GNG2101

# Design Project User and Product Manual

# Team Z-10 Daily Dose Medication Dispenser and Reminder System


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# List of Acronyms and Glossary

**Table 1. Acronyms**

| Acronym | Definition |
|---|---|
| UPM | User and Product Manual |
| | |
| | |
| | |
| | |

**Table 2. Glossary**

| Term | Acronym | Definition |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

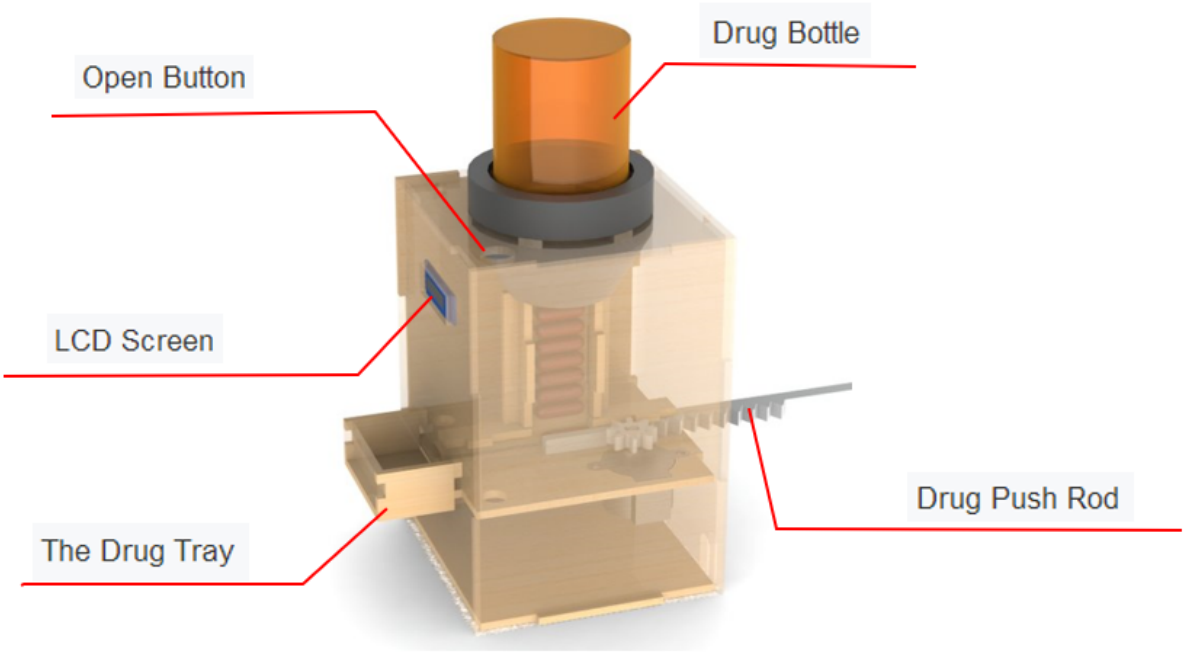
# 1 Introduction

This User and Product Manual (UPM) provides the information necessary for patients who need to take medicine every day to effectively use the Daily Dose Medical Dispenser and for prototype documentation.

It is important for customers to take the right dose of medicine at the right time. A common question for many patients is they always forget whether or not they took their medication today. The Daily Dose drug dispenser is the answer to that question. Just put the pill into this product in advance and press the button to get the medicine you need to take that day. This product can only be opened once a day to prevent repeat medication.

# 2 Overview

It is suitable for customers who often forget whether or not to take their medication, tired of the noisy alarm reminding way, and want to use the dispenser to help get daily medication. The Daily Dose Dispenser is an easy-to-use device that will hold and dispense medication as required, it is designed to quietly notify the user if medication has not been taken yet. The device is enabled only once a day to prevent the user from accidentally taking more medication than needed.




The customer will place the medicine into the drug bottle above the Daily Dose Dispenser, when customers press the button, and the circuit will drive the push rod to push the drug pill into the drug tray for the customer to use. The dispenser will automatically shut down after the dispense for the day.

## 2.1 Conventions

1. You can press the open button to begin dispensing.
2. You can check the remaining days and the number of medications on the LCD screen.
3. You can rotate the drug bottle on this product down to fill the new medicine.
4. You can change your medication regimen by reprogramming Arduino. (please seek professional help)

## 2.2 Cautions & Warnings

1. Please note that Daily Dose is only a medical dispenser. The specific drug type, time and dose to be taken should be set according to the doctor's instructions.
2. If the medications get stuck during the automatic dispensing process, try to pull the push rod manually to dredge the pills. If it does not work, please send it to the repair station in time for repair.
3. Please place this product correctly. Improper placement, such as upside down, may result the drug not being pushed out correctly

# 3 Getting started

A detailed description of the system from initiation to completion is provided in this section of the user manual, to guide the user in getting familiarized with the dispenser.

## 3.1 Set-up Considerations

Generally, the dispenser is split into two major components; the electronics and mechanical components respectively. Considering that the foundation and housing of these components has already been set up, the user would simply need to ensure that the mechanical components are properly installed and the dispenser is connected to a power supply. On that note a few set-up considerations that the user should be aware of whilst getting started with the device;

- The motor requires a power supply; Therefore, the dispenser must be connected to a stable source of power while in use. During testing, members of the team connected the dispenser to laptops or electrical outlets, depending on which was available.
- The integrated pill bottle feature is only compatible with the dimensions of the client's prescription bottle.
- The hole in the funnel as well as the shaft that releases the pill into position to be moved by the pushing rod, are both designed for tablets of a specific thickness and length, based on our client's prescriptions. The prescriptions were approximately 0.5cm thick and 1.7cm long. However, tablets that are about 0.2cm greater/less than in thickness and about 0.5cm greater/less than in length, may be able to fit the design of these components. The image below shows the vertical shaft filled up with 3-D printed models of the client's prescriptions during testing.

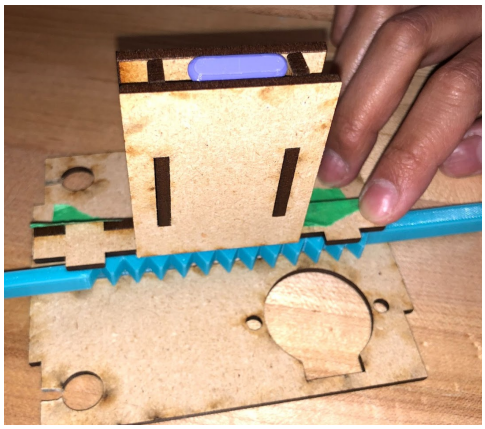


**Figure 3.1- Vertical shaft filled with 3-D printed pill models**

## 3.2 User Access Considerations

- **Children-** Generally, the product is designed for adults. However, children above the age of 8 may be able to use the dispenser so long as they keep out of the electronics and mechanical components including the; motor, wiring etc… Such components should be properly stored in the housing box to ensure that these components are out of reach.
- **Users with disability and Users with High Priority Prescriptions -** This also includes users with disabilities or illnesses such as; joint mobility issues. Such users may use the product sparingly. Ensuring that they do not place prescriptions of high importance into the dispenser to avoid emergencies in a situation where the product experiences a malfunction.
- **Elders-** They may use this product to make it easier for them to keep track of their prescriptions, so long as the dispenser is preset for them to use easily. Also, elders should not place all pills in the dispenser to avoid being left vulnerable in the case of a jam in the system.

## 3.3 Accessing the System

1. Start by removing the cap of the medication container given by the pharmacist, and attach the funnel, taking note of the apertures provided.

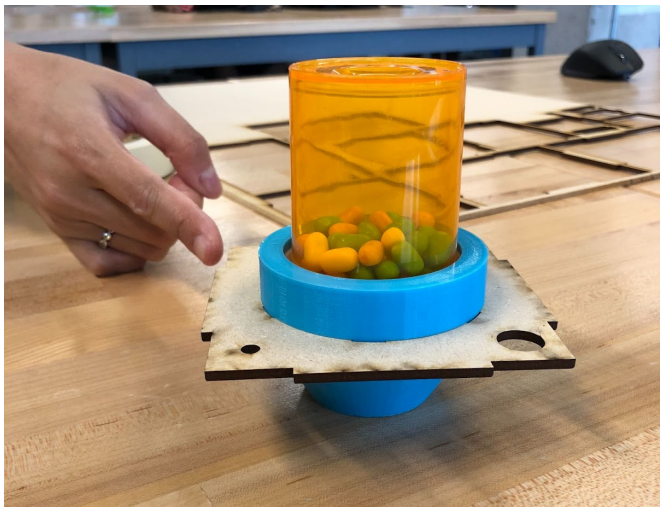


Figure x- Integration of Pill Container During Testing

2. Attach these combined parts as shown in the image above, to the main box, once again paying close attention to the apertures provided to guide the user during this stage of attaching both parts.
3. Once all parts have been amalgamated, connect the device to a power supply. Wait 30 seconds before continuing.
4. Finally, Press the blue button once to dispense prescriptions.

## 3.4 System Organization & Navigation

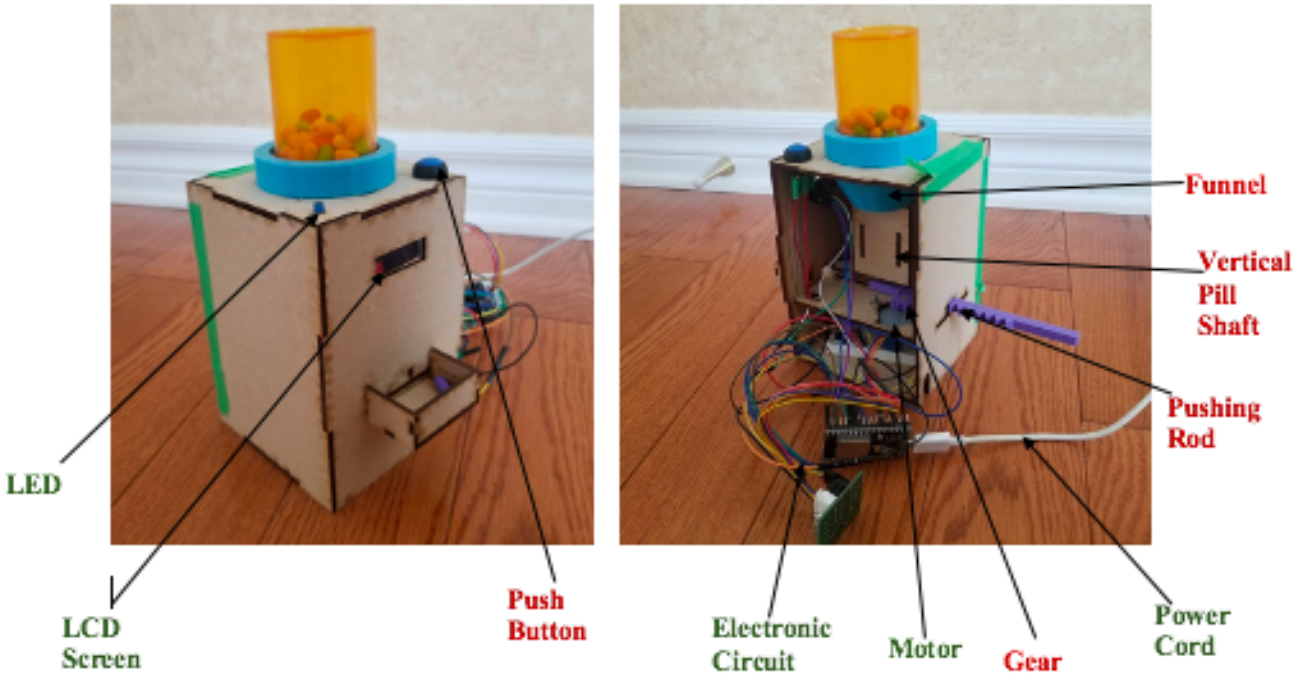



Figure 3.4: Electronic and Mechanical Components labelled (Final Prototype)

### 3.4.1 Electrical Components

The electronics of the dispenser mainly includes; the electronic circuit powers the LCD screen, LED and motor which powers the gear and the overall dispensing mechanism. The LCD Screen displays the days left till the user would need to refill the dispenser while the LED light will turn off once the user has taken their daily dosage. For the circuit to function, the dispenser must be connected to a source using a power cord as shown in the image above.

### 3.4.2 Mechanical Features

The dispenser functions through a strategically designed mechanical system. The user simply presses the push button, and the pills which have passed through the funnel, and are now arranged vertically in the shaft will be pushed out into the dispensing tray as required by the pushing rod. This pushing rod relies on the Gear to move it once the button is pressed. Ultimately, the mechanical and electronics components work in sync with each other to power the dispenser and reminder systems.

## 3.5 Exiting the System

Turning off the system is simple and straightforward. The user should simply unplug the dispenser from the power source and wait a few seconds to make sure the motor/pushing rod has stopped moving.

# 4 Using the System

There are four main parts from the product, which are pushing stick, pill bottle, and pill shaft and the final usage. And the users should keep the product charging, if they want to use the function of lighting.

## 4.1 Pushing stick

There is a pushing stick to control the mechanical system. As the user provides a push force, the machine will release the pill each time. The pushing handle is hard to destroy, unless the user uses extremely huge force which breaks the rod of the internal system.

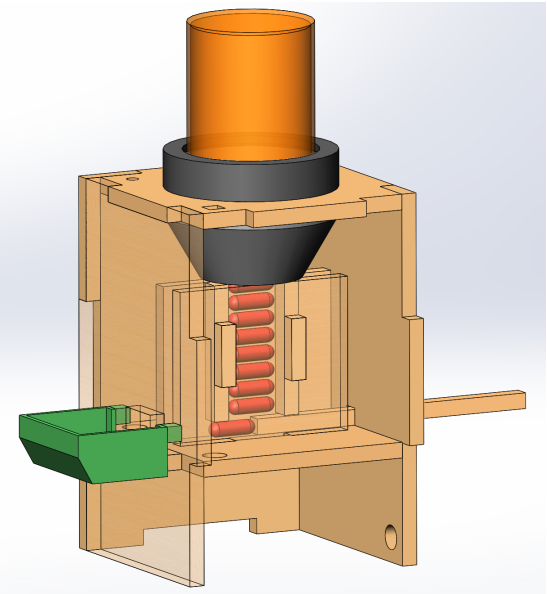


Figure 4-1: The CAD Sketching of Mechanical System With Operating Theorem

## 4.2 Pill bottle

Another part required for the user to know is that the pill bottle must be matched with our machine. The users can use the same recycled bottom. If you want to change a new one, you have to find the same size to connect. When opening the bottle, just reverse the product to make sure the pills will not drop out. Then, rotate the bottle to add or change new pills.

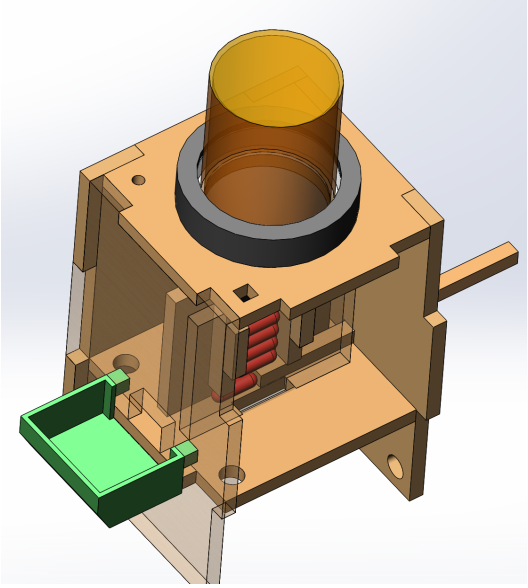


Figure 4-2: The CAD Sketching of Mechanical System With Pill Bottle and Pill Shaft

## 4.3 Pill shaft

There is a vertical pill shaft( from Figure 4-2) to catch the pill that is pushed out by the stick. So, as the users push the stick, the system will drop out one pill, the shaft will catch the one. The user needs to place the match.

## 4.4 Final Usage

To use the product in its entirety. Please first enter your SSID and PASSWORD to your WiFi access. This will allow the device to connect to the net and retrieve time information so that the device may dispense only once a day. Please ensure that this is crucial to the system's function.

Furthemore, once the device is connected and booted, output information can be monitored from the arduino serial monitor to diagnose any errors. Finally, once the device is ready. Once everyday, the LED on the device will turn on indicating that the button is active and can be pressed to dispense the medication. Please note that at the moment only 2 medications are dispensed as this is the prescription. This value can be changed in the global variables in the arduino code.

# 5 Troubleshooting & Support

This section will outline and describe errors that may occur during regular use of the Daily Dose Dispenser. Maintenance and support details are also outlined in this section.

## 5.1 Error Messages or Behaviors

If pills are not aligned properly in the dispensing chute, pills may become lodged and jam the dispensing mechanism. If the dispensing motion is taking more than 30 seconds, it is likely the a pill jam has occurred. To resolve a pill jam, unplug the device and remove the pill storage bottle from the top of the device. Remove pills from the dispensing funnel and dispensing chute. Reload pills horizontally into the dispensing chute and reassemble the device. Plug the device back in and restart the dispensing motion. The pills should no longer be jammed. If a pill jam has caused breakage of a pill, remove all debris and discard.

## 5.2 Button Issues

If the device begins dispensing without pushing the button, it is likely that the button is falsely activating. To resolve button issues, unplug and replug the device. Restart the dispensing motion by pushing the button. If the issue persists, the button must be replaced.

## 5.3 Uncalibrated Motor Position

The motor may become uncalibrated if the device is interrupted during the dispensing motion. If this occurs, the motor will try to continue to rotate when the pushing stick is at the maximum extension or retraction. If this occurs, unplug the device and remove the side cover. Lift the gear off the motor and retract the push stick to the furthest back position. Replug the device and push the button to activate a dispensing motion. Once the dispensing motion is complete, place the gear back on the motor shaft. Activate the dispensing motion once again to verify that the motor is calibrated correctly. Replace the side cover.

## 5.4 Maintenance

In order to keep the device in good working order and prevent the previously mentioned errors, regular maintenance should be performed. When loading pills into the device, ensure the pills in the dispensing chute are oriented horizontally. If pills are found in vertical or diagonal

positions, adjust the pill. When using the device, do not excessively push the button if dispensing is not working. Unplug and replug the device. To avoid uncalibrated motor position, do not unplug the device during a dispensing cycle. Wait until the end of the dispensing cycle to unplug the device. If the device must be stopped during the  dispensing cycle, perform the solution outlined in Section 5.3 to calibrate the motor.

## 5.5 Support

If any parts break or require repair, refer to the prototype files available on MakerRepo. All custom parts can be easily re-manufactured in the CEED MakerSpace for low to little cost.

# 6 Product Documentation

## 6.1 Mechanical part

### a) BOM (Bill of Materials)

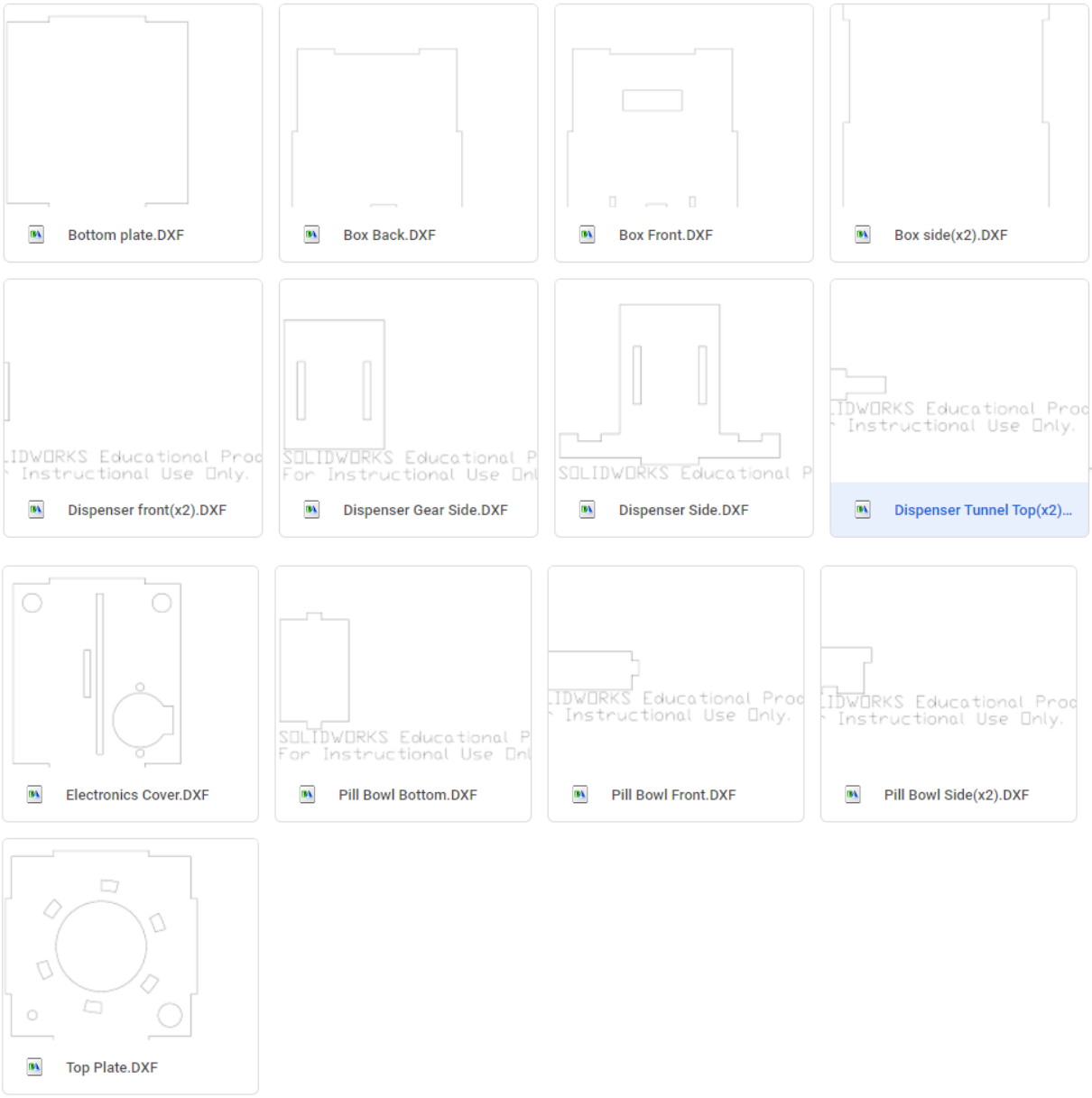
| Product name | Quantity | Price/item | Cost |
|---|---|---|---|
| MDF (1/8 in, 18in x 24in) | 1 | $3 | $3 |
| Protoboard | 1 | | 0 |
| M4 screws | 4 | | 0 |
| M4 nuts | 4 | | 0 |
| Total | | | $3 |

### b) Equipment list

- CAD software(SolidWorks, Fusion 360,etc)
- Ultimaker Cura
- 3D Printer
- Laser cutter
- Pill bottle
- Tape

### c) Instructions

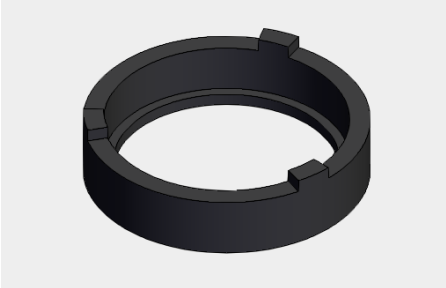
- Use the laser cutter to produce the parts of the  frame(all laser cutter files included)



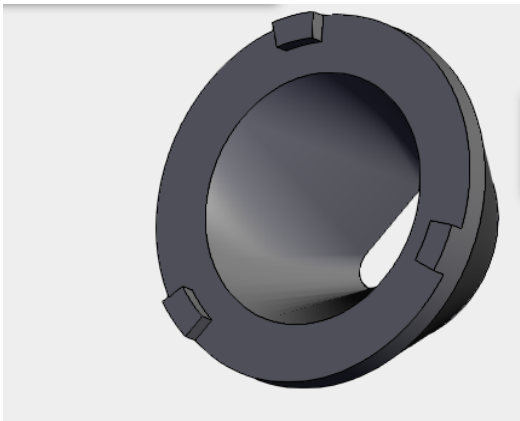

- 3D print the following components:

- the pills ( UM2_MockPill_X6.gcode)

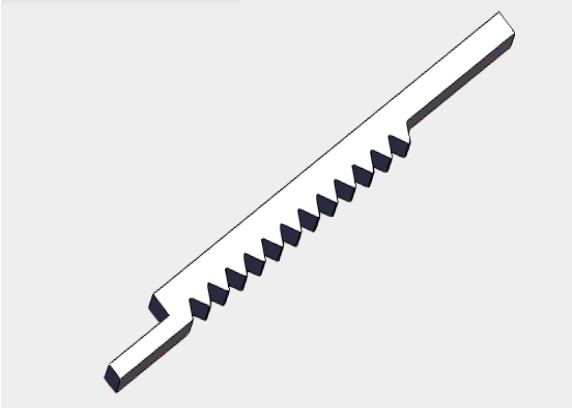
- the bottle thread holder (Bottle Thread Holder.gcode)



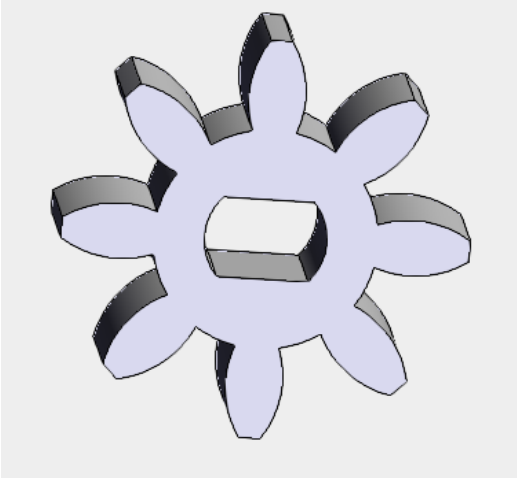
- the pill funnel (UM2_Pill Funnel.gcode)



- the pill pusher ( UM2_Pill Pusher.gcode)



- the pinion (UM2_Pinion.gcode)



- Using a ruban tape stick the parts of the rectangular  frame
- After assembling the mechanical parts together, the dispenser should look like this:

## 6.2 Electronics

### a) BOM (Bill of Materials)

| Product name | Quantity | Price/item | Cost |
|---|---|---|---|
| Small Reduction Stepper Motor | 1 | $8 | $8 |
| Tactile Button Switch (Momentary) | 2 | $0.25 | $0.50 |
| Female DC Power Adapter | 1 | $3.25 | $3.25 |
| ESP8266 -NODEMCU | 1 | | 0 |
| I2C - Display | 2 | | 0 |
| Power Supply (5v) | 1 | | 0 |
| 5 ft hook up wire | 1 | $1.60 | $1.60 |
| LED light | 2 | $0.60 | $1.20 |
| M4 screws | 4 | | 0 |
| M4 nuts | 4 | | 0 |

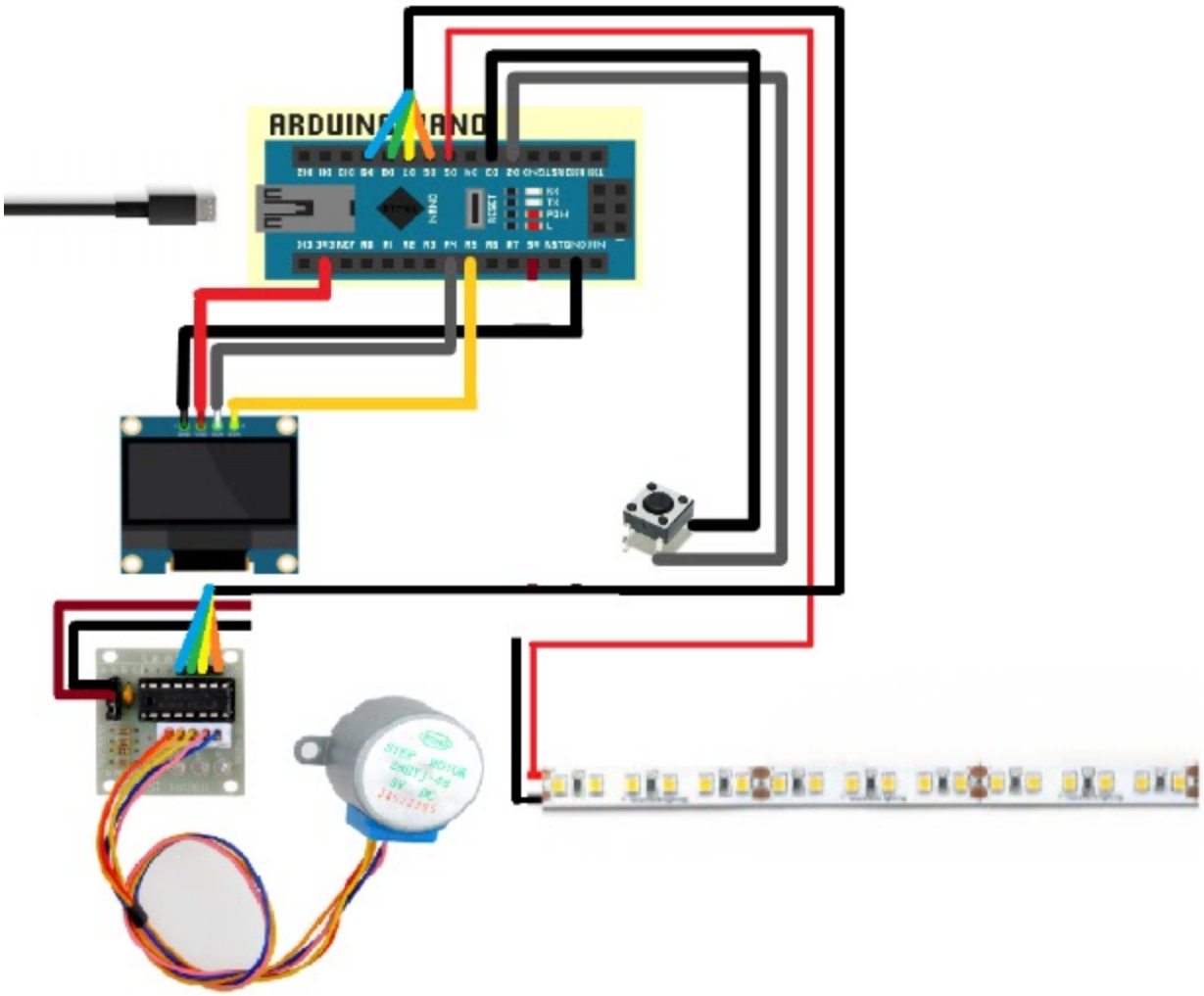
| | | | |
|---|---|---|---|
| Total | | | $14.25 |

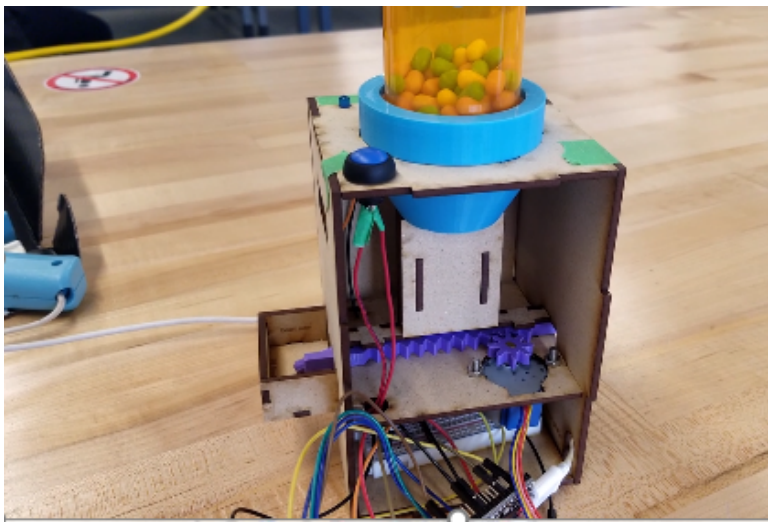
**b) Equipment list**

- Arduino software
- Breadboard for testing
- Solder iron

**c) Instructions**

- Using two wires, solder them with the push button
- Using a breadboard and the NODEMCU make the LED blink (in Arduino go to Files>Examples>Basics>Blink)
- Now verify the push button with a code that will make the LED turn on when the button is pushed( in Arduino go to Files>Examples>Digital>Button)
- Verify the I2C screen with the code provided
- Verify that the stepper motor is rotating with the code provided in Arduino (go to Files>Examples> Stepper > stepper_oneStepAtATime)
- Now that every component is working, install them at the bottom of the dispenser and use M4 screws and M4 nuts to attach the stepper motor to the whole system use this diagram with a **NODEMCU instead of a NANO**





- Open the Arduino and send the code below to the NODEMCU or another microcontroller you are using

```
#include <Stepper.h>



int LEDPIN = 19;

int BUTTONPIN = 4;

int buttonState = 0;

bool dispensed = false;


const int stepsPerRevolution = 2048;  // change this to fit the number of

steps per revolution


int in1Pin = 33;

int in2Pin = 32;

int in3Pin = 15;

int in4Pin = 14;


Stepper motor(512, in1Pin, in2Pin, in3Pin, in4Pin);


void setup(){

Serial.begin(115200);

pinMode(LEDPIN, OUTPUT);

// initialize the pushbutton pin as an input:

pinMode(BUTTONPIN, INPUT);
```

```
motor.setSpeed(30);
}

void loop() {

// read the state of the pushbutton value:
  buttonState = digitalRead(BUTTONPIN);
  Serial.println(buttonState);

  // check if the pushbutton is pressed:
  if (buttonState == HIGH) {

    // if pill still needs to be dispensed today:
    if (!dispensed){

      // turn LED off:
      digitalWrite(LEDPIN, LOW);

      //push pill forward:
      Serial.println("Push");
      motor.step(-13/8*stepsPerRevolution);
      delay(500);

      //retract push stick:
      Serial.println("Retract");
```

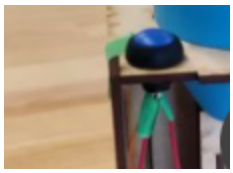
```
      motor.step(13/8*stepsPerRevolution); // 12/8 is rack teeth/pinion
teeth
      delay(500);

      Serial.println("Dispensing complete");
      dispensed = true;

    // reset the "day"
    } else {
      // turn LED on:
      Serial.println("It's a new day");
      digitalWrite(LEDPIN, HIGH);
      dispensed = false;
    }
  }
  delay(300);
  /*
  else {
    // turn LED on:
    digitalWrite(LEDPIN, HIGH);
  }*/
/*
//
*/
}
```

- Now verify that it pushes 2 pills by pushing the button

## 6.3 Testing & Validation

First of all, each electrical component has been tested separately to see if it may cause a deficiency in the whole system.

- The push button has been verified with Arduino ( go to Files>Examples>Digital>Button). You may experience some bugs like putting your hand close to the place you soldered and see the LED turn ON. This is due to poor connections and the low quality of the button. To fix this you may want to use a tape like in the figure below:



- The stepper motor has been tested with the connection of its Data Pins and Power pins using the NODEMCU and the code found in Files>Examples> Stepper > stepper_oneStepAtATime . This will make the stepper motor rotates at a particular speed

- The LED has been tested with the Blink program found in Arduino. Sometimes, it will not shine well, this is again due to poor connections in cables.

- The I2C was tested by using the following wiring :

| | |
|---|---|
| VIN | 3.3V |
| GND | GND |
| SCL | GPIO 22 |
| SDA | GPIO 21 |

More about how to display is found here :https://randomnerdtutorials.com/esp32-ssd1306-oled-display-arduino-ide/

Secondly the whole dispenser has been tested to see if it can dispense 2 pills at a time without bugs with the equipment and the code provided. The dispenser perfectly dispensed the numbers of pills corresponding with the code provided that can be modified.

# 7 Conclusions and Recommendations for Future Work

During the cooperation in the team, team members have problems with limited communication sometimes. Also, some tasks of the deliverables were split unevenly. Finally, we have met several difficulties during the building of the physical prototyping and final product.

In conclusion, our team has understood that communication with team members and participation in processing are essential. We will focus on personal tasks in each deliverable. The long term development requires a clear and close duration schedule, we need to make a well organized timing management.

# 8 Bibliography

# APPENDICES

## 9 APPENDIX I: Design Files

**Table 3. Referenced Documents**

| Document Name | Document Location and/or URL | Issuance Date |
|---|---|---|
| | | |
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# 10 APPENDIX II: Other Appendices