

GNG 1103
Design Project User and Product Manual

Pikwakanagan Guardianship Building Design

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List of Acronyms and Glossary Stella

Table 1. Acronyms

Acronym	Definition
B.O.M.	Bill of Materials
MDF	Medium Density Fileboard, used for LaserCutting
PLA	Polylactic acid, thermoplastic monomer derived from renewable, organic sources used for 3D printing
CAD	Computer Aided Design
3D	Three-Dimensional
HVAC	Heating, Ventilation, and Air Cooling System
UPM	User and Product Manual

Table 2. Glossary

Term	Acronym	Definition
AutoCAD		Computer aided design software used to design the early floor plans of the building.
OnShape		Another computer aided design software, used to create and share the 3D models of the building.
Environmental Monitoring Building	EMB	The building that we designed for the Guardian Program of Pikwakanagan. Used to monitor the environment.

1 Introduction Eli

This User and Product Manual (UPM) provides the information necessary for employees to effectively use the Environmental Monitoring Building (EMB) and for prototype documentation. The EMB is a building designed for the Pikwakanagan First Nations to monitor the effects of industrialization on the flora and fauna on their land and to practice their tradition.

The UBM is structured into 7 sections: Introduction; Overview; Getting Started; Using the System; Troubleshooting & Support; Product Documentation; and Conclusions & Recommendations. The UBM will begin with the Overview which will explain the problem the design solves and why it is important. Then it will continue with the Getting Started section to provide a general walkthrough of the system from setup to exit. This will be followed with Using the System, giving a detailed description for each user function. Troubleshooting & Support will follow to identify procedures for error correction and recovery. Product Documentation will give an in-depth explanation of how the final prototype was built, including design considerations and calculations. Finally, Conclusions and Recommendations will summarize the lessons learned from developing the prototype as well as the work related to the prototype.

Assumptions for the work include: assuming that HVAC, power, plumbing, and internet will be dealt with by a professional so they are not included in the prototype or budget; and the space where the EMB will be built will be flat and have unlimited space.

2 Overview Stella

The customer is looking for a culturally-inspired area where they may produce natural plant treatments and do research to safeguard the environment and track industrialization. Ten temporary employees and up to five permanent employees will work in the space. One of the building's features is a mobile plant processing station that can be moved in a computer lab-style space. The structure includes cargo docks, security measures, and elder accessibility. Outside, there is an area for processing fish and moose, storing snowmobiles, and holding cultural events. The problem is very important as it allows us to fully understand what the client needs. The design was fully based on the problem and how all the different subsystems and aspects of the building allowed us to solve this problem.

The user greatly valued community involvement, sustainability and cultural representation. The client also wanted us to ensure that we made the building large enough and include enough offices for future expansion of the program. The client was looking for a building that was capable of plant processing and environmental monitoring, this included a large lab space. The client wanted a large space to hold cultural gatherings, as well as having a space to clean animal hides.

There are some different considerations we made when designing our building that sets our product away from other groups. The bathrooms are spaced throughout the building to minimize travel time for any given person within the building to get to them. Every aspect of the building was tested with a scale model of a person to ensure the space was used effectively and everything was the right size. The lab benches and shared workspace tables can be moved to make a large space for gatherings and cultural activities. The building has three entrances. Every office has a window so that there are two ways to exit during an emergency. The roof is slanted to let snow fall off, and there are solar panels to reduce the carbon footprint of the building. The building is one story, which reduces building costs as well as heating costs, leading to a lower operating cost. Furthermore, it makes every room in the building wheelchair accessible by default. There are 14 offices, which takes into account the expansion of the guardian program within the next few years. This is at the request of the client during feedback sessions.

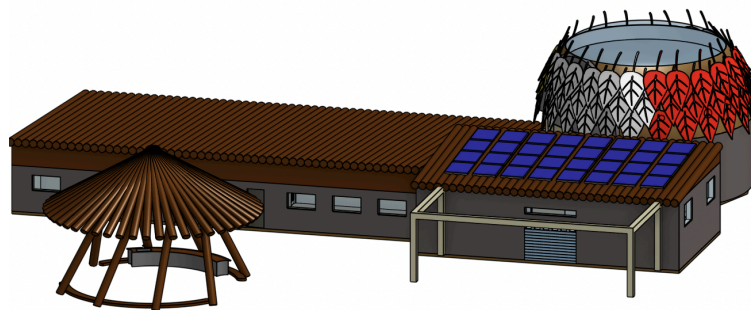


Figure 1 - Analytical Prototype Outdoor View

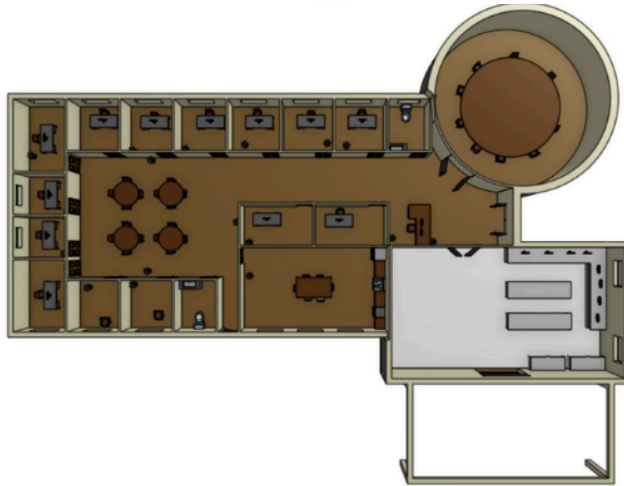


Figure 2 - Analytical Prototype Indoor View



Figure 3 - Physical Prototype Indoor View

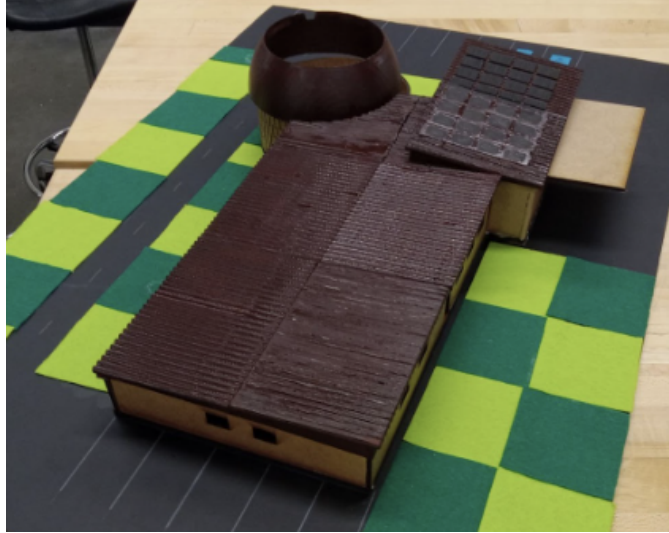


Figure 4 - Physical Prototype Outdoor View

The building has many key spaces that are fundamental to the function of the building while incorporating the needs of the client. The building includes an outdoor gazebo that can be used for cultural gatherings as well as for cleaning fish. The large lean to outside of the garage that leads to the lab, can be used to hang large moose hides as per requested by the client. The large lab space had room for many employees to work on computers as well as at the movable plant processing stations, this ensures that the guardians can sample and test different specimens from the environment. The communal work space can be used for indoor community gatherings by moving the tables out of the way.

The analytical prototype was created in outCAD this as well as onshape. The physical prototype was created using 3D printing and laser cutting. The laser cut portion is rastered and vectored on MDF, the 3D printed roof is done with PLA. If the building were to be realised the roof would be made out of repurposed treated wood. The foundation and walls would be made out of formworked concrete to conserve the amount of oil during manufacturing. We've also included forty-eight solar panels as well as a water collection system.

2.1 Cautions & Warnings

During the creation of the physical prototype one thing we didn't expect was the amount of time that the 3D printing would take. We also didn't realize that we would have to print our roof in seven different pieces, keeping this in mind if we were to do thi again we would insure to start the 3D printing slightly earlier within the production.

3 Getting started

This project consists of two main prototypes, one is a comprehensive analytical model, the other is a focused physical prototype. This section covers the configuration considerations, user access considerations, setup, navigation, and exiting subsections.

The physical prototype is assembled from three pieces, can be used to show the building in the context of the outside area, and can be disassembled to be stored.

The analytical model can be found on onshape, navigated like an Onshape resource, and exited by closing the Onshape tab in the browser.

Note: To access the editing permissions on the Onshape the user must request clearance from the owner (riley_heal000) this can be accomplished by direct messaging or email.

3.1 Configuration Considerations

The physical prototype is a blend of laser cut MDF and 3D printed PLA, mounted on a paper background. The laser cut base sits on the paper background, and the 3d printed roof sits on top of the base. Both the base and roof are made of several parts. Glue, files, and sandpaper are the only tools required for assembly.

The analytical prototype is a comprehensive CAD model of the entire project, hosted on the Onshape cloud computing service platform. The model includes an organised list of subsystems, each of which can be toggled on or off to appear in the viewbox. To view the CAD file, an onshape account is required, and an invitation to the document must be sent by the CAD file owner (Riley Heal).

3.2 User Access Considerations

The users of this prototype include interior designers, architects, the client, and financiers as well as the public in the Pikwakanagan community.

Interior designers and architects can use the CAD model for testing configurations and structural parameters. Interior designers are limited by the analytical model due to the fact that onshape does not have a furniture catalogue, and any models would have to be imported for testing. Architects are restricted by the analytical prototype as Onshape does not have an architectural testing suite, and the model would have to be exported to a third party software.

The client, financiers, and the general public of Pikwakanagan can use the physical prototype to better understand the scale and proportions of the building, as well as gain an understanding of

how the building impacts its surroundings. These users are limited by the physical prototype because it does not include the gazebo, nor does it include any furnishings.

3.3 Accessing/setting up the System

3.3.1 Physical prototype assembly

1. Glue the roof into one piece, according to the assembly in the analytical model.
2. Place the base of the model on a stable surface like a table or countertop

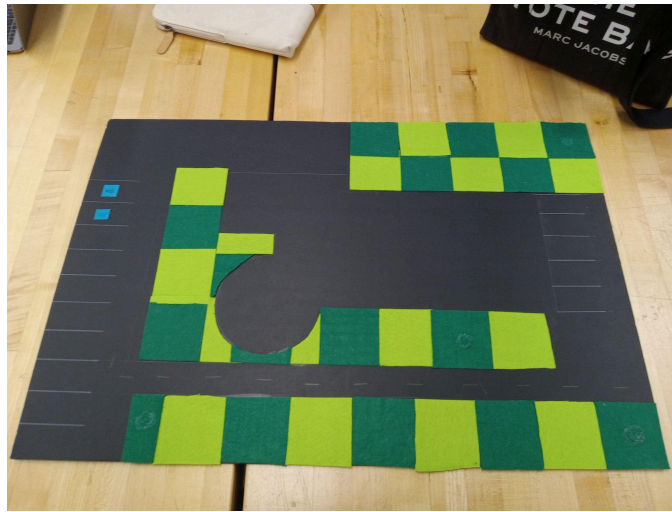


Figure 5 - Parking Lot of Physical Prototype

3. Place the laser cut portion onto the base

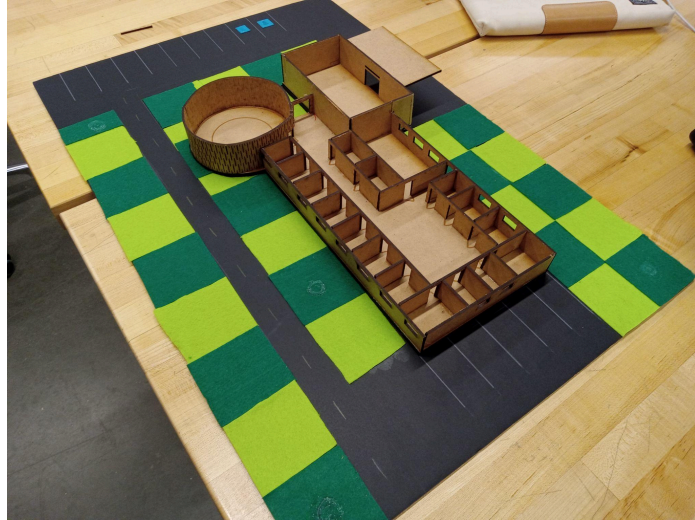


Figure 6 - Laser Cut Portion of Physical Prototype

4. Place the roof on the laser cut portion



Figure 7 - Full Physical Prototype Including Roof

3.3.2 Accessing Analytical prototype

To access the analytical prototype, acquire an onshape account and obtain an invitation to the document by the owner. Click on this link

<https://cad.onshape.com/documents/c5a52df02c5e85199e550400/w/ef66a0e65a7a3fbdcef7e63c/e/6d762fda8b443944d7034d79>

to open the file.

After doing this, you can navigate onshape using the file tree at the bottom to view individual components of the design, or use the view cube in the assembly to see the project as a whole.

3.4 System Organization & Navigation

3.4.1 Navigating the physical prototype

Base:

The base is connected to the bottom of the laser cut wall model using glue.

Laser cut wall model:

The laser cut wall model is below the roof.

Roof:

The roof sits above the laser cut wall model

3.4.2 Navigating the analytical model

Once the document has been opened in onshape, the file can be navigated like any other onshape model. There are two main ways to navigate in the viewbox: Using the view cube in the top left, click on the desired view to snap to it. Using the mouse, pan or rotate to view at any angle.

To navigate the sub-files, the file tree at the bottom of the window can be used to see part studios, reference material, STL export files, and more. For more information on how to navigate

Onshape, you can use the link provided to access free courses on how to use the software:

<https://learn.onshape.com/learn/course/fundamentals-navigating-onshape/getting-started/the-documents-page>

3.5 Exiting the System

To put away the model, store in a dry place.

To exit the Onshape model, close* the tab containing the workspace.

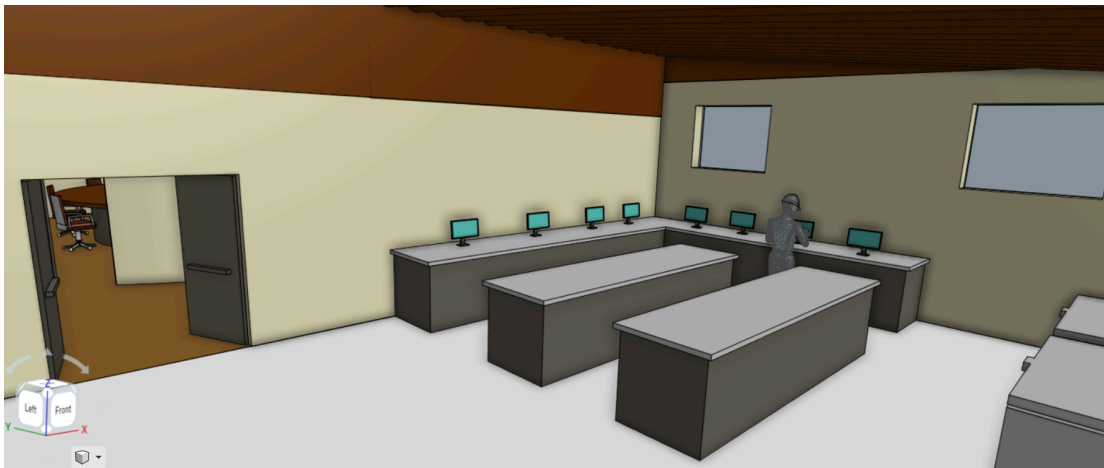
*Closing the tab on this program is harmless because the document is saved at all times, for other programs do not do this.

4 Using the System Novera

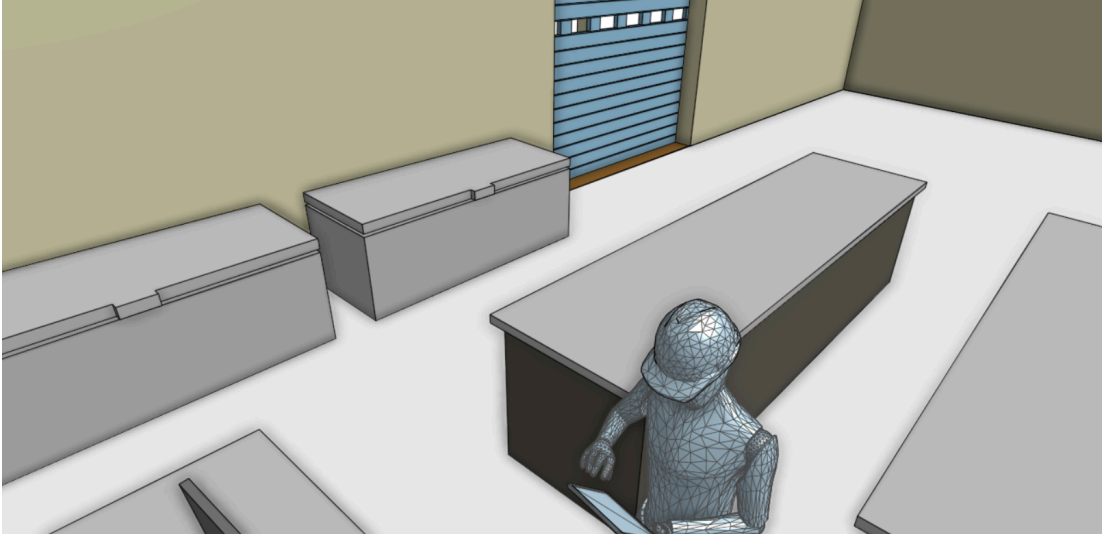
The following sub-sections provide detailed, step-by-step instructions on how to use the various functions or features of the Guardianship Program building.

4.1 Lab Space and Lean-to

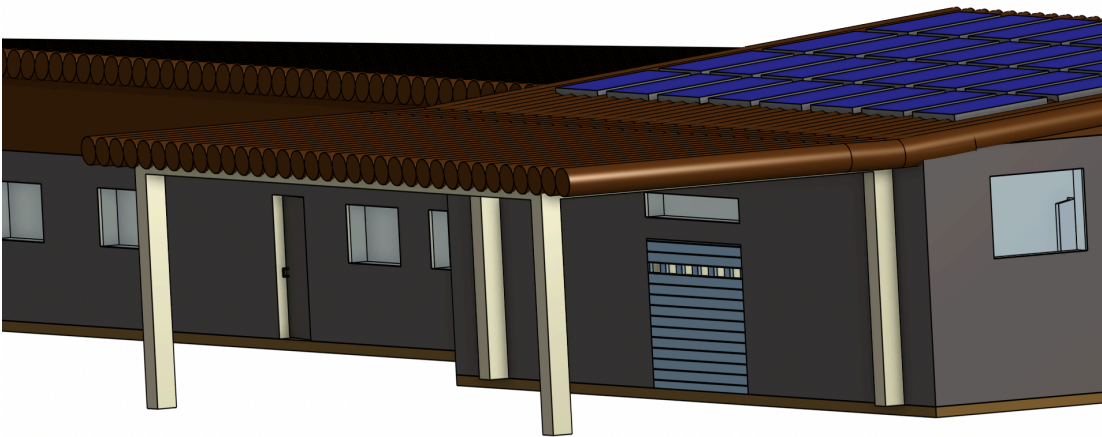
This lab space includes an L-shaped lab bench, providing space for 8 computers. There are two long benches located in the middle of the L-shaped bench for lab-work. As you enter through the double-doors of the lab from the inside of the building, there is a big open space on the right to leave room for a portable lab bench. There are two windows to naturally illuminate the lab, as well as a garage door next to two freezers attached to a 12-ft lean-to to give easy access to the outside from the lab.



(Figure 8; Lab Space, Entrance View)



(Figure 9; Lab Space, Garage Door View)



(Figure 10; Outdoor Lean-to)

4.1.1 Access to the Outside

The garage door allows access to the building exterior directly from the lab. By opening the garage, it makes it a lot more efficient to transport materials needed for labs into the lab space rather than bringing materials in through one of the exits of the building. Another positive with

this feature is that the portable lab bench can be moved outside if needed. The outdoor lean-to is perfect to process hides as the height allows for hides of various lengths to be hung.

4.1.2 Lab Work

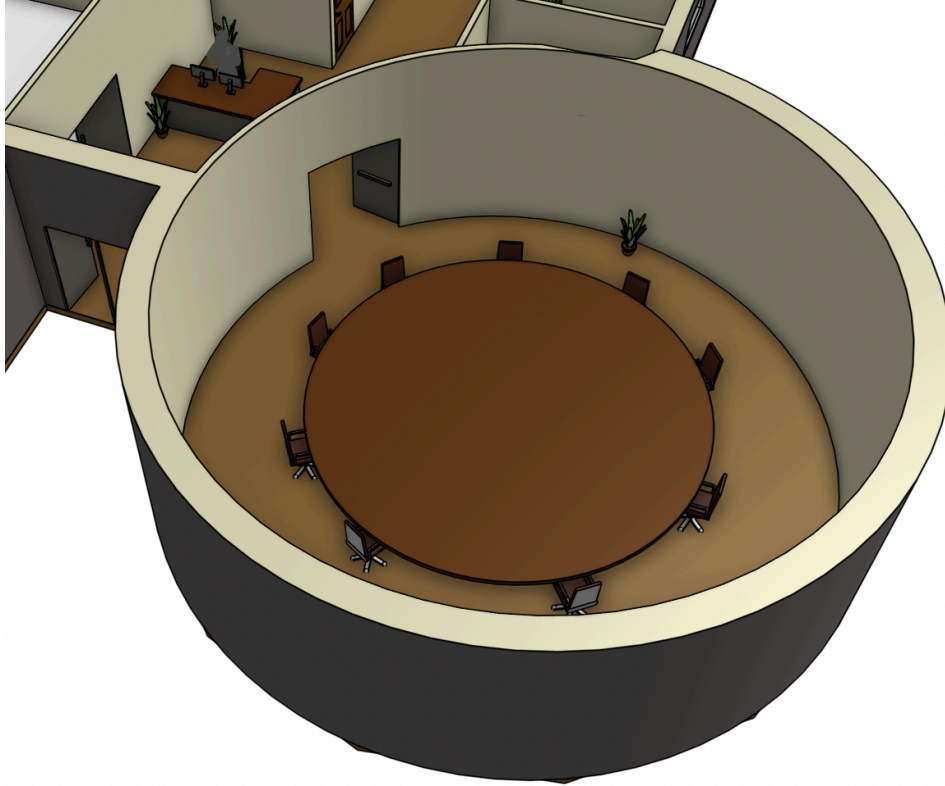
The two large benches provide a lot of area for the employees of the program to perform plant treatments and other required tasks. The freezers used during the plant processing are conveniently located near the benches and the garage door. The plants can quickly be moved from the benches to the freezer for drying, and any hides needed to be kept in a freezer will not have to travel far as it is right beside the garage door.

4.2 Meeting Room

The circular meeting room allows space to insert a nine-person table in the middle of the room. There is space for little decorations such as plants on the floor behind the chairs, or even paintings on the walls. The roof has a skylight and multicoloured leaves.



(Figure 11; Meeting Room, Exterior View)



(Figure 12; Meeting Room, Interior View)

4.2.1 Meeting Room Interior

The space for the meeting room allows for large discussions amongst employees from the program for meetings. The circular concept promotes inclusiveness to enable democratic meetings as well as it is an important symbol for the Algonquin community.

4.2.2 Meeting Room Roof

A large skylight on the roof of the meeting room permits an ample amount of natural sunlight to illuminate the meeting room. The leaves on the roof represent the Algonquin Community as it symbolizes sustainability, but as well as their colours which represent the colours on the medicine wheel.

4.3 Gazebo

The wigwam inspired gazebo is located right outside of the second building entrance, on the same side as the lean-to. It includes a large counter space with a sink.



(Figure 13; Gazebo)

4.3.1 Fish Cleaning

The counter space and sink within the gazebo makes it easy for the Guardianship program employees to clean fish and complete cultural activities. As it is not far from the garage door, if needed, materials can be transported to the lab from the gazebo. Further, this is a great area to host community events, as it is one of the program tasks.

4.3.2 Representation of the Culture

The exposed lumber design as well as the shape of this gazebo was well thought about. They both contribute to representing the Algonquin culture as the woody aesthetic represents sustainability and the shape took inspiration from the shape of a wigwam.

4.4 Washrooms

There are two washrooms with a toilet and a sink included within the building design. The first is located next to the meeting room, and the second is located next to the second building entrance. They were both positioned on either ends of the building so that employees from every part of the building would not have to walk far to use the washroom.



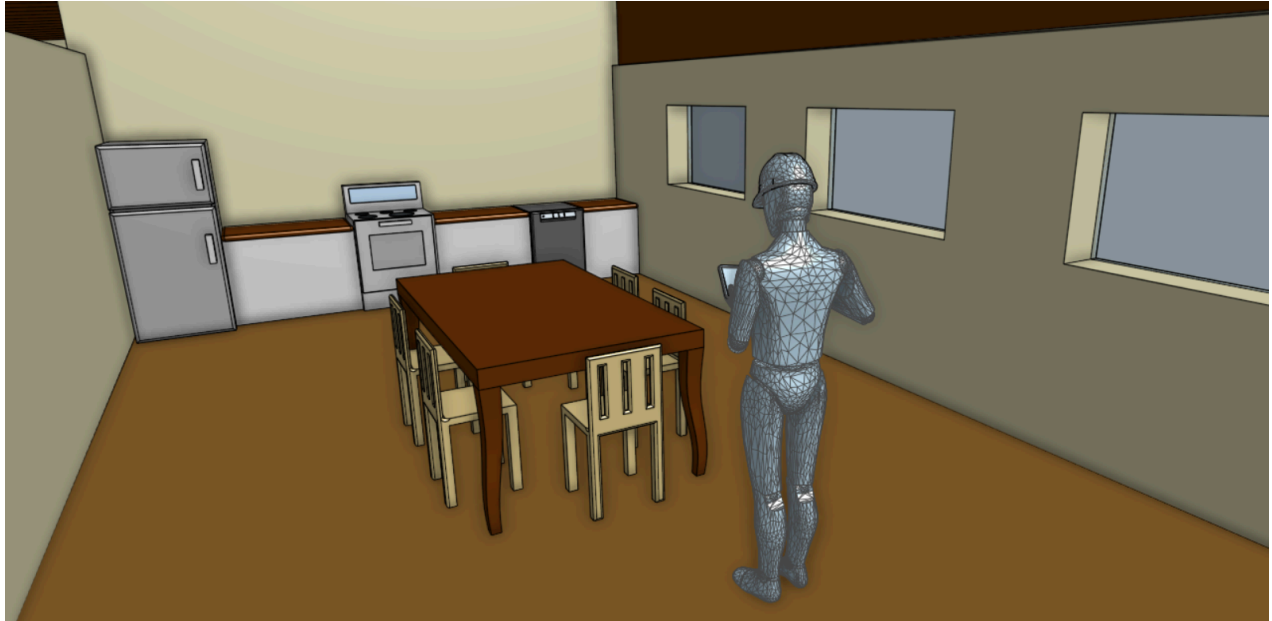
(Figure 14; Washroom)

4.4.1 Gender-Neutral Washroom

One issue people will run into while using the washroom is the fact that in most places they are separated by gender. Not only does gender-neutral washrooms eliminate this separation issue, however it also allows for anyone to use either washroom in the case one of the two is being used.

4.5 Kitchenette

The fully functional kitchenette includes a full-sized fridge, stove, dishwasher and even a table that sits 6. Windows on the wall allow for natural sunlight to enter while program employees are enjoying their break.



(Figure 15; Kitchenette)

4.5.1 Location of Kitchenette

The kitchen was specifically located towards the centre of the building. To ensure easy access for every employee, the kitchen was located near the middle. It is important to note that the offices span throughout the whole area of the building, thus the location of the kitchenette can make it easier for employees to go on break or have a snack.

4.6 Open-Concept Workspace

The open-concept workspace includes four different circular tables, each seating four people. It is conveniently located near the kitchenette and the second gender-neutral washroom. There is space around the tables to include plants and decorations for customizability.



(Figure 16; Open-Concept Workspace)

4.6.1 Community Events

Providing an open-concept work area provides a space for employees to come together and work as a team to complete tasks. This could also be used for a space to hold community gatherings as the program works to bring people together by holding these events.

5 Troubleshooting & Support

5.1 Error Messages or Behaviors

The roof of the prototype is prone to breaking, as the material is not very strong and the support for the roof is quite thin. To avoid breaking the roof, it must be held carefully and pushing the roof to remove warping will break it. If the roof does break, it will have to be glued back together.

The walls and floor are stronger than the roof, but they may also break. The walls are most likely to break at a door, where the wall is narrow because of the doorway. If a wall breaks completely off other walls and the floor, the remaining pieces of the wall section must be cut off and filed down then a new section of wall must be laser-cut and glued in place. If a section of wall is only partially broken off, then it must be cut free of the other walls and floor and a newly laser-cut section of wall must replace it.

The wall of the circular meeting room is also fragile because it is made out of bent MDF, which is not meant to bend. If the wall is broken, then the whole wall will need to be removed and laser-cut again. This means that another section will need to be cut into the right shape with the right pattern cut in, and the MDF must be bent again, which is a delicate procedure without breaking the wall.

5.2 Maintenance

There is no regular maintenance to be performed on the prototype. The only thing to avoid failure with the prototype is to handle it carefully because there are no moving parts or parts that will break on their own.

5.3 Support

Any emergency assistance for building this prototype can be found in the makerspace. They can be reached at 613-562-5800 ext. 1559 or at experts.makerspace@uOttawa.ca.

6 Product Documentation

Our main idea was to make something similar to a Barbie dream house, where you could lift the roof of our prototype and you would be able to see the inside of our building and its features.

When discussing the process of making the physical prototype, the main issue revolved around time constraints. There was a lack of free 3D printers and then when there were free ones the prints took so much time. We almost considered not making the roof but decided to try anyway. Luckily, this worked in our favor as we were able to accomplish our goal. The reason we were adamant about making our roof using 3D printing was so we could incorporate finer details such as logs in order to make our roof design cultural.

When making our main base, we decided to laser cut everything since it was the easiest and cheapest option whilst still being time-efficient. When designing our initial sketches we decided that our exterior wall would have a larger thickness hence we used $\frac{1}{4}$ MDF when laser cutting those walls. However, when it came to the rest of the interior walls and our floor plan we stuck to $\frac{1}{8}$ MDF. This was the best method since our prototype was mostly just rectangles and not irregular shapes. However, when it came to our circular meeting room's wall we had to do multiple trials until we were able to successfully laser cut it. We ended up using a specific technique that allowed us to bend the laser cut shaped into a circle as shown below:

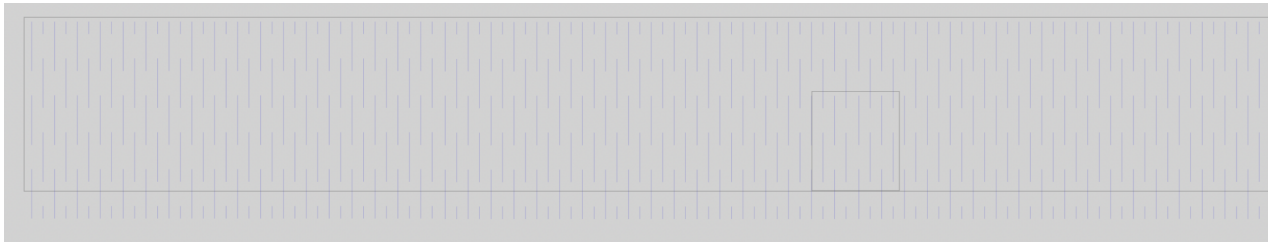


Figure 17 - Inkscape File for LaserCut Circular Meeting Room

6.1 Physical Prototype

6.1.1 BOM (Bill of Materials)

Physical: **List of equipment (software or hardware) needed to build each prototype:**

Material	Use	Amount	Price
$\frac{1}{4}$ MDF	We laser cut the: - Exterior walls This was done with $\frac{1}{4}$ MDF	Exterior walls: a total of 66 x 1.8 (height of walls) inches of MDF	\$3.50

		This means we needed one 12x24 inch sheet of MDF	
1/8 MDF	We laser cut the: - Floors - Interior walls This was done with 1/8 MDF	Floor: 7.5in x 18in Interior walls: a total of 67 x 1.8 (height of walls) inches of MDF. This means we needed 2 12x24 sheets of MDF	2 x\$2.50 =\$5.00
PLA	We 3D printed: - The roof - Furniture /interior details	We needed approximately 0.1425kg of PLA to 3D print the roof.	10c/g
Brown spray paint	We spray painted the roof	1 bottle	\$ 14
krazy glue	We needed glue for the majority of our prototype	1 bottle	\$ 8

Table 3 - BOM

6.1.2 Equipment list:

- 1/4 MDF
- 3D printer
- Laser Cutter
- Exacto knife
- 1/8 MDF
- PLA
- Spray paint (brown)
- Krazy glue
- Black Board
- Markers
- Scissors
- Felt paper
- mini tree figures
- toy cars

6.1.3 Instructions

1. Firstly, we started by laser cutting exterior walls using the $\frac{1}{4}$ MDF. We had two separate
2. files we used when printing the walls they looked like this:

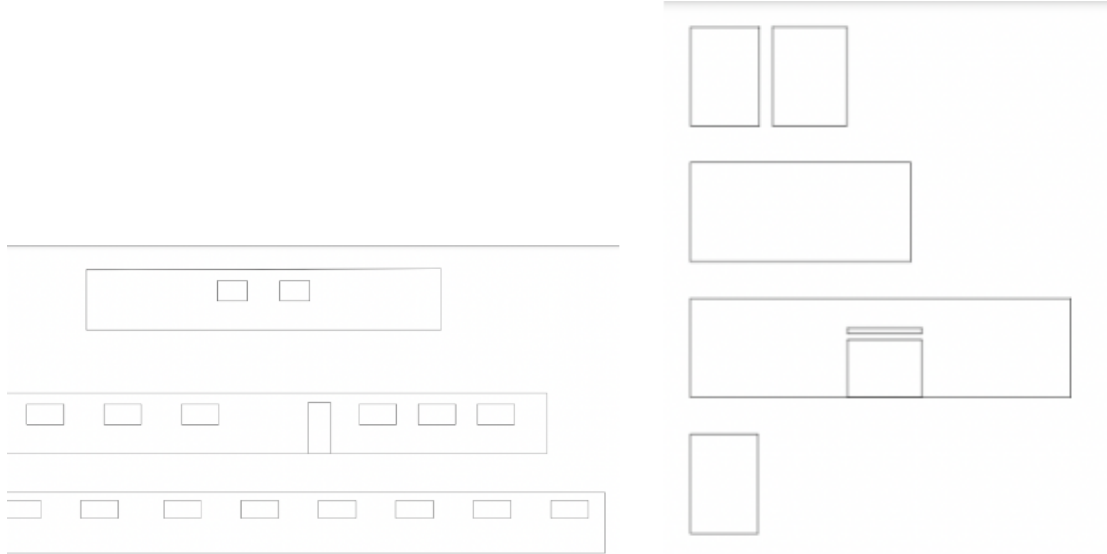


Figure 18 - Laser Cut Files for the Exterior Walls

3. Secondly, we used $\frac{1}{8}$ MDF to laser cut out the floor as well as the interior walls. Our laser-cutting files looked like this:

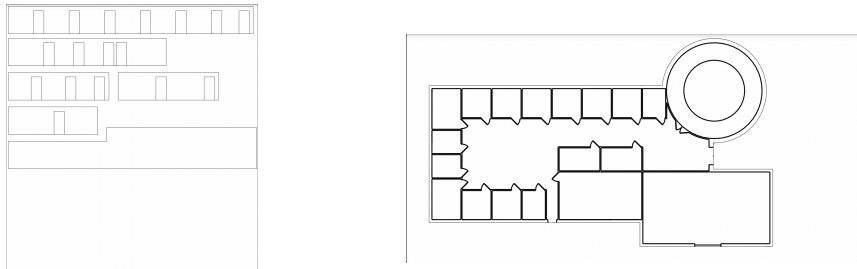


Figure 19 - Laser Cut Files for the Interior Walls as well as the Floor Plan

4. After that, we cut out all the pieces and glued them together.

- Furthermore, we started working on our roof by 3D printing our sliced-up roof (the roof was too big to print at once, so we had 7 different pieces). This was done by slicing up the analytical prototypes and then converting them into STL files on onshape. We then used UltiMaker Cura to format our files depending on the available 3D printer. Some examples of our 3D printing files are:

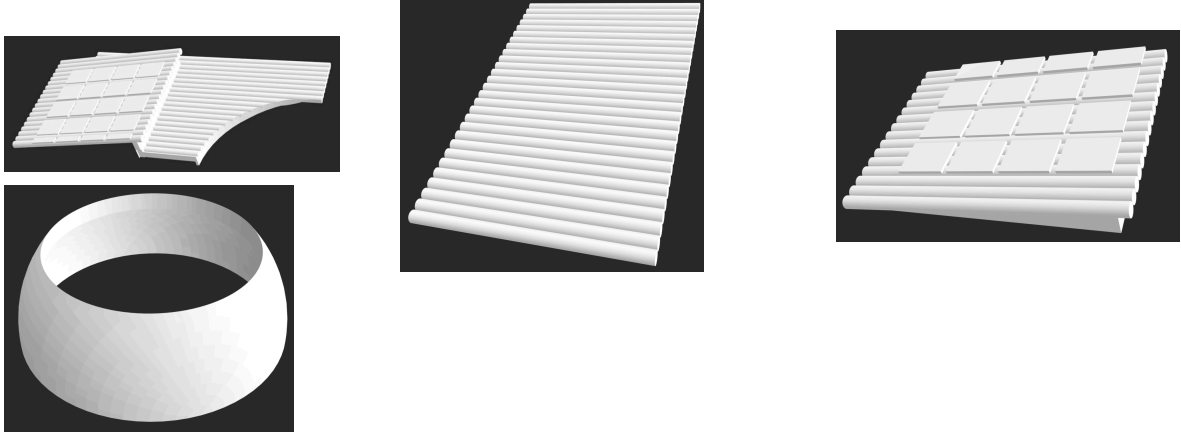


Figure 20 - 3D Print Files

- After all the pieces were 3D printed we glued them together.
- We then glued our floor plan base to a giant piece of black cardboard.
- We added green felt paper to add some greenery as well as the trees, we also added parking spaces and toy cars to give an idea of how everything will look like.

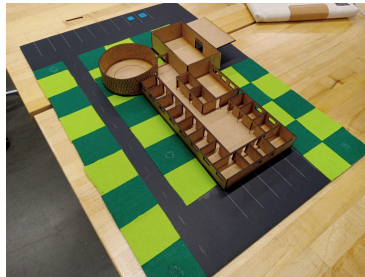


Figure 21 - Parking Area

6.2 Testing & Validation

The first test that we did on both our final analytical and physical prototype was making sure a person could actually fit through our dimensions. This test was carried out for the analytical design by using a scaled-down model of a person and ensuring it would be able to move around the building and fit through doors. For the physical model, we 3D printed the scaled-down person and moved it around our prototype. Both these tests were successful. We carried out this test to make sure that our measurements were calculated right. Furthermore, the next test we carried out was an accessibility test. We executed this test to ensure that our building would be wheelchair accessible. The test was executed by using a scaled-down wheelchair model and moving it around our analytical model, the test was successful. The next test we performed was a visual design test, where we asked family and friends if our design looked good. We also asked them to consider the cultural representation of our design. This was to check that our final prototype was aesthetically pleasing. The visual test was mostly successful. Many of our peers said that they loved the overall layout of the building, they said it was a functional office building. Although some people mentioned that they believed we should add more cultural aspects to the building. Additionally, we also tested our physical prototype's roof since our physical prototype included a base and a removable roof. We tested to verify if the walls of our prototype could support the roof. We discovered that the removable roof does work and that it is easily separated from the base of the building. The final test we enforced was ensuring the roof was water resistant and didn't keep water/snow stuck on it but rather was slanted. We discovered that the roof is water-resistant and that the angle of the roof works well for water flow, and snowfall. This was tested by adding snow to our roof and water drops.





Figure 22 - More Views of the Building Design



7 Conclusions and Recommendations for Future Work

While working on the design for the environmental monitoring building for the Guardian Program, many skills needed to be acquired to create of our prototypes. First, basic knowledge of CAD (Onshape) is required as the floor plan was made in CAD and then exported to Onshape. Following this, while using Onshape, it is most effective to make individual parts in part studios and then create and assemble them. This makes it easier to go back and make changes, get dimensions and improves the software's usability. To demonstrate, suppose a mistake has been made and seems to be irreversible. Go to the left toolbar, select the versions and history icon, go to primary and press Show Changes. Locate the change you want to undo and right-click on this part. A toolbar will appear on the top of your screen where you can select restore to Main, this unwanted change should now be reversed. Subsequently, the physical prototype was mostly a product of laser cutting. We used Inkscape which is primarily a vector drawing software to create the base and the walls. We took the scaled-down dimensions we had created on Onshape for the walls and drew them out on this software. At this time, we learnt that it would be much more efficient to import the CAD file of our floorplan into Inkscape. Doing this allowed us to easily raster where the walls and doors would sit on the floor, which increased productivity when it came to the assembly of our prototype. The 3D printing of the roof was a learning curve in itself. It's crucial to consider the geometry of your sections if you cut a part to print in sections. This will also save time when assembling the final prototype. Finally, taking into consideration the time it will take to print each part is essential. In the future, to improve our prototype, it would be vital to start the 3D printing of the roof as early as possible to allow for a more precise print of the design.

If the timeline of this project permitted, going into more detail about the mechanical aspects of this building would be ideal. Incorporating a separate mechanical room with an HVAC system, water tanks, heaters and pumps and fire sprinkler distribution piping and pumps. Including a design plan for the plumbing, electrical, and foundation. Considering the importance of sustainability in the design of this building, choosing specific formworks when building the foundation should minimize the concrete needed, thus limiting the use of oil and reducing the carbon footprint of this building.

APPENDICES

8 APPENDIX I: Design Files

This document includes all other preexisting documents that were completed since the start of the design process. They include the need identification and problem statement, design criteria and target specifications, conceptual design, project schedule and cost, prototypes, and customer feedback.

Table 3. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
MakerRepo-The Master Builders	https://makerepo.com/isabelledumais/1775.the-master-builders-	November 14th, 2023
Onshape Document	https://cad.onshape.com/documents/c5a52df02c5e85199e550400/w/ef66a0e65a7a3fbdcef7e63c/e/6d762fda8b443944d7034d79?renderMode=0&uiState=657609d7a88e15066686eec6	December 1st, 2023