The Growroom

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Abstract

The objective of our project is to provide the community at the African American Community Service Agency in San Jose with access to a healthy and sustainable food source, while educating about the importance of gardening and local sustainable foods. One of the biggest challenges of gardening is a lack of space, so through the Growroom we hope to promote local food production with architecture that is both beautiful and sustainable. Throughout this process, we have found that the Growroom means much more to the community than we initially thought. Not only does it provide a food source and reduce our footprint, but it has the potential to bring the entire community together. The community will be encouraged to have important conversations surrounding food and health, and will be empowered to create their own food and exchange with fellow community members.

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Introduction

Background

While the importance of fresh, organic food may seem obvious, the lack of access to these nutritious foods is shocking. Over 20 million Americans live in what's known as food deserts, areas that have more liquor stores per capita than access to fresh organic food. The people living in these 'food deserts' are often part of marginalized communities, such as low income and minority groups. Living in an area like this and lacking proper nutrition can have detrimental effects on mental health and wellbeing. This is why our community partner, We Start Gardens, is focused on providing edible landscaping and encouraging customers to grow and maintain organic food sources. Building more local urban gardens will allow communities that are currently food deserts to become self sustaining for healthy food production. However, in many urban areas access to adequate land for growing isn't available, so the newest innovation in urban agriculture is vertical gardening.

Figure 1: The Growroom and architects Mads-Ulrik Husum and Sine Lindholm.

One solution to this problem is a structure called the 'Growroom'. SPACE10, a research and design lab funded by IKEA, collaborated with the architects Mads-Ulrik Husum and Sine Lindholm to create an open source design for an urban farming pavilion (Figure 1). The design of the Growroom is a large, spherical, wooden pavilion with a hollow interior where people can interact with the herbs and plants. The goal of this design is to change how cities feed themselves through promoting local food production through architecture that is both beautiful and sustainable. A few benefits of local food sources are that they reduce food miles, produce high quality food, and educate future generations on food sourcing and sustainability. By using CNC milling to cut wood into the shapes given on the open source files, we will be able to cut and build this Growroom right in our area.

Community Partner & Critical Customers

Our community partner is We Start Gardens, and their goal is to have the Growroom built at the African American Service Agency in San Jose. We are currently working with Derek Bryant, founder of We Start Gardens, and his project manager Armani Donahue to figure out the funding, planning, and fabrication of this Growroom. After having a few meetings, we've found that Derek wants us to cut, waterproof, and build this structure so that it lasts for at least 10 years. It is also important that it has a structurally sound platform so that it's safe and doesn't allow soil to come in contact with and damage the wood. Overall, the goal for this project is to provide better access to fresh, local food sources. We are building this Growroom to serve as the first proof of concept of an urban community food source in San Jose. Our hope is that this will educate future generations about local sustainable food sources all while supplying the community with these organic vegetables.

Environmentally, we have found that the growth of natural food sources improves sustainability and reduces our footprint. We also are sure that the Growroom will financially help all members of the community. A study done by the UC Cooperative Extension found that home gardeners saved $92 a month on average, and community gardens saved members of the community $84 a month (Pam, 2016). In addition to saving money, the Growroom is a completely ethical food source. Instead of getting food from convenience stores or fast food restaurants, community members will be getting nutritious food options with the peace of mind that it was all grown locally. Another benefit to local growing is that there are many foods that may be inaccessible or of poor quality at local grocery stores, and community members will have access to these foods and maintain connections to cultural traditions. The construction of the Growroom at the African American Community Service Agency will benefit both the community and Derek's organization. One of the largest challenges in starting a garden is the lack of adequate space, and with the Growroom we will have plenty of room for growing in a relatively small space. We will be able to help Derek reach his goal of providing sustainable food options in an area that he believes will truly benefit from it. We can deliver the value on this project because we understand how important this is to him and are motivated to go through with the project because of this. We have the skillset and the willingness to do every aspect of this project from cutting the wood to assembling it, and at the end of the day we are happy to help out the community.

Discussion

Project Objective

Our main project objective is to cut and build the Growroom as designed by SPACE10 and the architects Mads-Ulrik Husum and Sine Lindholm.

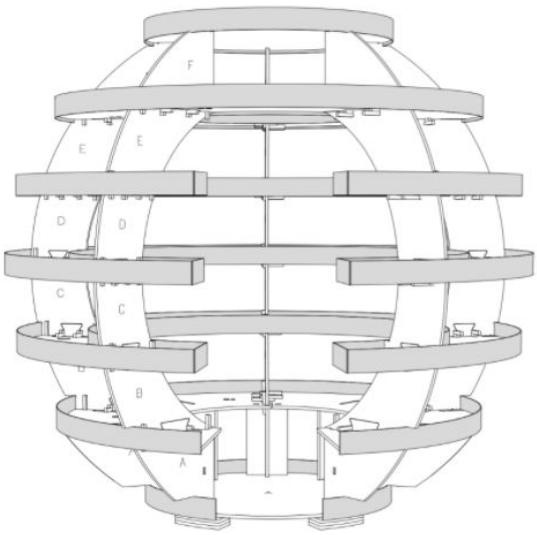

Figure 2: 3D model of Growroom

Additionally, we must modify the growroom to satisfy our customers' needs so that the structure will be weather resistant and will last ~10 years in an outdoor setting. To complete this project objective and to fulfill the needs of our customer we needed to make some key decisions on design additions, material types, cut process, and build process. The success metrics we will use to evaluate our final product will be if the Growroom is completely built and waterproofed, if the partner organization is happy with the final product, and if the community was involved in the assembly process which was very important to our partner organization.

Existing Solutions Research

Since the Growroom is an open source design, we found it would be beneficial to search online to see if anyone else has attempted to build this structure themselves. We were able to get one response from a previous builder and they offered some suggestions and tips on the materials and build process. The full response can be found in the appendices. Some suggestions that stood out to us was the use of marine plywood, marine epoxy sealant, and their method of sealing as they built. In our project the use of marine plywood and marine epoxy sealant would be ideal but the price was too high to justify the cost. Furthermore, we considered sealing as we assembled as they suggested but we decided that the

pieces and joints would not fit together as well which may lead to a risk of the structure not being properly put together. One very useful tip suggested was the recommendation to get 2 gallons of sealant to coat the whole structure.

Design Decisions

For our final materials we decided to use birch plywood, stainless steel screws, and spar urethane varnish. We are using birch plywood since it is a type of hardwood plywood which means it is more resistant to water and it is a denser plywood which allows for cleaner pieces when cut by a CNC machine. We are using stainless steel screws in our build to prevent rust from developing on our structure over time. For the same reason we are using water based spar urethane to apply as a varnish on the wood to provide waterproofing and UV protection.

We also made some additional adjustments to the design so that it could better suit our needs. First we decided to drill drainage holes in each layer of the growroom to allow for better drainage in rainy weather or plant overwatering. Secondly, we wanted to elevate the bottom of the growroom from the soil it was being placed on to prevent the moisture from rotting the base. Therefore we decided to place four 4x1 hardwood planks underneath to provide a level and sturdy platform without the risk of the plywood directly contacting the ground.

Cutting Preparations

To complete the cutting process, we were given access to a 4x4 ft. CNC machine at the woodshop in MakerNexus, a local maker space. To operate this machine, we had to complete a shopbot tutorial/safety class and learn how to use VCarve which is the software needed to design and export cut files for the machine to understand. However there was one major issue with this CNC machine as the cut vectors provided by SPACE10 were meant to be cut on a 1220x2440 mm. (~4x8 ft.) area instead of the 4x4 ft. one we had access to. As a result of this we had to break down the pieces into small pieces and large pieces. All the small pieces were rearranged so that they can fit on multiple 4x4 ft. cut areas while still maintaining efficient use of the material space. For the pieces that were larger than 4x4 ft., we had to make some additional adjustments so that we could cut them on in our restricted cut area. For large pieces, we first had to split the cut vectors into two 4x4 ft. cut areas so that it can be entered into the machine. We would first cut half of the large piece using one 4x4 ft. cut file and then shift the

plywood board over so that we can cut the second 4x4 ft. area for the other half of the piece. To make sure the two halves align perfectly we used the CNC machine to drill precise alignment holes on the board so that we can use wooden dowels to align the board when we shift it over.

Figure 3: Example of long piece cut

In addition to the small and large pieces, we had to cut over 250 pegs for the structure. Originally these pegs were to be cut out using the CNC machine, the issue with this is that the total time required to cut those pieces would be very long and an inefficient use of our time. Instead we will try to emulate the general shape of the peg using a miter saw which is much quicker and more efficient than using the CNC machine. Finally, before starting the cutting process we created a production tracker spreadsheet to keep track of all pieces we need to cut and its current status. We also plan on labeling each cut piece with a sticker label for easy identification and production tracking.

Civic Engagement

Our project aims to combat food insecurity and provide those living in food deserts with a healthy food source. There are several organizations who play a role in addressing this public policy problem of food deserts and food insecurity through the development of similar urban agriculture and community gardens. One organization that addresses this problem is the Center for Nutrition Policy and Promotion (SNPP), which is the subagency responsible for developing and promoting dietary and nutritional guidance based on scientific evidence. This organization has done a lot for the overall health

of Americans by serving as the federal guide to science-based food, nutrition, and dietary recommendations to advance healthy eating habits. Another organization addressing this problem is the Food and Nutrition Services, which is the subagency responsible for providing nutrition assistance through the Supplemental Nutrition Assistance Program (SNAP). Food and Nutrition Services aims to reduce food insecurity and hunger by providing low income people access to nutritional foods and increase their purchasing power by providing benefits that can be used to purchase food (USDA, 2021). A few other organizations that address our project's proposed solution are the USDA's Plant Materials Program and UC Master Gardeners. The Plant Materials Program has guidelines containing tips to help communities improve their gardening techniques as well as educate readers on garden preparation, fertilizing, weed control, and garden layout (NRCS, 2021). The UC Master Gardeners organization aims to be the primary resource for research based knowledge of home gardening and sustainable landscaping by providing gardening related events, classes, and help guides to educate community members on starting their own urban garden (University of California, 2021).

In addition to working towards solving food insecurity, we also addressed several civic issues with our project. Through the creation of our project we are contributing to the development of the local food system to allow community members to take control of their nutrition and become self-sustainable in their food production. This is in contrast to non-local agriculture where the cost of transportation, storage, and middlemen comes with a high price while decreasing freshness and increasing transportation related harmful emissions. Throughout our project, we haven't had any policies or regulations to follow, but we have used these to guide our design process. Firstly, in 2014 California's general assembly implemented AB 551, California's Urban Agriculture Incentive Zones Act, which allows landowners in metropolitan areas to receive tax incentive to put land to agricultural use (University of California, 2021). This measure was intended to kickstart local cities/counties to start creating urban agriculture incentive zones, leading to San Jose adopting the bill. In 2016, San Jose City Council adopted the Urban Agriculture Incentive Zone ordinance which allows property owners to obtain property tax benefits for urban agriculture if they fit certain criteria (City of San Jose, 2016). Some criteria include: 0.1 - 1 acre in size, no structures on the land unless agriculture related, must have proper water service, and must commence agriculture use within 90 days. We don't really have to worry much about these criteria, but being knowledgeable about policies like these are important when taking on the project we did.

Results & Analysis

Cut Results & Analysis

Prior to cut days we prepared around 30 unique cut files on VCarve. After a combined 22 hours of cutting over four days, we produced 21 long pieces, 67 small pieces, and 250 pegs using a total of 15 1220x1220 mm boards.

Figure 4: Final cut production pieces

The final pieces were all cut by the CNC machine precisely and accurately with what was designed. The use of a spreadsheet as a production tracking tool was very helpful and our completed table can be seen at Table A in the appendices.

However there were some issues that arose while cutting these pieces which lead to some piece imperfections and the production of 8 defective pieces. First, issues with the cut depth and material lead to almost all the pieces having rough edges that needed to be sanded down. Second, when ramping up production there were errors made in designing the cut files which lead to the creation of some defective pieces. Lastly, when initially experimenting with the long piece cut process there were some unexpected behaviors with the software when dealing with split cut vectors. As a result, the machine would cut inside the vector instead of outside or visa versa which lead to two defective long pieces. From there we realized this behavior and corrected it.

Build Results & Analysis

Prior to building the Growroom we visited the build site location to scope out the area we were planning on building. While we were there we measured the area for a 4x4 ft. base and then an area that extends up to a 8x8 ft. as shown by the dimensions in Figure 5.

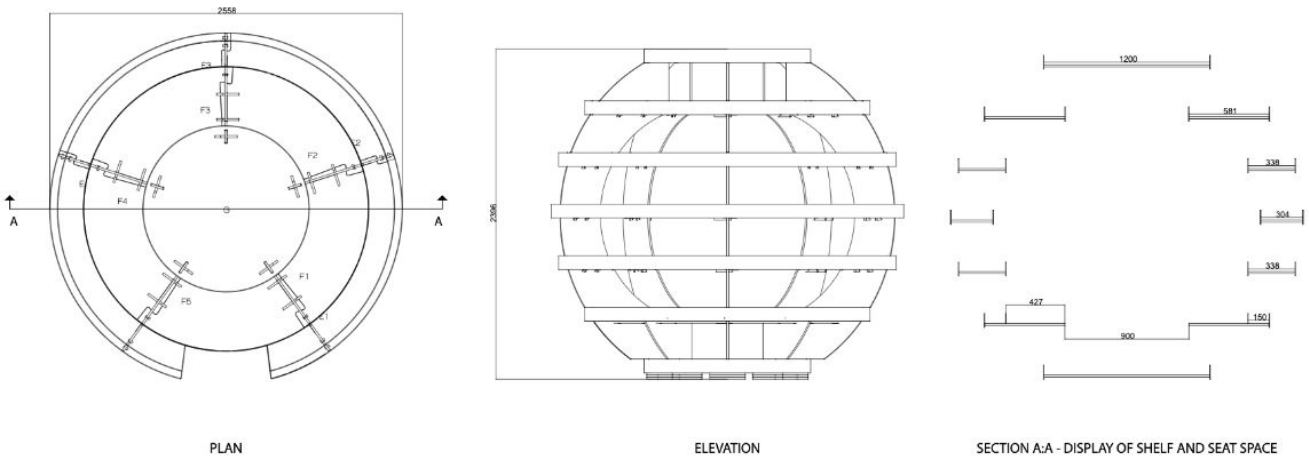

Figure 5: 2D Growroom models with dimensions.

From those measurements and some consultation with the partner organization, we decided that we wanted to do several landscaping changes to the area. This included removing the existing garden bed, removing plants in our way, and leveling the ground to install the protective planks that act as the base.

Figure 6A: Site pre-landscaping.

Figure 6B: Installing base planks.

After the site was prepared as shown in Figure 6A and 6B, we planned on having a two day build schedule with the first day for assembling the structure and the second day for sealing the structure with spar urethane.

The build process went mostly as expected, however there were a few issues that arose. While building we realized that some pieces were not cut perfectly so when putting them together it would not fit properly. To resolve this problem we had to trim some of the pieces with a saw to allow the pieces to fit together. This discrepancy between incorrect and correct pieces fit can be seen in Figure 7A and 7B.

Figure 7A: Correct piece fit.

Figure 6B: Incorrect piece fit with gaps.

However this solution of trimming the pieces to fit came at a cost as with the aggregate of all the adjustments, the last two pieces were not able to fit. We realized that since the globe is not fully completed each wall would fall away from the center causing the structure to expand which prevented the top pieces of the globe to be installed. To resolve this second problem we used ratchet straps to pull the whole structure together such that the structure is the correct size so we can fit the final pieces on as shown below in Figure 8.

Figure 8: Using ratchet straps to adjust structure size.

After the main frame of the structure was completed, we had to install the edging strips for each horizontal layer. This process took longer than expected as we were limited by the amount of power tools and clamps of the correct size. This tool limitation caused us only to be able to install two panels of

the edging strips simultaneously. Furthermore, our organization representative wanted the gaps between edging strips to be filled in so that there will be no holes for water to leak. We decided to fill the gaps with an epoxy cement, but in areas where it was applied too generously we had to sand it down. As a result of these two delay issues, we were not able to complete the edging strip installation process on the first day and had to complete it on the second day.

On the second day we completed the edging strip installation and coated the structure with spar urethane to waterproof the plywood. The process of applying the sealant took longer than expected and with some consultation with the partner organization we decided just to paint one coat. The reasoning for this is that they may paint the structure in the future, which will further improve the water resistance.

Figure 9A: Completed growroom.

Figure 9B: Growroom entrance.

At the end of our build process we were able to complete the assembly of the structure and provide it a degree of water resistance. The final Growroom structure can be seen in Figure 9A and 9B.

Overall, the build was very successful on the basis of the success metrics we mentioned in the project objective. The Growroom is completely built and waterproofed, the partner organization is happy/satisfied with the final product, and the community at the AACSA was involved in the assembly process which was a high priority to the partner organization.

Conclusions and Recommendations

Through the creation of the Growroom, we have provided the community at the African American Community Service Agency not only access to a healthy and sustainable food source, but also a way to educate the community about the importance of gardening and growing local sustainable produce. It will serve as a way to bring the entire community together to have important conversations surrounding food, health, and self care while empowering them to be more in tune with their green thumb. Furthermore, allowing the community to be involved in the assembly process of the Growroom gives them the sense of accomplishment and ownership of their new community garden.

Overall the fabrication of the structure went as planned and there were no major hiccups that prevented its completion. We learned a great amount of technical knowledge on how to use the VCarve software and how to safely operate a CNC machine for 2D plywood cutting. Additionally, we developed skills on how to manage a production process, coordinating with an outside customer, and how to work as an effective team.

From here, the AACSA organization will have the opportunity to choose their choice of plants, vegetables, and flowers they want to place in the growroom. If we had the opportunity to develop this project further we could consider adding an irrigation system for controlled consistent watering and including LED light strips in the structure for illumination at night. If we were to complete this project again for the cutting process we would consider using a sacrificial board when cutting to prevent piece edge splintering and increase the amount of quality control checks to make sure each board was cut correctly. For the building process we would find a better solution to fill the gaps between the edging strips and we would allocate more time to painting so we could apply more than one coat of spar urethane.

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Appendices

Correspondence with individual that has created the Growroom

Hi Jeffrey!

So here are a few things I learned while building the Growroom:

Materials

1) If it's going to be outside long-term and you are wanting it to hold up, I recommend using marine plywood and a marine waterproof epoxy sealant.
2) Whatever sealant you go with, you'll need quite a bit. I used two gallons and I really should have done 4.
3) Take your time on the sealant. You'll want to be sure to get a generous, even coat on every edge of the wood to prevent water from seeping into the grain. For this reason, I recommend you get one with at least 30 minutes to an hour of working time and only mixing the sealant you need to coat the piece or couple of pieces you are working on.
4) If you intend to fill each "shelf" with soil, I recommend using something other than thin plywood strips for the inner and outer rings that go along the edge of each shelf. These will degrade quickly. If you could find a sturdy, but flexible plastic that you can screw along the edge, I think that would be ideal.
5) I highly recommend purchasing two of your own bits for the CNC cutting. They are sharper and you have a backup in case you snap one (like I did).
6) Get at least one more sheet of plywood than you think you'll need.
7) Wear clothes AND shoes you don't care about incase the resin drips on it. Ruined a new pair of running shoes this way.

Building

1) When setting up your CNC files, you want to give enough space between each of your pieces so that you don't get unstable areas in the plywood while cutting. Trying to fit too many pieces on a sheet of plywood is what led to my CNC bit snapping. I recommend leaving the files as is on the downloaded build. Don't try to make them more effecient.
2) As you put each layer together, the tension on the entire frame increases. It becomes more difficult the more layers you add - so you'll need some extra hands from about the middle to the end of the build. And if you decide to seal each piece, you'll be adding a very tiny layer of width to each joint. So just keep in mind that measurement will compound on itself the more pieces you add.
3) Consider having a jigsaw around when you are building. Some joints required a little bit of widening to actually fit together. I don't think this is an issue with the files or measurements, but with that compounded fractional increase from the sealant.
4) You'll need a ladder to put the top together.
5) I decided to seal as I went. So I sealed and built the first layer on the same day, second layer sealed and built, and so on. The sealant, although only slightly tacky when assembling, acted as a waterproof glue for each piece fitting together. If I wanted to take my Growroom apart, I would almost assuredly have to cut and scrap it because it is sealed together.
6) Consider (perhaps post build) drilling drainage holes in each of the boxes if you intend to plant things in them. They very quickly become buckets of rain water if there isn't proper drainage. If you drill drainage holes, these holes will need to be well sealed with the epoxy.

Team Contract

Part A. (20 pts) Meet with your team and discuss and draft a Team Contract. Your contract should have a minimum of 4 content areas including:

- Goals - What are our team goals for this project? What do we want to accomplish? What skills do we want to develop or refine?
    - Help Derek Bryant design/obtain funding/build the grow room so that it fulfills his design/project requirements.
- Expectations - What do we expect of one another in regard to quality of work, attendance at meetings, participation, frequency of communication, etc.?
    - Equal partition of work and regular/transparent communication through text.
- Policies & Procedures - What rules can we agree on to help us meet our goals and expectations? How will decisions be made? How will you save evidence of each member's contributions to the project and ensure all members have access to all team documents?
    - Keep documentation of meetings/discussions on Google Docs.
    - When making decisions we can each discuss our pros and cons and reach a consensus from there.
    - Since we are a two person team it will be easy for us to keep track of our progress and keep each other accountable.
- Consequences - How will we address non-performance in regard to these goals, expectations, policies and procedures?
    - Clearly address our team members non-performance and figure out a solution.

Each member of the team should sign this Team Contract. Scan in document with signatures and submit a team copy of the Contract!

Oliver Jaros

Jeffrey Lin

Production Tracker Spreadsheet (Table A)

Vector File	Piece Type	Piece Num	Status	Date	Final QA Check
9	A1	1	Cut	2/12/2021	Check
11	A1	2	Cut	2/12/2021	Check
11	A1	3	Cut	2/12/2021	Check
11	A1	4	Cut	2/12/2021	Check
12	ABase	1	Cut	2/16/2021	Check
11	AShort	1	Cut	2/12/2021	Check
11	AShort	2	Cut	2/12/2021	Check
11	AShort	3	Cut	2/12/2021	Check
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