**Goals**

The first hardware project I ever created was a 4 x 4 x 4 LED cube. For this project, my main goal was to get more familiar with soldering electronic part, to be interfaced with an Arduino Uno microcontroller. I had never soldered before this, so I assumed that this would be the most challenging part of the build for me. I would have to solder together every LED and resistor, then wire them all back to the Arduino board to send different signals for the patterns. To do this, I would need to create a template to create one layer of the cube. After all the layers would be built, I would have to solder them together and wire it up to a perf board to make a more permanent and final structure. At each point, I would need to check to make sure each LED could light up after soldering the layers together with 5 volt and ground pins. After that, wires and resistors would be added to the board and the Arduino uno would be placed on the permanent. After that, I could use some test code I found online to test my cube and then create my own fun patterns.

**Process**

One challenge that I didn't consider until doing a hardware project like this was finding a proper setup and the right tools. It took me a decent sum of time to find the right tools from our garage and the right materials to make my project go as easy as possible. After enough searching, I found a drill and some small bits that would equip me to create a cardboard template to make each layer of the LED cube. Although, there were many things I had to order online that I didn't have readily available. The most important tool to order was my first soldering kit. I also got an almost excessive number of LEDs, resistors, and wires to help me with both current and future projects. After I set everything up in my kitchen, I was ready to go.

My first goal was to figure out an efficient process for making a 4 x 4 layer of LEDs. With the guide I followed, it recommended bending the cathodes of the LEDs down to be parallel with the cardboard template I designed. This made it so the overall cube would have the ground signals being controlled by the specific layer it was on, and the anodes be soldered together vertically between each layer. This technique is known as multiplexing, which makes it so I only would need 20 different pins to control each LED individually from my Arduino Uno, instead of 64. The positive LED ends would end up going through the holes of the final perf board, while the 4 ground wires would come out of the side of the cube. I ended up soldering the negative legs of the LEDs together in 4 rows for the layers, and soldered two wires on the ends of the layers to help connect the ground signal between each of the rows. This also helped in giving the cube more support for each layer. After I was successfully done with creating one layer, I created three more in the same way.

Now that I had four identical layers built, the next step was to solder the positive legs together to stack the layers on top of each other. To help do this, I cut out two small cardboard strips that would be used to prop up the layer when there were not many joints connected yet. Crocodile clips also helped with this, as I would clip the three corners while I soldered the first leg of one of the corners between the layers. I worked my way from the outside in, starting with each of the four corners. I found that this was the best way to build overall support for the cube, which made it easier to solder the inside joints. Once I had all four layers attached, I went over every layer with solder to ensure each ground signal had a solid connection to every LED. After that was confirmed, I moved on to the permanent setup.

My final product was based around building the cube on a perf board, as mentioned before. The first thing I did was get an adhesive pad, and I placed it between the Arduino Uno and the board to mount the Arduino on to one half of the board. After that, I placed 16 resistors for the LEDs right by the Arduino Uno, so the wires could come out closer to the Arduino. This made cable management much easier, and also made it so wires would not get in the way of the final lightshow. After this, I used crocodile clips and tweezers from my soldering kit to push the 16 positive LED legs through the prototype board. Once this was done, I soldered 4 wires, one going to each layer, that would end up connecting to the Arduino to control the ground signals. After that, I soldered the positive LED legs to the resistors on the backside of the prototype board. At this point, everything was soldered and set. At this point I loaded up preset code to test my cube to make sure it was running properly. After that, I created my own patterns using this code as a template to run my cube.

**Reflection**

Overall, this project ended up being more challenging than I expected, and in different ways than my other coding projects. I didn't expect the soldering to be as time consuming or difficult as it was, but that was because I was still a beginner with it at the time. Although, I did learn a lot about soldering and many helpful tricks through trial and error. At the time, this was my first exposure to directly working with electronics and hands on circuits, which definitely boosted my interest in electrical engineering as a whole. I think it is really satisfying to create tangible designs like this LED cube to interact with the real world. I hope I can write more of my own code from scratch in the future, to help further solidify using hardware and code together to make this projects function correctly.

Note from 2023: After editing this page, I got a wave of nostalgia from when I was working on this during COVID-19. I had a great time teaching myself about circuits and soldering, and this project definitely attributed to a lot of my motivation for the rest of the projects on my portfolio. Thanks again for reading!