4D Clock

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Product Summary

The problem exists when you need a clock in a large space that is rarely humanly occupied. Some examples might include a garage, storage shed, or workshop. In these places you need a clock that you can easily glance at from across the room and instantly be able to read it. Sure, you can buy a large cheap digital clock that breaks within 18 months from Walmart but instead you're looking for a clock that sets itself apart from the competition as being something you, your friends and your neighbors have never seen before and really "sets off" the drab wall it will be hanging on. While the solution to the proposed problem is a unique clock, we know there are certain requirements that go with it. These requirements include the following:

- 12 Hour Clock
  - This requirement is based on the desire of the US market. Analyzing what is available on Amazon for prime delivery we can see the "bestselling" and highest rated clocks sold are in 12-hour format. This also increases the number of people who can read the clock. A surprising number of people on the market are unsure how to interpret a 24-hour clock.
- Easy to update time
  - We achieve this by embedding a GPS module into the clock. It will auto-update the clock based on location and verify that it has not "slipped" out of time every one minute
- Physical Movement w/digital like readout
  - Plays too the customers above desire for a retro-esque art-piece
- Visibility in the dark
  - Increases the hours and period that the clock can be useful to the user.
  - This is achieved by typical bioluminescence from light energy stored in the vinyl pieces indicating an "on" segment

Project Justification

This project offers undergraduate students a chance to work on a structured design and manufacturing project. It provides real-world equivalent practical experience by enhancing their electrical engineering skills. Through the involvement of experienced faculty, the project will be kept on track with proper mentorship and guidance.

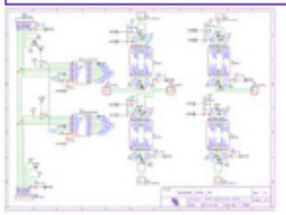

Figure 1. PCB Schematics

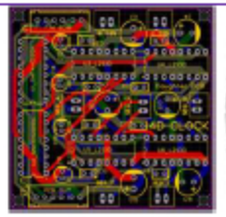

Figure 2. PCB Layout

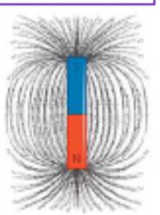

Figure 3. Magnetic Field

Engineering Characteristics

- Overall Size (mm)
- Weight (lbs)
- Cost ($)
- Audible Volume Of Movement (dB)
- Durability
- Time Required to Adjust/Set Time (s)
- Time Keeping Accuracy (s)

Design Concepts

While the methods of electromechanical interaction to display the time has been decided further discussion was had to determine the final overall design concept.
Below we see 3 different design concepts proposed by the team. In **Figure 4** we get to observe a retro style similar to that of a vacuum fluorescent display or led 7 segment display. In **Figure 5** we see classic flip dot matrix commonly dated back to the 50s. Finally in **Figure 6** we observe the all too well-known split flap style clock. Finally, we have our decision. The is the decision compiled from the first three. It is a combination of the 7-segment display but utilizing the flip dot's technology to create independent magnetic fields per "segment". Final design decision can be seen with the completed clock in **Figure 10**.

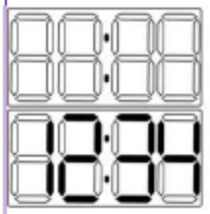

Figure 4. Seven Segment

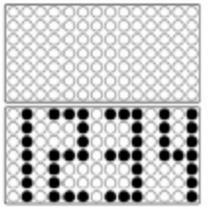

Figure 5. Flip Dot

Figure 6. Split Flap

Engineering Tests - Electromagnets

We setup a single digit to act as test point to determine the best route to go in regards to electromagnet wire gauge and number of turns, as seen in **Figure 7**.

Figure 7. Single Test Digit

Result:

For the 28-gauge wire with 500 turns, the rotation of each se inconsistent, with the segment only being flipped successfully 93 ti some rotations being notably slower than others. This indicates th strength is not strong enough for this electromagnet to be used. Th wire with 1300 turns, could rotate the segment all 100 times with a rotation. The 38-gauge wire with 2500 turns performed just as well 32-gauge wire with 1300 turns. However, when removing the elect from the 4D Clock assembly it was discovered that the electromagn generated a large amount of heat being dissipated from the electro This inconsistency of the 28-gauge and inefficiency of the 38-gauge electro-magnets led us to choose the 32-gauge electromagnet for our design.

Origin of The Team Name

- 4D Clock:

  The name is designed to spark a conversation. Yes, at the lowest level the clock has four digits, hence the 4D. But at the deeper level, the fourth dimension is time. Yes, by that standard every clock is a 4D device, but have you ever thought about that before? Are clocks essentially time machines waiting to be properly upgraded to travel through said time. Our clock is designed to be an art piece that hasn't been done in this way before. Sparking a conversation about where it can go it the key.

Methods and Materials

A digital circuit is be designed to drive the electromagnets. The electromagnets cause a flipping action of panels arranged to appear as a retro digital clock.

Completed First iteration Materials:

- 3D Printed Resin & Filament
- Neodymium Magnets
- Zinc plated steel core machine screws for electromagnets
- Enamel Coated Copper Core Wire
- 60mm x 60mm Custom Printed PCBs for each digit
- 50mm x 60mm Custom Printed PCB for each clock
- Microcontroller and associated digital components

Suggested Second iteration Materials:

- Injection Molded Plastic or Milled Aluminum Housing
- Neodymium Magnets
- Precision Machine Wound electromagnets
- Enamel Coated Copper Core Wire
- ~40mm x ~40mm Custom PCBs for each digit
- ~50mm x ~50mm Custom Printed PCB for each clock
- Microcontroller and associated digital components

Summary and Results

The main objective was to design and assemble a, retro clock utilizing mechanical movement with electrical techniques. Thus far, we have completed development on the first iteration and evolved the iteration to determine the feasibility of creating our own electromagnets that can create a large enough magnetic field to cause of a rotation of another component. It has been proven very difficult with an alarming amount of precision required. The selection of materials for production being the most critical.

We ran into many instances where the selection of materials was a poor choice, due to varying degrees of success. See **Figure 8**. Also, the exact gauge of enamel coated wire took a substantial amount of testing to find the real-world feasibility between; resistance, heat, current draw. See **Figure 9**. As well as the diameter and strength of static embedded neodymium magnets. See **Figure 10**.

Figure 8. Warped Resin

Figure 9. ectromagnet

Figure 10. Neodymium

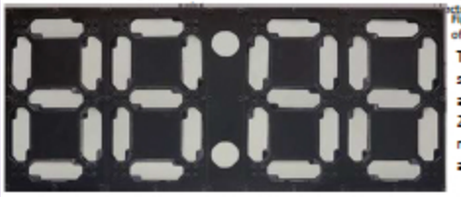

Figure 1. Completed First Iteration of Clock

The completed clock can be seen in **Figure 10**. It's approximately 21"Wx9"Hx3"D and weights right at about 5.5 pounds.

Expected MSRP of $199 based on current bill of materials

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