Deliverable H: Prototype III & Customer Feedback

Introduction

For this deliverable, we outlined the prototype for the Guardian Project research building. It has been decided that our final prototype will consist of a 3D model of the exterior of the building along with 2D floor plans and an interactive virtual 3D model of the interior of the building. Given that this is our final prototype, a section of this deliverable has been dedicated to the ‘why’, ‘what’ and ‘when’ of prototyping, as well as our justifications, reasonings and overall development of our prototypes. Finally, as with the other two prototypes, we tested the prototype and outlined the results in a table.

Final Prototype Progression

For our presentation at Design Day, we intend on sharing an interactive 3-part prototype that includes a 3D printed, physical prototype of the exterior of the building, accompanied by an interactive 3D AutoCAD of the interior and 2D AutoCAD floor plans. Finally, we will also have a website, outlining our use of the Engineering Design Process that the judges can use to revisit our project after the pitch.

1. Physical Prototype

Figure 1 - Progress of our 3D printed model of the exterior. It is currently being painted for Design Day to further resemble our concept for the design.

2. 2D Floor Plan

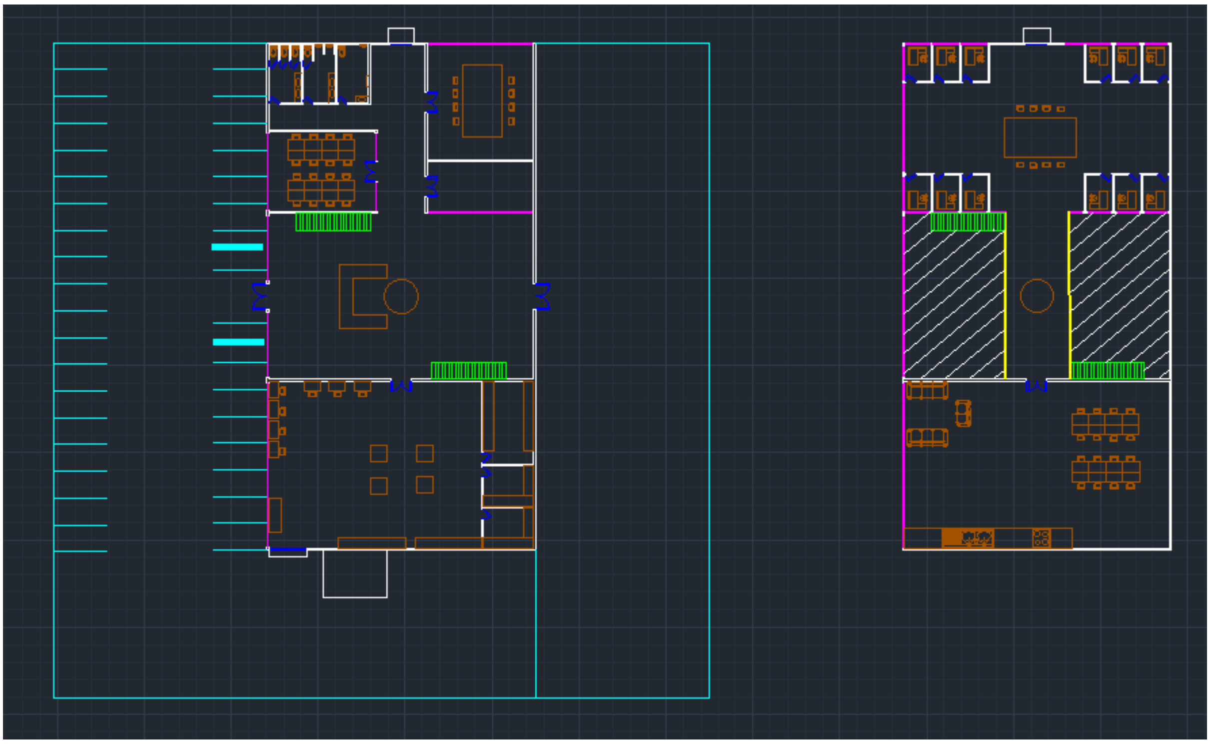


Figure 2 - Our final floor plan of the Guardian Project Research building. On the left is the first floor, which includes temporary office spaces, bathrooms, a lobby and the lab space. On the right is the second floor where the permanent offices, breakroom and meeting room can be found.

3. Interactive Model of the Interior

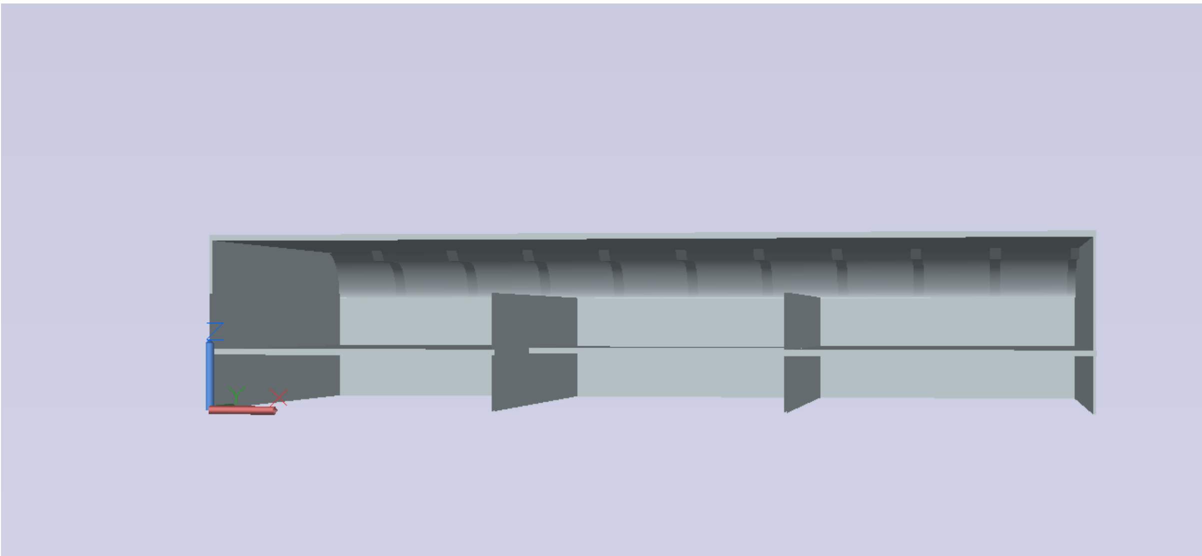


Figure 3 - The interactive 3D model of the interior of the building. The main purpose of this model is to display the cultural design aspect of our project which is the ribs of the canoe (can be seen on the far wall). For Design Day, more colours will be added to distinguish between the parts of the interior and more detail will be added to the design itself.

4. Website
   https://sites.google.com/view/guardianbuilding-designprocess/home

'Why', 'What' and 'When' of Prototyping

1. Why?

Our first two prototypes were analytical models. We decided we wanted them to be analytical models and not physical models because we have a limited amount of resources to work with and by using analytical models we were able to adjust our designs based off of client feedback and our tests without having to build or print another model and incur more costs. Our final model has a 3D printed part, because we were satisfied with the look of the building and by making a 3D printing we can continue with tests that can not be done with an analytical model as well as having a show piece for design day.

2. What is the prototype?

We have made three prototypes over the timeline of the project. Our first prototype was a 2 dimensional floor plan for the building which we presented to our clients. After we got feedback on our first prototype we started the design of our second prototype. The second prototype was a 3 dimensional CAD model with an adjusted floorplan made in AutoCAD. The 3 dimensional model was used to gather opinions on if the building looked good and if it needed to be adjusted, floor plan was adjusted according to feedback from the client. Our final and third prototype is a printed model of the outside of the building and a 2 dimensional floor plan of the building all of which have been adjusted based on tests and feedback from the clients.

3. When?

Our project started in September of 2023 but our first prototype was completed November 9th 2023, following the feedback received from our client, we were able to quickly produce another improved prototype on November 12th 2023. Our final and third prototype was finished by November 23rd 2023.

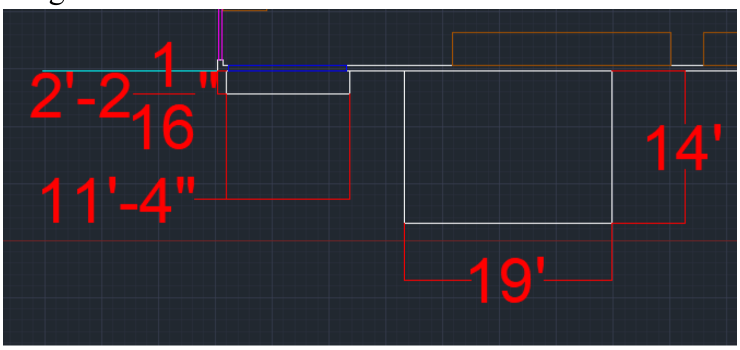
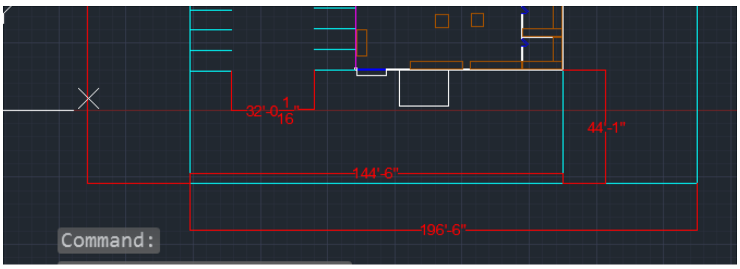
Justifications & Reasonings for the Prototypes

Our building's final prototype is the result of a comprehensive and iterative design process that prioritises user satisfaction, industry expertise, and a commitment to inclusivity and cultural resonance. In the initial phases, we tested office capacity, striking a balance between spatial efficiency and employee well-being. We also added surveys to get valuable user feedback on the interior and exterior layout, and each iteration was shaped by this input, ensuring the final design is user-centric.

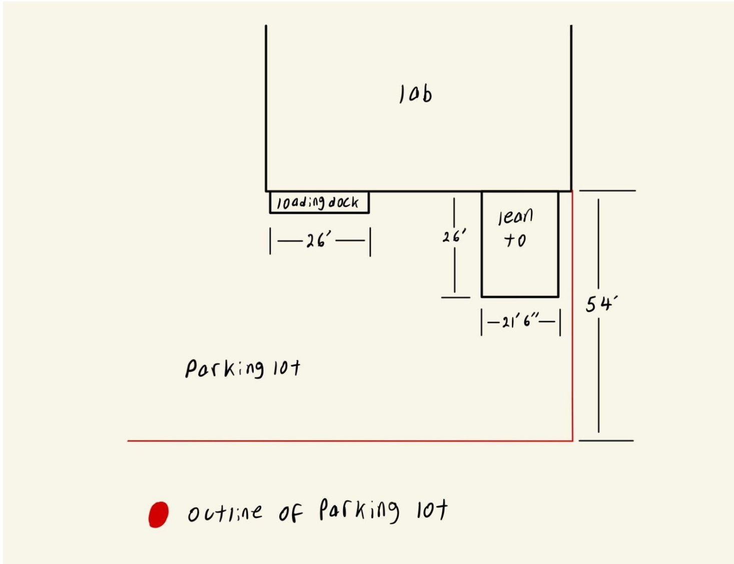
We also consulted with professionals and used their feedback to enrich our prototypes with the latest industry practices, elevating the building to meet both user expectations and professional standards. Universal accessibility has been a guiding principle, with each prototype undergoing meticulous checks to guarantee a welcoming environment for all. Adding cultural aspects, such as the canoe-inspired design, not only enhances the aesthetics of the building, but also fosters a sense of community among the occupants.

In addition, we worked hard to meet all the client's requirements, such as movable workstations to allow for flexibility in the workplace. We added a second floor to our building as a result of client requests for more office space, as well as a lounge for employees to relax in.

Prototyping Test Results

Test ID	Test Objective	Description of Prototype used and Basic Test Method	Test Results
1	Exterior Guardian Accessibility	During the client meetings, the client mentioned a need for Guardian trucks to easily access the lab space. This test will evaluate the efficiency of the lab access from the exterior (i.e. maneuver space, size of loading dock/garage door, etc). Dimensions of 1500 Chevrolet trucks will be used for the test.	<u>Dimensions of a 2022 Chevrolet Silverado 1500 with a regular cab and a long box:</u> - Length: 229.7” - Width without mirrors: 81.1” Likely around 130” if towing mirrors are being used. Minimum width will be at least 105.1” since truck mirrors are at least a foot wide. Width of loading dock: 11’ 4” = 136” Width of lean to: 19’ = 228” Length of lean to: 14’ = 168”  

			In our final design we expect there to be enough room for two trucks at a given time to pull into the loading dock with sufficient space to load/unload samples. Comparing the width of the loading dock with the width of a Chevrolet 1500, only one truck at a time will be able to pull into the loading dock. Therefore the width of the loading dock will need to be increased to at least 25' or even 26' for sufficient space for two trucks to load/unload samples. For the lean to, currently only one truck will barely be able to fit under it horizontally in the orientation shown above. Ideally, we expect both trucks to be able to park under the lean to with ample space for parking and getting in and out of the vehicle. For the layout of the parking lot, it would be ideal for both trucks to park under the lean to horizontally in the orientation shown above. Therefore a few changes need to be made. First the lean to needs to be moved to the right to allow for maneuver space between it and the loading dock. Secondly, the width of the lean to needs to be increased to around 21' 6" or 258" to allow the lean to to completely cover the trucks while parked and to make parking easier. Thirdly, the length of the lean to needs to be increased to around 26' or 312" to allow the lean to to completely cover the trucks while parked and to make parking easier. The width of this portion of the parking lot will also need to be increased by 10' to allow for increased maneuverability. With the changes the parking lot could look like this

			
2	General Safety Standards	This test will be used to assess whether our design for the Guardian Building adheres to the safety standards in Ontario, specifically the fire safety standards. The layout of the building will be evaluated using the Ontario Building Code to ensure that there are "barrier free paths", sufficient emergency exits, etc.	Barrier free paths: The layout of the building is up to Ontario Building Code. Sufficient emergency exits: The layout of the building is up to Ontario Building Code.
3	Sustainability	This test involves the integration of solar power through the installation of solar panels on the roof and an evaluation of the quantity of solar energy we expect to harness. The test would encompass a thorough site analysis, considering factors such as geographical location, orientation, and potential shading from nearby obstructions.	We plan to use standard 72 cell solar panels laid out in a 6 x 12 grid (72 total solar panels) on the roof. Individual solar cells are 6" x 6" squares, and 72 cell solar panels are laid out in a 6 x 12 grid. So the dimensions of 72 cell solar panels are roughly 39" x 77". These dimensions are not exact because they depend on the frame size of the solar panel used by the manufacturer. Let's assume we are using 72 cell solar panels with an output rating of 375 watts (J/s) when direct sunlight is shining on the entire solar panel. On a yearly average, Ottawa gets roughly 5.5 hours of sunlight every day. Since the latitude of Pikwakanagan First Nation is practically the same as Ottawa, let's assume that Pikwakanagan First Nation also gets roughly 5.5 hours of daily sunlight.

			It is also important to note the orientation of the solar panels. Since we are in the northern hemisphere, the sun sits in the southern sky. So the solar panels on our roof need to be facing south to maximise their power output. The angle of the solar panels will also affect their power output. $375\ W\ (5.5\ h)\ =\ 2062.5\ Wh\ =\ 2.0625\ kWh$ (average maximum daily energy output of one solar panel) $2.0625\ kWh\ (72)\ =\ 148.5\ kWh$ (average maximum daily energy output of 72 solar panels) $148.5\ kWh\ (365)\ =\ 54,202.5\ kWh$ (average maximum yearly energy output of 72 solar panels) Therefore, the 6 x 12 solar panel array on the roof has an average maximum yearly energy output capacity of 54,202.5 kWh. In contrast, 10,000 kWh is around the energy required by a typical American household for all of its needs. So the solar panel array on the roof has the potential to power the Guardian building for all of its needs year round. Keep in mind that this is the absolute maximum yearly energy output of this solar panel array. Solar panels are very inconsistent in their power output because of how many inconsistent factors play into the amount of sunlight that directly shines on the solar panels. Daily sunshine here in Canada can vary an incredible amount due to our position on the globe and the weather. In the summer days are long, so there is lots of potential for solar power. However, in the winter days are quite short and on top of that the sun rarely shines, so little solar energy can be harnessed. For maximum energy output, the ability to change the angle of the solar panels is very important in order to face the solar panels in the direction of the sun. In the summer the sun sits high in the sky, so the solar panels need to be flat with the roof. In the winter the sun sits low in the sky, so the angle between the solar panels and the roof needs to be increased. The solar panels also need to be clear of any obstructions such as trees to prevent shading.
4	Evaluation of the Roof	In addition to incorporating solar panels onto our roof, we	Considering we do not have a working model of our design of the Guardian building with proper structural

		would like to test the roof's structural integrity. This test will encompass assessments of stability, drainage, and other pertinent factors to ensure the overall functionality of the roofing structure. We could test the drainage capabilities by doing a rain test using a controlled water source such as a hose or a sprinkler system. Simulating water flow to mimic various levels of rainfall intensity.	components and realistic materials, simply testing the structural integrity, drainage, and other factors of the roofing structure is not feasible. However we can obtain a valuable preliminary insight of the roof's drainage capabilities based on the design and shape of the roof. On one side our roof is angled down, while on the other side our roof is curved (concave down). As long as our roof is waterproofed appropriately, rainwater will consistently drain off the roof because of its shape. As for where rainwater will drain off after it drains off the roof, there are multiple options. For the non-curved side of the roof, rainwater could run directly off the roof onto the parking lot and then into storm drains. An eavestrough could also be installed and rainwater could either run into the sewer system or a rainwater collection device. A large eavestrough-style runoff that drains into the sewer system or the ground away from the building will need to be installed on the ground right at the bottom of the curved section of the exterior of the building. This is absolutely necessary because of the way rainwater will drain off the curved roof and the fact that there is no parking lot on this side of the building. Rainwater will drain directly into the ground right next to the foundation of the building here without proper drainage runoff. This would be a serious problem as rainwater would seep into the foundation and severely affect the structural integrity of the building.

Conclusion

During the development of each of these three prototypes, we have been constantly asking our clients as well as various potential clients for feedback to utilise when creating the following prototypes. We have also implemented multiple prototype test plans in order to understand risks, limitations or advantages involved with our design.Throughout this process of continuous improvement, we have gotten closer to our final prototype that will be presented on Design Day.

Wrike Snapshot:
https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=szDD4tTmnUQAgFQCFsbGbw3dy5jWyRxa%7CIE2DSNZVHA2DELSTGIYA