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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.

Inventory List

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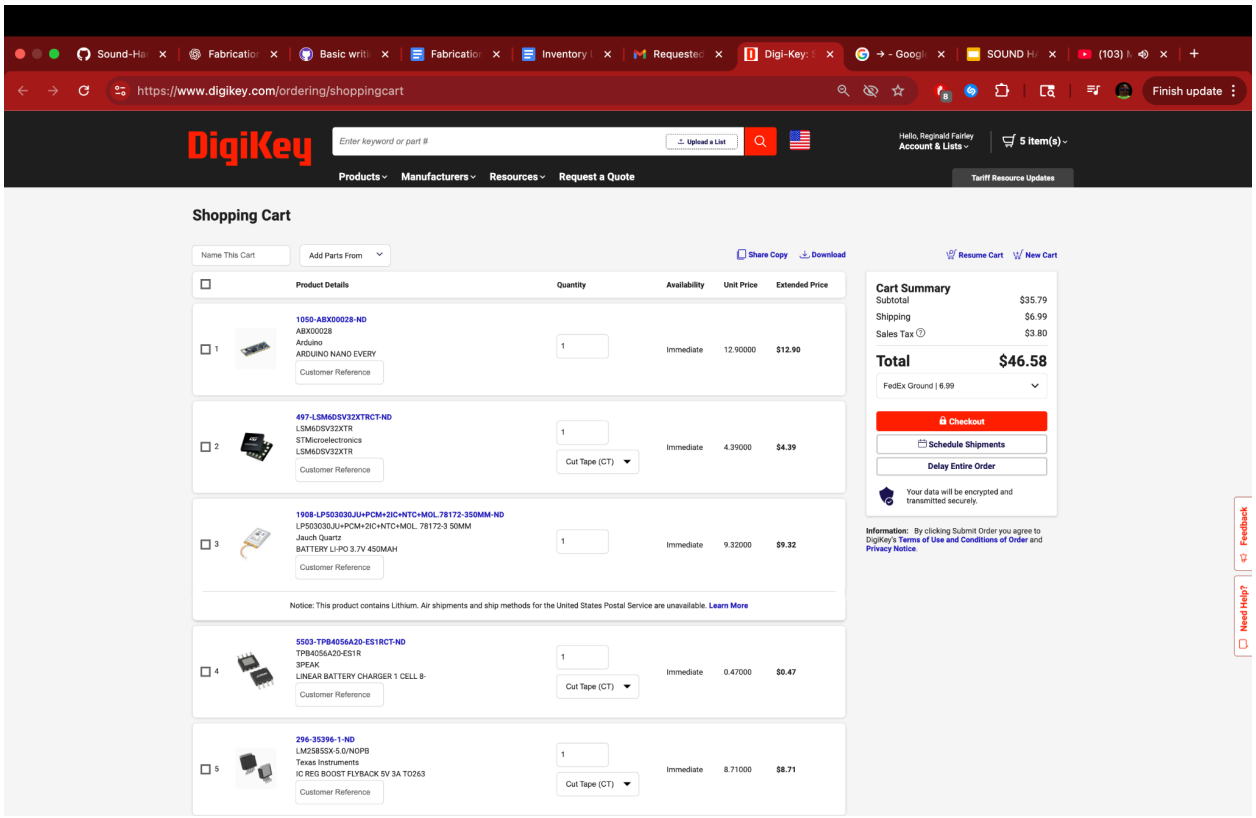
	A	B	C
1	**Component**	**Description**	**Notes**
2	Arduino Nano Every	Microcontroller	Controls sensors, LEDs, sound
3	LSM6DSV32XTR	Accelerometer + Gyroscope	Detects motion and impact
4	Li-Po Battery (3.7V 450 mAh)	Rechargeable power source	Powers entire system
5	Linear Battery Charger (1-cell, 8-pin IC)	Charging circuit	Connects to USB-C port
6	Boost Converter (5V 3A TO-263)	Voltage regulator	Steps up battery voltage to 5V
7	Piezo Buzzer	Sound output	Responds to impact force
8	RGB LEDs (x3 or x5)	Visual feedback	Placed in hammer head
9	Female Jumper Wires	Wiring	Used for breadboard/prototyping
10	Resistors	220 Ω for LEDs, 10 kΩ for pull-ups	Prevent overcurrent
11	Breadboard	For testing	Full-size (830-point) recommended
12	3D-Printed Hammer Body	Structural shell	Printed in PLA, ABS, or PETG
13	Heat-shrink tubing & tape	Insulation	For final wire management



Images located in as separate files to view in Final Report folder

SECOND OBJECTIVE

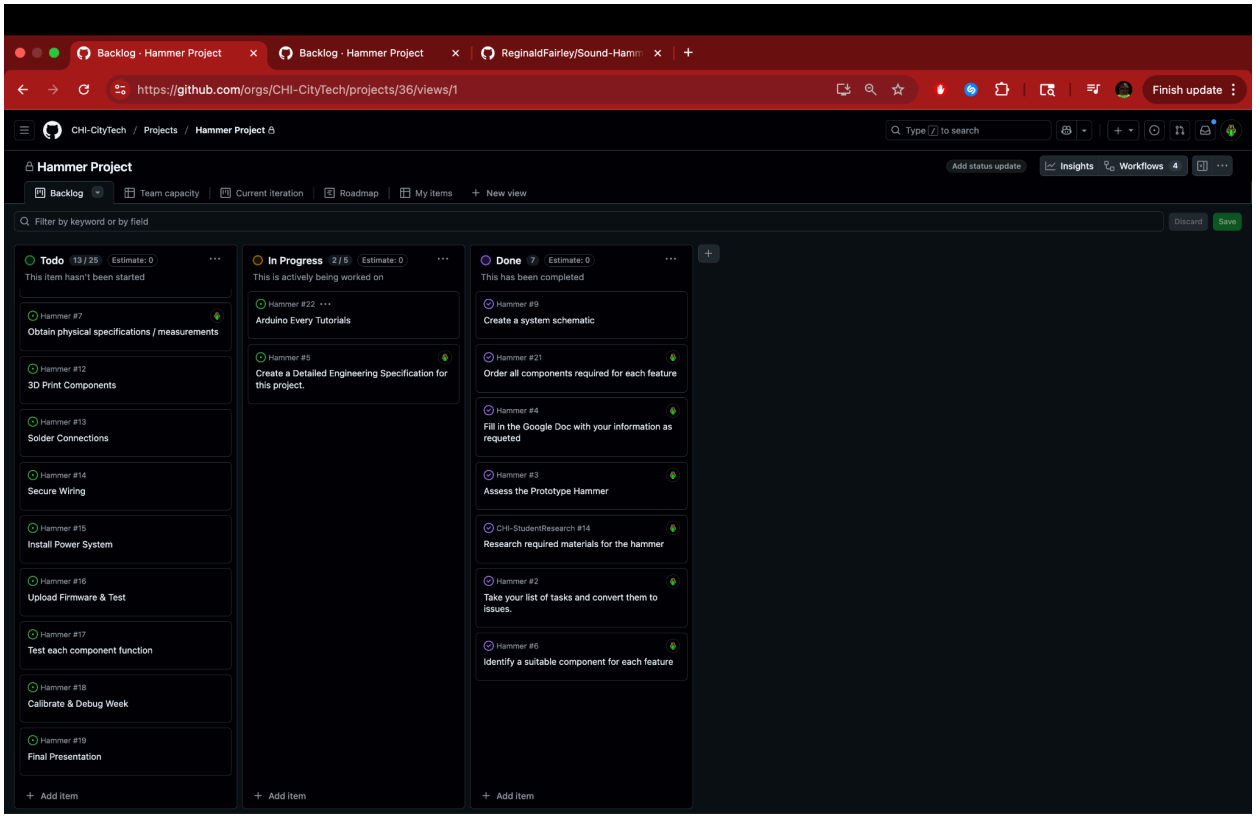
Once all new planned changes were confirmed. I set up a meeting with my instructor and together we built together a github project page for the project along with deliverables to break

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

List of Deliverables Created

1. Take your list of tasks and convert them to issues
2. Assess the Prototype Hammer
3. Fill in the Google Doc with your information as requested
4. Create a Detailed Engineering Specification for this project
5. Identify a suitable component for each feature
6. Obtain physical specifications / measurements
7. Create a component diagram
8. Create a system schematic
9. Create software modules
10. Order all components required for each feature
11. Arduino Every Tutorials
12. Implement code for hammer
13. 3D Print Components
14. Solder Connections
15. Secure Wiring
16. Install Power System
17. Upload Firmware & Test
18. Test each component function
19. Calibrate & Debug Week
20. Breadboard electrical circuit and prove functionality
21. Final Presentation

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.



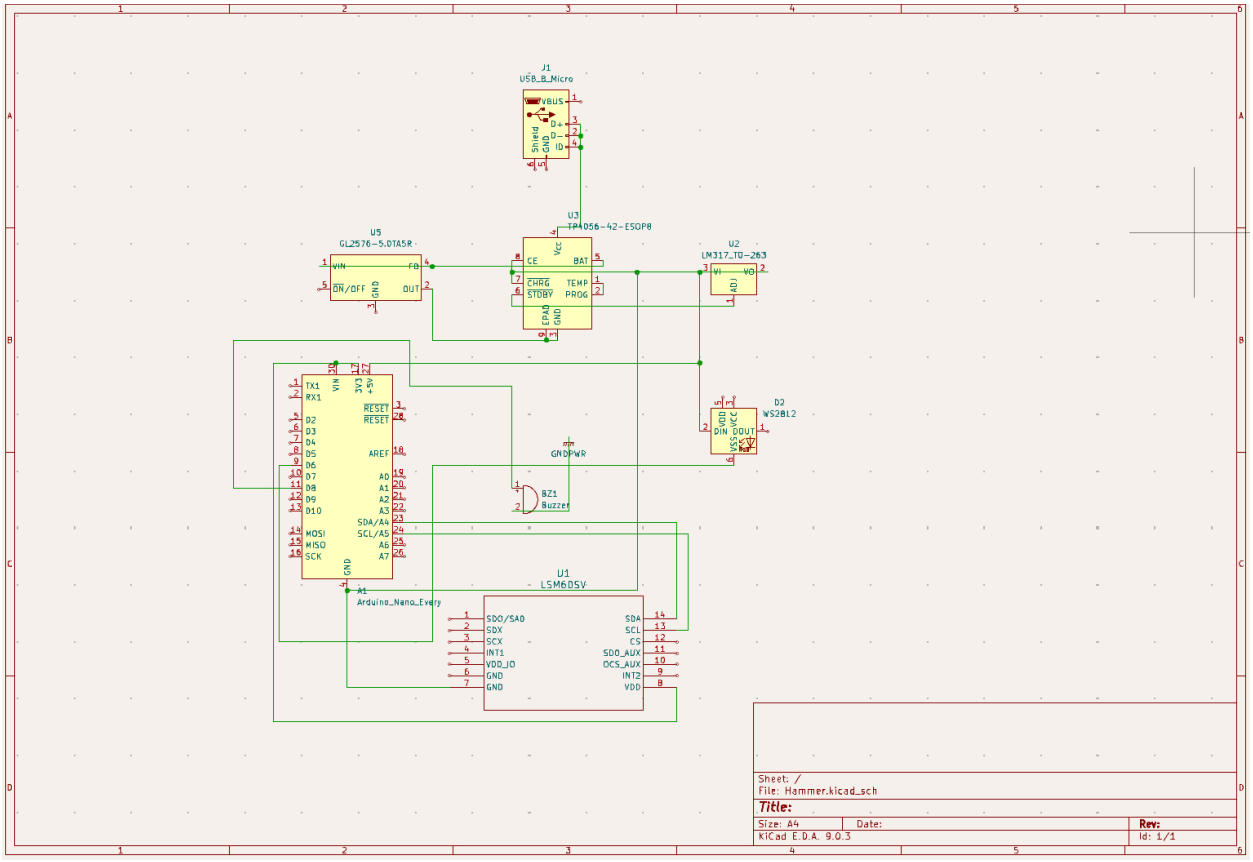
Link to this screenshot can be found [here]

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

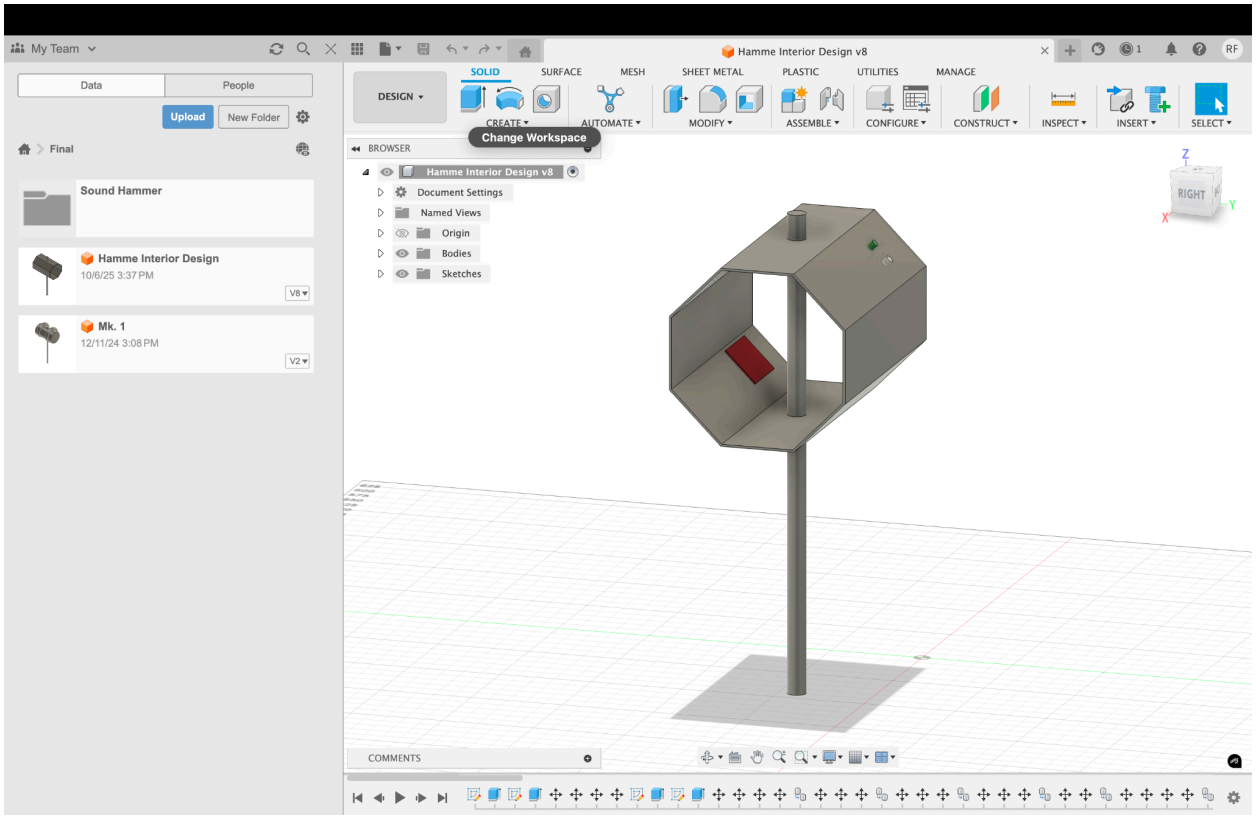
Ki-Cade



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 impact

Images located in as separate files to view in Ki-Cade Schematic Files Folder

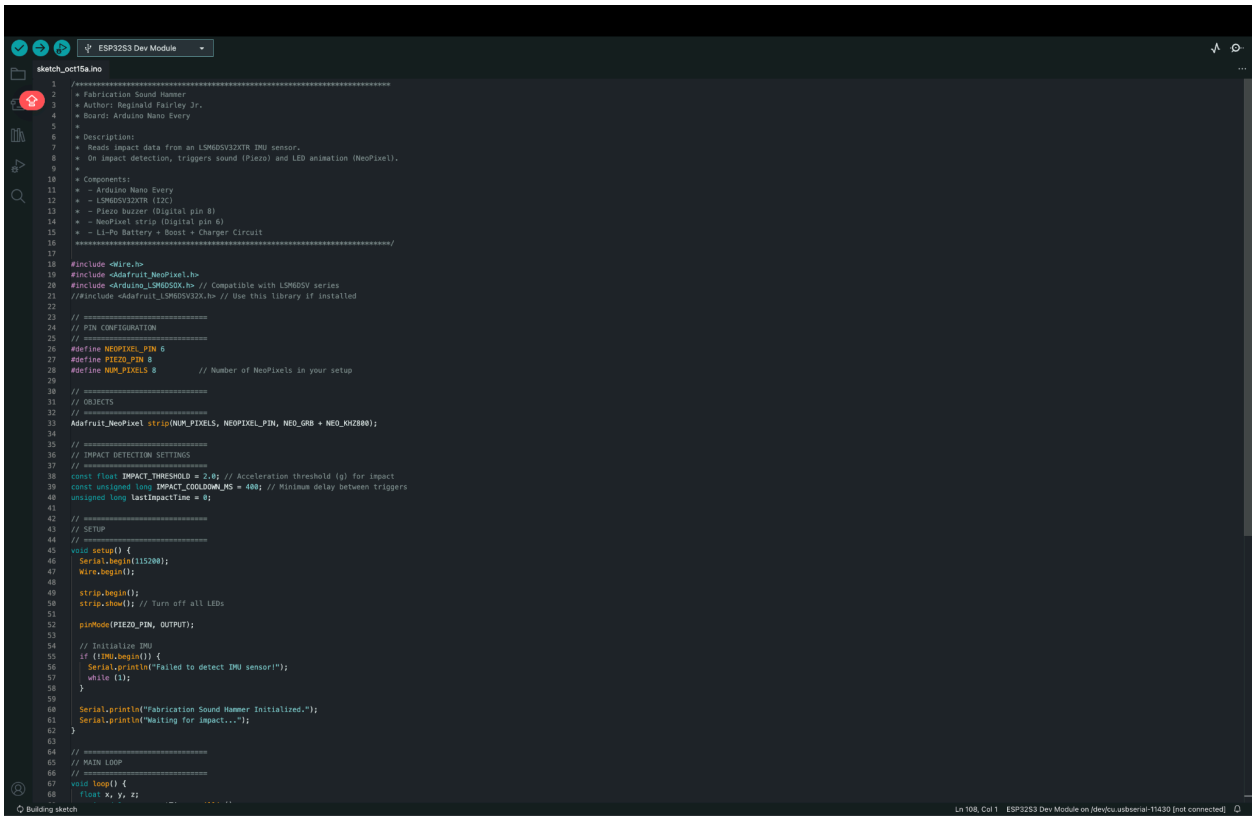
Fusion AutoDesk



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)

Images located in as separate files to view in Fusion Desk 3D Hammer Files Folder

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

Code can be found in Arduino Code File

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. Lessons Learned / Challenges

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.

I notice that because I never assigned any due dates for the deliverables I created, I spent too much time on certain ones and was constantly re-doing it instead of moving forward. For the current and future deliverables that I created, I will assign due dates so I can estimate how much progress and time I had easier.

Some steps were very difficult and I did not reach out for help until the very last minute. I took the term Independent Study literally and thought I could only use my own abilities for the project without outside interference. Next time I won't hesitate to ask other people or AI agents for assistance. That way I can cut down on time I spent on individual deliverables.

6. Next Steps

For the third iteration of the hammer project, I would make sure that the independent study is 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.

Future Deliverables will be added to move forward from my current position which was the completion of all planned files created such as "Create a blueprint for 3D Printing the Hammer's outer shell which follows CityTech's laser rules" and "Implement Power System using your Ki-Cade Power Schematic File"

Once all new deliverables are added, I will test the hammer project and troubleshoot if there are any problems with it.

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 not 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.