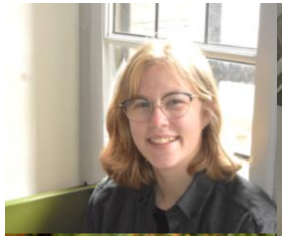
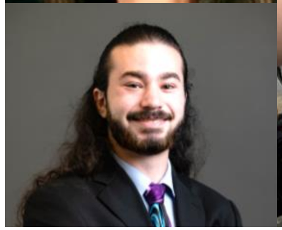
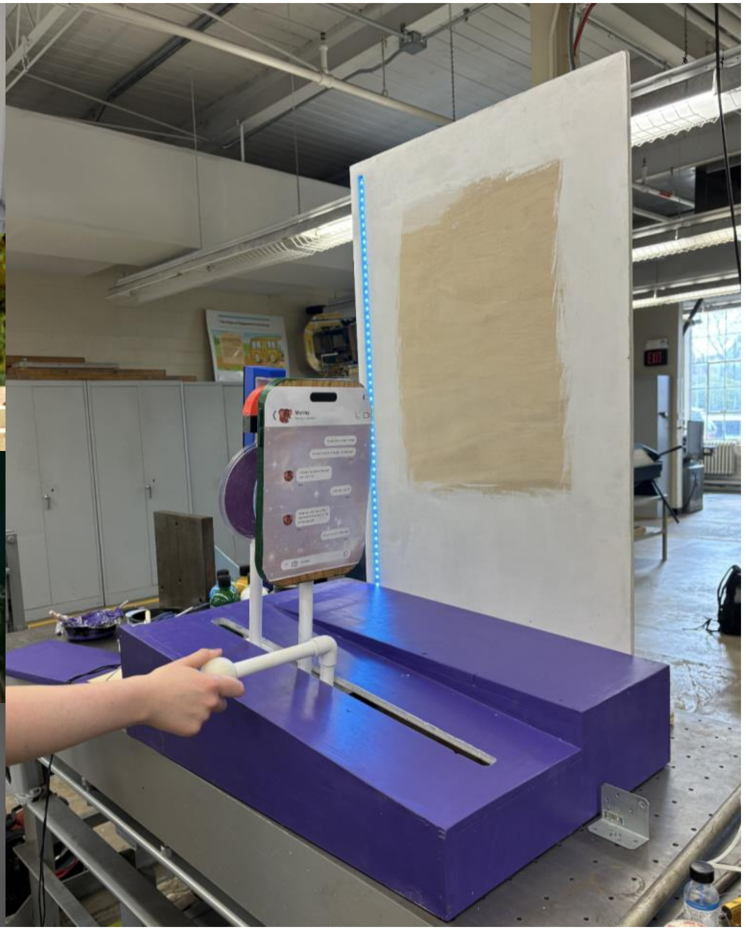
RMSC Interactive Science Exhibit



Team Members:

Katie Jarvis
Jennifer Yu
Anne Traczyk
Charles Herman

Customer:

ROCHESTER MUSEUM & SCIENCE CENTER

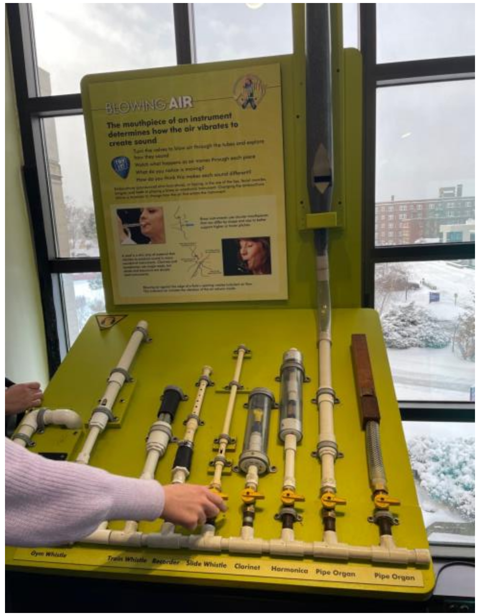
Project Overview:

The goal of this project is to visualize and prototype a new exhibit for the Rochester Museum and Science Center's *How Things Work* exhibit. The technology chosen for explanation was wireless charging, which is a relatively new and common modern technology.

Problem Statement

ROCHESTER MUSEUM & SCIENCE CENTER

Adults who take children ages 5 to 15 to visit the RMSC expect the museum to teach both them and their children about science, technology, engineering, and math (STEM) concepts in the world around them in a way that is intuitive as well as engaging to both the child and adult. In a broader scheme, the education of children in these STEM concepts will help in adjusting the child for adult life and contribute to the furthering of society as a whole. One topic that few people understand is wireless charging.



Deliverables, Requirements, and Specifications

Deliverables:

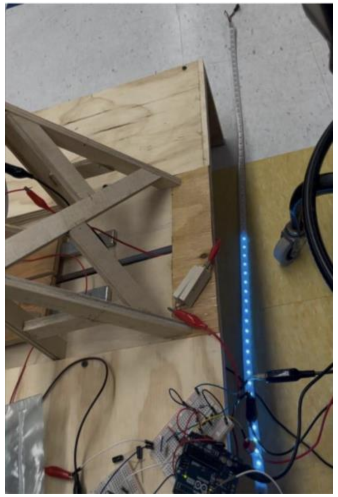
- Proof of concept
- First stage prototype
- Second stage prototype
- CAD model with Bill of Materials
- Final Report

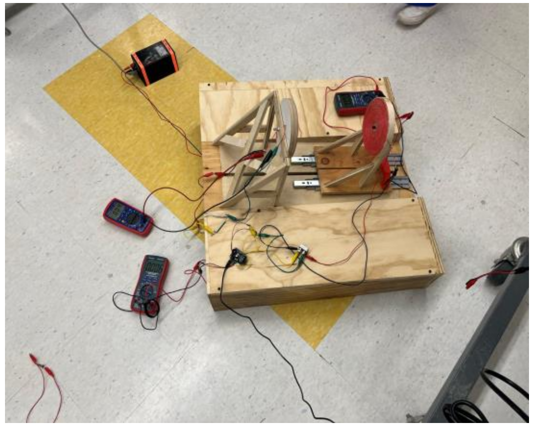
Requirements:

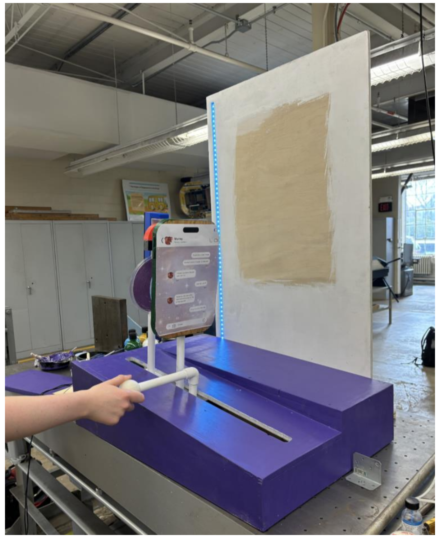
- Attractive to museum visitors
- Intuitive to use
- Not sensory overloading
- Easy to operate
- Safe to use
- Wheelchair Accessible
- Signage is readable
- Exhibit is interactive

Specifications:

- Exhibit footprint is within 30 in x 30 in
- Maximum height is 7ft
- Table height is 27 in
- Minimum text size 24pt
- Power demand less than 12 Watts
- Forced used to interact is less than 5lbf







Requirements	
• Must be attractive	• Safe to use
• Not overloading to senses	• Wheelchair accessible
• Must be intuitive to use	• Must be readable
• Must be easy to operate	• Must be interactive

Specifications	Units	Nominal	Actual	Passed?
Exhibit footprint	in	Within 30” by 30”	30” by 20”	Yes
Maximum height	ft	7’	60”	Yes
Table height	inches	27”	29” (ish)	No
Minimum text size	points	24	41	Yes
Power demand (coils)	W	12	20.275	No
Force to use	lb_f	Less than 5	0.4	Yes

Current Project Status (Concept/Detail Design)

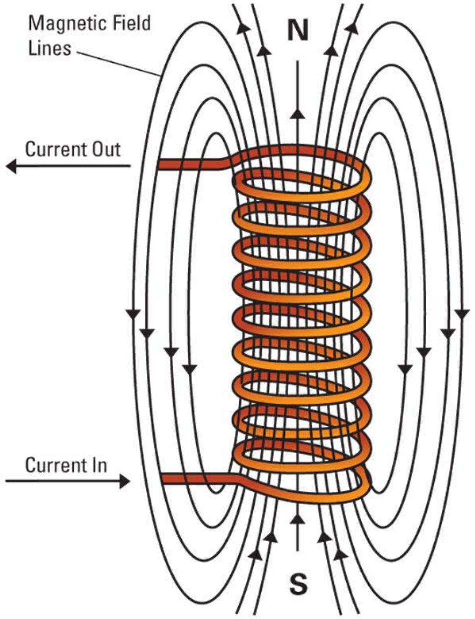
Main concept:

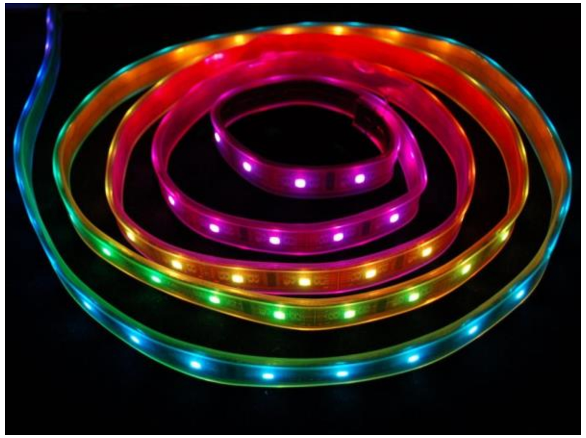
1) Demonstrate how wireless charging works through a proximity interaction and an interaction with magnetic fields produced by the inducting coils

2) Target audience's tactile preferences (ie. their emotions, touch, attention spans, etc.)

3) Ensure that the concept of wireless charging is grasped while providing a fun, safe exhibit that will leave a positive, memorable impact

4) Sliding the coils closer together to light up LEDs which model a phone being charged





Current Project Status (Concept/Detail Design)

Detail Design:

1) **Magnet Interactive** – models an actual magnet; shows where to be placed without intuitive thinking; shows the feel of the magnetic field

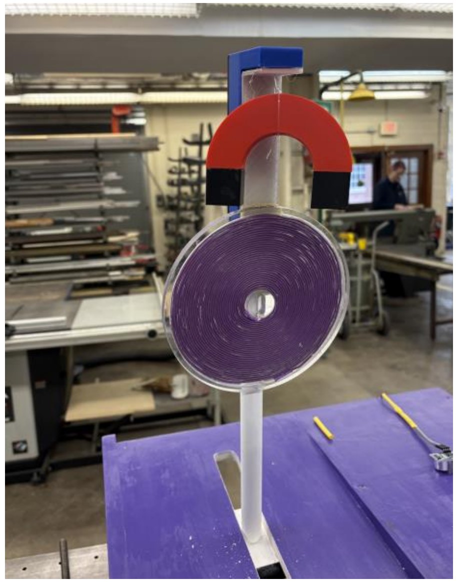
2) **Large Phone Demonstration** – relates the exhibit to wireless charging; made larger to see that it is a phone

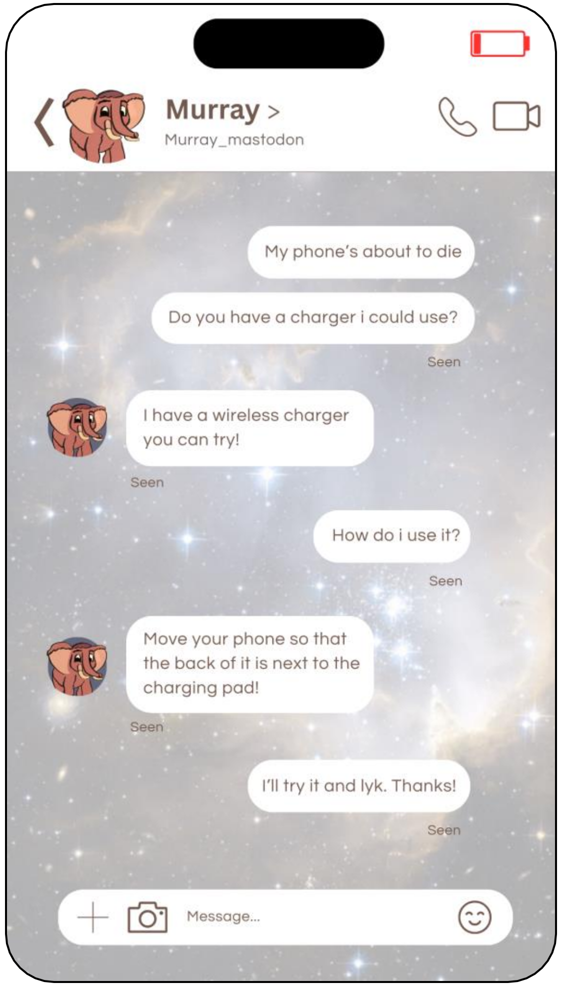
3) **LED Lights** – demonstrate the 'charging' feature

4) **Sliding Handle**– easily accessible without risk of injury; turned to face the new view of our exhibit

5) **Phone Screen Print** – clear text that explains how to use the exhibit in a fun, memorable way

6) **Colors chosen** – eye-catching; durable acrylic finish for a long-lasting exhibit





Current Project Status (Drawings)

Base:

- 9 wood pieces to build the base
  - 3 Surface Pieces
  - 4 Side Pieces
  - 1 Inside Wall Piece
  - 1 Floor Piece

Coil:

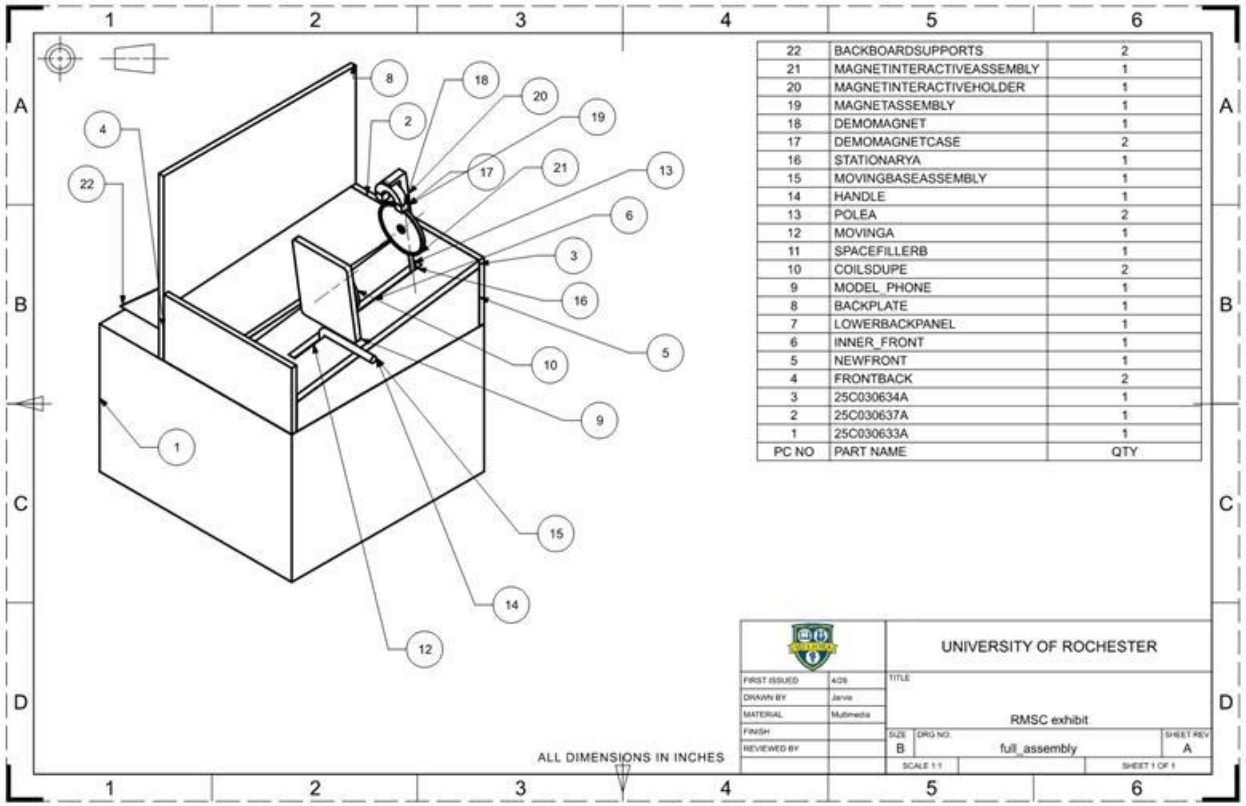
- 2 circular polycarbonate coil holders with an opening in the middle

Magnet Interactive:

- 1 Magnet Base
- 1 Magnet Case
- 1 Magnet
- 2 Magnet Holders

Knob:

- 1 Spherical PLA ball with a 1 inch hole in the center

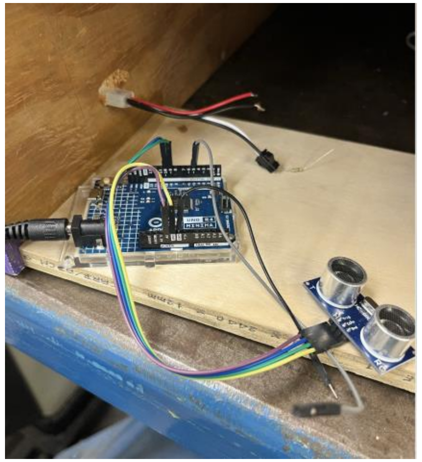


Current Project Status (Backboard/Circuit Diagram)

Backboard:

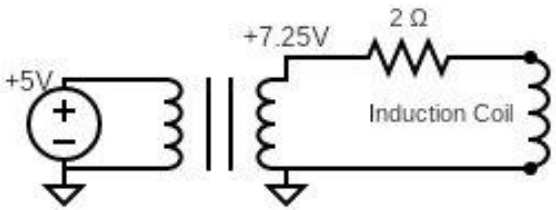
4 wood pieces to build the backboard

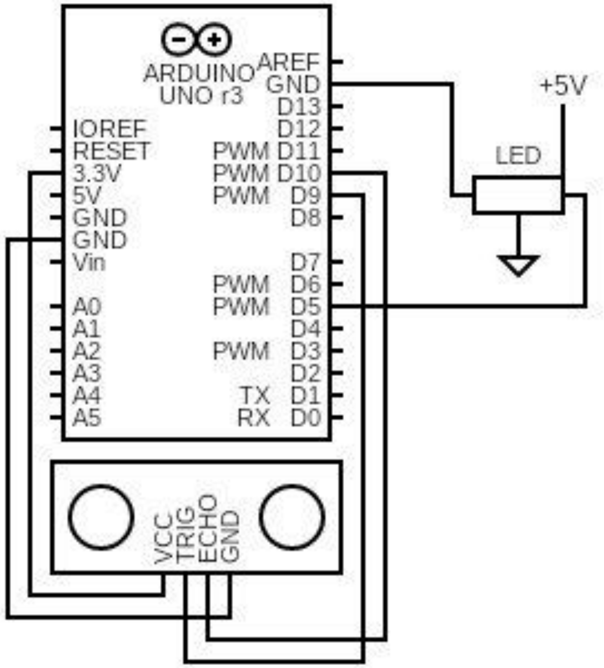
- 1 Vertical Piece
- 2 Triangle supports
- 1 Horizontal Connector Piece



Circuit Diagrams:

Schematic of circuit to power the coils and the connection to the Arduino Board/ LED lights





Current Project Status (Simulations, Analysis)

Tolerance Analysis:

- Inconsistent hole sizing between parts led to fit issues:
  - Longer curing time, tight fit that made assembly difficult
  - Range of 0.8248" to 0.8648" with tolerance of 0.02"

Physical Durability Testing:

- Analysis on pulling the handle and bases were conducted to ensure it can a longstanding exhibit

Fastener Torque Analysis:

- Proper torque is essential for secure attachment of the PVC board to the steel drawer sliders (using a 6-32 SAE Grade #8 screw and calculated 9.3 lb-ft of Torque)

Materials Section Analysis:

- Material choices were based on functionality, cost, availability, and educational value (PVC, Plywood, Cooper wire, polycarbonate)

Current Project Status (Simulations, Analysis)

Structural Finite Element Analysis:

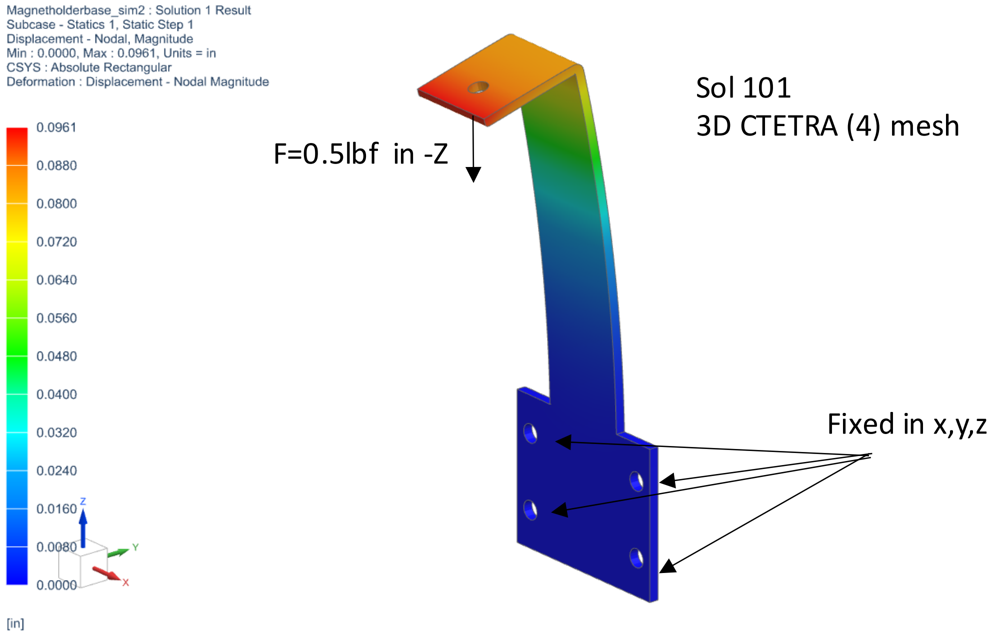
- A structural FEA analysis estimated a 0.0961" deformation under magnet load since (added glued components will increase stiffness and reduce actual deflection)

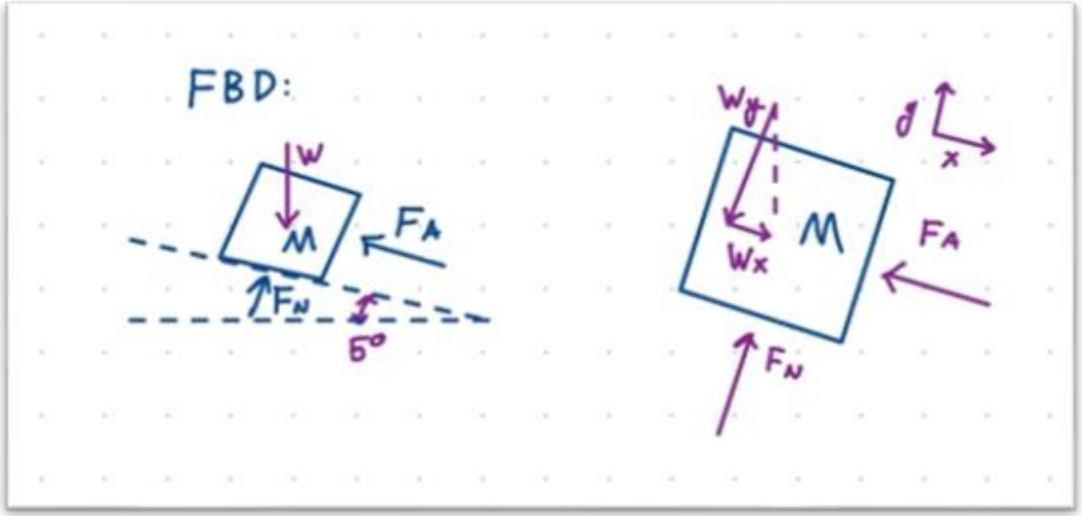
Fundamental Mechanical Analysis:

- A statics analysis confirmed the exhibit meets ADA accessibility requirements
  - Force of 0.4448 lbf (5 lb limit)

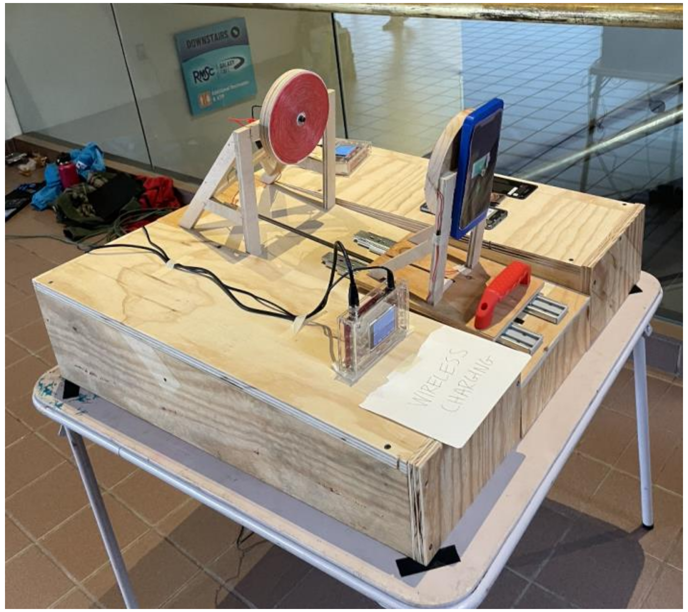
Magnetic Field Analysis:

- Maintaining a 6-inch distance from the powered coil keeps magnetic field exposure within safe limits for medical device users





Current Project Status (Public Testing Observations)



Observations:

- Oscilloscope was hard read, understand, and see on the table especially for young kids
- Words on the poster were positioned in a way that's hard to read
- Pushing the handle from the front made it hard to see the phone
- Connection of wireless charging to phone was unclear

Adjustments:

- Added lights to exhibit
- Changed view a different side to allow better view of coils
- Added a magnet interactive
- Made phone model bigger
- Redesigned coil stands

Conclusions/Future Work

Conclusions:

- Testing is an incredibly important aspect of user design
- Time is never enough
- Communication is essential when working within a team

Future Work:

- Adapt circuit to utilize the induced current in the second coil
    - (As opposed to now – using proximity as an input)
- Improve visual aids to show electron movement in the coils
- Add some way to shut off coil when not in use
- Conduct more audience testing
    - Will be taking notes during Design Day
- Katie will be interning at the RMSC this summer

Acknowledgements

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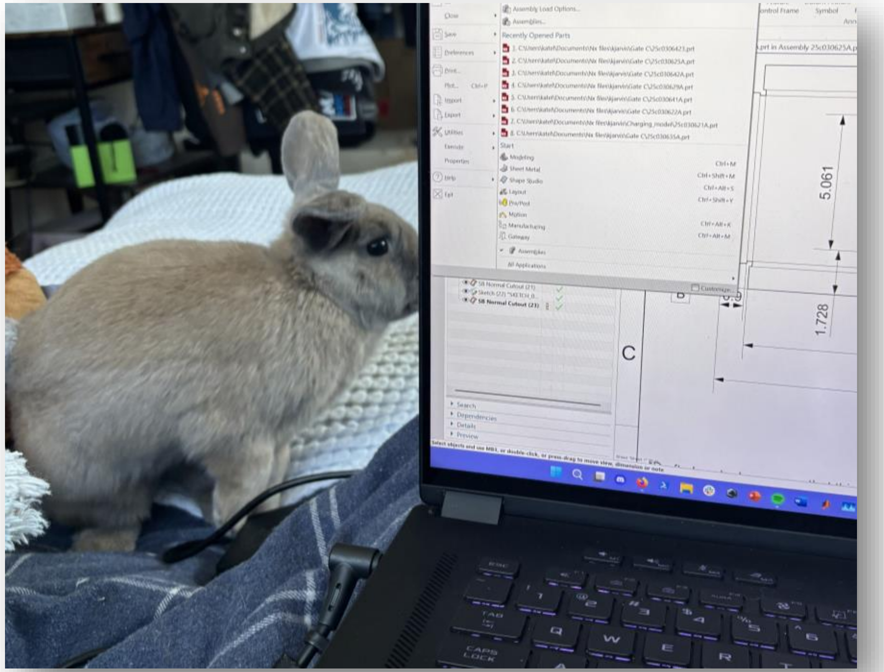

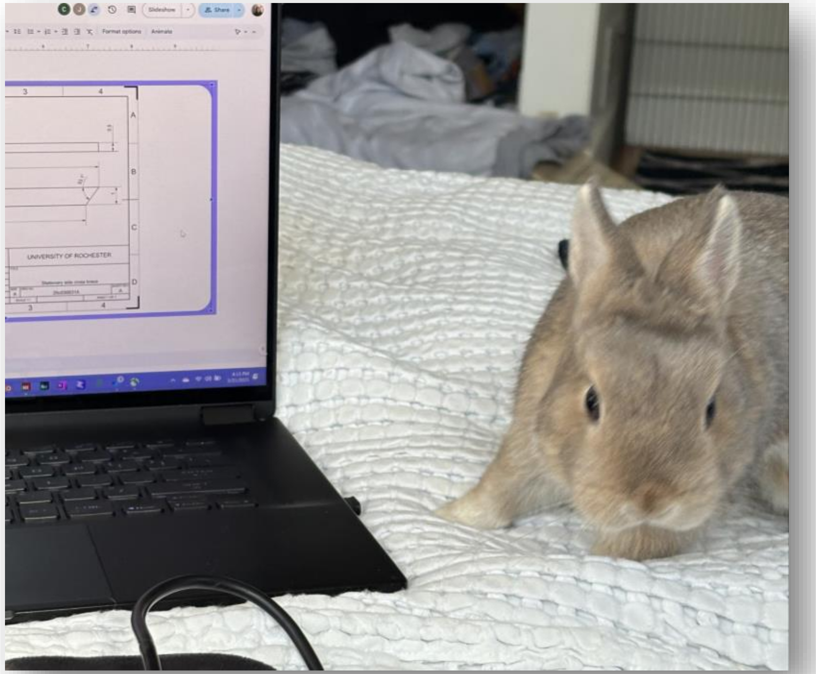

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