## **Purdue ECE Senior Design Semester Report**

## **(Team Section)**

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| **Course Number and Title** | ECE 47700 *Digital Systems Senior Design Project* |
| **Semester / Year** | Spring 2025 |
| **Advisors** | Phil Walter |
| **Team Number** | 20 |
| **Project Title** | Encrypted USB Drive |

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| Senior Design Students – Team Composition | | | |
| **Name** | **Major** | **Area(s) of Expertise Utilized in Project** | **Expected Graduation Date** |
| Brandon Liu | CompE | Software, PCB Design, Soldering, Wire Crimping | May 2025 |
| Abhijay Achukola | CompE | Software, PCB Design, Soldering | May 2025 |
| Joshua Wai | CompE | Mechanical, Software | May 2025 |
| Stanley So | ElecE | Software, PCB Design, Soldering, Wire Crimping | December 2025 |

**Project Description:** Provide a brief (2-3 page) technical description of the design project, as outlined below:

1. Provide a general description of the product to be delivered by this design project.

## The product has a fixed number of 4 users. When the user enters the correct password on the keypad or enters the correct fingerprint, they get to access the files corresponding to their user.

## Initially, all the users’ passwords are four 0s. When the user plugs in the USB drive, the LCD screen says, "Select User" and they must enter a number on the keypad to select the user (1 for user 1, 2 for user 2, 3 for user 3, and 4 for user 4). Then the LCD screen shows “Enter Passcode / Fingerprint” and the screen displays what the user types on the keypad. As the user types, their input is replaced with a dot. Once the user enters the correct passcode or inputs the correct fingerprint, the USB drive goes into the unlocked state where all the files for that user can be accessed. Each user gets their own designated flash chip. In the unlocked state, the user can press a button on the keypad to change the passcode or change the fingerprint and can press another button to lock the USB drive.

## The system is implemented using an STM32 microcontroller. It handles interfacing with the keypad, LCD screen, fingerprint sensor, four flash chips, and a host computer. It also handles keeping track of what state it’s in and handles keeping track of what user is accessing the flash drive.

## The system is powered through the 5V USB signal that is interfaced with the 5V USB-A female connector. According to the USB 2.0 specifications, it can handle an input voltage ranging from 4.75V to 5.25V. This input voltage directly powers the LCD screen. There is a low dropout regulator to step down the voltage to 3.3V to power the microcontroller, fingerprint sensor, and the flash chips.

## The system is enclosed in a 3D-printed rectangular case. Since the user must press down on the USB drive to enter a password, it can be connected to a computer using a cable instead of directly into a computer.

1. What is the purpose of this product? For whom is it intended?

## The purpose of this product is to have an encrypted USB drive that provides the end-user with the ability to store data secured by their fingerprint and password while keeping costs as low as possible; a great additional feature includes segmented memory such that different users using the same USB drive can only access certain files depending on their credentials via passwords, ID etc. The drive should provide an extra layer of security for access to user data. The intended audience for this product includes people who want to keep their data private. It can be bought by companies to be used by employees who want to transfer information via the drive, even if there is other sensitive data on there not yet erased, or even interest anyone involved in government or the military. The multiple users feature is great for companies that have workers on different shifts. These companies can buy one USB drive for different workers on different shifts to share, and that can save costs.

1. Describe how the engineering design process used to create your product was utilized in this project. Include how you were able to develop and conduct appropriate experiments, analyze and interpret data, and use engineering judgment to draw conclusions related to the development of your product.

## The main engineering design process used to create this product began with defining the problem and solution. The first task completed came up with a problem to be solved which ultimately led to the decision to develop an encrypted USB drive to solve the issue of data security. The next step was planning. This included looking at specifications of parts to meet goals and functionalities that the solution seeks to provide and then prototyping each part before making a PCB design and systematically integrating everything into one device (PCB connected to external components). There was lots of testing to debug issues not found in initial prototyping such as bridging the connection between USB host and flash memory.

1. Describe the design constraints, and resulting specifications, incorporated into your product (list a minimum of 3).

## **Constraint:** at least 100kB/s speed for reading / writing files between the computer and the flash drive.

## **Specification:** A microcontroller with USB built in was selected and USB 2.0 high-speed was used.

## **Constraint:** at least1Gb of memory for each user, and a total of four users.

## **Specification:** Our PCB has four 1Gb flash chips, all communicating over the same SPI bus. We used the CS pin to select which flash chip we’re using based on what user is selected.

## **Constraint:** We need to be able to communicate using one UART bus, two SPI buses, seven GPIO pins, and one USB bus. These will communicate with the fingerprint sensor, the four flash ICs, the LCD display, the keypad, and the host computer, respectively.

## **Specification:** We chose the STM32H7A3RGT6 microcontroller because it had enough peripherals and enough pins to handle all the communication.

## **Constraint:** We need to power the microcontroller, fingerprint sensor, and flash ICs using 3.3V and be able to supply up to 500mA. Our device also needs to be powered by the USB 5V. **Specification:** We chose the AZ1117IH-3.3TRG1 LDO, since that could supply 3.3V from 5V, and provide up to 1A of current.

1. Describe how each of the following factors influenced your design specifications and constraints.

## **Public Health, Safety, and Welfare:** One potential issue we considered was the risk associated with USB male-to-male connections and the possibility of electric shocks. However, the primary concern was the potential for users to accidentally damage the board due to static discharge from human contact. To mitigate this risk, we incorporated ESD diodes for the USB-A port, keypad, and fingerprint sensor. We also made a case out of insulating material to protect the electronics and user. Other than that, no significant risks were identified.

## **Global Factors:** Global factors didn’t play a significant role in this project, as it wasn’t specifically designed for any particular global market or to address geopolitical issues. However, we did consider the general global trend toward increased data security and privacy concerns, especially with rising cyber threats. This influenced our decision to implement strong and secure authentication features, such as fingerprint recognition and password protection, ensuring that the product would meet global expectations for secure data storage. We were not able to include all the languages for our UI so the understanding of English would be necessary for users to use our product, but choosing English as the language is useful, as it is the most widely known language and can make it accessible for the most people.

## **Cultural Factors:** Different cultures might also have varying preferences when it comes to things like the user interface, some might prefer simple, clean designs, while others may want more detailed instructions or support in multiple languages. With this in mind, we tried to make our design as simple and easy to use as possible. Unfortunately, we were not able to implement other languages other than English due to the LCD. However, as English is the most well-known language in the world, our product should have enough reach to be understood by most individuals. In areas with a higher risk of cyber threats, users might expect stronger security, like multi-factor authentication or biometric features, which is why we utilize two forms of authentication, password and fingerprint access.

**Social Factors:** This product would affect the social environment of corporations, allowing for easier collaboration and teamwork, with multiple people using the same drive. It’ll also allow for a more secure work environment with the data stored on the USB drives not being able to be stolen easily by malicious actors who also have access to it. This also prevents data being unintentionally shared with other unassuming users of USB drives.

## **Environmental Factors:** We were under the assumption that the product will not be used in extreme heat or cold, and it will not be used in an external environment where there is precipitation, so we have the freedom to select any components that could operate at the normal temperature of our lab, and did not have to consider waterproofing. PCBs and LCDs require hazardous chemicals and a significant amount of energy to manufacture. They also require a significant amount of energy to recycle, because they need to be smelted to recover metals. Because of these reasons, we chose the smallest LCD that could display our UI, designed our PCB to be as small as possible, and chose the smallest keypad that had enough buttons to easily navigate our UI.

## **Economic Factors:** The design in question aims not to be much more expensive compared to products already on the market. We did this by choosing the cheapest fingerprint sensor that could store 4 users, choosing the cheapest keypad that had enough buttons to navigate our UI, and choosing the cheapest LCD display that could display our UI. We also added a feature where four users could use one flash drive, so companies can buy one flash drive for four different employees, given that they won’t all be using it at the same time. This might happen if the company has employees on different shifts.

1. Describe the appropriate engineering standards incorporated into the creation of your product.  
     
   The main standards used in this project are the communication protocols implemented to interface external components with the microcontroller including USB 2.0, SPI, and UART. Other followed conventions include using IEEE 1185 standard ESD protection for components that may interact with human input as well as other rules set for PCB design involving ERC and JLC PCB dimension constraints.
2. Describe the final status of your product.

The product can transition between user select, receiving password, unlock, change fingerprint/pin, and locking states via the keypad input. While this functionality also works with the fingerprint sensor, it does not work the same within the packaging, making the functionality irrelevant in this context. The product can display the states transitioning and provide information upon what input to provide to the product to change states and access data using the LCD as a heads-up display (HUD). The product can interface with a host computer over USB and connect to the computer upon transition into the unlocked state and remove the device from the device list of the computer upon locking. In the unlocked state, the product can display the data stored in the flash IC corresponding to the user in the computer via USB.

1. Describe the makeup of your project team and how you were organized to establish goals, plan tasks, and meet the objectives of this project.

Although each team member took similar ECE courses prior to the senior design course, there were new tasks that required learning and interest such as soldering, CAD (for casing), and PCB design. Joshua was interested in the mechanical tasks of the project, so he primarily did the CAD. Stanley, Brandon, and Abhijay each prototype approximately 1-2 external devices ie. LCD, fingerprint sensor, flash ICs, and keypad due to their experience in working with these devices. Although Stanley was the most experienced in PCB design, Abhijay took a keen interest in it and therefore was the main contributor to this task. Abhijay often helped set goals, by highlighting the major blockers of the project that needed to be addressed and helped organize meetings. He also got more people to work on the major issues being faced. Each team member worked on tasks based on skillset and interests. These tasks were then individually planned on how to approach them, with input from teammates and check-ins with other teammates to ensure everyone got their tasks done on a timely manner. Near deadlines, the whole team got together to work on the project and aid others in them to meet those deadlines. Around a week before every deadline, Abhijay announced the deadline to ensure that everyone knew and was ready for it.

1. Did your project require the production of any written documentation other than this document (i.e., manuals, educational materials, etc.)? If so, describe the types, composition, and nature of the audiences for whom these materials were intended.

## This project involved the production of several written documents other than this document, including engineering journals and design documents. The engineering journals include the thoughts, progress, and achievements of each team member’s individual work. The engineering journals were mostly for internal use within the team, and tracked each team member's progress, ideas, problems we ran into, and what we achieved throughout the project. These journals were more reflective, helping us keep track of individual contributions and decisions made, and improving communication within the team. The audience for these journals was mainly team members and our teaching assistants and faculty advisors. We were instructed to document our progress in such a way that someone could easily follow along and understand our steps. The design documents include the planning of the various systems of the project including software and hardware, as well as analysis on the comparison between design components. These documents were intended for a wider audience, including our team and external reviewers like faculty advisors or professionals in the field. These documents went over the planning, technical specs, and design choices for both the hardware and software aspects of the project. They were more formal and technical, aiming for clarity so that anyone reading them, whether they were familiar with the project or not, could follow the reasoning behind our design decisions.

1. Describe the types, composition, and nature of the audiences in attendance for the final oral design review. Discuss how you prepared for this audience.

## In the final oral design review, the main audience are student peers and the instructional staff. The student peers are likely interested in seeing the functionality of the design and the process involved since they never conducted weekly check-ins to see the progress of this project throughout the semester. The instructional staff may pose more sophisticated questions as they were involved in seeing how the project progressed over time. To prepare for both audiences, it was key to reflect on the responsibility and achievement of each team member as this is what we will be presenting in addition to the demonstration of the project design.

## **Purdue ECE Senior Design Semester Report**

## **(Individual Reflections Section)**

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| **Course Number and Title** | ECE 47700 *Digital Systems Senior Design Project* |
| **Semester / Year** | Spring 2025 |
| **Advisors** | Phil Walter |
| **Team Number** | 20 |
| **Project Title** | Encrypted USB Drive |

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| Senior Design Student Completing This Section | | | |
| **Name** | **Major** | **Area(s) of Expertise Utilized in Project** | **Expected Graduation Date** |
| Brandon Liu | Computer Engineering | Software, PCB Design, Soldering, Wire Crimping | May 2025 |

**Individual Reflection:** Provide a brief (1-2 page) individual reflection of the design project, as outlined below:

1. Describe your personal contributions to the project.

## In software, my main contributions include prototyping the LCD, prototyping read JEDEC ID for the flash IC, setting up USB interface between host computer and the microcontroller, and storing user ID and password credentials in the MCU flash using C programming on the STM32CubeIDE. For PCB design related tasks, my contributions include routing the PCB layout and adding ESD protection to both the schematic and the PCB layout. I’ve also crimped wires & soldered wires together to establish connections between external components and the PCB which has a bunch of components that I soldered on including but not limited to the MCU, flash ICs, connectors, diodes etc.

1. Describe how your contributions to this project built on the knowledge and skills you acquired in earlier course work.

## During my work in prototyping the LCD using SPI, one command of the flash IC using SPI, USB interface setup, and storing user ID and password credentials in the MCU flash using the C programming language, my skills in accomplishing these tasks can be derived from ECE 36200 and ECE 43700. In ECE 36200, I learned to work with GPIOs, communicate with external devices using SPI and UART, configure interrupts, and more importantly, read datasheets for things I’m not familiar with which is what I did when working with a different type of LCD than one used in ECE 36200 and prototyping USB. In ECE 43700, I learned the concept of storing both program instructions and data in memory and reference them via addressing which helped me figure out how to best store user ID and password credentials.

1. Describe how you acquired and applied new knowledge as needed to contribute to this project. What learning strategies did you employ to do so?

## Prior to soldering the microcontroller, flash chips, resistors, diodes, capacitors, connectors, and wires, I only had experience soldering wires. I have never done anything with other kinds of components before, so I knew that I had to learn from people who have accomplished these tasks already. Luckily, the ECE 47700 course staff provided a workshop for how to solder, so after attending the workshop, I was able to solder the components listed above. As for routing the PCB and adding components to the layout, I have never really worked with KiCad before, and since this skill was to be self-learned, I watched YouTube tutorials that guided me step by step on the same KiCad version that I was using. After watching the videos, I was able to route the wires between the connectors and the microcontroller in one of the revisions, and learn how to add ESD circuitry by first adding them to the schematic file and then automatically update their presence in the PCB file which I later had to route as well.

1. Discuss your ethical and professional responsibilities as they relate to this engineering design experience.

## My ethical responsibilities involve being honest about my progress and what I am struggling with. It is important that other team members know what I have worked on and what I have not completed yet, so they have full transparency on other aspects of the project that they are not working on. My professional responsibilities primarily consist of following conventions for updating parts of a project shared and accessed by multiple members including but not limited to version control.

1. Consider what the impact of the product of this engineering design experience could have in economic, environmental, societal, and global contexts. Discuss how you would make (or did make) an informed judgement as to your product’s impact in each of these four contexts?

## Regarding the societal and global contexts, I would consider mainly privacy, data protection, and spy / intelligence networks run by government / military institutions. It can be determined that the secure USB drive has a huge impact in these areas because it prevents any user from simply plugging in the drive into their computer and accessing the data. There is a layer of authentication that must be breached in order to unlock access to the USB. This protects users in case they leave their drive lying around as well as people conducting military operations around the world because there is impedance to the data access. For the product’s impact in the environmental context, I would only think about what the product uses or releases, and since it does not release any substances to the environment, I would determine that the only environmental impact is electricity usage. As for economic impact, I would judge the product’s impact in this category by viewing its competitiveness against other products. I can determine that this product has one by being a competing product in the marketplace if and only if the product was smaller in size, had stronger wire connections, and provided more storage space. This is because most flash drives can store many gigabytes of data, while the current engineering design can only store a single gigabit per user, which is not ideal. In addition, the size of the design is bulky due to the requirement of holding a keypad, fingerprint sensor, and an LCD. If the design along with these external components were smaller, it would be more portable and competitive in the market. Otherwise, despite the potential to encrypt data and the ability to require authentication before accessing data, the product is on the lower end of meeting consumer needs and will therefore have difficulty in maintaining its standing in the USB drive market.

## **Purdue ECE Senior Design Semester Report**

## **(Individual Reflections Section)**

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| **Course Number and Title** | ECE 47700 *Digital Systems Senior Design Project* |
| **Semester / Year** | Spring 2025 |
| **Advisors** | Phil Walter |
| **Team Number** | 20 |
| **Project Title** | Encrypted USB Drive |

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| Senior Design Student Completing This Section | | | |
| **Name** | **Major** | **Area(s) of Expertise Utilized in Project** | **Expected Graduation Date** |
| Stanley So | Electrical Engineering | Software, PCB Design, Soldering, Wire Crimping | December 2025 |

**Individual Reflection:** Provide a brief (1-2 page) individual reflection of the design project, as outlined below:

1. Describe your personal contributions to the project.

## I wrote the code for the keypad by using a timer interrupt to poll each row using GPIO. I interfaced with the fingerprint sensor using UART. I made adjustments to the PCB design. I ordered all the parts for the project (PCB, on-board components, and off-board connectors). I soldered some of the components to the board, including the heartbeat LEDs, the female USB-A connector, the LDO, the reset switch, and various resistors and capacitors. I taught myself how to crimp wires, and I taught my teammates how to do the same thing. I turned Brandon’s state machine pseudocode into production code.

1. Describe how your contributions to this project built on the knowledge and skills you acquired in earlier course work.

ECE 362 taught me how most of the protocols used in this project worked (SPI, UART). Because of this, I knew what connections to make, what pins to debug with an oscilloscope, and how to translate the raw oscilloscope input into digital data. ECE 2k7 and 2k8 taught me how to use special oscilloscope functions (trigger, different horizontal modes), which helped in finding the data that I actually wanted to read. ECE 264 helped familiarize me with C syntax and how to use a debugger. This made writing code really fast and debugging a lot easier, since I could step through any individual instructions and see how the variables changed as I stepped through.

1. Describe how you acquired and applied new knowledge as needed to contribute to this project. What learning strategies did you employ to do so?

## My PCB design experience comes from a personal project where I made programmable diabolo (juggling prop) lights. I had to design a PCB in EasyEDA in order to make it structurally sound enough to be put on a spinning diabolo. This PCB design experience helped me make component placement and routing changes to the PCB very quickly. My soldering experience came from another personal project where I designed a drone, so I had to solder a lot of components together using wires. This made soldering together the two ends of the connector wires quick. Since we had to solder components onto a PCB for this project, I also had to watch YouTube videos on how to solder surface mount components. This allowed us to come up with a two-person system to solder components quickly, where one person managed the soldering iron and the solder, and another person managed the tweezers to put the component in place. I learned how to crimp terminals after watching YouTube videos for this project. This made it so then I knew what parts to order (both housing and crimp terminal), I knew how to make some connectors, and I knew how to teach Brandon how to also make connectors. I also learned how to use the oscilloscope to read serial data by watching YouTube videos. This made debugging UART data from the fingerprint sensor so much faster, since I didn’t have to manually decode the oscilloscope reading into digital data myself.

1. Discuss your ethical and professional responsibilities as they relate to this engineering design experience.

## Whenever I saw that something needed to be done, I would jump in and take care of it (everything in part A was something I volunteered to help for). At the very least, I always tried my best to be there when someone else was working. There are some unlogged hours missing from my journal where I’m just there for mental support, and ready to help with any small tasks that I could (they’re missing from my journal because I don’t know how to log those hours without points being deducted for not describing enough). I always tried my best to communicate with my teammates on Discord (about progress and also about my schedule), and I made sure I received all notifications from that Discord server so I could constantly be aware of what needed to be done.

## My ethical responsibilities included being honest and transparent about my work progress and my availability. This let my teammates know what needed to be done. I also followed all the lab rules, including not taking anything from anybody else’s lab station, and always having at least 2 people in the lab. Taking something from someone else’s lab station can lead to confusion, and in the worst case component damage, and having at least 2 people in lab meant that there was always someone else there if somebody got hurt.

1. Consider what the impact of the product of this engineering design experience could have in economic, environmental, societal, and global contexts. Discuss how you would make (or did make) an informed judgement as to your product’s impact in each of these four contexts?

## (If we polished our product more), some societal and global impacts this product might have are that this might be used by companies to protect their data, leading to more secure data storage since you have to physically get your hands on it to break into it. This might also be used by criminals to hide their data and communicate, like how mass criminal networks have used encrypted phones, but this is much less of a concern than encrypted phones because it has no internet access. If we added internet access, our project would become another encrypted phone, leading to really big ethical concerns regarding criminals using it. Like many electronic products, this product has environmental impacts on both the manufacturing and disposal stage. Every single component (PCB, ICs, LCD display) uses hazardous chemicals in the manufacturing process, along with a lot of energy. During the disposal stage, you have to smelt the electronics to get the metals back, which is more energy usage. To account for this, we made the PCB as small as possible and chose the smallest possible components that met our requirements. In terms of economic impact, we might be able to sell this to a lot of big companies that want to secure their data. Our project is probably not lower priced than the other secure USB drives out there, and it’s definitely not as small as other competitors. However, our project has a UI and a fingerprint sensor, which provides new users with an easier learning curve, and makes our product more convenient to unlock. Thus, our main selling point is that our project provides a more convenient alternative to existing competitors.

## **Purdue ECE Senior Design Semester Report**

## **(Individual Reflections Section)**

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| **Advisors** | Phil Walter |
| **Team Number** | 20 |
| **Project Title** | Encrypted USB Drive |

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| Senior Design Student Completing This Section | | | |
| **Name** | **Major** | **Area(s) of Expertise Utilized in Project** | **Expected Graduation Date** |
| Abhijay Achukola | CMPE | Software, PCB Design, Soldering | May 2025 |

**Individual Reflection:** Provide a brief (1-2 page) individual reflection of the design project, as outlined below:

1. Describe your personal contributions to the project.

I researched which flash IC to utilize, read through the data sheet, and implemented software interfacing with the flash IC from the microcontroller over SPI. I also designed most of the PCB Design and kept the schematic up to date with our updates prior to starting the PCB design. I also helped solder all the parts onto the PCB, helping place parts in place.

1. Describe how your contributions to this project are built on the knowledge and skills you acquired in earlier coursework.

I was able to utilize the datasheet reading knowledge I gained from prior classes like ECE 20001 to read through datasheets for the flash IC and microcontroller to properly interface them and connect them to the rest of the system properly. It also helped me find the proper way to wire the microcontroller to our PCB and the supporting circuitry from those datasheets. I also was able to utilize the KiCAD and stm32 microcontroller interfacing knowledge from ECE 36200 to create our electrical schematic and properly program the microcontroller to interface with the flash IC.

1. Describe how you acquired and applied new knowledge as needed to contribute to this project. What learning strategies did you employ to do so?

I acquired the knowledge of how to utilize stm32cube and interfacing with flash ICs by reading through forums and online datasheets on how to utilize it. I also learned more about these topics by trying to apply immediately in the project and then going back to the resources I utilized. I also learned how to design PCBs by listening to senior design lectures and watching videos online. Furthermore, I watched videos to expand my knowledge on how to solder SMD components properly and developed a system with my teammates to effectively solder them quickly. The learning strategies I utilized was to immediately apply the skills the resources I read to check if I fully understand the concepts.

1. Discuss your ethical and professional responsibilities as they relate to this engineering design experience.

I was in charge with keeping the team organized and ensuring that everyone knew which priorities had to be handled. I also ensured that we met together and ensured that the design process went smoothly, to avoid any malfunctions due to miscommunication. Ethically, I ensured that everyone documented their work, cited their sources, and ensured that I was transparent on my struggles and areas where I needed help.

1. Consider what the impact of the product of this engineering design experience could have in economic, environmental, societal, and global contexts. Discuss how you would make (or did make) an informed judgement as to your product’s impact in each of these four contexts?

Some economic impacts that this product would have include shaking up the market for storage devices by being able to sell this product to a lot of big companies that want to secure their data. This product might not be as cheap as many other USB drives but should be reasonably priced for hard drives in general, and the higher cost can be justified for the security it provides. Viewing this product with an environmental lens, this product would reduce the e-waste produced using massive number of USB drives as it condenses four users of four separate USB drives into all using our single product. The e-waste produced by electronics has major impact, as electronic components and PCBs utilize harmful chemicals to manufacture each time, so less devices being disposed of results in reduced harm to the environment. This product will have an impact on the social environments of corporations, which also would propagate this impact globally, allowing for easier collaboration and teamwork, with multiple people using the same drive. It’ll also allow for a more secure work environment with the data stored on the USB drives not being able to be stolen easily by malicious actors who also have access to it.

## **Purdue ECE Senior Design Semester Report**

## **(Individual Reflections Section)**

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| Senior Design Student Completing This Section | | | |
| **Name** | **Major** | **Area(s) of Expertise Utilized in Project** | **Expected Graduation Date** |
| Josh Wai | CompE | Mechanical | May 2025 |

**Individual Reflection:** Provide a brief (1-2 page) individual reflection of the design project, as outlined below:

1. Describe your personal contributions to the project.

I designed the mechanical casing using CAD software to fit the project’s electronics and 3D printed the parts. After receiving feedback from professors, TAs, and teammates, I made adjustments to improve the fit, add space for connectors, and reinforce key areas. I also helped with the assembly, tinning, crimping, cutting, and soldering wires to connect the components to the board. When the fingerprint sensor wasn’t cooperating, I troubleshot the issue by testing connections and making adjustments to get it working. Additionally, I updated the LCD UI by adding text prompts to improve the user experience.

1. Describe how your contributions to this project built on the knowledge and skills you acquired in earlier course work.

I built on the skills I gained from the 2K7 and 362 labs, where I learned the fundamentals of CAD design, electrical component assembly, and basic troubleshooting techniques. In the 362 lab, I learned about wiring, soldering, and circuit board assembly, which were crucial when working on the connections between the components. Building on these experiences, I was able to improve my understanding of integrating various components into a cohesive system, like when I had to troubleshoot the fingerprint sensor issue. I also applied what I learned about creating user interfaces in embedded systems when I updated the LCD UI with text prompts. This project gave me the chance to take those foundational skills and apply them to a real-world scenario, improving both my technical abilities and my problem-solving approach.

1. Describe how you acquired and applied new knowledge as needed to contribute to this project. What learning strategies did you employ to do so?

I had to learn how to use Onshape, the CAD software, from scratch, as it was my first time working with this tool. To get up to speed, I relied heavily on YouTube tutorials and online resources. I followed step-by-step guides, which helped me understand the interface and key features of Onshape. I focused on learning the basics first—like how to create sketches, extrude parts, and set up assemblies—before moving on to more advanced topics like constraints and part interactions. I also applied a hands-on approach by actively working on the CAD design for the project while referring back to the tutorials whenever I hit a roadblock. This approach of learning by doing was incredibly helpful, as it allowed me to see immediate results from my efforts and helped reinforce what I was learning. I wasn’t afraid to experiment within the software, and if something didn’t work, I’d troubleshoot the issue by watching more targeted videos or exploring community forums for solutions. This active problem-solving mindset, combined with iterative learning, made it easier to adapt to the software and apply it effectively for our project. Through this process, I gained a solid understanding of Onshape, which directly contributed to the successful design of the mechanical casing.

1. Discuss your ethical and professional responsibilities as they relate to this engineering design experience.

Throughout this project, I made it a priority to be transparent about any problems that arose, recognizing that honesty and clear communication are key to maintaining trust and ensuring the team could effectively address issues as they emerged. Whenever we encountered challenges—whether it was with the mechanical casing design, component connections, or troubleshooting technical problems—I made sure to bring these issues to the attention of the team right away.

1. Consider what the impact of the product of this engineering design experience could have in economic, environmental, societal, and global contexts. Discuss how you would make (or did make) an informed judgement as to your product’s impact in each of these four contexts?

The encrypted USB drive with user-specific memory banks has broad impacts across economic, environmental, societal, and global contexts. Economically, it meets the demand for secure data storage, offering opportunities for businesses needing high data protection. Societally, it provides affordable data security for individuals and organizations, addressing privacy concerns. Globally, it complies with international data security standards, ensuring relevance in regions facing growing cyber threats.