The 21st Century Farm

Illinois Institute of Technology
Chicago, IL

Professor: Blake Davis

Sponsor: John Edel & Kristin Ostberg of *The Plant, LLC*

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Where does Chicago get fresh produce in January?

- California - 2,200 miles
- Arizona - 1,800 miles
- Chile – 5,300 miles

Wouldn't it be nice to have...

- Fresh local produce all winter
- Local growing season extended 3 months
- Zero waste farming

Indoor Farming

- Controlled Environment
- No Chemical Treatment
- Fresher, Healthier Product
- Local Economic Boost
- Aid Regional Agriculture Stability

The Plant, LLC

- Indoor Farm
  - 100,000 sq. ft.
    3 story building
    3 acres
  - 50% farming operation

Our sponsors: John Edel & Kristin Ostberg,

Chicago Center for Sustainable Manufacturing

The Team

- 25 students, 4 sub-teams, 8 disciplines

Our Mission:

Make The Plant a Reality

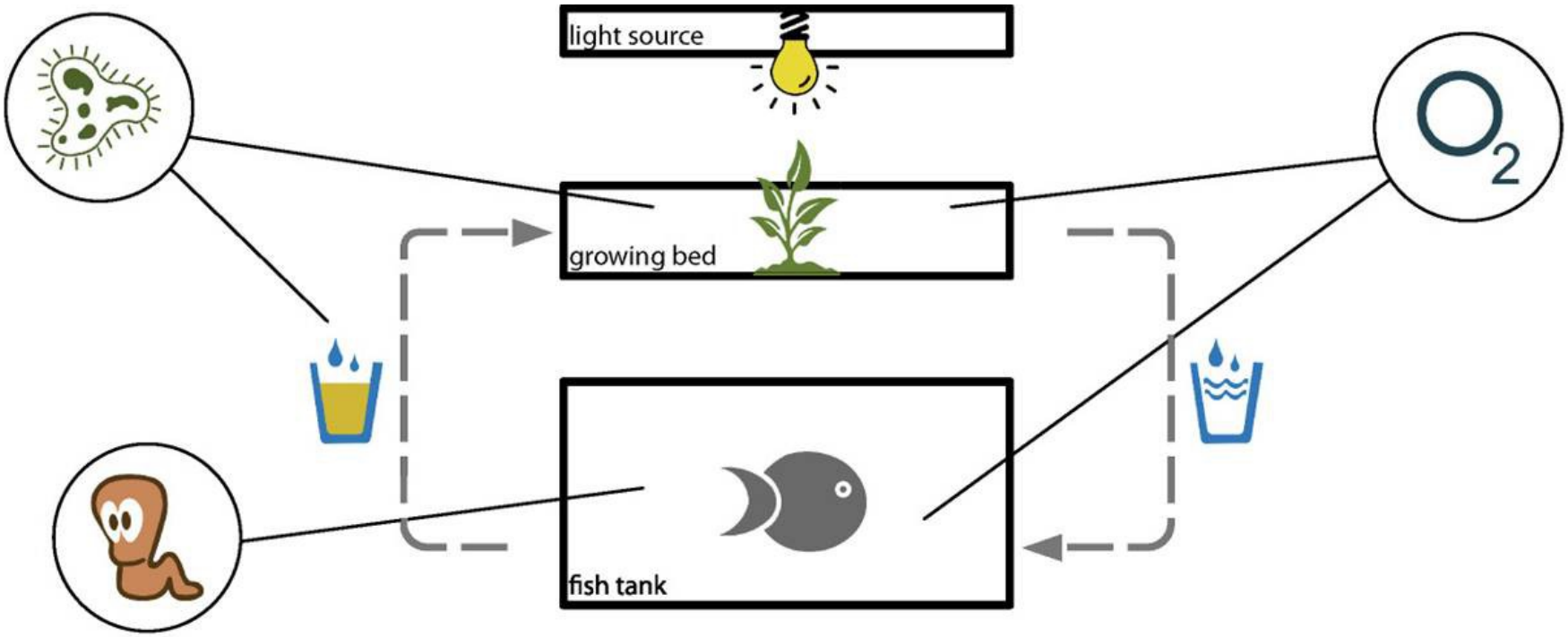
- Agricultural systems
- Computer Control
- Building systems
- Marketing

Agricultural Systems

- Explore growing systems
- Expand prototype
- Introduce fish into Aquaponics system
- Monitor system performance

Prototype

Aquaponics System



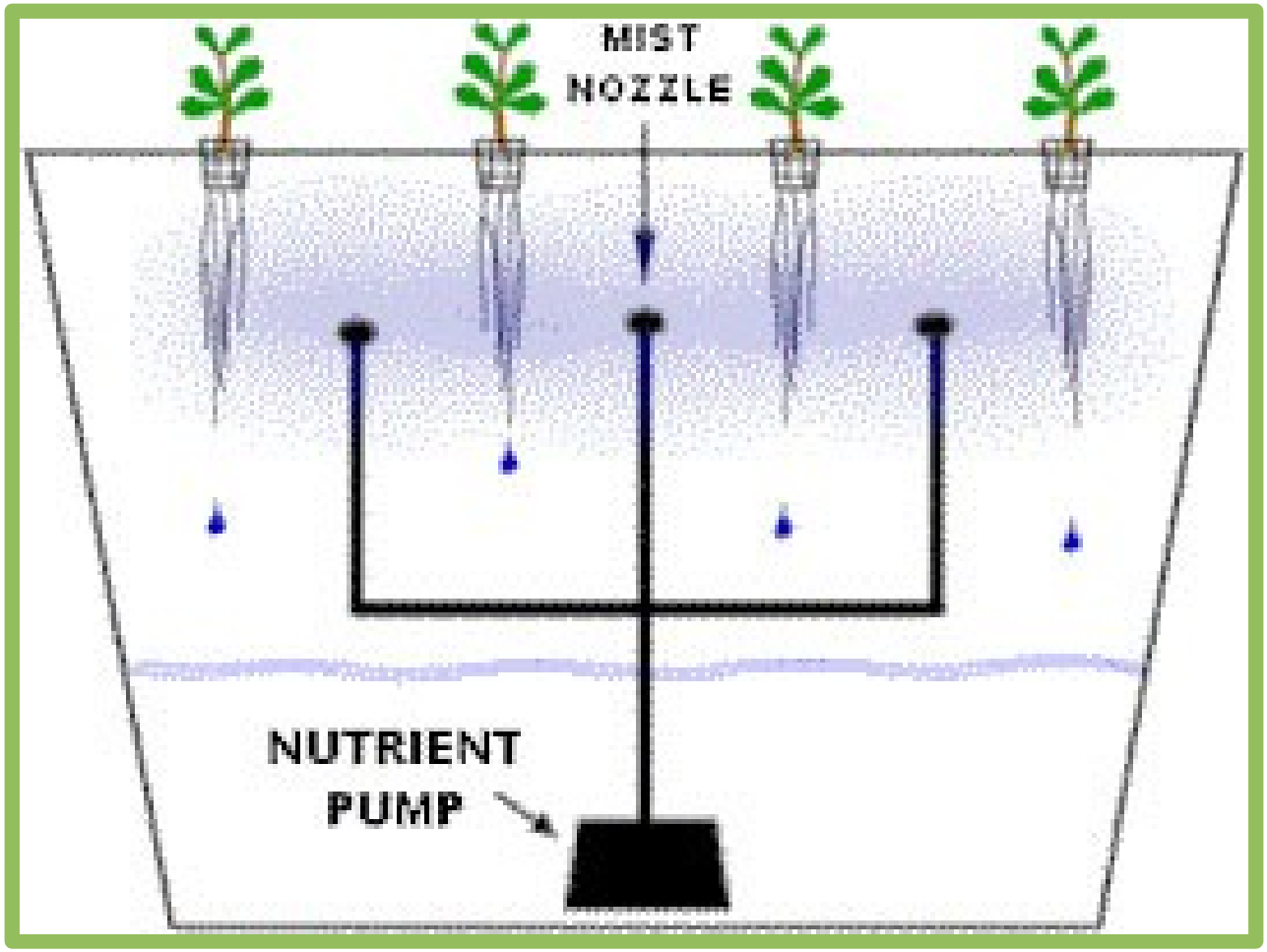
Aquaponics System

Tilapia tank

Growing beds

Chicago High School for Agricultural Sciences

Aeroponics System



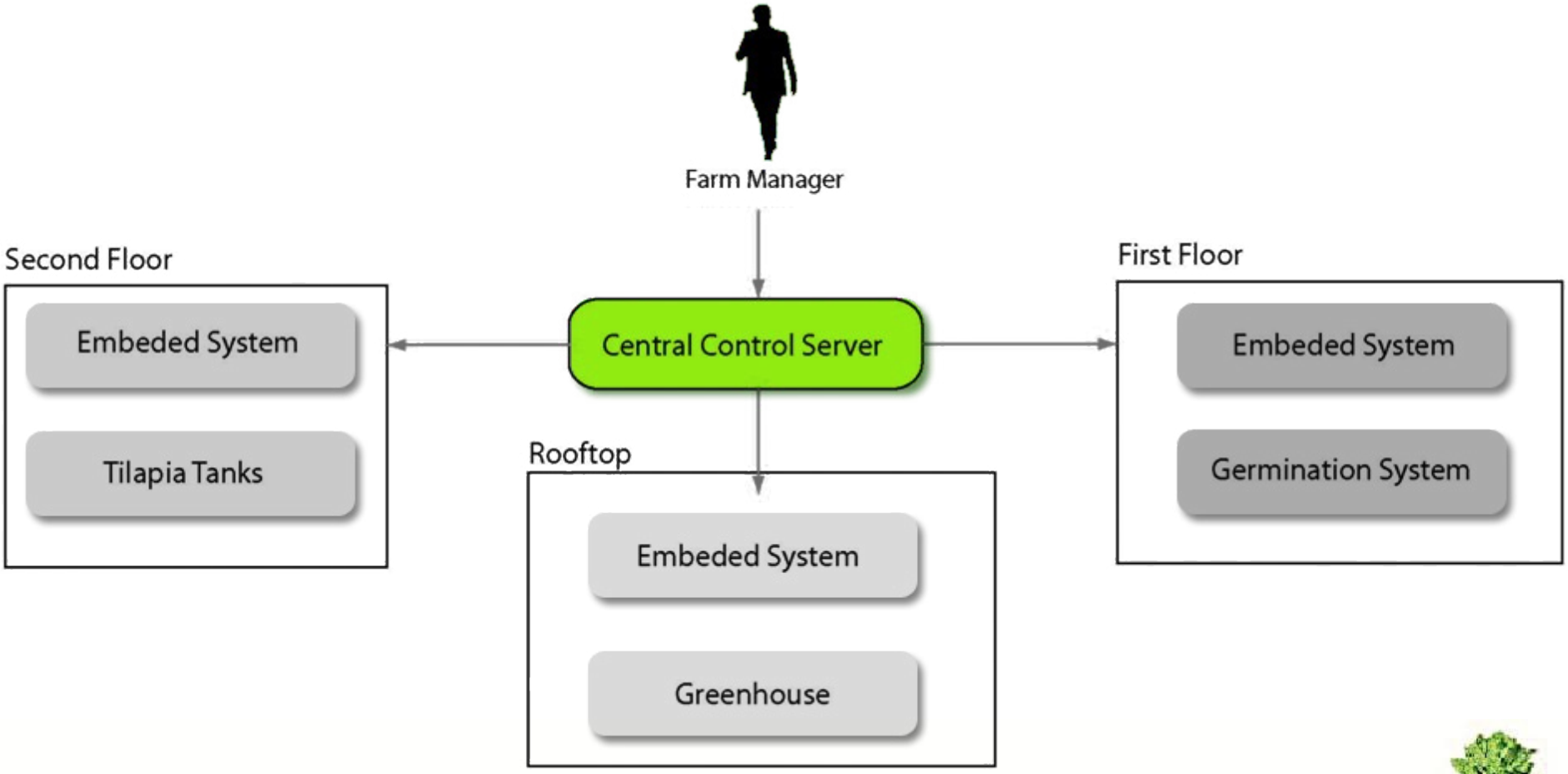
Aeroponics System

Drip System

Computer Control Team

- View/change environment variables
- Minimize maintenance of farm
- Gather operational data
- Integrate with building systems

System Architecture

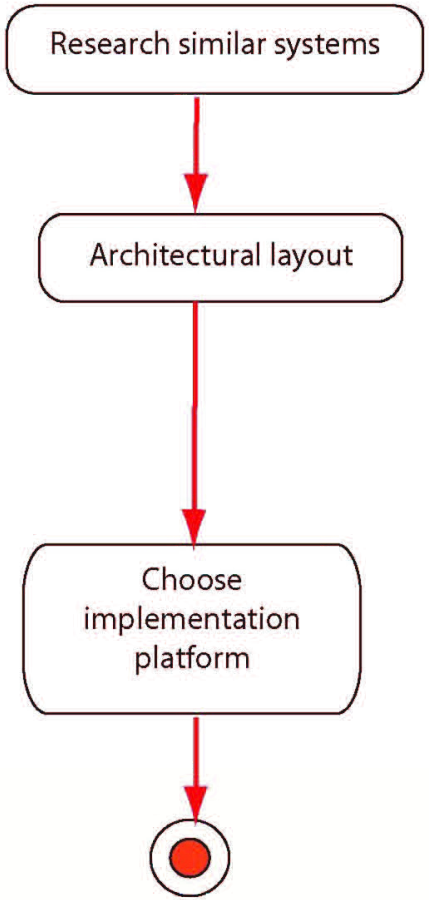


This Semester

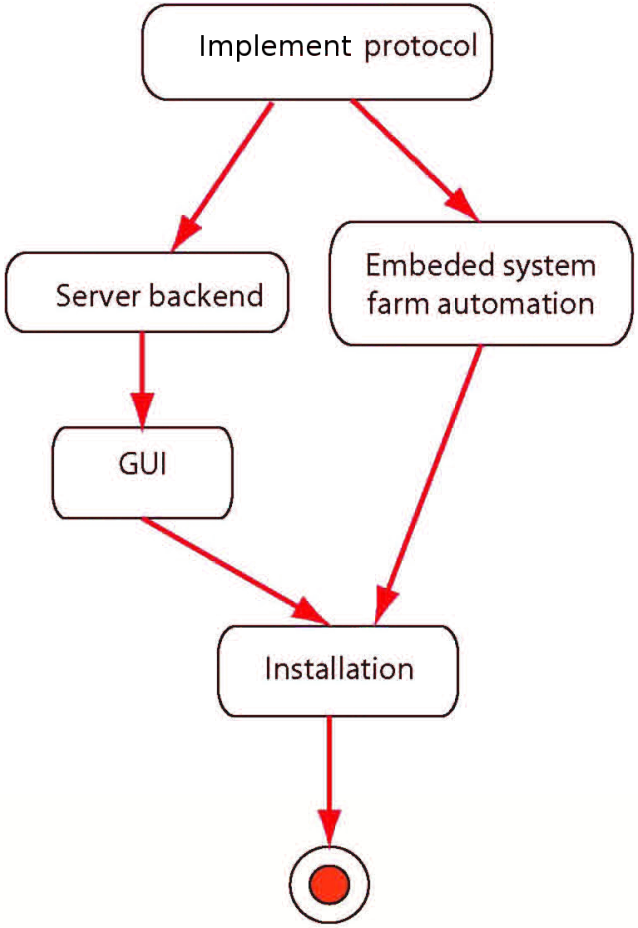
- Prototype the control system
  - Lights
  - Air temperature thermostat
  - Water temperature
  - Grow logs
  - Operations database

Progress

Previous Semester



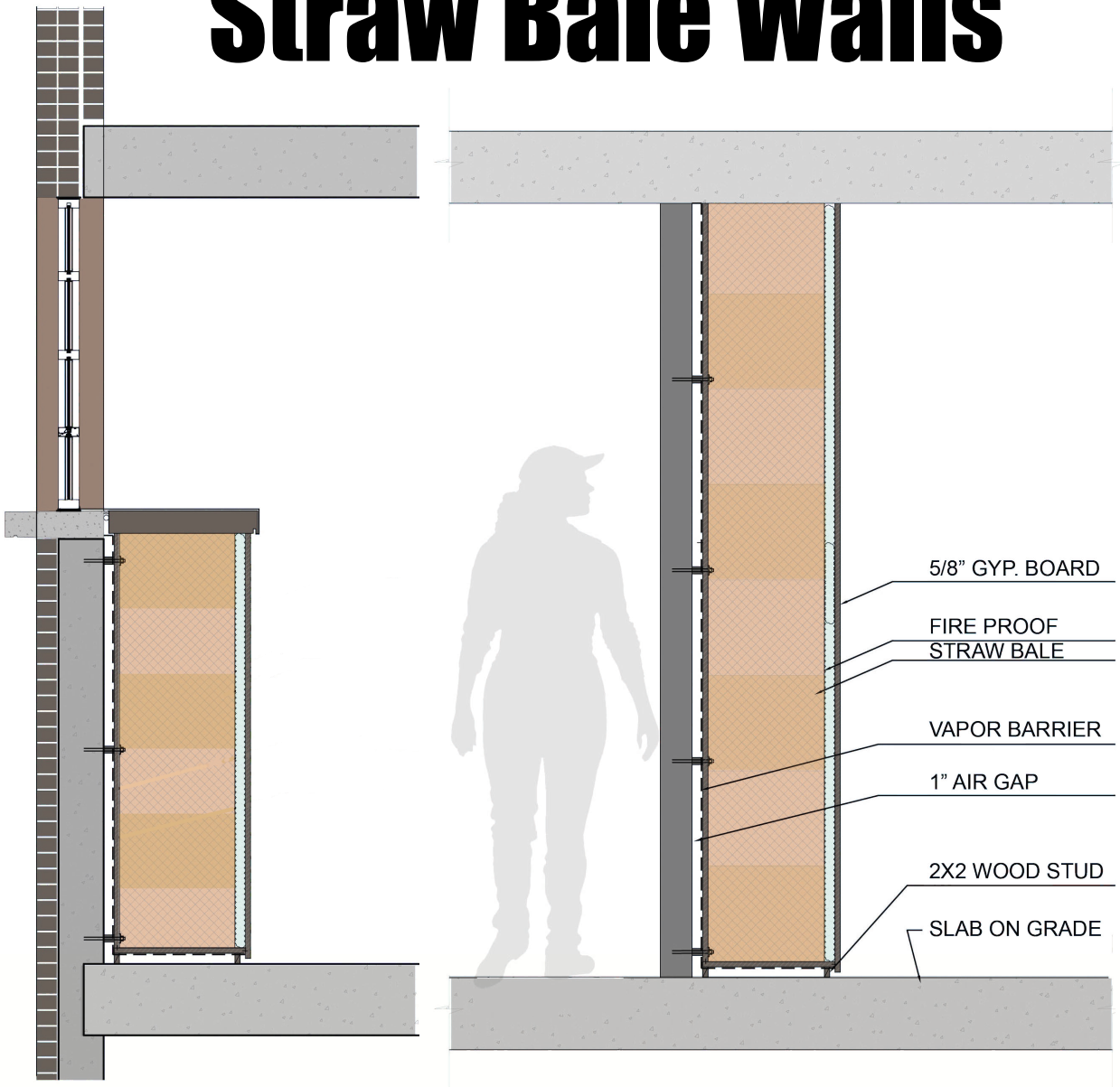
This Semester



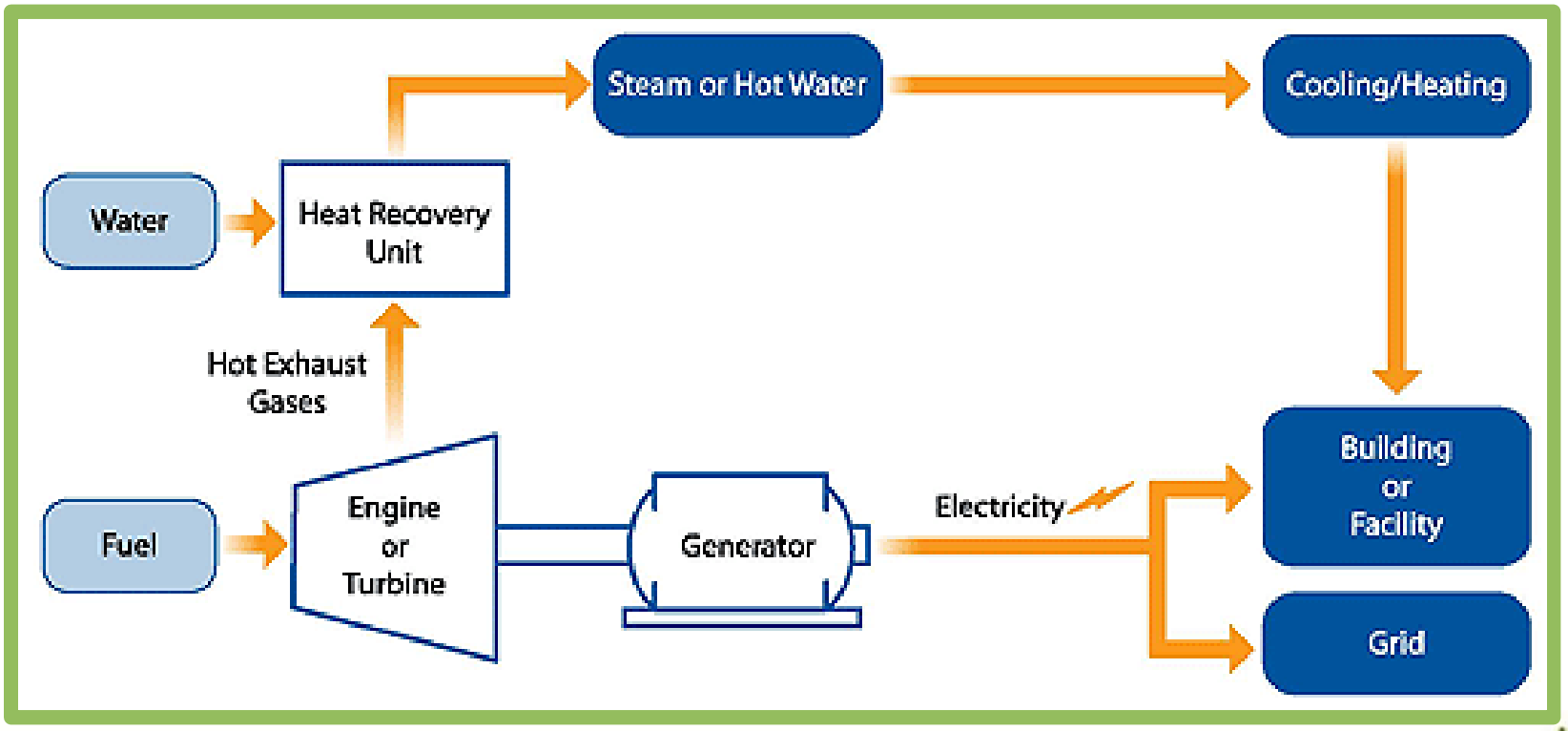
Building Systems

- Wall construction design
  - Affordable
  - Sustainable
  - Volunteer friendly
- Lighting analysis
- Energy management analysis

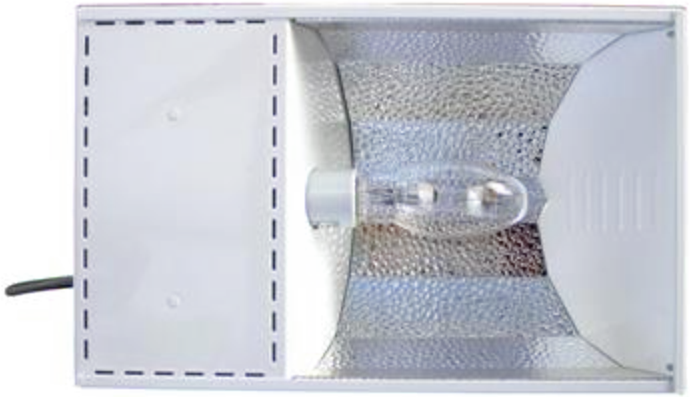
Straw Bale Walls



Combined Heat & Power System



Lighting Systems



Metal Halide

Luxim Plasma

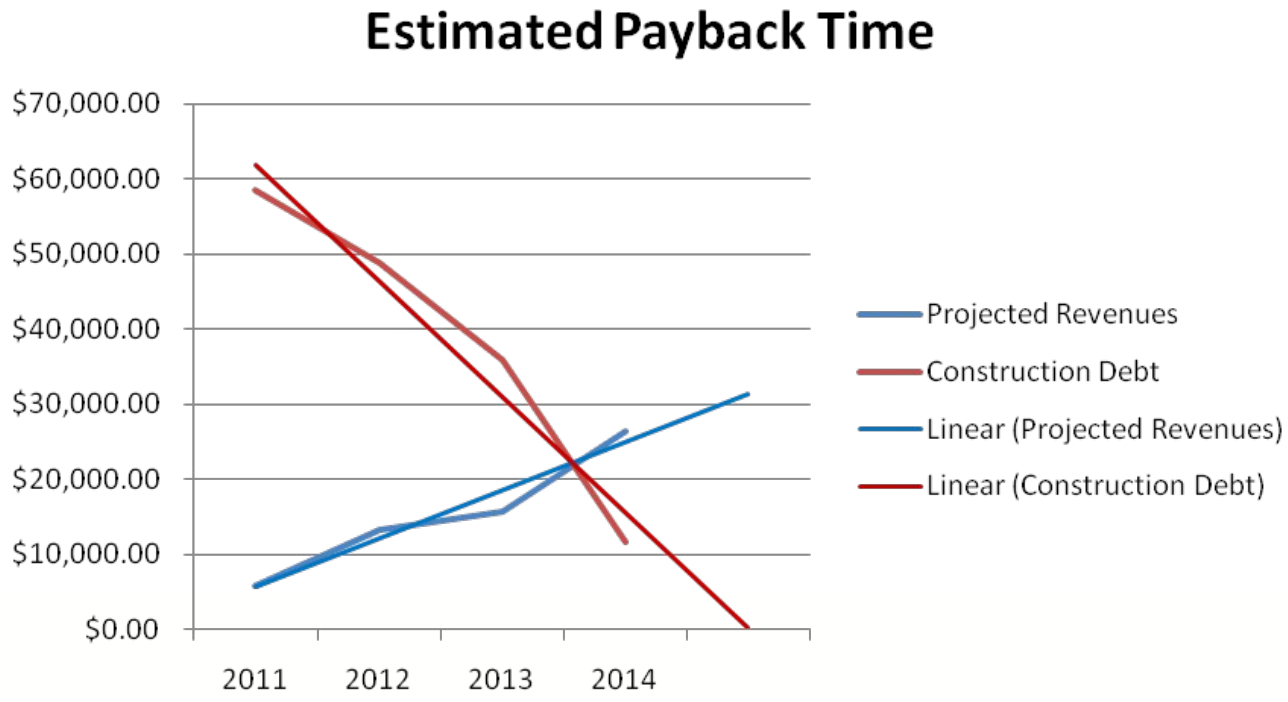
T5 High-Output Fluorescent

Marketing Team

- Double-check and expand the previous semester's work.
  - Lighting
  - Wholesale information
- Create a business plan for The Plant
  - Examine areas of interest to the sponsor concerning the business plan.
- Determine the cost of the growing systems

Viability Check

- Initial production: 18.5k lbs/year
- Initial construction costs paid in 5 years



Potential Markets

- Chicago Public Schools
  - Require 20% of all served food to be locally grown or produced.
- Restaurants
- Community Supported Agriculture (CSA) farms

Accomplishments

- Completed Aquaponics prototype
- Implemented and installed control system
- Developed wall and lighting systems
- Created marketing plan

The Next Step

- Moving and expanding the prototype into The Plant
- Continue exploring different growing systems
- Increase capabilities of control system
- Comprehensive evaluation of The Plant's existing building systems
- Create complete business model

Questions ?

Hours in Use Per Day:

Growing Area:

Targets	
Lumens / Sq. Ft	>2,500
Footcandles at Plant Tops	5,000 - 10,000
Watts / Sq. Ft	> 50

1 fc = 1 lumen/(sq. ft. * dist.²)

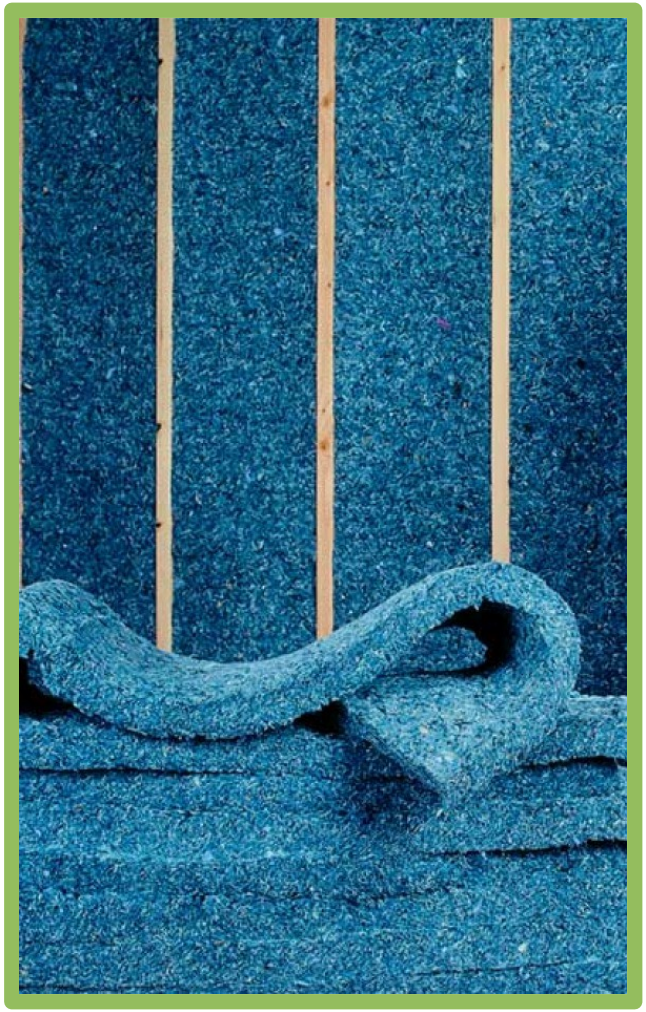
Complete All cells in Green

	Vendor & Manufacturer Provided Information			Coverage Calculations (per fixture)				Annual Costs				
Lamp Type	**Lamp Power (Watts/Lamp)**	**Total Power (Watts / Fixture) to Run Light (from Sheet "Heating" G8)**	**Usable Lumens / Fixture**	**Lumens/Watt**	**Watts/Coverage [W/sq. ft]**	**Lumens/Sq. ft**	**No. Fixtures in Growing Area**	**Annual Energy Used [kW]**	**Annual Energy Used full install [kW-hr]**	**Annual Energy Cost**	**Annual Energy Cost per Sq. Ft. Growing Area**	**Total Annual Cost Per Sq. Ft**
T5 HO	54	216	14,400	92.6	27.0	1,800.0	3,412.5	1419.1	4,842,747	$ 629,557	$ 23.06	$ 28.32
MH Horizontal	1000	1,075	45,630	117.0	40.0	1,825.2	1,092.0	7064.5	7,714,452	$ 1,002,879	$ 36.74	$ 99.31
MH Horizontal	250	269	8,970	92.0	41.7	1,495.0	4,550.0	1766.1	8,035,887	$ 1,044,665	$ 38.27	$ 78.94
Luxim Plasma	200	266	17,595	115.0	8.0	703.8	1,092.0	1747.3	1,908,096	$ 248,052	$ 9.09	$ 41.94
MH Horizontal	400	430	15,600	100.0	40.0	1,560.0	2,730.0	2825.8	7,714,452	$ 1,002,879	$ 36.74	$ 80.54

Straw Bale Cost Estimating

- 7‘ x 14‘ x (76 bays) =**7448 square feet** total area to be insulated (excluding the glazed area)
- Straw Bale Size: **18“ x 14“ x 36" to 24“ x 18“ x 48"**
- Therefore,
  If using the smaller bales (18” x 14” x 36”) horizontally so that it covers an area of 36”(L) x 14”(H) x 18”(D), the area covered by a single bale would be 3.5 square feet and a total of **2128 bales** costing approximately **$8512** would be needed to cover the total area of the wall surface.
- If we use the smaller bales vertically so that it covers an area of 36”(L) x 18”(H) x 14” (D), the area covered by a single bale would be 4.5 square feet and a total of **1655 bales** costing approximately **$6620** would be needed to cover the total area of the wall surface.
- If using the larger bales (24” x 18” x 48”) horizontally so that it covers an area of 48”(L) x 18”(H) x 24”(D), the area covered by a single bale would be 6 square feet and a total of **1242 bales** costing approximately **$4965** would be needed to cover the total area of the wall surface.

Jeans Insulation



Production Assumptions

	lbs/sf/yr	$/lb
Non-Mushroom Crops (Retail)	2.27	$4.04
Non-MushroomCrops (Wholesale)	2.27	$1.86
Mushrooms (Wholesale)	10.95	$4.17
	fish/gal/yr	$/fish
Tilapia (Restaurant)	1.4	$7.39

Production/Distribution Schedule

Year	2011	2012	2013	2014
# of Bays	30	30	30	35
Sqft. of Growing Beds	4320	4320	4320	5040
Pounds of Product				
-Non-Mushroom Crops (Retail)	6374	6374	6374	6864
-Non-Mushroom Crops (Wholesale)	2452	2452	2452	3432
-Mushrooms (Wholesale)	4730	4730	4730	5519
# of Fish	4899	4899	4899	5715.36

Farm Operating Projections

Year	2011	2012	2013	2014
Number of Bays	30	30	35	35
Gross Potential Revenue	$79,430.63	$79,430.63	$92,669.07	$91,422.02
Shrinkage Loss(%)	25.00%	23.00%	21.00%	19.00%
Effective Gross Revenue	$59,572.97	$61,161.59	$73,208.56	$74,051.84
Cost of Operations	$53,688.00	$53,688.00	$60,636.00	$63,478.40
-Initial Buildout	$64,493.19			
-Buildout on Farm Revenues		$ -	$10,147.01	$ -
Total Farm Operating Revenue	$5,884.97	$13,358.56	$15,784.12	$26,357.56