Final Design Report

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EGN2020C-EE09(30023)

Spring 2022

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Human-Centered User Needs

Figure 1: Customer Empathy Map

Given the current spread of COVID-19, people are more careful about their interactions with others; washing their hands more frequently, social distancing, and wearing facial coverings are just among the ways people are preventing the spread. Families with young children are among the population doing what they can to remain healthy. However, the biggest struggle they face is getting their children to wash their hands for a full 20 seconds (the CDC recommendation for removing bacteria from hands). With COVID-19 cases being reported daily and every news site reporting on the severity of the disease, parents of young children are increasingly cautious. Parents of young children want to follow the CDC (Center of Disease Control and Prevention) in order to prevent them from getting sick or getting their other family members and friends from getting sick. In addition, most families want to introduce good hygiene habits to their children, however they do not want to constantly remind them or have their children forget.

Our automated soap dispenser helps solve these issues. The main structure of the design is a rectangular prism with a rounded pattern around the perimeter and 3 cuts that will hold the LCD, motion sensor, and plastic tube that will connect the container holding the soap to the pump. The soap will be dispensed through a pump at the top once the motion sensor detects hand motion. By making the soap dispenser hands-free, there will be less bacteria spread between users and keep the pump/dispenser itself free of harmful bacteria. The LCD screen will display a screen that says “ready, go” once the soap is dispensed. A song will begin and play for 20 seconds. Once 20 seconds have passed, the LCD screen will display “finish”, indicating that the child should be finished with washing their hands. This will help young children keep track of the length of time remaining in the hand washing process. In addition, the short tune played will make the soap dispenser more appealing to young kids, motivating them to wash their hands more frequently.

Design Justifications

Figure 2: Design Matrix

Attributes	Weights (sum should be 1)	"Soap Dispenser and Timer" (out of 10)	Design A Weighted Score	"Automated Scrubber" (out of 10)	Design B Weighted Score
Low-Cost	0.10	5	0.5	7	0.7
Ease of Use by End User	0.30	10	3	8	2.4
Effectiveness	0.30	9	2.7	8	2.4
Safety	0.20	10	2	4	0.8
Environmental Impact	0.10	7	0.7	7	0.7
Total	**1.00**		**8.90**		**7.00**

The final design is the "Soap Dispenser and Timer" (automated soap dispenser). There were five categories considered when choosing the main design: low-cost, ease of use by the end user, effectiveness, safety, and environmental impact. After all categories were ranked, in terms of importance, a score was assigned to each design (out of 10). Ease of use by the end user and the effectiveness were the most important categories considered when comparing the automated soap dispenser and the automated scrubber. After prolonged use, both the automated scrubber and automated soap dispenser will need replacement parts. However, the replacement scrubbing head will cost more than the soap refill for the automated soap dispenser, causing the automated soap dispenser to score higher in the "low-cost" category. The automated soap dispenser scored a 10 out of 10, but the automated scrubber scored an 8 out of 10 for ease of use. The automated soap dispenser ranked higher in this category because it does not need to be manually turned on, limiting the chance for user error. Both the automated soap dispenser and the automated scrubber scored similar scores in the "effectiveness" category because both will successfully clean bacteria from both hands and surfaces. The automated scrubber scored a 4 out of 10 in the "safety" category because there runs the risk of user error by using the automated scrubber on glass, breaking the glass and potentially injuring the user. However, since the automated soap dispenser is motion detected, it scored a 10 out of 10 because the user does not touch the dispenser. Both designs scored the same in the "environmental impact" category because it will be made out of the same plastic and most parts are reusable. Overall, the automated soap dispenser was chosen because it will be more beneficial to the end user based on all five categories, scoring an 8.90 out of 10

Ethical & Environmental Considerations

The shell of the soap dispenser was 3D printed using PolyTerra PLA, making our product very environmentally friendly. The Polylactic Acid used in PolyTerra PLA is created by fermenting and polymerizing the long chain of sugar molecules extracted from corn. This allows the material to be biodegradable, making it even more biodegradable than regular PLA. The PolyTerra PLA, when correctly composed, breaks down into carbon dioxide, biomass, mineral salts, and water, leaving behind no toxic residues. The capability of properly composting allows and supports the growth of plants. The company where we acquire this material is also taking steps in becoming more environmentally aware by using recycled cardboard and other materials for the packing and labeling of the spools. Additionally, the company is promising on planting one tree for every spool of PolyTerra PLA sold. Purchasing one stool from the Polymaker website will already have a positive impact on the environment.

Another way we ensure our product does more good than harm to the environment is by using a reusable bag where the soap will be stored. Instead of using a plastic bottle for the soap and buying a new one every time, we decided to use a small plastic pouch that will easily be able to get taken out of the 3D printed case. With this, the user can just buy one big tub of liquid soap that they can use to refill the pouch once it runs out. At the end of the lifetime of our product, the user can easily recycle the reusable plastic pouch for the soap, as well as properly dispose of our 3D printed casing. The power source for our product helps with some environmental issues because it is powered by a battery that will be in it. This is beneficial because there are reusable batteries that can be recharged once they run out.

Lightbooth Pictures of Final Prototype

Figure 3: Isometric View

Figure 4: Front View

Figure 5: Top View

Tinkercad Electronics User Manual with List of Parts/Functions

User Manual

Intended Use:

This product is intended for dispensing soap and as a timer for washing hands.

Operation:

- Wave hand in front of sensor.
- Wait until soap has finished dispensing to move your hand.
- Begin washing hands when the screen displays "wash hands".
- Stop washing hands when the screen displays "finished".

Maintenance:

- When soap runs out, carefully flip the dispenser to access the soap container and refill with foam soap of choice. Once the soap container is full, ensure that the lid is secured and restore the dispenser to the upright position.
- If the dispenser is no longer reacting to motion, carefully flip the dispenser and replace the 9-Volt battery. Ensure that the battery is connected properly before activating the sensor again.

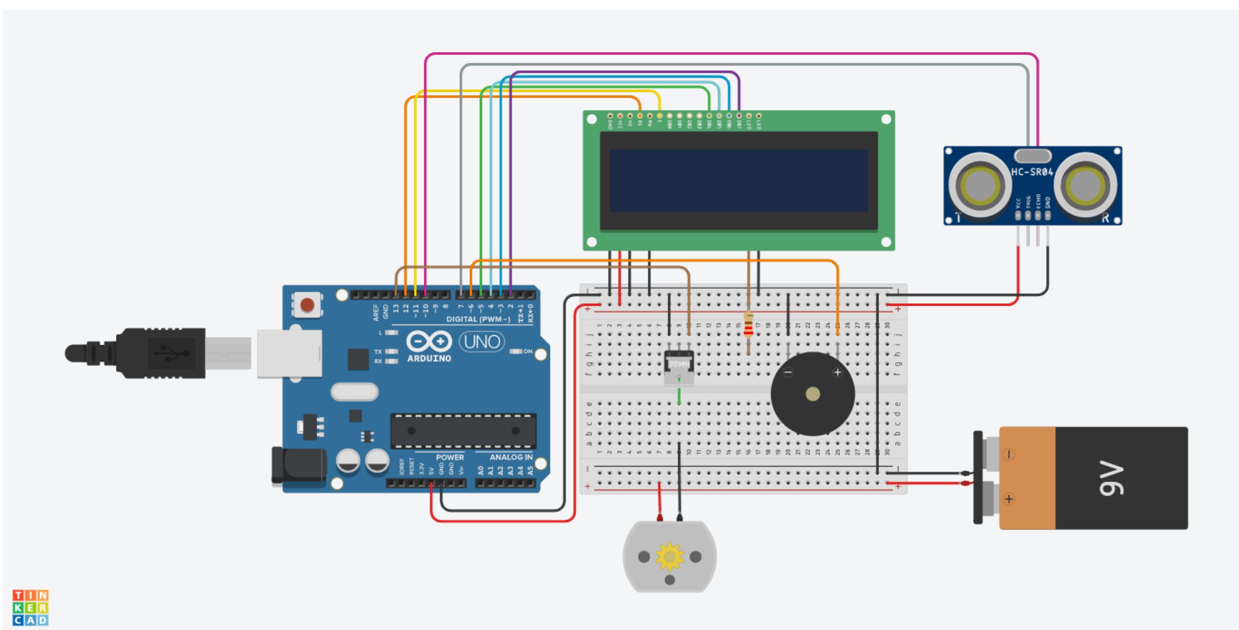


Figure 6: Tinkercad Circuit

Parts List

- Arduino Uno Board (1)
- Mini Breadboard (1)
- LCD Screen (1)
- Ultrasonic Distance Sensor (1)
- Piezo (1)
- DC Water Pump (1)
- 9-Volt Battery (1)
- nMOS Transistor (1)
- 220 Ω Resistor (1)
- Various Jumper Wires

Engineering Drawings

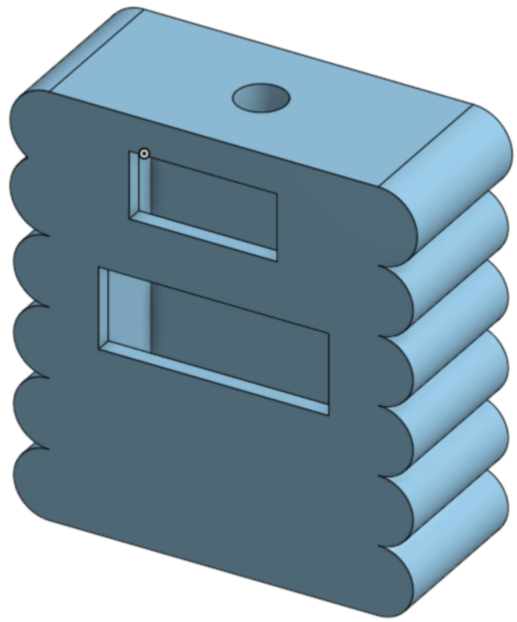


Figure 7: Isometric View

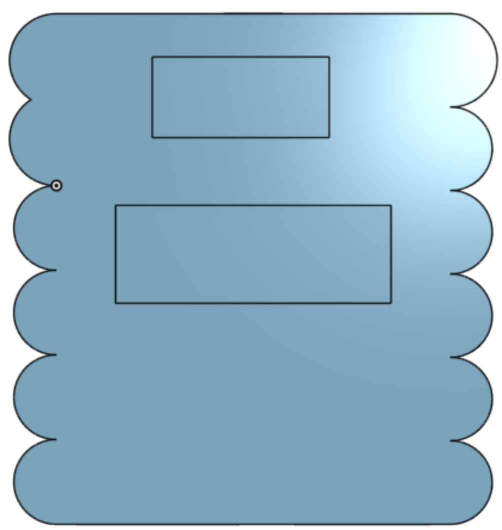


Figure 8: Front View

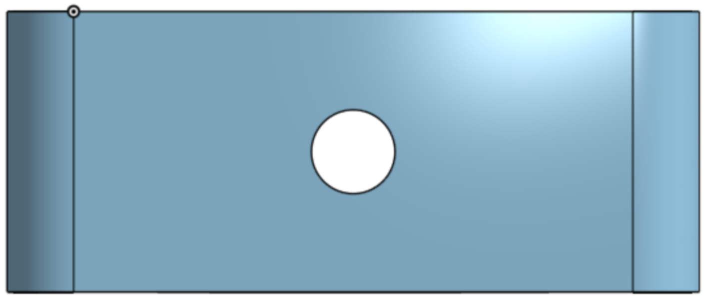


Figure 9: Top View

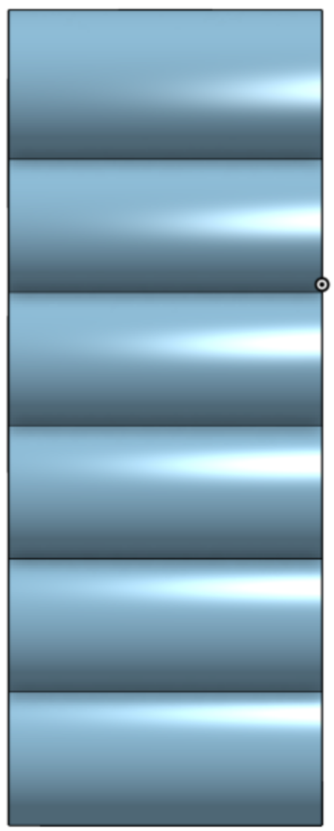
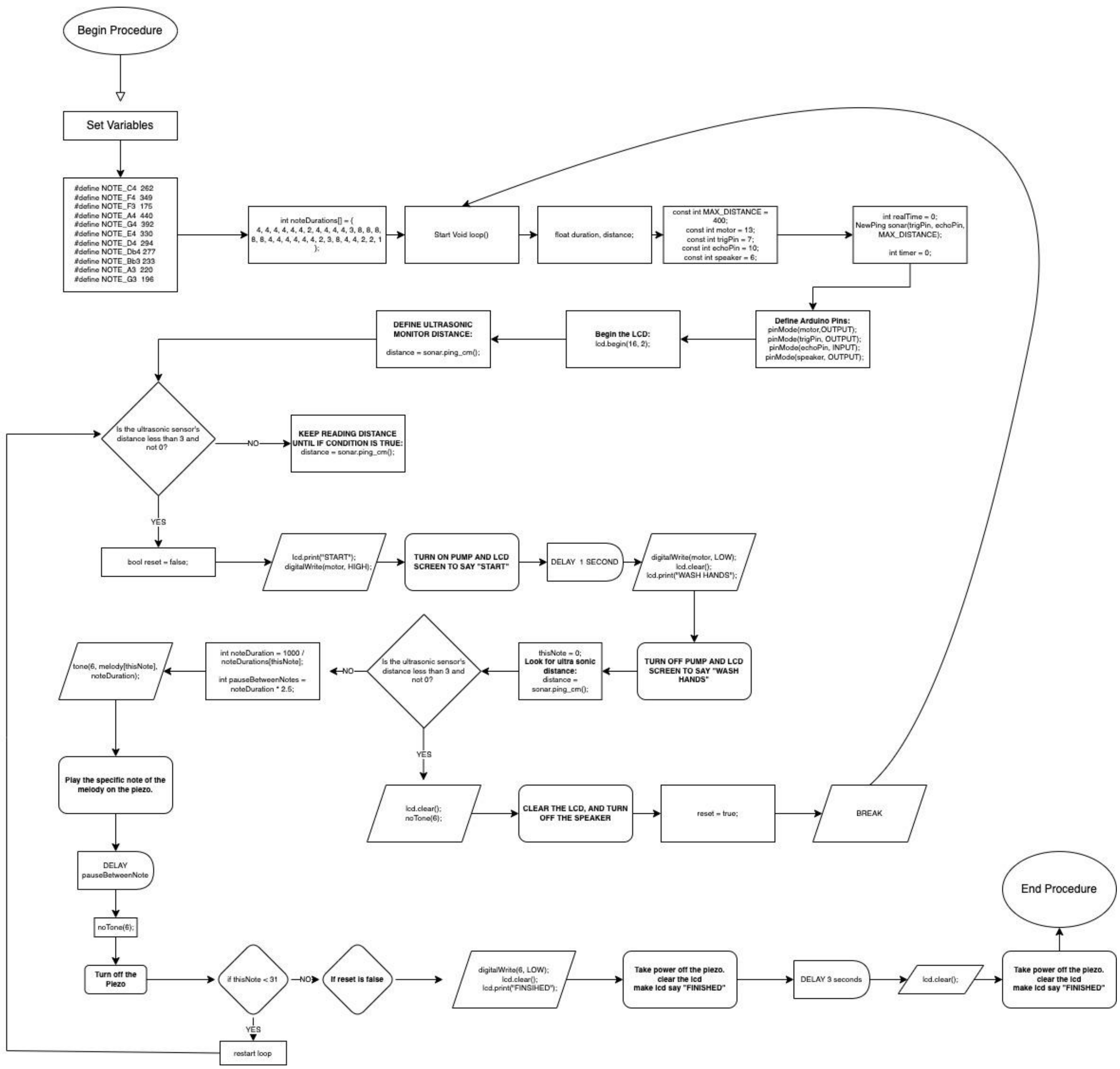


Figure 10: Right View

Onshape Link
https://cad.onshape.com/documents/cceea0afdfb41cd0f1522053/w/64781b05ca66bf309f8eeecb/e/e206a15f5c66666e73df975b?renderMode=0&uiState=624f11a900f6347094e16210

Flowchart



Full image: [here]()

Figure 11: Flowchart

Commented Code

```
// include the library code:
#include <LiquidCrystal.h>
#include "NewPing.h"

//defining each note that will be used in the song
#define NOTE_C4  262
#define NOTE_F4  349
```

```
#define NOTE_F3  175
#define NOTE_A4  440
#define NOTE_G4  392
#define NOTE_E4  330
#define NOTE_D4  294
#define NOTE_Db4 277
#define NOTE_Bb3 233
#define NOTE_A3  220
#define NOTE_G3  196

//initializing array of song notes and note duration
int melody[] = {
  NOTE_C4, NOTE_F4, NOTE_C4, NOTE_F3, NOTE_C4, NOTE_F4, NOTE_C4, NOTE_C4,
  NOTE_F4, NOTE_C4, NOTE_F4, NOTE_A4, NOTE_G4, NOTE_F4, NOTE_E4, NOTE_D4,
NOTE_Db4,
  NOTE_C4, NOTE_F4, NOTE_C4, NOTE_F3, NOTE_C4, NOTE_F4, NOTE_C4, NOTE_F4,
  NOTE_D4, NOTE_C4, NOTE_Bb3, NOTE_A3, NOTE_G3, NOTE_F3
};

int noteDurations[] = {
  4, 4, 4, 4, 4, 4, 2, 4, 4, 4, 4, 3, 8, 8, 8, 8, 8, 4, 4, 4, 4, 4, 4, 2, 3, 8, 4, 4, 2, 2, 1
};

float duration, distance;

//initialize the library with the numbers of the interface pins
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
const int MAX_DISTANCE = 400;
const int motor = 13;
const int trigPin = 7;
const int echoPin = 10;
const int speaker = 6;

int realTime = 0;
NewPing sonar(trigPin, echoPin, MAX_DISTANCE);

int timer = 0;

void setup() {
  pinMode(motor,OUTPUT);
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  pinMode(speaker, OUTPUT);
  Serial.begin(9600);
```

```
  lcd.begin(16, 2);
}

void loop() {
  //sensor activated turns on motor and timer
  distance = sonar.ping_cm();

//if statement is activated when user passes their hand in front of the distance sensor
//when activated, arduino will turn on the pump for 1 second, display instructions on LCD, and
//play song
  if(distance <= 3 && distance != 0)
  {
    bool reset = false;

    lcd.print("START");
    digitalWrite(motor, HIGH);

    delay(1000);

    digitalWrite(motor, LOW);

    lcd.clear();
    lcd.print("WASH HANDS");
    for (int thisNote = 0; thisNote < 31; thisNote++)
    {
      distance = sonar.ping_cm();

      Serial.println("entered for");
      if(distance <= 3 && distance != 0 && millis()/1000)
      {
        lcd.clear();
        reset = true;
        noTone(6);
        break;
      }
    int noteDuration = 1000 / noteDurations[thisNote];
    tone(6, melody[thisNote], noteDuration);
    int pauseBetweenNotes = noteDuration * 2.5;
    delay(pauseBetweenNotes);
    // stop the tone playing:
    noTone(6);
    }
    if(!reset)
    {
```

```
      digitalWrite(6, LOW);
      lcd.clear();
      lcd.print("FINISHED");
      delay(3000);
      lcd.clear();
    }
  }
}
```

Design Limitations

For our final functional prototype design, we had a couple of issues with it operating, but eventually, it was able to work as intended for the class to observe. We were really proud of our accomplishments, but do recognize the limitations we had that did allow it to be perfect. For starters, the 3D printed casing of the soap dispenser was not as big as it needed to be. This is due to the time constraints we have to print it, so we decided to downscale our design, causing it to be smaller than intended. As a result, it made some of our measurements for the holes of scale so we had to drill and readjust them, and then use tape to hold the parts up. In a perfect scenario, the display screen and distance sensor would fit in the whole precisely, not needing anything to hold it in place. The size constraint also limited us on where we could store the soap inside the container. In the beginning, our original plan was to keep the soap in the bottle that came in when purchased, but realizing that there was no space for it we changed it to a small plastic pouch that was much smaller.

If we could change our design, we would probably make it a little bigger so that all the parts fit inside of it. We would also change the LCD screen so that the words displayed on it are more visible to the user. Finally, we would use a smaller hose that dispenses the soap, so that it is not as long as the one we were using for the prototype. This would help its functionality of it since it is made for kids and with the long end the more prone to being knocked down.

In the end, with all our difficulties and limitations, we were able to deliver a final project that we are all satisfied with.

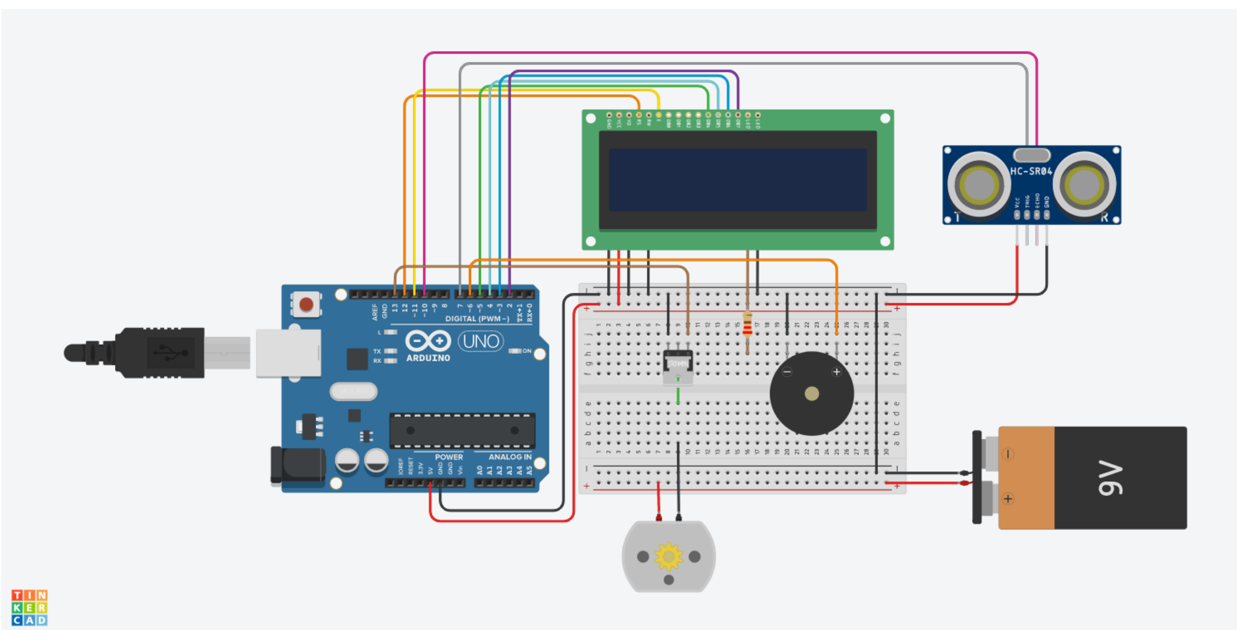
References

Frequent Questions About Hand Hygiene. (n.d). CDC. https://www.cdc.gov/handwashing/faqs.html.

Stiffelman, Susan. *My 5-year-old won't wash his hands*. (2015, June 22). Huff-Post. https://www.huffpost.com/entry/my-five-year-old-wont-wash-his-hands_b_7120410

Appendix

Tinkercad Snapshot



Tinkercad Link

https://www.tinkercad.com/things/j6MrMiih6Kk

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EGN 2020 Engineering Design and Society

TEAM CHARTER

The purpose of this document is to develop a charter for your team to establish many of the necessary ground rules for team meetings, interaction, and performance systematically. This charter should cover at the bare minimum the items listed subsequently. The expectation is that by establishing this document, the team will function more smoothly and efficiently.

Team name and logo

TAN'D

Communication Plan

First Name, Last Name	UF email	Other contact information
Diego Queipo Leon	dqueipoleon@ufl.edu	3212873697
Tiffany Rampersaud	rampersaudt@ufl.edu	3522722816
Annabela Ruiz	aruiz@ufl.edu	3057780563
Nathan Wand	wandnathan@ufl.edu	9546122450

Mission statement (Team purpose)

- Our mission is to work efficiently together to create a device to help families stay safe and healthy during cold/flu season, write a report about it and present it.

Meeting management (preferred meeting times and place to work outside class)

- Tuesday: 3-6pm
- Wednesdays: after 4pm
- Thursday: 4-9pm

Team Norms (some examples include: meeting duration, have a deliverable or outcome for the meeting, if you are unable to attend a meeting, let the organizer know as far in advance as possible, and it is your responsibility to find out what happened, listen without interrupting, etc.

- Meetings around 1-2 hrs
- Meet at EGN2020 classroom
- Preferred way of communication: message group chat
- Notice in advance if cannot attend meetings

Plan of Labor Division (Describe how as a team you will approach the division of work/effort in this project)

- Nathan & Annabela
    - Coding
    - Building
    - Wiring
- Tiffany & Diego
    - Designing
    - 3D printing
- We will split up the writing portions equally based on what part of the design process we are doing

Please include any additional information/agreement for making your teamwork more successful

All team members sign the team charter agreement to certify their endorsement and commitment to uphold the team charter.

Name	Signature
1. Diego Queipo Leon	Diego Quipo
2. Nathan Wand	NW
3. Tiffany Rampersaud	Tiffany Rampersaud
4. Annabela Ruiz	AR

(From left to right: Nathan Wand, Annabela Ruiz, Tiffany Rampersaud, Diego Queipo)