Deliverable F

uOttawa

GNG 1103

Group D-1.4

Names :

- Callum Bunston

- Yousef Hemdan

- Yassir Mechahouri

- Mohammad Rasheeq

- Yosr Ouali

- Jiahao Sun

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INTRODUCTION

After the conceptualization of a detailed design, the team has presented the work to the client. This second client meeting allowed us to clarify specific details based on his feedback and comments. In particular, the discussion helped to modify certain aspects valued in accordance to the client's needs such as electrical components, type of materials, budget constraints, piping system and dimensions. The goal of the deliverable F is to analyze these feedbacks and improve the detailed design, build a first prototype and document its outcome/result, and finally, outline a prototyping test plan for the second prototype.

Analysis of Client Feedback on the Detailed Design:

1. Despite the low thermal conductivity, the client rejects both of our propositions of aluminum and copper piping and prefers PVC piping instead due to its affordability and sustainanbility.
2. The client does not understand our inner pipe configuration and how it will be fitted inside the chamber. A new representation will have to be updated in the detailed design.
3. There needs to be some calculations involved with the sizing, thickness and placement of pipes.
4. Regarding the shutters, the client prefers the second option which works via a power supply but is not automated. The client isn't looking for any sophisticated technology.
5. Client did not approve the proposed coiled piping configuration as the coiling can be a complex process. The options to explore are either a horizontal or vertical piping system which is simple to design.
6. There needs to be some way to support/anchor the shutters on the inlet and how they will be held up or closed.

Analysis of critical components:

Air Inlet: The air inlet is where the outside air is received. There will need to be a slot design that can be opened and closed manually. The design of the top must be slanted for the snow to deflect. The height of the inlet is also to consider as we don't want it to be buried in snow at a low height. The height will have to be adjusted with an outer pipe that is connected to the top of the chamber box. The pipe will have to be insulated/air proofed at the connection to the bottom of the inlet.

Chamber box: The rectangular box buried 5ft underground will have 2 pipe entry points/holes: one on the top that receives the air from the inlet, and the other on the side that delivers the heated air to the furnace blower. Each entry will have to air/water proof sealed as pipes are connected to the entry points.

Inner pipe: The inner pipes are located inside the chamber box where the air circulates as the energy exchanges. Calculations are required to determine the number

loops/layers to be configured and the length of the pipes as well as the diameter which will influence the air flow. There has to be some mechanism that holds the pipes inside the box.

Outer pipes: The outer pipes consist of one pipe that connects the inlet to the top of the chamber box. Another set of pipes that are connected from the side of the chamber box to the furnace blower of the house. There should be 3-6 pipes that are connected to the house.

Test Plan of Prototype 1 :

Objective: The focus of prototype 1 is to verify/confirm the dimensions. This will allow us to get a visual of how all the systems will interact once assembled.

Design concept to be tested: The dimension and scale of air inlet, outer pipes, inner pipes and chamber box.

Testing method: A physical prototype made out of cardboard and duct tape will be built based on the metric on the detailed design. The test involves exploring a few sets of dimensions and deciding on the most reasonable scale in order to determine where some amount of materials can be reduced. There will also be an evaluation on the stability of the structure by adjusting some metrics to ensure all the subsystems are fitted properly.

Results:

Components	Dimensions
Inlet box size	10 In x 10 In x 16 In
Shutters / Air entry slot size	8 In x 4 In
Diameter of all pipes	1.5 In
Outer pipe length from inlet to chamber box	25 In
Chamber box size	2ft x 1.25ft x 1.25ft
Inner pipe length without joints (1 layer)	Roughly 20-22 inches per pipe

Analysis From Prototype 1:

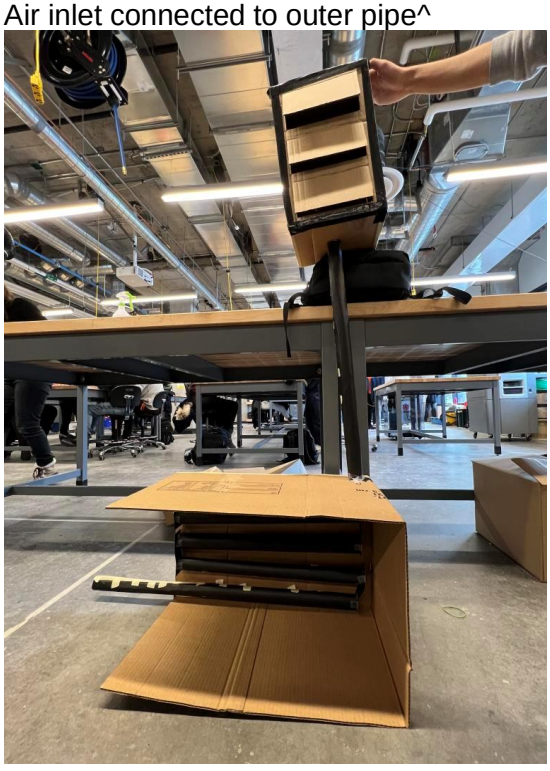
1. The air inlet size appears to be bigger for no reason. It has been decided to reduce the size to 10 In x 10 In x 10 In on the 2nd prototype.
2. The shutters/slots of the inlet will be modified to a single slot rather than 3 as the number of slots don't bring any benefits.
3. The shutters will be modified to a door like system which can be easily closed.
4. The height of the outer pipe connecting the air inlet was accepted and will be kept at 10 In. With this height, snow accumulation won't cover up the inlet.
5. A slanted roof will be added to the inlet for snow/rain to deflect off of.
6. The chamber box has been reduced to 1:2 scale and is accepted.

7. The pipe diameters will be kept at 1.5 In as this allows appropriate space for the elbow joints to be fitted at each turn.
8. Pipes are configured vertically with 5 layers with the last layer of pipe being the outer connection to the furnace blower. This configuration works and fits all the piping well within the chamber box.
9. To run on a low budget, the elbow joints on the prototype were represented as strips of papers connecting the intersecting pipes. Papers or any cheap materials do not bend like an elbow joint so they will be integrated in the inner pipes at the next prototype which will be used in the final product.

Photos of prototype 1:

Air inlet connected to outer pipe^

Inner pipes inside chamber box^



Representation of the whole THEC system ^

Test Plan of Prototype 2:

Objective and concepts to be tested: The focus of prototype 2 will be to test out the electrical/electronic components of our design and their integration into the design. The overall goal is for the electrical and physical components to be combined and work effectively. In addition to this we will work out the functionality of our pipe system and get a better real life testing of the system's capabilities.

Testing method:
For the next prototype, there are various aspects we need to look at. This first prototype having the sole purpose of testing the dimensioning of the different parts, it does not allow us to perform technical tests of the system. First of all we want to look at the relationship between the diameter of the pipes and the airflow. We got to verify if the configured pipes can deliver an airflow efficiently to the house without too much resistance or leaks. Indeed, we want to test if the diameter we have chosen makes it possible to ensure sufficient airflow for thermal transfer, especially by convection and advection. In addition, for our next prototype, we need to test the effectiveness of the heat transfer by conduction between the heating chamber and the pipes, then between the pipes and the air is effective. Once delayed this will show us if we have made the right choice for materials but also for the diameter (contact surface with the pipes depending on the diameter). Also, we need to test our inlet technically because one of the remarks that has been done about this first prototype is that it feels that the inlet is unnecessarily great. The shrink could allow us to save materials, even if you have to ensure the good airflow. Finally, we need to test the entire electric / electronic part (temperature sensor/ fan blower) that we could not test in the previous prototype. The fan blower will be represented with a LED.

Stopping criteria: We will stop development on prototype 2, once we feel as though our objective has been effectively met, and we have no needed changes to the design. Once reviewed objectviley by the team and accepted feedback from others, we will see that the prototype is done.