Collegiate Wind Competition 2017-2018

Mechanical Design

Devon Hardy,
Dakota Sallaway,
Spencer McMahon,
Jacob Peterson,
Soud Alsahli,
Kory Joe

NORTHERN ARIZONA UNIVERSITY
College of Engineering, Forestry, and Natural Sciences

COLLEGIATE WIND COMPETITION
U.S. DEPARTMENT OF ENERGY

Presentation Outline:

- Project Description
- Budget
- Design Requirements
- Design Subsystems
- Material Selection
- Design Process
- Manufacturing Process
- Final Design
- Testing Procedures
- Data Collection

Project Description

Collegiate Wind Competition (CWC)

- Event Sponsors:
  - U.S. Department of Energy (DOE)
  - National Renewable Energy Laboratory (NREL)
- Clients:
  - David Willy
  - Karin Wadsack
- Team Goal:
  - **<u>Build & Test a Small Scale Wind Turbine.</u>**

Budget

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- **Build/Design :**
  - GORE: $3000
- **Traveling:**
  - PAY 'N TAKE: $60.00
  - BIGFOOT BBQ: $150.00
  - ASNAU: $923.08

Table 1: Building Budget for Mechanical Team

Total	Expenses	Remaining
$1500	$756.82	$743.18
$3000	$1905.43	$1094.57

Design Requirements

- Turbine Size: 45cm x 45 cm x 45 cm.
- Operating Wind Speed = 2 - 20m/s ± 2m/s
- Cut-In Wind Speed = 2 m/s ⟶ 5 m/s
- Cut-Out Wind Speed = 20 ± 0.5m/s
- Power Generation > 10 WATTS @ 10 m/s
- Turbine Efficiency = 35% ± 5%

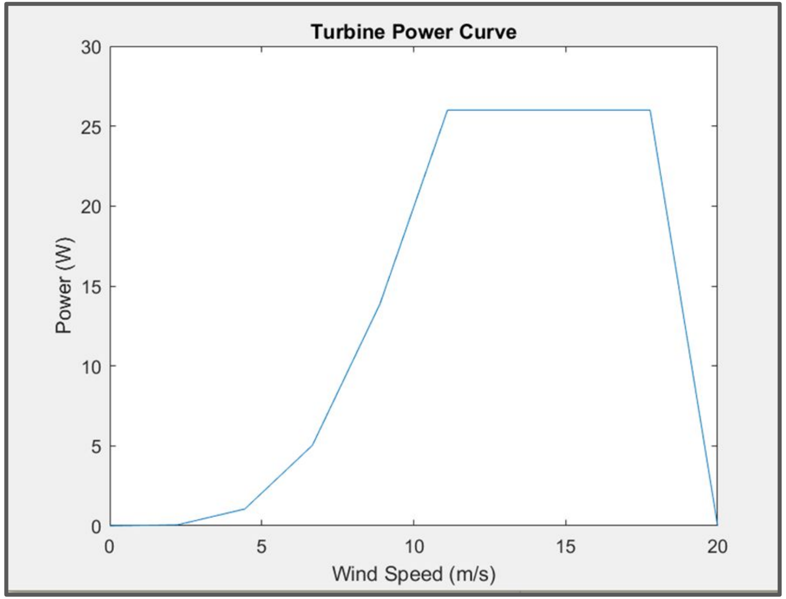

Figure 1: Turbine Power Curve

Design Subsystems

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- Blade Design
  - Devon
- Hub Design
  - Spencer
- Shaft
  - Soud/Kory
- Braking System
  - Jacob
- Yawing Mechanism Design
  - Jacob
- Nacelle Design
  - Dakota
- Tower Design
  - Dakota
- Base-plate Design
  - Dakota

Material Selections

3D Print

- Blades
  - ULTEM 9085
- Active-Pitching Hub
  - ABS 3D Filament

Structural Metals

- Blade Roots
  - T304 Stainless Steel
- Tower
  - 4130 Steel
- Baseplate
  - A36 Steel

Lightweight Metals

- Nacelle
  - 6061-T6 Aluminum
- Yaw Fins
  - 6061-T6 Aluminum
- Shaft
  - 7075-T6 Aluminum

Braking System

- Disk: Zinc Coated Steel
- Pads: Rigid Molded Non-asbestos

Design Process

- CAD design and modeling
- Programming verification
- Prototyping
- Redesign and prototyping
- Final design and approval

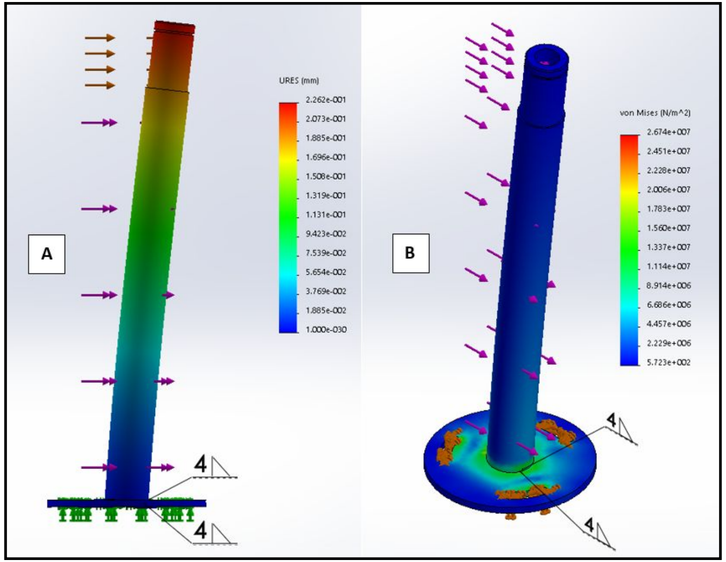

Figure 2: SOLIDWORKS FEA simulation

Manufacturing Process

Machines Used

- CNC Mill
- Manual Mill
- Lathe
- 3D Printer

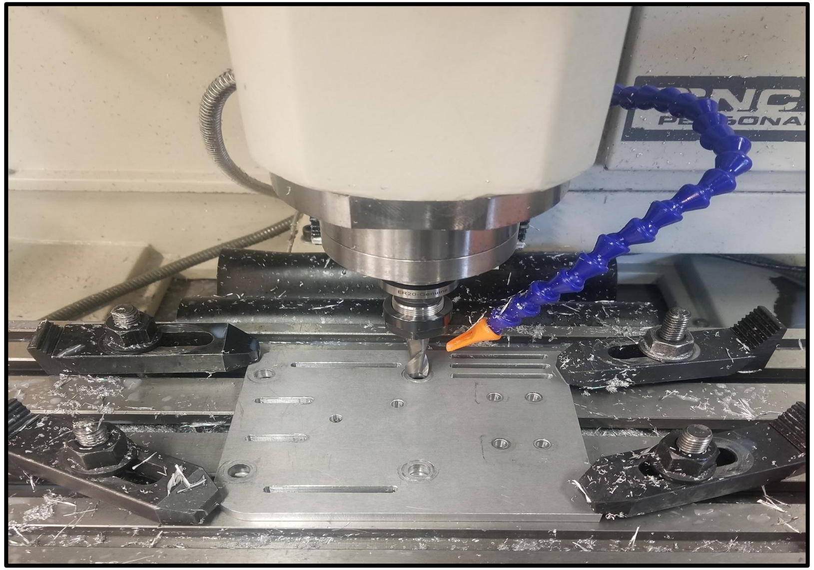

Figure 3: Top Nacelle on the CNC

Final Design

- Latching Solenoid Braking system
- Dual fin Passive yawing system
- Multi-layered Nacelle
- Direct Drive Shaft
- Active Pitching Hub

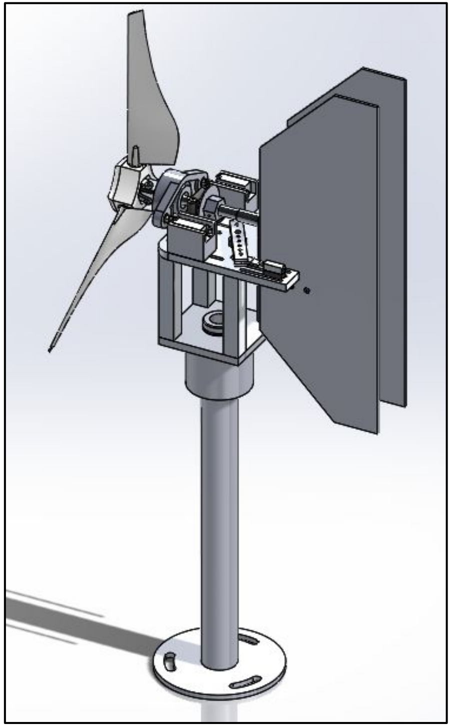

Figure 4: Final CAD Design

Data Collection

- Developed a LabVIEW data acquisition program
- Created for measuring wind tunnel wind speeds
- Used pre-created programs to produce functional program for our testing purposes

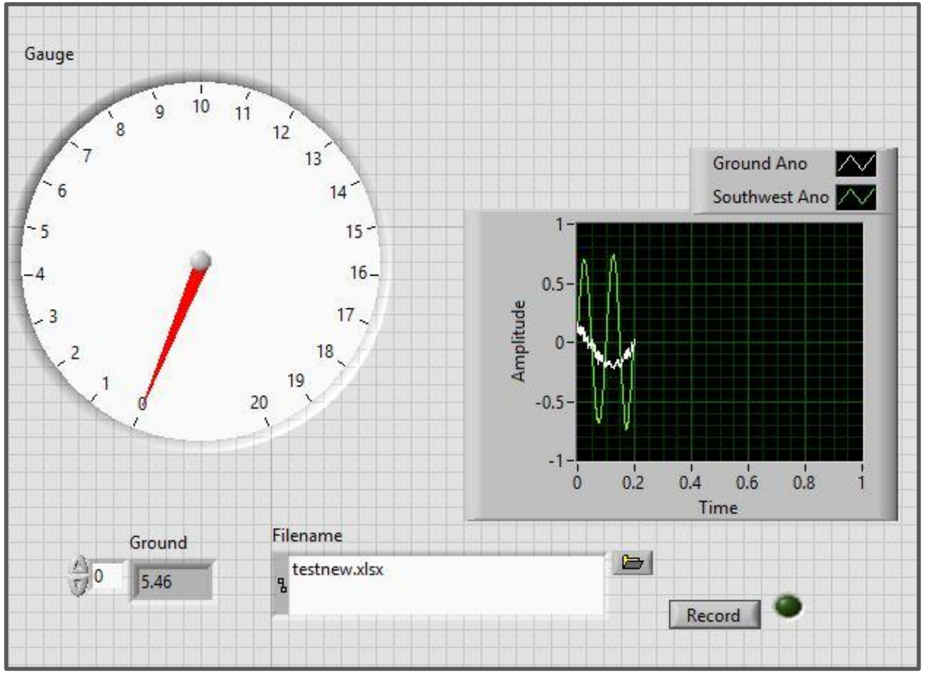

Figure 5: LabVIEW Wind Speed Program

Testing

- Procedure
  - Testing at an off campus wind tunnel provided by Southwest Windpower
  - Redesigned wind tunnel fixture
  - Redesigned anemometer mount for data acquisition
  - Testing single subsystems before testing the system as a whole
- Results
  - Blades start up at a wind speed of 5 m/s
  - Brakes can effectively stop the turbine from spinning up to a wind speed of 7 m/s

Data Collected

- Bench Testing

	Cut-in	Steady-State
Vin	0.50V	2.5V
Vout	2.0V	5.0V
Iin	1.0A	5.0A
Iout	0.50A	2.5A
Pout	1.0W	12.5W

- Wind Tunnel Testing

	Cut-in	Steady-State
Vin	0.11V	1.75V
Vout	1.0V	5.0V
Iin	1.81A	2.85A
Iout	0.20A	1.0A
Pout	0.20W	5.0W

Questions?