AEROPONIC AGRICULTURE IN CHICAGO

Chicago: 376,576 acres

2,853,114 acres to feed Chicago

Charles Maceachen, Spring 2010
why urban agriculture?

water use:

98% of all water used for industrial agricultural irrigation is lost to evaporation and ground absorption.

transportation:

More than 80% of the US population now lives in cities.

US produce travels an average of 1500 miles from rural farm to urban consumer, mostly by truck.
why urban agriculture?

pollution:

agricultural runoff is a significant source of water pollution

pesticides seep into groundwater and run into streams and rivers contaminating drinking water and killing wildlife (e.g. DDT)

fertilizers run off into waterways causing massive algae blooms which deplete the water of oxygen and block out sunlight, killing other life.
why urban agriculture?

land use:

according to the UN FAO, 80% of the planet’s arable land is already in use.

industrial farming techniques have seriously degraded soil quality, resulting in ever increasing fertilizer use.
With the collapse of the Soviet Union in the early 90’s, Cuba lost its main source of fuel and equipment, including farm machinery. Because it quickly became too expensive, or nearly impossible, to move produce from rural farms to the city of Havana, the city introduced a massive urban farming initiative which included free land for farmers and education on farming techniques for the city’s residents. Today, there are over 87,000 acres of farm land located within Havana itself. The city produces over half of the produce it consumes. This is all done using traditional soil farming by hand. And, because chemical fertilizers and pesticides are too expensive, everything is grown organically.
The South Central Community Garden in Los Angeles was a 14 acre vacant industrial site that the people of South LA took on as a community garden in 1994. It served 350 families until 1996 when the new owner of the site bulldozed the gardens. It was often called the largest urban farm in the United States.
Growing Home is an urban farm located in the South side of Chicago. They provide training and jobs for the homeless and low-income.

In 2008, their Wood Street site produced over 5,000 pounds of fresh vegetables. They expected to produce over 10,000 pounds in 2009.
OTHER EXAMPLES

VERTICAL FARMING EXAMPLES

Mithun’s entry for the GBG Living Building Challenge

Blake Kurasek’s “The Living Skyscraper”

SOA Architects “The Living Tower”
Bevan Suits of Sustainable Design Group and Access to Aquaponics is teaming up with others to convert an industrial site in Lorain, Ohio to an Aquaponics facility. There are further plans to open a new 55,000 aquaponics greenhouse near Boulder, Colorado.

The process of aquaponics involves growing fish and vegetable in a recirculating, self contained loop. Each fertilizes and feeds the other creating a low-input, high-output system.
Aeroponics is a system for growing plants which utilizes a method of spraying the roots with a fine solution of water and nutrient. The roots are left to freely hang within the mist, providing access for oxygen and the nutrient solution.

This method is different from hydroponics in that the roots are free, rather than being submerged in water and gravel or some other medium.

Advantages:

- Up to 95% reduction in water usage
- Closed loop and controlled environment
In 1997 NASA and AgriHouse, inc. began looking at aeroponic technology as a possible way to feed astronauts on long missions or even future colonies. Together, they developed a light, inflatable aeroponic device that could be easily set up during a mission and required minimal space in transit. Experiments undertaken on the MIR space station proved the project a success and it is still ongoing.

AgriHouse, inc. has gone on to become the largest manufacturer of aeroponic systems. Complete systems like the aeroflo2 are modular and can be combined at any scale.
The Epcot Center at Walt Disney World has an exhibition of current aeroponic agriculture technology. The food grown here is used in Disney World restaurants.
A company out of Sausalito, CA is currently seeking investment for a system they are calling the Bioshelter. This is essentially a greenhouse enclosing a modular aeroponic system. It is designed to be placed on vacant sites in an orientation where sun access is maximized.

There are 6 growing levels that are rotated throughout the growing cycle for ease of harvesting and to provide more light for younger plants.
AeroFarms is a relatively new company that just received $500,000 in venture funding. Their aim is to provide startup services including consultation, clients, equipment, and installation of Aeroponic equipment. Their focus is the conversion of existing industrial and warehouse spaces into aeroponic farms. They have conducted extensive testing and development of new types of aeroponic growers as well as LED lighting to mitigate the cost of conventional grow lights.

LEDs can be tuned to the specific wavelengths to which Chlorophyll is most receptive.
For the Reburbia 2008 competition, architecture firm Miller Hull proposed covering existing parking lots in strip malls and big-box retail with a suspended aeroponic system. The proposal included a system for raising and lowering individual sections for harvest and maintenance as well as using windmills to pump the water/nutrient solution throughout the site.
The project will reuse an existing and currently vacant light industrial/warehouse space. This space must provide a comfortable working environment for those who spend their days here as well as provide ample work space for aeroponic agriculture. In addition to those who work here, community outreach and teaching program will invite members of the community into both the workshop rooms as well as the grow rooms. An outdoor area suitable for, or able to be made suitable for, traditional soil-based farming would be ideal as it would provide an external identity for the project. This is, however, not necessary. If a prospective building meets the essential requirements for the program, but lacks an external gardening area, the building should still be considered. This is especially true on the North side of Chicago where exterior areas of this nature are much more rare.

Due to the tight connection with the community, it is imperative that any building chosen for this project be near a residential neighborhood. Density, however, is not necessarily a defining characteristic since density is constantly changing and one of the hopes for this project is that it will help bring back some life to languishing neighborhoods.

### SUPPORT SPACES

#### ELECTRICAL
1 @ 2000 SF  
**total of 2000 SF**

Must accommodate possible solar/wind electrical generation

#### MECHANICAL
1 @ 2000 SF  
**total of 2000 SF**

Must accommodate possible solar thermal, etc.

#### SEED STORAGE
1 @ 200 SF  
**total of 200 SF**

Stable, cool temperature, low humidity, low light

#### PRODUCE STORAGE
1 @ 800 SF  
**total of 800 SF**

Stable, cool temperature, low humidity, low light

#### LAUNDRY
1 @ 150 SF  
**total of 150 SF**

Space for a couple clothes washers/dryers

#### MISC STORAGE
1 @ 600 SF  
**total of 600 SF**

Long-term janitorial, other equipment

**SECTION TOTAL:** 5750 SF  
**+10 % GROSS:** 6325 SF
<table>
<thead>
<tr>
<th>MAIN LEVEL SPACES</th>
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</tr>
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<tbody>
<tr>
<td><strong>LOBBY / OUTREACH</strong>&lt;br&gt;1 @ 1000 SF&lt;br&gt;total of 1000 SF</td>
<td><strong>BREAK ROOM</strong>&lt;br&gt;1 @ 300 SF&lt;br&gt;total of 300 SF</td>
</tr>
<tr>
<td>lobby area with display / info</td>
<td>room for employees, adjacent to kitchen and offices</td>
</tr>
<tr>
<td><strong>OFFICES</strong>&lt;br&gt;5 @ 200 SF&lt;br&gt;total of 1000 SF</td>
<td><strong>PUBLIC REST ROOM</strong>&lt;br&gt;2 @ 400 SF&lt;br&gt;total of 800 SF</td>
</tr>
<tr>
<td>office space for admin</td>
<td>mainly for visitor use</td>
</tr>
<tr>
<td><strong>CLASSROOMS</strong>&lt;br&gt;2 @ 800 SF&lt;br&gt;total of 1600 SF</td>
<td><strong>PRIVATE REST ROOM</strong>&lt;br&gt;2 @ 100 SF&lt;br&gt;total of 200 SF</td>
</tr>
<tr>
<td>multi-use rooms for a variety of kinds of instruction</td>
<td>mainly for employee use</td>
</tr>
<tr>
<td><strong>CONFERENCE ROOM</strong>&lt;br&gt;1 @ 1200 SF&lt;br&gt;total of 1200 SF</td>
<td><strong>SHOWERS</strong>&lt;br&gt;2 @ 200 SF&lt;br&gt;total of 400 SF</td>
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<tr>
<td>large, central table, able to seat 12 with projection screen</td>
<td>private showers allowing employees to bike to work and for use after working in the garden</td>
</tr>
<tr>
<td><strong>LIBRARY</strong>&lt;br&gt;1 @ 500 SF&lt;br&gt;total of 500 SF</td>
<td><strong>STORAGE</strong>&lt;br&gt;1 @ 300 SF&lt;br&gt;total of 300 SF</td>
</tr>
<tr>
<td>small storage and study space for books and other media</td>
<td>janitorial and other storage, includes janitorial sink</td>
</tr>
</tbody>
</table>
| **KITCHEN**<br>1 @ 250 SF<br>total of 250 SF | \[ \text{SECTION TOTAL: 7550 SF} \]
| for preparing in-house-grown produce for events as well as instruction also for employee use | \[ +10 \% \text{ GROSS: 8305 SF} \] |
PRODUCTION SPACES

GROW ROOM
3 @ 10000 SF
total of 30000 SF

large rooms for aeroponic equipment
overall area and layout of these rooms is extremely flexible
but 30,000 SF overall is the least amount of space needed

STORAGE
3 @ 500 SF
total of 1500 SF

equipment storage directly related to aeroponics
one storage room accessible from each grow room

ROOF LEVEL
1 @ 2000 SF
total of 2000 SF
or as available

multi-use rooms for a variety of kinds of instruction

SECTION TOTAL: 33500 SF
+ 5 % GROSS: 35175 SF

BUILDING TOTAL: 49,805 SF

EXTERIOR SPACES

TRASH / RECYCLING PICKUP
1 @ 1000 SF
total of 1000 SF

adjacent to driveway or parking lot

RECYCLING DROPOFF

GREENHOUSE
2 @ 400 SF
total of 800 SF

a non-critical component which may be removed
if space does not allow

COMPOST DROPOFF

PLANTING BEDS
as available

for traditional growing, a non-critical component

PARKING
as available

a non-critical component

EQUIPMENT STORAGE
1 @ 500 SF
total of 500 SF

storage related to exterior building upkeep and exterior
farming if those components exist
These spaces are rarely used or accessed. They may be placed in a basement level or other back-of-house situation.

These spaces are used on a daily basis and should have near direct access to the main entrance. Offices should be close enough to the lobby to remain in control.
SITE IDENTIFIED FOOD DESERT GENERAL AREA OF SITE ENLARGED ON ES-O2 LOCATION OF SITE WITHIN ONE OF CHICAGO’S FOOD DESERTS
LOCATION OF SITE AND OTHER URBAN FARMING EFFORTS

EXISTING SITE

COMMUNITY GARDEN SITE

GROWING HOME
OE-03

COMMUNITY GARDEN SITE

SITE
ES-04

COMMUNITY GARDEN SITE
EXISTING SITE

SATELLITE VIEW OF SITE
LOCATION
849 W 79th ST

SIZE
55,890 SF

PREVIOUS USE
offices for Chicago Department of Human Resources

CURRENT STATUS
vacant, for sale by CB Richard Ellis

ASKING PRICE
$1,300,000

STRUCTURE
concrete beam and column

OTHER
fully sprinklered freight elevator
CANOPY STYLE GARAGE DOOR, TYP

REMOVE MASONRY INFILL AND REPLACE WITH STOREFRONT, TYP

GRAVEL CATCH BASIN/ LIGHT WELL

DISPLAY & EVENT SPACE

DEMONSTRATION KITCHEN

LOADING

STORAGE
SECOND FLOOR PLAN

OFFICE OFFICE

REMOVE MASONRY INFILL AND REPLACE WITH STOREFRONT, TYP

GROW ROOM

DESIGN PROPOSAL

SECOND FLOOR PLAN
ACCESS TO EXTERIOR GROW WALL

REMOVE MASONRY INFILL AND REPLACE WITH STOREFRONT, TYP
FOURTH FLOOR
AND BASEMENT PLAN

REMOVE MASONRY INFILL AND REPLACE WITH STOREFRONT, TYP

ACCESS TO EXTERIOR GROW WALL

REMOVE ENTIRE ROOF AND REPLACE WITH OPERABLE GREENHOUSE ROOF

GROW ROOM

UP
MECHANICAL
WATER STORAGE TANKS
STORAGE

08 32 FEET
08 16
04 16 32 FEET

DESIGN PROPOSAL
FOURTH FLOOR AND BASEMENT PLAN
SECTION

EXTERIOR VERTICAL GROWING SURFACES SIMILAR TO PARABIENTA GREEN WALL FROM SHIMIZU

COMPOST MIXING

LEO HIGH SCHOOL

S PEORIA ST
GROW WALL AT EAST FACADE

NORTH FACADE / ENTRY
HOW MUCH FOOD COULD BE PRODUCED IN A GIVEN CROP?

- **35.1 LBS/SF/YEAR**
  - 180,343.8 LBS/YEAR
  - @ $2 / LB = **$360,687.60**

- **8.6 LBS/SF/YEAR**
  - 44,186.8 LBS/YEAR
  - @ $3.50 / LB = **$154,653.80**

- **16.9 LBS/SF/YEAR**
  - 86,832.2 LBS/YEAR
  - @ $2.50 / LB = **$217,080.50**

- **47.9 LBS/SF/YEAR**
  - 246,110.2 LBS/YEAR
  - @ $2.125 / LB = **$522,984.18**

- **8.6 LBS/SF/YEAR**
  - 44,186.8 LBS/YEAR
  - @ $1.75 / LB = **$77,326.90**

ASSUMPTIONS:
- yields based on “The Vertical Aeroponic Growing System”, see resources section
- area based on a conservative 5138 SF of growing table area
- prices based on average of typical wholesale and market costs

HOW MUCH ENERGY IS REQUIRED?

- **3168 SF OF ARTIFICIALLY LIT GROW TABLE**
  - X 10 W SF
  - 31.68 KW
  - X 12 HRS/DAY

  - 380.16 KWH/DAY
  - 138,758.4 KWH/YEAR

  - X $0.14 ELECTRICITY COST

  - **$19,426.18 / YEAR**

ASSUMPTIONS:
- 4th floor will be naturally lit
- 10 W/SF of LED grow lamps represent about 1/5th of the necessary wattage for HID lighting
Chicago has no shortage of vacant industrial buildings and no shortage of neighborhoods in need of more fresh produce. By expanding on this prototype project, a network of aeroponic farms could be distributed throughout the city.


Kennedy, Benjamin N. Vertical urban farming: growing a better city with urban agriculture. 2008.

<table>
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<tr>
<th>RESOURCES AND FURTHER READING</th>
<th>PRODUCTS</th>
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The Vertical Aeroponic Growing System www.synergyii.com/aeroponic/VAP.pdf


