HexAir Turbines

By Lauren McLaughlin-Kelly, President
Sarah Morey, Vice President
Paige Smith, Researcher
Eric Lin, Researcher

Project Objectives

We want to create a turbine that would produce the maximum power output with the least amount of friction and resistance, while creating a design that has never been used before. To achieve this, we would need to do research and apply the fundamentals of physics to find the best possible options. Then we would design different versions of wind turbines, construct the turbine, test, and redesign our turbine to produce the most optimal results.

HexAir

Generation of Alternatives

- Orientation (horizontal/vertical)
- Number of blades
- Number of generators
- Blade Orientation/Pitch system
- Blade size (length, width, height)
- Blade material
- Blade weight
- Blade shape
- Rotor size
- Gear ratio
- Magnets

HexAir

Comparison of Alternatives

Design Factor	Design Factor Testable in Model	Hypothesis from Research	Hypothesis from Physics Analysis
Number of blades	Yes	6	Blade Solidity= c/s
Curved/straight blades	Yes	Curved	Tangential force, Angle of Attack, Laminar flow, and Bernoulli's Equation, Newtons 3rd Law
Sideways nacelle	Yes	Yes	Gravity, Friction
Number of gears/Gear size	Yes	2 gears: 8-tooth gear, 32-tooth gear	Torque, Force
Number of motors	Yes	1	Electromagnetism
Blade angle	Yes	10 Degrees	Angle of Attack
Blade material	Yes	As light as possible, Basal Wood	Newton's 3rd Law
Hexagonal shape?	Yes	Increased stability	Equilibrium

HexAir

Modeling of System Performance: Initial Build

Initial Turbine Features:

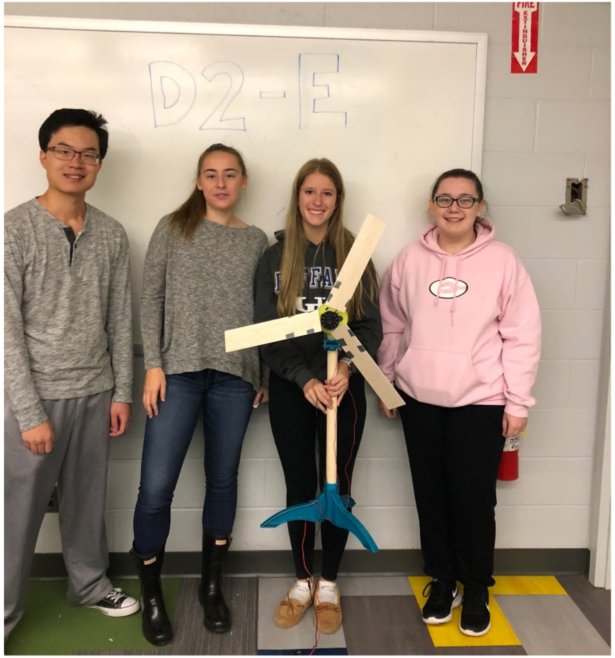
- 3 balsa wood blades
- Flat blades
- 2 gears (8-tooth, 32-tooth)
- 1 motor
- Multimeter set at 20 to measure voltage and current
- LED bulb

HexAir

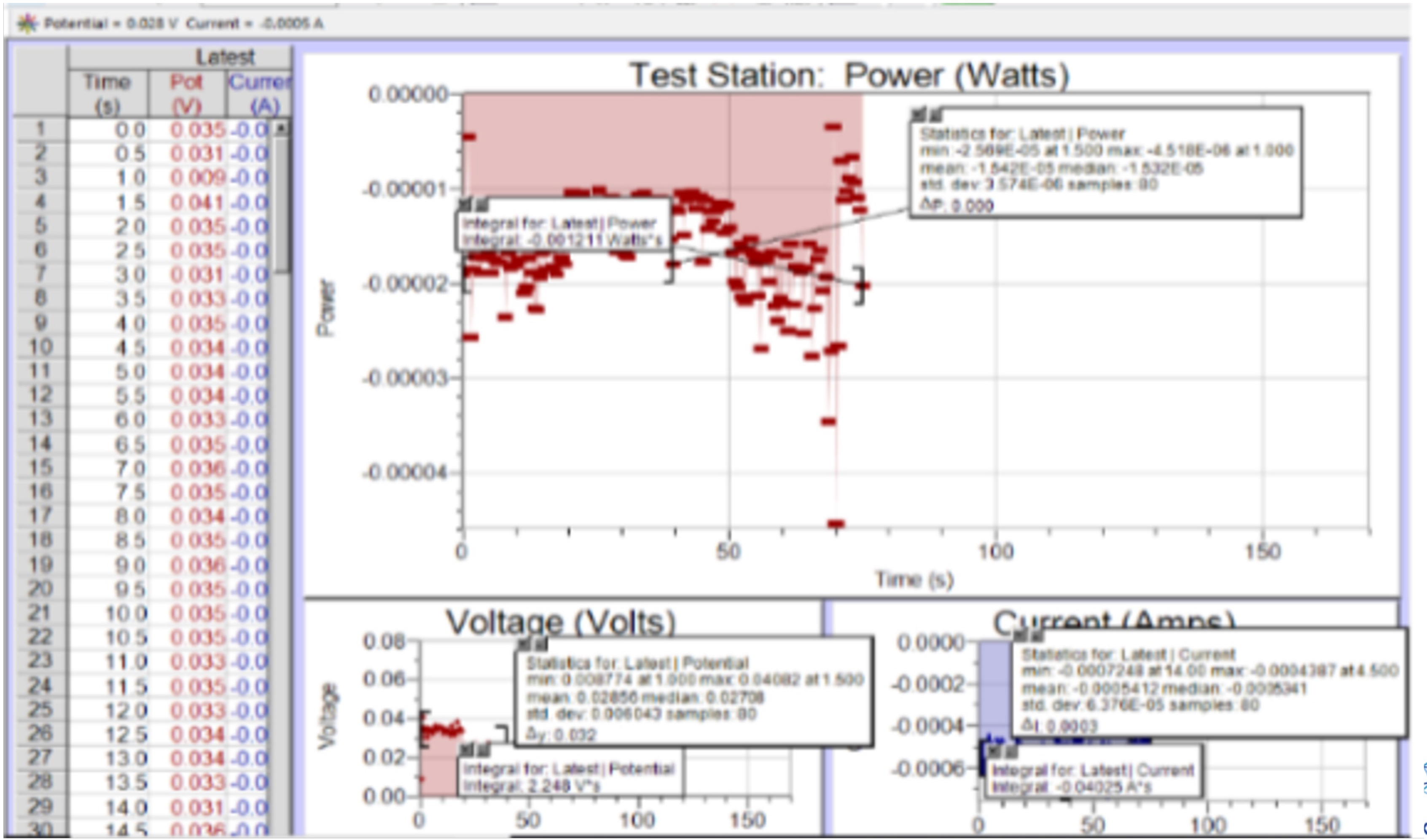
Modeling of System Performance: Initial Build

Horizontal Turbine

- Max Voltage: .041 Volts
- Max Current: .02 Amperes
- Max Power: .00082 Watts
- Cut-in time: 4 seconds
- Run-out time: 15 seconds
- Bulb used: LED
- Was bulb lit up?: No



HexAir


Potential = 0.028 V Current = -0.0005 A
Latest
Time (s) | Pot (V) | Curren (A)
1 0.0 0.035 -0.0
2 0.5 0.031 -0.0
3 1.0 0.009 -0.0
4 1.5 0.041 -0.0
5 2.0 0.035 -0.0
6 2.5 0.035 -0.0
7 3.0 0.031 -0.0
8 3.5 0.033 -0.0
9 4.0 0.035 -0.0
10 4.5 0.034 -0.0
11 5.0 0.034 -0.0
12 5.5 0.034 -0.0
13 6.0 0.033 -0.0
14 6.5 0.035 -0.0
15 7.0 0.036 -0.0
16 7.5 0.035 -0.0
17 8.0 0.034 -0.0
18 8.5 0.035 -0.0
19 9.0 0.036 -0.0
20 9.5 0.035 -0.0
21 10.0 0.035 -0.0
22 10.5 0.035 -0.0
23 11.0 0.033 -0.0
24 11.5 0.035 -0.0
25 12.0 0.033 -0.0
26 12.5 0.034 -0.0
27 13.0 0.034 -0.0
28 13.5 0.033 -0.0
29 14.0 0.031 -0.0
Test Station: Power (Watts)
Statistics for: Latest | Power
min: -2.569E-05 at 1.500 max: -4.518E-06 at 1.000
mean: -1.642E-05 median: -1.532E-05
std. dev: 3.574E-06 samples: 80
ΔP: 0.000
Integral for: Latest | Power
Integral: -0.001211 Watts*s
Power
Time (s)
Voltage (Volts)
Statistics for: Latest | Potential
min: 0.008774 at 1.000 max: 0.04082 at 1.500
mean: 0.02856 median: 0.02708
std. dev: 0.006043 samples: 80
Δy: 0.032
Integral for: Latest | Potential
Integral: 2.248 V*s
Voltage
Current (Amps)
Statistics for: Latest | Current
min: -0.0007248 at 14.00 max: -0.0004387 at 4.500
mean: -0.0005412 median: -0.0005341
std. dev: 6.376E-05 samples: 80
Δt: 0.0003
Integral for: Latest | Current
Integral: -0.04025 A*s

Modeling of System Performance: Experiments

- Experiment 1: Vertical, 3 flat blades: .1 volts produced
- Experiment 2: Vertical, 6 flat blades: .3 volts produced
- Experiment 3: Vertical, 3 curved blades: .2 volts produced
- Experiment 4: Vertical, 4 curved blades: 1.3 volts produced
- Experiment 5: Vertical, curved blades with cardboard base: .3 volts produced
- Experiment 6: Vertical, curved blades with wooden base: .4 volts produced
- Experiment 7: Vertical, curved blades with wooden base/top and wooden axle: .4 volts produced
- Experiment 8: Vertical, curved blades at 0 degrees: .2 volts produced
- Experiment 9: Vertical, curved blades at 10 degrees: .4 volts produced

HexAir

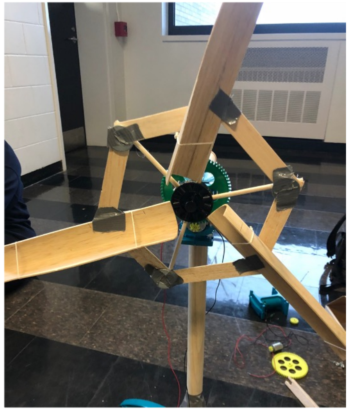
Modeling of System Performance: Experiments

- Experiment 10: Horizontal turbine, with curved blades and 3 weights: 1.4 volts produced
- Experiment 11: Horizontal turbine, curved blades and unweighted: .9 volts produced
- Experiment 12: Vertical, weighted blades, non weighted axle: 1.3 volts produced
- Experiment 13: Vertical, non-weighted blades, weighted axle: 1.6 volts produced

HexAir

Modeling of System Performance: Experiments

- Voltage was main system tested
- Unproductive to test every single system due to time constraint
- Many of the tests to show why certain factors do not work with vertical turbines
- Smaller number of tests done to see how that factor affected the power output of the turbine



HexAir

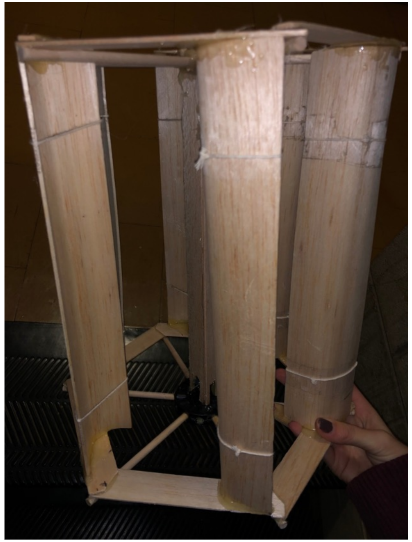
Modeling of System Performance: Final Improved Design

- Vertical vs Horizontal turbine
- Curved Polyurethane Balsa Wood Blades
- Hexagonal base /top
- Wooden axle
- Sideways nacelle

HexAir

Modeling of System Performance: Final Improved Design

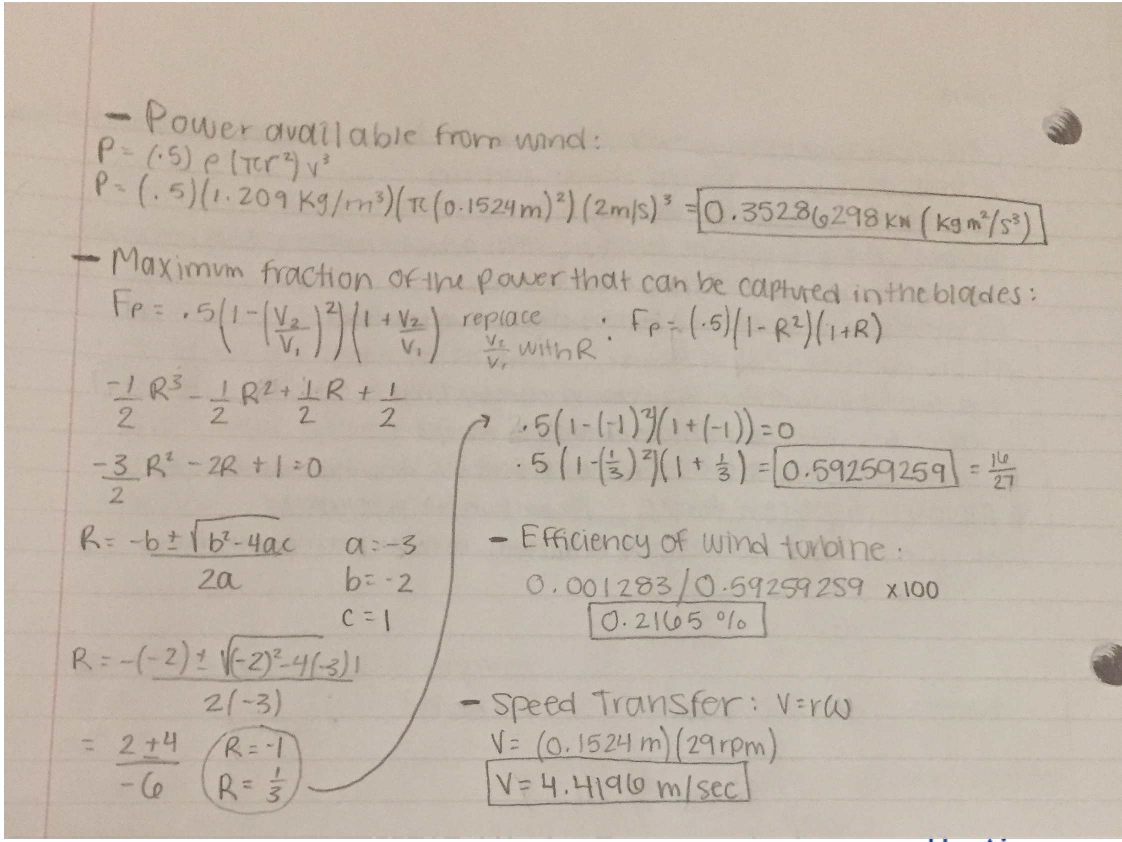
- Curved Polyurethane Balsa Wood Blades
- Hexagonal Base/Top
- Wooden Axle
- Sideways Nacelle



HexAir

Performance at Final Testing

- Power available from wind: **0.35286298 kW (kgm^2/s^3)**
- Maximum fraction of the power that can be captured in the blades: **0.59259259**
- Efficiency of wind turbine: **0.2165%**
- Speed transfer:) **v=4.4196m/sec**



Final Testing

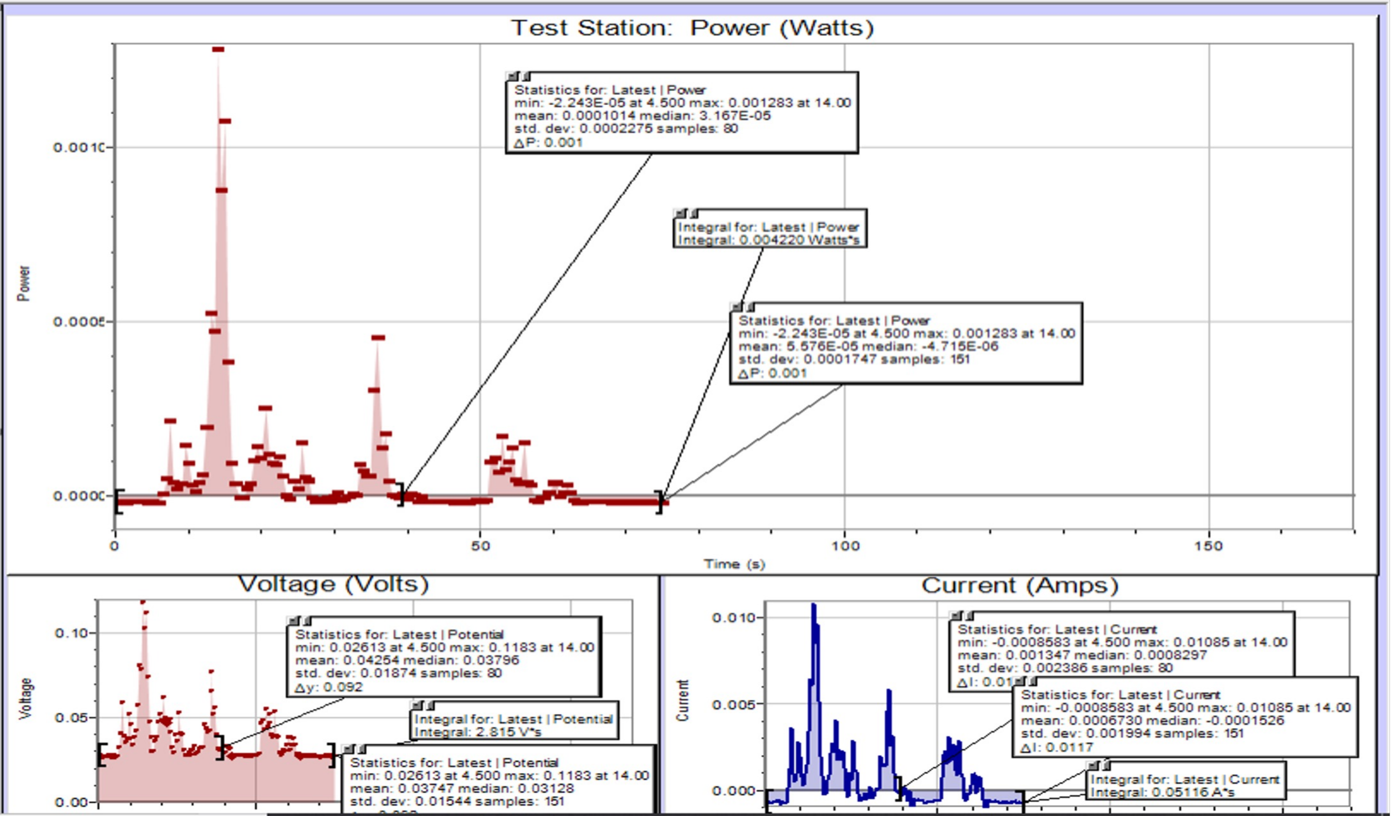
- Max Voltage: 0.1183 Volts
- Max Current: 0.01085 Amperes
- Max Power: 0.001283 Watts
- Energy Generated in 75 seconds: 0.00422 Watts
- Cut-in time: 6.5 Seconds
- Run-our time: 3 Seconds
- Bulb used: Incandescent
- Was bulb lit up?: Yes
- Estimated Blade RPM: 29 rpm

HexAir

Page 1 Collect

Potential = 0.028 V Current = -0.0006 A

	Latest		
	Time (s)	Potential (V)	Current (A)
88	43.5	0.028	-0.000
89	44.0	0.028	-0.000
90	44.5	0.028	-0.000
91	45.0	0.028	-0.000
92	45.5	0.028	-0.000
93	46.0	0.028	-0.000
94	46.5	0.027	-0.000
95	47.0	0.027	-0.000
96	47.5	0.028	-0.000
97	48.0	0.027	-0.000
98	48.5	0.027	-0.000
99	49.0	0.027	-0.000
100	49.5	0.028	-0.000
101	50.0	0.028	-0.000
102	50.5	0.028	-0.000
103	51.0	0.029	-0.000
104	51.5	0.047	0.002
105	52.0	0.048	0.002
106	52.5	0.043	0.001
107	53.0	0.055	0.003
108	53.5	0.045	0.001
109	54.0	0.047	0.002
110	54.5	0.052	0.002
111	55.0	0.040	0.001
112	55.5	0.039	0.000
113	56.0	0.053	0.002
114	56.5	0.039	0.001
115	57.0	0.038	0.000
116	57.5	0.029	-0.000
117	58.0	0.028	-0.000
118	58.5	0.031	-0.000
119	59.0	0.030	-0.000
120	59.5	0.034	0.000
121	60.0	0.039	0.000
122	60.5	0.039	0.000
123	61.0	0.031	-0.000
124	61.5	0.034	0.000
125	62.0	0.038	0.000
126	62.5	0.034	0.000
127	63.0	0.029	-0.000
128	63.5	0.027	-0.000
129	64.0	0.027	-0.000
130	64.5	0.027	-0.000
131	65.0	0.028	-0.000
132	65.5	0.028	-0.000
133	66.0	0.027	-0.000
134	66.5	0.028	-0.000
135	67.0	0.027	-0.000



HexAir

Engineering Recommendations: Interpretations of Results

Successful results:

- Creating an innovative and unique design
- Produced power
- Lit bulb

Unsuccessful results:

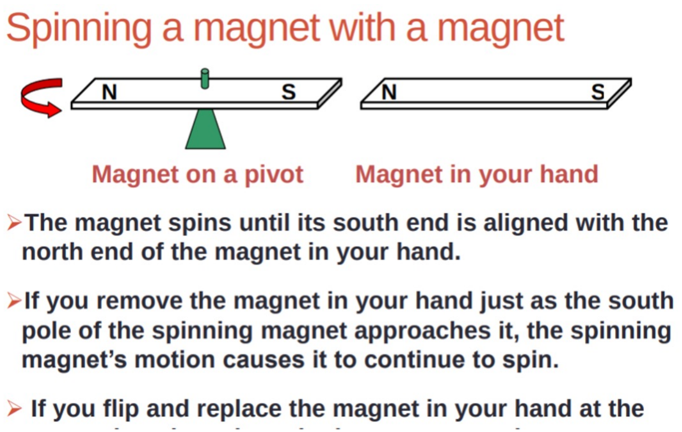
- Did not produce a large amount of power

HexAir

Engineering Recommendations: Future Research

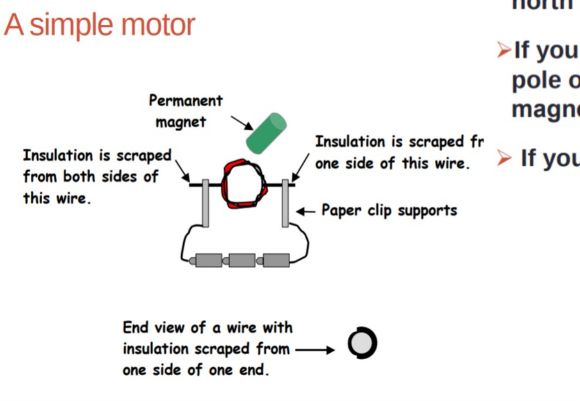
-With further funding and time, implementing research / testing with **magnets**

-Using electrostatic forces of the northern and southern poles. When the forces are attracting and repelling each other, assist in the rotation and improve performance of the wind turbine.



Benefits of Neodymium Magnets in wind turbines:

- Reliable
- Low-maintenance
- Cost-efficient
- Increase power output
- Less energy loss (friction)



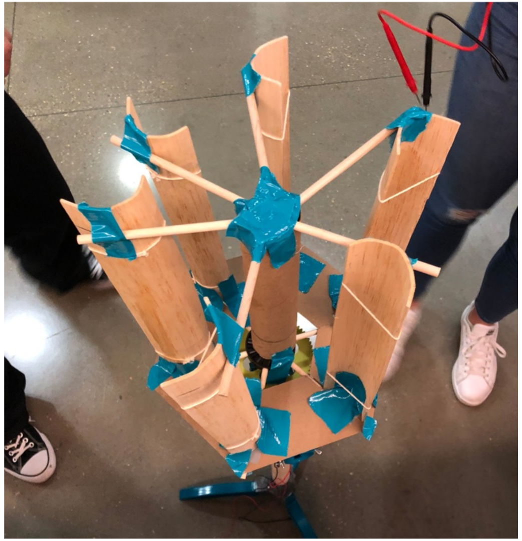
Most promising: Imbalanced System (Spin Alignment System)

HexAir

Engineering Recommendations: Future Research

3D Printing:
-Inconsistent angles due to curving blades by hand
-With more funding, 3D printed blades (with current funding this was an unattainable goal, around $800)

- Curved
- Ligheight
- Durable



Maglev: inspiration for vertical turbine with magnetic motor

HexAir


Bulls