CWC Generator

Christian Brown, Naomi Echo, Alonso Garcia, Javan Jake, Kaitlyn Redman

NAU NORTHERN ARIZONA UNIVERSITY

And Dynamometer

NAU NORTHERN ARIZONA UNIVERSITY

Project Description

- Goal: Create a small-scale generator for the NAU CWC team
  - Helps save time and resources
  - Improves performance of the turbine
- Client and Advisor: Professor Willy
  - 20+ years experience in industry
- Wind Energy is growing nationwide
  - Wind Energy in US [1]: 2014 - 4% VS 2023 - 10%

Figure 1: Wind Turbine

Design Efforts

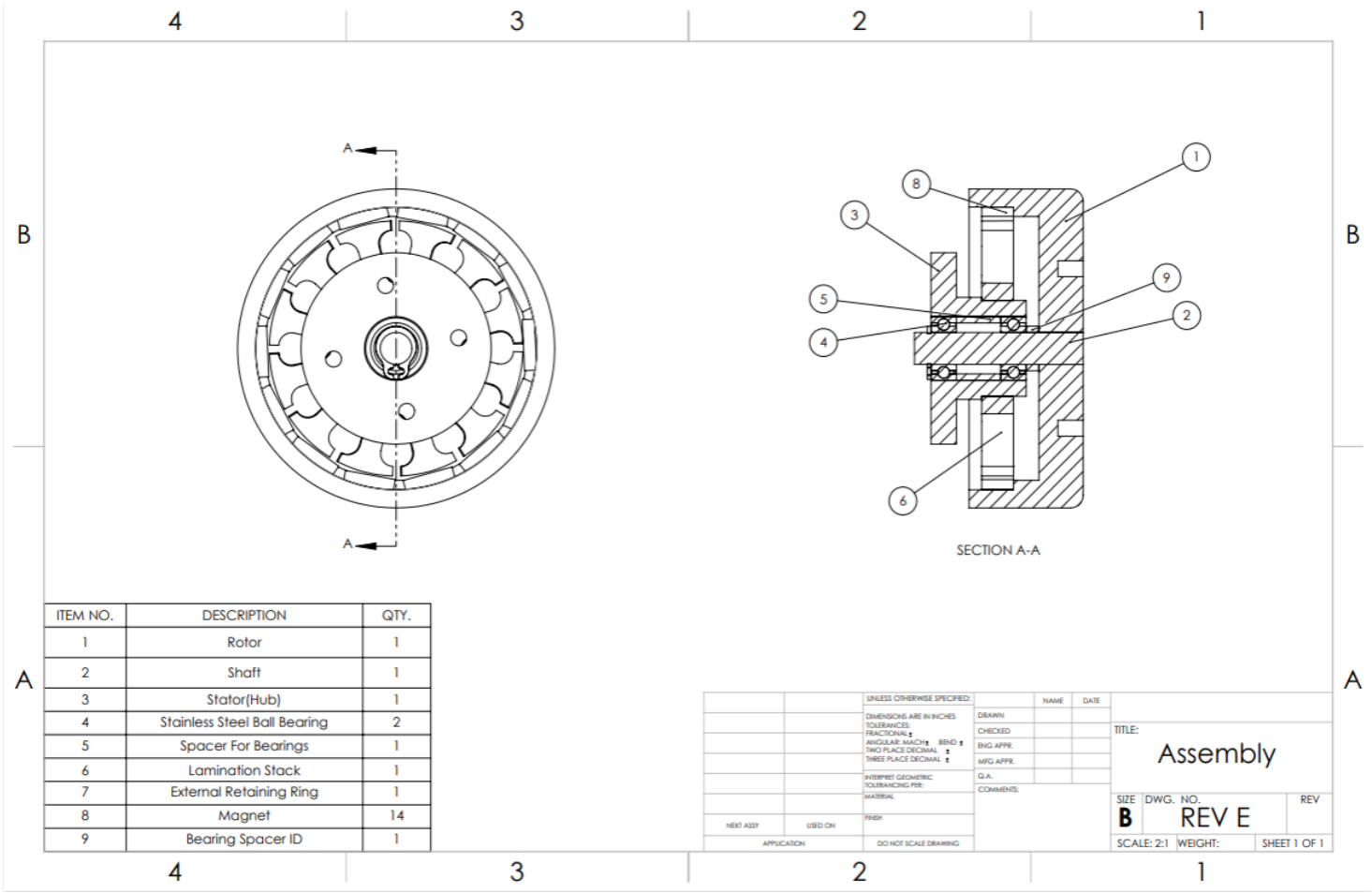

Figure 2: Rev E Assembly CAD

Purchasing Plan Generator

ITEM NO.	PART	DESCRIPTION	PURCHASE QUAN	Price $	Total Price $	PART STATUS	PRIMARY VENDER	LINK	NOTES	IMAGE
1	Magnet Wire	1pc Magnet Wire, 23 AW	1	$ 31.36	$ 31.36	Received	Remington Industries	https://www	More wiring	
2	Aluminum Rod	1pc - 2 1/2 inch diamete	1	$ 116.00	$ 116.00	Received	McMaster-Carr	Tight-Toleran	Manufacturing Casing and Hub	
3	Retaining Ring	100pc - External Retaini	100	$ 6.71	$ 6.71	Received	McMaster-Carr	External Ret	Only need 1	
4	Steel Rod	1pc - 2 1/2 inch diamete	1	$ 53.96	$ 53.96	Received	McMaster-Carr	Low-Carbon	For making the shaft of the generator	
5	Epoxy Glue	EFT Epoxy Glue	1	9.14	$ 9.14	Received	Harbor Feight	Quick-Settin	Appling to magnets to casing	
6	Ball Bearings	4pc Ball Bearings Bore 4	4	7.64	$ 7.64	Received	Amazon	uxcell MR10	Only need 2	
7	Magnet Wire	1pc Magnet Wire, 23 AWG Enameled Copper 8oz	1	19.09	$ 19.09	Received	Remington Industries	https://www	First wire purchase with donation	
8	Magnets	14pc Magnets	14	0	$ -	Received	Elemental Motor	-	Donation	
9	Silicon Steel	1pc Silicon Steel Sheet	1	0	$ -	Received	Elemental Motor	-	Donation	
11	Reamer Tool	1pc - High-speed Steel F	1	51.28	$51.28	Received	McMaster-Carr	https://www	Used cash funding	
12	Retaining ring	100pc - External Retaini	100	17.83	$17.83	Received	McMaster-Carr	External Ret	Need different size. Used cash funding.	
			Total Parts Nee	24	Total Parts Recei	24				
			Total Spent	$ 313.01	Parts Required (%	100%				
					Assembled (%)	100%				

Figure 3: Bill of materials - Generator

Purchasing Plan Dynamometer

ITEM NO.	PART	DESCRIPTION	PURCHASE QU	Price $	Total Price $	PART STATUS	PRIMARY VEND	LINK	NOTES	IMAGE
1	IR Sensor	Sensor IR transmitting Arduino	1	$9.99	$9.99	Received	Amazon	Amazon.co	Used Cash	
2	Current Sensor	Sensor Module Arduino	1	$11.99	$11.99	Received	Amazon	Amazon.co	Used Cash	
3	Electric Motor	Electric Motor	1	$0.00	$0.00	Received	Amazon		Donation	
4	Display Screen	Module Blue Backlight X 2	2	$39.96	$39.96	Received	Amazon	Amazon.co	Used Cash	
5	Breadboard	ElectroCookie Solerable Breadboard	1	$8.49	$8.49	Received	Amazon	Amazon.co	Used Cash	
6	Electrical Box	LeMotech Electrical Box 5.9"x3.9"x2.8"	1	$15.99	$15.99	Received	Amazon	LeMotech	Used Cash	
7	Black Cord	Black Rubber Cord	1	$0.00	$0.00	Received	The Home Dep	Southwire	Donated	
8	Power/Battery Co	Connectors Assortment kit	1	$30.12	$ 30.12	Received	Amazon	Amazon.co	Power kit for dyno	
9	Brushless Motor	Brushless Motor	1	$24.20	$ 24.20	Received	Amazon	Amazon.co	generator. One is for tesing other is to dissemble.	
			Total Parts Ne	10	Total Parts F	10				
			Total Spent	$ 140.74	Parts Requi	100%				
					Assembled	100%				

Figure 4: Bill of materials - Dynamometer

33% Recap

- Lamination Stack
- Coil Windings
  - 3-phases
- Hi-pot Testing
- Total hours to manufacture > 37 hours

Figure 5: 33% Built

67% Recap

- Machining
  - Hub
  - Shaft
  - Rotor
- Dyno Redesign
  - Coupler
- Mad Jenny Results

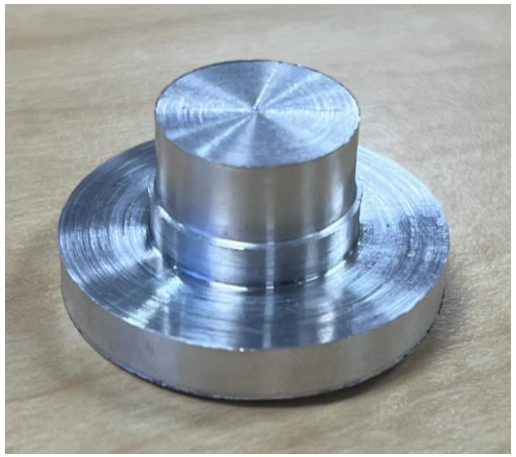

Figure 6: Machined Hub

Figure 7: Machined Shaft

Figure 8: Machined Rotor

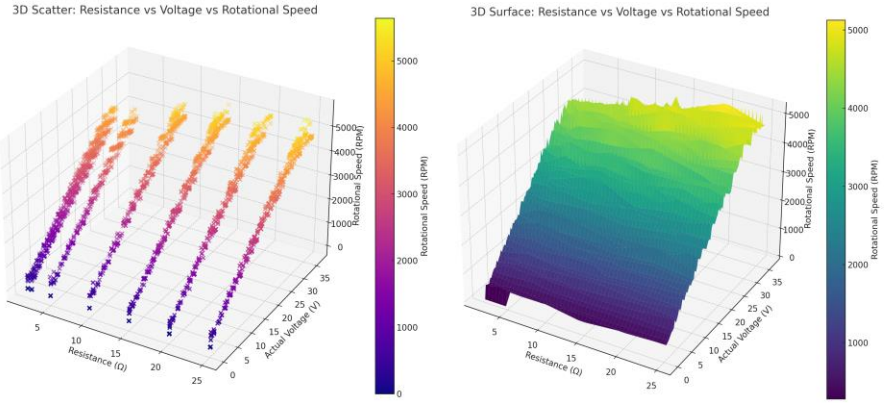

Figure 9: Initial Testing Results

100% Demonstration- Assembly

- Extremely low cogging torque
- Assembly
  - Glued magnets
  - Re machined shaft, rotor, and stator
  - Shrink fit
  - Coil wiring

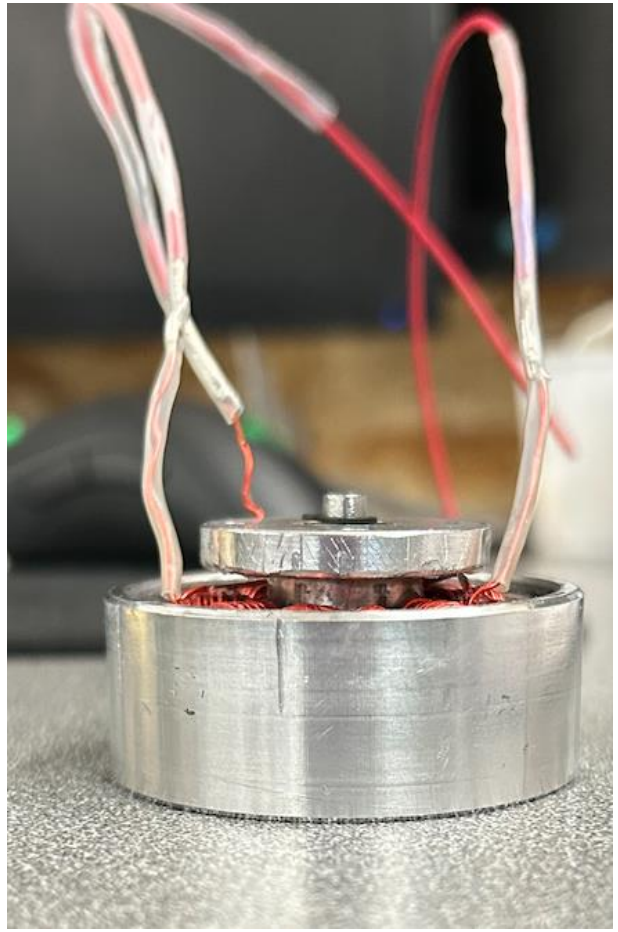

Figure 10: 100% Built

100% Demonstration- Stator

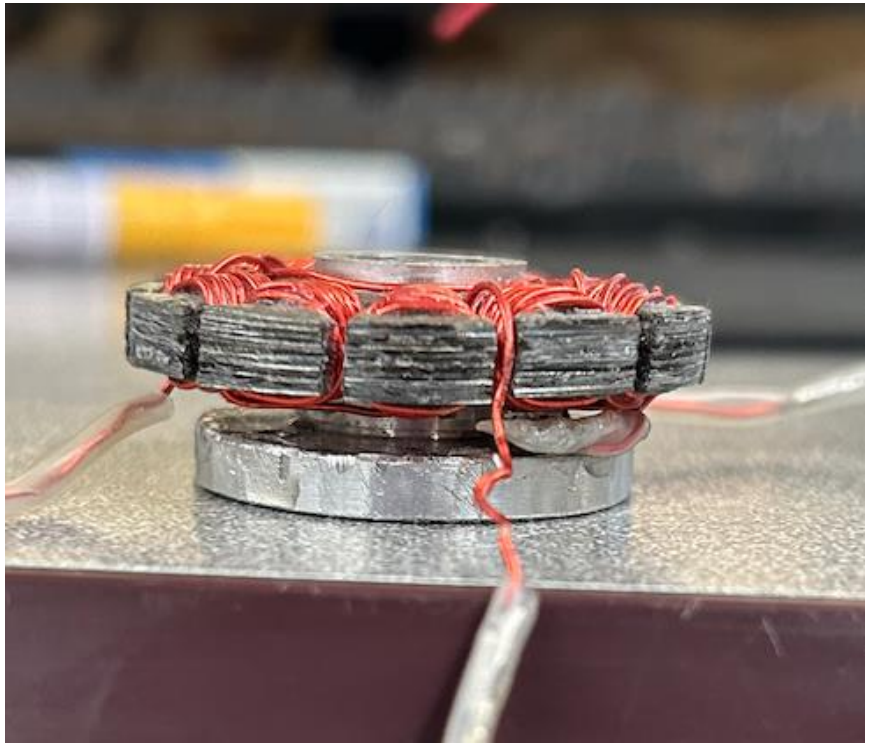

Figure 11: Side View of Stator

Figure 12: Rear Side of Stator

Figure 13: Front Side of Stator

100% Demonstration- Shrink Fit

- Rotor heated to 220 degrees Celsius
- Shaft was cooled to

–3.8 degrees Celsius

Figure 14: Shrink Fit

100% Demonstration- Rotor

Figure 15: Magnets in Rotor

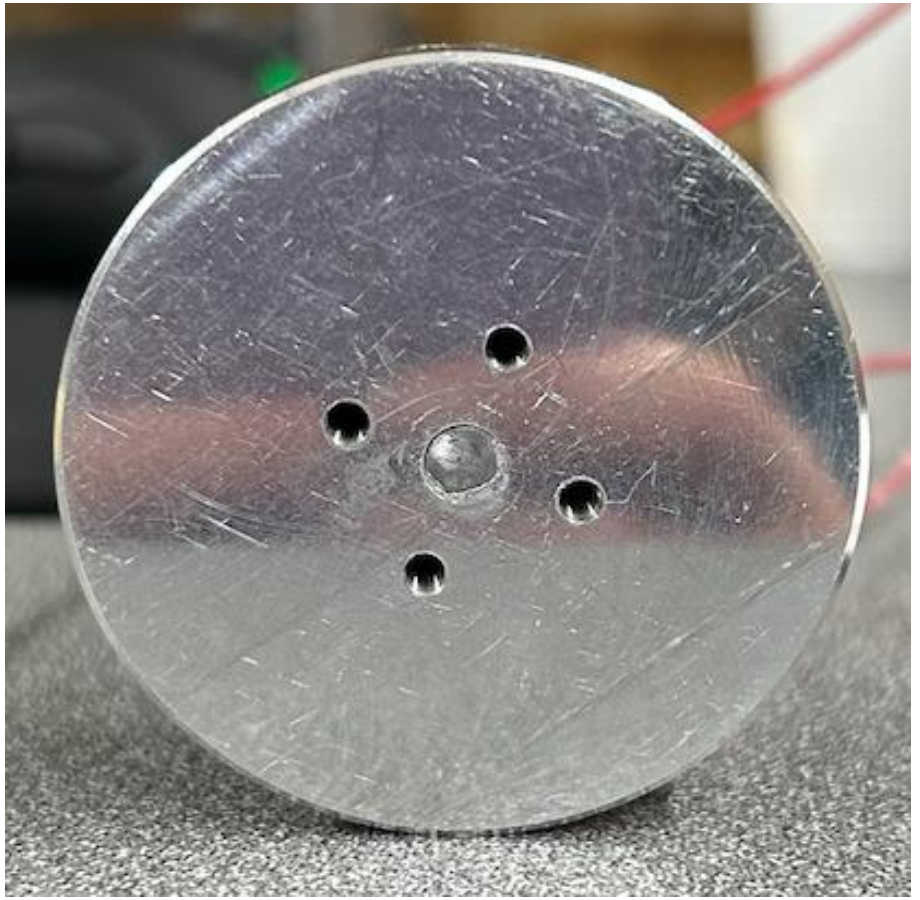

Figure 16: Front of Rotor

100% Demonstration- Soldering

- Created a "neutral point"
- All other wires are the individual phase wires
  - Grey – Phase A
  - Purple – Phase B
  - White – Phase C

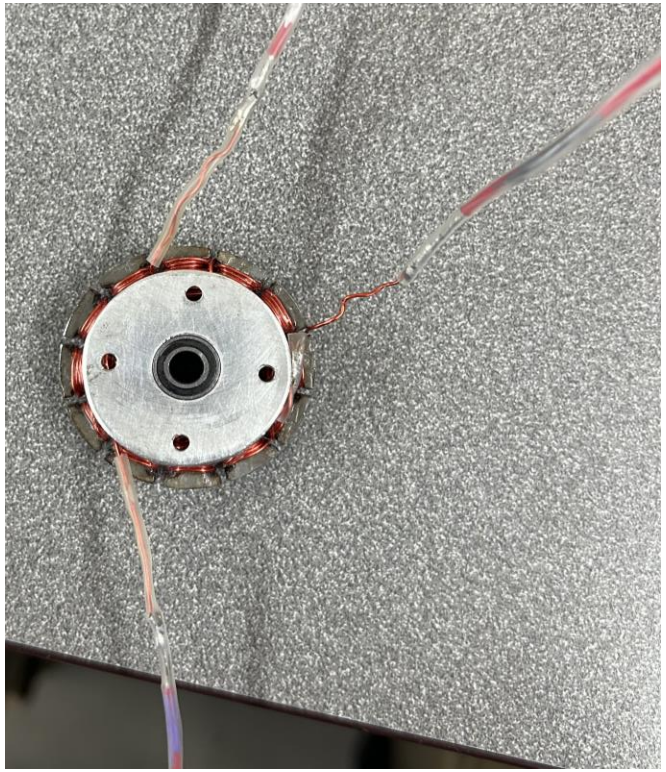

Figure 17: 100% Wired Generator

100% Demonstration – Dyno

- Removed destructive vibration
  - Provided tension to coupler
  - Little to no vibrations while experimenting
- Thicker L-brackets and coupler adapters for generator

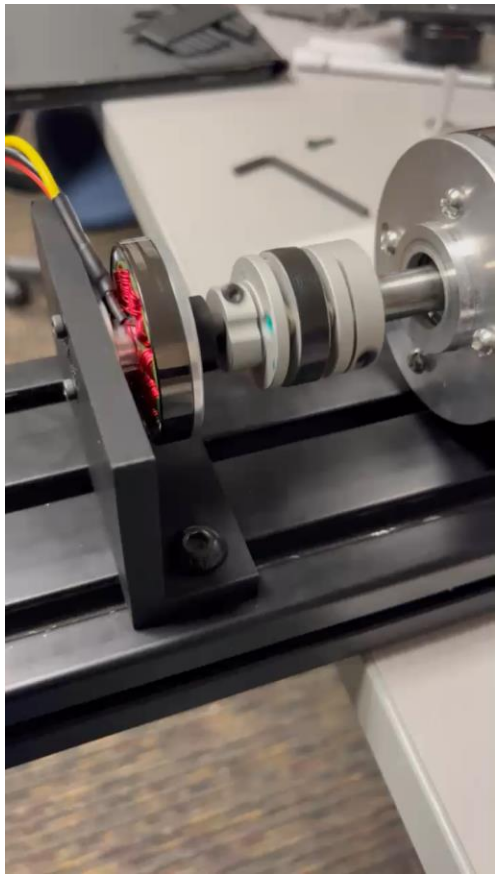

Figure 18: Dyno Demonstration

Figure 19: Dyno

100% Demonstration – Melon Motor

- Peak Power Achieved:
  - Mechanical Power = 75 W
  - Electrical Power = 60 W
- Exponential growth as power input increases
  - Should plateau
- Actual Kv rating = 345
  - Expected Kv rating = 360

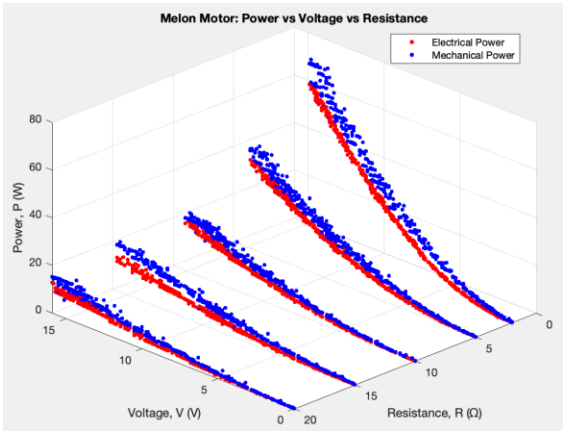

Figure 20: Constant Resistance Results

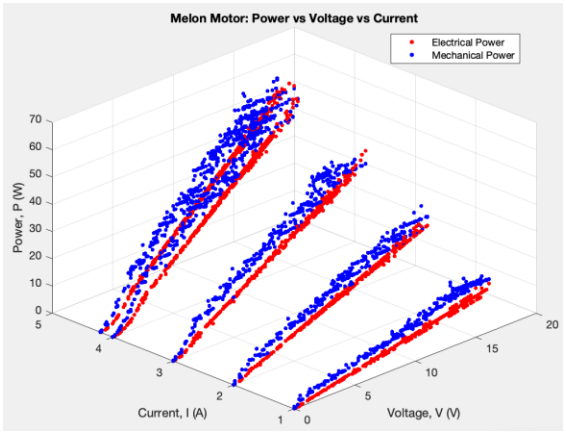

Figure 21: Constant Current Results

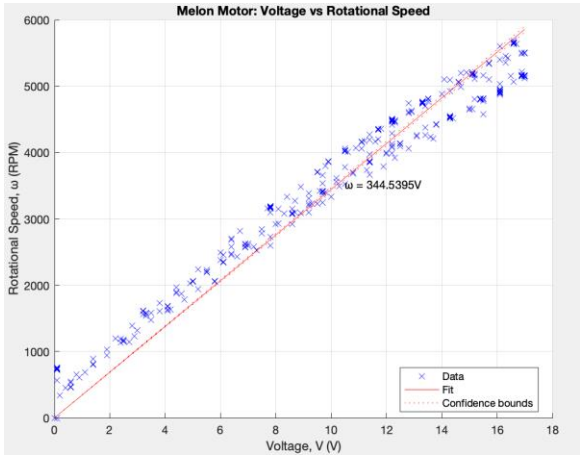

Figure 22: Kv Curve

QFD

House Of Quality			Technical Specifications (How)													Competitive Assessment		
			Maximum 48 Volts	45 cm Rotor Diameter	Low Cogging Torque [Nm]	Low Kv Rating	High Power Output [W]	Number of Coils	Wire Gauge	Cut Out Speed	Cut In Speed	RPM	Current	Generator Torque	Stator Skew	Small Scale			
	Customer Requirements (What)	Importance	1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3
1	Low Voltage	100	9	3	9	9	9	9	9	9	9	9	9	3	3	1	1	9	3
2	Small Size	74	3	9	9	1	9	9	9	1	1	1	3	1	9	9	1	9	1
3	High Power	100	9	1	9	9	9	9	9	9	9	9	9	3	3	3	9	3	1
4	Under Budget	34	1	3	1	1	3	3	3	3	3	1	1	1	1	9	1	3	9
5	Adaptable Kv and Power	52	1	3	3	9	3	9	9	1	1	3	3	3	3	1	3	3	1
6	Up to CWC Standards	100	9	9	9	9	9	3	9	9	9	9	3	3	1	9	9	9	3
7	3 phase AC	48	3	3	3	3	1	9	3	1	1	3	9	3	3	3	3	9	9
8	70 m/s Tip Speed Ratio	62	3	9	1	3	3	1	1	9	9	9	1	3	1	9	9	9	9
	Target		48 V	45 cm	2 N-m	<150	100 kW	15 coils	23 AWG	25 m/s	3 m/s	5760-7200 RPM	23 A	2 N m	2 degrees	1.18 in Diameter			
	Importance		38	40	44	44	46	52	52	42	42	44	38	20	24	44			

Figure 23: QFD

Looking Ahead

- Test our generator
- Compare results to the ANSYS simulations and the existing generators

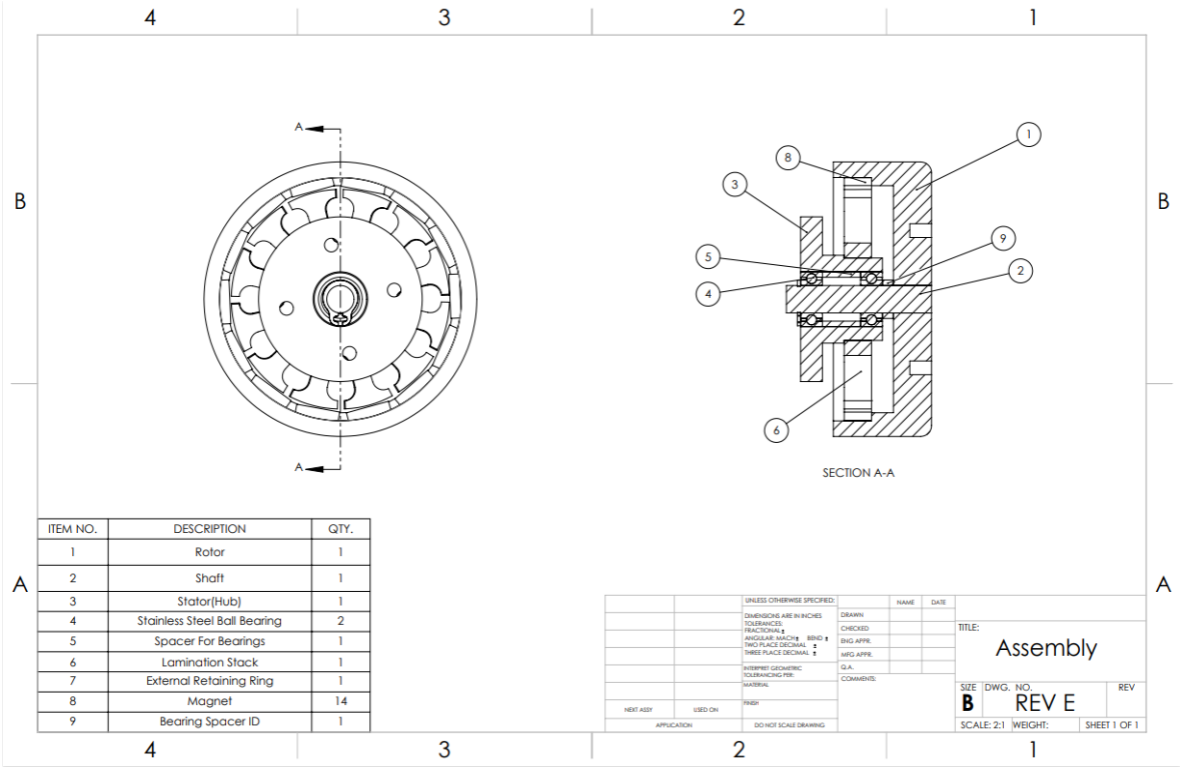

Figure 24: Full CAD

Gantt Chart

TASK	ASSIGNED TO	PROGRESS	START	END
Initiation				
Update Dr. Willy on any progress during the summer	Everyone	100%	8/25/25	8/29/25
Revise CAD	N.E.	100%	8/25/25	9/1/25
Finalize CAD Drawings	K.R.	100%	8/28/25	9/1/25
Finish Dyno	A.G., C.B.	100%	8/28/25	9/14/25
UGRADS Registration	Everyone	100%	10/2/25	10/23/25
TBA	TBA			
Planning and design				
33+% Build	Everyone	100%	8/25/25	9/25/25
67+% Build	Everyone	100%	9/26/25	10/16/25
Draft of Poster	Everyone	100%	9/26/25	10/30/25
100+% Build	Everyone	100%	10/17/25	11/6/25
Final Poster	Everyone	50%	10/30/25	11/16/25
Inital Testing Results Video	Everyone	0%	11/7/25	11/20/25
Product Demo	Everyone	0%	11/7/25	12/4/25
Final Testing Results Video	Everyone	0%	11/21/25	11/26/25
Practice Presentation	Everyone	0%	11/7/25	11/16/25
TBA	TBA			

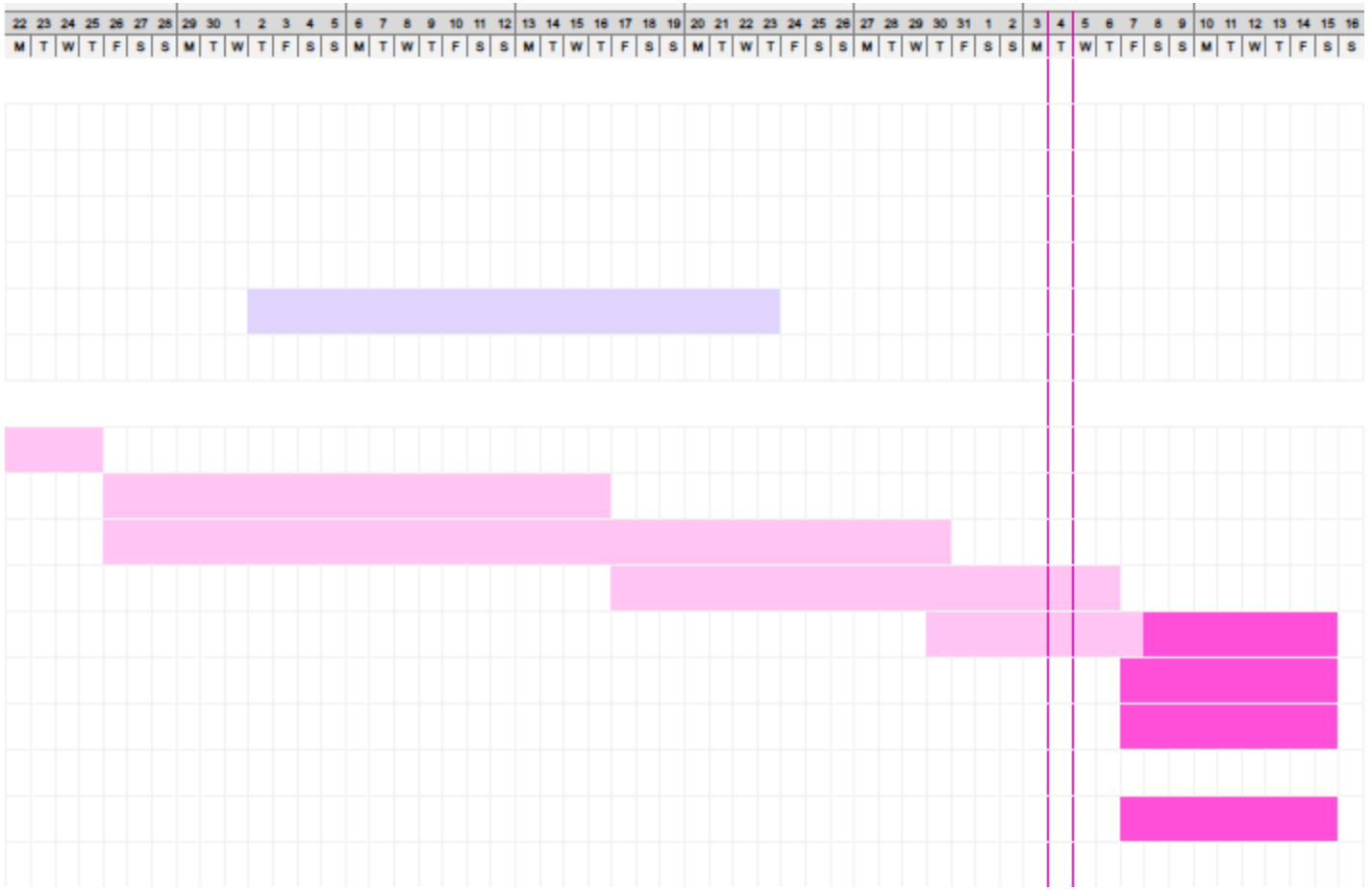

Figure 25: Gantt Chart

Thank you
Any questions?

References

[1] Climate Central, “A Decade of Growth in Solar and Wind Power: Trends Across the U.S. | Climate Central,” *www.climatecentral.org*, Apr. 03, 2024. https://www.climatecentral.org/report/solar-and-wind-power-2024
[2] “Moteur / Alternateur 3 phases,” Letmeknow, https://letmeknow.fr/fr/moteurs-et-servo-moteurs/1828-moteur-alternateur-3-phases-652733948892.html (accessed Sep. 22, 2025).

Appendix