ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

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Lessons Learned from a First-Year Engineering Wind Turbine Project

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Todd France is the director of Ohio Northern University's Engineering Education program, which strives to prepare engineering educators for grades 7-12. Dr. France also helps coordinate the first-year engineering experience at ONU. He earned his PhD from the University of Colorado Boulder in Architectural Engineering, and conducted research in K-12 engineering education and project-based learning.

Mr. William Sierzputowski, Ohio Northern University

A senior Engineering Education student at Ohio Northern University, Will participates in robotics, is the past president of his school's ASEE chapter, and is a member of Tau Beta Pi, IEEE and ACM. His engineering interests lie mainly in the fields of electrical and computer engineering. Upon graduation, he hopes to begin teaching engineering to high school students and to serve as both a role model and advocate for pursuing STEM, and specifically engineering as a field of study and career.

Lessons Learned from a First-Year Engineering Wind Turbine Project

Project Description

- Design, create, test, and analyze small-scale wind turbines across 3 independent variables (4 weeks)
- Tools utilized..

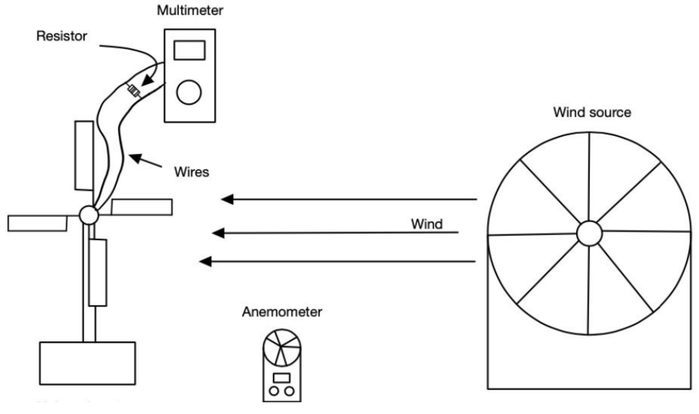
Onshape

Ultimaker Cura

Excel

Learning Objectives

1. Demonstrate basic 3D modeling → Slicing → 3D printing
2. Execute a test plan & record data
3. Present data (tables, scatter charts, photos)
4. Use math modeling to justify conclusions

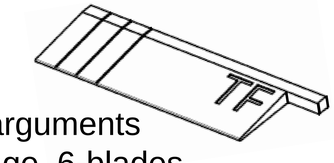


Future Iterations

- Provide data table template. Students struggle to create their own two-dimensional data tables like this…

Voltage Output (mV)	Wind Speeds (m/s)						
Number of Blades	1.0	1.2	1.3	1.4	1.5	1.8	2.2
3	5.2	6.0	6.4	7.6	9.9	11.4	12.3
4	6.0	6.5	7.7	8.8	10.6	11.7	12.6
6	2.0	2.5	3.0	4.0	4.5	7.0	10.7

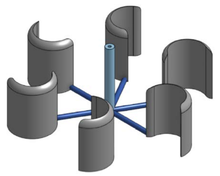
- Blades still take ~90 min each to print – modify design to reduce to < 60 min?

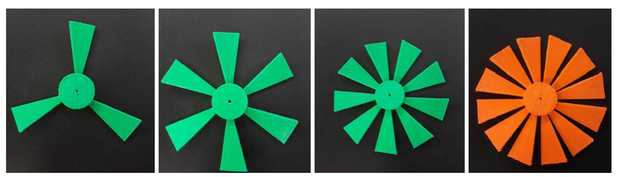


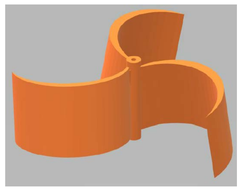
- Provide framework for more quantifiable arguments e.g., “6-blades worked best” vs. “On average, 6-blades produced XX% more power than 3- & 4-blades”
- **Emphasize structured inquiry over unguided discovery**

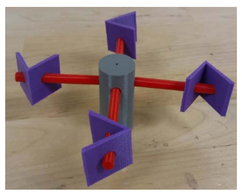
1st Iteration: Fall 2018

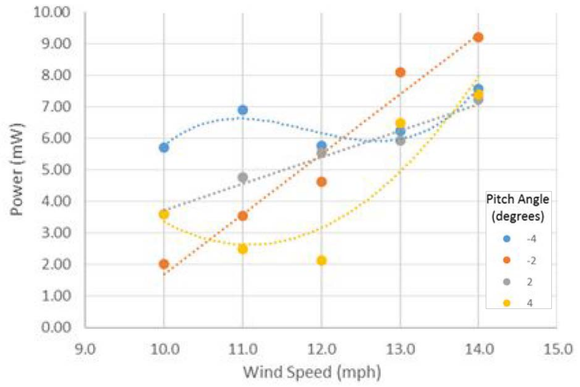
- Open-ended design: vertical-axis & horizontal axis
- Challenges: long print times, inconsistent data, vertical-axis turbines performed poorly





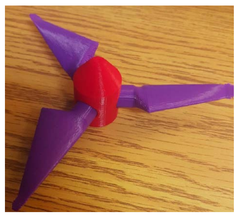


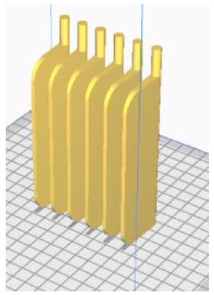




2nd Iteration: Fall 2019

- Common hub
  (+) Less print time, less print failures, variable pitch angle
  (–) Low 3D print tolerance → unsecure blades, slippage on motor axle
- Internal resistance of large motor → fan very close to turbine (blades flew off)
- Each student printed 6 blades (too many)
- Many printed blades vertically → weak in vertical dimension

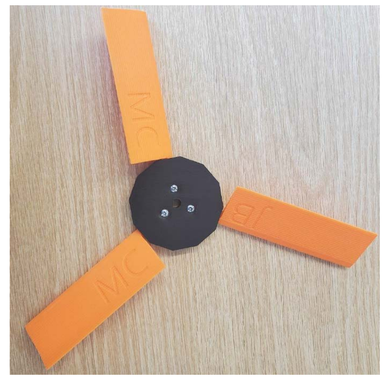


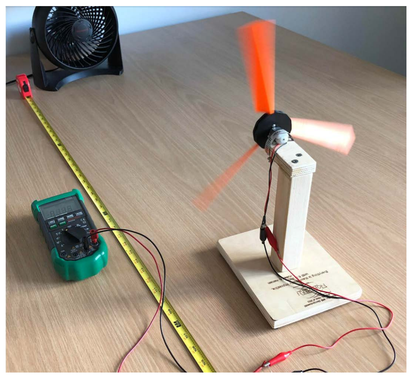


3rd Iteration: Fall 2020

- Smaller motor → blades worked at 15’+ from fan
- D-shaped axle adapter → easy to remove common hub
- Interdependence: each team member printed 1 or 2 blades
- Individual accountability: each team member responsible for CAD drawing, data collection, data table, scatter chart

Key takeaway: while we want to foster creativity in design…
Constrained design → no print failures + consistent data = accurate math models + less student & instructor frustration





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