

Greenovation 2015

# Urban Farming: Bringing Hydroponics to Georgia Tech

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## Table Of Contents

I.	Executive Summary.....	2
II.	Background.....	2
III.	Physical Changes.....	3
IV.	Environmental Sustainability.....	4
V.	Social Sustainability.....	5
VI.	Economic Sustainability.....	5
VII.	Conclusion.....	6
VIII.	References.....	7
IX.	Appendix.....	8

## **Executive Summary**

Hydroponics is an innovative farming method that utilizes a nutrient solution to sustain plant life instead of soil. This method uses 90% less water than traditional farming, decreases the growth time, and allows crops to be grown pesticide-free and out of season [1]. Engineers for a Sustainable World (ESW) currently has a functional hydroponics system and can attest to its advantages over traditional farming. ESW believes that using hydroponics is a powerful form of urban farming, which merits better representation at the Georgia Institute of Technology.

ESW's primary intention for the Greenovation Competition is to introduce urban farming via hydroponics to the renovated Student Center. Introduction of a designated hydroponics room, in addition to setting up hydroponics systems in various spaces around the Student Center, would promote social, economic, and environmental sustainability, using a utilitarian, production space as an innovative study area.

The hydroponics room converts part of the Student Center into a greenhouse-study room hybrid. This room will be located on the south side of the second level, near the current WREK Radio offices. In order to let in sunlight and achieve the greenhouse effect, the existing roof and walls would need to be replaced with glass. This room would thus be a fully-functioning greenhouse. Hydroponics trays would be stacked on a rack, each tray receiving its own grow lights.

The room will be design to incorporate the hydroponic system, necessary storage, and usable space for students to eat and study. The aim of the hydroponic room is to be of similar use compared to the Clough Common's rooftop garden. This innovative area would be a focal point for students who wish to study among living plants, eat in a naturally lit, comfortable environment, or enjoy viewing the growing process of fresh produce, all while being in an urban environment.

The fresh produce grown in this system would be used to promote social and economic sustainability in the community. To increase social sustainability and have a greater impact on the community around Georgia Tech, a portion of fresh produce would be donated to nonprofit organizations, e.g. The Atlanta Community Food Bank. To increase economic sustainability, the remaining fresh produce could be sold at the Georgia Tech Farmers Market or used in campus dining halls and food courts.

An important part of a hydroponics display is ensuring that it is used to inform the public about urban farming and healthy eating. For this reason, the hydroponics room would feature a TV screen with images of information about hydroponics, and show how students could get involved in helping to maintain the hydroponics room, or promote urban farming.

## **Background**

Engineers for a Sustainable World is a project-based organization which has been on campus at the Georgia Institute of Technology since 2011. Since then, ESW has established and executed several initiatives in the Atlanta area, such as a project developing sustainable cement

using a recycled aggregate. ESW received a hydroponics project proposal last spring and worked over the summer to formulate a plan for establishing hydroponics on campus. Last autumn, ESW received approval to use the greenhouse on the roof of the Cherry Emerson building to set up a small hydroponics system (see Figures 1 and 2). ESW worked with Atlantis Hydroponics and SEEDS Global to get the supplies necessary for this feat. This semester, ESW germinated and grew a crop of leafy greens, donating the produce to the Atlanta Community Food Bank (see Figure 3). ESW is currently growing a second crop and working to establish a larger hydroponics presence on campus via displays in buildings and a new research greenhouse.

This greenhouse has received approval by College Of Engineering Dean Dr. Gary May and the Chair of the School of Biology, Dr. Terry Snell. The greenhouse plan has been presented to and developed in conjunction with GT Capital Planning and GT Landscaping Services. In addition, the hydroponics team is dedicated to teaching sustainable practices and bringing hydroponics to elementary schools in the area, such as Perkerson Elementary and Ways Academy (see Figure 4).

ESW sees Greenovation as a unique opportunity to further increase green awareness and sustainability on campus via hydroponic practices and urban farming. The ESW proposal will directly impact the students, faculty, and outside community of Georgia Tech socially, economically, and environmentally.

### **Physical Changes**

A hydroponics study and relaxation room is the key feature of this project. This room is proposed to be located on the southern side of the Student Center, on the southern side of the second floor (see Figure 7). This location will provide the maximum amount of sunlight for the plants. The existing exterior walls and roof would need to be replaced with glass panels to increase the amount of light, and thus will also provide the room with a more open, natural feeling.

The interior of the room will consist of hydroponic systems along all four walls. The systems along the external walls will be composed of 2 hydroponic tiers to allow for maximum usage, while still giving students the ability to see outside. The upper level tier of the systems will utilize natural sunlight, while the lower level will utilize LEDs to provide light. There will also be a tiered hydroponic and aquaponic system near the center of the room, but spaced out enough to ensure ample space for tables, couches, and chairs for the students to be surrounded on all sides by greenery or fish, giving them a feeling of being part of nature.

Finally, the windowless walls will incorporate a 4-tiered hydroponic system. This system will require lighting on each level to sustain the fresh produce. This system will not extend across both walls, as there will also be a mounted TV in the center of one to promote the hydroponic room's functionality and impact. A series of information slides and videos will promote sustainability, urban farming, and tips on how to incorporate sustainability in a college environment. A bulletin board will also be placed on this wall to allow students to share their

own ideas, motivational quotes, and achievements. The aim of this bulletin board is to help engage students with the hydroponics room and help students cope with the stresses of college by allowing them to celebrate their achievements. The center of the room will house tables, couches, and chairs for students to utilize for studying, eating, or de-stressing.

The floor of the room will be tile, as this room's utilitarian purpose requires that the room be easy to clean up should the system break or require maintenance. Rugs will be placed by the couches and tables to make the space more inviting. Figures 8, 9, and 10 illustrate a mockup of the envisioned hydroponics room. All in all, this space should be an area with open, natural lighting and consist of fresh growing produce via hydroponics and aquaponics. This room will provide students with relaxing green haven in the heart of the city - a comfortable, organic, and natural environment for students to relax, study, enjoy, and celebrate themselves.

### **Environmental Sustainability**

Overall, the hydroponics system would be very environmentally sustainable. In general, hydroponics is an efficient way to grow fresh, healthy food in an urban environment. Hydroponics uses 90% less water than traditional farming, decreases the growth time, and allows crops to be grown pesticide-free and out of season [1]. In addition, since hydroponics uses water as the growing medium rather than soil, it can take up much less space (preferable in urban areas) and also does not exert any stress on the land. Based on current population trends, we will be expected to produce 70% more food by 2050, and farming in soil will lead to a reduction in water quality, increased soil erosion, and possibly less nutritious food as the food would be grown in increasingly nutrient poor soils [2]. Hydroponics and aquaponics, which can be used in vertical farming methods, are one of the solutions to this problem. Our vision in the Student Center will allow for a large production of fresh greens, and although the total number of trays in the room will depend on its size, it should be noted that up to 20 plants can be grown per tray, and all our system includes either 2 or 4 tiered trays. Thus, a significant amount of fresh produce will be generated for the students of Tech as well as for the Atlanta Food Bank.

Hydroponics is also in line with the "grow your own food" movement, since it allows fresh produce to be grown and sold locally, the transportation mileage is often within a 5-10 mile radius within the city, and that is also the case with this system in the Student Center in particular. This significantly decreases "food mileage," or the amount of time and miles it takes for your food to go from the farm to your plate. Thus, will decreased transportation time, there is a significant decrease in greenhouse gas emissions released from long truck/plane rides (remember your bananas come here all the way from Columbia!), and thus a significant decrease in cost as well. Also, since less time is used to transport your food, the produce retains more nutrition.

Our hydroponics system in the Student Center would be exceptionally eco-friendly, as it will use recycled water from the rainwater collection system that will be placed on the roof. The solar panels would cause another reduction of greenhouse gas emissions by not acquiring power

from a power plant. The aquaponics system (hydroponics linked to a fish tank) would be an even more sustainable system, since waste from the fish would be able to “feed” the plants (decreasing or negating the need for nutrient solution), and growing algae could be used as fish feed.

### **Social Sustainability**

At its most basic level, ESW’s enterprise is promotes social sustainability because a portion of the harvested crop is donated to the Atlanta Community Food Bank. With the Student Center’s superior resources, its system could produce much more than ESW’s small test system. Thus, it seems beneficial for the Student Center to create a community connection by becoming a donor.

Furthermore, the hydroponic room will impact Georgia Tech’s student population. The combination of hydroponics trays, the fish tank, and seating will create a unique study space. ESW members have witnessed firsthand that people enjoy spending time in non-traditional areas. At the Georgia Aquarium, many people just sit in viewing theatre and watch the fish swim back and forth. People pay substantial sums of money to be immersed in nature at the Atlanta Botanical Gardens. Additionally, Georgia Tech students enjoy studying in the nature-filled rooftop garden of the Clough Undergraduate Learning Commons. ESW believes that a hydroponics room would create a similarly enjoyable place to be and would attract students to the Student Center. Such an attraction would foster social interaction.

In addition, hydroponics and urban farming in general provide a way to cure food deserts in the city. The United States Department of Agriculture (USDA) defines food deserts as low-income communities located more than one mile from a reliable source of fresh produce and other healthy foods [3]. This is largely due to a lack of grocery stores, farmers' markets, and healthy food providers. According to the USDA’s food desert locator, there are nearly 2 million Georgians living in a food desert, and there are over 263,000 people living in a classified food desert in Fulton County, which is nearly 50% of the total population (see Figure 5 and 6) [3,4, 5]. Over 30% of these people are from a low income family or without vehicle access to food.

Therefore, this hydroponics room will not only provide fresh, healthy food to the students of Tech and the Food Bank, but it will also be used as an educational tool to encourage the spread of urban farms in other areas of Atlanta that are deprived of local, fresh, and healthy produce. Students at Tech and all Atlantans in fact will be able to view this room as a successful model of a sustainable farm in the city. Information will be provided in the room that educate those who enter about how to grow their own food and also how to implement general sustainable practices into their own lives.

### **Economic Sustainability**

While this system would have a significant implementation cost, its installation would help the Student Center save money in the long run and would help earn back the investment. A

hydroponics system does not require soil, but still needs electricity, nutrient solution, and water to function. In order to avoid additional costs accrued from purchasing these resources, solar panels and a rainwater collection system would be added to the Student Center rooftop. While simultaneously fostering environmental sustainability, these setups would decrease the time required to make returns on investment.

Currently, the rooftop of the Student Center has an abundance of space ready to be used. Thus, it can accept solar panels to generate energy. A hydroponics system only requires energy for pumps and lighting, and for a two tray system, this requires roughly 80 - 100 watts. A crude calculation shows how effective solar panels could be on the Student Center's roof. A typical residential solar panel measures 60x40 inches (18 sq. ft.) and can garner 200 Watts under open sunlight [6]. Given the size of the Student Center's roof, it is easily possible to install hundreds of panels. Assuming arbitrarily that a cell of 80 panels is chosen, the system would produce 16,000 watts for 10 - 16 hrs. of daylight, every day. Based on these estimates, a solar cell would generate around 208 kilowatt-hours of energy a day, which would be much more power than necessary for the room alone. The extra power could directly curtail the Student Center's existing energy bill.

Rainwater collection would offset the amount of water needed to sustain the hydroponic and aquaponic system. The collection system involves large bins or tanks that collect rainwater to store when it rains. Given Atlanta's high rates of precipitation, rain collection seems to be an obvious choice to reduce water costs, while also benefiting the environment. While rainwater is not sanitary enough for use in cooking or drinking fountains, it is a viable source of water for the hydroponic/aquaponic systems, as well as sinks and toilets, which find much use in the Student Center.

The nutrient solution will be necessary for the hydroponic system, although not the aquaponic system. An aquaponic system will require fish-food algae to feed the fish. A two tray system can survive off of approximately 5 gallons of nutrient solution per year, so the effective cost would be around \$80 per every two tray solution for a year. However, this cost can be offset by a portion of the produce itself, which could be sold at the farmers market, in the Student Center, and possibly in the dining halls.

## **Conclusion**

Engineers for a Sustainable World sees supporting this initiative as a no-brainer. While the renovations necessary to install this setup may be costly, the plan is economically feasible and will provide long-lasting benefits to the Georgia Tech community. Additionally, the implementation of a hydroponics room in the Student Center has tremendous social and environmental effects via creating an alternative study space, growing healthy, fresh produce for the students of Tech as well as those in need, while also providing an area for students to unwind and relax in a peaceful green area.

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