ENGR 111 Experimental Report: Motor Mount

Department of Engineering Fundamentals

ENGR 111-01

Team 15

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Introduction

Building onto the introduction into the principals behind power, force, and work along with its implementation into the creation of a windmill. The team is now tasked with adding an AC/DC motor onto the windmill itself. The motor will generate a steady stream of electricity when spun and with the correct configuration, will produce either direct current or alternating current, however, the current windmill build does not properly house the motor unit. To overcome this, the team has been tasked with building a motor mount that will house the motor on top of the windmill itself. Several constraints have been implemented to represent real-world restraints.

The following constraints were based on how much surface area the part could be to represent a limitation on available materials. The mount itself should be a single piece in order to easily produce the piece. The motor mount should not protrude further than the windmill's nacelle width or length. Finally, the motor mount should not alter the windmill in any way and should only be an extension/addition onto the windmill. In order for the windmill to generate power from the wind, the motor mount will also need to house an axle and 16 tooth gear that will connect the other axles together. Depending on how the mount is built, the orientation of the gears will vary.

To further explore and document the work and power as well as the power generation behind a windmill, a methodology is needed to create the optimal motor mount needed for such.

Methodology

This experiment involves designing and 3D-printing a mount for an AC/DC motor that was created in class to the windmill system that was created in a prior experiment. The goal of this design was to make a mount that could sturdily secure the motor to the windmill, withstand the weight of the motor itself, as well as being underneath the 40 square inch maximum that was set prior to the design. With this design, the motor would be able to accurately record and put out power readings that the windmill would give off during a run/trial. The original design of the mount (created in SOLIDWORKS) can be seen in *Figure 1,* and the motor to be attached to the system can be seen in *Figure 2*.

Figure 1: The original design of the mount that the team designed

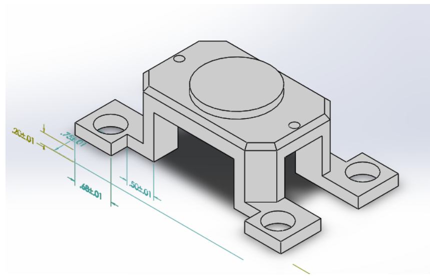
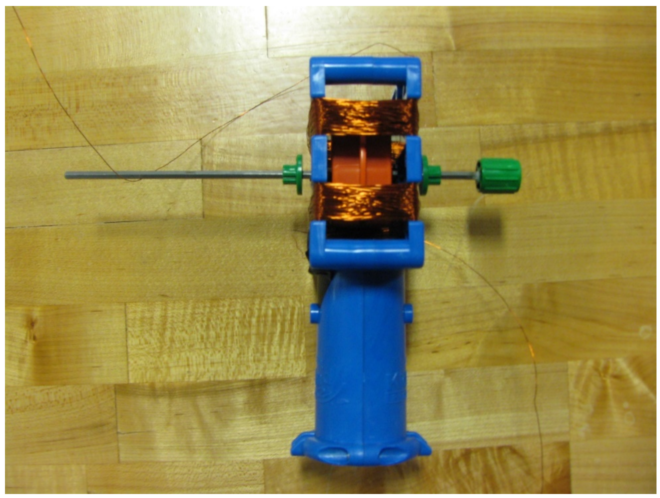


Figure 3: The AC/DC motor



The motor “recorded” (put off) power by placing a magnet on a freely moving axle through the motor with copper wire revolved 150 times (which creates a coil) along 2 channels on the base of the motor. The system of windmill blades was attached to the long end of the axle to catch airflow (simulated by an electric fan) in order to rotate the magnet as the blades spun. As the blades rotated throughout the trial, the magnet rotated alongside it, energizing the coils The electric fan was set to the highest power setting in order to create a consistent result within the experiment. Prior to the installation of the motor, mechanical power was recorded and calculated by testing how long it took (using a stopwatch manned by a person watching the side of the windmill throughout each trial) for the bucket filled with washers to move up the length of the windmill. However, after the implementation of the motor and motor mount, mechanical power can be recorded by using a multimeter throughout each trial. The design of the motor mount is integral in allowing for the recording of power to even take place. Without the motor mount, it would be impossible for the system to work due to the motor and windmill system being two different pieces, rather than one combined system.

In this experiment/design process, the following assumptions were made:

Assumption 1: The 3D printer would successfully print out the design created by the team on time (e.g. completely printing the mount without any parts left out within a reasonable amount of time so as to not delay the experiment)

Assumption 2: The mass of the string could be ignored throughout the experiment and that the only relevant masses in the system were that of the bucket and the washers (in order to ensure that the readings put off by the motor system are accurate and aren't skewed).
Assumption 3: The pitch of all of the fan blades remained consistent throughout the trials to ensure that there was little deviation within the system.
Assumption 1 is ensured by allowing certified teaching assistants to handle the printing process by saving our design to an SD card and leaving it to them to print for us. With this, the team can ensure that the printing process will be more successful since it takes up to 5 hours to print the design.

Mathematical Model
The power that the system used to pull the bucket full of washers up the side of the windmill is called the rate at which work is done:

$$P = \frac{\Delta W}{\Delta t}$$

where Δt is the rate at which time changes ($t_f - t_i$) during which the amount of work (ΔW) is done.

ΔWcan be calculated using:

$$\Delta W = FD$$

where *D* is the distance that the force (*F*) travels. Newton's Second Law of motion can be used to calculate the force needed to lift weights, which is the action that the windmill:

$$F = ma$$

where *m* is the mass and *a* is the acceleration due to gravity (SI: $9.8\ m/s^2$)
Results
The original design for the team's motor mount unfortunately did not function properly to hold the motor in place. Overall, the mount was approximately half an inch too tall for the gears to be able to function together. The holes for the screws to hold the motor onto the mount were also too close together to be able to screw the two pieces together. Due to these design flaws, the piece needed to be redesigned to be shorter and the holes needed to be spread out enough to be able to screw the pieces together.

Conclusion

This report describes the process of designing a piece that will successfully mount a motor onto the windmill while simultaneously aligning gears across several axles. The experiment will be validated through several trials in which a part is created and altered to fit the need of the project. As more variations of the part are created, the more optimal the piece will become. Even if the piece produced is in an unusable state, it will provide the groundwork for improving the overall quality of the piece as a whole.

The next step involving the windmill would most likely be to attach a motor onto the nacelle. The motor would theoretically be powered by the windmill generating power from wind. The motor itself would be used to lift a weight and could be connected to an Arduino circuitry set-up to display the power and time required to lift that said weight.