Widget Studio B - Team Case Design - Individual Submission

In this document, I will describe Team 106C's final case design. In chronological order, I will review the final design, how we arrived at it, and my individual contributions regarding both process and design. I will conclude with a reflection on the experience, from both a team and individual skill-building activity.

Description of Team's Final Case Design: Our team's final case consists of two parts; a top and bottom, attached using screws to cover the breadboard. The final system (excluding top) and sketch is shown below.

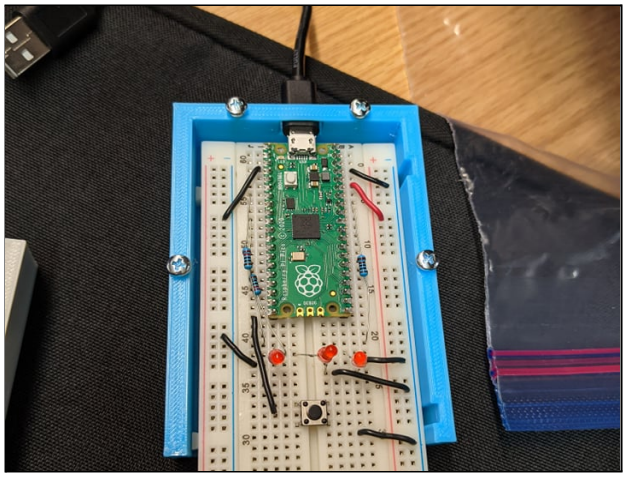

Figure 1: Final Case Design

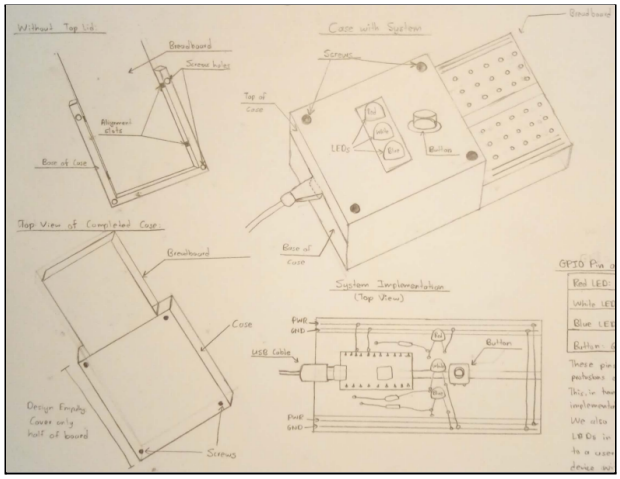

Figure 2: Sketch of Design

The main features of our design are listed below, corresponding to the labelled diagrams below.

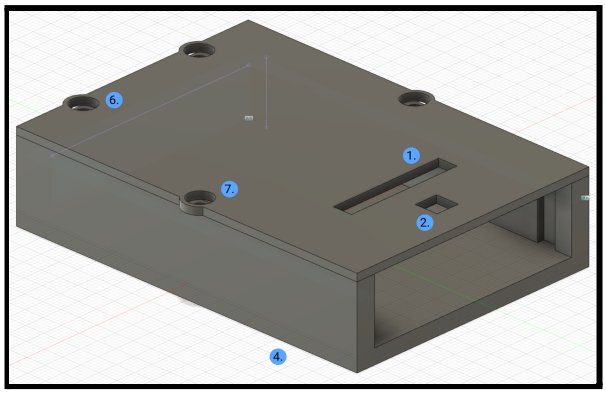

Figure 3a: Labelled image of assembled case

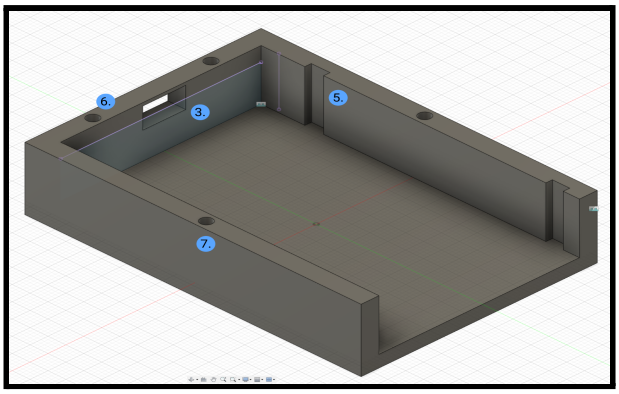

Figure 3b: Labelled image of base

To begin, we cut a 30x5 mm rectangular gap, so that the head of the LEDs can protrude from the top of the case (1). This allows the case to effectively encompass the LEDs, and strategically placing LEDs relatively close to each other (7.5mm apart) inside the centralized gap allows a uniform distribution of light with strongest intensity at the center of the greenhouse, which is an optimal lighting condition[]. The slot for our button is a 6x6 mm hole in the top (2), just enough for the button to fit inside, so that the user cannot see or access the system underneath. Another hole is required to plug a micro-USB cable to the port on a Raspberry Pi Pico(3). This is intuitively placed at the side of the bottom lid, on the opposite end of button/LEDs, so that set-up and operation are distinct.

An important aspect of our design was ensuring all wires are covered by the case and lid (4), to meet stakeholder's desires for the case. To satisfy this without increasing the dimension of the case that covers the breadboard, wires were made short and straight, without compromising them.To ensure stability of the combined system, indentations were made on the sides of the case that match protrusions on sides of breadboard, allowing for a snug fit that keeps the breadboard secure in the case, even after turning upside down and shaking (5).

Finally, the two components (case, lid), are assembled using M3 countersunk screws, with a ¼" length (6). This allows the lid to be easily placed and removed (7), resulting in better maintenance upon implementation in the greenhouse. The entire case + lid casing system took 4 hours 41 minutes to print.

How Team arrived at this final design: Our team arrived at our process plan after a group discussion during Studio A in week 3. All group members' designs consisted of a case and a lid, with variations in how they would be attached, and spacing of the LEDs, buttons, and their corresponding apertures. While all group members had sketches of their design, only 2 members had used Fusion360 to CAD their design. Amongst them, Ritvik was more confident in the accuracy of his CAD, so we moved forward with it, adapting his initial design to satisfy UN sustainability goals and incorporate our team values.
First, we switched the securing mechanism from clasping to screws. This increased error tolerance when 3D printing; reusability and sustainability were also enhanced(above). Then, we introduce a Risk Management procedure: if screws fail, we would use rubber bands, satisfying the constraint of designing without adhesives. Continuing, our team values an aesthetic design. These influenced the arrangement of LEDs in a single row, centered openings for LEDs and switch, and intuitive locations for screws (2 on each edge, evenly spaced out), creating an overall symmetric display. Finally, edits to dimensions of case were mandatory to account for height of different components. This was crucial to meet safety and aesthetics- we want electronic components covered After finalizing design, our team split roles, based on responsibilities outlined in our Team Charter. Loosely, this was: *Ritvik:* finalize CAD design, verify dimensions of breadboard, Pico, etc; *Jasmine:* Make necessary edits to Ritvik's design (clasps → screws), *Yawar:* responsible for ensuring parts are printed and picked up, *Sophie + Fatima:* team write-up, *Hshmat(me):* sketch, electronic aspect.

Individual Contributions:
Process: I volunteered to sketch our final design (Fig 2). This made it easier for others to CAD it, and to present our idea to assessors (informally or in a report). I was also responsible for ensuring the electronic aspect was working. This meant wiring the circuit to fit our case design, and making sure code was functional.
Design: I was active in the design process by suggesting changes to Ritvik's initial design. Specifically, I highlighted the need to straighten wires, center components, keep USB and button physically separate for usability, and selecting a system using one switch to minimize cost when considering scalability.

Reflection: This experience taught me the importance of iterative design. When we printed our case, we expected all the components to attach and comply with the electronic aspect. However, (i) screw holes were slightly too large, (ii) button holes did not line up perfectly, (iii) USB cable hole slightly low, and (iv) case did not align perfectly with the breadboard. I now realize it is realistic to expect errors, and thus, the importance of prototyping first, to highlight your assumptions and limitations. I also learned that two products manufactured from the same company aren't exactly the same. Error (iv) above arose because the breadboard used was owned by a team member who was not responsible for the CAD design. This was not a communication error, we both expected our breadboards were the same dimension. What helped my learning was resources provided by the FaCT team, and consciously designing towards empathy and UN sustainability goals. Further growth related to this experience involves getting familiar with CAD. I had not completed the individual CAD design during the group meeting, and presented a sketch instead. CAD will be important for our team as we move towards building our IoT device, so I hope to be more involved later. Overall, this experience was a good way to re-learn a lot of basic electronics from highschool (LEDs, buttons). I recognize the importance of "divide and conquer"- splitting tasks within a team while keeping effective communication, to finish a task early. Moving forward, I hope our team keeps this process, but works on more complex, sensor-based solutions.

References:

[1] D. Singh, C. Basu, M. Meinhardt-Wollweber, and B. Roth, “LEDs for energy efficient greenhouse lighting,” *Renewable and Sustainable Energy Reviews*, vol. 49, pp. 139–147, 2015.