Building a Greenhouse in a Community Farm: Urban Science and Community Democracy

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Abstract

A greenhouse program in a community garden in Brooklyn, New York, is developed for year-round urban farming. The program exercises technical skills to design and build the greenhouse, and also exercises community democracy skills to address interpersonal issues such as land usage in over-crowded spaces and volunteer organization operations. We describe here the planning and construction of the greenhouse and also the process of community group discussion, debate, and voting in a volunteer run community garden.

Introduction

The urban environment of New York City (NYC) offers an endless supply of sensory and cultural experiences, but it does not offer much by way of open green spaces, and even less access to healthy, locally sourced food. Community gardens are green spaces in which the residents enjoy, steward, and cultivate a small plot of soil in the city. There are more than 900 community gardens across the five boroughs (Design for Public Space 2014), each one with a unique governance and farming mission. Organic farming for food production and education is vital, especially in urban environments where the availability and desire for whole food based diets are rare.

The community garden discussed in this report is located in Northern Brooklyn and occupies the land of three adjoining building lots. The garden has nearly one hundred members, operates a public compost collection system, and has over 1300 square feet of organic vegetable growing space. Until recently, the winter all but stopped our farming activities except for the use of small cold frames to grow greens and seedlings through the colder months. The next step in the garden's mission to grow food and educate the community was to establish a year-round gardening program in a greenhouse. This project report describes the obvious and non-obvious parts of the project that were important to ensure a successful outcome, including grant writing, technical design and construction, and, most importantly, community democracy.

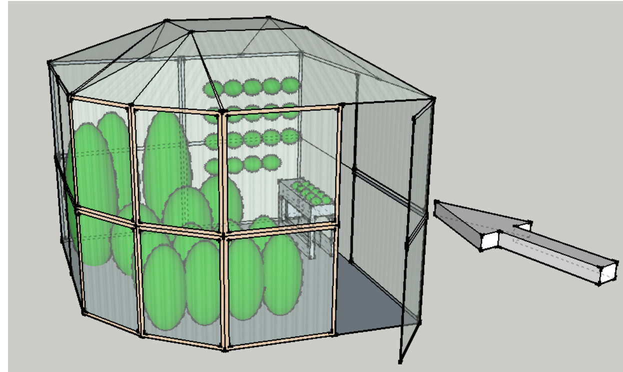

FIG. 1:
Original proposal for the greenhouse with an arrow pointing north. The vertical space in the greenhouse is utilized for maximum space efficiency. The rounded corners create a softer visual effect, but the final construction was a square greenhouse.

Planning Stages

The greenhouse development was funded by a generous grant from Citizens Committee of New York City. The grant mission statement was to develop a year-round farming space so that seedlings could be grown in the early spring for farm use and public sale, and to offer an educational and public laboratory space for anyone interested in greenhouse growing. The grant was written by three garden members during the winter of 2016 and notice of the $2300 award was given in the spring of 2017.

It is becoming increasingly important, especially in NYC, to justify the use of land space and grant money. There are many groups developing new metrics to understand and measure the impact of their community projects (Design for Public Space 2014). The metrics to measure the outcomes of the greenhouse are

1. Count of seedlings grown that are distributed to the farm
2. Revenue from greenhouse-grown seedlings at public plant sales
3. Record of crop yields from greenhouse-grown plants
4. Record of events and number of garden members working in the greenhouse.

The grant application included a proposed location of the greenhouse with adequate sun in the winter months, since a greenhouse relies on the sun for passive heating. From an aesthetic viewpoint, it is important to place the greenhouse in a position that does not obtrude on the visual experience of the garden. To accommodate these requirements, a south-facing space was chosen on the edge of the farm area, which is visually buffered by surrounding trees to the north. The greenhouse construction must also follow all zoning laws. This type of greenhouse would be considered a noncommercial greenhouse (Rules of the City of New York). In addition, the construction must follow building codes, including the roof loads for snow (Department of Buildings, New York City).

The average price per square foot of Brooklyn real estate is approximately $750 (www.trulia.com). This expense creates a huge pressure on the utilization of open spaces. Allocating eight square feet (worth approximately $48,000) for a greenhouse is thus a difficult decision. Even though the dollar value is not an actual cost, it does reflect the challenges confronted when proposing to use shared open space.

Community Democracy

Our community garden is a democratic organization comprised of community volunteers, and the deliberations to build the greenhouse presented a very valuable and in-depth exercise of community democracy. The ages of the participants ranged from children to senior citizens, and the team was comprised of architects, scientists, lawyers, artists, teachers, and corporate workers with varying skill levels specific to greenhouse construction. Some members supported the construction of the greenhouse, whereas other members were opposed to the project. Ideally, a rational and scientific approach can be a valuable strategy for moving forward while acknowledging the input of all members.

FIG. 2:
Josh, Traci, and Nathalie preparing the ground and the foundation timbers.

The primary question to address was whether or not to add an additional structure in the garden, because the surrounding urban environment is made of human made structures with small amounts of green space. To address this concern, the design of the greenhouse was modified to minimize the total vertical height by making a gable roof instead of a simpler shed roof. A slope is needed for snow and rain runoff, and an angled roof also provides increased light transmission. Additionally, we noted that a Spiraea shrub on the east side and overarching trees on the north of the greenhouse will visually buffer the structure in the summer months. Garden members stressed that a greenhouse structure is visually transparent, and that it is also a natural garden structure with visual vegetation inside.

Aside from the overall visual design of the garden space, we needed to consider sunlight exposure of the greenhouse and the shadows that it casts. A suggestion was made to place the greenhouse in a corner of the garden, but it was not clear how much sunshine the greenhouse would receive during the winter. The greenhouse requires direct sunlight in the winter months, so a suitable location must be far from tall fences or neighboring buildings. The sun's angle in the winter sky was an important detail to consider when locating the greenhouse. Areas receiving sun in the summer or fall months may not be illuminated in the winter due to neighboring buildings. To address these questions, a sun study was performed to determine the shadows cast by neighboring buildings in the winter months. The results of this study showed that the greenhouse would be in the winter shade if it were located in the back corner of the garden, because of the adjacent buildings and fences. It was also questioned if the greenhouse itself would cast shade on any plants behind the structure. However, this issue is not a serious concern, because the greenhouse is constructed with transparent polycarbonate panels that are 80% transmissive, which means that 64% of incident light can pass through two walls to the plants behind the structure. The final site was chosen as far from southern buildings as possible, and in a position with trees behind so that it would not cast shade on small plants.

Another concern raised was the potential effects of a non-natural structure on pollinating insects. This is a very important issue, because pollinating insects are critical to the natural cycles of a plant ecosystem. We were fortunate that our grant coordinator from Citizens Committee had firsthand knowledge about pollinating insects in urban environments, and she informed us that pollinating insects navigate by sunlight, shade patterns, and color. The transparent panels are expected to have minimal effect on their natural pollinating courses in the warmer months.

Finally, since a greenhouse creates an ideal environment for the growth of plants, it is also conducive to the growth of fungi, pests, and plant pathogens. The interior of the greenhouse remains constantly moist and stays warm. Without electrical fans, the air is stagnant and promotes fungal and bacterial growth. A modern technology solution to this problem is temperature activated vents that mitigate the problem of overheating and can provide air current channels through the structure. These automatic vents do not require electricity and are passively operated by temperature-sensitive wax-filled pistons attached to the windows. It is also necessary to remove any dead plant material as soon as possible to minimize fungal growth. In addition, there are several organic essential oils such as neem, cedar, and citrus that are being tried as fungal deterrents. It is important to address this issue because a disease or pest that grows in the greenhouse might spread into the farm. The community farm is crowded, just like the rest of the city, so plant or airborne diseases and pests can spread quickly. It is critical that the greenhouse be operated with the best scientific practices possible to ensure the well-being of the rest of the communal farm space.

There were three meetings of the general membership, each lasting an hour, to discuss the greenhouse. The garden organization has chosen to operate with a loose interpretation of Robert's Rules of Order. At the second meeting of discussions, a motion was made to implement the greenhouse. Among the 26 members present, the votes cast were 13 ayes, 10 nays, and 3 abstentions. According to our implementation of Robert's Rules, any decision is based on the majority of voters present and not on a simple majority of votes. Consequently, the motion did not pass because 14 aye votes were requited for a majority of voters present (abstention votes act as a nay when a majority is defined in this way). The close count of the vote prompted advocates of the greenhouse to propose a revised plan that was scaled down in size as a concession to the opposition concerned with land usage. A new motion was presented the following month and the votes cast were 17 aye and 10 nay with no abstentions. This vote passed the motion so that the greenhouse project could be implemented.

Splitting a community is problematic, both emotionally and politically. Most projects in these types of organizations are of smaller scale with smaller impact, and they move forward with near unanimous support. Overall, the fundamental challenge is to separate the science-based concerns versus emotional concerns and address each appropriately. Emotional resistance can sometimes be overcome by providing a scientific explanation. In other cases, science-based criticisms can lead to very constructive discussions; we can use science to support our ideas but must acknowledge that science can also oppose them. For example, some who were opposed to the project identified specific plant pathogens and microclimate issues that occur in a greenhouse, and this was one of the most important issues to address. Also, the concern to minimize the visual impact while maximizing sunlight exposure led us to a very informative sun study of our garden. This respect for science and rational discussion is critical in our current society, and forward progress can be made by focusing on tangible and rational methods.

Future Plans

All the work described above generated an 8-ft square greenhouse. The future work requires designing the interior space to be most space efficient and to the liking of the members. Initial ideas are to run multiple levels of shelving around the walls to maintain the maximum possible floor space for mobility. However, plants along the south-facing wall will block the sun, and so the density of shelves and plants on the south wall should be carefully considered. An irrigation system is being planned that will take roof runoff into gutters that feed directly into drip irrigation for plants in the greenhouse. The greenhouse will require regular maintenance throughout the year to keep plants watered and to deter infections. Other programs in the garden have been successful in sustaining a group of dedicated workers and a publicly available sign-up schedule, and we hope to replicate the successful model already in place in our garden. Also in progress is a process to plan and coordinate volunteer work. We intend to use the space for projects, instead of allocating space to individual members.as is the case in the rest of the garden. We hope that this will be a more equitable method of sharing the space.

Conclusions

An 8-ft square polycarbonate greenhouse was constructed in a community garden in Brooklyn, NY. This process was completely developed and executed by community volunteers. We have detailed the democratic discussions and scientific arguments needed to move forward through a system of community democracy to achieve success. We found that discussions among a large group of emotionally invested community members can be navigated by applying specific scientific principles in a democratic and objective manner. We hope that this project report can be of use to other community groups looking to undertake complex projects in a diverse community.

Acknowledgements

The author wishes to thank Citizens Committee for New York City for the generous grant and the entire garden membership of Prospect Heights Community Farm for working through this complex project to a successful completion.

About the Author

Jeff Secor has been a resident of Brooklyn for 10 years and a member of PHCF for nine of those years. He was a freelance gardener around Brooklyn during his graduate studies at the City College of

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APPENDIX

Construction Details for the Greenhouse

The materials for constructing the greenhouse are listed in Table 1. The greenhouse framing material was chosen to be cedar wood since it is an excellent exterior wood for greenhouse framing. It lasts through years of weather exposure and acts as its own insect repellent. Cedar wood is also locally available and within the budget of the greenhouse. The transparent covering is made of 6 mm-thick twin wall polycarbonate (PC) greenhouse panels. PC greenhouse panels are a relatively new material. The insulating R value of 1.54 for polycarbonate compares very well to the R value of 1.72 for a ¼-in. spaced double pane window. It is lightweight (a few pounds per 4 ft ×8 ft panel) and has no risk of breaking into sharp pieces as glass could. It should be noted that the PC panels have a slight blurring effect and are not as visually clear as glass. The PC panels are specified to pass 80% of the sun spectrum that is useful for photosynthesis (400–700 nm).

Local building codes were consulted to ensure compliance with applicable laws. The building codes in NYC are available online through the Department of Buildings. In NYC, this type of greenhouse would be considered a noncommercial greenhouse (Rules of the City of New York). This ordinance requires that the greenhouse be more 3 ft from the lot line. The roof was designed to conform to roof load specifications of 30 lb per square foot of horizontal extent (Department of Buildings, New York City). In general, the square foot of horizontal extent is 1 square foot multiplied by the cosine of the roof pitch. Finally, the PC manufacturer's specifications determined the required roof framing spacing to support the necessary roof load and resulted in roof purlins spaced 24 in. apart.

The greenhouse will be a warm and moist space in the winter, and the surrounding urban environment contains rodents. Galvanized wire mesh should be placed on the subground as a barrier to prevent rodents burrowing into the greenhouse. During the summer the greenhouse can easily rise above 100 °F. The windows for the greenhouse are fitted with automatic wax hinges which actuate according to the interior temperature to prevent excessive heating and promote air circulation in the warmer months. Two vents are placed on the roof panels, and one vent is placed closer to the ground to achieve a chimney effect.

The greenhouse construction was completed in three phases: (a) site preparation, (b) framing construction, and (c) installation of the PC panels. Site preparation is the most physically intensive phase. The existing plants and garden soil were removed in order to level the foundation soil and to make room for the 6

TABLE 1: MATERIALS FOR GREENHOUSE CONSTRUCTION

Item	Quantity	Price ($)	Total cost ($)
6mm polycarbonate sheet, 4 ft x 8 ft	11	50.68	557.48
2x4x8 cedar stud	41	13.6	557.60
2x4x10 cedar stud	1	17	17.00
2x6x8 cedar ridge board	1	26	26.00
6x6x8 foundation lumber	4	22.57	90.28
automatic wax hinge	2	63	126.00
metal mesh	1	45.94	45.94
door hinge	3	5	15.00
1/2" x 3 ft. rebar	8	3.5	28.00
screws and washers	50	1.00	50.00
foil tape	1	7.98	7.98
10" lag bolt	4	4.70	18.80
stainless stell rafter tie	12	2.54	30.48

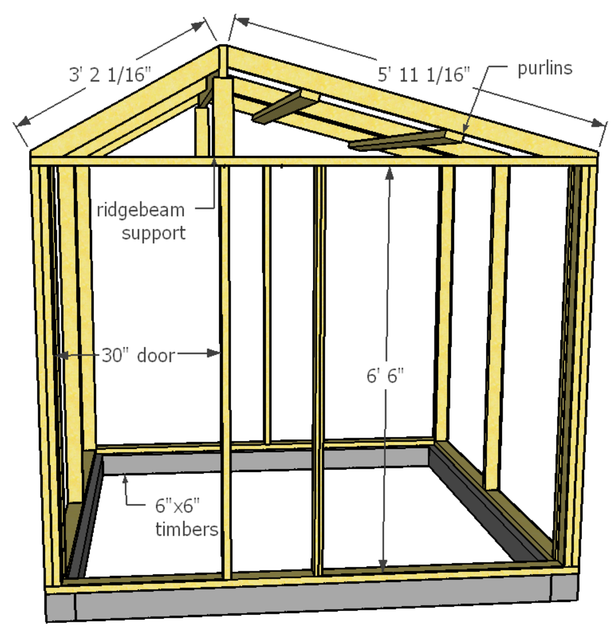

FIG. 3:
Cedar framing details. The door is framed at 30 in. wide. The ends of two side walls have a double stud, resulting in three studs in each corner of the structure. The lengths for the roof framing were a result of the 8-ft. span and minimizing scrap from the roof of the PC panels.

in. x 6 in. foundation timbers. The area was compacted with a 10-in. hand tamper. We chose not to pour a concrete foundation in order to minimize the impact on the natural area and to minimize the eventual work of removing the greenhouse. Once the timbers were leveled in an 8 ft x 8 ft square arrangement, they were bolted together in the corners with 10-in. galvanized lag bolts, and each timber was anchored in place with two rebar "L" shapes inserted 3 ft below ground level. This part of the project took approximately three days over two weekends.

The second phase was constructing the framing. The wall panels were built first using 3-in. coated decking screws. A group of a dozen members, including a 12-year-old boy, assembled the wall panels, thereby gaining first-hand experience with framing squares, drill bits, circular saws, and with creating a level work space in a community garden. Afterwards, another group of members templated the roof boards using a speed square and a circular saw. In order to provide additional support, stainless steel rafter ties connect the wall framing to the roof boards. (Stainless steel does not interact with cedar wood.) The frame was attached to the foundation using 4½-inch stainless steel screws and washers. The entirety of the framing work required five days over three weekends.

Finally, the double walled PC panels were installed. The PC panels can be cut by an electric circular saw. A saw blade with fine teeth must be used when cutting the PC to prevent plastic shrapnel and rough edges. The tops of the PC were sealed with metal foil tape to prevent water from entering the channels. The PC panels were attached directly to the cedar framing using 1 ½- in. dip coated screws with 1-in. neoprene washers. The neoprene washers are common applications where a soft washer is needed in order to prevent cracks and punctures in the panels. It is important not to use galvanized screws as they will cause rust bleeding with the cedar. The framing geometry is made so that all of the panels end on a cedar framing stud. This makes for a more stable structure and also reduces thermal leakage. A door was cut from one of the wall panels and hung on zinc plated hinges. The hinges were installed on the outside of the panel, not in contact with the framing, so there is no danger of galvanic interaction between zinc and cedar.

FIG. 4:
Anna, Traci, Greg, Melissa, and Josh inside the greenhouse frame, working together on the details of the roof framing.

FIG. 5:
Completed greenhouse with polycarbonate panels. The Spiraea bush in the forefront will grow many times in size. The blue Atlas cedar is behind the greenhouse on the north side.