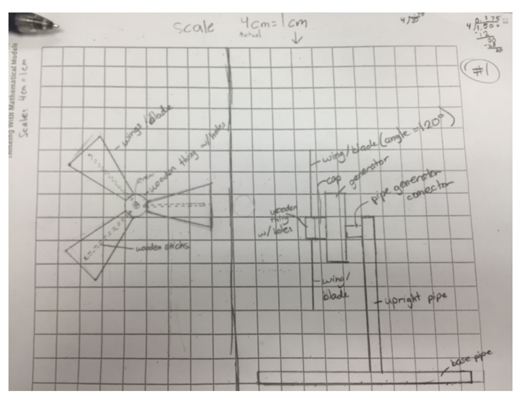
Explore

To begin the project, several engineers came to talk to each group about this project and how we should get started. The first process we had to go through was designing what the turbine would look like. We were supposed to think up multiple designs of turbines and brainstorm to get ideas flowing. Then, we looked through a box of other designs made by previous schools. We found one design that used four blades and all the blades were slightly curved and were made out of white Styrofoam. We brainstormed off of that design to come up with the first design we thought of (refer to design #1). We had to change the design slightly so we wouldn't be copying the other group's design. Instead of using four blades, we used three, and instead of using white Styrofoam, we created the turbine blades out of plastic milk carton material. The angle we put the wings on was at 20°, although we initially accidently put them at a 120° angle. We put them at 20° because the angle needed to be in between 0° and 45° in order to catch wind to spin. We decided that 20° was around the middle and we didn't want the angle to be too big so we settled on a 20° angle.

Design number 1 consists of three blades made out of milk carton plastic. Each blade is at 120°. This required a bottle cap to secure the turbine to the generator and the bottle cap was glued to a wooden piece, or hub, to hold the turbine blades together. Wooden sticks were glued to the hub and the blades were then glued to the wooden sticks. When this was tested, it didn't move or produce any sort of energy/power.

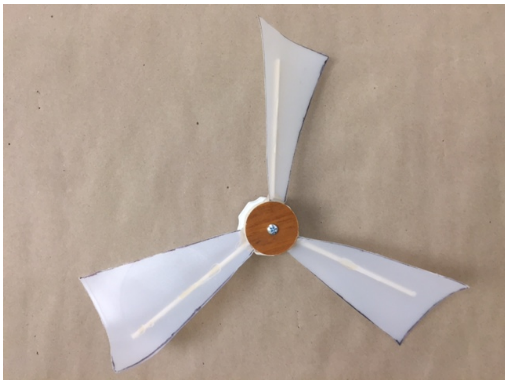


Design 1

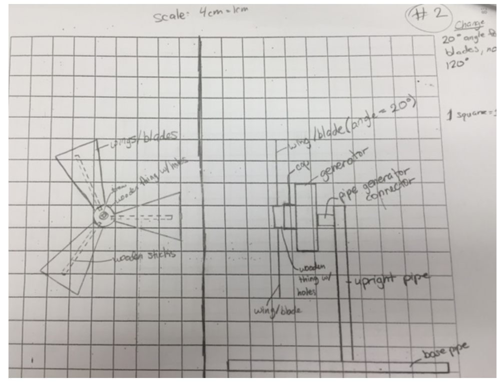


Scale Drawing of Design #1

When we tested design number one, it didn't move when attached to the generator, and we realized that the reasoning behind that was because the angle on the blades was too much. So, for our next design, design number 2, we made everything the same, except for the angle on the wings. On design number 1, the design didn't move because the angle on those things was at 120°. This time, for our new updated design, design number 2, the angle was 20°.

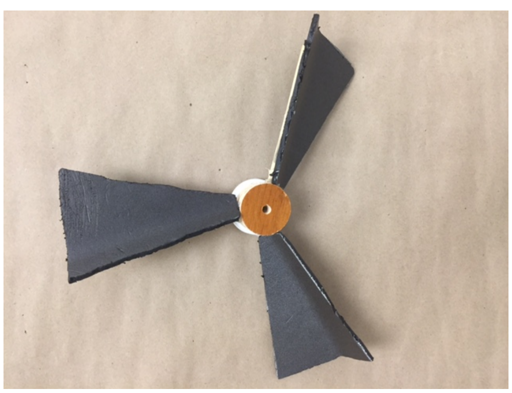


Design #2

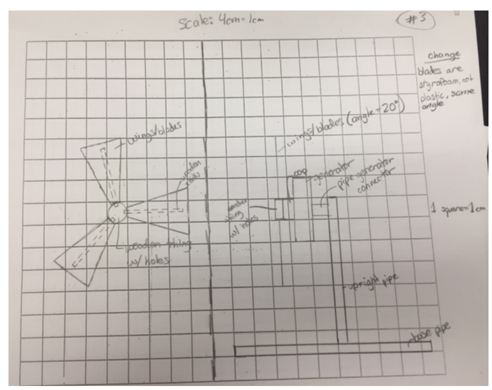


Scale Drawing of Design #2

After we ran the tests for design number 2, we found out that, with the new improvements of the angle on the blade, that when attached to the generator, it moved and spun very fast. We got the idea that we would keep everything the same, angle size and shape of the blade and all, except we would make the blades out of a material that didn't weigh as much as plastic. We used black Styrofoam instead of plastic, so that our turbine would move faster and have higher voltage and milliamps, which would lead to having more power.



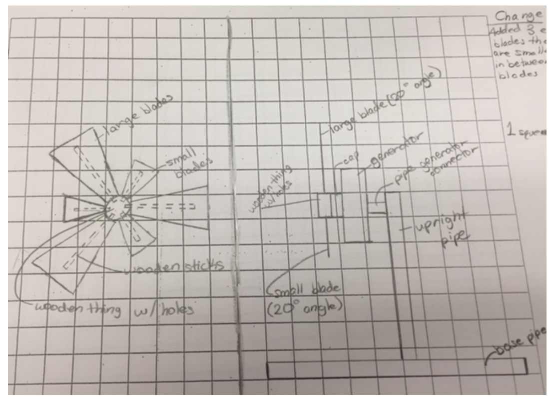
Design #3



Scale Drawing of Design #3

Our third design worked very well but we saw room for improvement. We decided that the blades were good in terms of size and angle, so we added smaller blades in between each of the bigger blades. The smaller blades were exactly half the size of the bigger blades in every dimension. The reason we chose to put smaller blades in between the bigger ones is because we wanted to get the power higher. We figured that to get more power, we would need more blades so we added the smaller ones. These would catch more wind, making the turbine spin faster and generate more power.

Design #4



Scale Drawing of Design #4

Plan:

Design number 4 was chosen as our prototype because it produced the best efficiency, it is a low costing material, and it is easy to shape. Also, the three smaller blades was the reason why it moved faster than the just the three large blades. More blades were being hit by the wind causing the whole turbine to move faster.

The materials needed for construction of the design were:

- Around 1 square foot of Styrofoam
- 3 wooden sticks 12 cm long
- 3 wooden sticks 6 cm long
- 1 circular wooden block (hub)
- 1 bottle cap

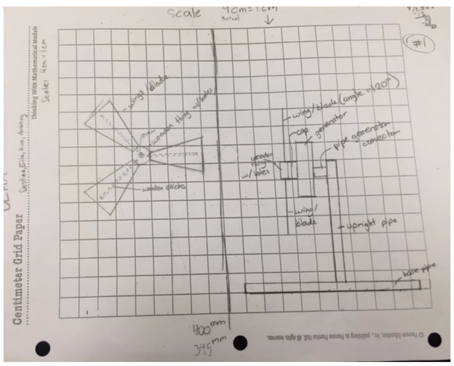
The tools required were:

1. Any type of cutting material (X-ACTO knife, scissors, etc.)
2. Hot Glue Gun

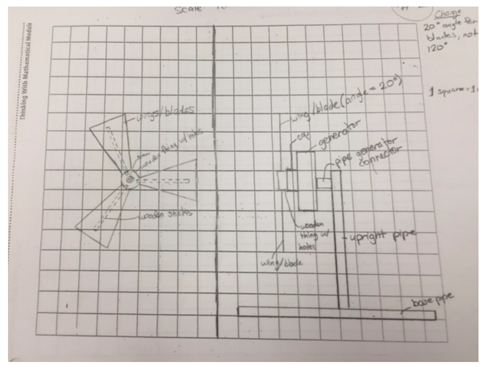
Prototype:

The 4th design was constructed off the original and basic ideas of design number 3. We took the three large blades from design number 3 and the same material, and added three smaller blades that were half the dimensions of the large blades. We used a template with the large dimensions and cut out three large blades into the Styrofoam with an X-ACTO knife. We then made a template for the smaller blade that had half the dimensions as the large one and then repeated the step before. We then put the wooden sticks into alternating holes (large stick, small stick, large stick, etc.). When all the wooden sticks were glued in with the hot glue, we put glue on the Styrofoam and glued them to the stick at 20° angle.

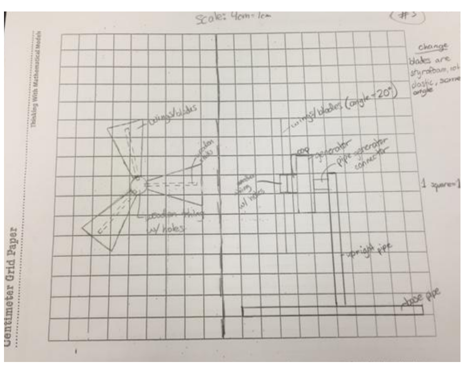
Build:



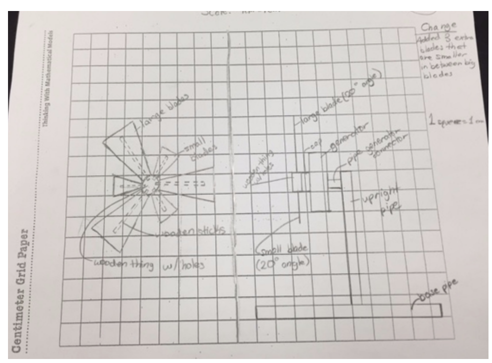
Scale Drawing of Design 1



Scale Drawing of Design 2



Scale Drawing of Design 3



Scale Drawing of Design 4

Test:

The test of design number 4 was consistent for the most part. There was an incident where a scientist from a different group accidentally broke off one of our large blades. We were able to glue it back on and afterwards our turbine did move a little bit slower but only by a couple hundredths on voltage and milliamps.

Trial	Air Speed (m/s)	Voltage (V)	Current (mA)	Current (A)	Power (W)
1	5.2	1.86	2.85	0.00285	0.005301
2	5.4	1.82	2.6	0.0026	0.004732
3	5.4	1.81	2.75	0.00275	0.0049775
4	5.5	1.85	2.74	0.00274	0.005069
5	5.4	1.85	2.78	0.00278	0.005143
6	5.5	1.86	2.76	0.00276	0.0051336
7	5.1	1.82	2.7	0.0027	0.004914
8	5.1	1.81	2.71	0.00271	0.0049051
9	5.1	1.82	2.76	0.00276	0.0050232
10	5.5	1.86	2.74	0.00274	0.005094
11	5.5	1.84	2.77	0.00277	0.0050968
12	5.6	1.84	2.72	0.00272	0.0050048

Analyze:
If we were to make more of these turbines, we could find a stronger glue or stronger tool to make the blades more reinforced in case a blade were to be hit like during our testing. Some of the variables we took into consideration during this process were the changing of the angle on the blades, the change of the material we used for the turbine, and adding on new blades at the end for our final design.

Conclusion:
The average power created by our first design was 0 watts. The average power created by our second design was 0.002210 watts. The average power created by our third design was 0.003135 watts. The average power created by our prototype was 0.005033 watts, which is the greatest power we generated. Turbine design 4 had the best efficiency and power out of all our designs. Because of its extra blades and lightweight material it was the top design out of the 4. We found the efficiency of design 4 by multiplying Voltage x Current divided by Air Density x Blade Diameter (squared) x Air speed (Cubed) x π/4. So after we calculated all of those variables, we were able to find the efficiency, which came out to be 0.04429%.

Future Plans:

If we were to do more designs in the future. We would change our focus from number of blades to weight of the turbine. When the blade was broken off we noticed that the turbine was creating better numbers. We believe the reason why is because it loss some of its weight making it spin faster.

Resources:

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