

# The Heat Exchange Chamber

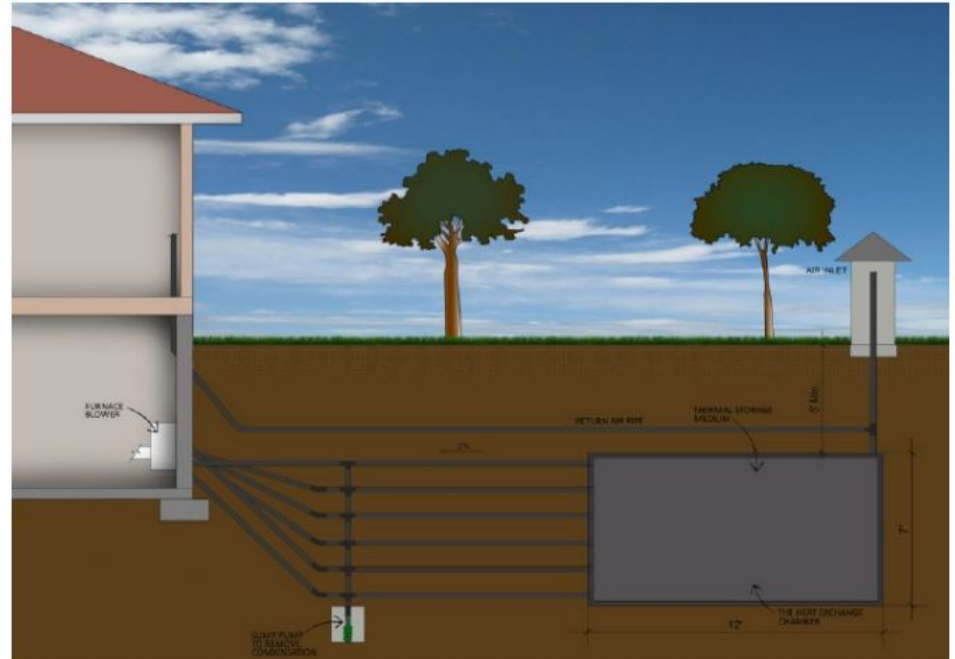
## *Final Project Presentation*

**Group D1.4 - Team Rocket**

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# Background Information

What is the THEC system?  
Regulate the temperature with zero-emissions via the natural geothermal exchange of energy





# Design Process



# Empathize

1. Research about context
2. Formulate questions
3. Interview
4. Transform answers into needs
5. Group needs into aspects
6. Classification of order of importance



# Define



## 1- Functional requirements :

- Be able to heat to 22-23 degrees celsius
- Be self sustainable
- Able to install in new and existing buildings
- Able to extract energy from ground
- 10 feet of clay soil installed around the box
- System strong enough to be buried

## 2- Non-functional requirements :

- Environmentally friendly
- Long product life
- Easily accessible
- Easy installation
- Reduced technology

## 3- Constraints :

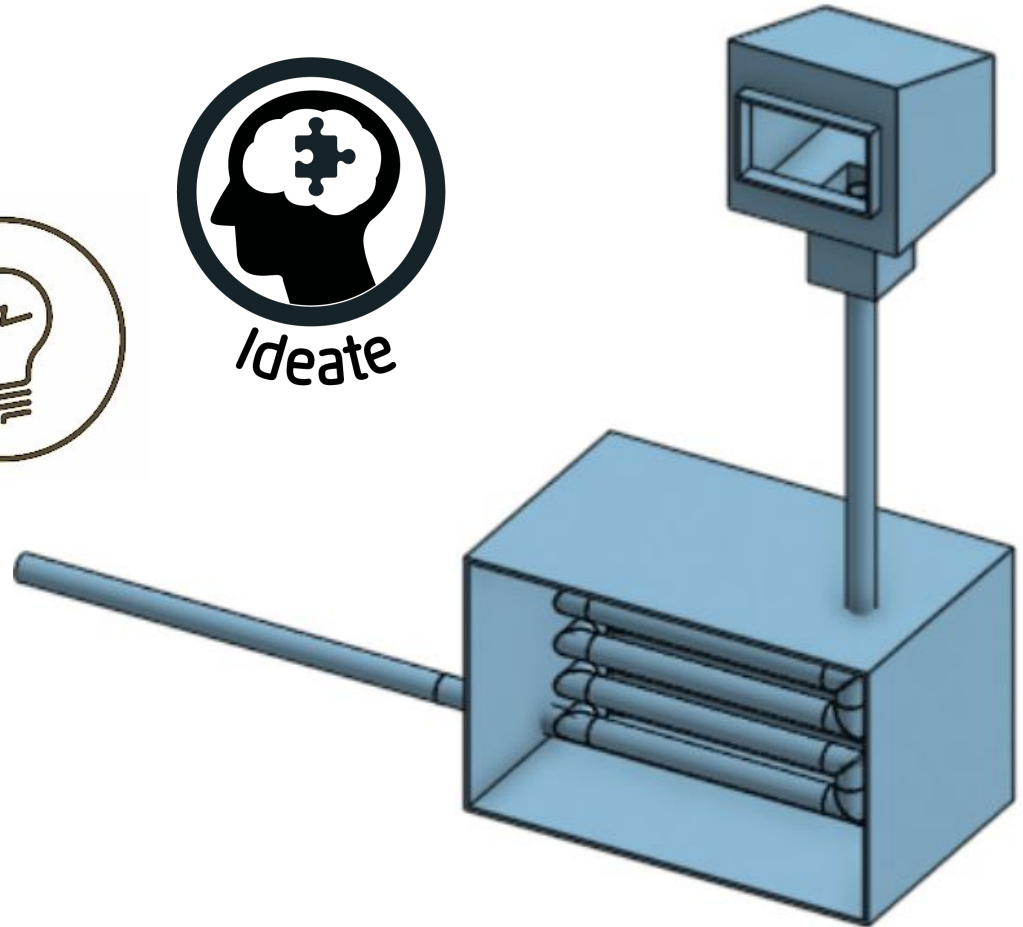
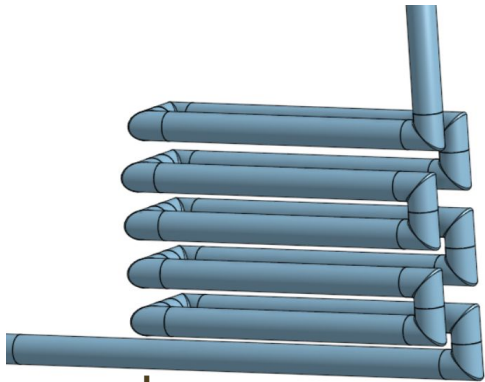
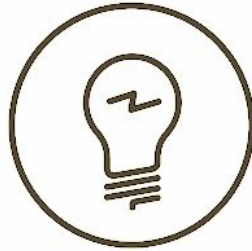
- Weight
- 4ft x 2.5ft x 2.5ft in size
- Cost

Furnace Blower					
	Product	Cost	RPM	Horse power	Weight
<a href="https://allaroundindustrysup">https://allaroundindustrysup</a>	U.S. Motors Emerson 1865	131.13 CAD	1075	0,5	8.00 lbs
<a href="https://www.oemhvapartsc">https://www.oemhvapartsc</a>	GE 3583 Motor	180.00 CAD	1050	0,25	12.00 lbs
<a href="https://www.oemhvapartsc">https://www.oemhvapartsc</a>	Furnace Blower Motor P257-8585 Canada	194.96	1075	0,3333333333	10.00 lbs
	Best				
	Medium				
	Worst				



# Ideate

3D model of the inlet,  
chamber box and pipes  
system:





# Prototype 1

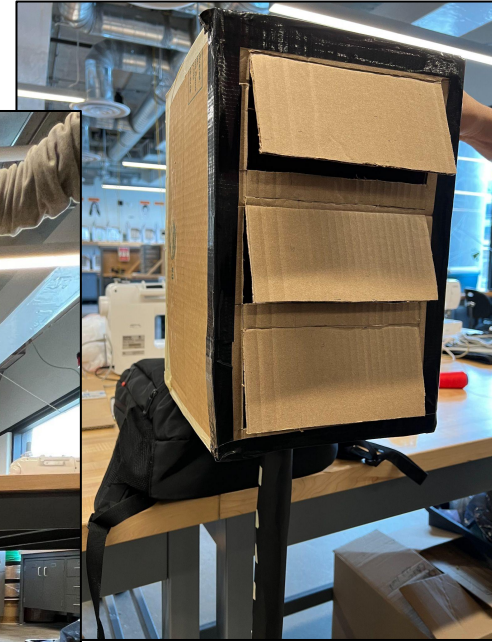
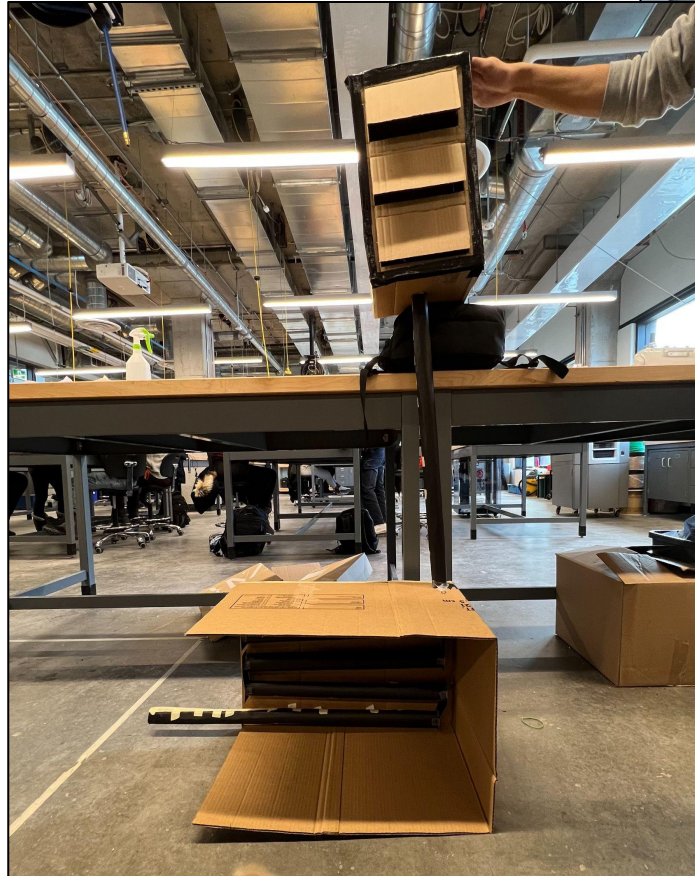


## Goal of Prototype 1

To confirm the overall dimensions and to get a visual of how all the systems will interact once assembled.

Focus on mechanical aspects and metrics

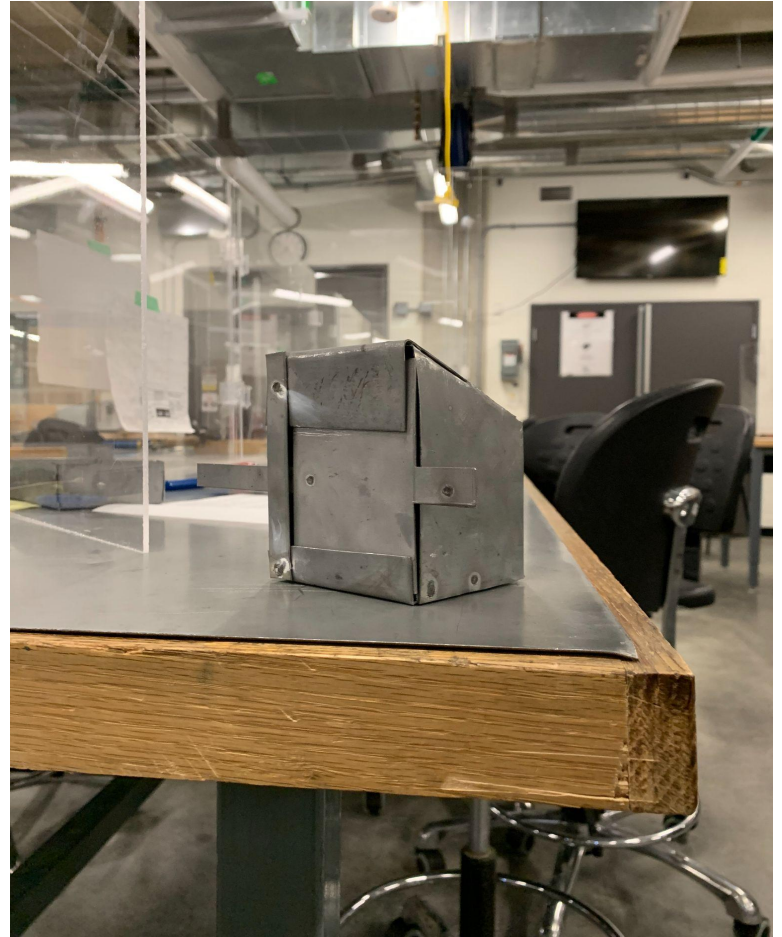
Cheap materials and easy to make





# Prototype 2

# 1st Air Inlet Design



# Heat Transfer

To cool from 30°C to 23°C:

- Total length of pipes: 90 in

- Diameter of pipes: 0.75 in

- Heat transfer: 8.4 J/L of air

- Air flow: 45.5 m/s

• Outside: 30°C • Box: 10°C • Target: 23°C

\* For now we take an arbitrary volume of air that goes into the system each second:  $V = 1 \text{ L}$

$$\rho_{\text{air}} = 1.2 \text{ g/L} \Rightarrow m_{\text{air}} = 1.2 \text{ g} = 1.2 \times 10^{-3} \text{ kg}$$

$$\begin{aligned} c_{\text{air}} &= 1,00 \text{ kJ/Kg} \Rightarrow Q = m_{\text{air}} \cdot c_{\text{air}} \cdot \Delta T \\ &= 1.2 \times 10^{-3} \times 1,00 \times 10^3 \times (30 - 23) \\ &= 8.4 \text{ J} \end{aligned}$$

↳ To cool 1 L of air from 30°C to 23°C, the heat transfer needs to be of 8.4 J

$$T_p = 10^\circ\text{C} \quad T_f = 23^\circ\text{C}$$

• heat transfer coeff of air (based on lab 5):  
 $h_{\text{air}} = 100 \text{ W} \cdot \text{m}^{-2}$

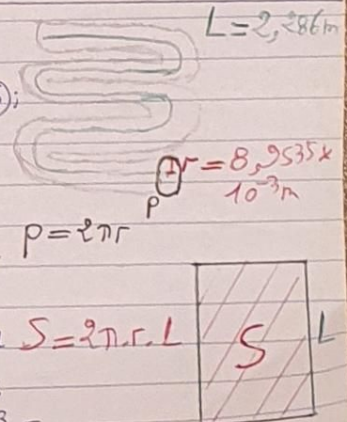
$$\Phi = h_{\text{air}} \cdot S \cdot (T_f - T_p)$$

$$\begin{aligned} &= 100 \times 2\pi \times 8.9535 \times 10^{-3} \times 2.86 \\ &\quad \times (23 - 10) \\ &= 167,183 \text{ W} = 167,183 \text{ J} \cdot \text{s}^{-1} \end{aligned}$$

• Time spent by 1 L of air in the system:

$$t = \frac{Q}{\Phi} = \frac{8.4}{167,183} = 50,244 \times 10^{-3} \text{ s}$$

$$\text{• Target speed of air: } v_{\text{air}} = \frac{L}{t} = \frac{2.86 \times 10^3}{50,244} = 45,5 \text{ m} \cdot \text{s}^{-1}$$





**Prototype 3**  
*Final Design*



# Air Inlet

## **Function:**

Allows external air to enter into the system

## **Features:**

Manual adjustable shutters

Slanted top

Easy to manufacture

## **Material:**

Sheet metal



# Chamber Box

**Function:** The chamber box contains the inner pipe and is buried 6ft underground. It is the intermediate between the air inlet and the furnace blower at the house.

## Features:

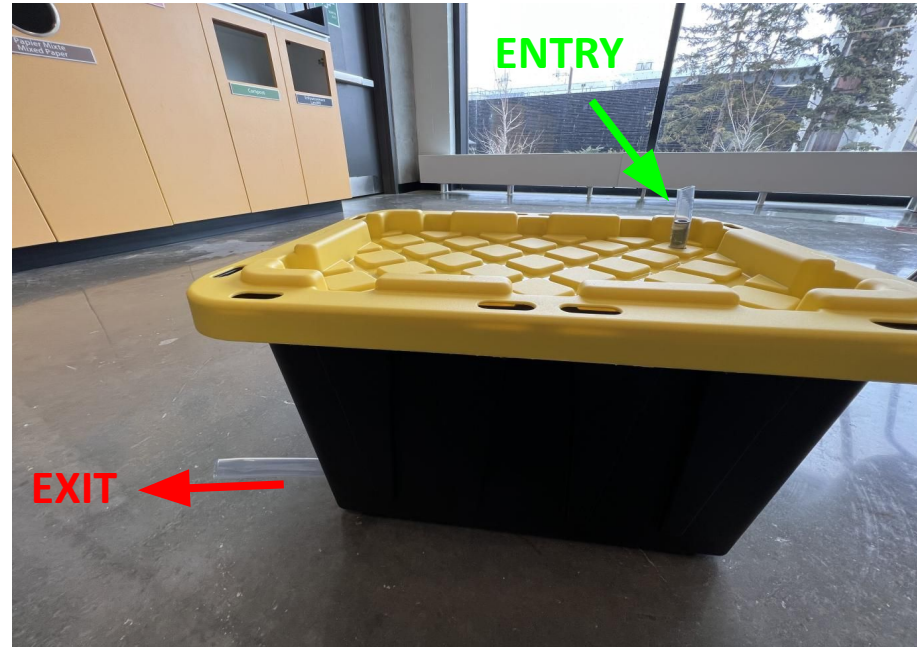
Insulated

Light weight

Adjustable enclosure with lid

## Material:

Plastic box



# Inner Pipes

**Function:** Air circulation is enclosed inside the box and heat exchange process occurs

## **Features:**

Use of zip ties: Holds in position

Prevents rotation of joints

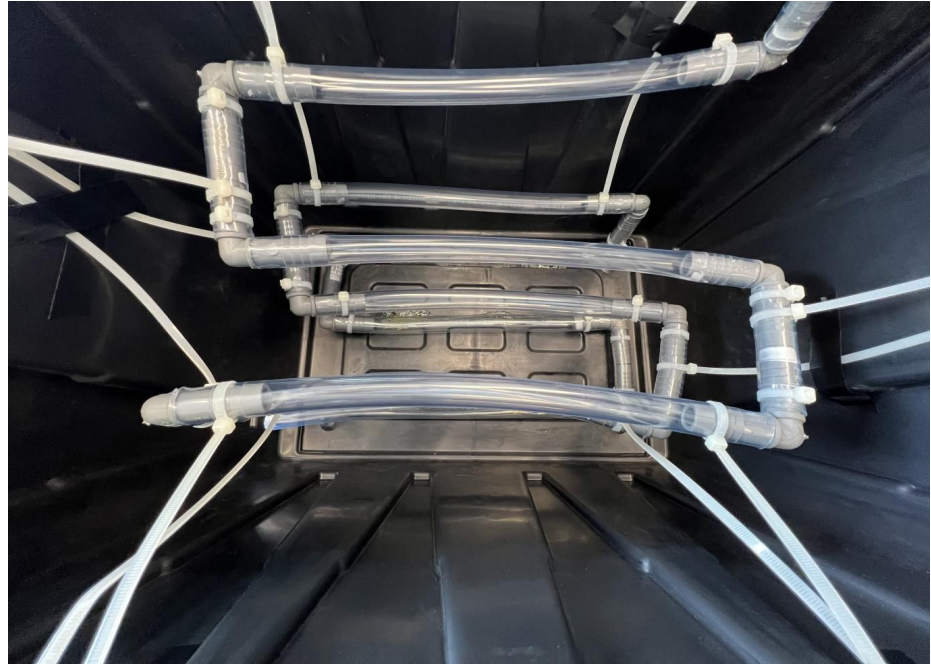
Seals leaks around the joints

## **Materials:**

0.75" diameter vinyl pipe

17 elbow joints

18 zip ties





# Outer Pipes

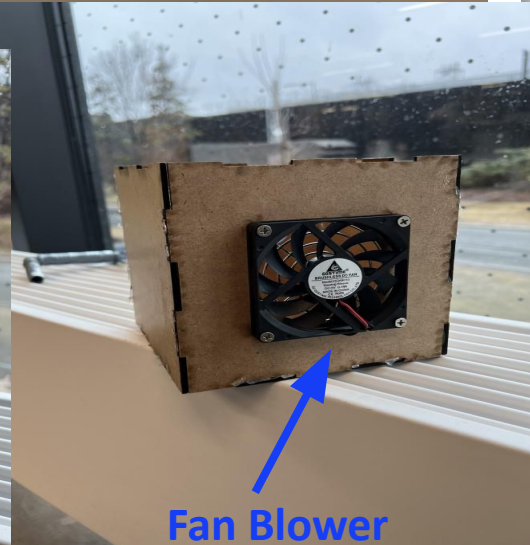
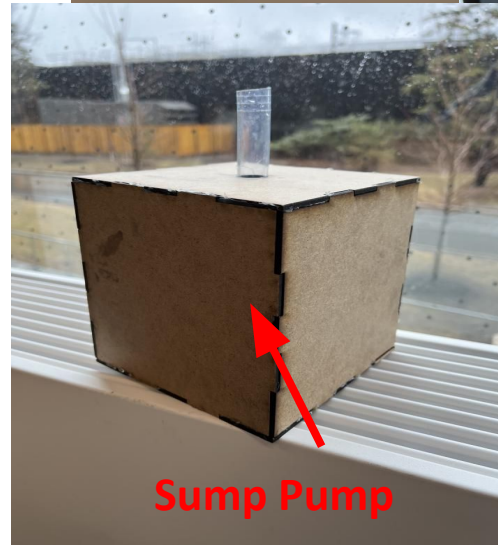
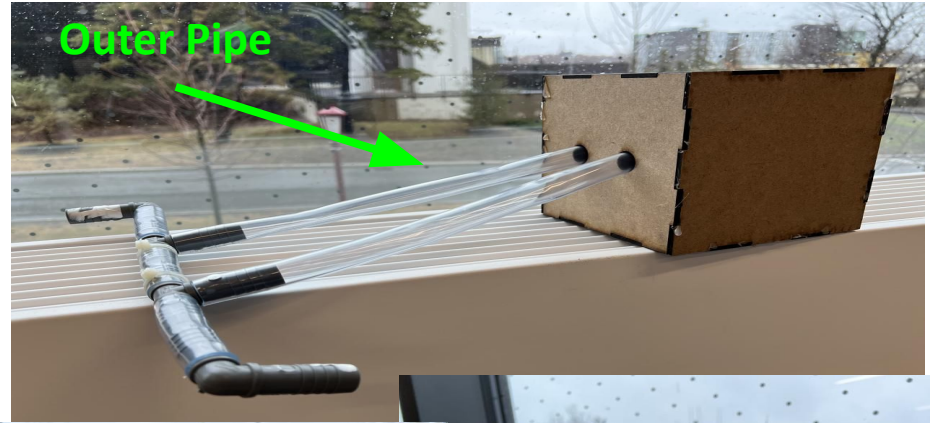
**Function:** Deliver the heated or cooled air to the furnace blower

**Features:**

- Connection from chamber box to house
- Connected to sump pump to remove condensation

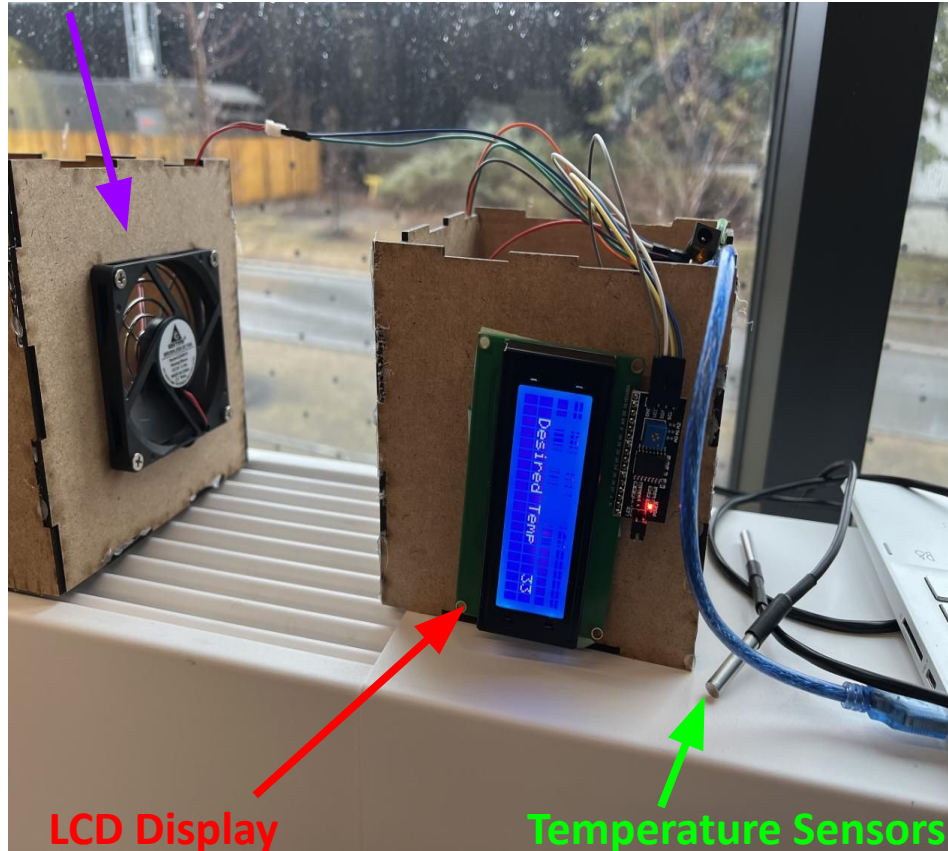
**Material:**

- 0.75" diameter vinyl pipe
- 2 elbow joints
- 2 T Joints

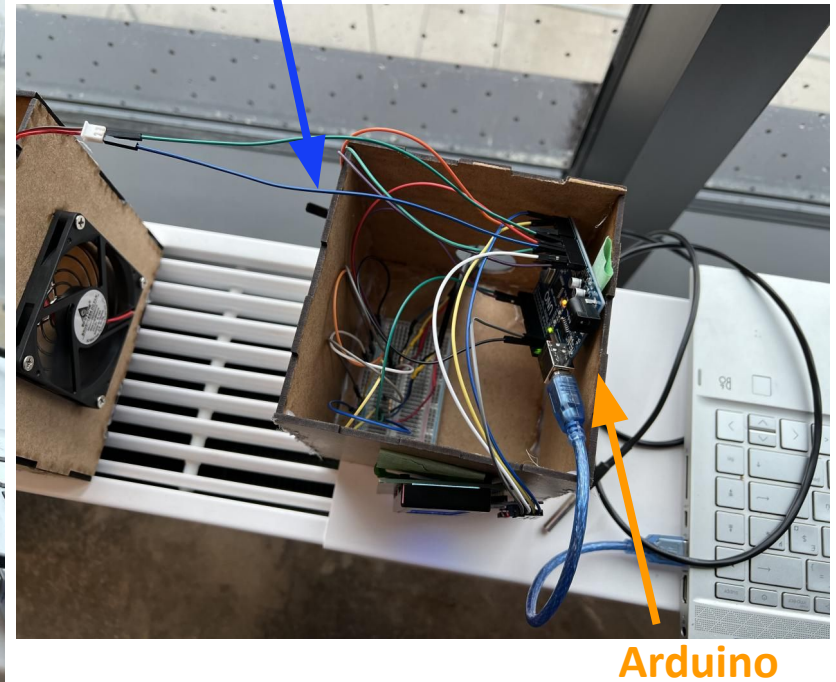


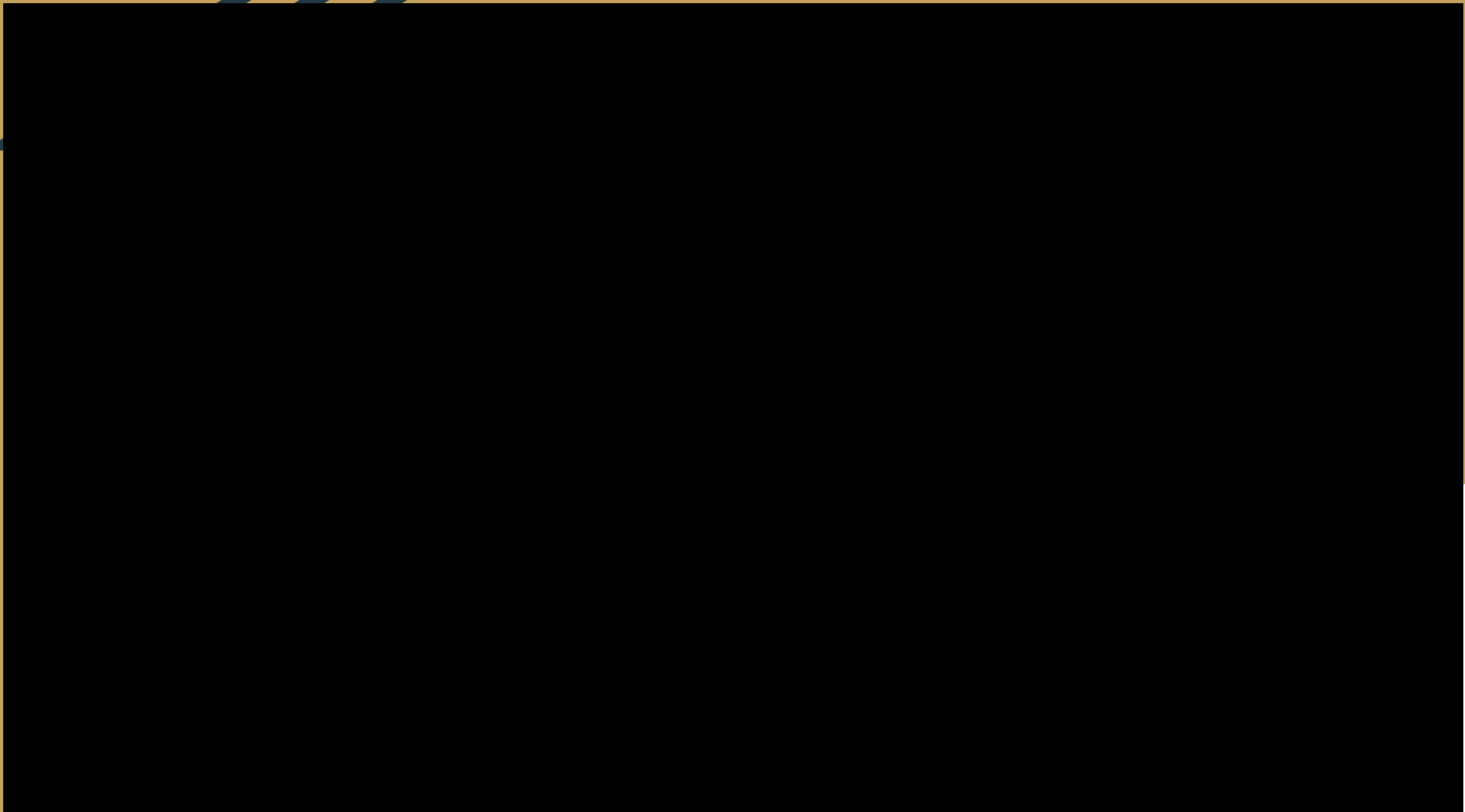
# Furnace Blower and Electronics



Fan



Potentiometer



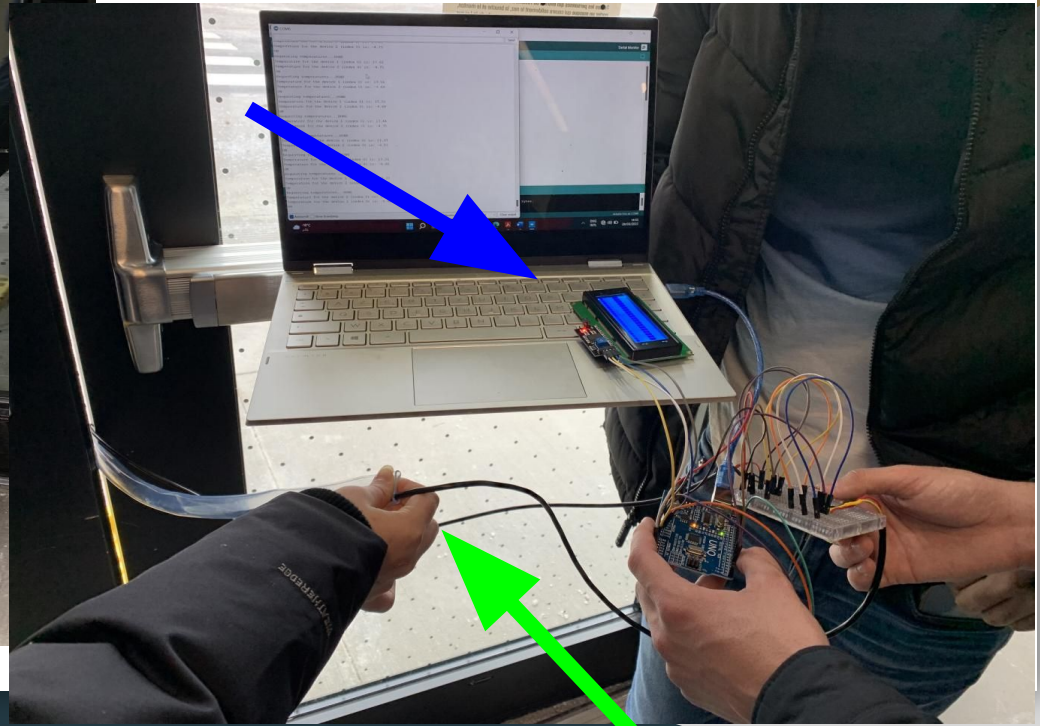




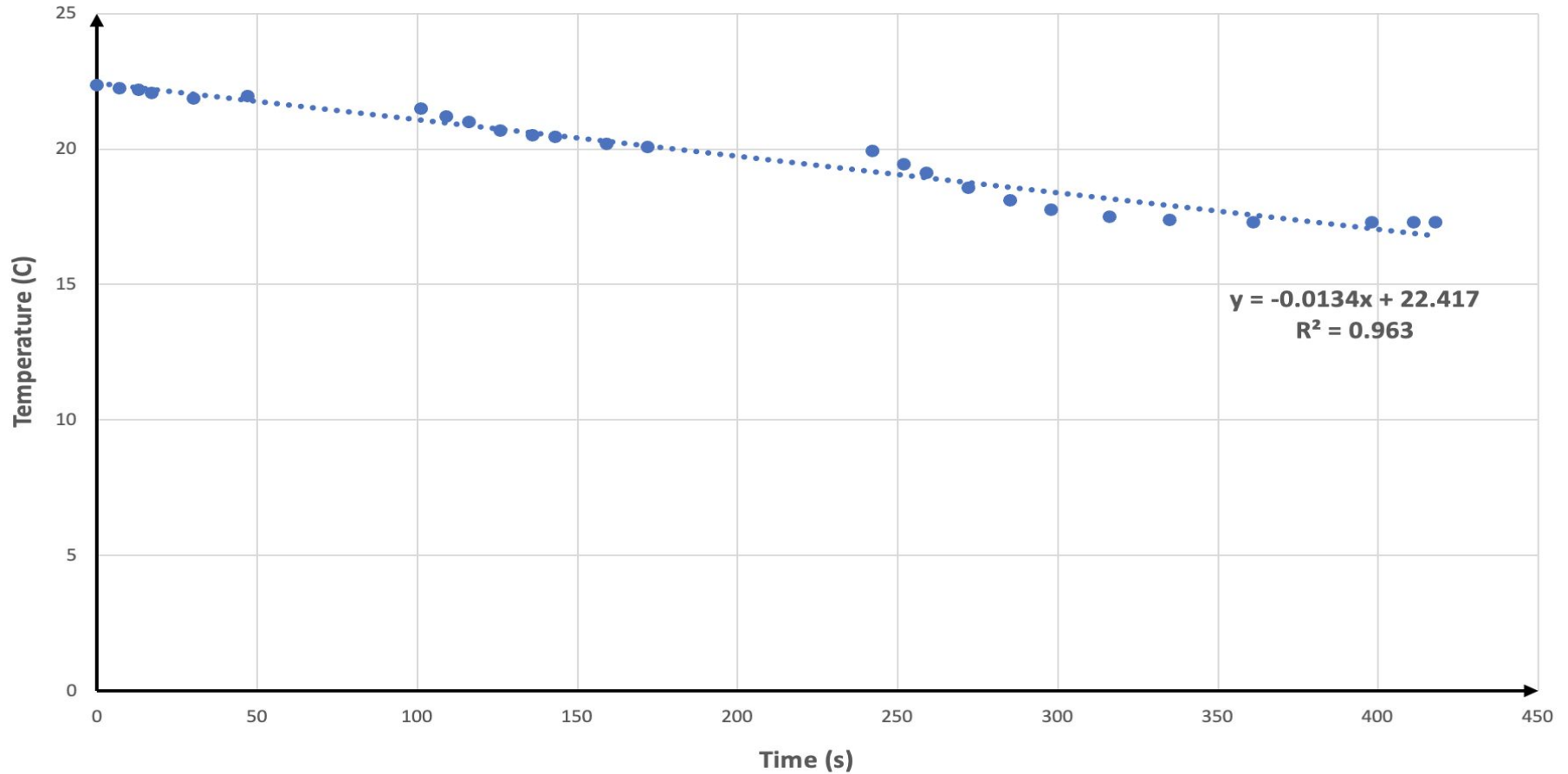
# Final Testing

# Testing Process

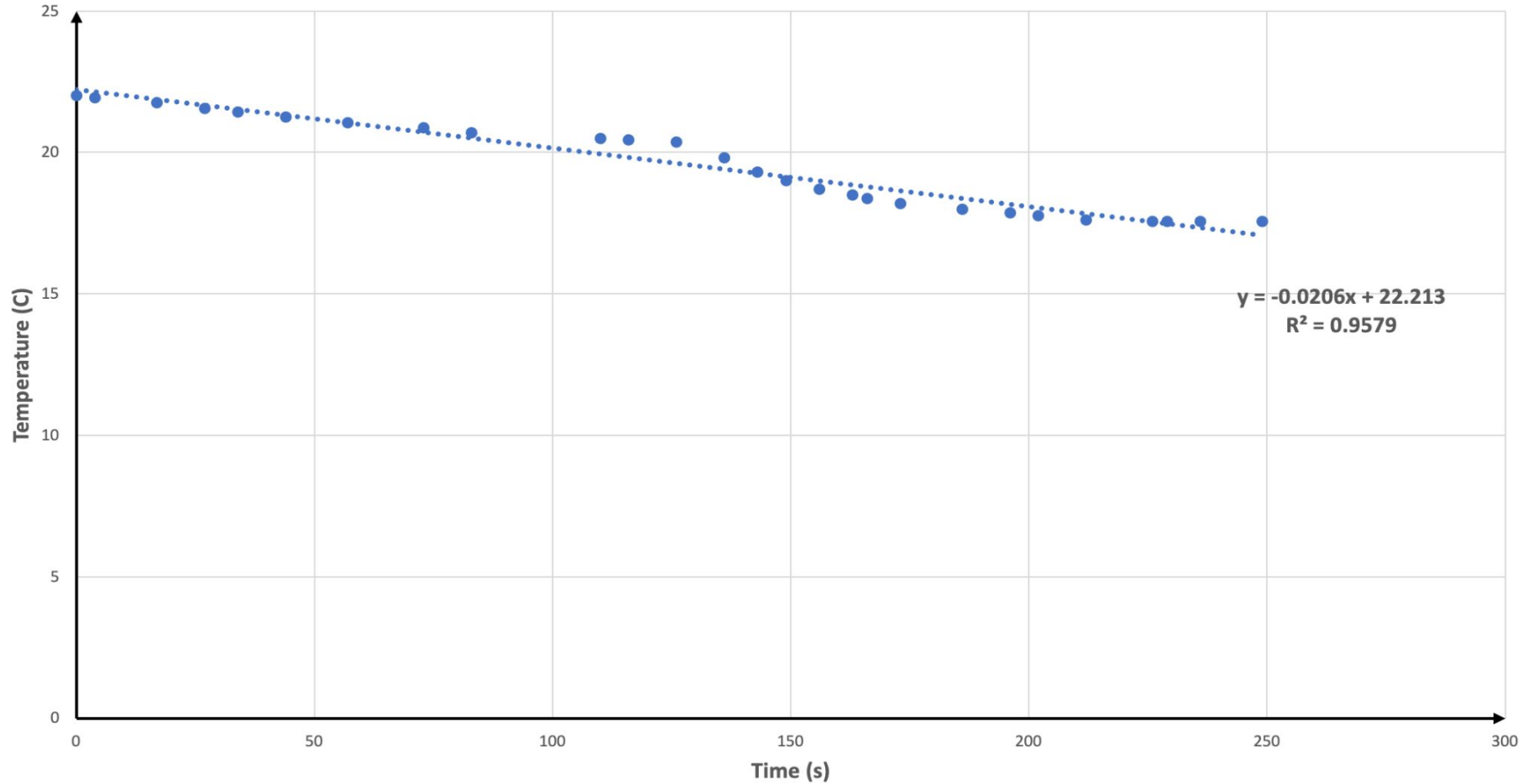
Is the designed system capable of cooling the house?



## Test 1 of Piping system for Cooling: Variation of Temperature with Time

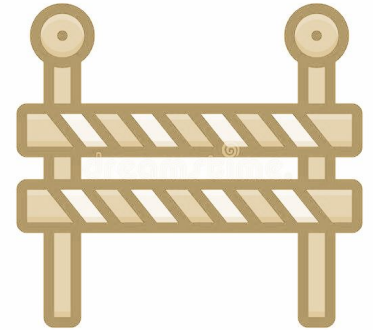


## Test 2 of Piping System for Cooling: Variation of Temperature with Time



# Obstacles

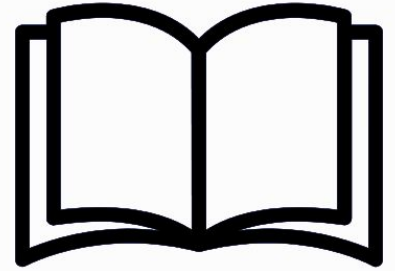
- Uncertainty of the project at times
- Time/group management problems
- Choice of materials
- Electronics: Wiring/Fan





# Lessons Learned

- How to manage time better
- How to work better with group
- Divide group tasks
- Manufacturing designs
- Using Design Process





Questions???

