EML4551 – Team 15 – 11/19/15

Sponsor: Dr. Sungmoon Jung – Advisors: Dr. Jung, Dr. Shangchao Lin, Mr. Sean Martin – Instructor: Dr. Nikhil Gupta

# Portable Wind Turbine

**Katelyn Bamundo**-Stephen Freeman-Matthew Hutchisson-**Stephanie McLellan**-**Garrett Rosenthal**-Rishad Walker

# Project Scope and Objectives

- The objective of this project is to create a lightweight, portable wind turbine. The design must be easy to assemble and disassemble so that inexperienced operators may use the device.
- Revised Objectives/Constraints
  1. Operate in wind speeds of $4\ m/s$ at an approximate height of 2m
  2. Lightweight (80 lb max)
  3. Easy to assemble and disassemble
  4. Budget of $2,000
  5. Power output of 5W

# Previous Work

- Created Schedule and Divided Tasks
- Researched Existing Small Turbines and Previous Projects
- Developed HOQ
- Brainstormed Design Concepts
- Developed Pugh Matrix
- Selected Design Concepts

# Selected Design Concepts

Standard Blade Type


Figure 1

"Bodiless" Turbine

Figure 2

Tripod/Anchor Base Type

Figure 3

Figure 4

# Wind Speed Data

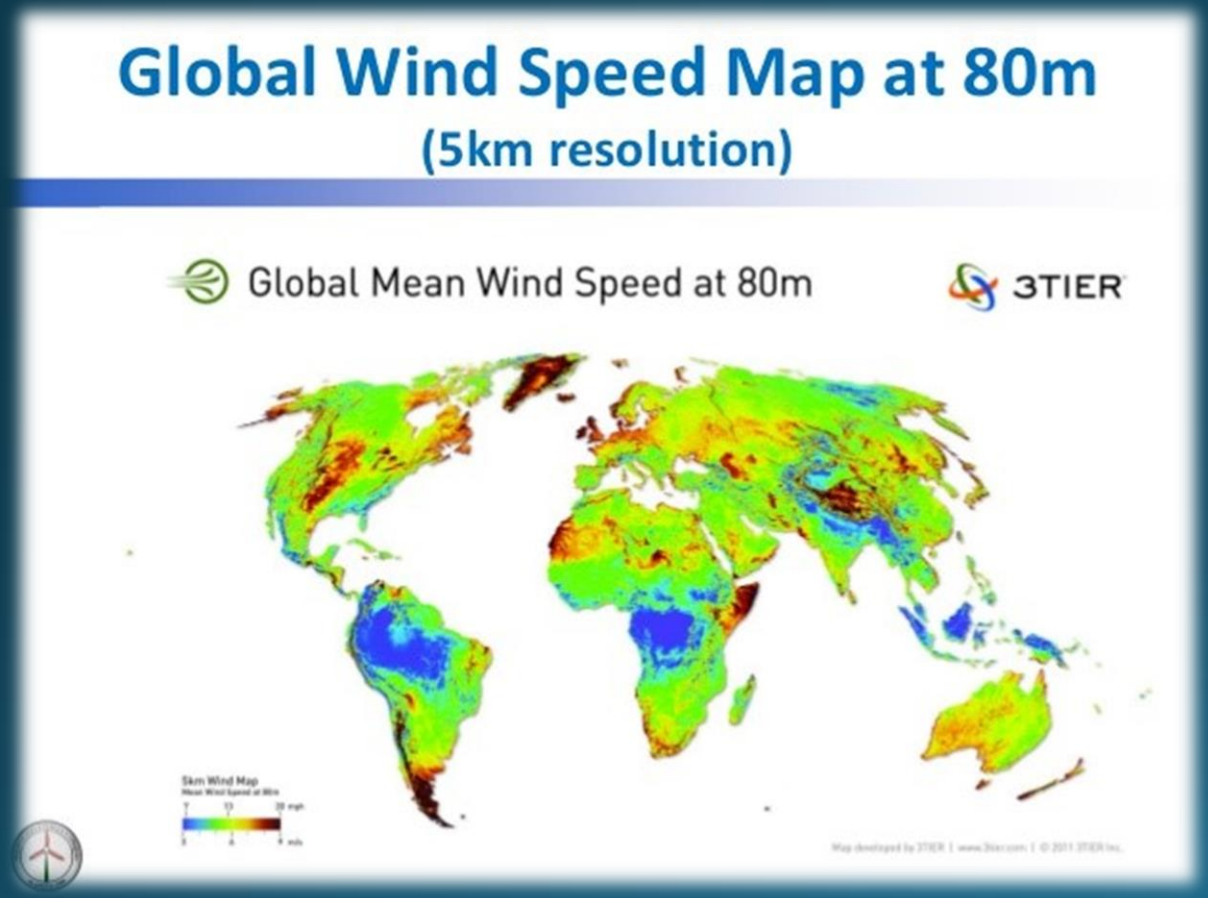



Figure 5

## Log Wind Profile Ratio

$$V_1 = V_2 * \frac{\ln\left(\frac{Z_1}{Z_0}\right)}{\ln\left(\frac{Z_2}{Z_0}\right)}$$

Where $Z_0$ is determined base on desired environment

# Turbine Base

- Goals
  - Minimize number and size of parts
  - Easy assembly/disassembly
- Model created on Inventor Pro Software
  - Telescoping aluminum tubes
  - Pin connections
  - Minimize leg length, maximize neck length

# Turbine Base (Cont.)

- Parts
  - Aluminum telescoping tubing
  - Pins (Locking with retainer)

Figure 6

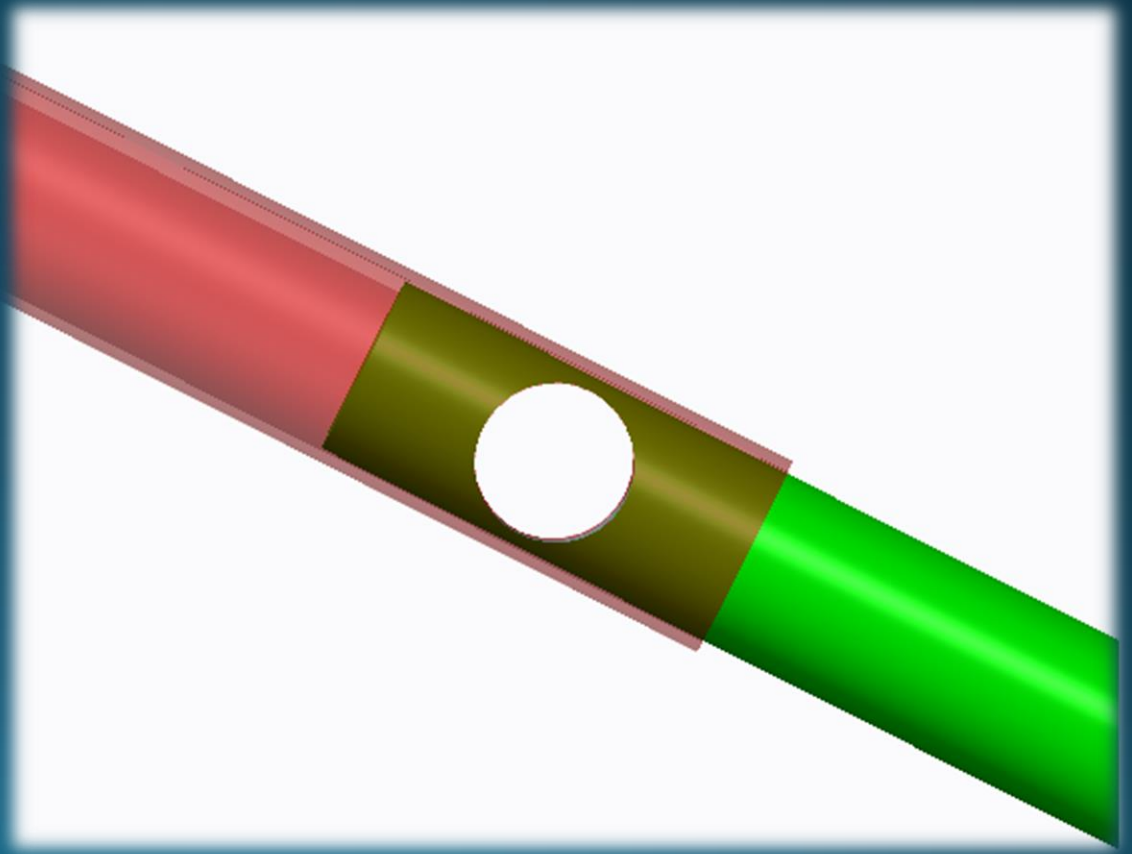


Figure 7

# Turbine Blades

- Several manufacturers considered
- Narrowed choices to Windy Nation
  - More specifications available
  - US based – easier communication
  - Variety of sizes and material


Figure 8

Figure 9

# Turbine Blades (Cont.)

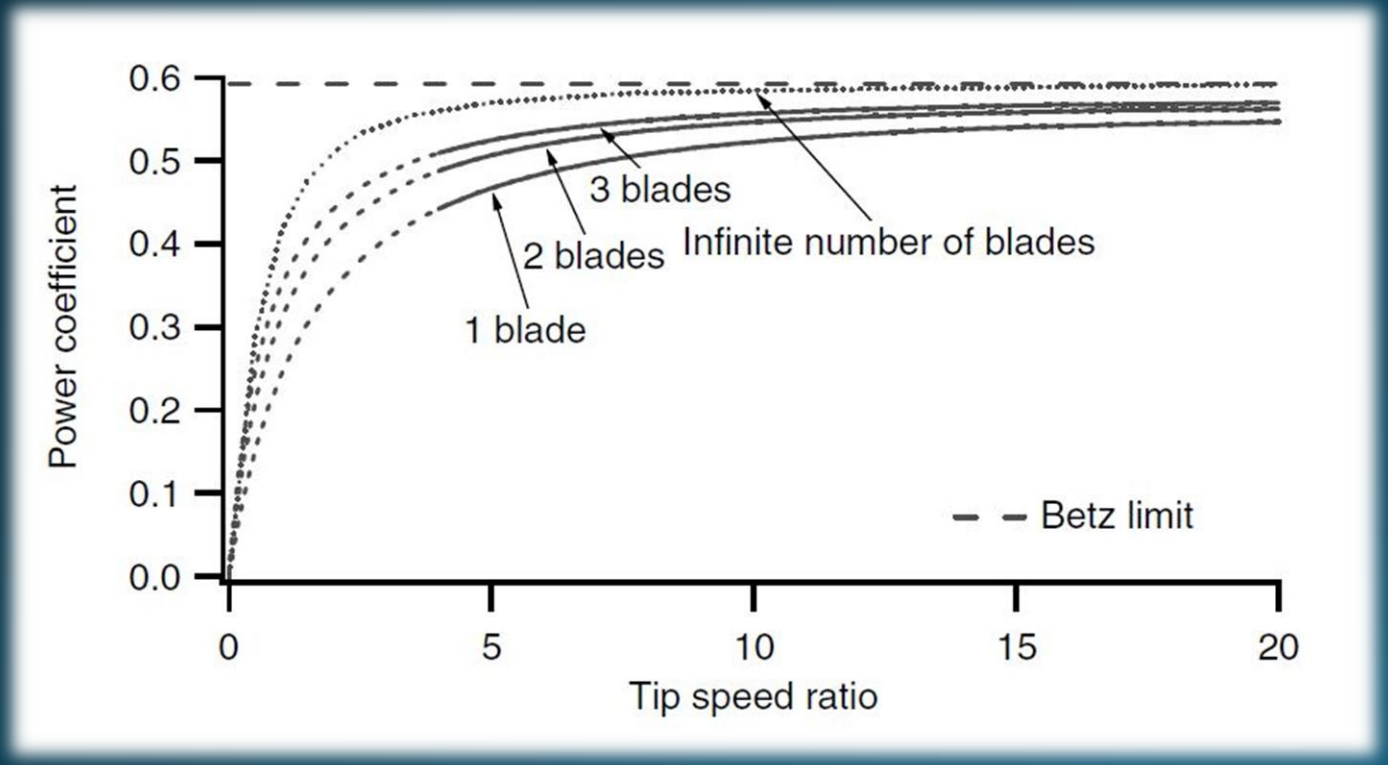



Figure 10

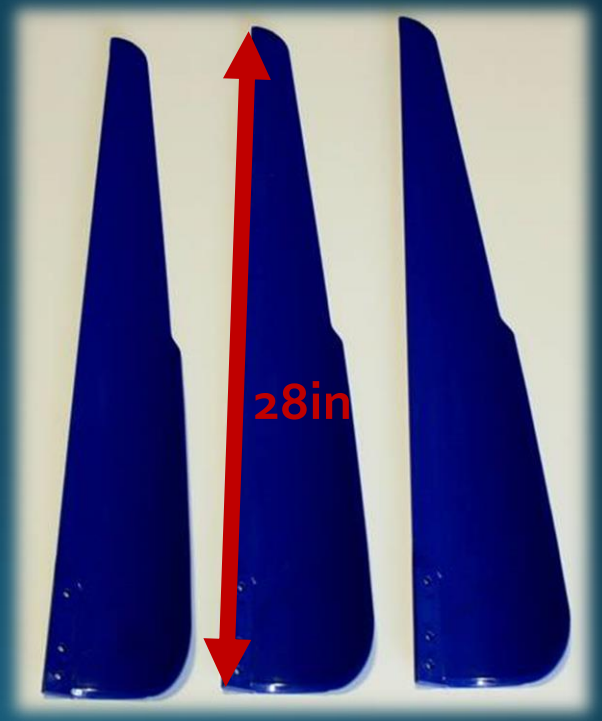



Figure 11

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

# Turbine Blade Mounting

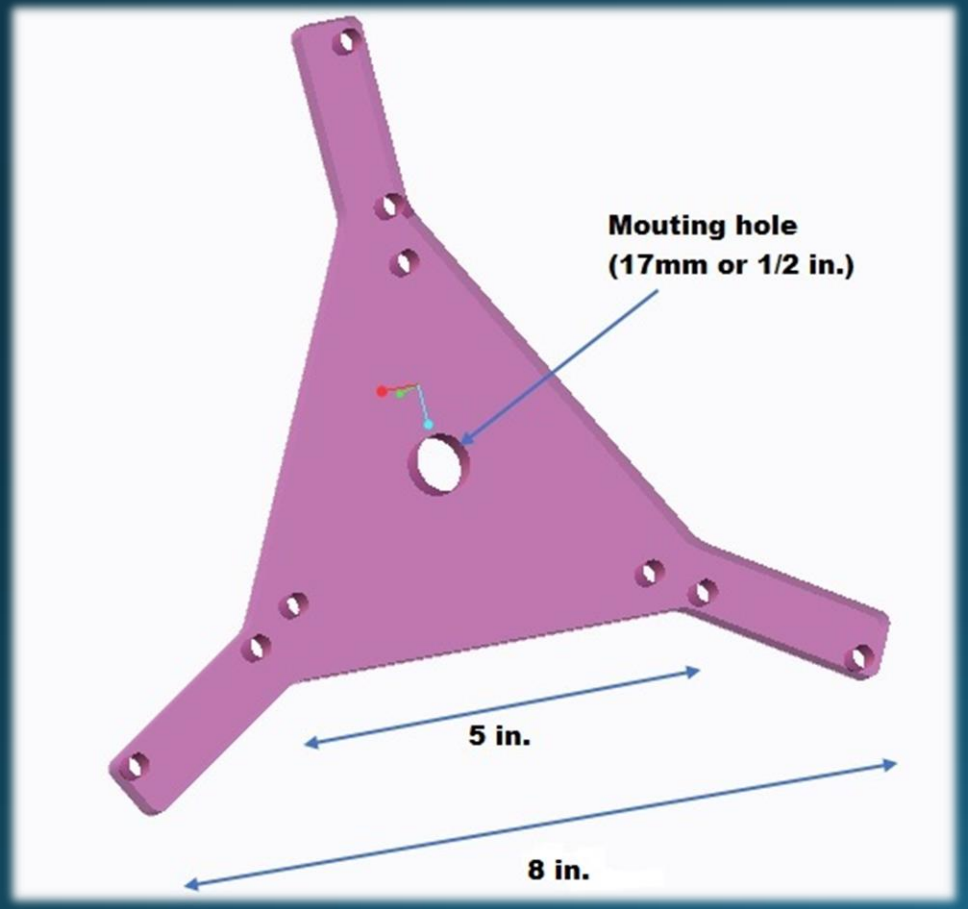



Figure 12

- Standard small wind turbine 3-blade hub
- 1/2 inch or 17mm diameter mounting hole
- May add hinges for increased portability
- Utilization of different/optional fasteners

# Nacelle Mounting

- Must allow easy assembly/disassembly
  - Minimize/eliminate tools required
- Pinch style idea discarded
  - Difficult to access under nacelle
- Pin idea discarded
  - Concerns of too much play
  - Additional parts required
- Selected Steering Wheel Quick Release

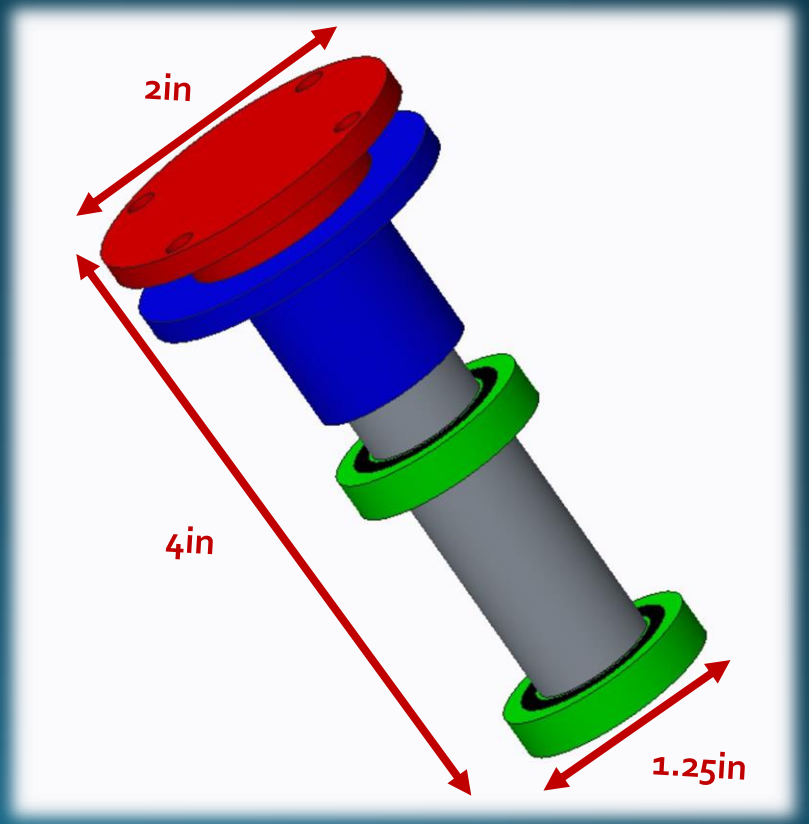



Figure 13

# Nacelle Mounting (Cont.)

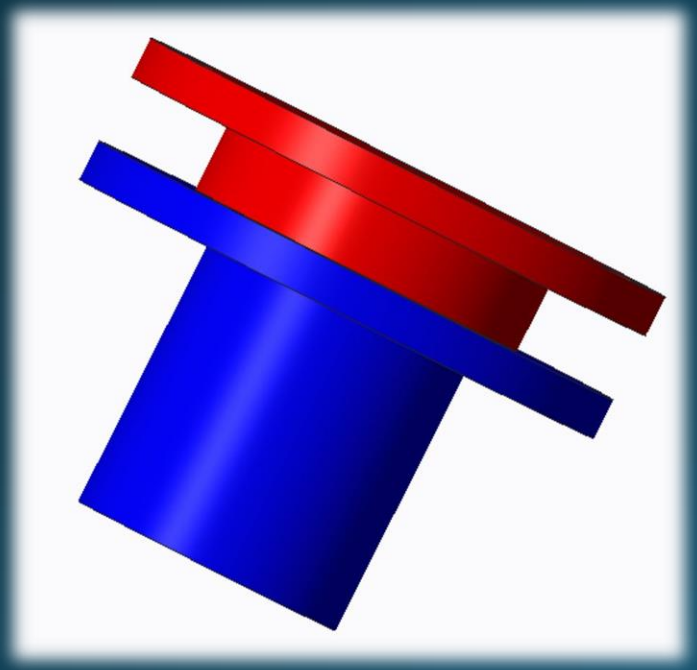


Figure 14

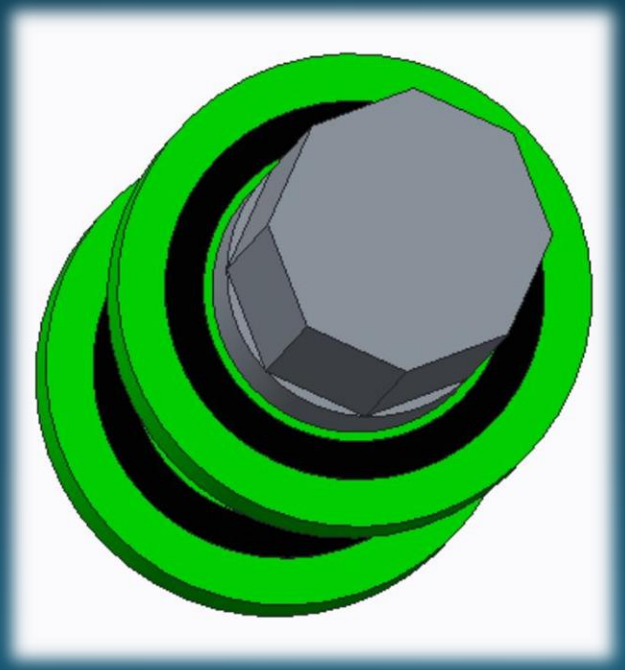


Figure 15

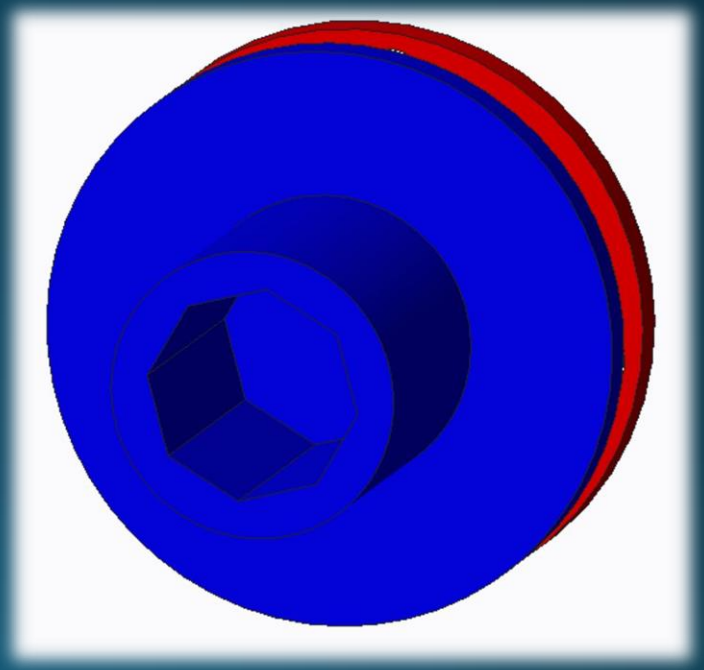
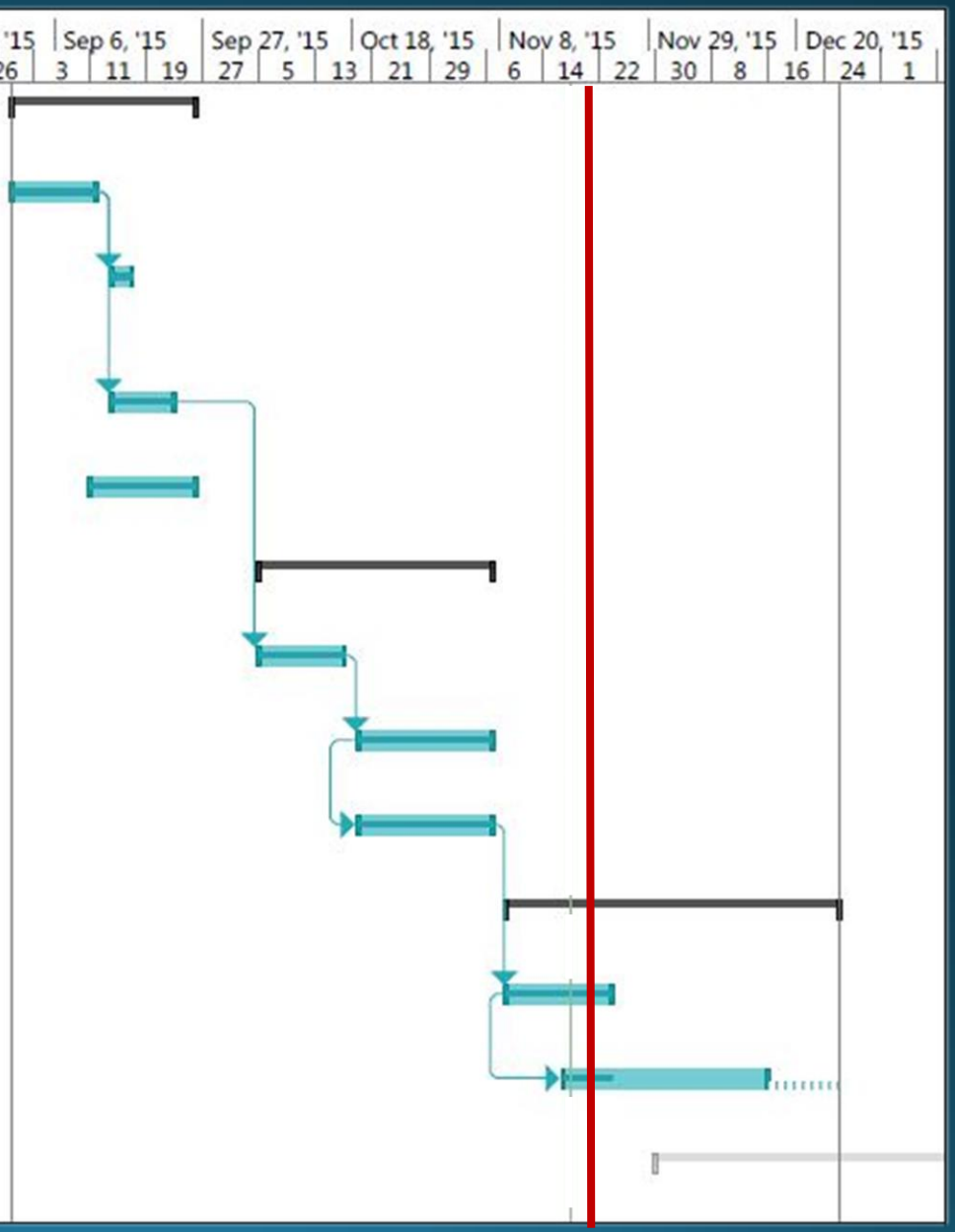


Figure 16

| ID | Task Mode | Task Name | Duration | Start | Finish |
|---|---|---|---|---|---|
| 1 | | **Project Planning** | **20 days** | **Mon 8/31/15** | **Fri 9/25/15** |
| 2 | | Meet Group and Advisor | 10 days | Mon 8/31/15 | Fri 9/11/15 |
| 3 | | Determine Contraints and Objective | 3 days | Mon 9/14/15 | Wed 9/16/15 |
| 4 | | Develop Need Statement | 7 days | Mon 9/14/15 | Tue 9/22/15 |
| 5 | | Create Schedule | 11 days | Fri 9/11/15 | Fri 9/25/15 |
| 6 | | **Conceptual Design** | **25 days** | **Mon 10/5/15** | **Fri 11/6/15** |
| 7 | | Brainstorming | 10 days | Mon 10/5/15 | Fri 10/16/15 |
| 8 | | Evaluate Concepts | 15 days | Mon 10/19/15 | Fri 11/6/15 |
| 9 | | Select Concept | 15 days | Mon 10/19/1 | Fri 11/6/15 |
| 10 | | **Detailed Design** | **35 days** | **Mon 11/9/15** | **Fri 12/25/15** |
| 11 | | Material Selection | 11 days | Mon 11/9/15 | Mon 11/23/1 |
| 12 | | Analysis | 21 days | Tue 11/17/15 | Fri 12/25/15 |
| 13 | | ~~Embodiment Design~~ | ~~110 days~~ | ~~Mon 11/30/1~~ | ~~Fri 4/29/16~~ |



# Moving Forward

- Power Generation
- Charging the Battery/Complications
- Ordering Parts
- Assembly/Testing

# Moving Forward - Power Generation

- DC Motor as generator
  - Permanent Magnet Motors
  - Volts-to-RPM Ratio
  - Amperage Rating

Figure 17 – DC-540 PMA Generator

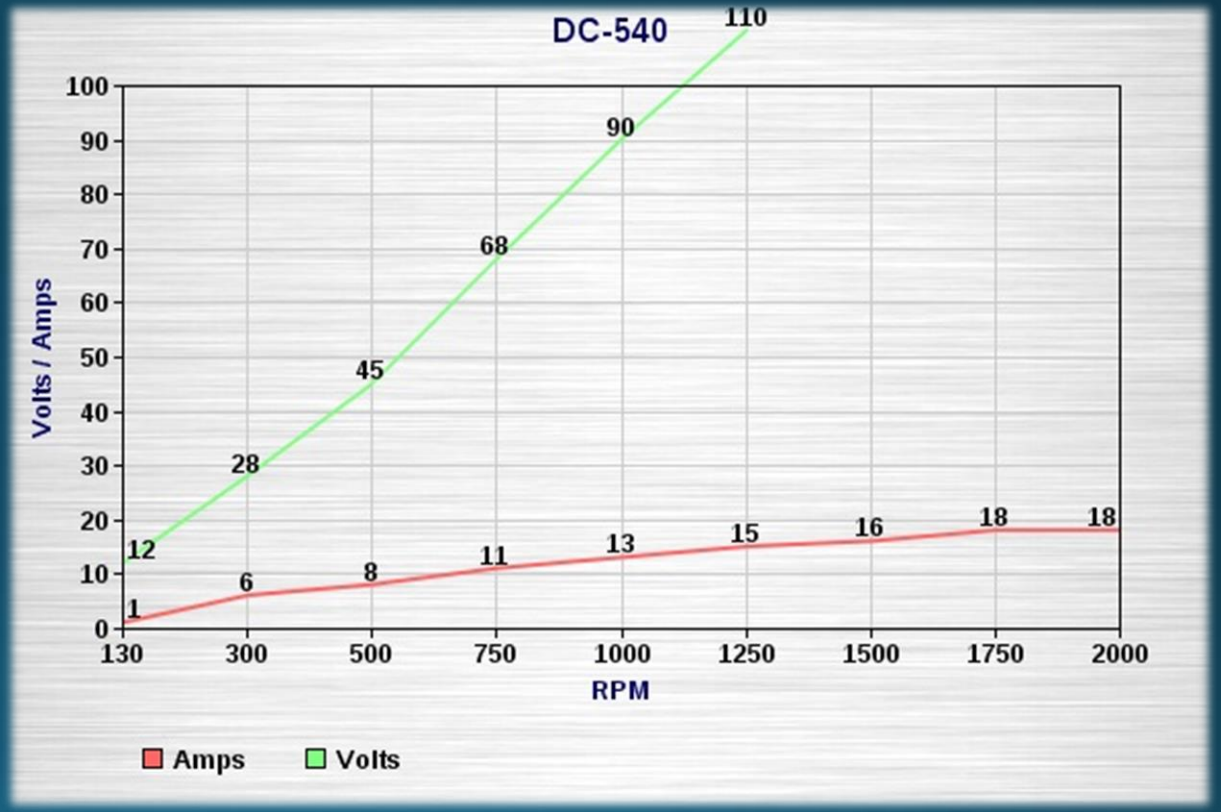



Figure 18 – DC-540 PMA RPM vs Volts/Amps

# Moving Forward – Battery Charging

Table 1. Moving forward with battery charging

| Problems | How To Handle |
|---|---|
| Voltage must be high enough | Select correct motor based on blade selection and wind speeds |
| Current only flow one direction | Diode |
| Current must be high enough | Problem to be researched |
| Must not overcharge the battery | Charge controller |

# Moving Forward – Ordering/Testing

- Ordering Parts
- Assembly Testing

# References


1. Claremont. Stick Figure Drawing Checklist, Image, Web, Accessed Nov. 16, 2015. http://claremont.sd63.bc.ca/pluginfile.php/20101/mod_page/content/9/stick_figure_drawing_checklist_800_2328%20(1).jpg
2. WindyNation. 28in HyperSpin Aluminum Wind Turbine Generator Blades, Image, Web, Accessed Oct. 21, 2015. http://www.windynation.com/Blade-Sets/28-inch-HyperSpin-Aluminum-Wind-Turbine-Generator-Blades-Set-of-5/-/651?p=YzE9NQ==
3. Explora. Tips on Upgrading to a Professional Video Tripod System, Image, Web, Accessed Oct. 21, 2015. http://www.bhphotovideo.com/explora/video/tips-and-solutions/tips-upgrading-professional-video-tripod-system
4. Wind Map
5. WindyNation. 28in HyperSpin P Series Wind Turbine Generator Blades, Image, Web, Accessed Nov. 18, 2015. http://www.windynation.com/Blade-Sets/28-inch-HyperSpin-P-Series-Wind-Turbine-Blades-Set-of-3/-/172?p=YzE9MTM=
6. Manwell, McGowan and A.L. Rogers. *Wind Energy Explained: Theory, Design and Application, 2nd Ed.* West Sussex, UK: John Wiley & Sons Ltd., 2009. PDF, pg 140.
7. Club Frontier. Pin with Retainer, Image, Web, Accessed Nov. 18, 2015. http://www.clubfrontier.org/forums/attachments/f76/116849d1420690335-dumont-sand-dunes-new-years-1-3-2015-41188ool.jpg
8. PresenterMedia. Running Up Arrow Stairs, Image, Web, Accessed Oct. 21, 2015. http://www.presentermedia.com/index.php?target=closeup&maincat=clipart&id=5692
9. WindyNation, DC-540 Motor, Image, Web, Accessed Nov. 18, 2015. http://www.windbluepower.com/Permanent_Magnet_Alternator_Wind_Blue_Low_Wind_p/dc-540.htm

# Questions?