Project Deliverable H: **Prototype III and Customer Feedback**
GNG 1103 – Engineering Design
Faculty of Engineering – University of Ottawa

Objective:
Devise a test plan and develop your third prototype. Get customer feedback on your prototype.

Instructions:

Teams will outline a prototyping test plan based on the template provided in "Lecture 11 – Prototyping Test Plan" and develop a prototype which will be used to achieve the objectives your team has set out in this plan (i.e. you need to answer the "why", "what" and "when" of prototyping). Typical objectives include communicating and getting feedback for ideas, verifying feasibility, analysing critical subsystems or system integration or reducing risk and uncertainty. You must also define a stopping criteria which will allow you to end the test once you are satisfied that you have achieved your testing objectives. Be very clear about what you are trying to measure and define an acceptable fidelity based on the objectives of your prototype.

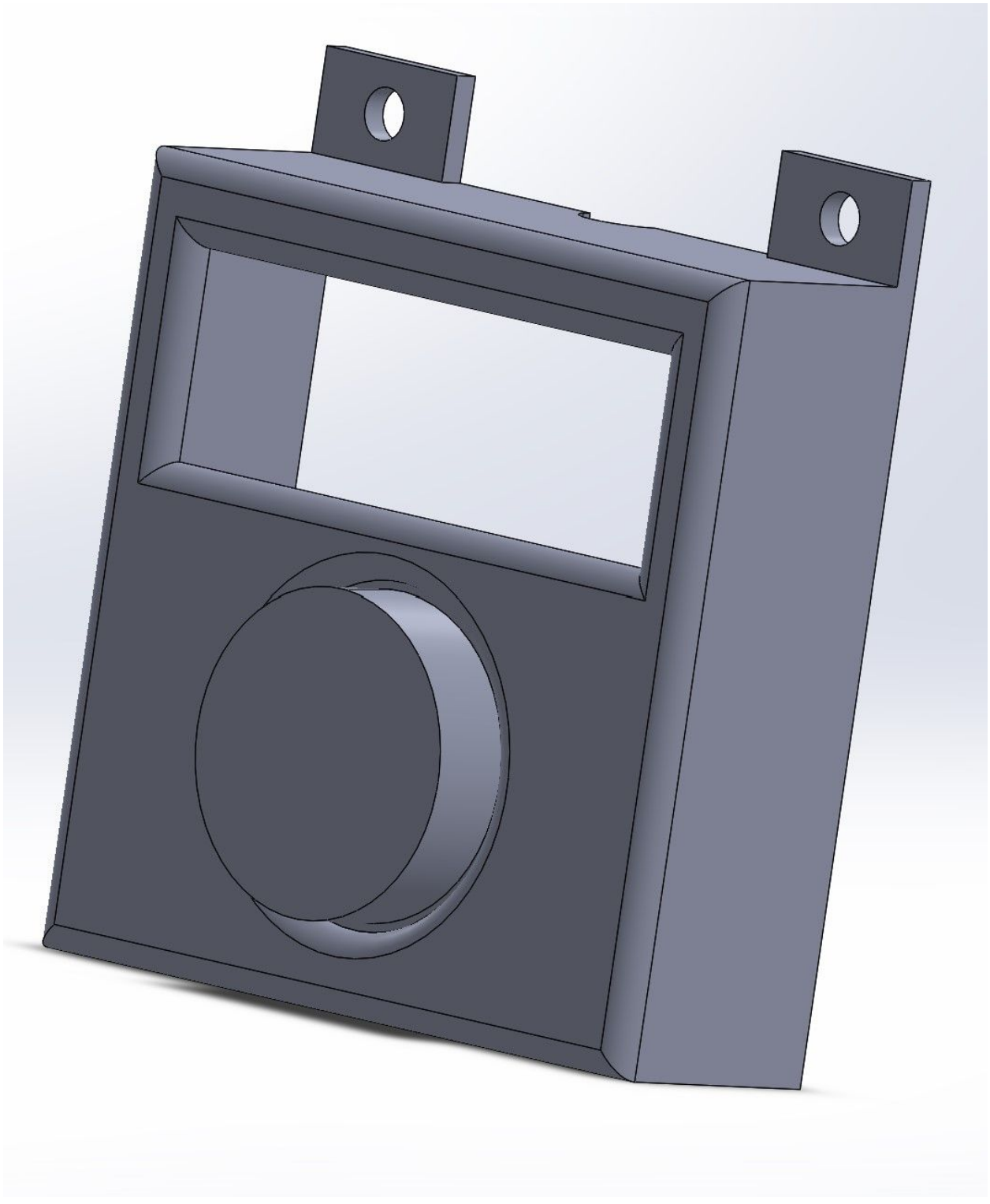
Since this will be your team's third prototype, your justifications and reasoning for this prototype should include a short explanation of your results from your previous prototypes and how this third prototype continues the development of your solution. This third prototype should be a fully functional version of your solution (i.e. a comprehensive prototype). Keeping in mind the total course budget of $100, get creative in order to improve your results. It does NOT need to be the version you would actually sell. Finally, you must gather feedback and comments on your ideas and prototype from potential clients/users that you have sought out and identified on your own and/or your actual client.

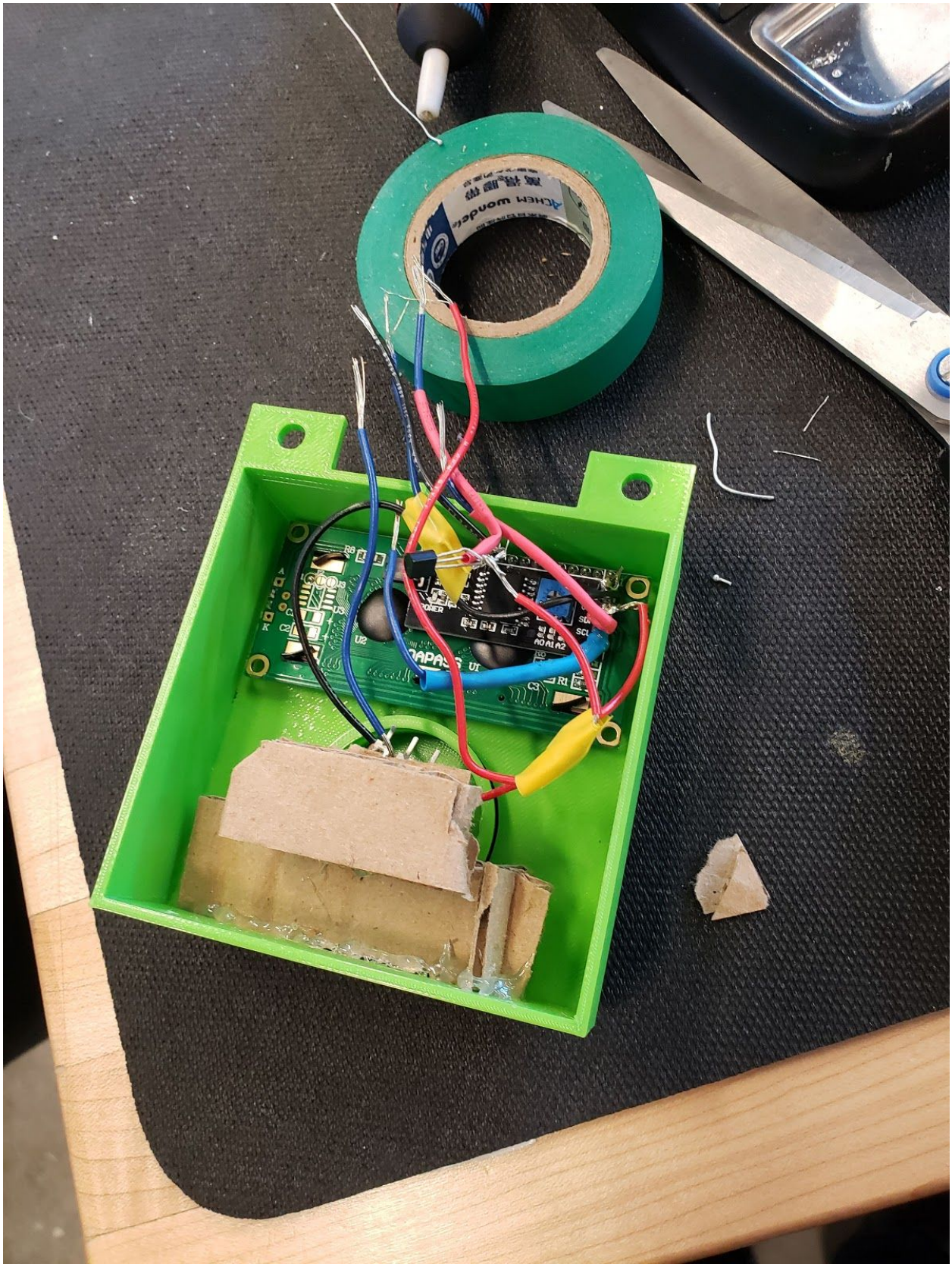
Carefully document your prototyping test plan and results (including detailed images of your prototype), as well as the feedback and comments you have gathered. Again, it is strongly recommended that you start early. You may have two weeks to complete this prototype, but keep in mind that this prototype should be comprehensive and will require a significant amount of time to complete.

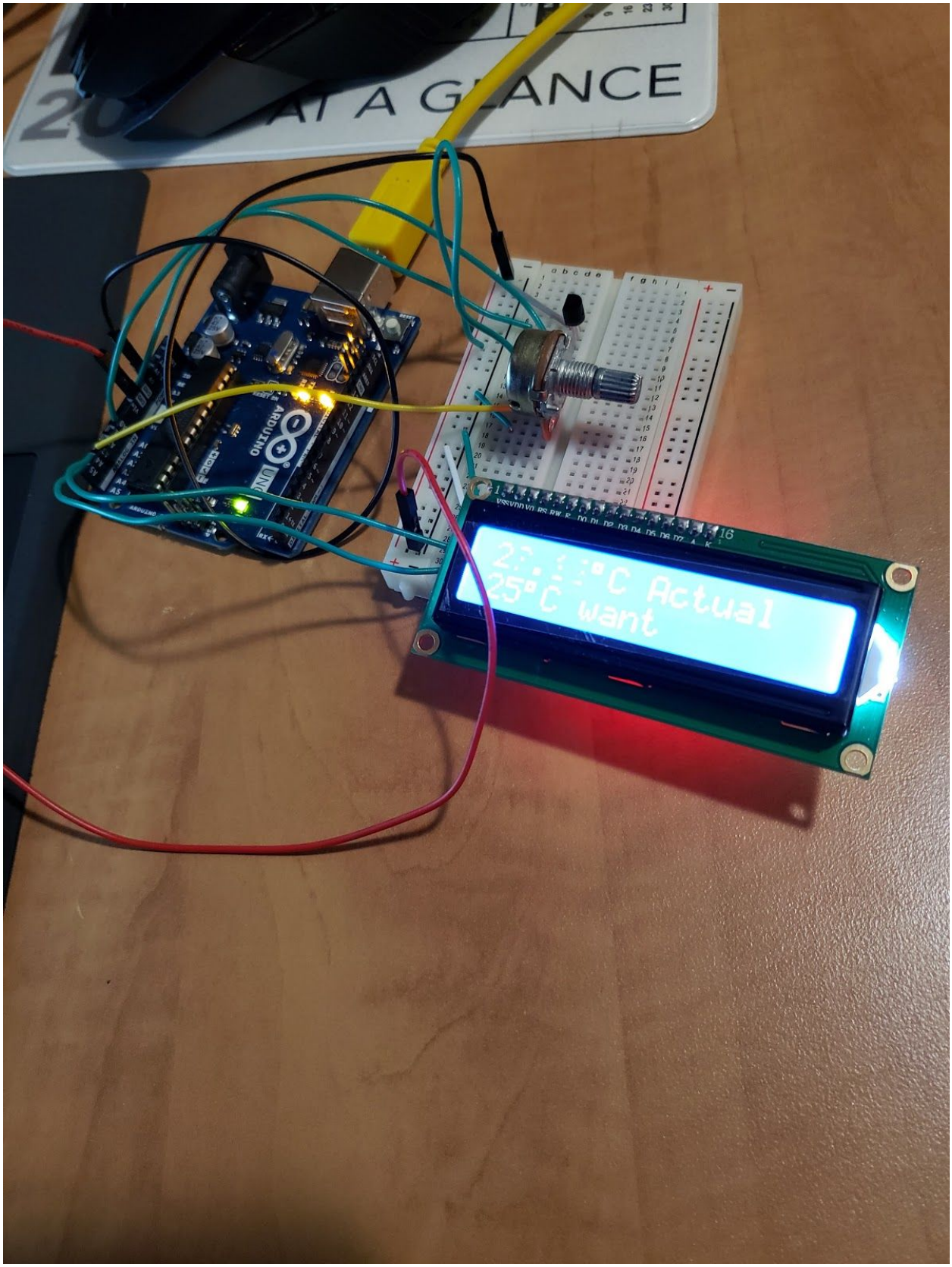
Submission:
Each team (only one person from each team) must submit a PDF copy of this deliverable by uploading the file as an attachment into BrightSpace.

Due Date:
March 24 at 11:59 PM

Lighting:






AT A GLANCE
ARDUINO
UNO
25°C Actual
25°C want

In the second prototype, we used our diagrams to create simple circuits and tested them to ensure that they worked. The code had a few mistakes that we were able to find and correct when we tested it on a circuit with the motion sensor and relay. We continued to test our circuit and code and improve it. Once we were happy with the result, we began to solder wires onto the arduino, relay and sensors where needed. We also began mounting the light fixtures and switches onto the house. We drilled a small hole in the front side of the house in order to bring the wires from the outdoor light fixture and sensor inside. Once that was done, we wired up the fixtures and the switch. During the lab on monday the 25th, we had planned to finishing setting up the arduino and sensors in order to finish connecting all the wires. However, the construction team still had a lot of work left to do and there was no room for us to get in and do our part. Therefore we are returning to the structures lab wednesday night in order to complete our part of the house. Below are images of our current progress: the light fixtures and switches. All of the soldering is also complete. All that is left is to finish connected all of the wires to the arduino and sensors.

Below you will find out updated code. On wednesday we will combine the code from all three parts (lighting, heating and water) and test it out on our final prototype which will be complete and functional with all the wiring done.

sketch_feb28a §

```
int relay_outside = 8;
int relay_inside = 9;

volatile byte relay_outsideState = LOW;
volatile byte relay_insideState = LOW;

int sensor_outside = 2;
int sensor_inside = 3;

long lastDebounceTime1 = 0;
long debounceDelay1 = 10000;
long lastDebounceTime2 = 0;
long debounceDelay2 = 10000;

void setup() {
  pinMode(relay_outside, OUTPUT);
  digitalWrite(relay_outside, HIGH);
  pinMode(relay_inside, OUTPUT);
  digitalWrite(relay_inside, HIGH);
  attachInterrupt(digitalPinToInterrupt(sensor_outside), detectMotion1, RISING);
  attachInterrupt(digitalPinToInterrupt(sensor_inside), detectMotion2, RISING);
  Serial.begin(9600);

}

void loop() {

  if((millis() - lastDebounceTime1) > debounceDelay1 && relay_outsideState == HIGH)
  {
    digitalWrite(relay_outside, HIGH);
    relay_outsideState = LOW;
    Serial.println("OFF Outside\n");
  }

  if((millis() - lastDebounceTime2) > debounceDelay2 && relay_insideState == HIGH)
  {
    digitalWrite(relay_inside, HIGH);
```

sketch_feb28a §

```
  if((millis() - lastDebounceTime1) > debounceDelay1 && relay_outsideState == HIGH)
  {
    digitalWrite(relay_outside, HIGH);
    relay_outsideState = LOW;
    Serial.println("OFF Outside\n");
  }

  if((millis() - lastDebounceTime2) > debounceDelay2 && relay_insideState == HIGH)
  {
    digitalWrite(relay_inside, HIGH);
    relay_insideState = LOW;
    Serial.println("OFF Inside\n");
  }
  delay(50);
}

void detectMotion1() {
  Serial.println("Motion Outside\n");
  if(relay_outsideState == LOW)
  {
    digitalWrite(relay_outside, LOW);
  }
  relay_outsideState = HIGH;
  Serial.println("ON Outside\n");
  lastDebounceTime1 = millis();
}

void detectMotion2() {
  Serial.println("Motion Inside\n");
  if(relay_insideState == LOW)
  {
    digitalWrite(relay_inside, LOW);
  }
  relay_insideState = HIGH;
  Serial.println("ON Inside\n");
  lastDebounceTime2 = millis();
}
```

The costumer gave good feedback when we presented the second prototype. The client was impressed with how much was accomplished for the second prototype; however, wanted some more clarification as to where exactly everything was going to fit in the house. The prof gave an excellent answer as to what the three houses were designed to do come design day; all three modules were to be connected to make one bigger house. With this new information that we were received, we had to plan out the house and location as to where everything was going to fit in the house due to some walls being taken out to combine multiple modules together. We quickly had a discussion between our team to figure this problem out and went to go talk to the construction team for more clarification on the subject. At the end we decided that the walls that were going to be permanent no matter how many modules are added on were to be the front door, the back wall, and the first panel of wall coming out from each side of the front and back wall. Therefore, with the help of the construction team indicating that the door will swing outward with the hinge being on the left side of the door frame, we decided that the first thing you walk into should be the light switches. When we went down to the structure lab, we placed light fixtures and light switches on the corresponding walls where they would not interfere if you were to take off the walls and add more modules to the house. In conclusion, the client was satisfied again with the progress that was made and asked multiple questions that we could easily clarify as we were well prepared for the client meeting.

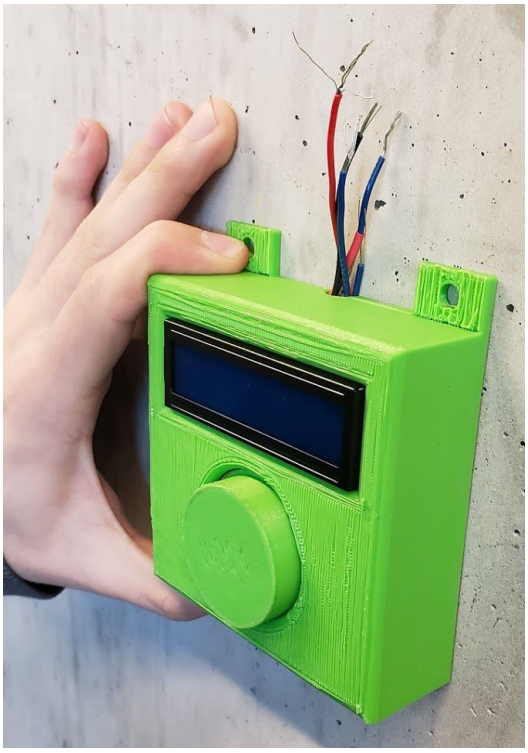
Heating:

The second prototype had unfinished coding and buggy wiring. The temperature sensor relied on a difference in voltage, but as more sensors and outputs were added to the circuit the voltage reading would vary, resulting in the wrong temperature being read. To make up for this, the third prototype changed the wiring to cover this change in voltage. In addition, the code was completed, and edited to make up for any unusual deviations in temperature. The reasoning behind the latter change in code was to spot and ignore anytime the wiring could be acting up and providing the wrong voltage.

The coding was completed by adding the component for the motion sensor which checks to see if the user is currently in the home. This component in addition with the heat sensor allows the creation of the section of code that will automatically turn the heat on/off if the sensors detect a user in/outside the home.

In addition, a casing was 3d-printed to store a bulk of the wires along with the LCD display and dial. The design of the case itself was also slightly altered to add supports for the dial and itself, so that it could be attached to walls with screws or nails. Finally, we have started to move away from the breadboard by soldering wires together.

Concerning the client this time, the idea of the backlight of the LCD monitor was brought up once more. Unfortunately, after discussing the matter, we decided that it would be for the best not to include this function. It would eat up too much time to properly implement, and the constant change in power requirements for the LCD screen results in a variation in voltage required for the temperature sensor, which in turn gives a false reading.

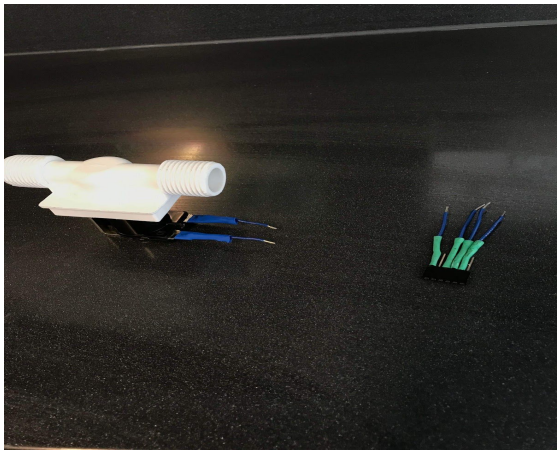


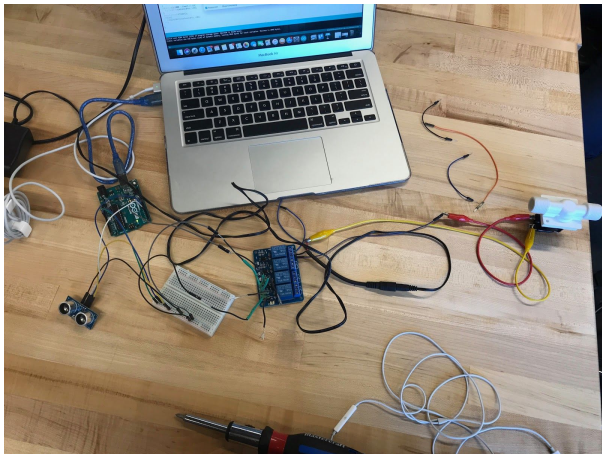
Heating code:

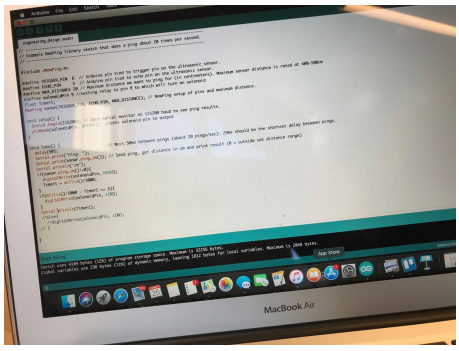
https://pastebin.com/T477drgv

Water:

Finally, concerning water, we have completed the code and tested it with an Arduino Uno using a breadboard and relay. The test was a success and we were able to make the ultrasonic sensor activate the solenoid pipe when there was movement within 20 cm of the ultrasonic. We were also able to keep the solenoid activated for 3 seconds after the movement was detected using the millis() function. This function allowed us to get the exact number of milliseconds the program was running for. Using this we created an if statement which states that if the milliseconds the solenoid was on for went over 3 seconds and the ultrasonic sensor was no longer activated the solenoid would turn off.







Now moving on to the base/ sink. It is still yet to be complete but will hopefully be done by design day on Friday. We were able to successfully find a PVC lock and at the same time we were also able to drill a whole into the center of the steal bowl we acquired. All that needs to be done is to properly seal the hole and also make sure that water will only pass through the PVC lock. Lastly we need to make sure we install the sink/ bowl on some base to make sure it

something holding it in place in the house. We decided leftover wood to act as the support due to our budget. The inner diameter of the bowl has been sketched out and all the remains is the fact that we have to use a jigsaw to cut the whole before we mount the bowl.