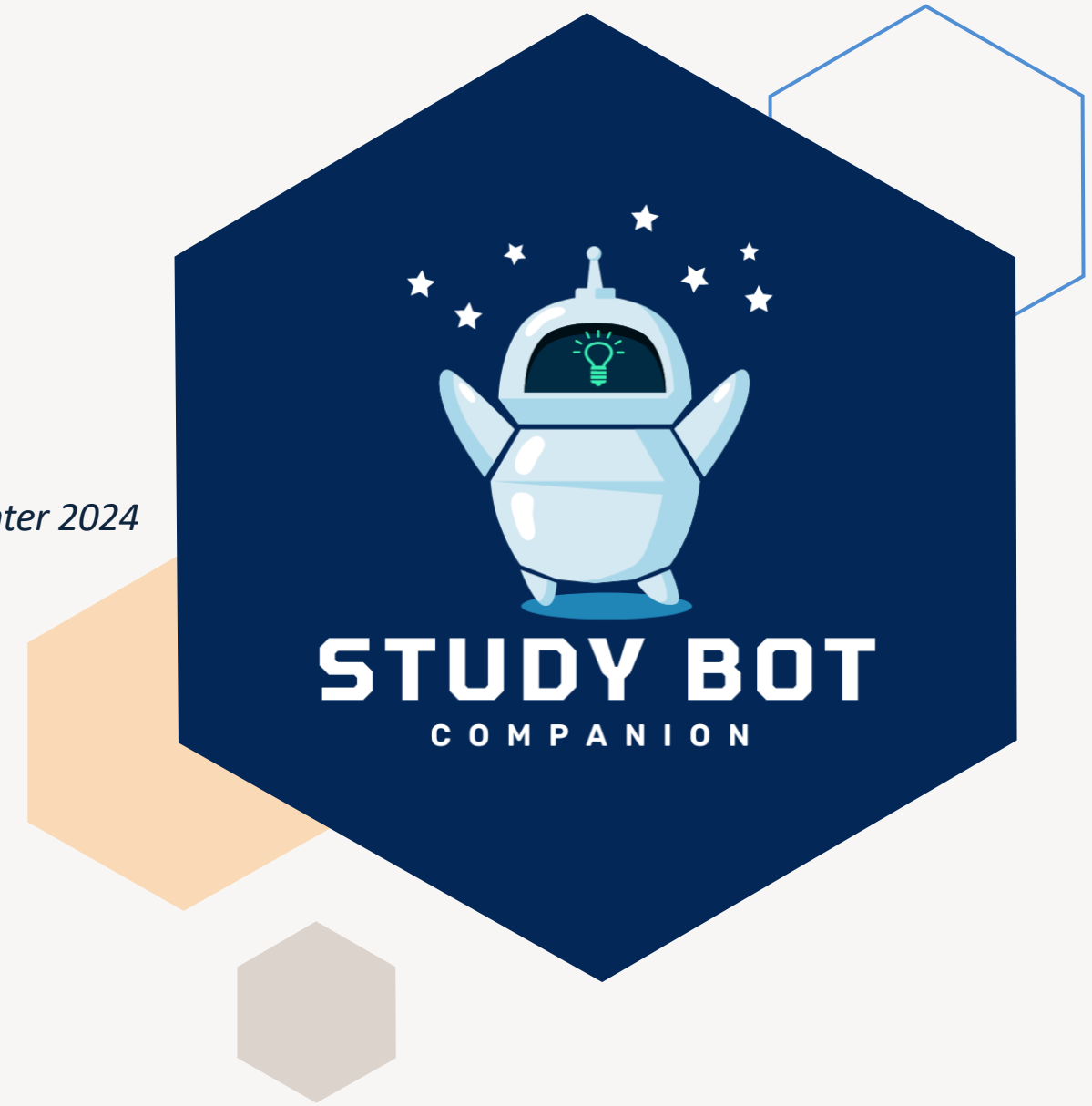
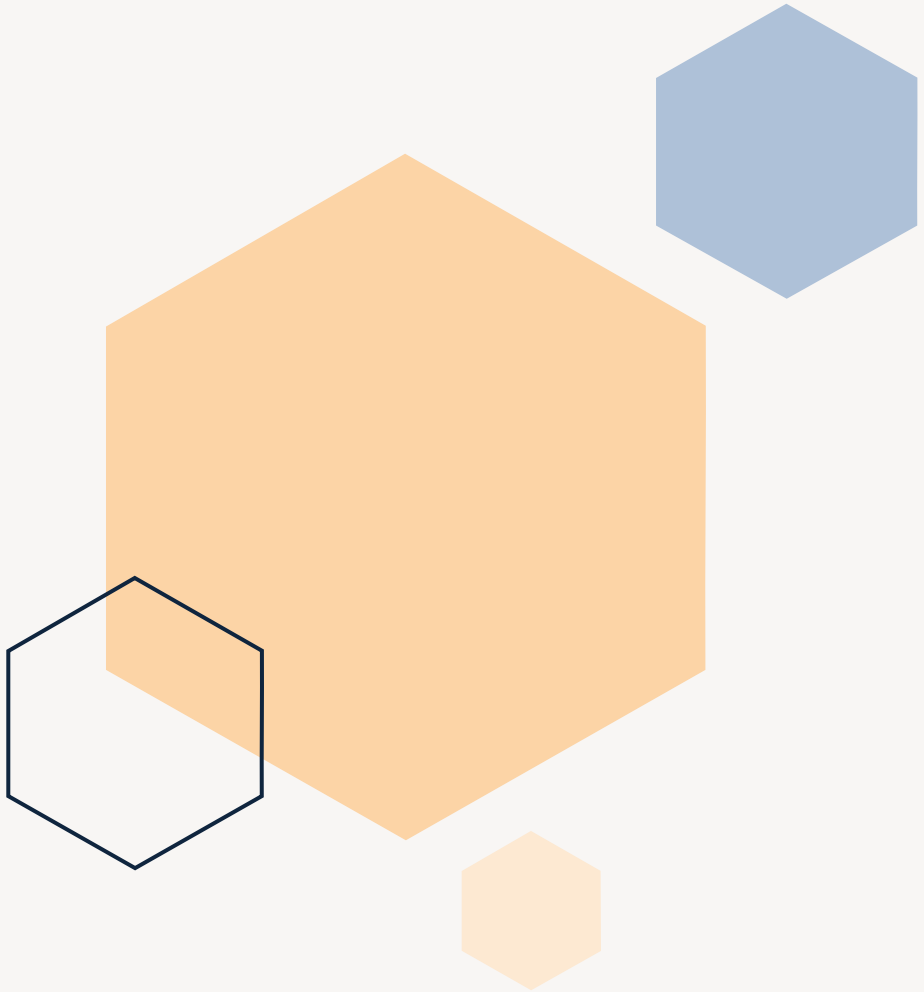
STUDY BOT COMPANION

Engineering Design, Innovation and Entrepreneurship (ENGG 200) – Winter 2024

Krishna Patel

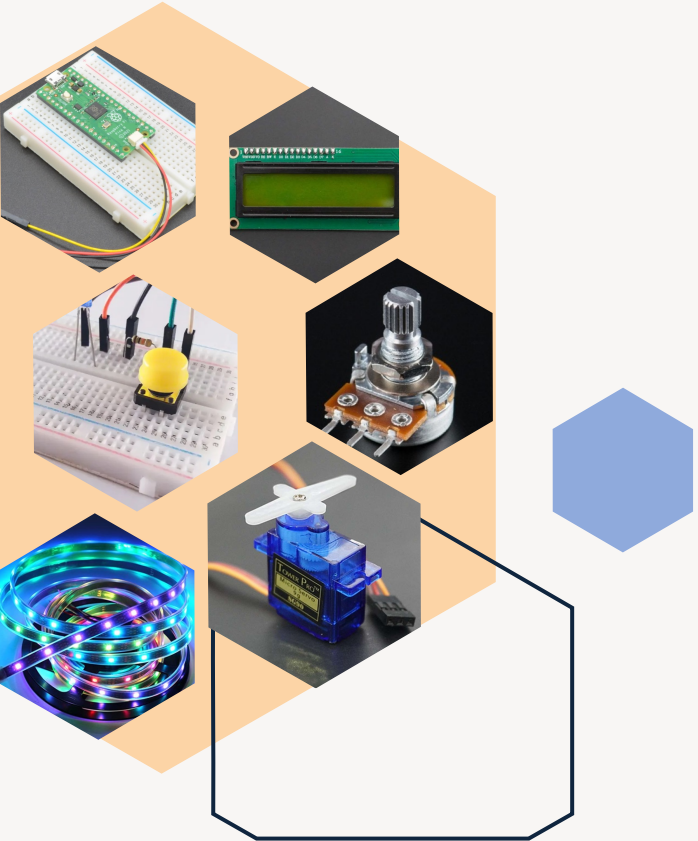




Project Objective

The goal of this project was to design and build a friendly companion that enhances the well-being of its user(s) through positive interactions, emotional support, and practical functionalities. The companion should be tailored to meet the specific needs and preferences of the user(s), providing a harmonious blend of technology and companionship. The design process should involve the complete integration of electronics, including power supply management, programming, and the construction of a durable and accessible casing. The companion should be user-friendly, with considerations for easy battery replacement and software updates.

Project Requirements



Key requirements included:

- **1. Design and Ideation:** Students were tasked with conceptualizing a friendly companion that not only offered positive interactions and emotional support but also incorporated practical functionalities to enhance the user's well-being. The design needed to be user-centric, addressing the specific needs and preferences of the intended audience, and balancing aesthetics with functionality to create an engaging and approachable companion.

- **2. Technical Implementation:** The project required the integration of various electronic components provided for the build. This included:
  - Displays and Indicators: 2.8" ILI9341 LCD, 16x2 LCD (I2C), 8x8 LED Matrix (MAX7219), TM1637 7-Segment Display, WS2812 RGB Light Ring
  - Sensors: HC-SR04 Ultrasonic Sensor, HC-SR501 PIR Motion Sensor, MK03 Reed Switch, HW827 Heart Rate Sensor, Photoresistor, DHT11 Temperature & Humidity Sensor, MPU6050 Accelerometer/Gyroscope
  - Actuators and Output Devices: 3.3-5V DC Motor, PAM8302A Audio Amplifier, 2W 8Ohm Speaker, MAX9814 Auto-gain Microphone
  - Input Devices and Controls: 10k Potentiometer, Button, Rocker Switch
  - Power Management: AA Battery Holder

  The team was responsible for precise electronic wiring and programming to ensure all components functioned seamlessly together. A key requirement was to manage the power supply effectively, ensuring reliable operation while facilitating easy battery replacement. Additionally, the software needed to support straightforward updates, requiring thoughtful design of the companion's software architecture and user interface.

- **3. Materials and Construction:** Constructing a durable and accessible casing was a critical aspect of the project. The casing needed to protect the internal electronics while allowing easy access for battery replacement and software updates. The design had to consider the use of provided materials and resources, including the utilization of 3D printers for creating custom components. The selection of materials and construction methods had to ensure the casing was robust, aesthetically pleasing, and user-friendly. Creativity in material usage was encouraged, provided that any additional materials used were recyclable or 3D printed.

Design Process

Brainstorm/Research

Plan/Strategize

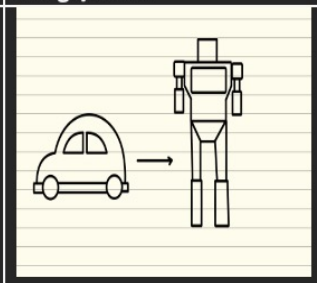
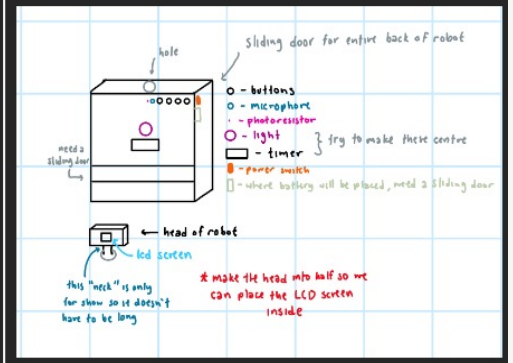
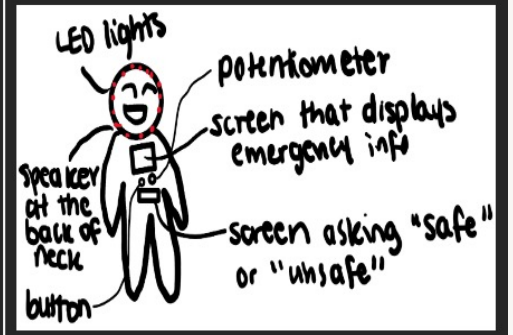
Design

Test/Troubleshoot

Final Product

Brainstorm/Research

Given the success of our last project, my team of four once again initiated the design process by conducting a comprehensive analysis of the electronic materials provided. This research phase was crucial in identifying and understanding the limitations and constraints of our components. With this foundational knowledge, we proceeded to brainstorm potential project ideas, focusing on how best to utilize the electronic components and create a successful companion.

Ideas	Design/Visual
Idea 1: Car Transformer Voice command transformer that interacts with kids through certain voice commands: • "Roll out": Rolls back and forth in alt mode. • "Forward": Walks forward in robot mode. • "Hello": response back with "hello"	
Idea 2: Study Bot Interactions: • Buttons for user to select a time and the countdown time shows on the screen. • Phone turns so user can't access their phone. • Equipped with emergency restart so user can access their phone immediately. Target audience: students	
Idea 3: Teddy bear • Has a potentiometer with a corresponding screen that asks the kid if they feel safe or unsafe & lights display red if in danger and green if not in danger? • If the kid selects unsafe, then there is a loud emergency noise to get attention. • The other screen has a corresponding button that if selected, displays the contact information of the parents/guardians. (Target user: kids aged 5-10 in emergencies - physical and mental needs)	

Plan/Strategy

Following the ideation and formulation of potential solutions, my team collectively decided to pursue the Study Bot Companion. This decision was made after carefully considering our available timeframe, materials, and resources.

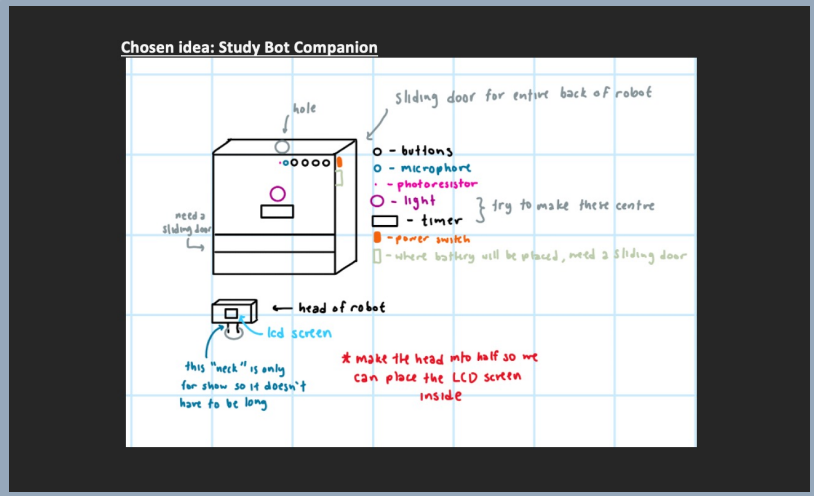
We adopted a collaborative team approach, opting to work together closely rather than following a traditional project management structure. This approach allowed us to efficiently assign tasks based on each member's strengths:

Team Member 1: Coding/Wiring
Team Member 2: Coding/Wiring
Myself: Coding/Wiring
Team Member 4: 3D Printing

To ensure the project progressed smoothly, we developed a comprehensive timeline that accounted for potential challenges, providing us with the flexibility to address any issues that might arise. Our timeline was structured as follows:

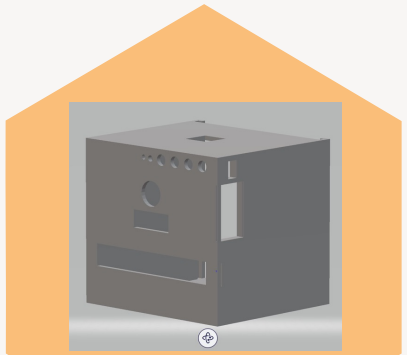
Week 1: 3D printing and initial coding/wiring of electrical components
Week 2: Complete 3D printing and continue coding/wiring
Week 3: Finalize coding/wiring
Week 4: Assembly of all components
Week 5: Presentation

This plan allowed us to stay on track while ensuring we had ample time to troubleshoot and refine our work as needed.



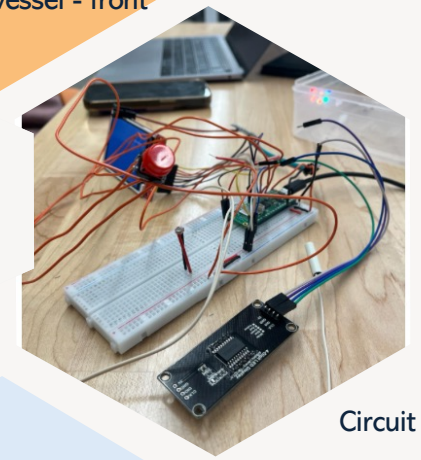
Design template

Design

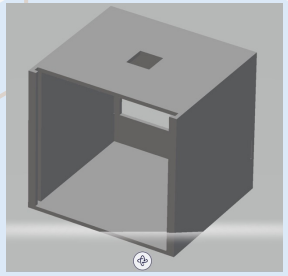


3D printed vessel - front

Vessel + back sliding door



Circuit



3D printed vessel

During the design process, we regularly checked in with each other and referenced the timeline we had created to ensure we were on track and to identify any potential delays.

Coding/Wiring: The most challenging aspect of this project was coding the buttons, as we had only two buttons that needed to perform multiple functions, including scroll, enter, and cancel. To address this, we began by developing a menu system for the 2.8" ILI9341 LCD screen and implementing the necessary button interactions. Once these key components were in place, the remainder of the project proceeded smoothly. We successfully wired and programmed the additional components—such as the TM1637 7-segment display, WS2812 RGB light ring, servo, photoresistor, HC-SR501 PIR motion sensor, MK03 reed switch, MAX9814 auto-gain microphone, rocker switch, and AA battery holder—integrating them as functions that seamlessly communicated with each other.

3D Printing: For the 3D printing aspect, our team member began by measuring the breadboard and other components to design a custom enclosure. This enclosure featured cutouts to accommodate the 2.8" ILI9341 LCD screen, buttons, WS2812 RGB light ring, TM1637 7-segment display, rocker switch, AA battery holder, photoresistor, MAX9814 auto-gain microphone, and MK03 reed switch. The design was inspired by a robotic aesthetic, so 3D-printed wheels were added to enhance the visual appeal and reinforce the overall theme.

Test/Troubleshoot

During the testing phase, we conducted thorough evaluations to ensure everything was functioning correctly. We also invited others to test our code, providing us with an external perspective and valuable feedback on its performance. The testing process went smoothly, with suggestions focusing on minor adjustments such as text alignment and button responsiveness. We promptly implemented these suggestions, ensuring our code met the highest standards of accuracy and functionality.

Challenges Encountered:

1. **Cutout Issue:** During the design planning phase of our project, we initially designed the enclosure with three cutouts for buttons. However, due to the unavailability of a third button, we were left with an extra cutout. Additionally, the cutouts for the microphone and photoresistor turned out to be too small. Given the time constraints, reprinting the enclosure was not an option. To adapt quickly, we repurposed the extra cutout by installing an LED light as an indicator for when the robot was powered on. For the undersized cutouts, we used a drill to enlarge them to the appropriate size. This allowed us to effectively address the design challenges and proceed with the project without delays.
2. **2. Component Alignment Issue:** Our initial plan was to attach the buttons directly to the breadboard. However, during assembly, we realized that the buttons could not be properly secured to the breadboard while also aligning with the designated cutouts in the enclosure. To resolve this issue and ensure a seamless fit, we soldered the buttons, along with the other electronic components. This adjustment allowed us to proceed with the assembly smoothly and maintain the integrity of our design.

These challenges required quick thinking and adaptability, ultimately leading to effective solutions that allowed us to maintain the integrity and functionality of our project.

Final Product

The final product is a 3D-printed vessel that integrates various components, including a 2.8” ILI9341 LCD screen, two buttons, TM1637 7-segment display, WS2812 RGB light ring, servo, photoresistor, HC-SR501 PIR motion sensor, MK03 reed switch, MAX9814 auto-gain microphone, rocker switch, and AA battery holder. The companion prompts the user to specify their desired study duration. Once the study time is confirmed, the companion assesses the current environment, alerting the user if there is insufficient lighting or excessive noise. The robot then instructs the user to place their phone inside the designated slot and initiates the timer. In case of an emergency, the user can use a magnet to activate the reed switch, allowing immediate access to their phone.

I believe the most rewarding aspect of completing this project was creating something relatable and impactful. As a student, I recognize the value of a companion like this in fostering effective study habits, and it is fulfilling to know that I helped create a practical solution that can benefit others in my age group.

Entrepreneurship

Entrepreneurship played a crucial role in the design and execution of the Study Bot Companion project:

Presentation Innovation: Entrepreneurship drove the team to think creatively, developing a unique solution that combined data visualization with artistic design. The challenge was to make a companion that was both user-friendly and engaging, which required an entrepreneurial mindset to balance technical functionality with user experience.

Resourcefulness: Faced with material and time constraints, the team displayed entrepreneurial resourcefulness by innovating with available resources. For example, when the buttons wouldn't fit the cutouts, the team quickly adapted by using long wires to solder the buttons to the breadboard, demonstrating the ability to pivot and solve problems on the fly.

Iterative Improvement: Reflecting the entrepreneurial process of iteration, the team actively sought feedback during testing and made improvements based on suggestions. This willingness to refine and optimize the product ensured that the final version was polished and met the project's goals.

Overall, entrepreneurship was at the heart of the project, driving innovation, problem-solving, and user-focused design.

Light bulb in my brain

Teamwork

- The biggest takeaway from working in a group on a collaborative project, especially one where none of us had prior experience, was the importance of clear **communication, open-mindedness** and maintaining **focus** on our end goal
- The most surprising aspect was how much my team and I were able to directly apply what we learned from our classes to the project, making the transition from theory to practice almost seamless.
- The most rewarding part was seeing our efforts culminate in a **practical** and **functional final product**.
- I gained a deep understanding of how to work effectively within a **diverse team**, learning to **trust my team** members, make **collaborative decisions**, and **problem solve** together.

End of Project Reflection

The most valuable lesson I've learned from working on a practical and collaborative project is the importance of effective communication and unwavering commitment to the end goal. Although the project was challenging and frustrating at times, in retrospect, it provided an incredible learning opportunity since it pushed me to think creatively and approach problems from new angles. This experience has deepened my appreciation for project-based learning, as it not only reinforces theoretical concepts but also challenges my understanding in a practical, hands-on way.

I've always enjoyed working on projects, but what truly set this ENGG 200 class apart was the emphasis on design and the opportunity to demonstrate my comprehensive knowledge through a project rather than traditional exams that focus primarily on memory.

As I enter my 2nd year of engineering and begin to apply for internships, I'm excited to apply the technical experience from clubs/courses and my soft skills that I have spent 5 years developing, to help me in a job setting.

Thank you

Krishna Patel

krishnapatels@hotmail.com