Plantmosphere

Project Presentation

|		
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Outline

- Meet the Team
- Background
- System Overview
- High Level Design
- Timeline
- Business Case
- Future Plans
- Sources
- Acknowledgements
- Questions

Meet the Team

Plantmosphere Technologies

- Jane Horton
- Mike Thiem
- Faisal Emami
- Alex Naylor
- Jeffrey Shum
- Terry Hannon
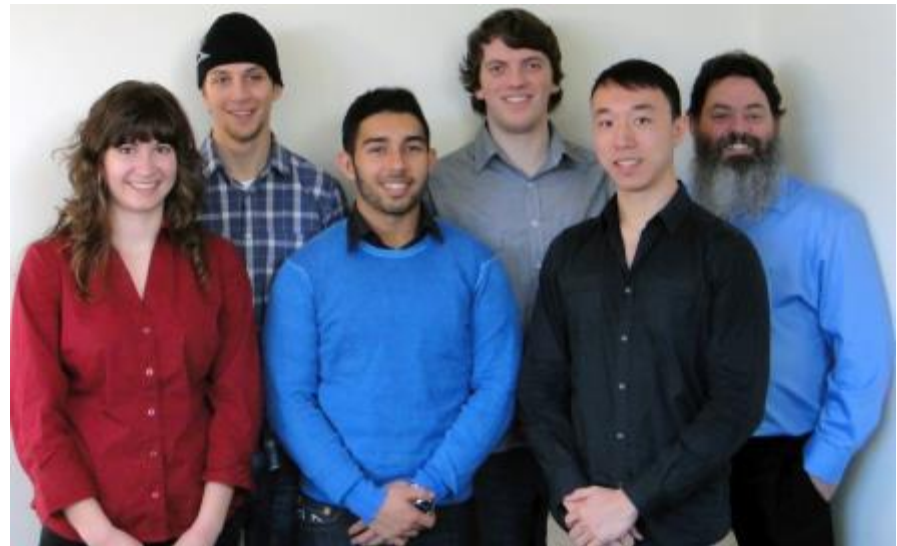
Meet the Team

- Faisal Emami
  - Hardware Engineer
  - Lighting system Designer
  - Lighting System implementation
  - Design Assistant
- Terry Hannon
  - Project Manager
  - Irrigation & Humidification Designer
 - Testing Design Assistant
  - Arduino Developer

Meet the Team

- Jane Horton
  - Design and Software Support Engineer
  - Code Base Maintenance and Algorithm Development Assistant
  - Soil Heating Designer
  - Data Logging Designer
- Alex Naylor
  - Design & Hardware Support Engineer
  - Power Supply Designer
  - Ventilation Design Assistant
  - Lighting Design Assistant

Meet the Team

- Jeffrey Shum
  - Software Engineer
  - Ventilation System Designer
  - User Interface Designer
  - Woodwork Assistant
- Mike Thiem
  - Structural Designer
  - Workshop Technician
  - Purchasing Coordinator
  - Algorithm Development Assistant
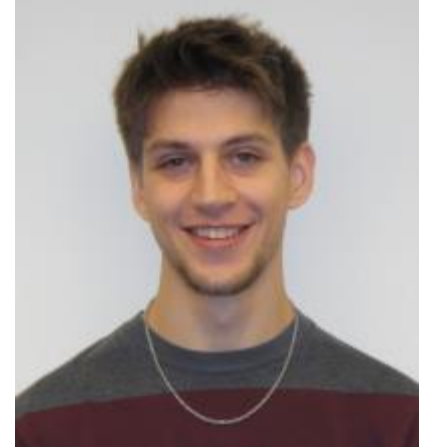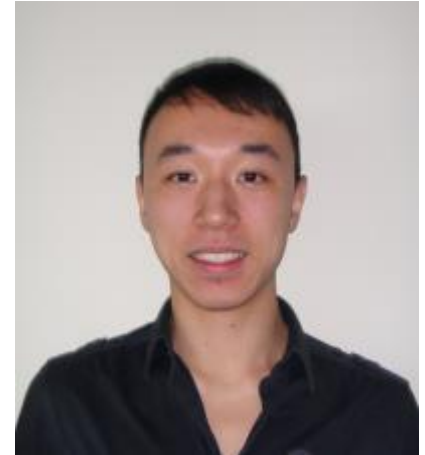
Background

- Vegetables cannot easily be grown in all environments
- Not everyone has that ability or know-how to grow plants
- A self sustained greenhouse which requires little to no maintenance is a start
- Efficiency is important:
  - Use less water
  - Use less power
  - Collect rain water

Background: Motivation

- To help people
- To support a healthier diet
- The project was interesting and required many different skills
- For hobbyists

Business Case: Market

Several diverse markets exist:

- Agencies assisting in disaster areas
- People living in areas where food does not easily grow
  - Too cold
  - Too hot
  - Too dark
- People who would like to grow their own vegetables
- People who feel grocery store vegetables are not healthy or organic enough

Business Case: Existing Solutions

- Large scale systems exist
  - Climate Control Systems Inc.
  - Hoogendoorn – Growth Management
- Smaller scale projects
  - Home grown
    - GardenBot – www.gardenbot.org
    - The Smart Greenhouse – www.makezine.com
    - Plantduino Greenhouse – www.revoltlab.com
  - Fisher Innovation Automated Greenhouse
  - HarvestGeek
  - niwa

System Overview

- Fully automated greenhouse
- Subsystems include:
  - User Interface
  - Humidification and Irrigation
  - Lighting
  - Soil heating
  - Ventilation
  - Rain water capture
- Developed using Arduino microcontroller
- Started with greenhouse kit from Palram

High Level Design

Plantmosphere System Overview				
Inputs	**Input Signal Conditioning**	**Signal Processing**	**Output Signal Conditioning**	**Outputs**
Analog Sensors - Soil Temperature - Soil Moisture - Reservoir Water Level - Light	Signal Amplification → A/D Converter	Microcontroller	Motor Drivers	Motors - Water Pump - Ventilation Fans - Recirculation Fans - Upper Vent Opener
Digital Sensors - Air Temperature - Air Humidity Serial Communication	Signal Amplification → A/D Converter		Solenoid Drivers	Water Solenoids - Humidification - Irrigation - Reservoir Overflow
Digital Sensors - Reed Switches			Pulse Width Modulators	Lighting LEDs Lower Vent Opener
User Interface - Input Buttons	Debouncer → Filter		Display Data Formatter → USART	Display
				Soil Heating Cable

User Interface

Major Components

- LCD Display
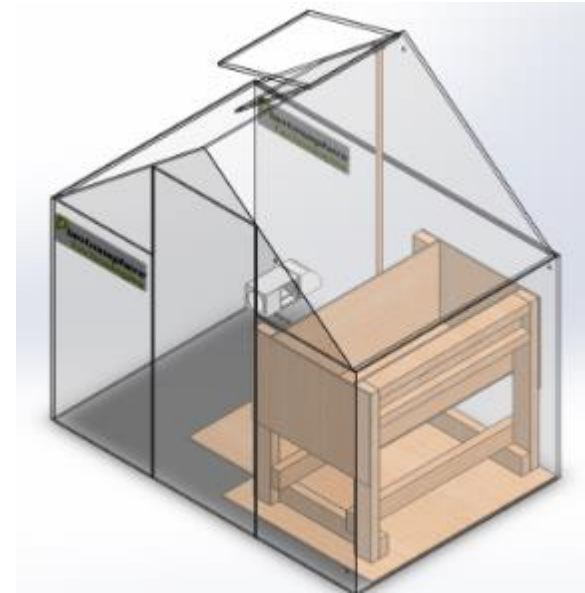- Keypad

User Interface – Video

Structure

Major Components

- Palarm Greenhouse kit
- Trough
- Water Reservoir
- Baseboard

Kit vs. Custom Greenhouse

Water Reservoir

Greenhouse with Trough

Trough

Water Reservoir

Power

Major Components

- LOGYSIS 480 Watt PSU
- Tripp-Lite Power Strip
- Surge Protector
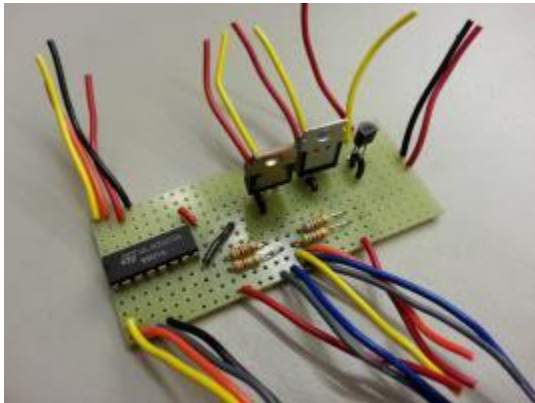
Why PSU?

LOGYSIS 480 Watt PSU

Tripp-Lite Power Strip

Root Ball

Microcontroller

Major Components

- Arduino Mega 2560
- Sainsmart 8 Channel Relay Shield
- RTC Data logging Shield
- Proto-board

Proto-board

Sainsmart 8 Channel Relay

Humidification & Irrigation

Major Components

- Humidification Misters and Irrigation Drip Nozzles
- Mister and Drip Irrigation Solenoids
- Control Unit with Filter
- Soil Moisture and Temperature Sensors

2 Solenoids vs. 2 Pumps
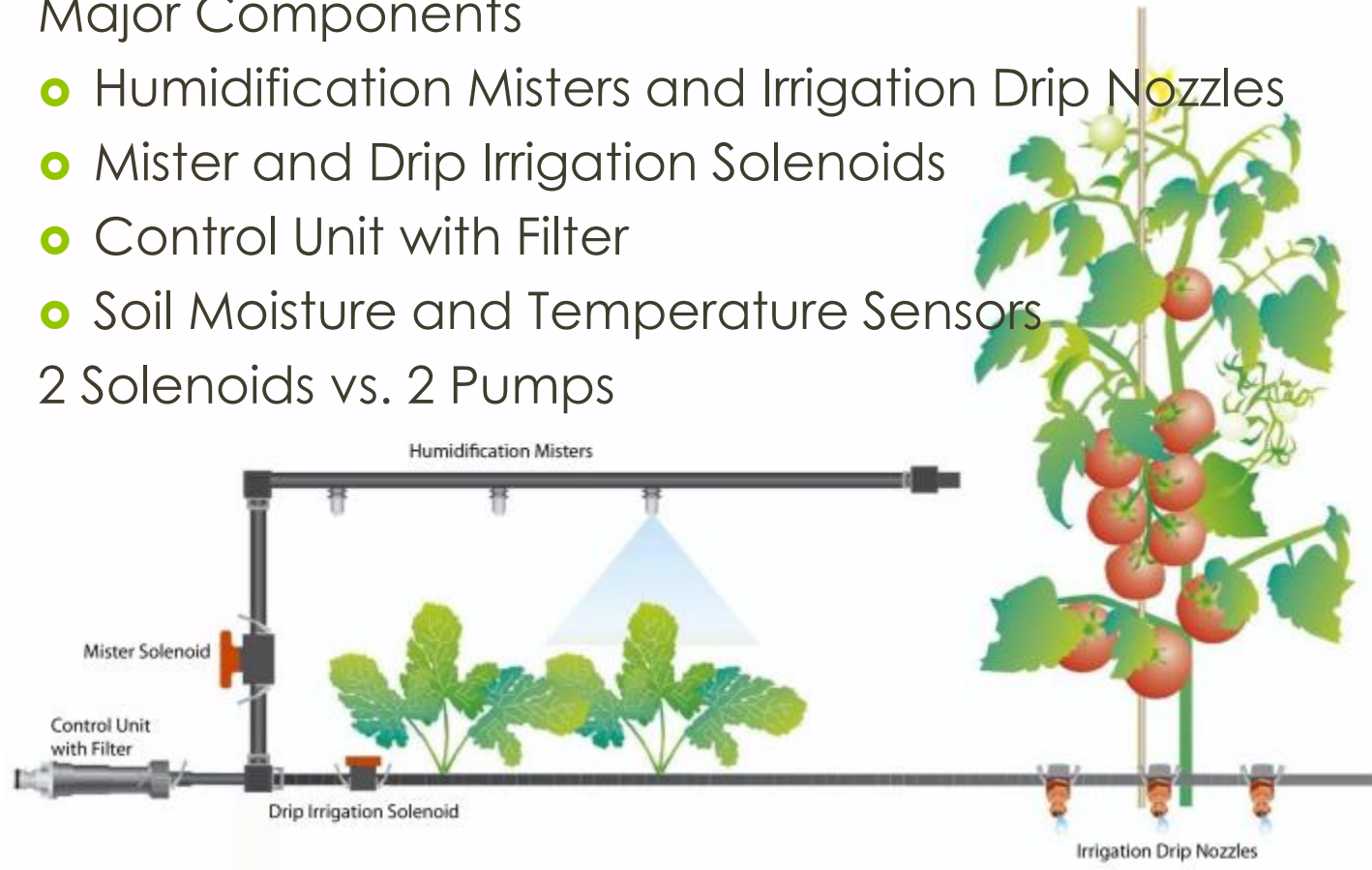
Irrigation and Humidification Layout

Humidification & Irrigation

Mister Nozzles
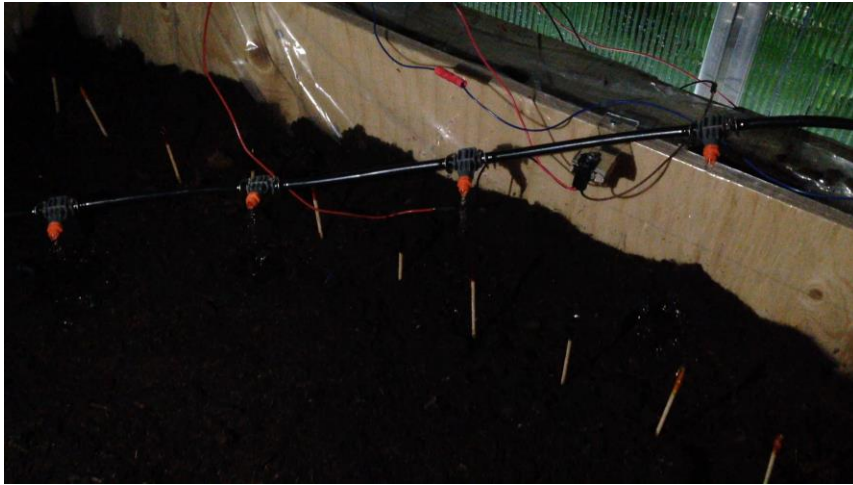
Drip Nozzles

Ventilation

Major Components

- Upper Vent Opener
- Lower Vent
- Recirculation Fans
- Air Temperature and Humidity Sensors
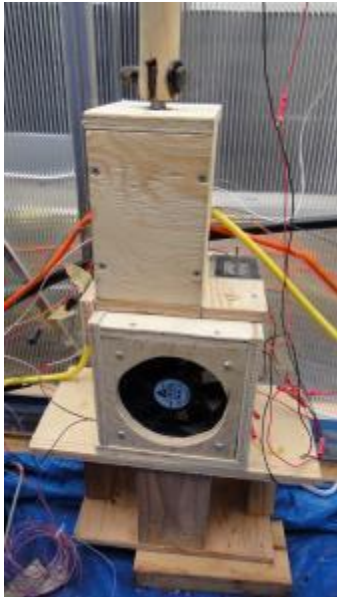
Linear Actuator

Upper Vent

Ventilation - Videos

Upper Vent Opener

Lower Vent Opener

Lighting

Major Components

- LED Array
- Light Sensors

LEDs vs. Grow Light

LED Array – Turned Off

LED Array – Turned On

Soil Heating

Major Components

- Soil Heating Cable
- Soil Temperature Sensor

Soil Heating Cable

Projected Timeline

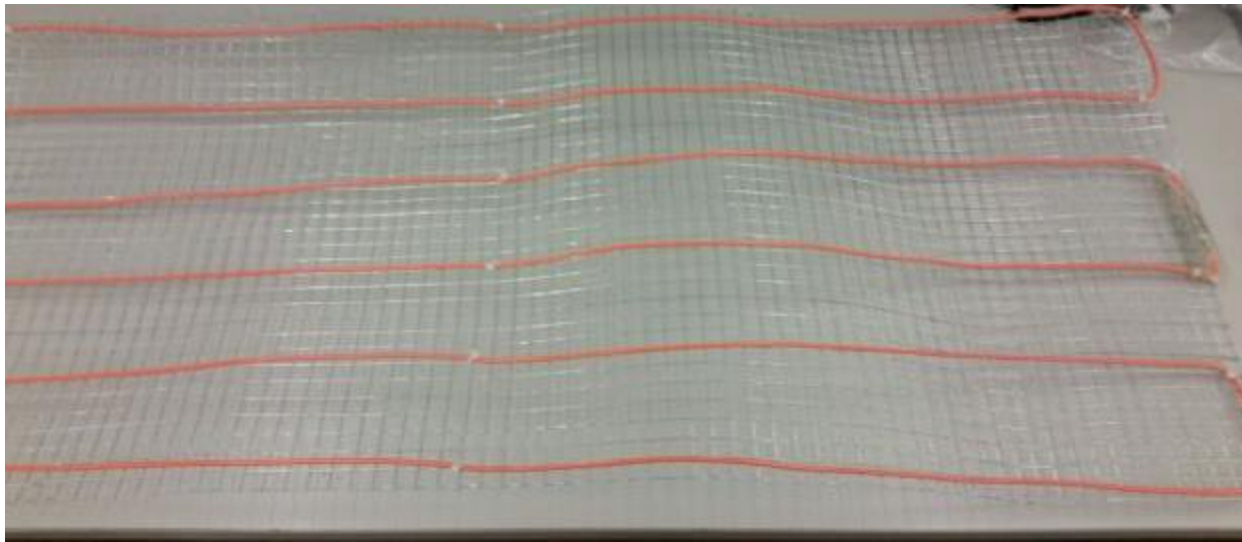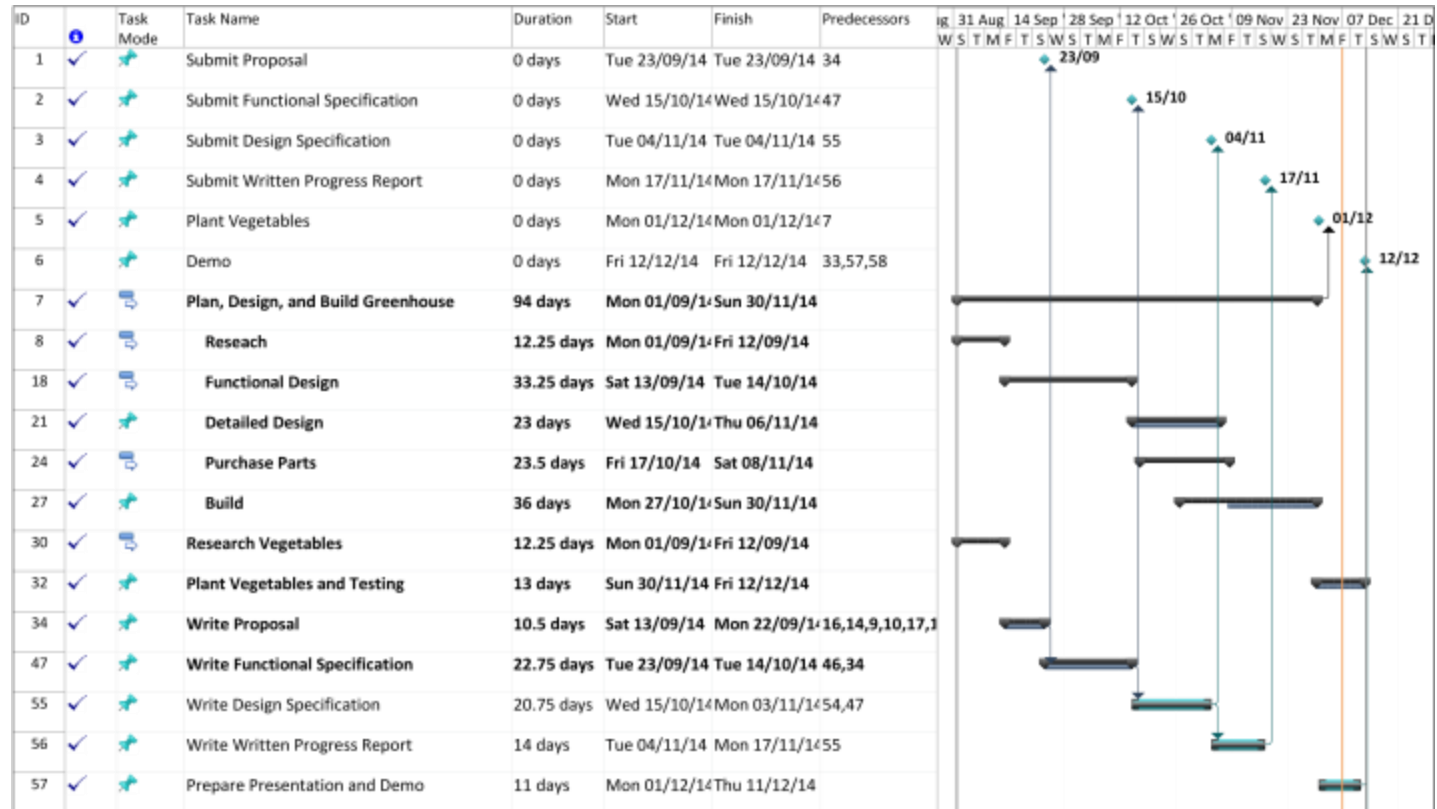| ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors
1	✓	🛪	Submit Proposal	0 days	Tue 23/09/14	Tue 23/09/14	34
2	✓	🛪	Submit Functional Specification	0 days	Wed 15/10/14	Wed 15/10/14	47
3	✓	🛪	Submit Design Specification	0 days	Tue 04/11/14	Tue 04/11/14	55
4	✓	🛪	Submit Written Progress Report	0 days	Mon 17/11/14	Mon 17/11/14	56
5	✓	🛪	Plant Vegetables	0 days	Mon 01/12/14	Mon 01/12/14	7
6		🛪	Demo	0 days	Fri 12/12/14	Fri 12/12/14	33,57,58
7	✓	🕏	Plan, Design, and Build Greenhouse	94 days	Mon 01/09/14	Sun 30/11/14	
8	✓	🕏	Reseach	12.25 days	Mon 01/09/14	Fri 12/09/14	
18	✓	🕏	Functional Design	33.25 days	Sat 13/09/14	Tue 14/10/14	
21	✓	🛪	Detailed Design	23 days	Wed 15/10/14	Thu 06/11/14	
24	✓	🕏	Purchase Parts	23.5 days	Fri 17/10/14	Sat 08/11/14	
27	✓	🛪	Build	36 days	Mon 27/10/14	Sun 30/11/14	
30	✓	🕏	Research Vegetables	12.25 days	Mon 01/09/14	Fri 12/09/14	
32	✓	🛪	Plant Vegetables and Testing	13 days	Sun 30/11/14	Fri 12/12/14	
34	✓	🛪	Write Proposal	10.5 days	Sat 13/09/14	Mon 22/09/14	16,14,9,10,17,1
47	✓	🛪	Write Functional Specification	22.75 days	Tue 23/09/14	Tue 14/10/14	46,34
55	✓	🛪	Write Design Specification	20.75 days	Wed 15/10/14	Mon 03/11/14	54,47
56	✓	🛪	Write Written Progress Report	14 days	Tue 04/11/14	Mon 17/11/14	55
57	✓	🛪	Prepare Presentation and Demo	11 days	Mon 01/12/14	Thu 11/12/14	

Deviations in Timeline

- Limited access to greenhouse
- Parts acquisition took longer than expected
- Integration of some modules more complex than originally thought
- Re-design of some sub-systems required due to unforeseen hardware limitations
- Design document took much longer to write and validate than planned.
- Calibration of sensors was more work that realized

Cost and Funding

Category	Projected Cost	Actual Cost
Electronics	$150.00	$354.90
Hydration	$40.00	$328.92
Lighting	$90.00	$32.98
Soil Heating	$35.00	$49.06
Structure	$645.00	$897.87
Ventilation	$215.00	$207.67
Tools	$0.00	$17.89
Contingency	$125.00	$0.00
Total	$1,300.00	$1,889.29

Summary	Amount
Original Budget	$1,300.00
Actual Cost	$1,889.29
Overbudget (%)	45.33
Overbudget ($)	$589.29

Production Cost Evaluation

- Some parts were poorly made
- Integration was not as smooth as we thought
- Some subsystems required higher rated parts than were purchased
- Using scrap parts initially cost less but in some cases required more parts and therefore ended up being more expensive
- With a better understanding of the parts needed cost could be reduced

Future Plans

- Solar power
- Water runoff reclamation
- Water filtration
- CO_2 sensor
- Automatic fertilization with pH sensor
- Modular design
- Hydroponics support
- Sunlight filtering or blocking
- Water reservoir and greenhouse heating
- Mobile device integration
- More options for different plants

Summary

Sources

- GardenWorks
- www.gardenbot.org
- EMCO Corporation

Acknowledgements

- Dr. Ash Parameswaran
- Gary Shum
- Gary Houghton
- Fred Heep
- GardenWorks
- ENSC Office
- Fred Naylor
- ESSEF
- Wighton

- Dr. Barbara Frisken
- David Lee
- Jim Thiem
- Tom Horton
- EMCO Corporation

Questions?