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Professor Smith

Independent Study Project

13 October, 2025

1. Introduction

This is my attempted second iteration of the sound hammer project. The goal for this iteration was to analyze the errors within the first design that I did for my final project for my physical computing fabrications class, then figure out how I could improve on its design and capability with the second version. Once I have deducted those two tasks, I would then create a guide on how to create the new hammer that any person within the physical computing major could use to replicate the project. I decided to use all three goals for my independent study project.

2. Project Scope and Objectives

There were 3 objectives that needed to be met:

1. Analyzing all the errors that happened within the first design and find solutions to each along with finding ways for improvement
2. Take all the research and information from the first objective then design and execute new plan of making a second improved model
3. Create a plausible guide based off the steps I took during the second objective

Once I had finalized my objectives, I began progress on the first one.

FIRST OBJECTIVE

I re-read my old presentation on the first sound hammer project to analyze all the errors that occurred during the process. The original hammer had the following problems :

1. Architectural Design
2. Very weak
3. Absence of some parts to fulfill desired features
4. Limited to no performance

Each of these problems could be fixed. For “Architectural Design, I discovered that the way the stem was attached to the head of the hammer was impractical as I had the stem and head stacked

on top of each other and connected using hot-glue. Though a temporary solution, it would later cause the heavy head of the hammer to fall apart. The best way I came up with for improvement was to have the next design have the stem going *through* the head of the hammer to give the components more support and the weight distributed better.

The second problem was that the hammer's structure was very weak as I had made the entire project out of a chipboard and a wooden dowel for the handle. The best way to fix this problem was to find stronger material that can withstand surface impacts better than actual cardboard. Either wood or 3D Printed material can solve this problem and I chose to use the 3d printed material for the shell of my hammer.

The third problem occurred because I was heavily reliant on the class' materials and tools provided by the college. Since this was an independent study project, I wasn't limited to what I could add to the project and I used ChatGPT & Google to identify the materials needed for each feature I wanted this hammer to have and where I could buy them.

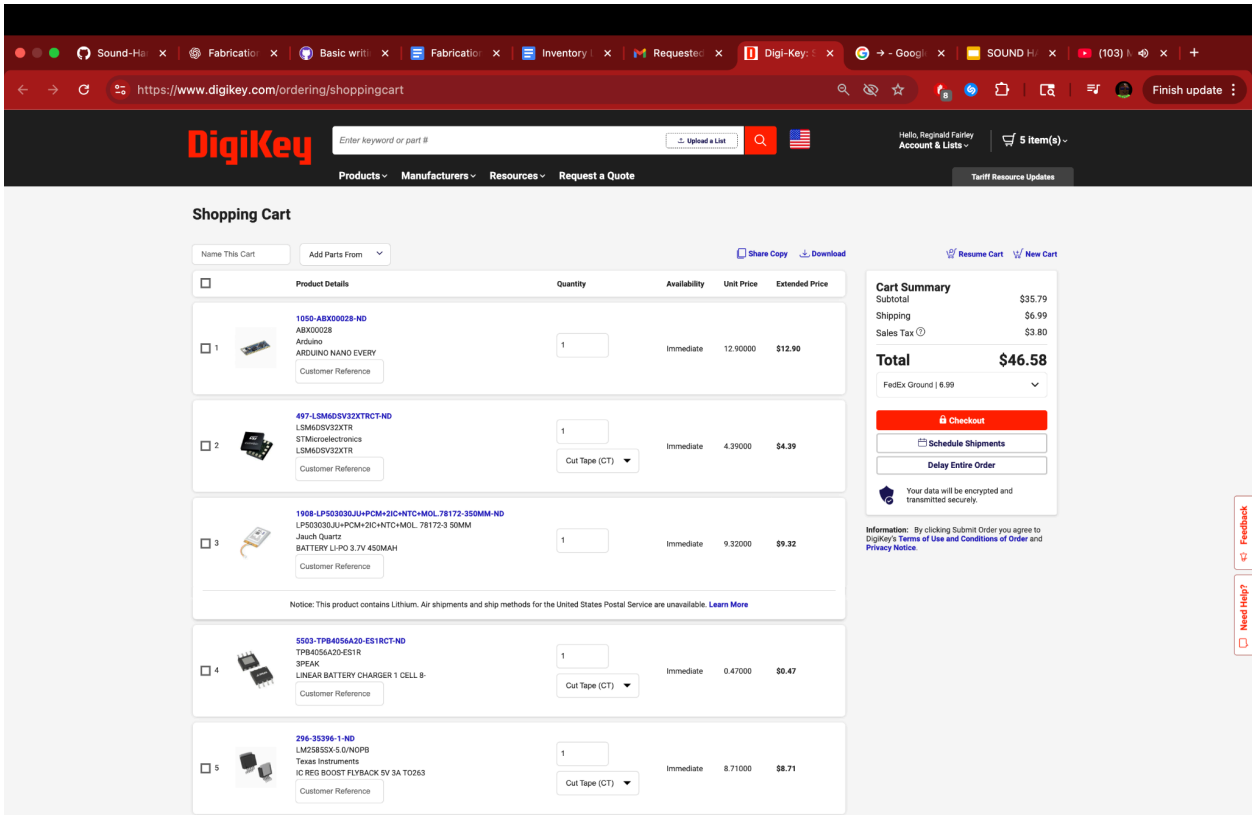
The final problem is understandable. The first could only light up after pressing the button on one of the faces the hammer had which fit my description on how the hammer would respond to activity. To add more features to make the project more appealing, I got feedback from adults such as my instructor, my parents, and fellow students on what features should I give my project and came up with focused on Impact Detection, Sound Effects, Lighting Feedback, Durability, Power Supply, Programmability, and Microcontroller firmware.

Schematic Electric Diagram

Orange - In Cart
Purple - At School
Green - Owned
Red - Out of Stock

Inventory List

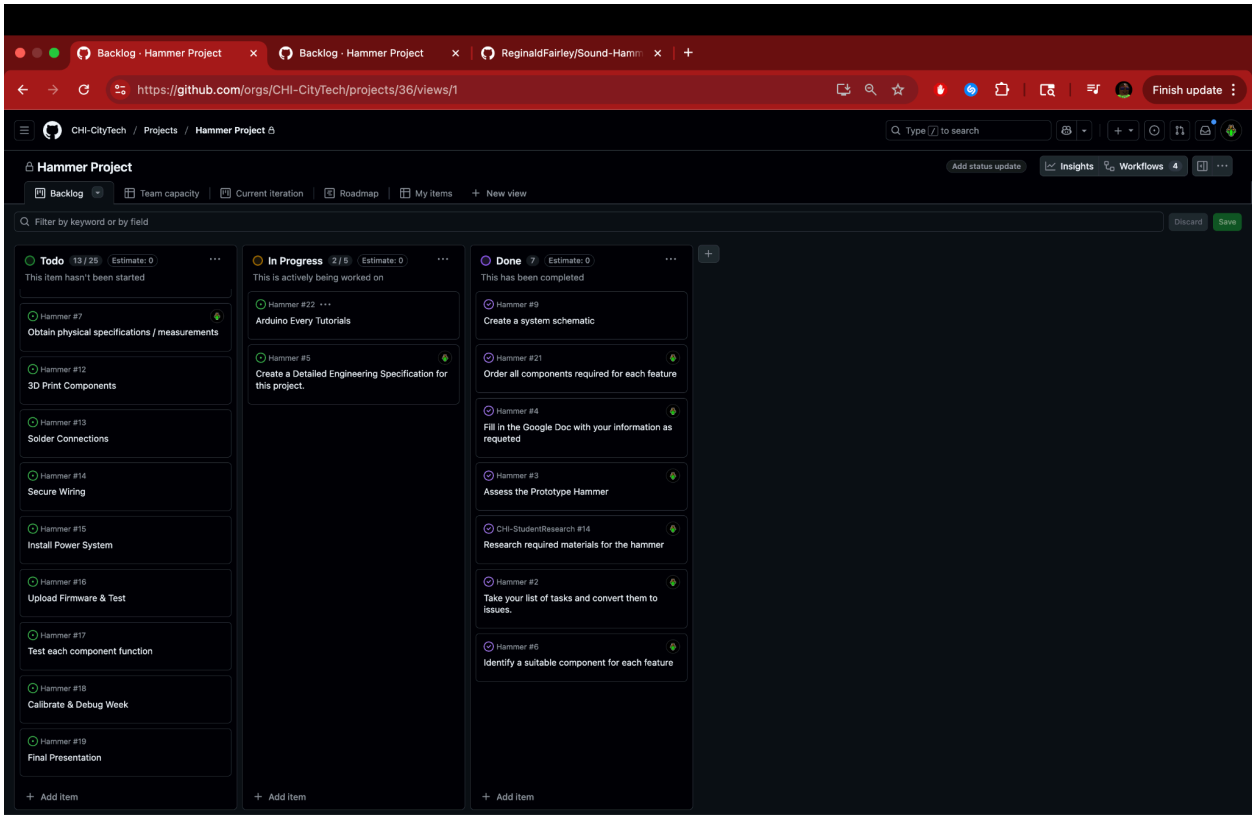
1. Microcontroller - Arduino Nano Every / Nano RP2040 Connect (for more power + wireless) / ESP32-S3
2. Impact Sensor - LSM6DSV32X 6-Axis IMU with 32 g Accelerometer
3. Audio Output - Piezo Buzzer
4. LED Feedback - LEDS from class
5. Power Supply
    a. Li-Ion Battery 3.7V / 1200–2500mAh LiPo
    b. Battery Charging Module / TP4056 USB-C Module (with protection circuit)
    c. Boost Converter / (if powering 5V LEDs from 3.7V battery)
6. Wiring & Connectors
7. Mechanical & 3D Print Supplies
    a. Wood
    b. 3D Print Filament / PLA+, ABS, or PETG
    c. Grip Material / Rubber grip tape or silicone wrap
    d. Fasteners / M3 screws, standoffs
    e. Foam or Vibration Dampening / For sensor cushioning
8. Tools Required
    a. Soldering iron + solder Circuit assembly
    b. Multimeter Debugging/testing
    c. Hot glue gun Fixing components inside hammer
    d. 3D printer Structural fabrication
    e. Wire strippers/cutters Wiring
9. Testing & Debugging Components
    a. USB to Serial cable For Arduino programming
    b. Cheap Breadboard Prototyping before permanent soldering
    c. Logic level shifter (optional) If interfacing 3.3V/5V devices
    d. Serial monitor software Arduino IDE or PlatformIO serial debug



SECOND OBJECTIVE

Once all new planned changes were confirmed. I set up a meeting with my instructor and together we built together a github project page for the project along with deliverables to break down each step of this process. I could put any deliverable item in either To Do, In progress, or Done allowing for great convenience. Each deliverable was detailed and specific allowing me to make progress with it

I purchased the tools recommended for this project after finding their equivalents on DigiKey. I got ChatGPT's assistance for coding the necessary components using Arduino, creating a schematic using the application, Ki-Cade, and modeling the 3D sketch of the hammer using Fusion Autodesk. (All 3 of these actions were deliverables that were created including some from the First Objective's class.



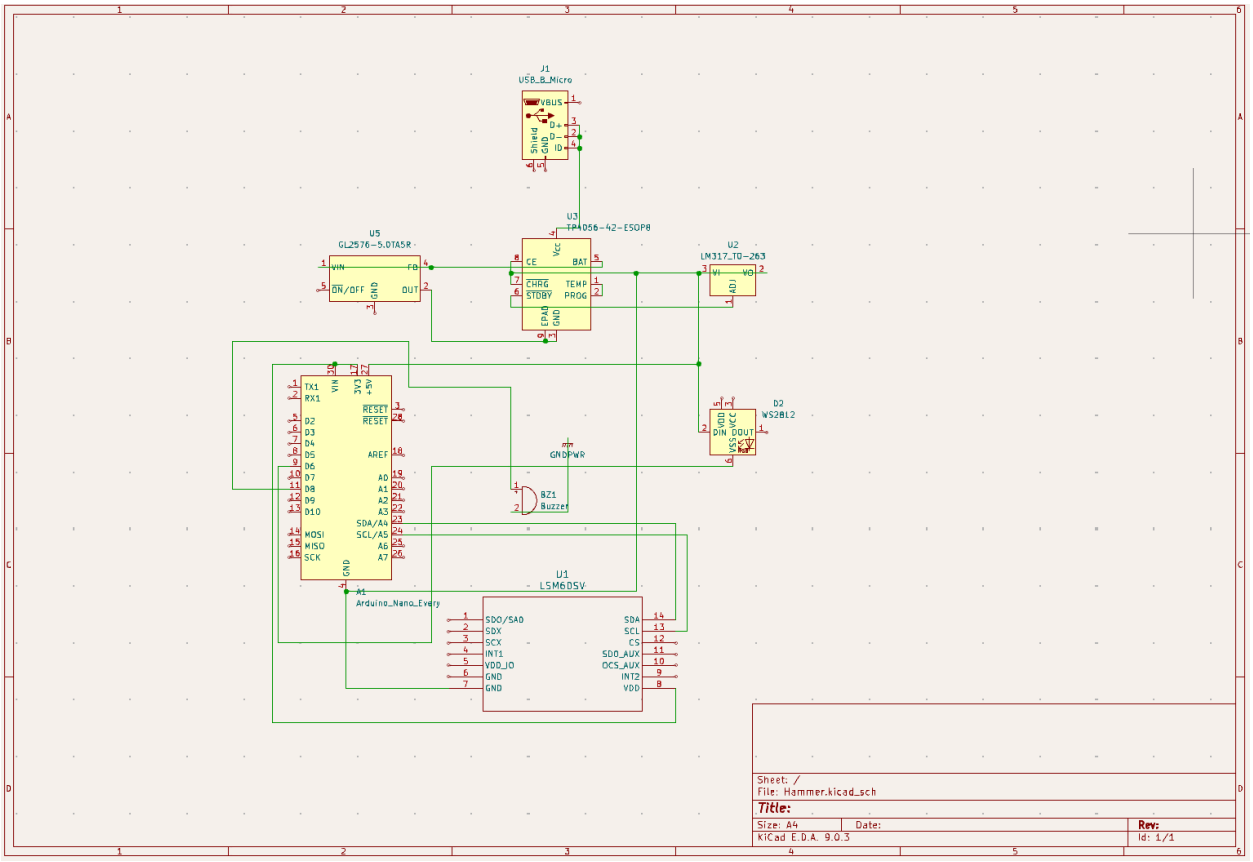
THIRD OBJECTIVE

The middle phase of the independent study took the most time to do and I was short on time so I moved onto the third objective once I had the general info on how I would go about physically designing the hammer. I created a new private github page which housed all the files that I used while getting through my plan on how I would bring this project to life. I also added the guide composed of the steps I took while making the project and using ChatGPT to give logical steps

on how to finish the other parts to the project I didn't get to. Using my familiarity with Github I finished my easy to read guide on how to create my project.

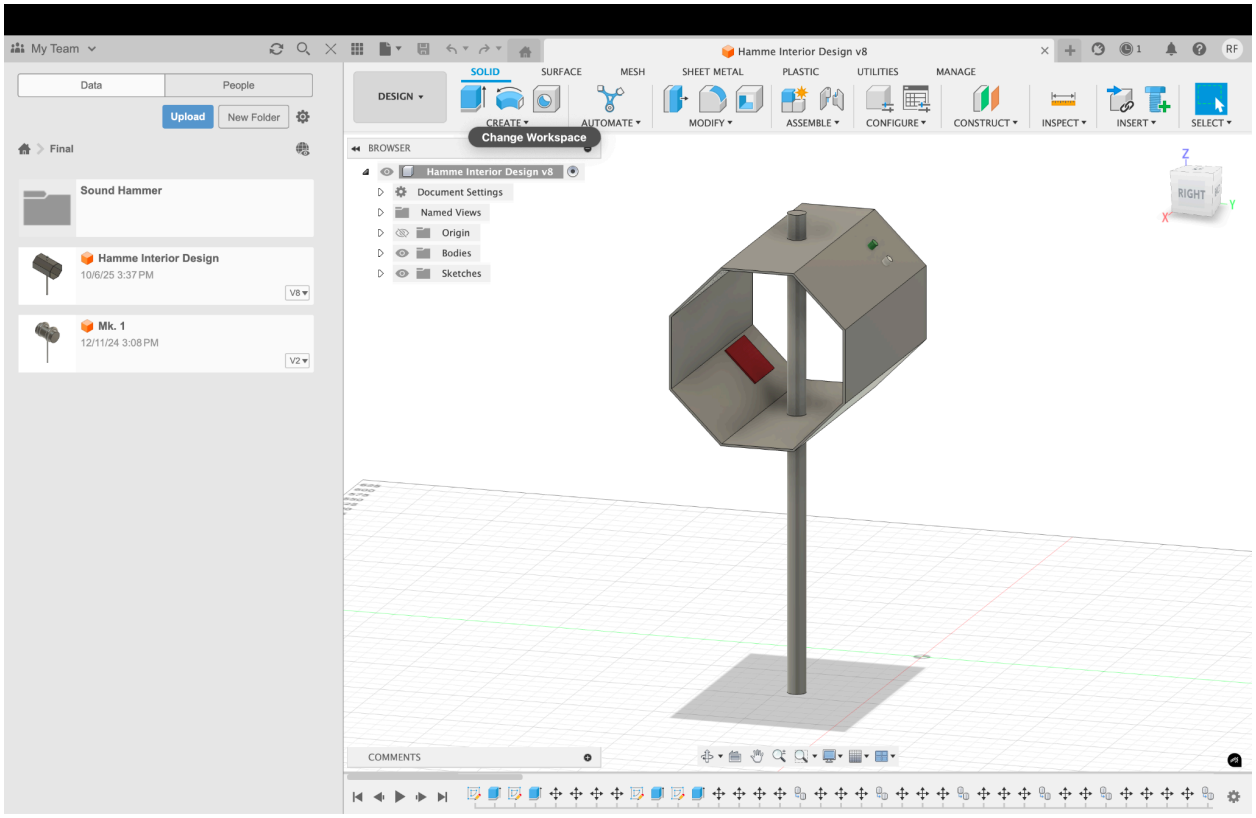
3. Methods and Design

Ki-Cade



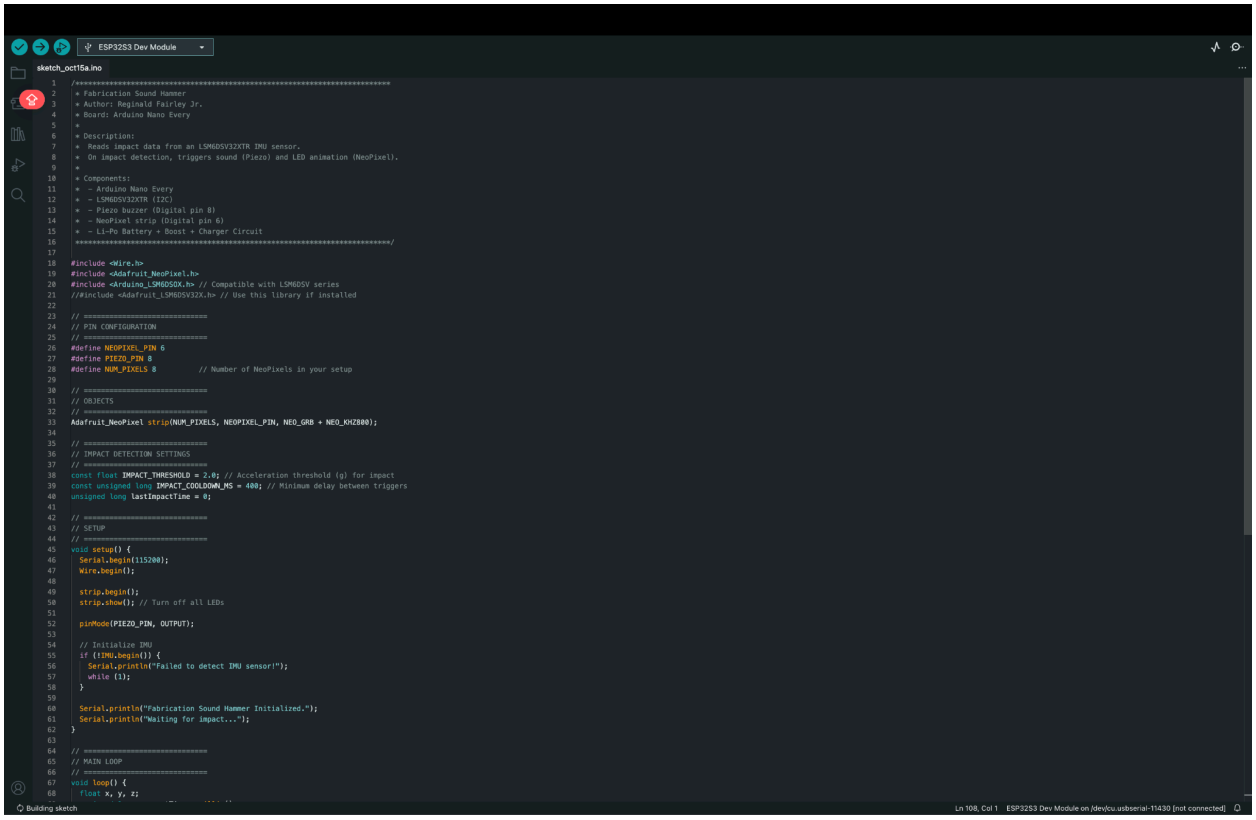
This was the schematic which explains how the power flow works for the hammer based on the tools I purchased that linked to the symbols I found on Ki-Cade. Some tools didn't have themself or a similar symbol to represent them so I had to custom make a couple of symbols like the LSM6DSV32XTR who was an accelerometer + Gyroscope to detect motion and mpact

Fusion AutoDesk



Fusion Autodesk allowed me to make a 3D-Model to help plan how everything would fit on my hammer project. It even comes with accurate measurements akin to what I prefer which was millimeters (mm)

Arduino IDE



The Arduino IDE software was perfect for checking any possible errors that ChatGPT could've made while simulating how the code should be to allow the hammer components to function properly

4. Results.

The 1st and 3rd objectives were successful as I was able to analyze and design a better version of the hammer project that I had previously. The 2nd objective wasn't completed to my liking as I wasn't able to finish physically making the hammer.

5. Challenges and Lessons Learned

Time management was a major factor in the performance of this project. I should've kept my summer and spring schedule light enough for me to handle the scope of this project which I would admit, I was too ambitious with and not as realistic about.

6. Future Improvements

If I were to make plans for a third iteration of the hammer project, I would make sure that the independent study was center focus and no other important events were interfering such as other classes or work.

I would also set due dates for each deliverable that I create during the planning phase of the project so that I don't spend too long on one deliverable.

Last, I would do better to balance ambition with realism in order to not work outside my own knowledge as much as I did with this project.

7. Conclusion

All in all, this was a new experience for me in terms of improving a previous project and taking an independent study. I know how to properly go about tackling new material from now on and I now have several new sources of research and applications that I can use for projects in the future such as but no limited to:

- https://www.digikey.com/
- https://www.arduino.cc/en/Guide/NANOEvery/
- https://www.autodesk.com/products/fusion-360/overview

This was a great learning experience. I would like to see if someone can replicate my project using what I have.