To: Dr. Trevas

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Subject: Implementation Memo 2

The Vertical Farming project became an interest after years of learning about methods of self-sustaining farming that was also user friendly. Vast farmlands should not be the only way that people can grow and eat their own food source, it should be reasonable and affordable investment on a smaller scale to be able to grow enough food feed a family. The design should allow for an ease of use for clients, as well as being aesthetically appealing. The typical composting method could be used since it is the best method for nutrients... but the downside is that you would need to build up your compost with many types of decomposing natural materials. Decomposition comes with many negatives, such as the time needed to decompose, the smell, and of course the need to move said material from a pile or bucket to a planting site. Now with this information people usually have an interest in aquariums and fish waste is all in the water column and depending on the tank and fish type the plants would have nutrients readily available to use and the user would have little maintenance. As well as the added benefit of freshening the air inside of the home creating a nicer smell depending on the plants.

The project will be made as user friendly as possible and has the option of a DIY build or a semi assembled option that comes with everything the user would need to assemble his or her system. The team is leaning towards a semi assembled product since there can be user error in DIY systems which will have customers unsatisfied and requiring customer service. The plan that the team has made is that we will have a wooden base to keep cost down while using Unistrut for above the tank scaffolding that will hold the water troughs. The troughs will use a capped method covering the top with 2-inch diameter holes drilled into it to house mesh nets that will hold onto the plant's roots. The wooden stand will hold a fish tank that will feed the plants above using the nutrients from fish deposits. With the exception of feeding the fish, the goal is create as close to a self-sustaining system with minimal monitoring to appeal to the general population that may not have lots of time to focus on growing homegrown vegetables. By offering a simplistic design with lots of room for customization, the project will ultimately be a proof of concept where the focus will be on the components required to run the system successfully.

1 Implementation – Weeks 7-11

The team has made great strides in the assembly of the design after the budget was finalized. A full-sized fish tank was purchased along with a wooden stand to save on building materials costs. Unistrut has also been purchased to begin assembly of the upper frame system that will carry the load of the troughs and plants. The project is currently in motion to fulfilling the updated design.

1.1 Manufacturing

For last months' worth of work on this project, the team has been primarily cutting and assembling Unistrut. Alongside this, in preparation for assembly, the team resealed the tank. Resealing the tank involved using a caulking gun and silicone sealant to form a bead around the edges and corner of the tank. The team used razor blades and acetone to clean the seams of the tank in preparation for this process.

To cut the Unistrut, the team used an angle grinder with a cutoff wheel to perform semi-accurate cuts after measuring and marking the lengths. After the cuts, the team used a handheld belt sander to clean and smooth the cut ends of the Unistrut. To mount the Unistrut, the team used carriage bolts, nuts, and lag screws to assemble and mount the lengths to the stand. An impact drill was used to ensure the lag bolts went through all pieces of supporting wood and that the Unistrut beams would not shift.

For the reinforcement of the tank stand, the team used 2x4 and 2x6 pieces of wood. To cut these, the team measured and marked the wood, then used a circular/skill saw to trim the pieces to the correct length. There was no finishing done on these pieces as they are either underneath the stand or inside of the cabinet. The team also removed the doors to the cabinet to ensure they were not damaged during the building process. This was done with an electric handheld drill.

1.2 Design Changes -Weeks 7-11

Implementation for the project began with cleaning and resealing the fish tank with silicone adhesive. Doing this ensures that no leaks can occur from the tank through cracks in the glass sealant. Once the adhesive was allowed to dry, the team began working on assembling the Unistrut framing. The first step in this is reinforcing the existing stand to ensure that casters could be installed in the future as well as ensure that the weight of the troughs could be supported. This step, along with mounting the Unistrut, can be seen in the design iteration below. Once this step was done, the team began cutting and assembling the square Unistrut cross sections. As of writing this report, the Unistrut cross sections have not been decided on and the troughs have not been implemented yet.

1.2.1 Design Iteration 1: Change in Unistrut Mounting

In our original design, the team was going to build a fish tank stand and source or build a 48 x 24 x 18-inch fish tank. To cut down on prototype expenses, the team found a prebuilt fish tank and stand combination with a size of 72 x 24 x 18 inches. Due to this, the team has changed some of the Unistrut lengths as well as the mounting points for the Unistrut.

The team decided on reinforcing the current frame that came with the fish tank with 2 x 4 pieces of wood on the interior and 2 x 6 pieces of wood on the underside to accommodate casters as seen in figures 1 and 2.

Figure 1: 2x4 Internal reinforcement Figure 2: 2x6 Bottom reinforcement

Along with this, the team decided to mount the Unistrut along the back of the tank stand instead of through the top. This is due to not having an upper rim around the tank that is suitable for mounting on as seen in the CAD model. This change can be seen in figure 3.

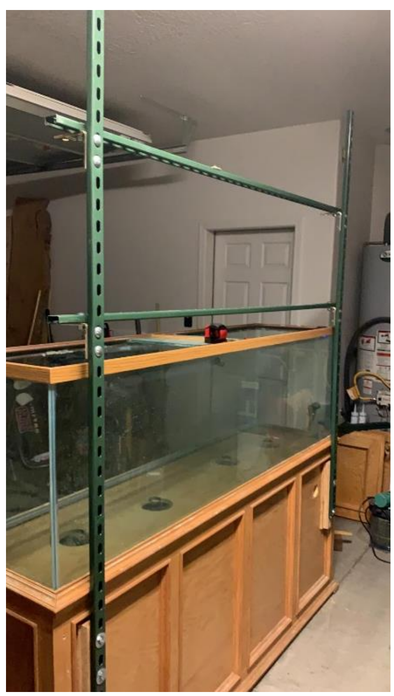

Figure 3: Rear mounted Unistrut

2 Standards, Codes, and Regulations

2.1 Standards applied to project

Table 1 table of standards

Standard Number or Code	Title of Standard	How it applies to Project
NEC Article 680	Requirements for pool, hot tub, and fountain installations	Compliance will reduce the risk of electrocution
ISO22000	Food Safety management	Will help create an effective food safety management system.
HACCP	Hazard analysis and critical control point	Compliance will ensure safe food is produced by identifying and controlling food safety hazards.
NEC 210-23(a)	Permissible loads	Will determine the maximum load that can be placed on a wall outlet

The fish tank in our design will hold approximately 90+ gallons of water. This body of water being placed next to an electrical outlet means that we need to meet code requirements listed in NEC article 680 for installation, design, and inspections to protect people from electrical hazards. Requirements include electrical equipment cord lengths not exceeding 3ft, cords must have copper equipment grounding not smaller than 12 AWG that terminates to a grounding-type attachment plug, all receptacles used must be GFCI protected and equipment disconnecting means must be accessible within sight (within 50 ft).

ISO22000 is an internationally accepted standard used by organizations involved in food production and distribution. The objective of ISO22000 is ensuring food safety. ISO22000 requires us develop a food safety management system and a risk analysis to evaluate every food safety hazard identified in the design. A food safety hazard identified is the coating and paint on the grow troughs. The grow trough's zinc and painted coating will need to be removed prior to running water through them.

HACCP main principles are identification and assessment of hazards associated with the food product, determination of the critical control points to control the identified hazards, and establishment of a system to monitor the critical control points. HACCP will require us to conduct a hazards analysis, determine critical control points, establish critical limits for the control points, establish a monitoring system for each control point, establish corrective actions, establish varication procedures, and establish documentation/record keeping.

Outlets in homes in the United States can carry maximum loads of 15 amps or 20 amps. Multiplying this by the standard 120 volts gives us the maximum loads of 1800 watts or 2400 watts. NEC 210-23(a) reduces these amounts to 1440 watts and 1920 watts because it requires that only 80% of the maximum capacity is used. The current design uses 600 watts for lighting, 616 watts for water heating and pumps, and 5 watts for an Arduino circuit. The total is 1221 watts. This well below the maximum load.

3 Risk Analysis and Mitigation

The team has kept the same design from the get go to help mitigate errors in the build process while some revisions are being made depending on the changes needed and what is not working well for the design.

3.1 Potential Failures Identified Fall Semester

The fall semester has shown the team that there are certain factors of our build that were over engineered and that there are some cutbacks that can be made. The racking system being one of the aspects that the team decided to change for the design instead of the rack having four vertical mounts from the stand we opted out of that system to have a rear mounted 2 upright system instead while accounting for a brace that may be needed in the front of the stand.

3.2 Risk Mitigation

The team will do a risk analysis tomorrow on the stand to see if the braces and two mounting points will be sufficient to hold up the racking system. This will include measuring from a datum to see if there is any deflection in the material as well as deciding upon a system to brace from. This should use less material and could potentially cut cost on the overall budget by at least a hundred dollars.