

EML4552 – Team 15 – 01/19/16

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Portable Wind Turbine

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Overview

- Project Scope and Objectives
- Project Background
- Previous Work
 - Conceptual Design
 - Detailed Design
- Current Work
 - Embodiment Design
- Moving Forward
 - Prototype Testing



Project Scope and Objectives

- Objective: create lightweight, portable wind turbine that is easy to assemble and disassemble so that inexperienced operators may use the device.
- Revised Objectives/Constraints
 1. Operate in wind speeds of 4 m/s (~10mph) at an approximate height of 2m
 2. Lightweight (80 lb max)
 3. Easy to assemble and disassemble
 4. Prototype (Budget of \$2,000)
 5. Power output of 5W

Previous Work

- Created Schedule and Divided Tasks
- Researched:
 - Existing work
 - Locations
- Developed HOQ
- Brainstormed Design Concepts
- Developed Pugh Matrix
- Selected Design Concepts
- Detailed Design



Parts of a Wind Turbine

1. Blades
2. Nacelle
3. Body / Neck
4. Base/ Legs
5. Tail Vane



Figure 1. Parts of a Wind Turbine.

Turbine Blades (Cont.)

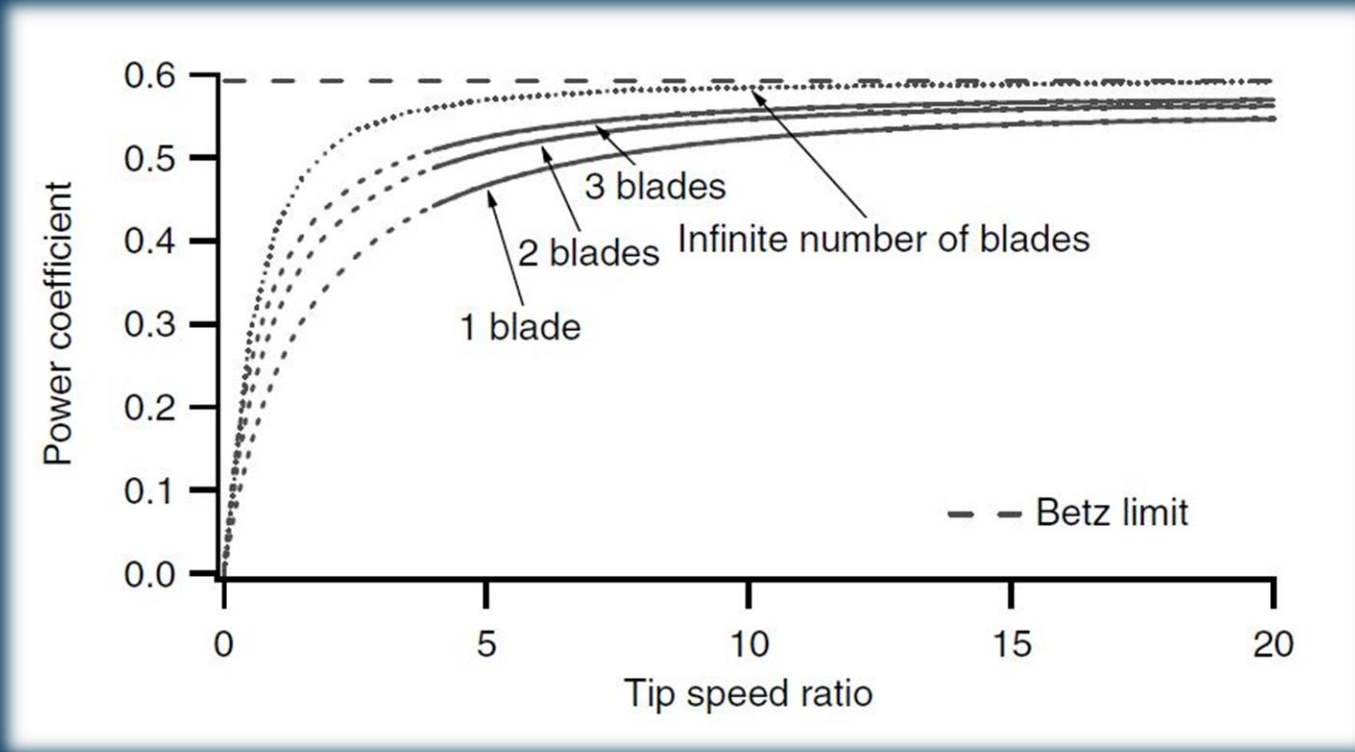


Figure 2. Power coefficient vs. TSR

$$\text{Tip Speed Ratio (TSR)} = \frac{\omega * R}{V_w}$$

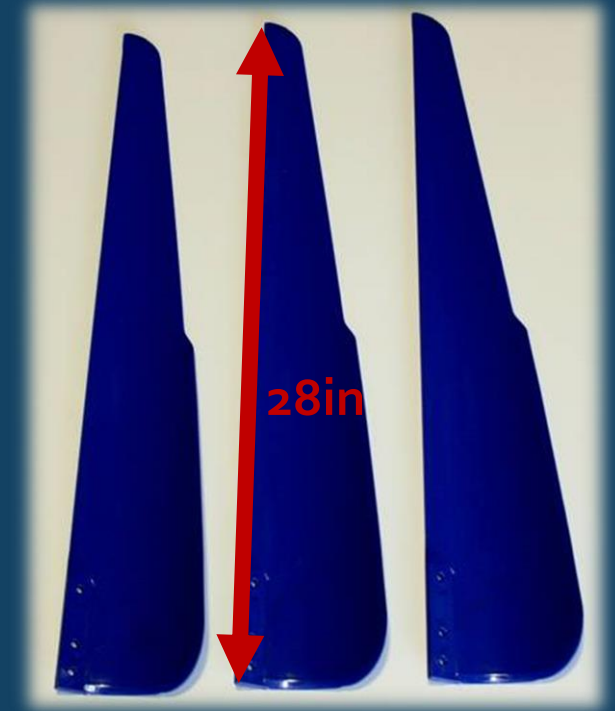
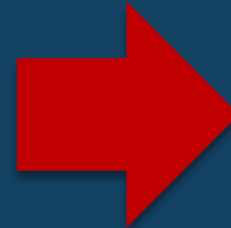


Figure 3. Selected blades.

Nacelle Mounting

- Must allow easy assembly/disassembly
 - Minimize/eliminate tools required
- Selected Steering Wheel Quick Release

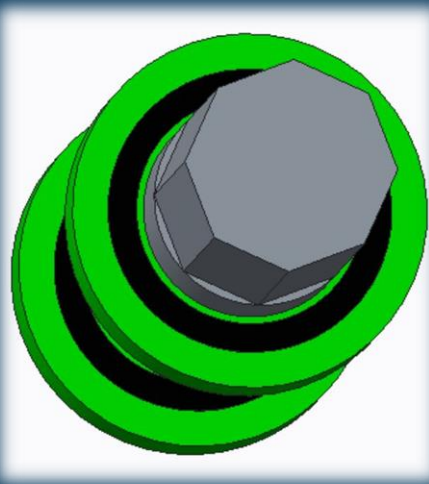


Figure 4. Quick release shaft

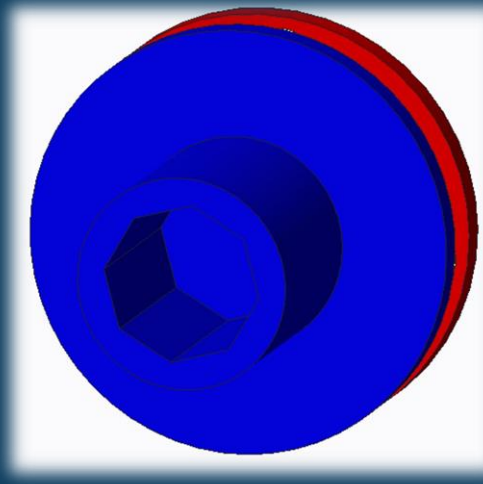


Figure 5. Quick release hub

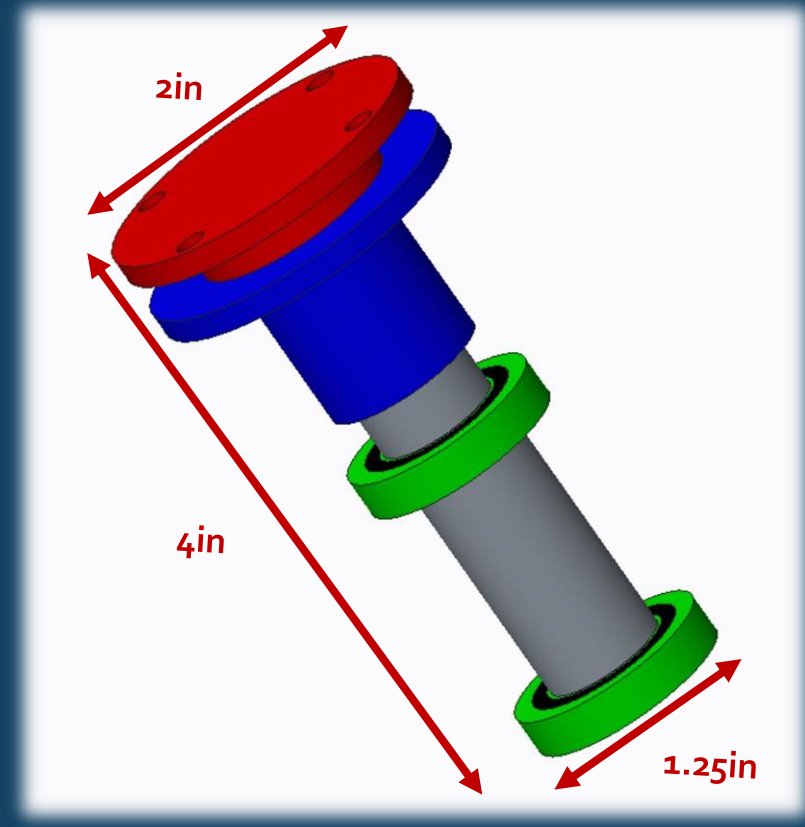
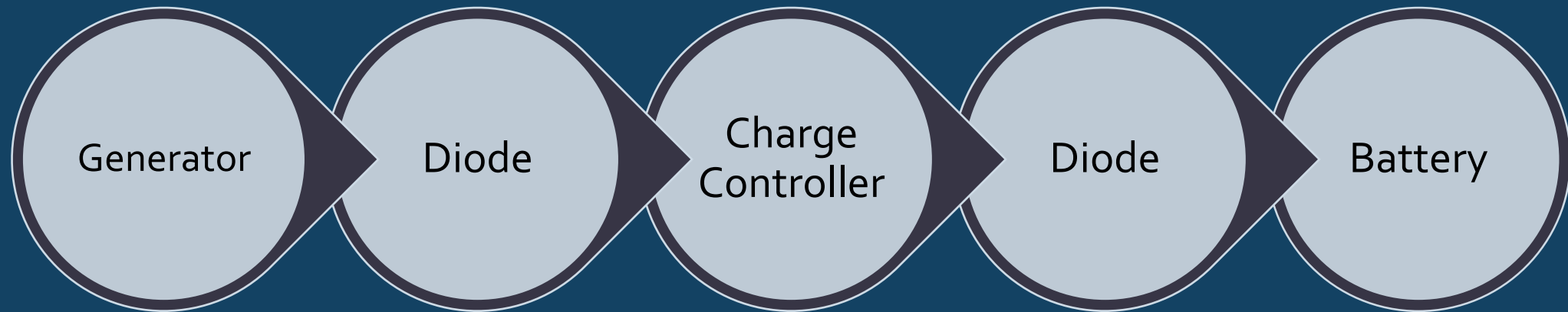


Figure 6. Quick release concept

Electrical Components



Electrical Components - Generator

- Selected WindBlue Power DC-540
 - Permanent Magnet Alternator
 - Designed for low wind
 - Ordered - \$257.90



Figure 7. DC-540 PMA Generator

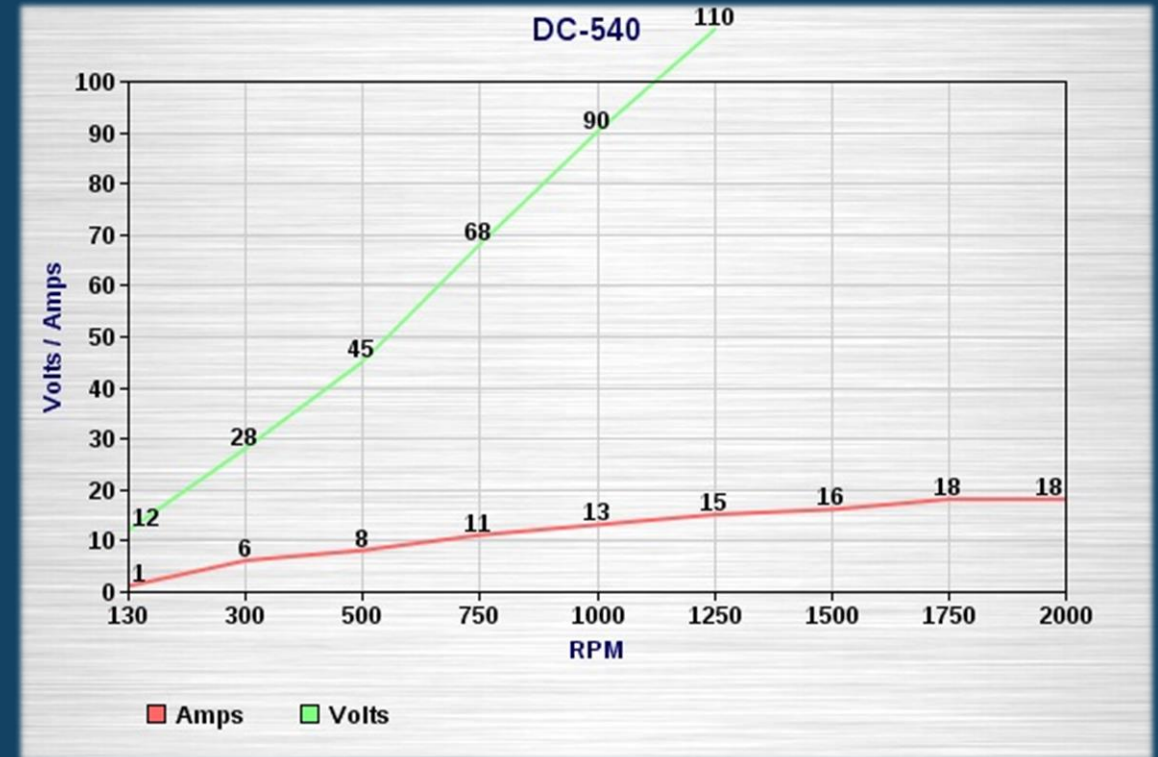


Figure 8. DC-540 PMA RPM vs Volts and Amps

Electrical Components-Charge Controller

- Protects against overcharging
- Act as voltage regulator
 - Eliminates peaks in generator power output
- Maximum Power Point Tracker (MPPT)
 - Adjust charge rate based on battery level to allow charging closer to maximum capacity
 - Considerable efficiency gains
- Not Ordered

Electrical Components - Battery

Lithium Ion

<i>Pros</i>	<i>Cons</i>
High Energy Density	Requires Protection circuit to maintain power within safe limits
Low Maintenance	Battery can age, even if not in use
Common rechargeable battery	Expensive to manufacture

Still doing research on batteries

Turbine Base

- Goals
 - Minimize number and size of parts
 - Easy assembly/disassembly
 - Minimize leg length, maximize neck length
- Concept Selection
 - Telescoping aluminum tube members
 - Pin connections

Turbine Base - Concepts

- Anchor Connection
- Foot Type
- Possible Accommodation for Sloped Surface
 - Adjustment of Individual Leg Length



Figure 9. Nacelle



Figure 10. Anchor Connection



Fig 11. Tripod Foot

Turbine Base - Calculations

- Failure of Parts
 - Aluminum Tubing
 - Bending
 - Buckling
 - Bolts
 - Shearing
 - Assume:
 - Self Weight
 - Wind Load

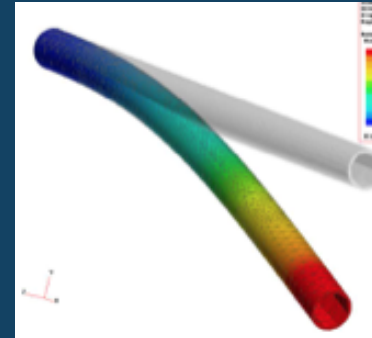


Figure 12. Forces in tubing

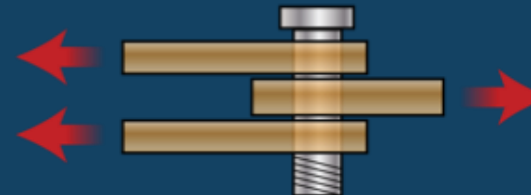


Figure 13. Shearing of Bolt

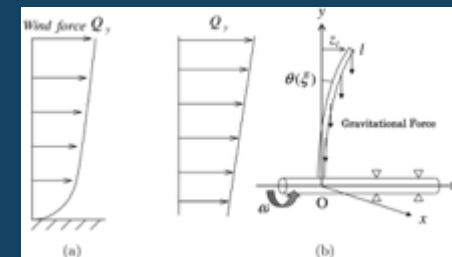


Figure 14. Wind Load

Turbine Base - Calculations

- Stability Against Overturning
 - Accidental Bump
 - About 8 inch offset
 - Wind Load
 - Assume:
 - Rayleigh Wind Distribution
 - Sloped Surface

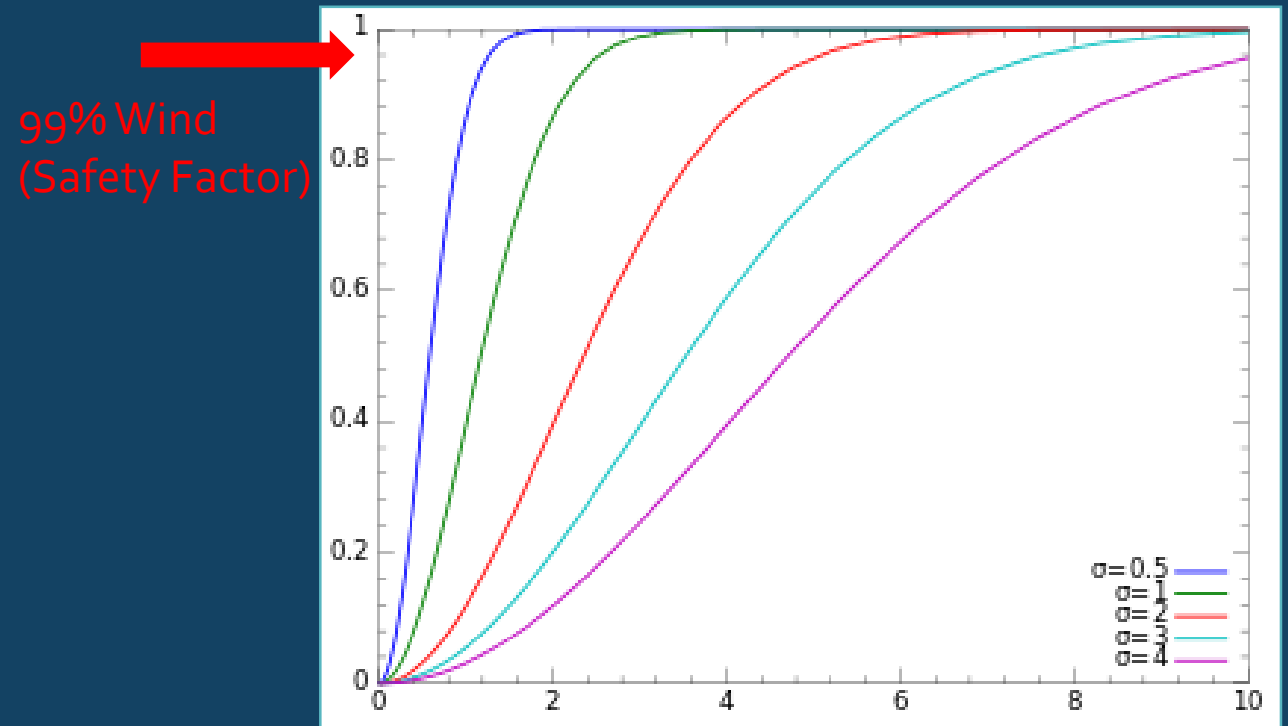


Figure 15. Rayleigh Distribution

Turbine Base - Calculations

- Foundation Capacity for Anchor
 - Extra factor of Safety against tipping
 - Varying based on soil type
 - Analyze Several



Figure 16. Tripod Anchor (1)

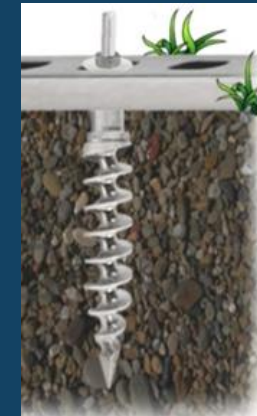


Figure 17. Tripod Anchor (2)

Moving Forward

- Electrical System
 - Test Generator Power Output
 - Select Parts
 - Charge Controller
 - Battery
- Base
 - Concept Selection
 - Calculations
 - Selection of Parts
 - Trial and Error (Through Calculations)
- Ordering Parts
- Assembly/Testing



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Questions?