Green Space

BY,
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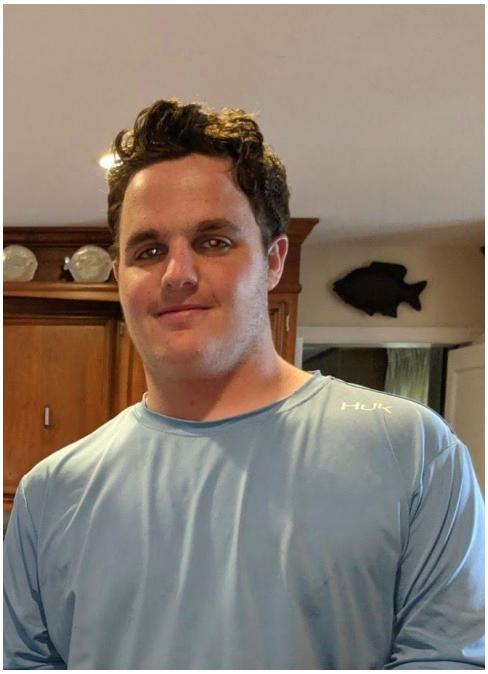

I am a student graduating in the class of 2020 at Science Leadership Academy. I have been in the CTE Engineering Program for the past three years at SLA. I am a member of SLA's engineering and robotics club, I could also be found working at my Uncle's Hardware store, or offshore fishing. I am also a Philadelphia Futures Scholar, and I am going to Villanova University's College of Engineering this fall. I plan to major in Mechanical Engineering, and look to be an active student on campus.

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My Love For Horticulture

Over the past few years horticulture and growing plants has become a big hobby of mine. I believe that greener living environment has all sorts of positive benefits. Growing plants is proven to reduce stress, improve social skills, and improve memory and cognition. There are also many positive benefits to physical wellness associated with horticulture. Eating a plant-based diet is proven to reduce carbon emissions, and

plants produce oxygen improving air quality. A goal for my greenspace was to promote a “cleaner and greener” environment, and to promote eating habits that have a positive impact on the environment.

Introduction

For my capstone I planned to make an automated greenspace in SLA that could later be used to by students, and members of the SLA community. I planned to use my skills in engineering in order to design and build this space. I also wanted to use my engineering skills to control different variables that affect plant growth. I also planned to learn how to code and learn how to design a complex system.

I chose to work with horticulture for my project because I have really liked growing plants, and I wanted to spend time focusing on them with my capstone. I helped build a greenhouse at my uncle’s store last year, and I learned a lot throughout that process. I have a bunch of plants that I grow at home, and I thought that it would be a fun and challenging topic to work with. I also knew that SLA needs a greenspace, because it would be a great thing for students to interact with.

I feel like my capstone does a great job addressing all of SLA’s core values. Inquiry and research are big parts of my project, I think that each of the core values played a key part in my project. As I began brainstorming different potential locations and layouts for my project, I embodied the core values of inquiry and research. I felt like

I had utilized my resources pretty well as I designed my project. I collaborated with Mr. Kamal a lot, and had a ton of questions for him as I laid out my project design. As far as presentation goes, I would have been able to work with this core value a lot more if I could have actually built my greenspace.

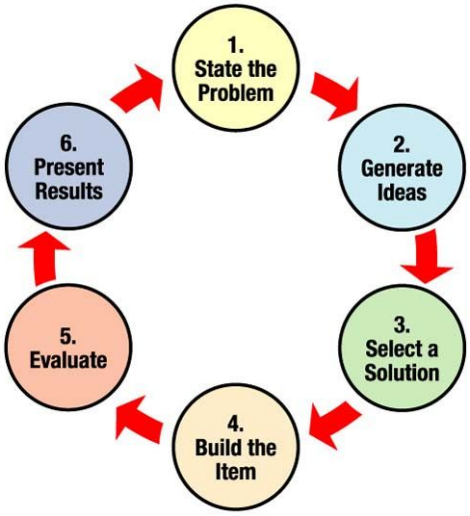
Process

I spent a lot of time inquiring and doing research in order to come up with a design for the green space I planned to make. I faced a lot of obstacles throughout the process, because there are a lot constraints when it comes to putting a green space into the school. One big concern had to do with using electricity to control the different parts of my growing system, and making sure it was safe to have low voltage near water.

I started working on this project by watching a lot of youtube videos about growing plants, and utilizing the list of resources I had made. I also looked at a lot of designs that have already been created with similar urban growing spaces. There are many obvious obstacles when trying to grow plants in a classroom, and making a complex growing system. A big resource for me had been knowledge I gained from my work at the plant store. A mentor that helped me with this project had owned a bunch of greenhouses in the past, and he had spent a lot of time working with Raindrip watering systems, LED grow lights, Capillary mats, floating shelves, and othe creative devices used to grow plants efficiently in a controlled setting.

The Engineering Design Process

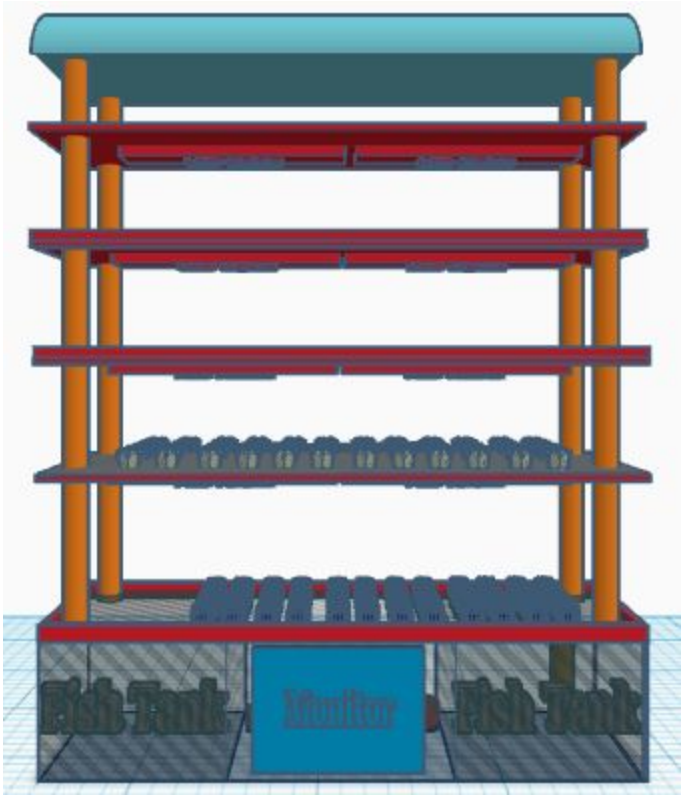
During my time in SLA's CTE Engineering program I learned a whole lot. We spent a lot of time working on projects, and with every project there was always one constant. We needed to use the engineering design project in order to solve our problem and create our product. Whether it was the Bridge Building Challenge or our final project on Climate Change and Global Warming.



With my capstone I had only made it through the first three steps of this process, but hopefully someone will be able to finish the project in the next couple of years. There was recently a green club created at SLA, and hopefully that club can take the initiative to follow through with making a greenspace.

Inititally I had developed five different ideas and potential designs I could use to make a greenspace. These ideas included a greenhouse on the 6th floor terrace, a greenwall in the hallway on the fifth floor, and a few other similar concepts. After going over each idea, the purpose I wanted my project to serve, and the resources I had I moved forward with further conceptualizing of my design. The space that I had chosen was perfect, because it had access to everything needed to successfully grow all types of plants. This solution seemed perfect, especially with the means and capabilities that I had to build the space I envisioned.

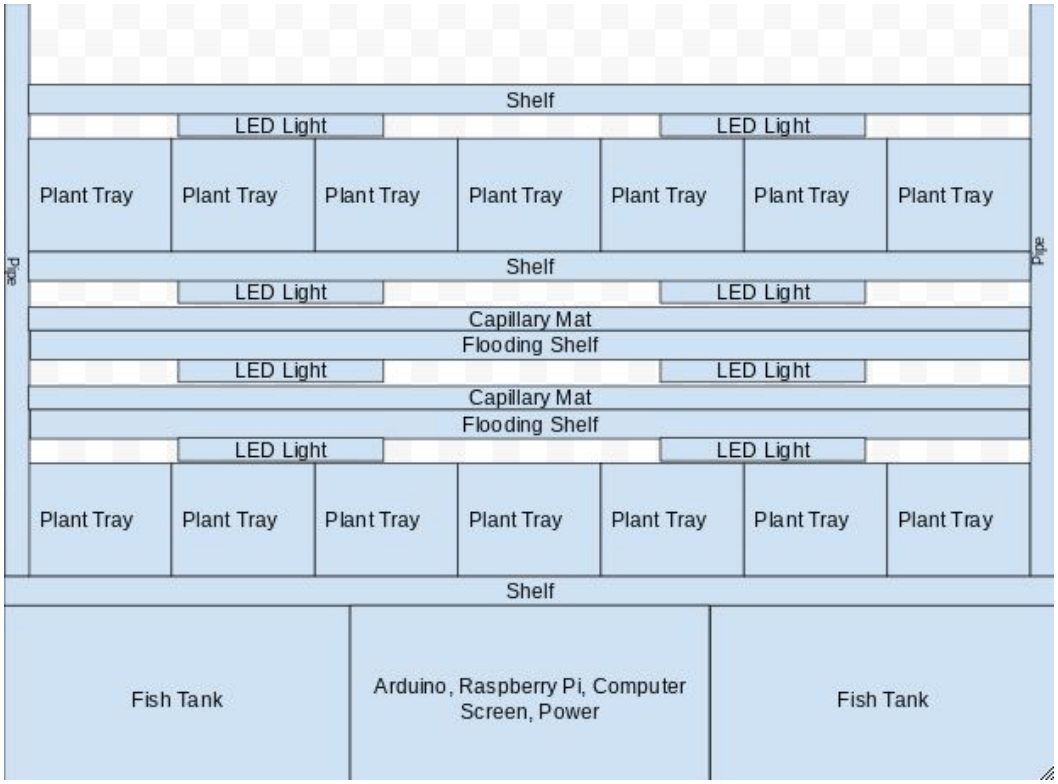
Overall Design



The space I originally planned to use for my project design was the room between the science labs on the 5th floor of SLA's new building. There is a countertop against the window in that room, and the space is approximately 108" long by 36" wide by 72" tall. In order to house the plants that could be grown I planned to install two modules made out of PVC piping, marine grade plywood, and some stainless steel hardware to hold them together. Each module would be 54" long by 36" wide, by 60" tall.

After installing those modules the next phase of the plan is to install trays on each shelf that could be flooded using the plumbing system that would be installed later. These trays would be designed to allow water to flow into the bottoms of the potted plants, and this exposes the roots of the potted plants to water. In order to control the water that the plants receive, you would need to use Pex tubing, sprinkler line valves, fittings, and an arduino.

After setting up the plant watering system, there are other variables that will need to be focused on in order to keep the plants healthy and growth rates high. The other important variables affecting the plants grown include strength of Sunlight, length at which sunlight is provided, Temperature, Nutrients/Food in soil, Humidity, Water PH Level, and soil Drainage.



Sensors and Systems

When creating a controlled and automated growing space, sensors are crucial to allow your computer and program to keep a controlled growing environment. Different parts of the growing system that I planned to install included a watering system with drainage and moisture sensors. I also planned to install a fan with temperature sensors.

Materials Used

Below is a list of the supplies that I planned to use to build the structure

Part Needed	Units needed
10x20 Trays	10
2 CF Organic Mechanic Potting Soil	1
LED Wide Spectrum Light Strip	8
Black Oil Organic Sunflower Seed	1
Spinach Seeds	1
Pea Seed	
½ inch pex tubing 50 feet	1
¾ inch pex tubing 50 feet	1
Misc. Pex fittings set	1
PVC Pipe 2 inch 10 feet	2
PVC pipe 1 inch 10 feet	2
Raindrip Watering System Installation Kit	
Arduino Circuit	

Rasperry Pi 4	
14 gauge electric Black/red Wire	2
Computer Monitor	
Varius Succulents, Greens, Flowers	
Support, and Storage for the greenhouse	
Nutrient Water Storage Tank	
Moisture Sensor	
Heating Pads/Cable	6
Flooding Shelves and capillary mats	2
10-15 gallon fish tanks with pump and filtr	2

Code and My Program

A big part of the plan for my project was to have all of the growing variables controlled by a computer using code. I planned to use an arduino with a bunch of different code to determine when the plants needed water, or how much supplemental light they needed.

CAD

With the inability to actually make a prototype and build my plant unit, CAD was a great design tool that I able to use in order to make a model of my project. I wasn't able to use advanced CAD Software, and I needed to use a software that is cloud-based with my Chromebook.

Reflection

Overall I am really happy to have chosen to do a greenspace as my capstone. Unfortunately, I wasn't able to produce a physical project like I had planned to do. I ams still glad to have a good conceptual design, and that the idea is in place in case someone wanted to do this project at a later date. I did learn a lot throughout the research process writing this paper. I also learned a lot more about the different ways you could grow plants. Prior to this project I didn't know very much about hydroponics or aquaponics.

Throughout the capstone process I learned a lot about the topics/concepts I studied, and also a lot about working on a long challenging project as a whole.

If I were to do this capstone all over again I think there a few things I would do differently. My capstone was kind of dependent on the resources I had, and I had to come up with an economical budget. I would have spent more time focusing on the CAD and modeling aspect of the project. I wasn't really able to make the CAD drawings

in which I had planned to make, but with more time and the ability to CAD I think that would have been a great addition to my project.

I have learned a whole lot in the time that I spent at SLA. Throughout the last four years, SLA has engrained it's core values into me in a variety of different ways. Through each project that I did, I never once could say it didn't tie back to the core values. I

Bibliography

Here is a list of resources that I used to influence ideas for my project design. Feel free to read through them, some interesting tips on automatic growing, hydroponics, and other concepts relative to horticulture are included.

Adelson, I. (2019, April 25). The Best Fertilizers for All Types of Plants, According to Experts. Retrieved January 31, 2020, from http://nymag.com/strategist/article/best-fertilizers-for-houseplants.html

A major variable for the rate at which plants grow is the type of soil they are grown in, and the way they are fertilized. You need to be extremely careful when you are fertilizing plants because they will die if they are given an overwhelming amount of nitrogen. Fertilizer also impacts the taste of the greens, but it has to be organic or it will not be worthwhile. I have learned that certain types of plants like certain kids of soil. For example sunflowers like heaver soil that spinach does. Most microgreens will tend to grow better in a "seed starting blend" soil that is aerated better for them to have the ability to grow faster.

Ballard, G. (2018, April 2). Top 4 Healthiest and Tastiest Microgreens. Retrieved from https://blog.backtotheroots.com/2018/03/13/top-4-healthiest-tastiest-microgreens-seeds/

In doing this project the most important thing about growing the Microgreens is that they need to be edible so that people are abe to eat them, and they like them. With

this source I determined that I will be using primarily sunflowers and peas at first because they are the most popular microgreens to grow. They are the easiest to grow, and apparently the tatiest as well. I also learned that microgreens tend to have a lot more flavor then regular greens do. I hope to also be able to grow spinach and other greens that this source taught me all about.

Beaulieu, D. (2020, January 14). Learn About Automatic Irrigation Systems, Pros, Cons, and Benefits. Retrieved January 30, 2020, from https://www.thespruce.com/automatic-irrigation-systems-2130775

Automatic irrigation systems are a very interesting piece of engineering that I think will be good to include in my project. I will be controlling when each individual shelf gets watered in case I want to keep different kinds of greens on each shelf that require more or water. Cons of an automatic watering system is that they can get to be kind of complex. When watering a lot of plants the systems can get really complex, and expensive at the same time. In the long run it probably saves money because I will not be using nearly as much water with the system that I will be installing compared to how much I would use if I were to just water the plants manually by myself every day. I will also consider working on possibly installing humidifiers where I will be germinating the seeds.

Bloom, F. (2019, January 12). Hydroponic Systems 101. Retrieved January 31, 2020, from https://www.fullbloomgreenhouse.com/hydroponic-systems-101/

If I have time after installing everything else on my plant growing cart I will install a full shelf of hydroponic growing. I always really wanted to make a hydroponic growing system, and I think this woul be a really fun experience. There is also a lot of engineering involved in growing hydroponic plants. This source provides a lot of detail about growing plants without soil, and different factors such as the amount of Acid in the water and how much pH different kinds of plants like. I also think that it would be pretty cool to try and make a model of a hydroponic growing system in CAD.

Bootstrap Farmer. (2019, March 25). Growing Microgreens 101. Retrieved January 31, 2020, from https://www.bootstrapfarmer.com/blogs/microgreens/how-to-grow-microgreens-101

Growing microgreens is a lot more complex than it seems I have realized. Ensuring that microgreens will germinate is extremely important. When the plant seeds aren't kept at optimal temperature the rate at which they germinate or die is extremely different. The optimal temperature at which seeds will germinate is 85 degrees. It is also recommended that you soak your seeds for a few hours before putting them in soil. After soaking the seeds you should line a tray with a thin layer of soil before placing the seeds on top. After that you need to put an additional tray on top of the seeds so that they will be pressed down and begin growing roots faster.

Buckley, I. (2018, July 6). How to Program Your Raspberry Pi to Control LED Lights. Retrieved January 30, 2020, from https://www.makeuseof.com/tag/raspberry-pi-control-led/

Using this article I was able to determine all sorts of factors about greens. I learned that often time greens like to have more hours of sunlight than they are naturally given. An ideal amount of lighting time for greens is 14 hours or more. This will be useful to make the microgreens grow faster and healthier. Another major variable in growing microgreens is how much water they receive. Microgreens can't be over watered or it will stunt their growth. There are all sorts of lights that you can use in order to grow plants. I also learned you can use LED lights to grow plants which tends to be much more energy efficient.

Francis, B. (2018, February 6). How to build your own private smart home with a Raspberry Pi and Mozilla's Things Gateway – Mozilla Hacks - the Web developer blog. Retrieved January 31, 2020, from https://hacks.mozilla.org/2018/02/how-to-build-your-own-private-smart-home-with-a-raspberry-pi-and-mozillas-things-gateway/

In order to power my cart correctly I will need to learn a lot about coding, and how raspberry pi computers work. I think that this will be possible, and this source taught me a lot about raspberry pi's. I will also need to use my circuitry skills in order to connect all of the wiring necessary to my computer properly. I have also considered where on the cart I will keep the raspberry pi and the important electrical components that cannot become damaged. I think the best place will be on the botton shelf of the cart where I will not be keeping any plants.

Grist, D. (2019, March 11). How to Start Seeds - Germinating Seeds: Gardener's Supply. Retrieved January 31, 2020, from https://www.gardeners.com/how-to/how-to-start-seeds/5062.html

Germinating seeds is an extrenely complex process if you want to be good at this. In order to be successful and not waste any seeds, you need to soak them before planting them in soil. After letting them sit in soil for a couple of days until they start growing roots you need to keep them in complete darkness for a couple of days. When keeping the plants in complete darkness they will be stressed out which promotes faster growth. This is very important because the grow cycle for microgreens considering some only have a grow cycle of 7-10 days.

Prakoso, E. (2009, July 21). Home. Retrieved January 31, 2020, from https://www.cad-notes.com/a-simple-guide-12-steps-to-mastering-autocad/

While desiging my project I will be using CAD as a part of my presentation, and I also need to learn the skill. I looked at this website in order to learn the 12 most important steps for making sure that I am good at CADing. Learning how to use all the different features of a CAD software will allow me to have a step up. I also will be able to model the system that I am trying to create so that I can show it to other people. It has been over a year since the last time that I was really actually trying to CAD, and I really like it. This source breaks down all important steps in CADing pretty well.

Warner, J. (2012, August 31). Tiny Microgreens Packed With Nutrients. Retrieved January 30, 2020, from https://www.webmd.com/diet/news/20120831/tiny-microgreens-packed-nutrients#1

An interesting aspect about microgreens that I am looking into is whether they are more nutrient rich that regular greens. After looking at this source I established that microgreens are much more nutrient rich than regular greens, they often have more than 5 times more vitamins and nutrients than mature greens. This is especially true for Peas, Spinach, and Sunflowers. There is also a larger variety of types of greens you can eat before they reach first leaf. Researchers in universities around the country are currently learning new things about microgreens and the amount of nutrients that they have. According to this WebMD article microgreens have many different health benefits.