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ARCHITECTURAL PROTOTYPES IN SUPPORT OF URBAN FARMING AND THE SUSTAINABLE CITY

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ABSTRACT

Sustainable cities of the future can no longer be just consumers of food and producers of waste (Cockrall-King, 2012). A growing movement toward food production within urban areas, "urban farming", is sweeping across America, in particular throughout the Midwest and "rust belt" cities suffering from population loss. Urban farming repurposes vacant properties resulting from economic decline, home, and business foreclosures, to bring food production and distribution full circle to the way the system operated before refrigeration and long-distance trucking (Heikens, 2010). The city of Indianapolis, USA will be used as a case study to look at new architectural typologies designed to support this growing movement. Like many cities throughout the world, Indianapolis has an eroding manufacturing base, marginal public schools, and high crime rates, which have all contributed to significant attrition. City officials in Indianapolis have supported urban farming as a strategy to address the 21,000 vacant and abandoned properties in this city of just under one million residents. This paper will present and learn from a series of recently completed (architecture) student design-build projects which offer insight into new architectural typologies designed to support urban farming efforts throughout the country and throughout the world.

Disciplinary: Green Architecture, Urban Agricultures, Agricultural Sustainability, Agriculture Green Economy, Sustainable City.

1. INTRODUCTION

As pointed out by Wes Janz and Olon Dotson in their paper "Distress Road Tours", Indianapolis is a place of extremes. Tremendous investment has led to a resurgence of the downtown, and affluent suburbs thrive and grow. In stark contrast, the historic neighborhoods that ring the city, the fabric of the place, continue to struggle with significant challenges. There are too much crime and too little neighborhood organization. High drop-out rates lead to low incomes. Poor access to health care exists alongside easy access to low nutrition foods (Janz, 2014). Like many cities in the region

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and throughout the world, an eroding manufacturing base, marginal public schools, high crime rates, among other pressures, have all contributed to significant attrition.

While many see only the challenges in the blighted neighborhoods, others see opportunity as a range of interesting energies is emerging. Among these, a growing number of urban farmers are beginning to create a new urban economy putting the vacant property to use and making temporary improvements. Income is derived through farmer's markets, CSA (community supported agriculture) shares, and sales to restaurants dedicated to a farm-to-table fair. Community members are empowered to participate, to benefit, to learn from, and often to expand these efforts. In many "rust belt" cities, including Indianapolis, "urban agriculture has emerged as productive reuse of vacant land resultant from economic decline, population loss, and home foreclosures". (Masi et al., 2014)

These energies are moving to the mainstream, increasingly embraced and supported by the establishment. To cite just a few examples; urban farming was identified and encouraged and foregrounded as a food security strategy in the U.S. pavilion at the 2015 world expo in Milan (2015). Municipalities, such as Cleveland, are incorporating strategies such as "garden zoning", allowing individual parcels to be zoned for agriculture (Masi et al., 2014). Here in Indianapolis, home to over 20,000 vacant inner-city properties, former mayor Greg Ballard heads a host of community leaders who have come out in support of these initiatives:

"The city has provided leadership by encouraging urban gardens and making the city-owned property available to people who want to grow food." -Mayor Greg Ballard 2015

While different economic models have been tested to support local and regional urban farming efforts, and capital intensive architectural solutions such as vertical farming have been developed for urban conditions, relatively few innovations have been made to create facilities that support grassroots farming operations that make use of vacant or underutilized urban land. These types of grassroots farms are often small in scale, economically challenged, and are often located on marginal sites where conventional structures might not be allowed. The urban interventions required to support the expansion of farming operations on abandoned or vacant land present certain challenges, requiring development to find creative and diverse avenues of approval. Neither guerilla architecture (operating completed outside the law) nor fully legal, our prototypes navigate within the seams between the temporary and the permanent and populate the voids left through attrition and abandonment.

Over the past five years, working with a broad range of community and professional partners, architecture students at Ball State University have designed, developed, fabricated, and deployed a series of architectural prototypes on four separate farming sites in inner-city Indianapolis, designed to both facilitate and support local farming efforts and to provide a vehicle to research and develop new architectural typologies shaped by these collective energies and constraints. This paper will briefly present and learn from three case studies emerging from these urban conditions. These projects could be discussed through various lenses, but for the purposes of this paper, I will focus on the potential of these built projects to inform new architectural typologies suited to the varied needs of grassroots urban farmers and shaped by contemporary urban conditions such as vacancy, abandonment, and lack of access to healthy foods common to many aging industrial cities.

2. GrOwING GREEN, Center for Urban Ecology

GrOwING GREEN is a prototype for a fully automated mobile greenhouse (Figure 1) designed to address the unique conditions of the urban farm and is the fifth in a series of projects built by BSU architecture students in support of urban farming operations in Indianapolis over the course of the last five years. The project, funded with a grant from the Butler University Innovation Fund and built at a cost of $40,000, is designed to function year-round and can be reconfigured to grow starts for a wide variety of crops. Mobility allows the facility to be shared between farming operations which are often small in scale, and mobility also amplifies the potential for community engagement and outreach by actually taking the farm to the community. The project incorporates automated heating, cooling, and ventilation systems as well as a four-zone irrigation system. All building components were rigorously researched, prototyped, and fabricated to maximize durability, flexibility, and efficiency while minimizing cost.

Figure 1: The mobile greenhouse on-site at the Center for Urban Ecology farm shortly after being transported over sixty miles by a standard pickup truck. Sited in the floodplain mobility allows the structure to be legally installed.

Both the custom shelving system designed to maximize yield and exposure to sunlight, and the custom entry ramp are fully retractable for transport. Active electrical systems, which include thermostat operated exhaust and intake fans, an air conditioner and a heater for year-round operation, and utility lighting, run off of a conventional circuit panel which is powered by an RV style electrical hookup to a power pole. The irrigation system, utility sink, and interior hose bib run off of a conventional hose hookup all run at line pressure with no need for pumps. A pressure regulator is installed on the exterior hose bib to guard against potentially damaging pressure surges in the system.

The greenhouse consists of a demountable steel frame, powder-coated for durability, and a custom-fabricated galvanized steel shelving system fully retractable for transport. The steel frame is wrapped with fiberglass furring strips and clad with a dual wall polycarbonate skin with aluminum channels and trim. Wood framing is kept to a minimum and uses naturally decay-resistant cedar or a chemical-free and locally manufactured decay-resistant heat-treated wood where needed. The trailer bed is surfaced with a recycled composite plastic decking incorporating aluminum drainage gutters on each side, and then overlaid with galvanized steel grating, allowing all interior surfaces to be serviced by the mist irrigation system without fear of either a slip hazard or rust and decay, and can be hosed out as needed. An exterior gutter system catches water from the roof and diverts it to two downspouts intended to feed rain barrels on site. With the exception of the trailer itself, which was outsourced and custom fabricated to the specifications of the student team, the entire assembly was sourced, prototyped, and fabricated by the group of the fourth year undergraduate students.

The mobile structure is well suited to the legal constraints of marginal properties, such as flood-prone areas, where farming operations often exist. In this specific installation, the farm exists in a flood plain, where both local and FEMA building codes do not allow the installation of permanent facilities but do allow the legal installation of the (mobile) greenhouse. Mobile structures navigate within the seams of the building codes which distinguish between the temporary and the permanent, allowing structures to be installed legally on properties where conventional facilities might not be allowed. Mobile structures also lend themselves to the temporal nature of the urban farm which can be subject to frequent dislocation through shifting patterns of urban development - when the farm moves the facilities move with the farm.

Mobility also helped manage the logistics of building the project with students in Muncie, Indiana, and then transporting it to Indianapolis, a little over an hour's drive apart. Perhaps more significant, if the thought of on a larger scale, centralized manufacture would allow the greenhouse units to be produced and distributed more efficiently and cost-effectively. Ease of transport and potential relocation was an important criterion for all three of these projects with one notable exception which will be discussed in the context of the next project.

GrOwING GREEN is the first fully automated fully mobile greenhouse. This solution represents the evolution of mobility in this stream of projects and is simultaneously specific and universal in its potential application. Since its completion, we have received inquiries from five separate organizations from around the world regarding the development of a second prototype. Although each organization has separate needs, there seems to be a shared interest in the potential for education and outreach, as well as the potential for one greenhouse to service multiple small farms.

3. GRIDfarm, Growing Places Indy

The GRIDfarm was designed and constructed working with community partner Growing Places Indy and a wide range of community and professional partners. Consisting of two extensively modified forty-foot shipping containers grouped around a central canopy structure (the Gridshell); The GRIDfarm project offers a groundbreaking collaborative involving educators, students, urban farmers and community groups, business partners, and local professionals working together to create innovative facilities in support of urban farming operations in Indianapolis.

The building design itself is innovative, intended to demonstrate sustainable building practices, and extend the discussion of a healthy lifestyle to the built environment. In addition to providing useful facilities for the farm, the buildings use a range of re-purposed materials, including shipping containers, tables made from recycled blackboards and recycled steel, fly ash content concrete, and re-purposed fabric salvaged from the RCA Dome, a recently demolished stadium (Figure 2). Rainwater is collected on-site and used to irrigate the produce.

Figure 2: Construction nearing completion on the Gridshell dome at the GRIDfarm, spanning close to 30 feet using only one-inch rebar and clad with a double layer of fabric "sails" made from salvaged material.

Of the three case studies offered for consideration, the Gridshell dome and the wash station components of the GRIDfarm were the only "permanent" structures and as such were subject to a different and more stringent code review. The Gridshell dome, in particular, was engineered, permitted, and reviewed for code compliance throughout the course of construction, making its design and construction a more formidable task particularly considering it was built by the students who were just ramping up the necessary skill sets. The structure, which spans close to thirty feet using just one-inch rebar, demonstrates extreme utility in the use of the material and provides a gathering place for tours of the farm, educational events, and scheduled classes such as a community yoga class held every Sunday.

As mentioned, the dome is clad with a dual-layer system of tensioned "sails" fabricated out of salvaged roofing material from a recently demolished stadium. While we take great pride in the successful completion of this relatively complex small structure, the specificity and rigorous requirements of this component make the thinking less transferable to other farms and underscore the challenges of building permanent facilities. The structure is anchored by four forty-two inch square footings with matts of #6 rebar; all hand dug by the students. The custom-designed joints which connect the sixteen-inch diameter reinforced concrete piers to the rebar dome consist of a two-way system of 3/4 " thick steel plate, water jet fabricated and welded by the students. The joints are beautiful in their resolution but massive, labor-intensive, and relatively expensive.

Contrast this with the two shipping containers at the GRIDfarm, which were permitted as "temporary" structures and sit on cast concrete blocks serving only to level the structures. Screw jacks and cable ties were installed voluntarily to act as hold-downs in the event of high winds, these were not required by code. The installation of the containers was comparatively quick and simple and they could be similarly relocated if necessary.

Figure 3: This modified shipping container serves as a classroom/meeting space and as a farm stand.

One container is fitted out as a public space, with large sliding doors and custom fabricated tables that open to the Gridshell, and a farm stand used as a community pick up point for the fresh produce (*see* Figure *3*). The other container opens to the wash station and is used for equipment storage and has a large walk-in cooler for storage of the produce. The cooler is insulated with rigid foam and cooled by a conventional wall air conditioner controlled by a “cool bot” designed to keep the fresh produce at optimal temperature. As shipping containers are relatively inexpensive, easy to modify, and are readily available and in surplus in our region, lessons learned in the fabrication of these two components of the GRIDfarm are directly transferable to other farming operations and are cost-effective solutions. This project was funded with grants from a local food bank and Eli Lilly, a local corporation, and was designed and built over the course of three semesters at a cost of approximately $32,000.

4. urbaRn, “We are What We Grow”, The Project School

The Project School (Figure 4), a K-12 inner-city charter school was our partner for the first of our urban farm projects. I was approached by Tarrey Banks, school principal, who shared with me the following brief at the outset of the project:

> *We have all heard the saying “We are what we eat”. Another idea that is just as true is, “We are what we grow”. With this in mind, the Farm Project brings together business, school, and community around the concept of reclaiming impacted urban space and turning it into a working farm and urban green space. The one-acre organic farm will consist of a half-acre of growing plots and raised beds, a chicken coop, beehives, and meeting and workspace. The Farm Project will provide space for gathering and enjoying the outdoors, teaching space for a local K-12 school and community groups, and it will have a farm store that will sell organic produce at affordable prices. The farm will not only provide students and community residents with nutritious meals but will also get them connected to their food and introduce the various user groups to models of sustainable agriculture and healthy and sustainable lifestyles* (Banks, 2011).

Figure 4: urbaRn completed installation at the Project School (left) and then re-deployed at Big City Farms one year later (right).

The first completed component of the Farm Project was our contribution, the "urbaRn"; a classroom/meeting / living lab which was designed and constructed almost completely from waste stream materials, intending to extend the lessons of the Farm to that of the built environment. The urbaRn was designed and fabricated by a group of fourth-year architecture students working with students from the project school throughout the design of the project. The design incorporated two repurposed shipping containers, extensively modified for use at the Farm.

The students were challenged to design the facilities using low / no impact materials, and after some research came to recognize the containers as a potential waste stream resource. In addition to being at the end of their useful life, the containers selected for the project were contributing to a surplus of shipping containers in the region due to a regional trade imbalance. The choice of containers also facilitated the staging of the project, which was fabricated largely off-site and then delivered to the Farm, and allowed for the potential of relocation in the future. Modifications included creating large openings with sliding panels and fitting out the interiors with shelving, rolling farm tables, and windows created from salvaged materials diverted from the local landfill. Educational materials directed to various user groups ranging from community members to grade school students frame these principals and extend the lessons of the farm to the built environment. This first phase of the project was completed over the course of two semesters for a budget of approximately $9,500.

Shortly after the project opened, suddenly and unexpectedly the school closed and the project went dormant before the farm was complete. After the initial shock and disappointment, we came to see the unexpected turn of events as an opportunity to test the idea of mobility. Funds were obtained through an internal University provost grant and two new project partners were identified. A new group of students was charged to coordinate and oversee the relocation of the two shipping containers to two separate sites, the Center for Urban Ecology and Big City Farms. The Project school site was dismantled and prepped for transport, and the containers were fitted out with site-specific features at the new farms. The relocation was relatively smooth, easy, and inexpensive, and supported our premise that mobility lent itself to this new typology where farm sites are often subject to the shifting tides of market-rate development and other outside pressures.

5. CONCLUSION

Our urban farm prototypes attempt to infuse potentially utilitarian projects with a critical agenda. Our projects are pushing against established boundaries, navigating between the seams of the building codes to create useful and legal facilities that skirt around the sometimes onerous requirements of the Building Department and other government agencies, requirements which often do not lend themselves to these types of small scale but potentially meaningful urban interventions. Neither "Guerilla Architecture" (Fontenot, 2007) which suggests a subversive agenda, nor fully legal, our Architectural Prototypes seek clever and transferable solutions for new and emerging building typologies shaped by our contemporary urban condition.

6. AVAILABILITY OF DATA AND MATERIAL

Information can be made available by contacting the corresponding author.

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Professor Timothy Gray (AIA, LEED, AP, Professor of Architecture) is an architect, educator, and environmental advocate with extensive expertise in sustainable design. Tim has led multiple undergraduate studios which have resulted in a variety of community-based design-build projects, working with multiple community partners such as Indianapolis Food Bank, Butler University, and the near east side Legacy Center. Tim has also served as co-director of the CAPItalia and CAP Asia Field study programs since 2006, and this past summer led a group of students on a groundbreaking workshop in Russia partnering with the St. Petersburg Institute of Architecture and Civil Engineering. Also, Timothy has an active practice, Gray Architecture, which was established in 1995 and has completed a broad range of critically acclaimed and award-winning projects. Recent recognitions include Indiana AIA Citation Award for Excellence in Architecture, 2017, Ball State University Immersive Learning Award, 2017 and the Indianapolis Chamber Monumental Achievement Award, 2016

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