UCI Zephyr Project - Midterm Presentation

UCI
Zephyr Project

University of California, Irvine

MAE 189 - Capstone Project

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Problem Definition and Goals

- ## Problem Definition

A limited number of small, portable charging devices for camping applications exist in the current market. Our goal is to design a wind turbine that will be small enough to fit in a hiking backpack, be quickly assembled, and be capable of charging several small electronic devices overnight.

- ## Goals
    - Create a design that is lightweight, small, and compact
    - Allow the product to be quickly assembled
    - Maximize energy output for charging
    - Minimize the cost of manufacturing

Current market Portable Wind Turbine

Gerardo Barajas

Design Attributes

Key design principles:

- Reliability
- Ease of Assembly
- Ease of Operation
- Portability
- Capability

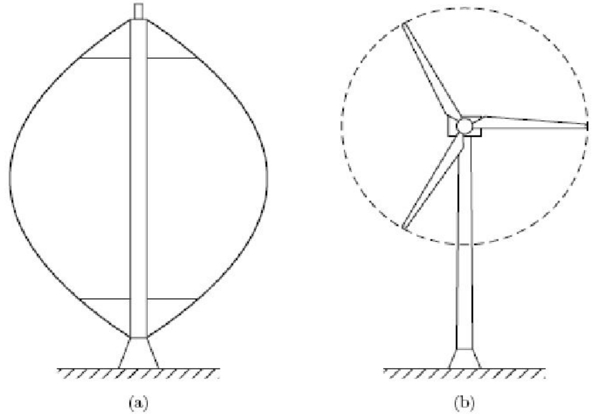
Attribute	O	C	F	M
Must be easy to manufacture and assemble	X			
Should be simple and compact	X			
Must be reliable	X			
Must be safe	X			
Should be easy to operate	X			
The packing size and weight should be very small to be added to a hiking backpack.		X		
Must be able to charge portable appliances of a camping family (2 Cell Phone, Camera battery Charger, flashlight, backup battery bank)			X	
Might use an energy storage system				X
Might be collapsible				X
Must resist deterioration from natural elements (rain, dust)	X			

Brendan Watson

Key Mechanical Design Decisions

Wind Turbine Type

- Vertical versus Horizontal



* (A) Vertical and (B) Horizontal Turbine types*

Power Generated

$$P = C_p \frac{1}{2} \rho v^3 A$$

$$\rho = 1.225 \frac{kg}{m^3}$$

V = 10 m/s

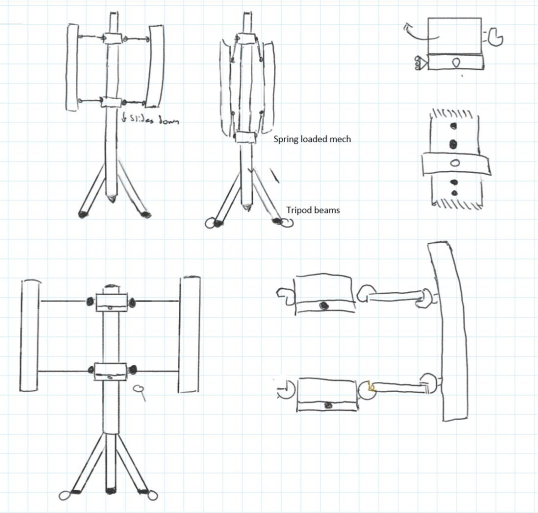
	Cp	Radius (ft)	Height (ft)	Wattage
H Type	0.38	0.5	1.25	27.0
D Type	0.40	0.5	1.25	28.5
Helical	0.43	0.5	1.25	30.6
HAWT	0.45	1	N/A	80.2

Andrew Lam

Key Mechanical Design Decisions

Portability Mechanisms

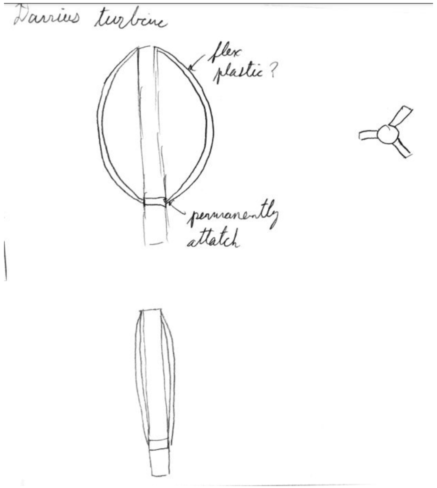
- Tower Subsystem
  - Telescoping vs Multiple Components Tower
- Blade Subsystem
  - Removable vs Retractable Blades
- Base Subsystem
  - Stake versus Tripod



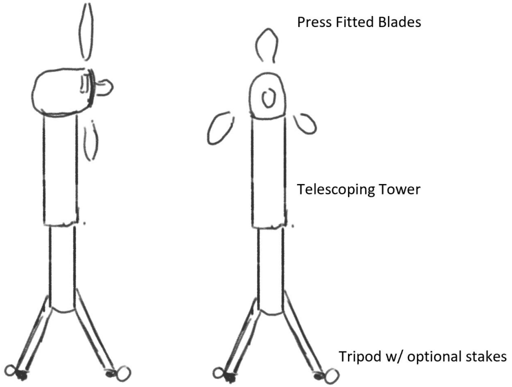
H type turbine -
Umbrella Cast concept

Andrew Lam

Other Mechanical Design Concepts



D type turbine -
"Bend-a-Plastic" concept



"Collapsed HAWT" concept

Andrew Lam

Key Electrical Design Decisions

Motor Type

- Brushless DC
- Asynchronous AC
- Synchronous AC

Power Conditioning

- Rectification
- DC to DC conversion
- Inverter

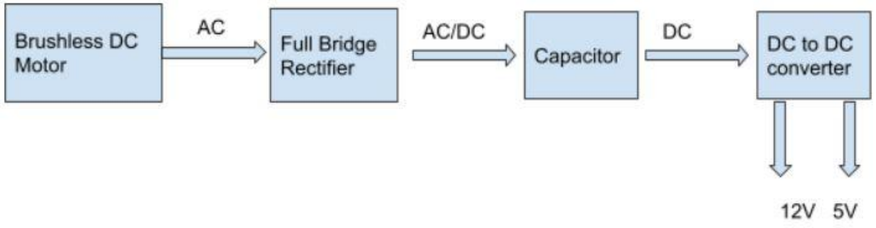
Criteria

- Power/weight ratios
- Volts/rpm ratios
- Efficiency
- Maintenance Requirements
- Cost

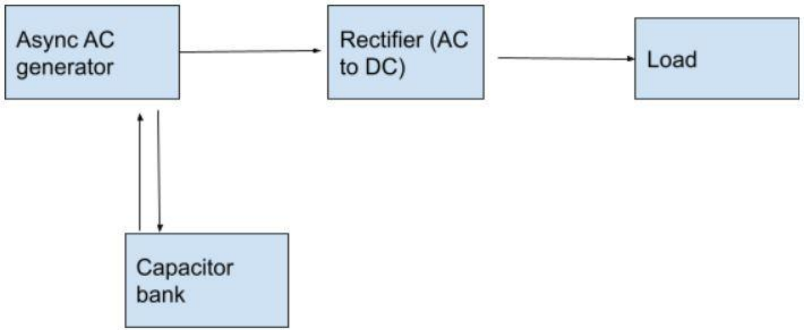
Felix Avila

Electrical Concepts Diagrams

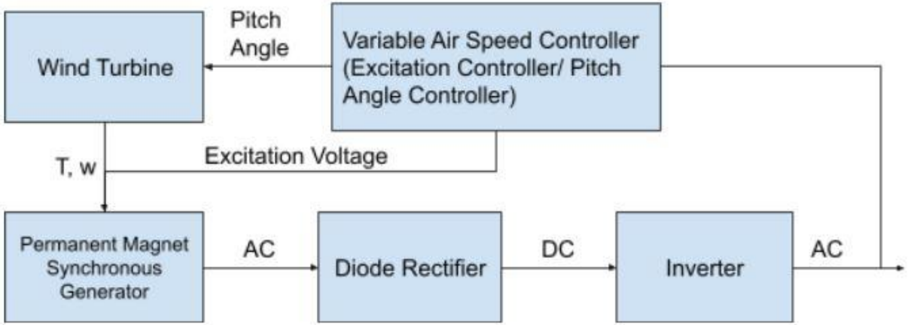
Brushless DC



Asynchronous AC

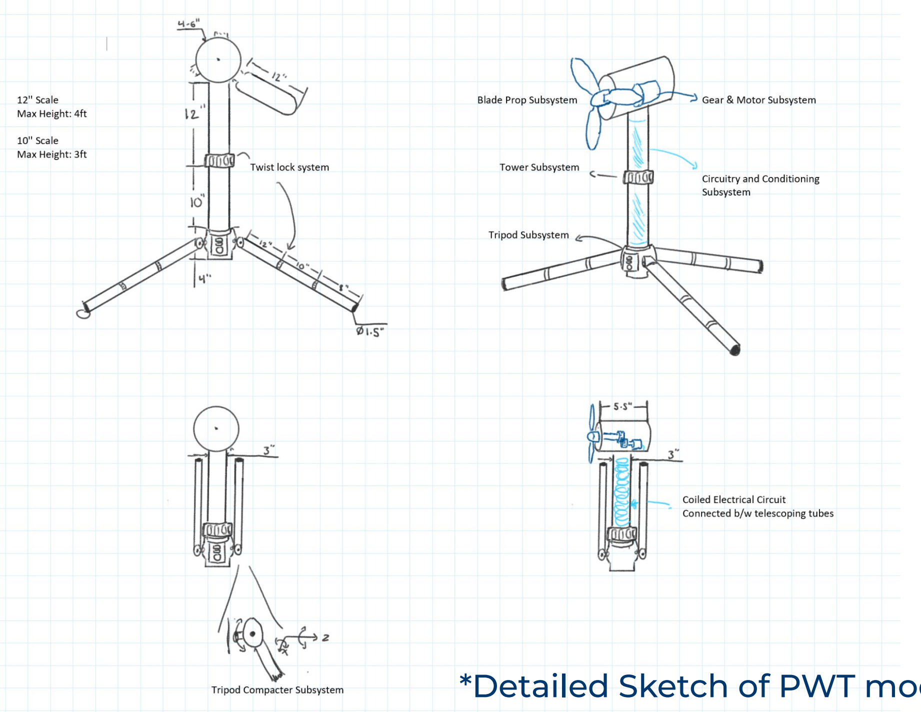


Synchronous AC



Felix Avila

Design Summary



Detailed Sketch of PWT model

- Design Features
  - Horizontal Axis Wind Turbine
  - Brushless DC Generator
  - Telescoping tower
  - Folding and telescoping tripod
  - Removable blades

Nausir Firas

Design Summary Cont.

Strengths	Weaknesses	Opportunities	Threats
• Incorporating the horizontal wind turbine allows for far greater efficiency compared to vertical wind turbines • The telescoping base allows for the design to be small and compact • The use of a BLDC generator allows for low maintenance and high durability while minimizing weight	• The design would need to incorporate a method of facing optimal wind direction • Portability mechanisms are complex and add more failure points • Ability to generate enough power to support the charging of all the requested items overnight • Blade sizing can affect fit within a hiking backpack	• Provide more power than current market designs • Provide a cheaper product than current market designs	• Potentially low demand for such a product because it would not provide enough power for extended camping trips

Nausir Firas

Design Schedule

- Detailed Engineering Analysis
- 3D Modeling and Drawings
  - 5/2-5/12
- Prototype Plan
  - 5/9-5/12
- Design Verification
  - 5/9-5/12

- **Mechanical** (Brendan, Andrew, Nausir)
  - Blades
  - Tower and Tripod
  - Generator Housing
  - Portability Mechanism

- **Electrical** (Gerardo, Felix)
  - Generator
  - Control System
  - Circuit Board

Nausir Firas

Concerns

- Verification of power generated (ANSYS or MatLab)
- Tower material choice (Acrylic vs PVC Pipe)
- Wiring complications due to telescoping tower
- 3D printing blades and blade housing
- Orienting mechanism

Thank you for listening
Questions?