

# Requirement & Verification

## Power

| Current Load<br>(10 trials) | Voltage Read<br>(5V   3.3V) |
|-----------------------------|-----------------------------|
| 100 mA                      | 5.05   3.305                |
| 350 mA                      | 5.05   3.305                |
| 510 mA                      | 5.01   3.3                  |
| 910 mA                      | 4.98   3.28                 |

**Subsystem supplies 5V and 3.3V within +/- 6% under 100 mA load**

Tested via a multimeter

| Current Load<br>(10 trials) | Transition Time |
|-----------------------------|-----------------|
| 100 mA                      | Instant         |
| 350 mA                      | Instant         |
| 510 mA                      | Instant         |
| 910 mA                      | Instant         |

**Transition from external to battery power takes 5 seconds**

Tested via a stopwatch

| Current Load<br>(3 trials) | Backup Battery Time |
|----------------------------|---------------------|
| 100 mA                     | 6+ Hours            |
| 350 mA                     | 6+ Hours            |
| 510 mA                     | ~ 6 Hours           |
| 910 mA                     | ~ 3 Hours           |

**The backup battery provides 4 hours of continuous power**

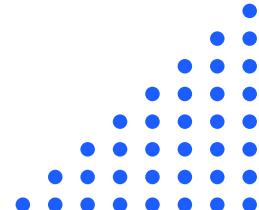
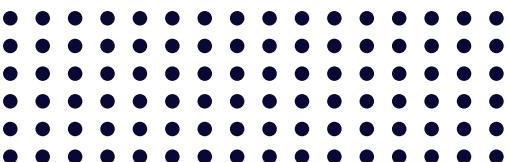
Tested via a stopwatch



# Smart Medical Pill Dispenser

## ECE 445: Team 40

Aryan Gosaliya, Aditya Perswal, Aryan Moon



# 01 Introduction



# The Smart Medical Pill Dispenser

A single device to house all your medication

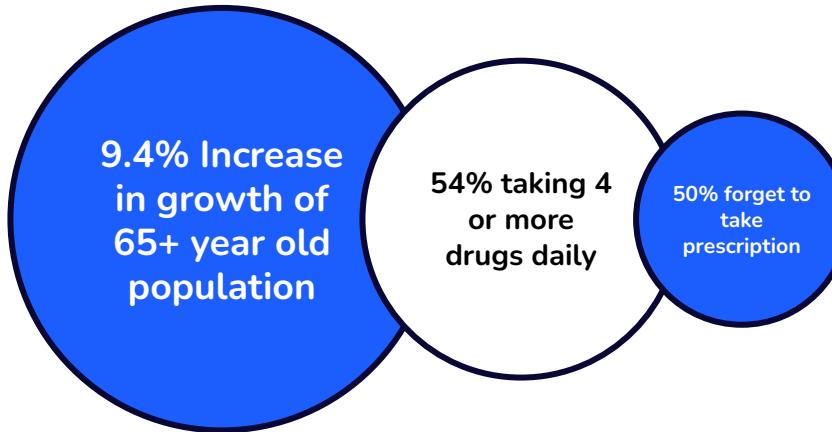
- Refill your medication on time
- Take your medication on time
- Dispense your medication accurately
- Interact with your medication seamlessly



# 02 Objective



# Rising drug costs & elderly population



\$500 - \$800  
spent per year  
on drugs

98.4%  
Pharmacist  
accuracy

10.9% of 65+  
year olds live  
below the  
poverty line

# Making a product that beats the market standard



Work 4 hours during a power outage



Work without a WiFi connection



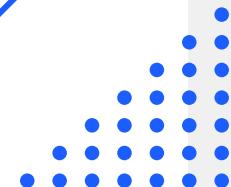
Work at a cost of \$250 & \$5/month

**High Level Requirements**

98.4% Pill Dispensing Accuracy

The SMPD alerts the user within 5 seconds

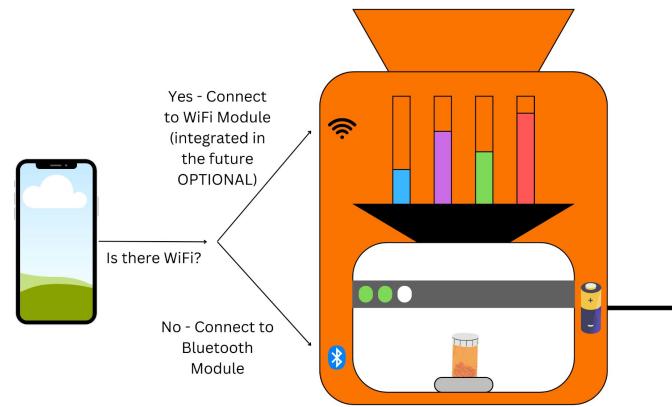
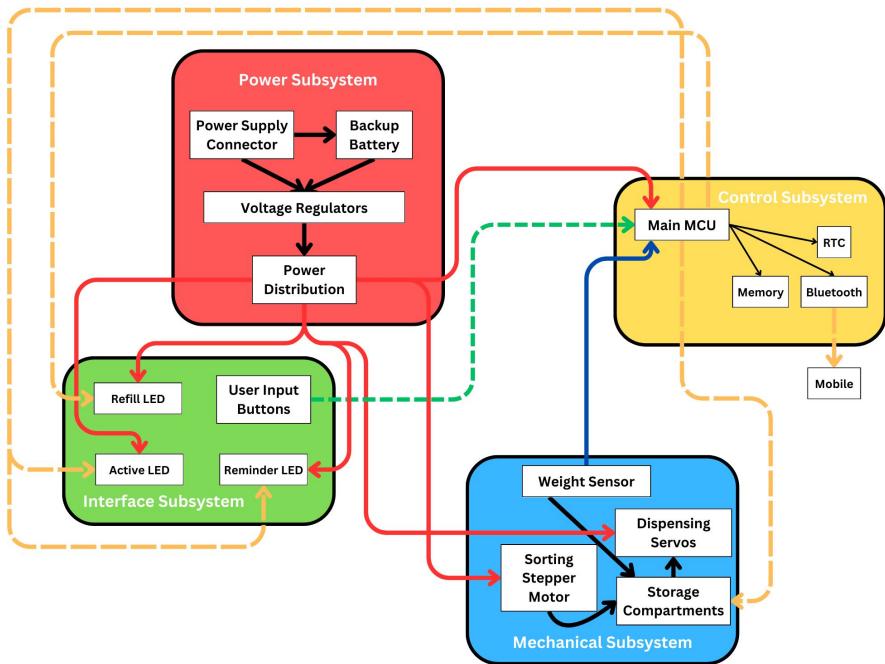
Refill alerts are sent out when left with 10%



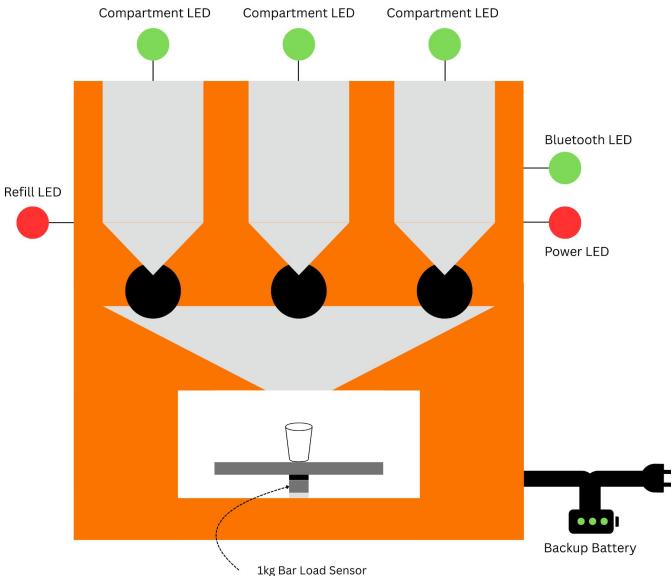
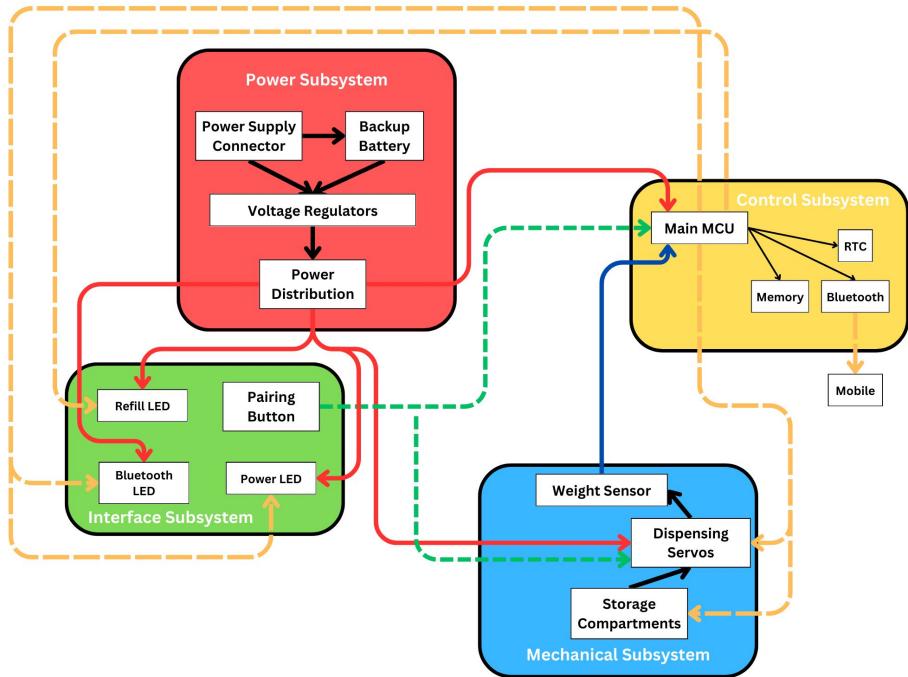
# 03 Brief Overview



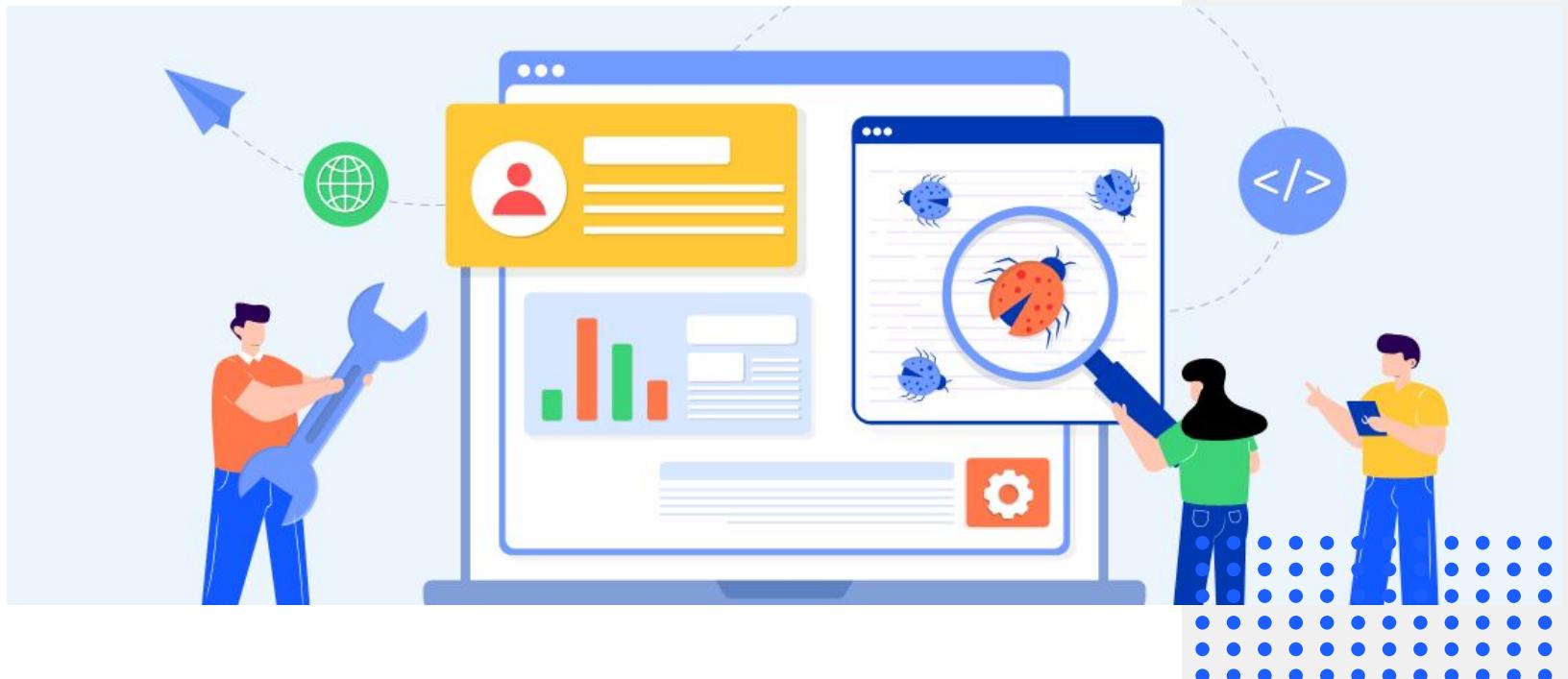
# Original block diagram & design

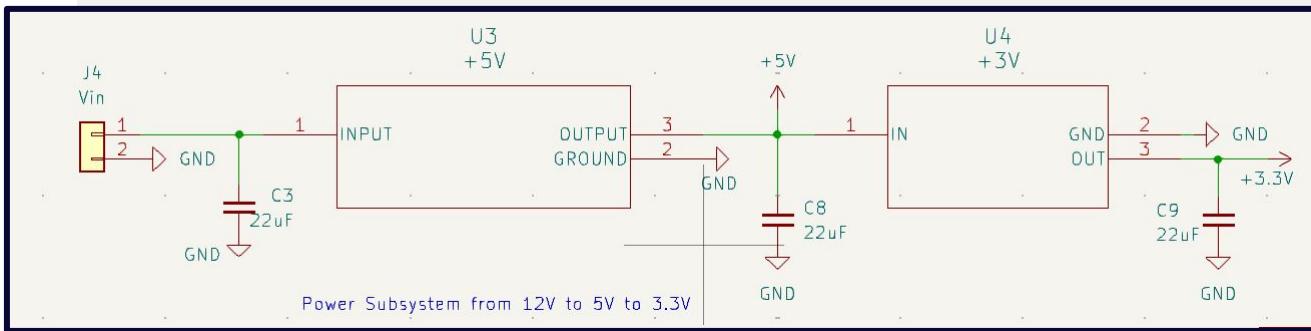
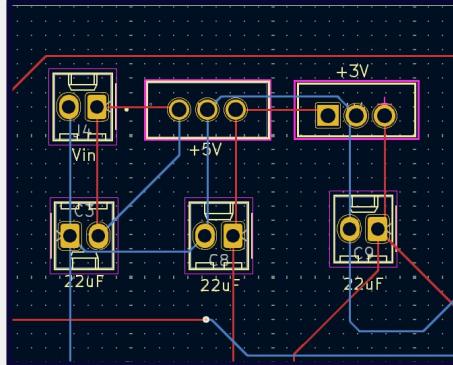


# Final block diagram & design



# 04 Project Build





# Power Subsystem

# Requirement & Verification

## Power

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|-----------------------------|-----------------------------|
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Tested via a multimeter

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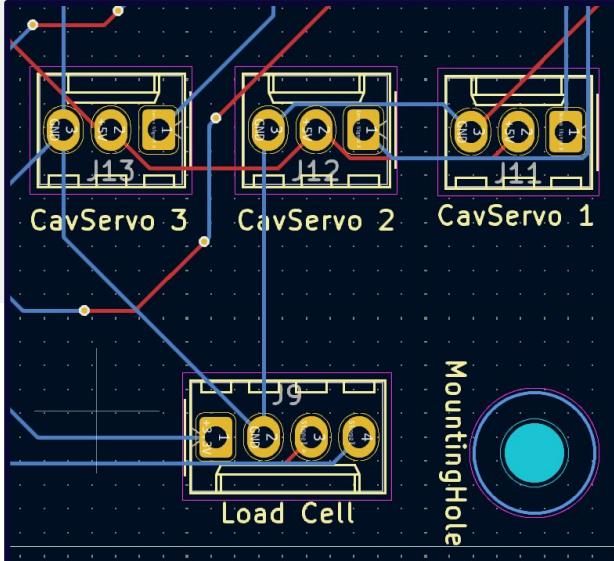
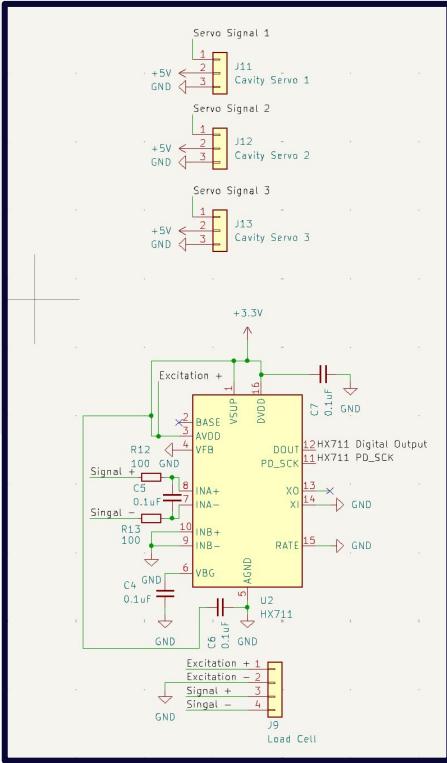
**Transition from external to battery power takes 5 seconds**

Tested via a stopwatch

| Current Load<br>(3 trials) | Backup Battery Time |
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| 100 mA                     | 6+ Hours            |
| 350 mA                     | 6+ Hours            |
| 510 mA                     | ~ 6 Hours           |
| 910 mA                     | ~ 3 Hours           |

**The backup battery provides 4 hours of continuous power**

Tested via a stopwatch



# Mechanical Subsystem

# Requirement & Verification

## Mechanical

| Comp Combos<br>(10 Trials) | Accuracy |
|----------------------------|----------|
| 1   2   3                  | 98.89%   |
| 1   2                      | 98%      |
| 1   3                      | 97%      |
| 2   3                      | 100%     |
| Total                      | 98.47%   |

Dispense pills within 98.4% accuracy

Counted expected number of pills vs actual dispensed pill count

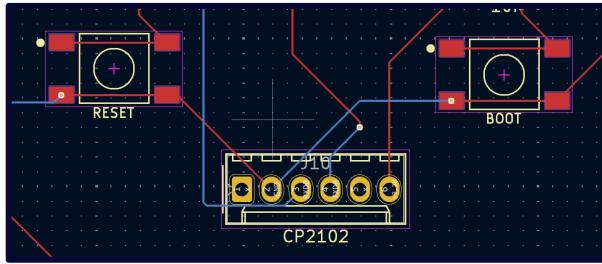
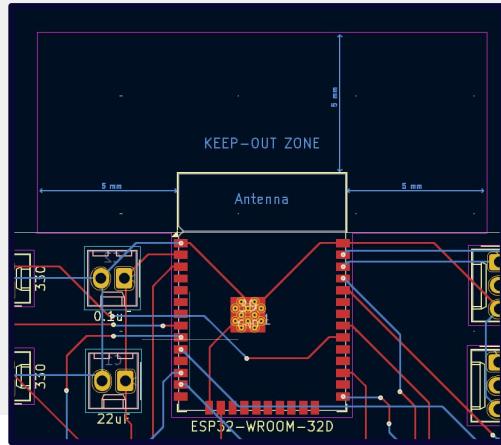
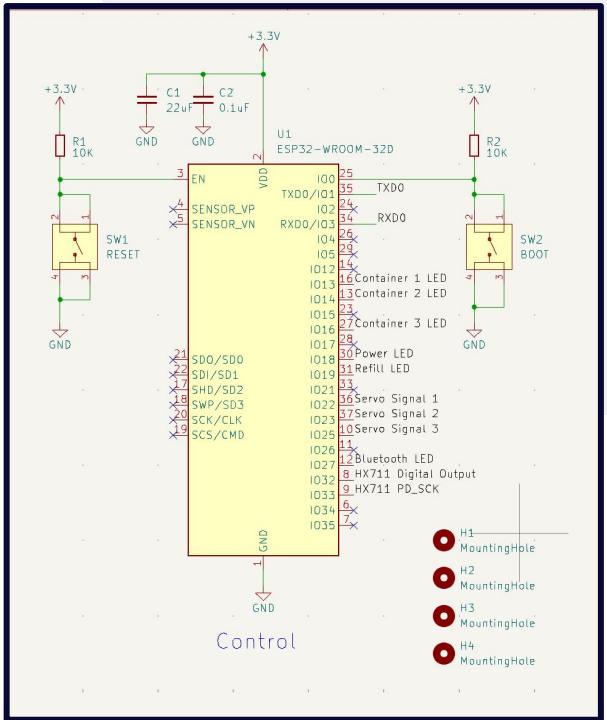


| Actual Weight (10 Trials) | Measured Weight |
|---------------------------|-----------------|
| 25 g                      | 25.3 g          |
| 50 g                      | 49.8 g          |
| 100 g                     | 100.2 g         |
| 150 g                     | 150.1 g         |
| Total                     | 0.2 g diff.     |

The load sensor weighs pills within 0.5g of actual weight  
Used a food weighing scale

| Target angle (10 Trials) | Measured angle |
|--------------------------|----------------|
| 45.0                     | 45.8           |
| 90.0                     | 91.6           |
| 135.0                    | 137.1          |
| 180.0                    | 179.2          |
| Total                    | 1.39%          |

Servo motors position their angles within 2% margin of error  
Used a protractor



# Control Subsystem

# Requirement & Verification

## Control

| Time (5 Days) | Time to Dispense |
|---------------|------------------|
| 9:00 AM       | 1.92 Seconds     |
| 1:00 PM       | 1.54 Seconds     |
| 5:00 PM       | 1.29 Seconds     |
| 10:00 PM      | 2.17 Seconds     |

**Initiates dispensing event within 5 seconds of pressing “dispense”**

Used a stopwatch

| Time (5 Days) | Accuracy (based on schedule) |
|---------------|------------------------------|
| 9:00 AM       | Instant                      |
| 1:00 PM       | Instant                      |
| 5:00 PM       | Instant                      |
| 10:00 PM      | Instant                      |

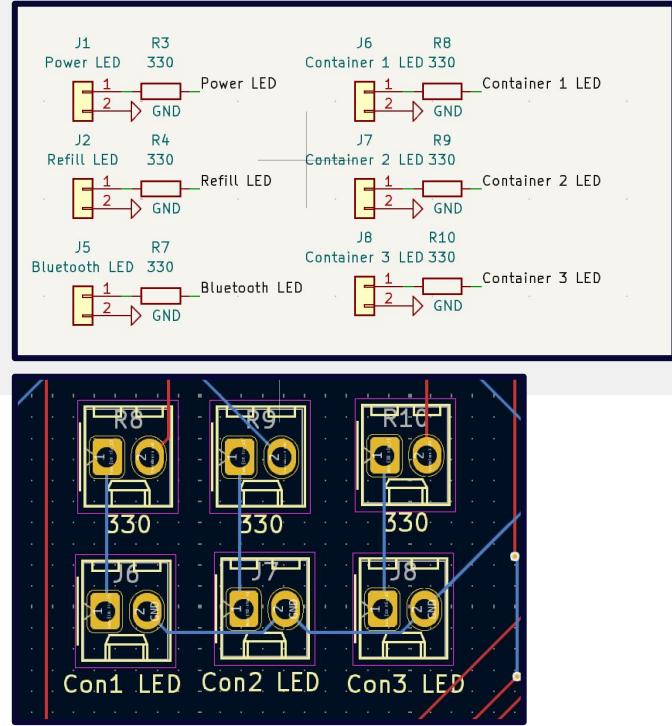
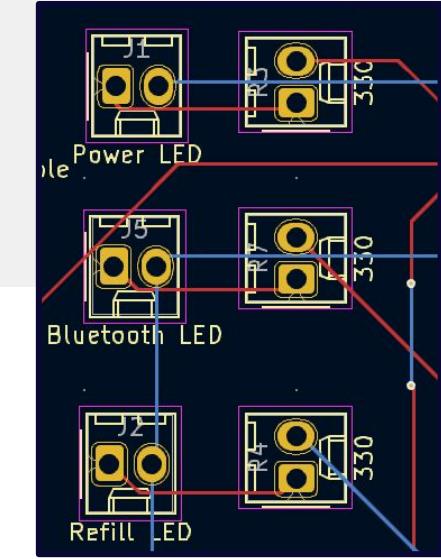
**ESP32's RTC maintains time accuracy within +/- 1 minute / month**

Used a stopwatch

| Events (10 Trials Each) | Command Execution |
|-------------------------|-------------------|
| Fill                    | 100%              |
| Schedule                | 100%              |
| Dispense                | 100%              |
| Refill                  | 100%              |

**100% command execution between control and other subsystems**

Sent commands through ESP32 and read against the application's activity log and dispenser actions



# Interface Subsystem

# Requirement & Verification

## Interface

| Time (5 Days) | Results      |
|---------------|--------------|
| 9:00 AM       | 1.41 seconds |
| 1:00 PM       | 2.35 seconds |
| 5:00 PM       | 1.74 seconds |
| 10:00 PM      | 2.02 seconds |

**Interface alerts user within 5 seconds of scheduled time**  
Used a stopwatch

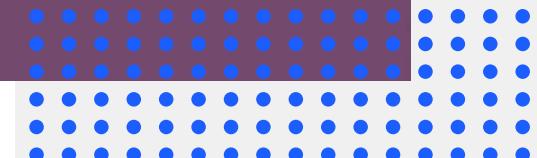
| Trials | Results |
|--------|---------|
| 1      | 43 ms   |
| 2      | 27 ms   |
| 3      | 32 ms   |
| 4      | 29 ms   |

**Bluetooth button registers press reliably with debounce time of 50 ms**  
Used Arduino Serial Monitor

| Conditions | Results  |
|------------|----------|
| Night      | 5 meters |
| Daylight   | 5 meters |
| Unlit Room | 5 meters |
| Lit Room   | 5 meters |

**LEDs clearly lit and useable under varying lighting conditions**  
Used a ruler and our sight

# 05 Success & Challenges



# Successes

## Interface Subsystem

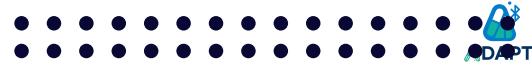
Setting up LEDs, coding the Electron app, converting it to a functional Android APK, and have an intuitive UI/UX was far easier to build than anticipated.

## Programming the ESP32

It took us quite a bit of time to understand how to code with Arduino IDE. However, we were able to pick it up and build a bluetooth server that followed commands with 100% adherence to the Electron app.

## Keeping Fixed Costs Low

We were initially expecting the cost of our design to reach around \$250 and need \$5/month for server upkeep. However, after designing the whole device we realized parts costs came to be around \$190 and we didn't need a server at all since everything ran locally. This helped us make the product far more affordable for the user.



# Challenges



## PCB's Power Subsystem

Our power subsystem repeatedly burnt out our voltage regulators. We tried multiple solutions:

1. Using a breadboard for power only
2. Using a heat sink
3. Changing trace widths across power
4. Supplying 5V and 3.3V directly into output pins of regulator through holes in the PCB

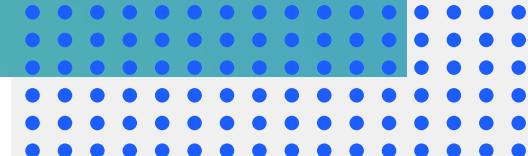


## Dispensing Accuracy

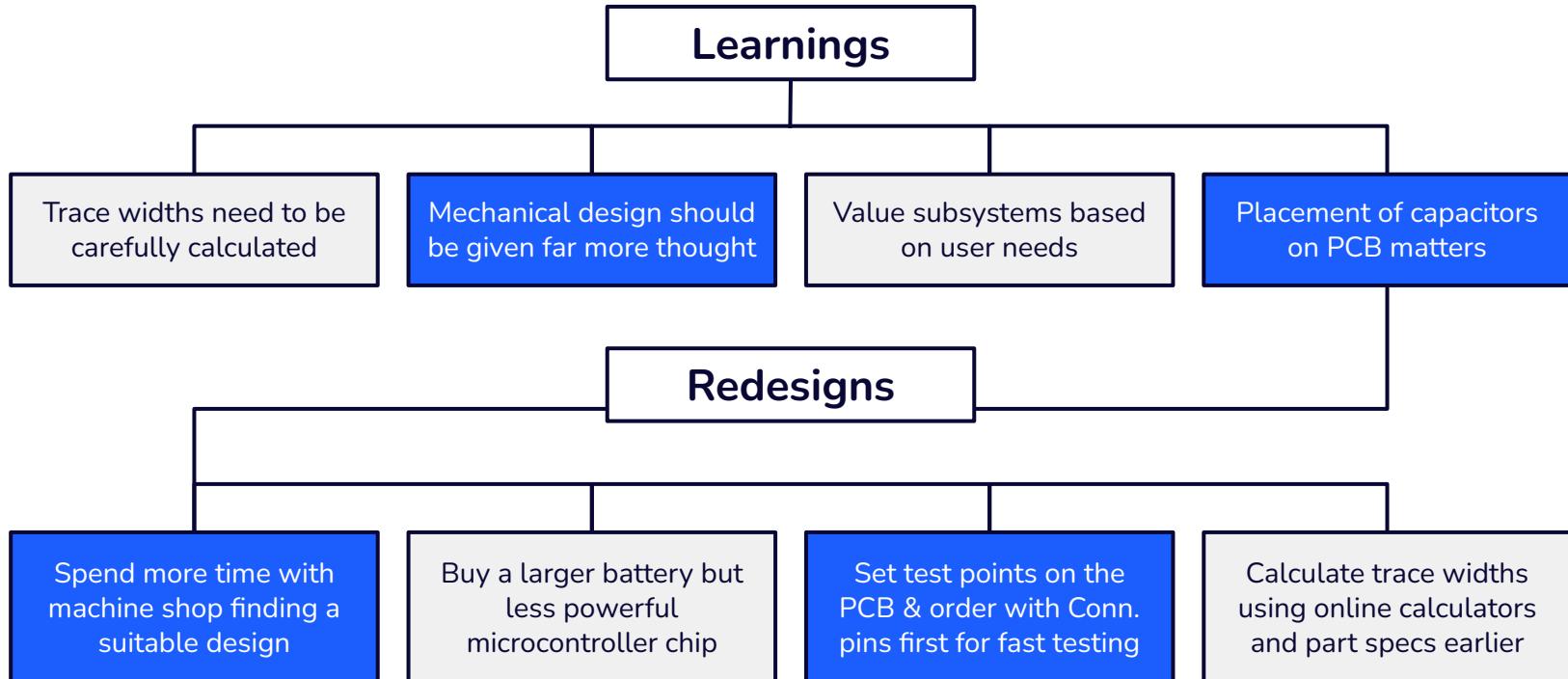
Dispensing accuracy required multiple changes to our dispenser. The following all were redesigns to increase accuracy.

1. Used thinner and long oval pills
2. 3D Printed compartment blockers
3. Adjusted servo motor angles to tenth decimal point for accuracy
4. Used 3.3V Vibration Motors

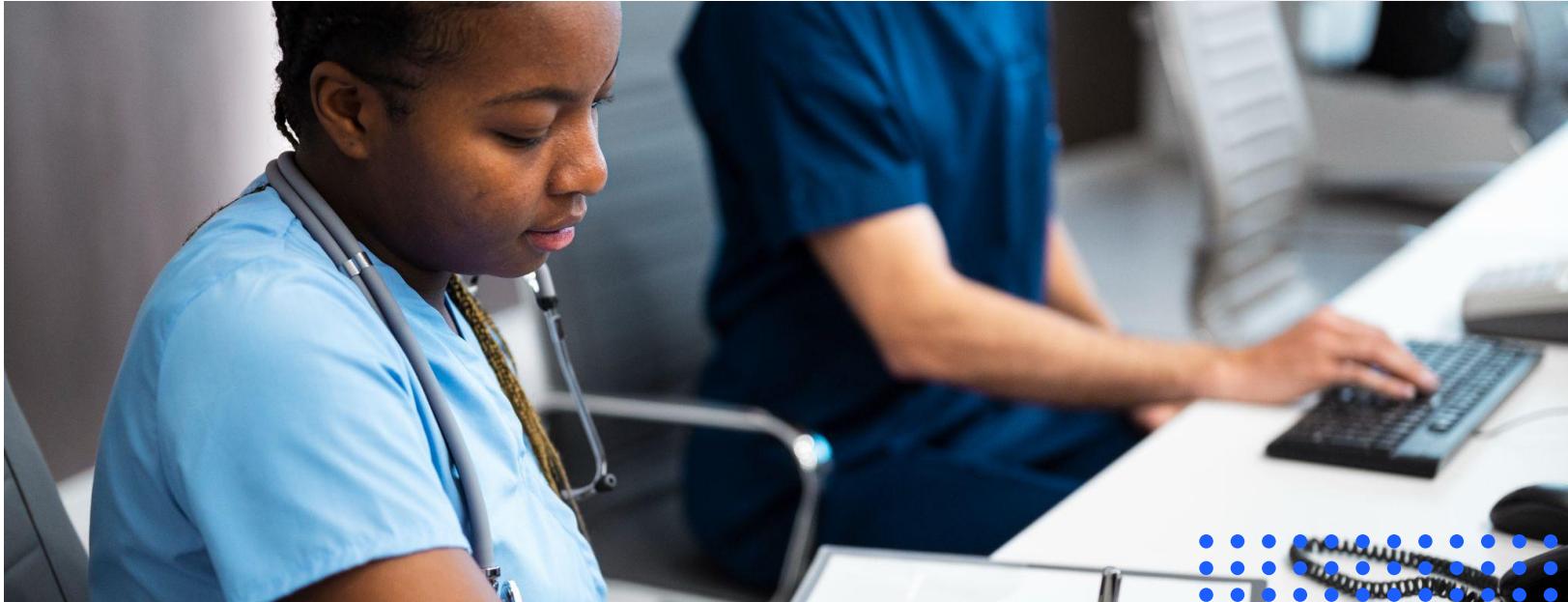
# 06 Conclusion



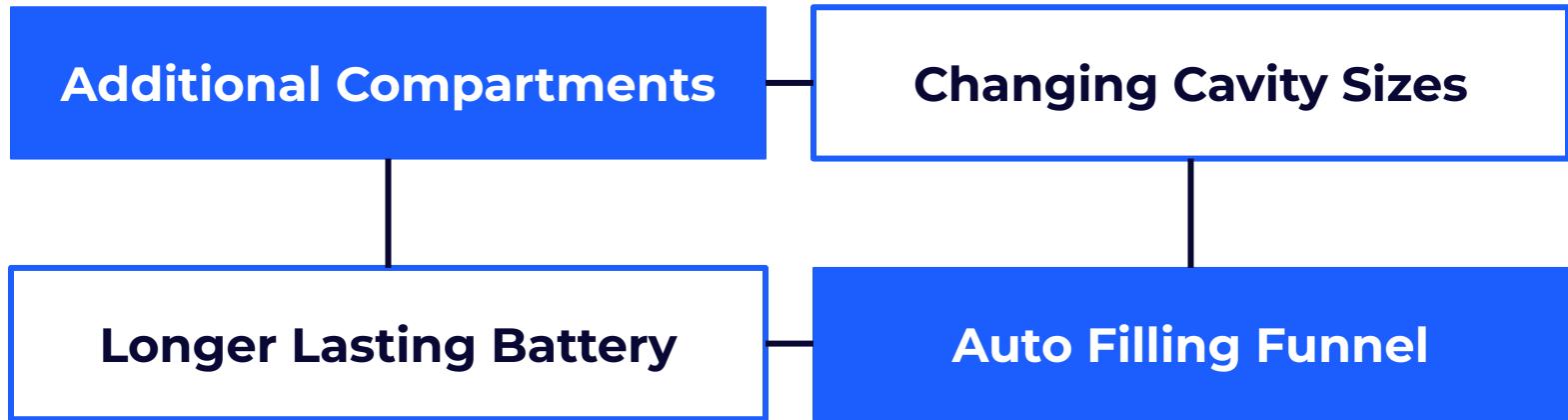
# Learnings and Redesign Choices



# 07 Looking to the future



# Upgrades we plan to implement



**Ethical Consideration:** Currently logs can be read by anyone that pairs with the device, giving access to unauthorized users to changing a user's medication schedules or monitor their prescriptions

# Working with core demographics for user testing

## Senior Living Associations

- 30,600 communities in USA
- 5.86% CAGR until 2030
- 90% of residents take medication

## Hospitals

- 26% of hospitals have a pharmacy
- 18% of patients are 65+ year olds
- 34% of prescriptions given to elderly

## Personal Homes

- 57.8 Million 65+ year olds in USA
- Hero's Dispenser costs \$540/year
- 88.6% of elderly take medication

## Private Practices

- Pediatrician group's 7.6% CAGR
- At home nurse's 8.4% CAGR (2031)

# Demonstrated User Interest

Dear Aditya, Aryan, and Aryan,

I am writing on behalf of WithAarya NGO, an organization founded in 2016 that focuses on healthcare, nutrition, and support for underprivileged patients and their caregivers in Mumbai, India.

Our mission is to create "waves of kindness that encompass the underprivileged and make them feel safe and cared for," particularly in healthcare settings.

I recently learned about your Smart Medical Pill Dispenser project through our partnership network with educational institutions. Your innovation has captured our attention as it directly aligns with our mission to support caregivers and patients managing complex medication regimens.

Our organization currently provides support to caregivers of patients with various illnesses, many of whom struggle with the management of multiple medications. Through our various initiatives, we have been serving these communities since a very long time, one of our key initiatives is "Dava Daan" where we provide medicines and we've observed firsthand the challenges they face:

- \* Many caregivers struggle to maintain medication schedules while balancing hospital visits
- \* Approximately 65% of our beneficiaries report medication non-adherence due to confusion or forgetfulness
- \* The cost of existing medication management systems is prohibitive for most of the families we serve
- \* Long hospital stays often mean caregivers must manage medications with limited resources

Your affordable solution with its automated reminders, accurate dispensing, and backup power system addresses these challenges perfectly.

The price point of \$150-200 makes it significantly more accessible than commercial alternatives, which is crucial for our community.

We would be very interested in:

1. Learning more about your device through a virtual demonstration
2. Exploring a potential pilot program with 15-20 of our caregiving beneficiaries
3. Discussing adaptations that might be needed for implementation in the Indian context
4. Collaborating on potential funding opportunities to support distribution to our communities

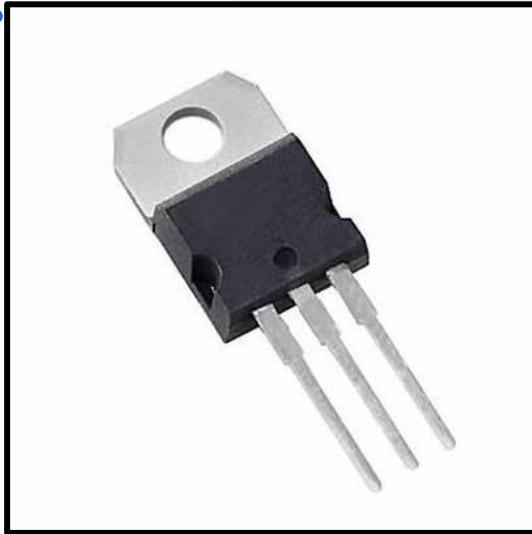
Could we schedule a video call in the next two weeks to discuss this potential collaboration? We believe your project has tremendous potential to support our mission of creating "waves of kindness that encompass the underprivileged and make them feel safe and cared for."

Best regards,  
Forem Lapsiwala  
Chief Operations Officer  
9833879040

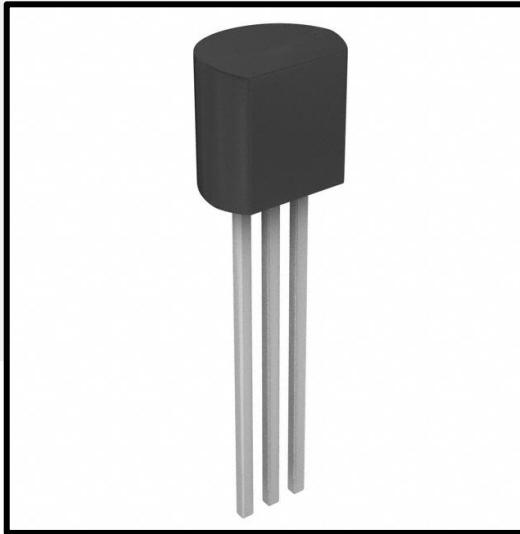
# Thank You!

A special thanks to Professor Zhao, Jiankun Yang, Sainath Barbhai, and the rest of the ECE 445 Team

# 08 Appendix



5.0V Linear Regulator LM7805ACT



3.3V Linear Regulator LP2950CZ



TalentCell Rechargeable 12V DC  
Output Lithium ion Battery Pack

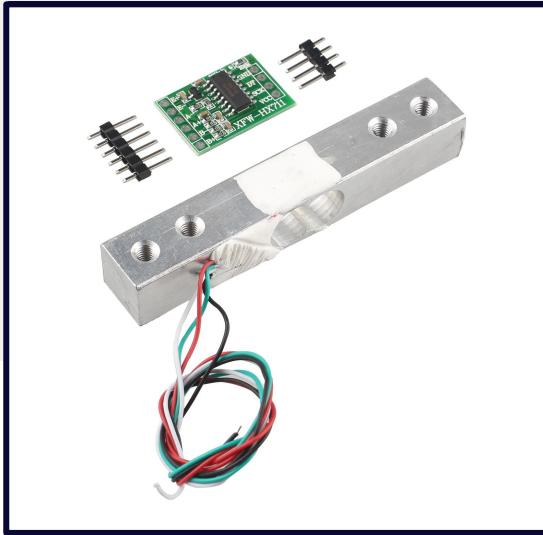
## Power Subsystem



Servo Motor HS-318



3D Print PLA Filament

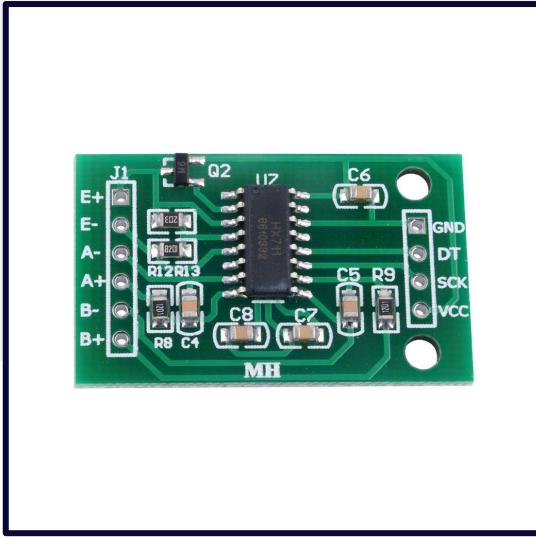


1kg Load Sensor

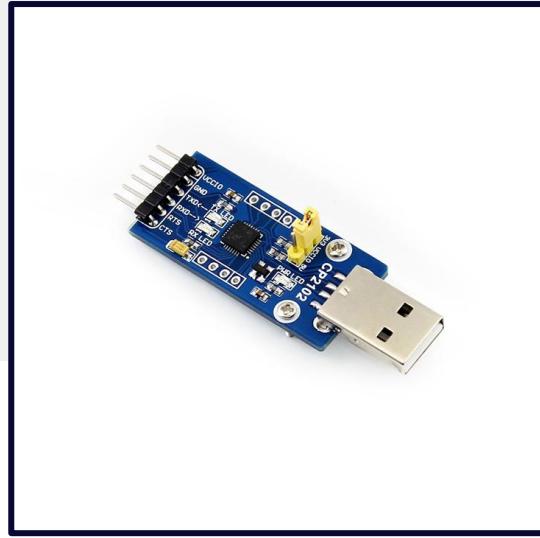
## Mechanical Subsystem



ESP-WROOM-32D



HX711



CP2102

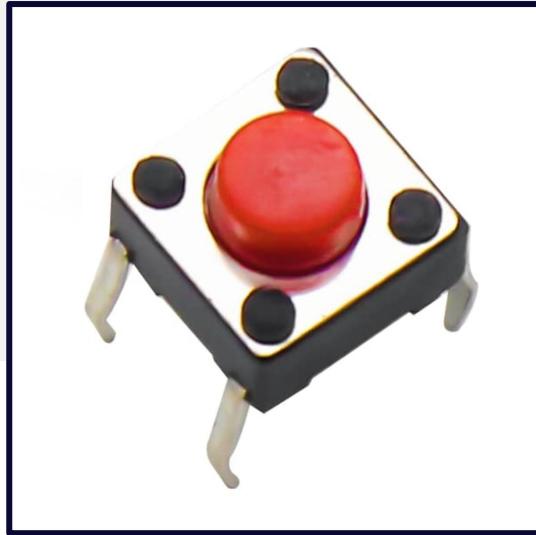
# Control Subsystem



Red LED



Green LED



Push Button

# Interface Subsystem