Magnetic Levitation Rail System

Justin Hopkins, Dean Rose, Luke Gorham, Taylor Chumley.
Stephen F. Austin State University, Department of Physics, Engineering and Astronomy

Introduction

Magnetic Levitation (Maglev) technology is not well understood in the United States. Most Americans with the mention of Maglev only think about the bullet trains in Japan and Europe when Maglev technology could be applied to a variety of industries.

The Maglev team has designed and constructed a Maglev rail system using two different concepts. Solenoids for propulsion, permanent magnets for levitation.

The Maglev team's goal with this rail system is to demonstrate and educate others on Maglev technology. And how Maglev technology can be implemented to a wide variety of uses.

House of Quality

Using our engineering characteristics and customer requirements, the team created a house of quality shown in **Table 1**. This made clear what's most important when coming up with the designs.

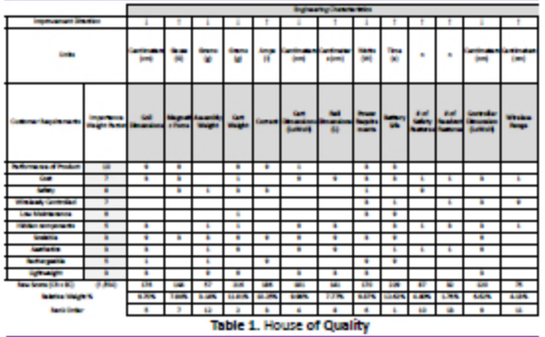

Table 1. House of Quality

Project Design Specifications

A product design specification (PDS) is a statement of how a design is made, what said design is intended to do, and how far the design should comply with the requirements

Product Identification
Product Name: Mag Lev Demo
Basic Functions of the Product: The function of the product is to Demonstration the effects of magnetic levitation.
Special Features of the Product:
- Photosensor control
- Produces magnetism in two different methods
- Designed for educational purposes

Key Performance Targets:
- System needs to be repeatable
- System needs to be scalable
- System needs to be directional (move back and forth)

Physical Description
Material:
- Wood
- Electrical components
- permanent magnets
- PLA or ABS filaments

Weight Targets: 40lb
External Dimensions: 4ft x 1.5ft

Financial Requirements
Target Manufacturing Cost: $700 to $800

Life Cycle Targets
Useful Life: 5 to 10 years

Social, Political, and Legal Requirements
Standards: NSPE, IEEE, ANSI, ASME

Manufacturing Specifications
Suppliers: Amazon, Mouser, Lowes, eBay

Design Renderings

Figure 1 shows an exploded view of the propulsion section of the rail system. **Figure 2** shows an exploded view of the cart. **Figure 3** shows the cart and the propulsion section of the rail. Design Parameters are located in Section III of the Final Report.

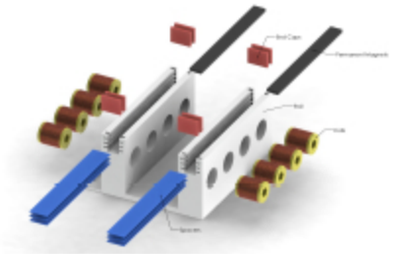

Figure 1: Rail Assembly Exploded

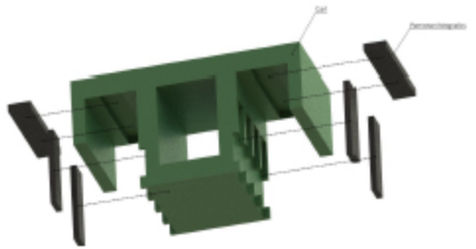

Figure 2. Exploded Cart

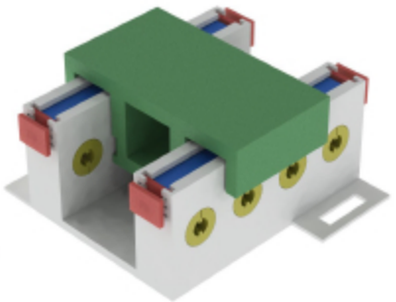

Figure 3. Cart and Rail

Circuit Diagram

Figure 5 shows a breakdown of the Circuit

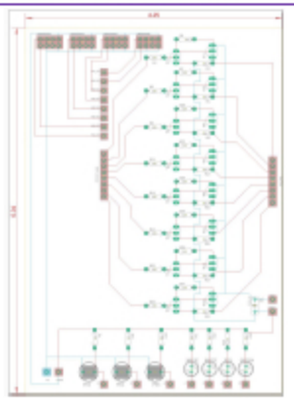

Figure 5. Circuit Diagram

Schematic Diagram

Figure 4 is a representation of how the electrical components fit together.

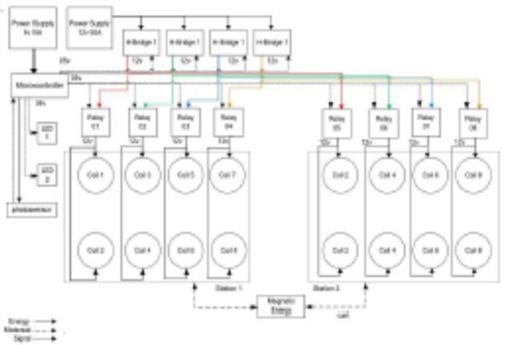

Figure 4. Schematic Diagram

Parts List

The **Table 2** below show the items, part numbers, and quantity of the parts used in the rail system.

Engineering Parts List (Team 03) - MagLev Project

Item Description	Part No.	Quantity
Arduino Mega 2560	782-A000067	1
Magnets	10x20x2 (mm)	40
Magnets	10x20x2 (mm)	48
Photo Sensors	-	2
LED lights (green)	-	1
LED lights (red)	-	1
LED lights (White)	-	2
Switch power supply adapter (12V 50A)	12V 50A 600W	1
Relay	JD2912-1H-12VDC 40A	8
H-bridges	BTS7960 43A	4
Half H-Bridge		8
Solenoids	-	16
Cart	-	1
Rail	-	2
Support Rails	-	4
Spacers	-	10
End Caps	-	12

Table 2: Engineering Parts List

Results/Conclusion

The Maglev team was able to successfully design and build a working demonstration of a magnetic levitation rail system using solenoids for propulsion and permanent magnets for levitation. Using these two different methods, the cart successfully travels from one end of the track to the other in a controlled system.

Recommendations For Redesign

- Redesign coils
  - Coils need to be keyed (for easier replacement)
  - Heatsink for coils (add ventilation)
- More sensors for relays
  - Result in less coding and more accuracy
- Run system off one power supply (12V)
  - Simplifies circuit
  - Reduces cost

Failure Mode and Effect Analysis

Table 3 is used to brainstorm on possible ways the rail system could fail. Rate the severity (S), likelihood of occurrence (O), and the chance of detection (D) of the failure. Develop a Recommended action to stop the failure or reduce the S or O of the failure. And reassess the S, O, and D for after applying the recommended corrective action.

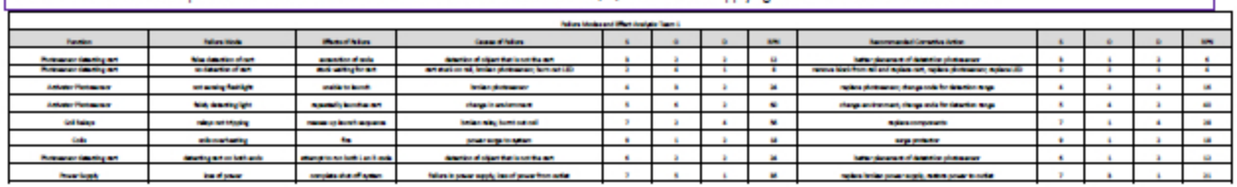

Table 3. FMEA Table

Acknowledgements

Special thanks to an anonymous donator for their donation and support for this project.