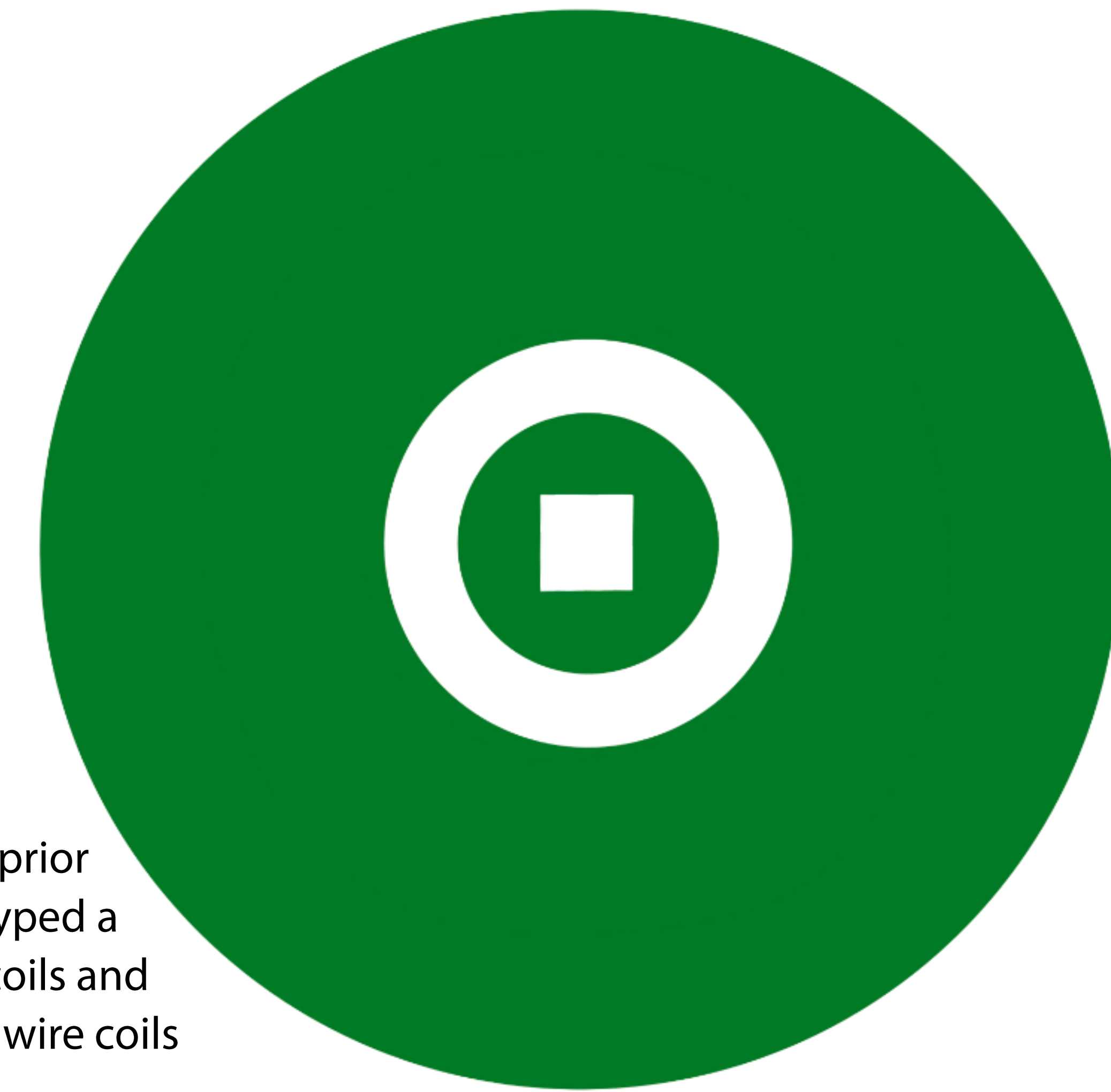


Engineering Projects in Community Service, EPICS-017

Imagination Station, 600 N Fourth St Lafayette, IN 47901

IS - MAG RACERS

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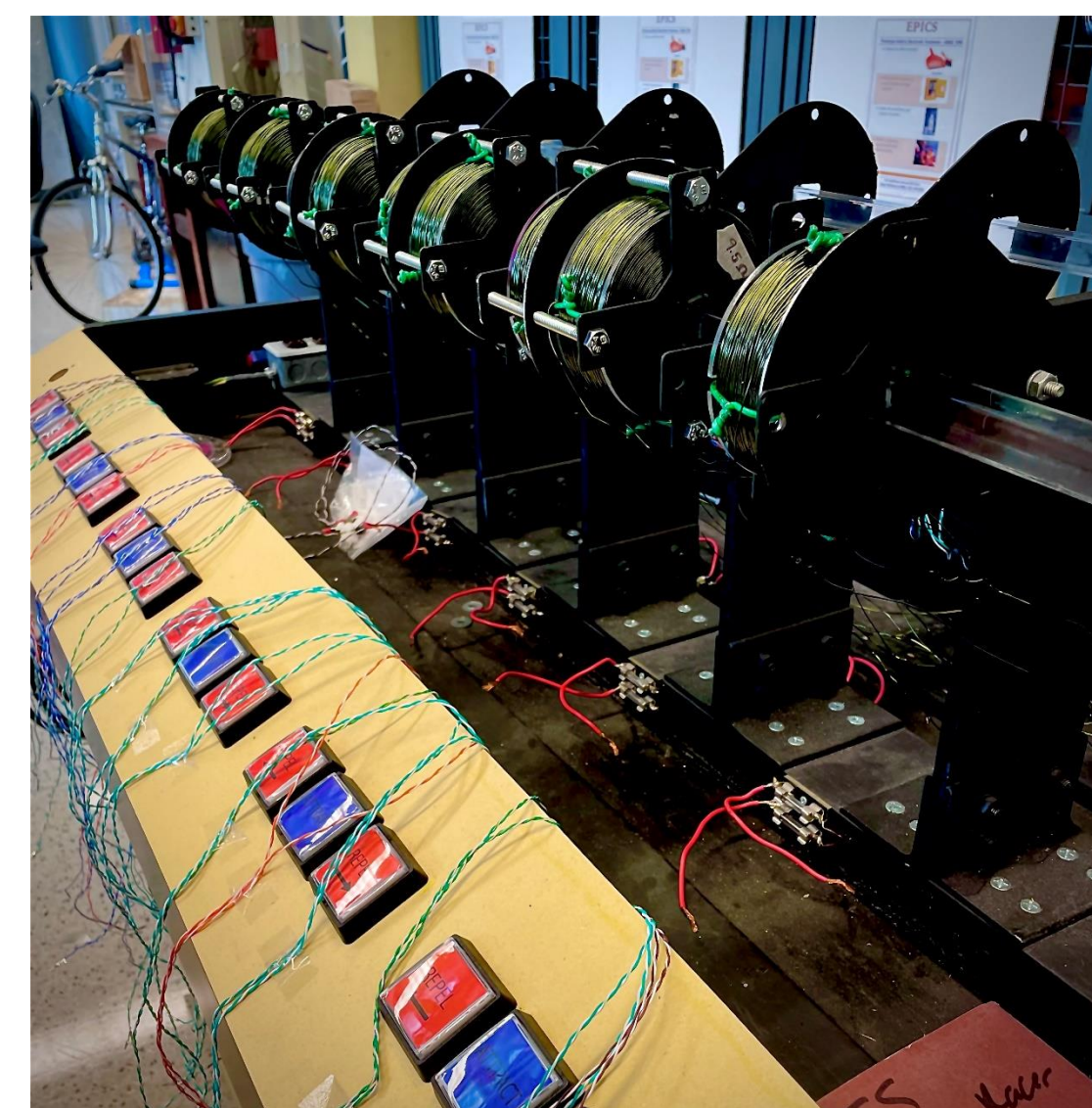


INTRODUCTION

The IS EPICS Project is working with Lafayette's Imagination Station, a local interactive science museum, to make and refurbish interactive, educational, science exhibits. The Mag Racers team is dedicated to refurbishing the Mag Racers exhibit, a game that was originally built and sent to Imagination Station in the early 2000s, so that it can continue to be enjoyed by kids for many years to come. Due to the age and extended degradation of the exhibit, it was sent back to Purdue in 2019 for its worn components to be replaced and educational materials to be updated.

The Mag Racers exhibit is a racing game that uses electromagnetism to move the two magnetic race cars. There are two tracks, and each track has six pairs of magnetic wire coils, which when electricity is flowed through, will create a magnetic field in the center of the coil, right where the track is, which will then either attract or repel the magnetic race car. After many years of play, the coils had rubbed off some of their protective coating leaving the game no longer safe to operate.

The Mag Racers team's main goals are to finish making the new wire coils, update the circuitry, and design new educational signage so the many patrons of Imagination Station can gain a better understanding of magnetism and electromagnetism.



Source: Mary Duquette, 9/21/22



Source: Mary Duquette, 2/1/23

OBJECTIVES

1. Wind All Remaining Coils
2. Update Circuitry and Arduino Functionality
3. Educate Kids on Magnetism/Electromagnetism

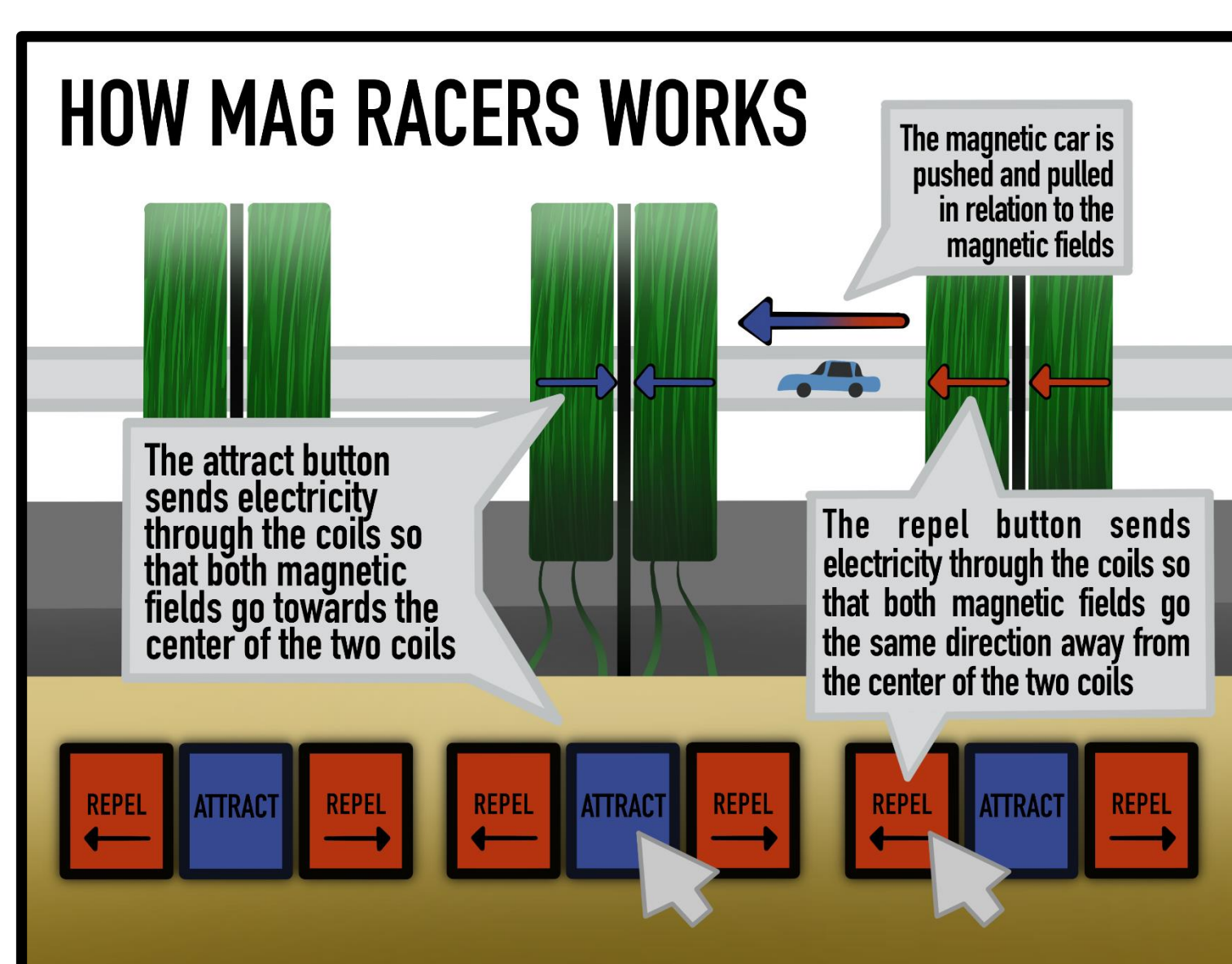


Figure B.
 "How Mag Racers Works" Poster
 Source: Mary Duquette

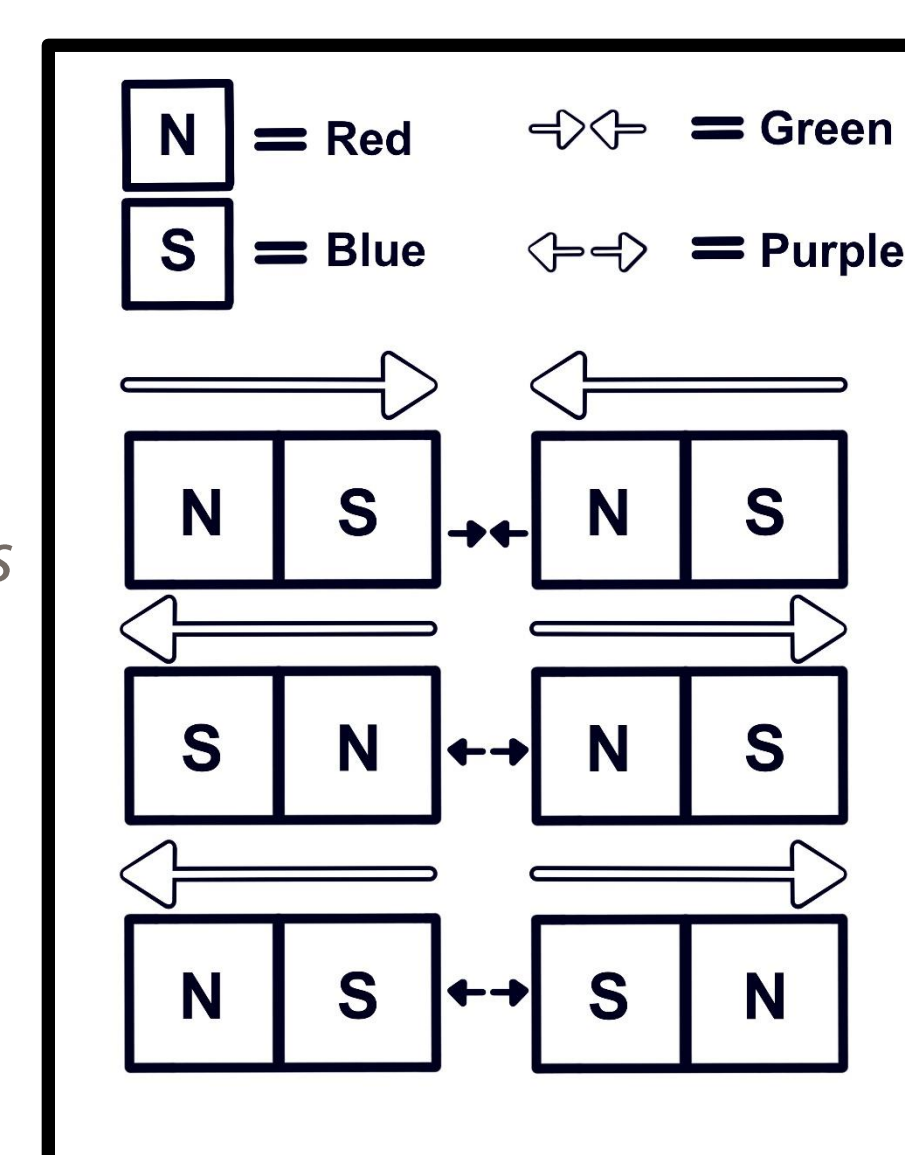


Figure C.
 PreK-2nd Grade level
 Coloring Sheet
 Source: Mary Duquette,
 and Lily Mathews

METHODOLOGY

- Winding the Coils

o Fall 2022:

- Due to the entire team being new members, they focused on learning how to operate the coil winding apparatus as efficiently as possible
- They ordered more wire partway through the semester as the leftover wire was not enough to complete a single coil

o Spring 2023

- The returning members of the Mag Racers team educated the new members on how to efficiently operate the winding apparatus
- The team collectively decided to prototype a new winding apparatus to improve efficiency
- They completed winding the first wire coil and placed it within the build

- Updating the Circuitry

o Spring 2023

- Two members of team focused on testing the optimal circuit board layout for the electronic portion of the build

- Education

o Fall 2022

- The team completed two educational posters covering how the magnetic coils work in relation to the race car (See Figure A. and Figure B.)

o Spring 2023

- Completed a lesson plan for PreK-2nd grade class field trips with a coloring sheet (See Figure C.)

EDUCATIONAL IMPACTS

- In Fall 2022, the Mag Racers team made two posters, the first compares the magnetism between a fridge and fridge magnets to the wire coils and the race car in the exhibit. The purpose of the first poster was to give a comparison to something present in a kid's home or classroom and that the coils and fridge magnets work in the same way. (See Figure A.)
- The second poster illustrates how the different buttons on the exhibit will lead different magnetic field combinations to move the magnetic race cars. This poster's purpose is to explain how to play the game without giving exact rules, allowing kids to compete using an understanding of the process being used instead of a recommended method. (See Figure B.)
- In Spring 2023, the Mag Racers team designed a lesson plan for PreK-2nd grade teachers for field trips. The lesson plan focuses on the basic concepts of magnetism and how the two poles can attract or repel each other. The lesson plan includes a coloring sheet for kids to practice these concepts (See Figure C.)

TECHNICAL IMPACTS

- The Mag Racers team, prior to Fall 2022, had prototyped a system of winding the coils and completed 11 out of 24 wire coils

- The Fall 2022 team attempted to use a Lathe to speed up the winding process, however the process was abandoned due to the inconsistency between new coils and existing coils that would be caused, and the large number of times the lathe broke the acrylic holding the coil together

- In Spring 2023, the Mag Racers team started winding the remaining 13 coils, and prototyping a second winding apparatus to improve the likelihood of completing winding in the Spring 2023 semester

The Spring 2023 team also started work testing the new circuit boards in the build.

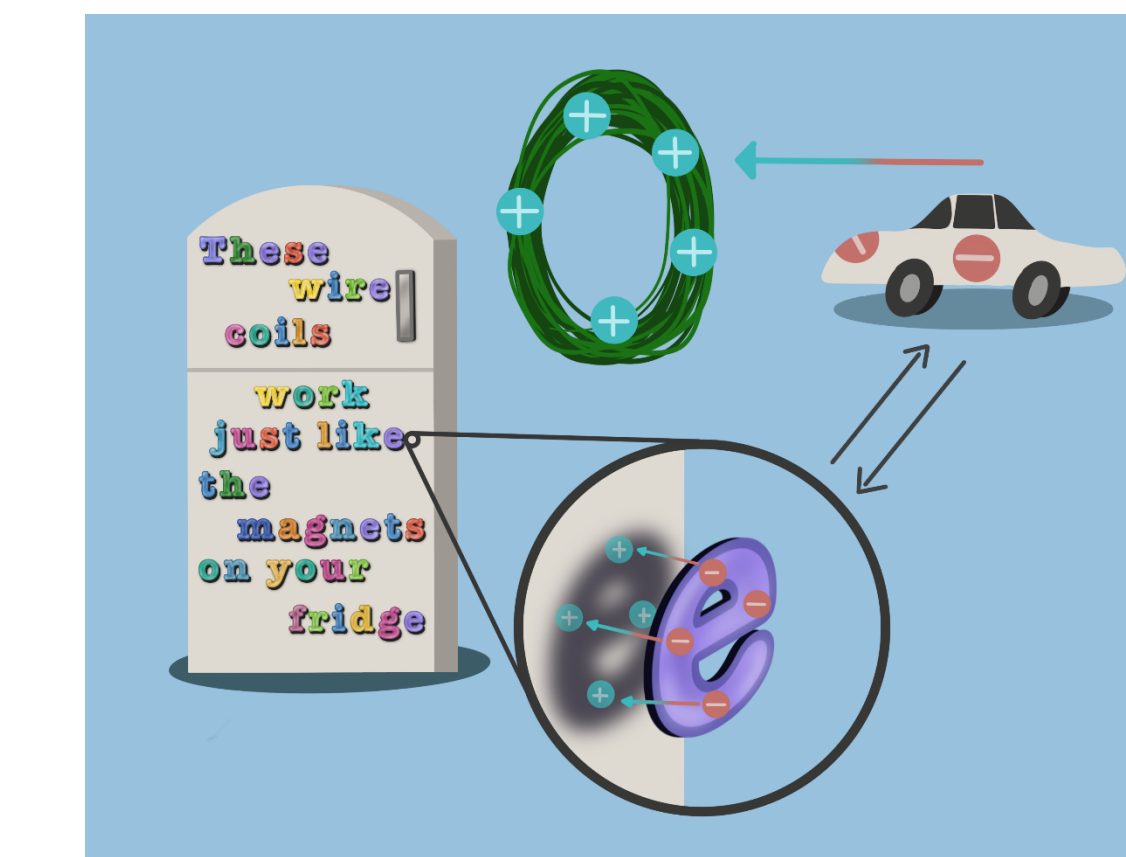
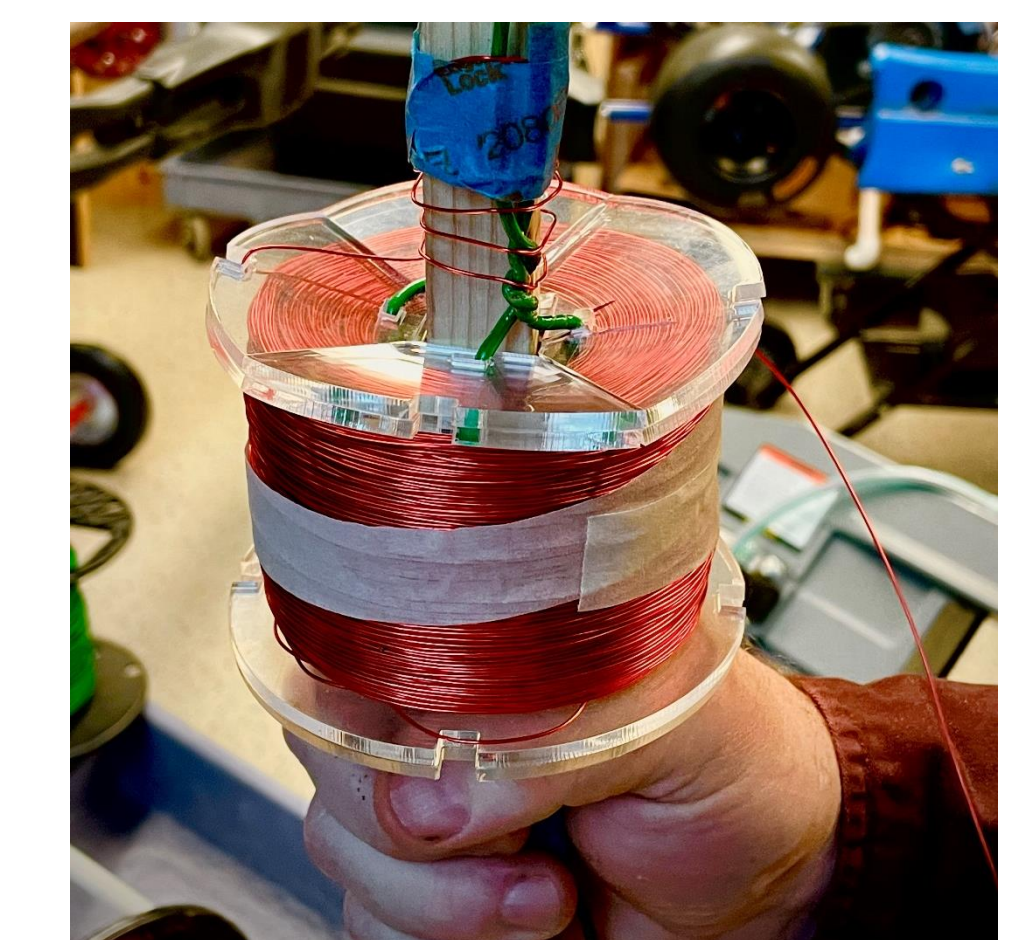


Figure A.
 "Fridge Magnets and Electromagnets" Poster
 Source: Mary Duquette



Source: Mary Duquette, 11/16/22

REFLECTION & CONCLUSION

The Mag Racers team has learned how to handle many challenges while working on our project. While first figuring out the coiling process, we ran out of wire before we could finish a single coil and instead of just doing nothing while we waited for our new wire to be shipped, we focused on our upcoming presentation and updating our documentation with a transition report because even when it feels like progress is at a halt there is still necessary work to do.

This semester we had more members allowing us to put more time into the aspects of the project that we hadn't had time to look into in the Fall, like the circuitry and improving the winding process. The new discoveries we are constantly making about our winding process, like the fact that we can make two wire coils at once just on our original apparatus, were the result of our new members wanting to see if it would work. Our larger number of members also allowed for more specialization within the team.

Specialization and vocalizing then acting on those odd and slightly impulsive ideas have resulted in an extraordinary amount of progress for our team. We want future team members to be comfortable sharing their ideas and focusing on the things that interest them. In upcoming semesters, the plan is to finish testing the circuitry, ensuring consistency between the coils, and child-proofing the build while still making it easy for Imagination Station to repair.

ACKNOWLEDGEMENTS

Thank you to our Advisors, Leah Jamieson and Tim Pritchett, the other IS-EPICS sub teams, and to Imagination Station for all their help and feedback.