Open Ended Wind Energy - 13
HardWare Review 2

Michele Tsosie
Abdulrahman Alossaimi
Ahmad Saeed
Fahad Almutairi
Besongnsi Ntoung

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Summary

The presentation involved the extent of our progress in manufacturing and understanding the components of the Wind Turbine. During the presentation, the topics discussed were the purpose of the capstone project, the original design that was developed through Customer Requirements and Engineering Requirements, and the Final Design of the Wind Turbine. The constraints were determined by the Collegiate Wind Energy Competition and the client, Professor David Willy. The CR and ER determined the path in understanding the systems that are involved in the mechanics behind the wind turbine mechanism.

The space allowable was given by the size of the testing site, which is 45cm x 45 cm x 45cm.

Our design has changed from the previous semester to this semester and from Hardware Review 1 to this point. We were able to develop a complete CAD package using Solidworks. The new design was evaluated by the client on several meetings. The blades involved 65 iterations using three airfoils. The blades were important in starting the analysis of the wind turbine forces that would affect the hub, shaft, braking system, and the generator. The old design continued to give negative power and thrust values. These were not acceptable to the client. The final design, which is the NACA 2414 gives the best optimization in power and thrust values needed to continue in the next phase of the design. The blades were 3D printed at the Rapid Lab. The following figure 1 is the first 3D print.

Figure 1 : Blade Design

The fin design is a direct yaw system that initially was a single fin and now has been redesigned to a two fin mechanism. As the wind hits the fins the entire mainframe apparatus turns the blades perpendicular to the wind which will be allowed by a two bearing system. The following figure 2 is our chosen bearing for the tower yaw system suggested by the client.

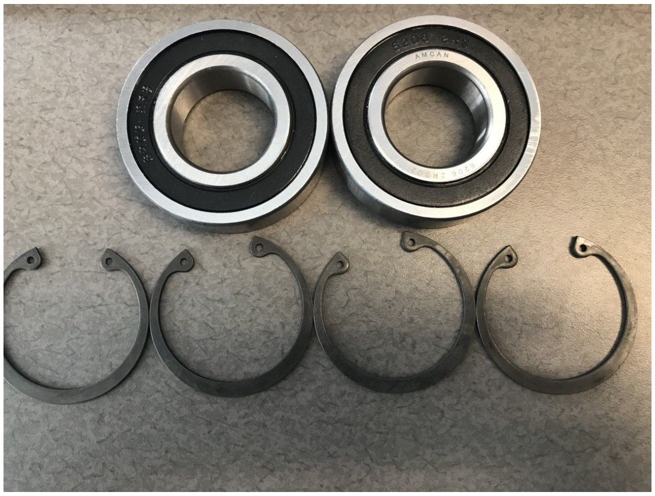

Figure 2 : Bearings

The nacelle involves the entire mainframe of the wind turbine. The shaft, braking system, and the generator will be mounted to the nacelle. The fin is also attached to the nacelle for support. The original design of the nacelle involved a covered apparatus that would be 3D printed to cover the components. We decided to develop a nacelle that did not have effects of drag and decreasing the lift for the blades. The flat plate design was the best choice. The final design will have no cover and the all components will be exposed. The fins will be attached to the back of the nacelle and the generator will sit to the back between the fins.

Shaft design involves understanding the forces that affect the shaft and generator mechanism. The thrust from the blades was needed for the analysis as well as radial and moment. The braking system also affects the shaft mechanism as it is applied at 20 m/s. In figure 3 and 4, shows the braking system that was accepted by the client.

Figure 3 and 4 : Brake

The updates for the design is incorporating several components that were approved by the client. Our client approved the bearing sizes, the brake disks, and the linear actuator for the brake system. In moving forward in the design, we will be using the Fab Lab and outsourcing some of the tasks for the tower apparatus and also welding. Artisan Metal Works will be our location for the purpose of milling, turning, and welding. The blades will be 3D printed at the Rapid Lab for quality and also the maker lab for comparison. The braking system will be evaluated for assembly to our shaft and determining the location on the nacelle.

The design will be tested theoretically through calculations and experimental methods. Our client has suggested a possible test for the generator which involves building a circuit and attaching a heatsink to analyze the amount of power that is generated. A drill will be attached to the shaft to create the blade turning simulation. Figure 5 and 6 shows the suggested generator from client and the circuit build that the client recommended for testing and evaluating the power output.

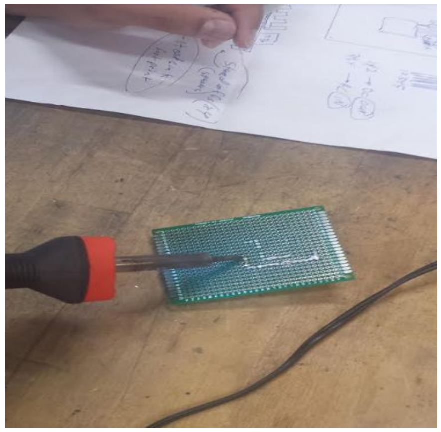

Figure 5 : Generator Figure 6 : Building a Heat Sink on Circuit Board

Experimental and theoretical analysis was conducted through FEA in solidworks. The factor of safety and the deformation of the tower were evaluated using this particular method. Values were obstructed from solidworks and mathematical calculations were evaluated at this point in the project.

Bill of Materials and Gantt Chart were presented to aid in visually understanding the extent of the project and how far we have come to this point in the completion of the wind turbine. Cost analysis in material selection and the time constraints involved in the manipulation of the material was addressed and the components that were fully assembled based on the limited availability of the Fab Lab. The following Bill of Materials was generated for expense analysis and references to parts location.

BILL OF MATERIALS (BOM)

ITEM N(	Material	Purchase	QTY.	COST PRICE	Manufacturer	Description	Part Number	Website
1	Brakes	X	1	$35.00	king motor	stainless steel / carbon pads		https://m.ebay.com/itm/NEW-KING-MOTOR-Brake-Hardware-HPI-BAJA-5B-SS-5T-5SC-Compatible-GB9-/312092464877
2	Shaft	X	1	$38.76	master carr	stainless steel rod		https://www.mcmaster.com/#precision-shafts/=1djjpt2
3	Generator	X	1	$45.24	Turnigy power system	HD 3508 Brushless Gimbal	9244000018	https://hobbyking.com/en_us/turnigy-hd-3508-brushless-gimbal-motor-bldc.html
4	Welding	X	1/2	$90.00/hr.	Artisan Metal Works	Welding and Metal Fabrication	xxxxx	http://www.artisanmetalworks.net/
5	Turning	X	1/2	$90.00/hr.	Artisan Metal Works	Turning of metal pipe	xxxxx	http://www.artisanmetalworks.net/
6	Milling	X	1/2	$90.00/hr.	Artisan Metal Works	Milling of raw metal	xxxxx	http://www.artisanmetalworks.net/
7	Aluminum 6061-T6	X	1	$32.00/sheet	Metals Depot	0.04 " thick metal sheet 4x3 ft	S3040-6061	https://www.metalsdepot.com/aluminum-products/6061-aluminum-sheet-plate
8	HR Steel	X	1	$6.60/2ft.	Metals Depot	3/8' by 3/4' HR A36 Steel Rolled flat	F23834	https://www.metalsdepot.com
9	Blades	X	3	$3.38	Maker Lab - Cline	PLA 3D printing		https://nau.edu/library/
10	Blades	x	3		Rapid Lab - Fab Lab	3D printing		https://nau.edu/cefns/engineering/mechanical/research-and-labs/labs-facilities/engineering-fabrication-lab-(machine-shop)/
11	Hollow Steel Pipe	X	1	$0	Metals Depot	HR A36 Hollow Steel	xxxxx	https://www.metalsdepot.com
		TOTAL PRICE		$295.98				
	RAW MATERIAL							
	SUB-ASSEMBLED							
	MANUFACTURE							

Figure 7: Bill of Materials

Utilizing data from previous wind teams gave us the available known data that we could incorporate in our design for Factor of Safety and determining the acceptable data for our design. The client evaluated our values and has accepted the blade design and several other components to aid in completion.

A list of Action Items:

For this section a description of the tasks that are subdivided for the completion of the final product will be defined by each team member and determined by the extent of the subsystem. The Final Product Testing Proof is listed below by team member and the list of assigned tasks.

Besongnsi: He is responsible for designing the brakes , tower, and bearings.

Ahmad: He is responsible for designing the fin.

Abdul: He is responsible for designing the nacelle and blade design.

Michele: She is responsible for designing the blade.

Fahad: He is responsible for designing the shaft and bearings.

References

[1] Collegiate Wind Competition
https://www.energy.gov/eere/collegiatewindcompetition/collegiate-wind-competition

[2] SolidWorks
https://www.solidworks.com/how-to-buy/request-a-demo?mktid=7571&gclid=EAIaIQobChMIiebzuK2d3AIVhWV-Ch0Fmw-EEAAYASAAEgImTfD_BwE

[3] Qblade
http://www.q-blade.org/