DesignOtt Engineers Inc.

PROTOTYPE II

GNG1103, Section # F, Team # F3

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Table of Contents

Prototype II Testing Summary 3

  Test 1 3

  Test 2 4

  Test 3 5

  Test 4 6

  Test 5 6

Prototype III Outline 9

References 10

Appendix A: List of Tasks to be Completed (from Deliverable F) 11

Appendix B: Prototyping Test Plan (from Deliverable F) 12

Appendix C: Temperature Sensor Code 13

Appendix D: Peltier Plate Code 14

Prototype II Testing Summary

Test ID	Test Objective	Description of Prototype	Test Method
1	Assess temperature measurement abilities of Arduino	Connect components to an Arduino and set up as per the prototype	Measure temperature of air, then hold sensor in hand to check that temperature decreases
2	Analyze and test how long it takes and how easy it is to install the sample using a revised design	Generate sample containment unit lid	Time how long it takes to take out a sample, then place another in over multiple trials, and calculate the average expected time.
3	Analyze and test how easy it is to install and remove the plug	Scale model of plug and drainage system	Generate plug and connect to drainage system while filled with water, then pull the plug and time how long it takes to drain.
4	Analytical model: calculate amount of time to decrease volume of sample by 10%	Research from internet, then extrapolate	Find the time at which 10% of the volume would be lost using extrapolation.
5	Assess the physical components of the thermoelectric cooling system	Connect components to an Arduino and set up in a somewhat insulated environment. Test when one cooling component is engaged	Over the course of 20 minutes, the temperature will be measured and recorded every 5 minutes. Recorded temperature values will be analyzed.

Test 1

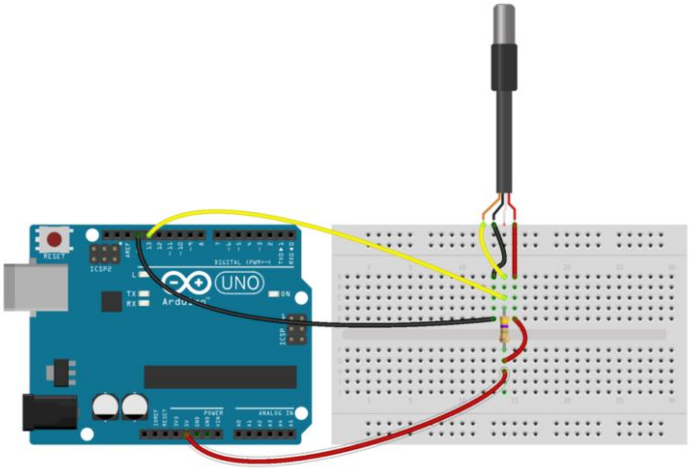
The objective of this test is to measure the temperature of the testing environment using a waterproof temperature sensor connected to an Arduino Uno.

The testing will be done by using the code written in the Arduino IDE and building the temperature sensor circuitry using an Arduino and breadboard.

The testing will be evaluated by testing if the Serial monitor outputs the correct temperature results.

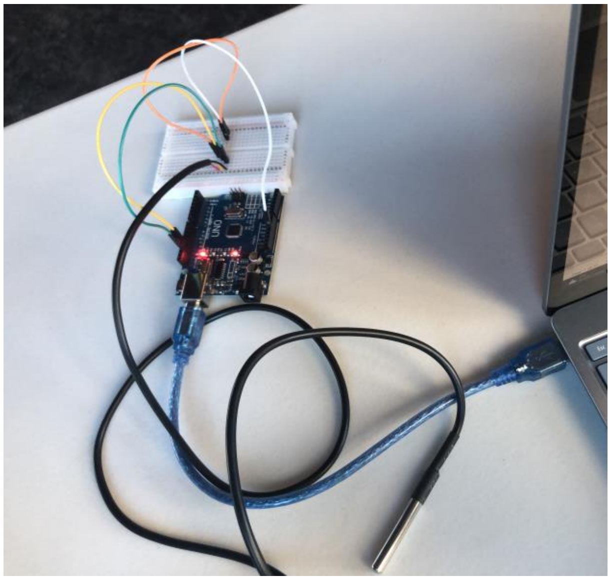
The results of the testing were successful as the serial monitor would register the temperature of the sensor every other second.

The proposed test setup was as such:



Tinkercad diagram of temperature sensor with Arduino.

The actual test setup was as such:



Temperature sensor connected to breadboard, with measurements done by Arduino.

Test 2

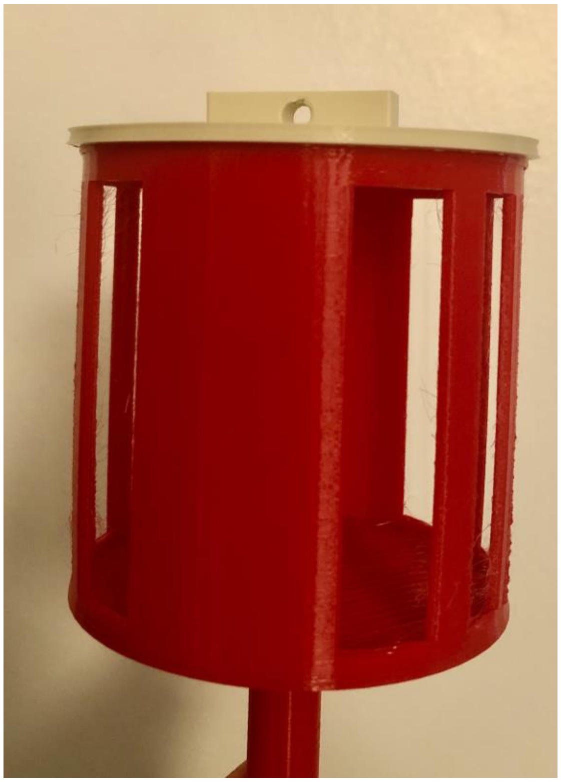
The objective of this test is to analyze and test how long it takes and how easy it is to install the sample using a revised design.

The testing will be done by generating a sample containment unit lid in an appropriate scale and fitting it onto the existing sample containment unit bottom.

The testing will be evaluated by timing how long it takes to take out a sample, then placing another in over multiple trials, and calculating the average expected time.

The results of the testing were that it takes an average of five seconds to remove the lid, remove the sample, insert a new sample, and close the lid.

The test setup was as such:



Sample containment unit with fitted lid.

Test 3

The objective of this test is to analyze how easy it is to install and remove the plug.

The testing will be done by using the test draining system and timing how long it takes to install and take out the plug over multiple trials.

The testing will be evaluated by the time it takes to place the plug inside, securely, then take it fully out. This will be done five times.

The results of the testing were an average of 10 seconds between 5 trials to successfully insert and secure the plug as well as removing the plug.

Test 4

The objective of this test is to calculate the amount of time it takes for the volume of the sample to decrease 10% in volume.

The testing will be done by completing research on how long the sample material takes to lose volume in similar conditions.

The testing will be evaluated later when the project has been built and we can compare the analytical data to the tested results.

The results of the testing were that the sample should take ~7 days to reduce in volume by 10%.

The test setup was that research was done on machines that operate similar procedures to our own, as well as sandstone, a material that will be used as the sample. Sandstone is very slow to erode due to water- it is more prone to wind erosion. It is a very porous material, and matter passes through it easily, but when inside the device, with the constant flowing water and the force it carries, the sandstone will not be able to resist erosion as it would be able to in a river or other similar environments.

Test 5

The objective of this test is to assess the physical components of the thermoelectric cooling system: Peltier plates with heat sinks.

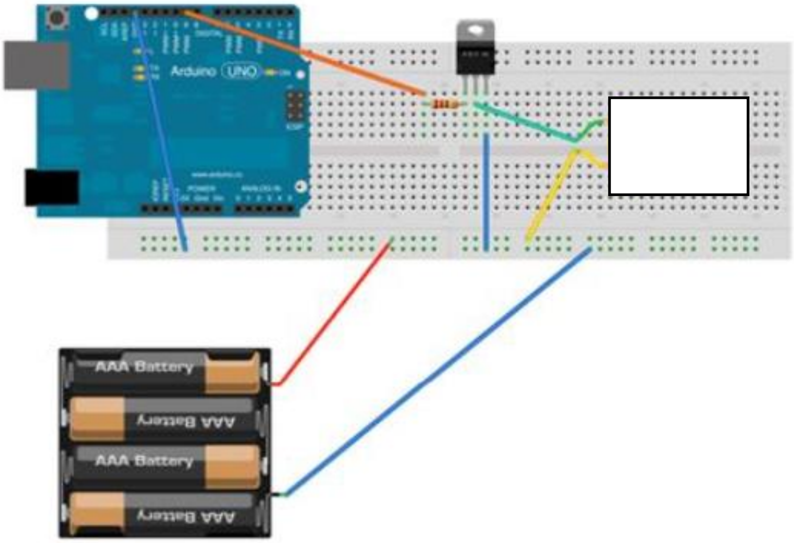
The testing will be done by connecting components to an Arduino and setting up the components as per the circuit diagram, in a somewhat insulated environment. Measurements will be recorded when one Peltier plate is engaged.

The testing will be evaluated by data gathered over the course of 20 minutes, during which time the temperature will be measured and recorded every 5 minutes (5 measurements in total per sub-test). Recorded temperature values will be analyzed. Based on the power of one Peltier plate, it can be calculated how much power is needed for the Peltier plates to cool the water during the test.

The results of the testing with one Peltier plate were:

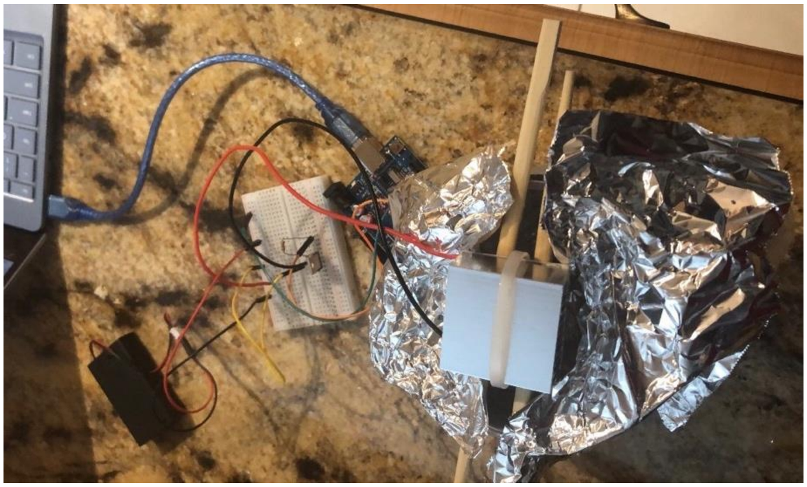
Time (minutes)	Temperature (degrees Celsius)
0	22.6
5	22.3
10	22.1
15	22.1
20	22.0

The proposed test setup was as such:



Tinkercad diagram of circuit.

The actual test setup was as such:



Peltier plate suspended between two wooden rods with tinfoil insulation. The Arduino was programmed to provide the full power of three AAA batteries to the Peltier plate.

Prototype III Outline

Test ID	Test Objective	Description of Prototype used and of Basic Test Method
1	Solder PCB	From wiring scheme determined from previous prototype, solder the PCB connections and test whether motor operates
2	Propellor	3D print full size propellor using PETG and attach to motor, confirming rotation of propellor
3	Determine feasibility of container	Purchase container, fill with water, insulate, and confirm no leakage as well as rate of heat absorption
4	Assemble lid of test container	Connect Arduino, circuit board, temperature sensors, cooling system, DC motor, and propellor, then confirm whether motor runs or not
5	Construct drainage system	3D print drainage system with filter & bottom of sample containment unit, filter cover, and plug for stopping water leakage using PETG, then confirm whether water drains and how quickly
6	Install drainage system into container	Secure the 3D printed system into the test container and observe if there is leakage or not; if so, use hot glue to seal
7	Install sample containment unit	3D print using PETG and fit lid f sample containment unit
8	Begin test	Set up system and power to motor, checking on the sample daily to confirm erosion

References

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Appendix A: List of Tasks to be Completed (from Deliverable F)

Task	**Description**	**Name**	**Due Date**
Acquire some raw materials	Order and bring Arduino, breadboard, wires, DC motor, and temperature sensors to campus.	Lauren	February 27
Write Arduino DC motor code	Write code to turn motor.	Yusra	February 27
Propellor	Design and print small scale propellor (for testing purposes).	Yusra	February 27
Container modeling	Design full-scale and small-scale plastic container, and 3D print small-scale container and lid (for testing purposes).	Sendwe	February 27
Sample containment	Design and 3D print full size sample containment lid and bottom.	Gurshaan	February 27
Write Arduino temperature control code	Write code to turn on power to cooling system when water temperature is above a certain threshold.	Ahmad	February 28
Acquire further raw materials	Order and bring insulator, container, and coffee filters.	Lauren	February 28
Prototype I	Combine successful subsystems to make an initial prototype.	All	March 3
Improve subsystems and implement additional requirements	If some subsystems were not included in the first prototype, install them and refine the ones that did not work.	All	March 3-10
Prototype II	Construct the second prototype.	All	March 10
Find a place to begin the erosion test	Look around campus and ask professor where to run test.	Yusra	March 10
Solder PCB	From wiring scheme determined from previous prototype, solder the PCB connections.	Lauren	March 11
Propellor	3D print full size propellor.	Ahmad	March 12
Construct lid	Connect Arduino, circuit board, temperature sensors, cooling system, DC motor, and rod.	Yusra	March 14
Construct drainage system	3D print drainage system with filter & bottom of sample containment unit, filter cover, and plug for stopping water leakage.	Gurshaan	March 16
Install drainage system into container	Secure the 3D printed system into the test container.	Sendwe	March 17
Install sample containment unit	3D print and fit lid onto bottom of sample containment unit.	Lauren	March 18
Begin test	Set up system and power to motor.	All	March 19

Check on test	Confirm daily that the test is still running successfully.	All	March 19-
Prototype III	Construct the third prototype.	All	March 24
Minimal changes	Perform maintenance and change small details as needed while test is running.	All	March 24-
Calculations	Do calculations to find the expected time to erode based on the speed of the water and amount of force that the water is exerting on the eroding material.		April 2
Final Product	Construct the final product.	All	April 3
Design Day Presentation	Generate PowerPoint showcasing the final product. Its construction, the steps taken to complete it and everything else attached to the process.	All	April 4
User and Product Manual	Type out manual, complete with everything needed to know about the product and how to operate it properly.	All	April 10

Appendix B: Prototyping Test Plan (from Deliverable F)

Test ID	Test Objective	Description of Prototype used and of Basic Test Method	Description of Results to be Recorded and how these results will be used	Estimated Test Duration and Planned Start Date
1	Analyze the overall containment and drainage	Set up the containment system with the fluid and the drainage system in a small-scale model	Qualitative results: whether all the fluid drains out without any remaining inside the container. If not, the design should be modified	15 minutes (10 minutes to fill and 5 to drain). February 26th
2	Test the rotation	Run the Arduino connected to the motor and rod	Any visual or audible signs of fatigue of the motor after 20 minutes of running. If so, a new motor will be selected	30 minutes March 1st
3	Analyze and test how long and how easy it is to install the sample	Generate sample containment unit top and bottom and connect to rod	Sizing of sample container top and bottom. If it doesn't fit together, the CAD model will be modified. Time required for sample installation. If it takes more	10 minutes March 6th

			than 2 minutes, the CAD model will be simplified	
4	Assess the physical components of the cooling system	Connect components to an Arduino and set up the components as per the prototype, in a somewhat insulated environment. Test when all cooling components are engaged, 50% of cooling components are engaged, and 0% are engaged	Over the course of 20 minutes, measure temperature every 5 minutes (5 measurements in total per sub-test). Recorded temperature values will be analyzed. If fluid temperature continues to increase when all components are engaged, add more cooling coils to the final design	1 hour March 8th
5	Adjust rotation speed while motor in operation	Run the Arduino connected to the motor and rod while changing values of speed in the Arduino IDE	Qualitative results: See if the rotation of the blade changes as expected.	10 mins March 12th

Appendix C: Temperature Sensor Code

```
#include<OneWire.h>
#include<DallasTemperature.h>
int pinMotor = 9; //pin number which motor is connected to in the arduino
int speed = 10; //between 0 and 255

const int SENSOR_PIN = 13; // Arduino pin connected to DS18B20 sensor's DQ pin

OneWire oneWire(SENSOR_PIN);         // setup a oneWire instance
DallasTemperature tempSensor(&oneWire); // pass oneWire to DallasTemperature
library

float tempCelsius;

void setup()
{
  Serial.begin(9600);
  tempSensor.begin();

  pinMode(pinMotor,OUTPUT); //setting pin 9 as the output pin

}
```

```
void loop ()
{
    tempSensor.requestTemperatures();             // send the command to get
temperatures
    tempCelsius = tempSensor.getTempCByIndex(0);  // read temperature in Celsius
    Serial.println("Temperature: ");
    Serial.print(tempCelsius);    // print the temperature in Celsius
    Serial.print("°C");
    delay(1000);
    analogWrite(pinMotor, speed);
    delay(2000);
}
```

Appendix D: Peltier Plate Code

```
int pinPlate1 = 9; //pin number which plate is connected to in the arduino
int userInput = 1; //default value
int power = 255; //between 0 and 255

void setup(){
  Serial.begin(9600);
  pinMode(pinPlate1,OUTPUT); //setting pin 9 as the output pin

}

void loop () {

  analogWrite(pinPlate1, power);

  delay (30000); //runs for 5 minutes at the given power
  printf("Do you want to continue test?");

  scanf("%d",&userInput);
  if (userInput==0)  {
    power=0;
    analogWrite(pinPlate1,power);
    Serial.println("Power off.");
  }
  //if user does not enter 0, the test will run for another 5 minutes
}
```