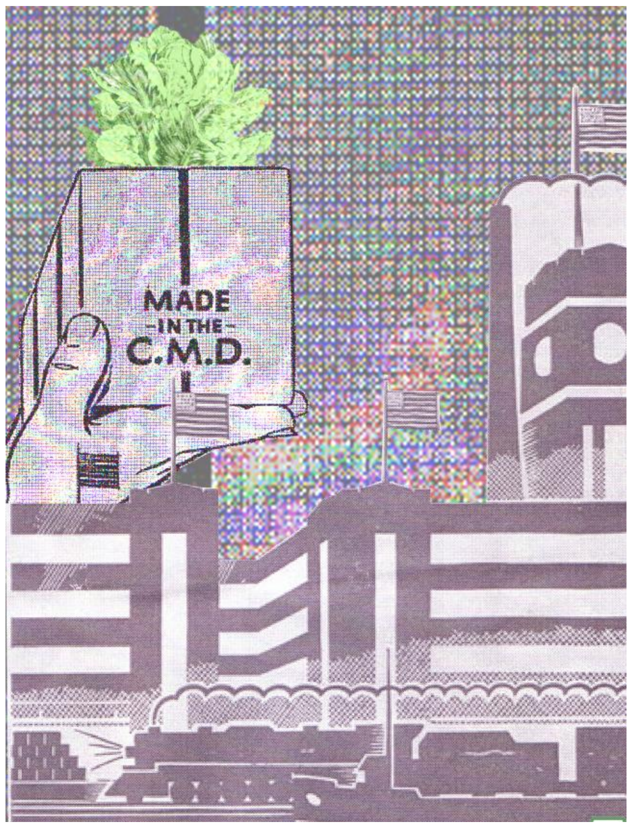
Plant: The 21st Century Farm

IPRO 336-Spring 2010



Faculty Advisor: Blake Davis

IPRO Sponsor: John Edel, Bubbly Dynamics LLC

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Background

The sponsor of this project is John Edel of Bubbly Dynamics, LLC and this is his second semester working with the IPRO program. He is still in the process of securing the title of an out-of-use warehouse building on 39th and Ashland which has a total of 600,000 sq.ft. of usable space. Of this space, he would like to designate 200,000 sq.ft. for the growth and production of economically viable agriculture. He is interested in diversity among crops and programming in order to maximize profit and create a sustainable business model. Our IPRO will be concerned with developing sustainable energy and agricultural systems in the context of the urban environment and providing a model for a successful urban agricultural business. We will also explore the best ways to passively maintain the systems and to program the spaces for optimal circulation and efficient processing. In addition to the ongoing work from last semester which includes marketing research and agricultural systems and the prototype, the Spring 2010 semester will be about designing a control system and building system which can be implemented to increase efficiency and sustainability of this project.

Team Values Statement

Our team values consist of accountability and productivity throughout the entire group. In order to be successful we feel as though each individual must both be personally and collectively willing to organize both thoughts and physical work. This work must come as a product of the three teams as a whole and therefore we must place a large emphasis on conducting our individual work with the group in mind. This implies an emphasis on efficient communication both in sharing our own ideas and seeking out those of others. We feel as though a commitment to accountability, productivity / communication, and teamwork will allow us to be as successful as possible in the upcoming project.

TEAM CHARTER

1. Team Information

NAME	CONTACT EMAIL	STRENGTH	DEVELOP	EXPECTATIONS
Jacob Davis	jdavis29@iit.edu jdavis135 @gmail.com	Design, space planning, 3D modeling/ rendering, animation	I would like to learn more about sustainable design and working with passive systems.	
Zachary Phillips	zphilli1@iit.edu	Very good at gardening and with different sorts of fish.	I feel that I need a creative environment with little constraints to exercise my skills and talents	
Jake Skaggs	jskaggs@iit.edu	Drawing, energy modeling, design, large scale planning.	Agricultural systems, mechanical/ electrical, project coordination.	To learn how to harvest both agricultural goods and underutilized energy sources in the urban context.
Konrad Sobon	ksobon@iit.edu	Strong design skills. Very proficient with various computer software as well as with visualization techniques.	Better knowledge of agricultural systems and its future applications in ever changing urban environment.	I would like to finally see this project take off with full force. I would like us to be able to move into the proposed building so that we can experiment with greater variety of systems. Finally I would like to gain a better understanding of environment and realize all of the opportunities that arise from urban agriculture.
Katarzyna Handzel	khandzel@iit.edu khandzel @yahoo.com	Programmatic and design development experience. Strong leadership and problem solving skills.	A sensible approach to Agricultural design and building systems through collective efforts.	My expectation would be to attain a greater knowledge of systems and procedures involved in executing a large project, as well as the ability to communicate effectively with professionals from different trades.
Ivan Silvestre	isilvest@iit.edu	Design, 3D renderings, creating scale models, and good research skills	I am interested in learning the various techniques for growing indoor crops	To see all the proposed systems running efficiently and successfully market our crops to prospective clients.

			and understanding how these systems work together in an energy-efficient environment.	
Mohammad Al-Sabah	malsaba@iit.edu malsabah87@gmail.com	Research. Design. Comp software.	a better understanding of agriculture systems and how it can be incorporated in architecture.	
Regine Antenor	rantenor@iit.edu	Committed, problem solver	Want to learn more sustainable design and that would help me understand my MechElec class better. It will theory in practice.	Learn more building systems and how to apply them.
Michael Gubser	mgubser@iit.edu	Organization and leadership	Learn about sustainable design	Apply knowledge learned at the university.
Joseph Millham	jmillham@iit.edu	Project management, making connections between disparate inputs	Balancing all the various variables within a design,	Learn about an urban farming project and how to harvest energy.
Indira Oraziman	iorazima@iit.edu	Creative, hard-worker	Gain some team work experience, place my knowledge gained in college into practice	Learn more about energy and cost efficient building technology, urban farming
Hyeonji Im	him@iit.edu	Organizing files and document, researches	Communication skills , mechanical systems in range of sustainable design	How to design existing building systems in a sustainable way.
Ralitza Todorova	rtodorov@iit.edu	Architecture and Design, Research	To develop a better knowledge in mechanical systems and sustainable design	To learn more about implying sustainable design in an existing building. How to make an existing building a lot more efficient (especially working within a tight budget)
Claire M. Simmonds	csimmond@iit.edu	I am experienced with Java programming. As a software tester, I have a good	I will be working on the GUI and software testing.	I have not worked with a system like this before so I see this as a learning experience, and I hope to better understand the

		understanding of end-user needs and software reliability and usability, specifically for users without much advanced computer knowledge. Also because of my software testing experience, I will be able to test our system.		development process when working with a complex embedded system. By the end of the IPRO, I hope that we have completed the task of creating a working prototype.
Frank Lockom	**flockom@iit.edu**	**software design, hydroponics knowledge**	**arduino-server communication, server implementation**	**a functioning prototype**
Dawid Broda	dbroda@iit.edu	knowledge and experience in computer engineering field	Hardware	Get some new experience. Learn working in a group
Mike Schmidt	Mschmid5@iit.edu	**Experience in Microprocessor programming and low voltage electrical systems**	**embedded systems (Arduino) programming/ interfacing with hardware to monitor and control the environment.**	**a fully functional prototype and more experience in working with microprocessors.**
Philip Speroff	psperoff@iit.edu	Programming knowledge as well as understanding of circuits.	Working on the embedded system.	Gain a better understanding of micro-controllers and see a proto-type working in conjunction with a control system.
Travis Valmores	tvalmore@iit.edu	Public Speaking, Data Acquisition and team management	Time management and further agricultural knowledge	Further business experiences
Janette Ochoa	jochoa1@iit.edu	Punctuality and organization	Time management and detailed understanding of energy efficiency	Apply energy efficiency knowledge into architecture field
Alexander Wiff	awiff@iit.edu	Leadership skills,	Implementing a	Learn developing

		ability to criticize constructively, and problem solving	business plan	technologies in urban farming
Alexander Derdelakos	aderdela@iit.edu	Real world business experience, strong ambition to succeed	Urban farming and it's social context	Help to develop a theoretical business plan

2. *Team Purpose and Objectives*

Team: **Building Systems Design**

Members: Michael Gubser, Ralitza Todorova, Hyeon Im, Regine Antenor, Indira Oraziman, Joseph Millham

Purpose & deliverables

Purpose of this team is to design the most efficient building systems for a property located at 1845 W. Pershing, on Chicago's South Side. The building, an old US armory built during World War II, is currently the property of the City of Chicago, and is in the process of being sold to XXXXX for a light sustainable manufacturing / mixed-use facility. The Building Systems team will focus on developing HVAC, plumbing, and building envelope designs to maximize passive and internal heat gains. We will start with an investigation and analysis of the existing building and the proposed uses of some anchor tenants. One of these large anchor tenants will be an indoor hydroponics farm managed by the development company, and is expected to create a large internal heat gain. Based on that research, we will investigate solutions that incorporate mechanical and plumbing systems maximize the effects of the farm on the indoor environment of the building. The final proposed building envelope will be subjected to a full energy analysis, including life-cycle, utility, and preliminary construction cost estimates.

Client / Sponsor Expectations & Desires

Look into on-site micro generation using a natural-gas turbine to create hot/cold water, generate electricity

Reuse as much of the existing systems as possible, including:

Radiators – double manifold

Hot-water heating systems on 5th & 6th floors

Air handlers

Built-out office areas on 5th & 6th floors

Examine feasibility / issues with placing greenhouses on rooftop

Keep projected energy costs less than $10 per square foot

Maintain exterior façade (rated orange historical building) while improving windows

Keep window replacement / upgrade to below $1000/window

1st floor is for renters, with ½ of 1st floor and 2nd floor reserved for Delta Institute.

Main building access on East side

Challenges

Replacing existing Single glazed windows

Reuse existing radiator piping for new radiator systems

Make basement as heat sink

CO2 removal

Passive system

Deliverables (numbered with sub-tasks/challenges below them)

1. Existing building calculations

- Exiting building conditions
  (Window systems, mechanical and plumbing systems)

- Drawing of Existing building sections

2. Solutions / Expected installations

- Method of reducing energy consumption
- Last semester theory
- Farm, chickens, pumps, CO2
- Restaurant / Brew

3. New energy calculations

4. Building sections / wall composition

- Windows : Specs that contribute to lower energy consumption
- Solid wall: Insulations.

5. Mechanical HVAC design

6. Plumbing initial section

Team: **Computer Control System**

Members: Mike Schmidt, David Broda, Phil Speroff, Claire Simmonds, Frank Lockom

Purpose & deliverables

Purpose of this team is to design a fully functional prototype of a computer control system. This system is going to control a prototype at 1048 West 37th Street, and will be designed in such a way that it can be up scaled with very little change to the system, so that it can be used on multiple rooms. We will start with a simple approach by getting the basic sensors working and controlling basic variables, such as temperature, humidity, CO2, Oxygen, water levels, etc. Once we get this system working we will be able to add and subtract sensors, as the agriculture team needs/ wants to try.

Client / Sponsor Expectations & Desires

We require a control system that allow us to monitor and control the temperature of the building and control several variables conditions in an Aquaponic and Hydroponic systems.
We will need to build a Control System Prototype for the Aquaponic System prototype.
The Control System prototype must be able to control the oxygen levels in the water, control the

temperature, water circulation and control the lights. Also the system must provide a graphical user interface to monitor and control the Aquaponic Systems, we will have only one kind of user for the system.

For the main project we will need develop a Control Systems with the next requirements.

For the farm area:

-Control the lights

-Control CO_2 air levels

-Control the temperature

-Control de humidity

For the Aquaponic Systems:

-Control water temperature

-Control Oxygen levels in the water

-Control water circulation

-Control lights

Each Farm and Aquaponic area must have their own control system console. In each console the user must be able to monitor and change the environment values for that specific area. Each console will send a report of the area's environment to the main Control System.

For the entire building

-Control the temperature

-Control gates to allow the flow of heat through a pipe network, this pipe network would be in all the building.

-Control heat pumps, compressors.

In our control system we will use a distributed computer system, we can see this distribution and the control flow in the figure 18. We will have electronics boards (embedded systems) that will be directly connected to the sensors and to the water pumps, light system, oxygen system, etc. The embedded systems will be monitoring the environment of a small area a will keep the temperature levels of that space, the embedded systems will send a report to the main computer, using the TCP/IP protocol. The main computer will monitor the environment of the full building and will take the decision of move hot air from one place to the other.

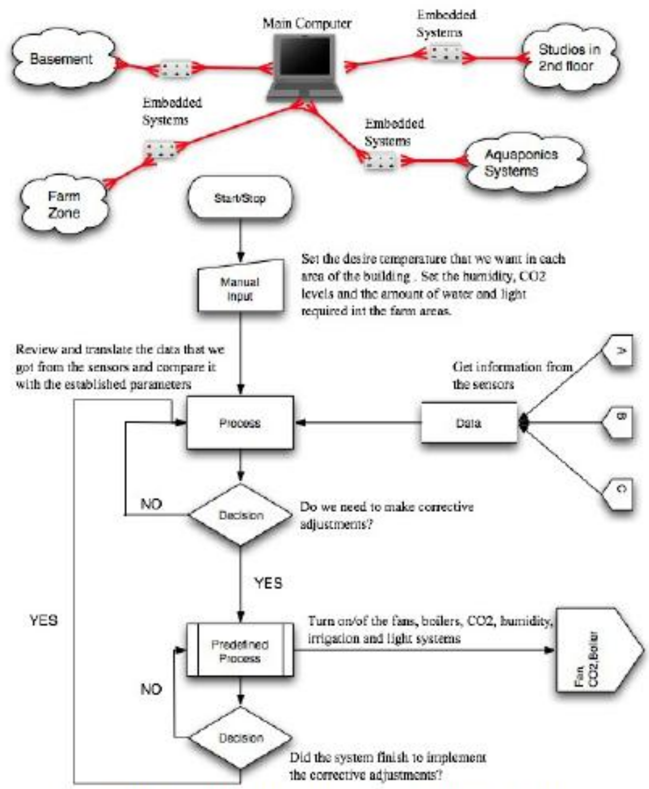


Figure 18. Control system architecture and flow control.

Challenges

Making the system up scalable

Deliverables (numbered with sub-tasks/challenges below them)

1. Multiple sensor/control modules

- Make the units independent of each other thus making it easily upgradeable/changeable

2. Embedded system communication with main server

- Find/design a protocol that communicates efficiently between the server and all the embedded systems.

3. Fully secure and User friendly Graphic User Interface

- Different tiered access to manage, view, or change constants.

Team: Agricultural Systems

Members:

Jake Skaggs, Jake Davis, Konrad Sobon, Katarzyna Handzel, Ivan Silvestre, Mohammad Al-Sabah

Purpose and Deliverables:

The purpose of the agricultural systems team is to research and test the alternatives to traditional agriculture and plan a system based on integration of marketing/building systems data. This will include both the research of individual agricultural systems in the prototype setting and hands-off research for the purpose of compiling data based on scientific precedent. Our group will attempt to determine how to operate the indoor farm at optimal efficiency in collaboration with the other groups with respect to environmental conditions both natural and imposed. We will examine a number of different methodologies in order to draw inspiration for designing an appropriate and efficient system unique to the conditions at John Edel's prospective property.

The deliverables for the project will be mostly data driven and we will be closely tied to the marketing group in order to ensure cohesive research. They will tell us what needs to be grown, we will determine how to grow it, working all the while with the building and control systems groups to optimize existing conditions and to create closed energy loops wherever possible. Also, we will be working to expand the current prototype both in terms of space and data output. The control systems group will be beginning to monitor the environmental conditions and we will need to make alterations and collect data of our own regarding plant / fish health, as well as the overall productivity of the individual systems we are testing. We will be working with Adrien and Zach (independent study; participated in the beginning phases of the prototype) to implement as many possible growing systems as possible in order to gather as much data as we can. Again, our deliverables will be mostly usable data with the addition of some creative ideas for design and implementation, including distribution. They will include but are not limited to:

1. A Seasonal Plan

- Working with the marketing and building systems groups
- 2. A Distribution Plan

3. Prototype output data analysis / synthesis

- Scientific monitoring

4. Design schemes for space / lighting arrangement

5. Recommendations for plant choice and volume…

	Agricultural Systems
Week 1 – 2	1. Initial research. 2.New systems implemented at prototype.
Week 3 – 4	1. Marketing research adaptation 2. New systems testing
Week 5 – 6	1. Design Development 2. Monitoring Updated/Refined
Week 7 – 8 **Week 9 – 10**	1. Design Development 2. Strategies/New prototype
Week 11 – 12	1. Create Seasonal plan 2. Create Distribution plan 3. Begin synthesizing data from prototype into cumulative report.
Week 13 – 14	1.Finalize reports/collaborate with other teams.
Week 15	1. Final Production

Client / Sponsor Expectations and Desires:

The way that our group can help the sponsor of this project is simple. We must demonstrate, via the prototype and scientific research what method of growing is most suitable for his building / idea. John expects / desires usable data in all forms which can help him achieve his lofty goal in the old manufacturing district. We believe the ways in which we can be of most help include completing a schedule for the seasonal changes of the farm based on marketability and to continue to test any ideas via the prototype space at Bubbly Dynamics. Also, we will need to think of creative ways to make the farm work because we have very little (or no) precedent and as a sustainable venture, the farm needs to be able to be reproduced and created using as little resources as possible. We must help find a solution to the ailing agricultural industry.

Team: Marketing

Members:

Travis Valmores, Janette Ochoa, Alexander Wiff, Alexander Derdelakos

Purpose and Deliverables:

The marketing team's purpose in this IPRO is to work with the sponsor to create and assist in the creation of a workable business plan for the farming operations. In order to do this we will examine other business plan for both greenhouse and vertical farming operations to use a reference points in designing our own plan. In addition we will be working with all three other teams to determine capital and operating expenses, as well as determining the revenues from the farm.

The deliverables for this project are based on the results of each groups work from this semester as well as the last semester's information. The final deliverable will be a business plan with three outlooks: optimistic, pessimistic, and average. We will also be creating a risk assessment for this operation. Additionally, we intend to provide a data base of information concerning not only our final plan, but the data used in the process including information from nonproductive experiments.

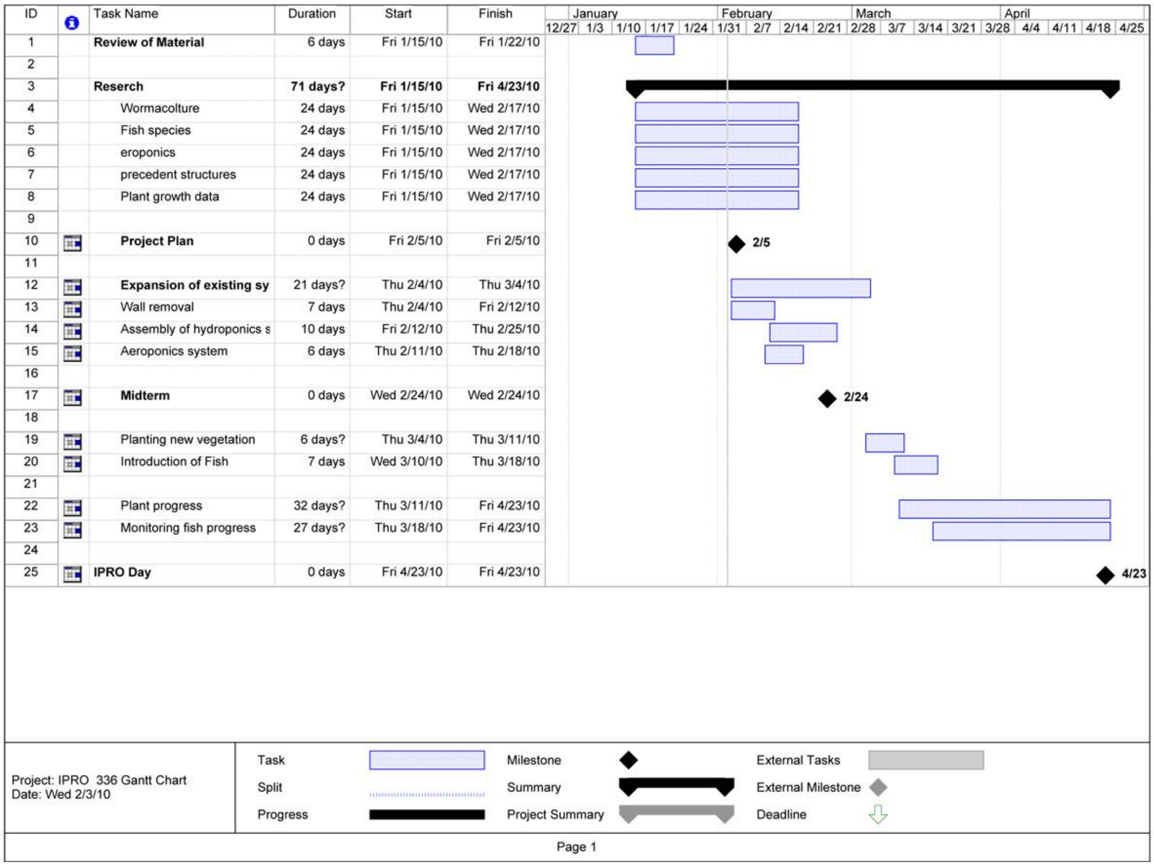
Client / Sponsor Expectations and Desires:

Our group is working with the sponsor closely to keep them up to date with the current progress made across all the groups as well as to develop and understanding of what they need to have looked at. Additionally, the marketing group will be providing the sponsor with the business plan that they will use to make decisions regarding purchasing and production. We have a secondary role to preserve all the data acquired and make it available to the sponsor.

PROJECT METHODOLOGY

1. Work Breakdown Structure: Gant Charts

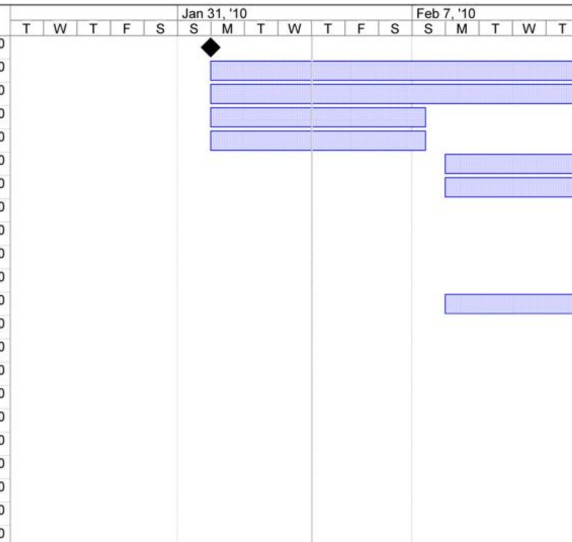
Ag. Systems



ID	Task Name	Duration	Start	Finish
1	**Review of Material**	6 days	Fri 1/15/10	Fri 1/22/10
2				
3	**Reserch**	**71 days?**	**Fri 1/15/10**	**Fri 4/23/10**
4	Wormacolture	24 days	Fri 1/15/10	Wed 2/17/10
5	Fish species	24 days	Fri 1/15/10	Wed 2/17/10
6	eroponics	24 days	Fri 1/15/10	Wed 2/17/10
7	precedent structures	24 days	Fri 1/15/10	Wed 2/17/10
8	Plant growth data	24 days	Fri 1/15/10	Wed 2/17/10
9				
10	**Project Plan**	0 days	Fri 2/5/10	Fri 2/5/10
11				
12	**Expansion of existing sy**	21 days?	Thu 2/4/10	Thu 3/4/10
13	Wall removal	7 days	Thu 2/4/10	Fri 2/12/10
14	Assembly of hydroponics s	10 days	Fri 2/12/10	Thu 2/25/10
15	Aeroponics system	6 days	Thu 2/11/10	Thu 2/18/10
16				
17	**Midterm**	0 days	Wed 2/24/10	Wed 2/24/10
18				
19	Planting new vegetation	6 days?	Thu 3/4/10	Thu 3/11/10
20	Introduction of Fish	7 days	Wed 3/10/10	Thu 3/18/10
21				
22	Plant progress	32 days?	Thu 3/11/10	Fri 4/23/10
23	Monitoring fish progress	27 days?	Thu 3/18/10	Fri 4/23/10
24				
25	**IPRO Day**	0 days	Fri 4/23/10	Fri 4/23/10

Marketing:

ID	Task Name	Duration	Start	Finish
1	Building Tour	1 day?	Mon 2/1/10	Mon 2/1/10
2	Capital Costs	45 days	Mon 2/1/10	Fri 3/12/10
3	Mechanicle Equipment	14 days	Mon 2/1/10	Sat 2/13/10
4	Packaging System	7 days	Mon 2/1/10	Sun 2/7/10
5	Processing System	7 days	Mon 2/1/10	Sun 2/7/10
6	HVAC Systems	7 days	Mon 2/8/10	Sun 2/14/10
7	Refrigerated Truck	7 days	Mon 2/8/10	Sun 2/14/10
8	Computer Systems	14 days	Mon 2/15/10	Sat 2/27/10
9	Plumbing	7 days	Mon 2/15/10	Sun 2/21/10
10	Aquaculture Systems	14 days	Sun 2/28/10	Fri 3/12/10
11	Agricultural Systems	14 days	Sun 2/28/10	Fri 3/12/10
12	Planting Beds	7 days	Mon 2/8/10	Sun 2/14/10
13	Lighting	14 days	Sun 2/28/10	Fri 3/12/10
14	Operating Costs	22.5 days?	Sat 3/13/10	Thu 4/1/10
15	Utilities	21 days	Sat 3/13/10	Wed 3/31/10
16	Labor	7 days	Sat 3/13/10	Fri 3/19/10
17	Seeds	7 days	Sat 3/20/10	Fri 3/26/10
18	Packing	7 days	Sat 3/20/10	Fri 3/26/10
19	Trasportation Upkeep	7 days	Sat 3/20/10	Fri 3/26/10
20	Risk Assesment	14 days	Thu 3/18/10	Tue 3/30/10
21	IPRO Day	1 day?	Fri 4/23/10	Fri 4/23/10
22	IPRO Day Prep	24.75 days?	Thu 4/1/10	Thu 4/22/10



Project: GroupPlan
Date: Thu 2/4/10

Task | Rolled Up Task | External Tasks
Progress | Rolled Up Milestone | Project Summary
Milestone | Rolled Up Progress | Group By Summary
Summary | Split | Deadline

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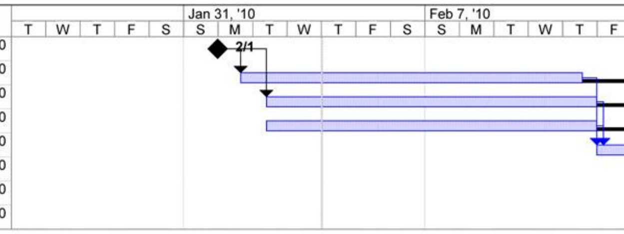
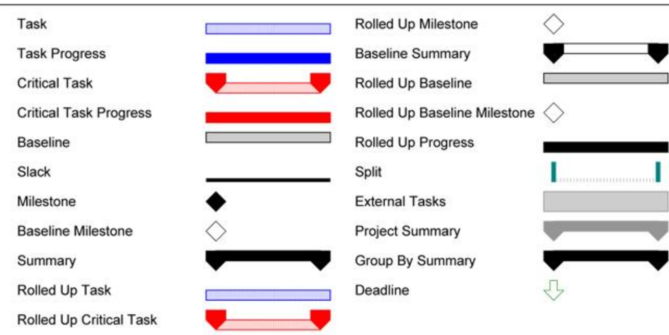
Building Systems:

ID		Task Name	Duration	Start	Finish
1		Building Tour	1 day?	Mon 2/1/10	Mon 2/1/10
2		Calculations of Ext. Bldg Heat L	11 days	Mon 2/1/10	Thu 2/11/10
3		Detailed / Tagged Building Sect	11 days	Tue 2/2/10	Thu 2/11/10
4		Obtain/Examine Plans, Theory,	11 days	Tue 2/2/10	Thu 2/11/10
5		Building Wall Section / Wall Coı	40 days?	Fri 2/12/10	Fri 3/19/10
6		Mech. / Plumbing Designs	22 days	Wed 3/17/10	Mon 4/5/10
7		Presentation, Paper, Poster Pre	15 days	Sat 4/3/10	Fri 4/16/10
8		IPRO Day	1 day?	Fri 4/23/10	Fri 4/23/10



Project: GroupPlan
Date: Thu 2/4/10



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2. Project Budget

Subgroup	Amount	Note
Agricultural Systems	$300	Prototype; PVC, rockwool, hydroton, filters, pumps, lighting, etc.
Building Systems		
Control Systems	$500	Webcam, rent a projector and laptop from OTS, sensors, relays, etc.
Marketing		
Total:	$800	

3. Team Roles:

Building Systems:

Name	**Email**	**Major**	**Task**
Regine Antenor	rantenor@iit.edu	Architecture	
Michael Gubser	mgubser@iit.edu	Architecture	Building Cross-Section Development
Joseph Millham	jmillham@iit.edu	Architectural Engineering	E-Quest Energy Models
Indira Oraziman	iorazima@iit.edu	Architectural Engineering	
Hyeon Im	him@iit.edu	Architecture	Building Cross-Section development
Ralitza	rtodorov@iit.edu	Architecture	

Todorova			

Ag Systems:

Name	Email	Major	Task
Jake Skaggs	jskaggs@iit.edu	Architecture	Prototype Monitoring / Expansion,
Ivan Sivestre	isilvest@iit.edu	Architecture	Vermicompost research, data compile
Konrad **Sobon**	ksobon@iit.edu	Architecture	Prototype development. New prototypes and different system experimentation. Space planning for different systems.
Jake Davis	Jdavis29@iit.edu	Architecture	Researching different types of agriculture systems. Prototype development and experimentation. Finding out what plants grow best with what system type.
Mohammad Al-Sabah	malsaba@iit.edu malsabah87@gmail.com	Architecture	"
Katarzyna Handzel	khandzel@iit.edu khandzel @yahoo.com		"

Control Systems:

Name	Email	Major	Task
Mike Schmidt	Mschmid5@iit.edu	CPE	Designing and Implementing sensors and coding the Ardiuno
Phil Speroff	psperoff@iit.edu	CPE	Designing and implementing sensors and testing GUI and communication protocols for quality assurance.
Frank Lockom	flockom@iit.edu	CS	Designing protocol to communicate java server with the embedded system.
Claire	csimmond@iit.edu	CS	Designing fully functional user friendly Graphical User interface for reading and modifying environment

Simmonds			variables.
Dawid Broda	dbroda@iit.edu	ITM	Research possible other control systems. Design hardware interfaces for sensors to communicate with Arduino.

Marketing:

Name	**Email**	**Major**	**Task**
Travis Valmores	tvalmores@iit.edu	Political Science	Business models for packing system, plumbing, packaging materials, lighting
Janette Ochoa	jochoa1@iit.edu	Architecture	Business models for processing system, aquaculture system, transportation upkeep, utilities
Alex Wiff	awiff@iit.edu	Biomedical Engineering	Risk assessment, computer systems, tables, and seeds
Alex Derdelakos	aderdela@iit.edu	Architecture	HVAC system, refrigerated truck, planting beds, labor costs.