Conceptual Design

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1 Introduction

This document will provide descriptions on our group's greenhouse design. It will first include a subsystem breakdown that will help define the overall structure and importance of individual elements of the greenhouse. Then, each group member's proposed greenhouse design will be presented. Specific design constraints, measurements, and the pros and cons of each design will be identified. Finally, one final design will be compiled based on the 5 designs presented.

2 Subsystem Breakdown

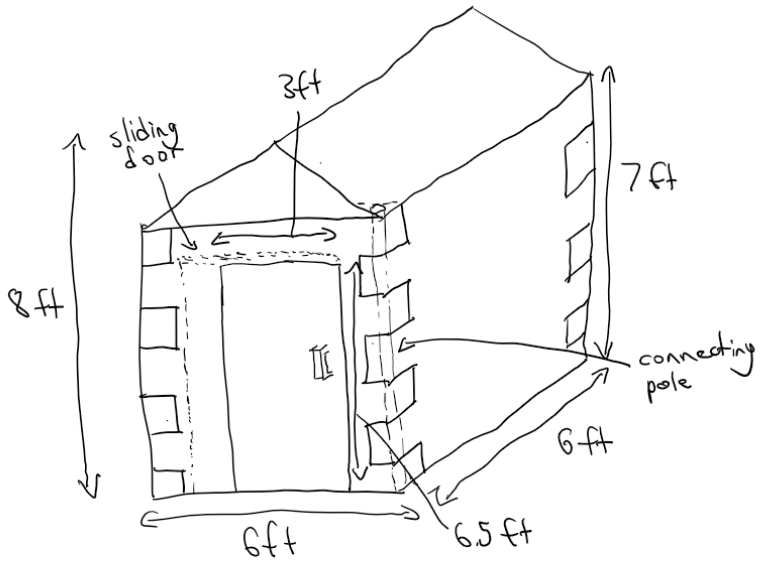
The greenhouse structure consists of the following subsystems: the roof, the skeleton/walls, the unit connectivity, and the floor. The roof needs to be able to compensate for Ottawa's climate and adapt to the addition of new units so that rainfall or snow does not build up in the crevices between rooftop members. This can become tricky as the stability and cost of the roof will become undesirable if the design is too complex. The walls need to be properly insulated such that the internal temperature is kept constant; the temperature inside cannot be exposed to cold external temperatures. The greenhouse needs to be modular and expandable, therefore unit connectivity must be incorporated somehow into the greenhouse design; that is, how are units connected, how are individual greenhouse units accessed through each other, and how will other subsystem designs be affected by the unit connectivity. Finally, the floor needs to be sturdy and reliable for maintaining the weight of the other subsystems and for any interior additions such as plants and the hydroponics system.

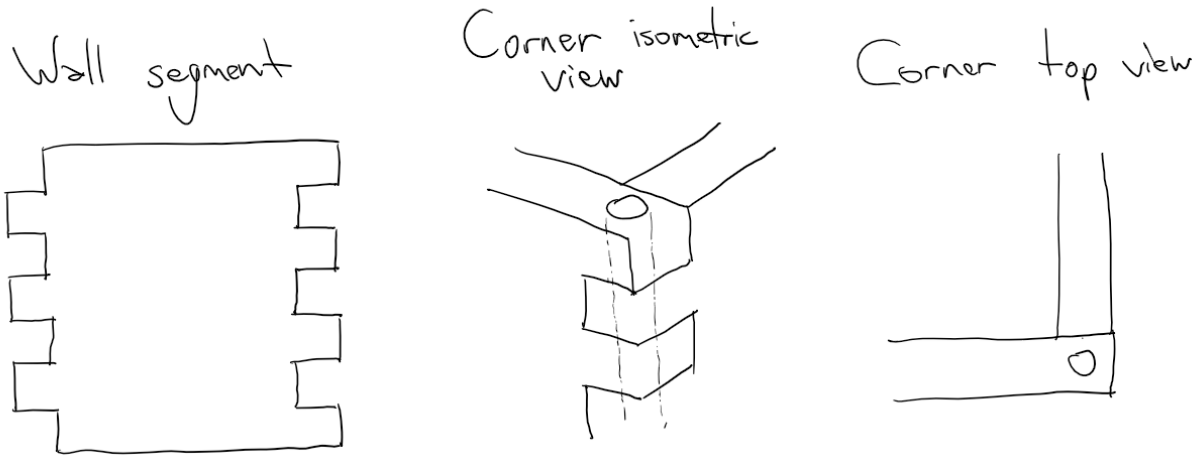
2 Individual Greenhouse Sketches

The following greenhouse designs are for the house location.

2.1 Jason's Design

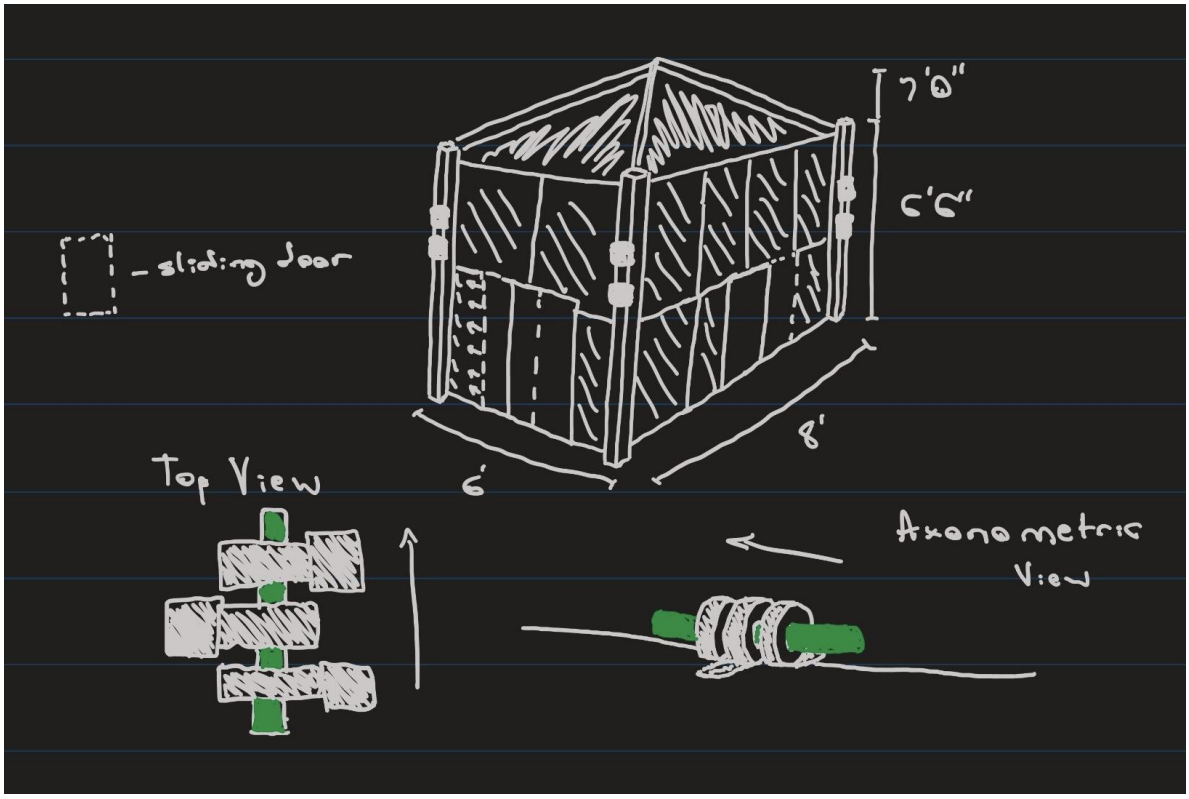
This design consists of an entire plexiglass design with a 6x6 foot base and a height of 8 feet (including the roof). Each of the wall segments is 7 feet high, 6 feet wide, and 3 inches thick. One of the wall segments features a sliding door which measures 6.5 feet tall and 3 feet wide. The wall segments are connected via an interlocking design which is secured by a pole that runs through the entirety of each wall segment.





2.2 Jacob's Design

The greenhouse design consists of wood frames and polycarbonate window material. The greenhouse is accessed by 4 sliding doors, one on each of the four walls. Greenhouse units are connected by a wooden latch structure in which a wooden shaft is slid into the hollow cylinders to keep the structures from separating. The structure is 6 feet wide, 6 feet in depth, and 7 feet tall at the highest point of the roof.



Pros

- Units are easily expandable.
- Easy unit locking mechanism
- Fairly spacious
- The sliding door won't require interior space to open compared to a sweeping door.

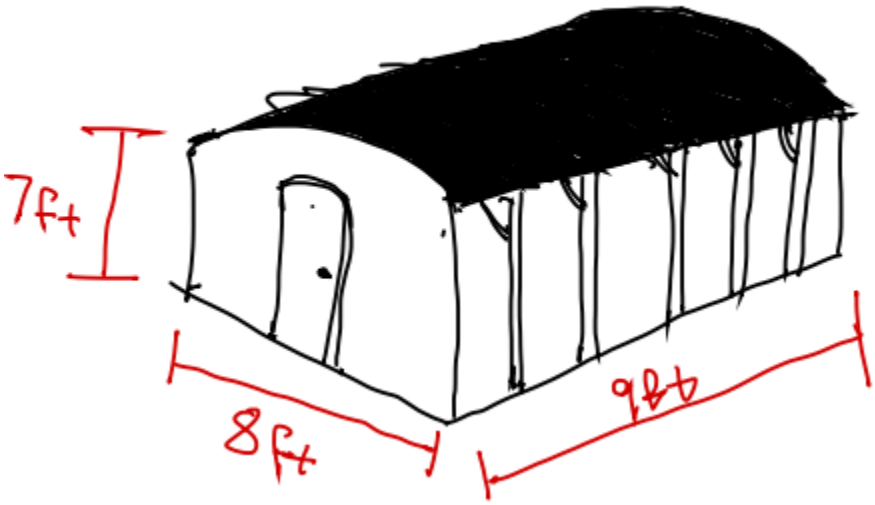
Cons

- The roof may become an issue once multiple units are connected together.
- The wooden latch system may become an issue. The wooden pole is working against Gravity and may fall through once it becomes weathered or shrinks in cold temperatures.
- Polycarbonate is a type of plastic and is the less preferred material of use as said by the client.

2.3 Feyi's Design

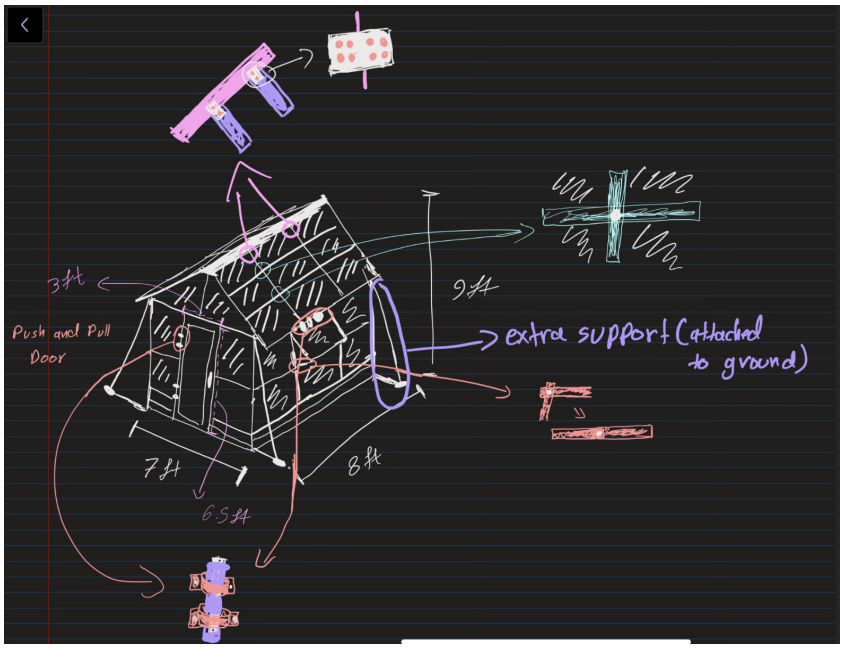
This design is a 9ft length by 12 ft breadth and 7ft height. The greenhouse is made from double-pane tempered glass for better control of the temperature. The building also has steels as the columns which connect to the ceiling of the greenhouse. There is one door for access at the front. An advantage of using glass is that it is durable, easy to clean and can regulate temperature very well. Additionally, the glasses at the two ends are built in a way that can be

detached if they need to expand. On the other hand, the material is quite expensive and if it is not double-pane, the temperature cannot remain constant .



2.4 Joudi's Design

The greenhouse is made of a aluminum alloy frame that supports the entire structure. It also has a 0.8 ft base for extra support. UV-fighting a polycarbonate sheet helps keep plants, vegetables, and flowers safe from rough weather while allowing natural light to pass through. The door is a push or pull door that is 3x6.5 ft. The greenhouse is 7x8 ft and 9ft long, and has 2 windows that are also push and pull.



Pros

- simple design
- supported for rough weather
- Triangle-shaped roof that is stable, more robust and ensures perfect water drainage.
- UV-fighting sheets that keep plants, vegetables, and flowers safe from rough weather while allowing natural light to pass through.
- easy handling push or pull doors.

Cons

- polycarbonate is a less preferred material for the client
- might be a little heavy

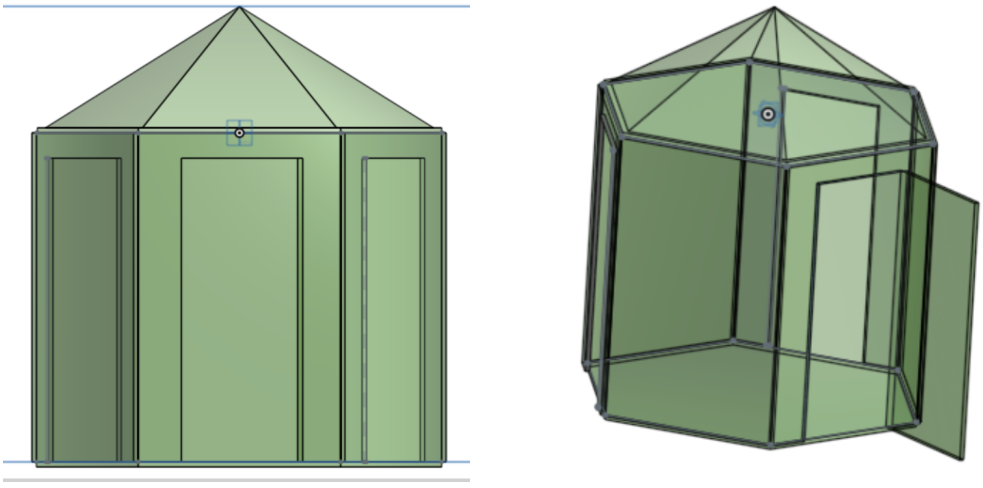
2.5 Pablo's Design

The greenhouse consists of an hexagon-shaped structure for which the apothem and sides all are 4 ft long. It spans an area of 48 ft^2 and a height of 9 ft. The greenhouse can be accessed by three entrances with single 6 ft tall doors opening in and out and it can be attached to other identical units by assembling the aristas resembling a bee hive.

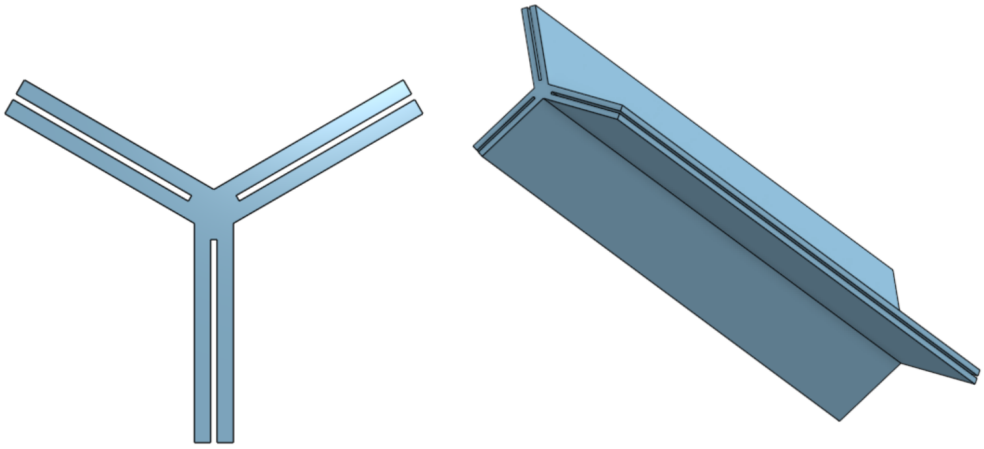
The glass walls and roof are made out of polycarbonate glass, since it has a better price-efficiency ratio than other materials for glazing.

The raftering for the sides can be done by sliding the window panels into a three way metallic joint that will leave a third empty spot for possible expansion. However if a client does not wish to expand their greenhouse, it can be installed only using two-way joints.

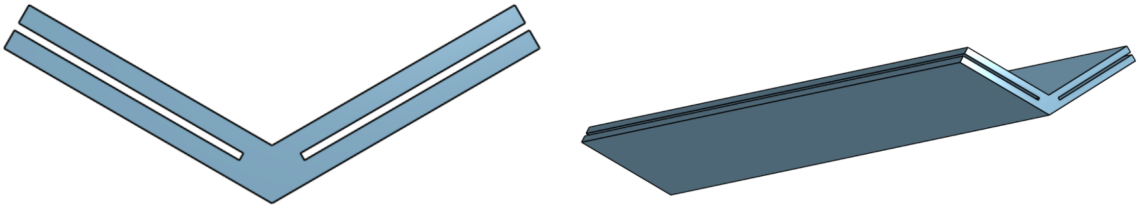
The floor can be just plain gravel to allow drainage for spilled liquids.



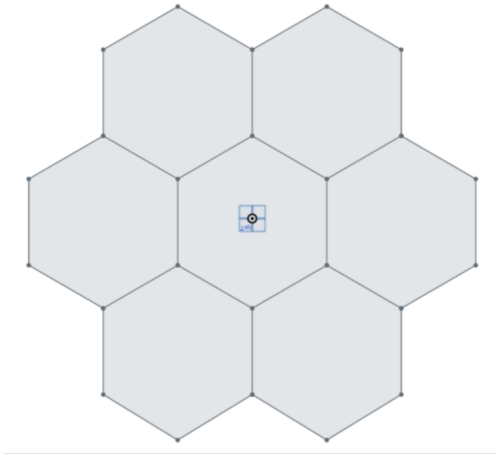
kiosk design of greenhouse



3-way joint



2-way joint



aerial view of attached greenhouses

Pros

- Relatively simple design
- Versatile
- expandable
- multiple entrances

- lightweight, durable and low maintenance glazing.
- More light is diffused than other glasses when the sun rays strike it, benefiting plant growth. At the same time, harmful UV rays from the sun are broken, protecting the plants inside.

Cons

- If possible expansion is wished, the third side of the joint sticking out of the structure might pose a hazard.
- Scratches on the polycarbonate are not easy to get rid of
- Replacing polycarbonate is not as practical as replacing glass since its acquisition is not very straight-forward.
- Polycarbonate is a synthetic material, which is not ideal for the client's preferences.

3 Final Greenhouse Design Selection

Our final greenhouse design will consist of Pablo's hexagonal greenhouse structure including the joint connectivity that was proposed. This design is easily expandable and is easy to access between greenhouse units. The design will maintain Pablo's specific dimensions: 9 ft in height, 4 ft long sides, 48 ft^2 area, and 6 ft tall doors. For this design, a sliding door will not be ideal as there is little space for the door to move, therefore a regular sweeping door will be used. Doors will be made easy to remove so that access is easier between connected greenhouse units; we don't want the users to be constantly opening doors between sections. The material for the windows will be made of plexiglass rather than polycarbonate as the client does not want synthetic materials in the design. The roof will be triangularly shaped with some pointed vertice such that light diffusion is efficient for the plants and rainfall will slide down the roof to avoid a buildup of water. The final design will also incorporate Joudi's idea to have a base with an extended height of 0.8 ft for extra support. The floor will ideally be made of a smooth stone material such that shelves can easily be placed without the worry of imbalances that would come with having a rough floor like gravel.

4 References

1. *Glass vs polycarbonate greenhouse - which glazing is better?* Greenhouse Emporium. (2023, January 13). Retrieved February 12, 2023, from https://greenhouseemporium.com/blogs/greenhouse-gardening/glass-vs-polycarbonate-greenhouse/

2. *Greenhouse building materials: Should I choose glass ... - dengarden*. Dengarden. (n.d.). Retrieved February 13, 2023, from https://dengarden.com/landscaping/greenhouse-glass-guide