UMassAmherst
The Commonwealth's Flagship Campus

GrowingGreen PDR

Team Members: Austin Hiller, Nate Lemons, Matthew Sargeant, Jason Trainor

Advisor: Professor Kundu

10.11. 2019

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Who We Are...Nice to meet you!

Austin Hiller CSE

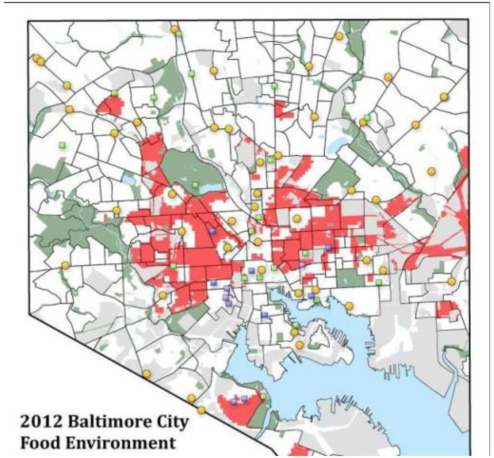
Nate Lemons CSE

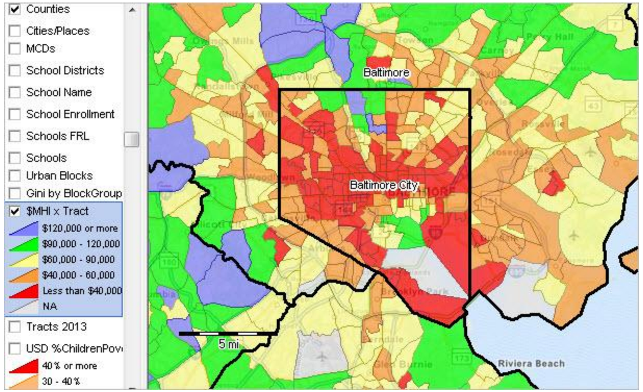
Matthew Sargeant EE

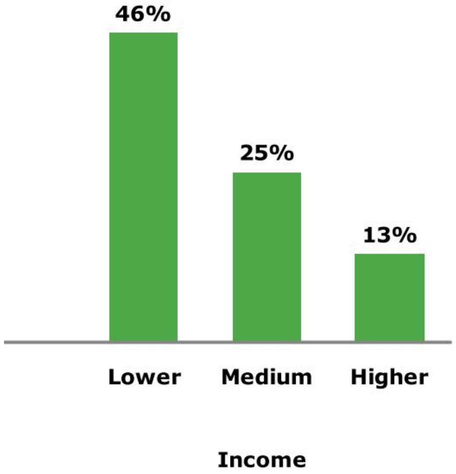
Jason Trainor CSE

Problem Statement

- The Grocery Gap
  - Low income zip codes have 25% fewer supermarkets
  - Rural and urban communities affected
- Proximity to a supermarket is correlated to healthy diet habits
- Low-income neighborhoods have half as many supermarkets as the wealthiest neighborhoods and four times as many smaller grocery stores



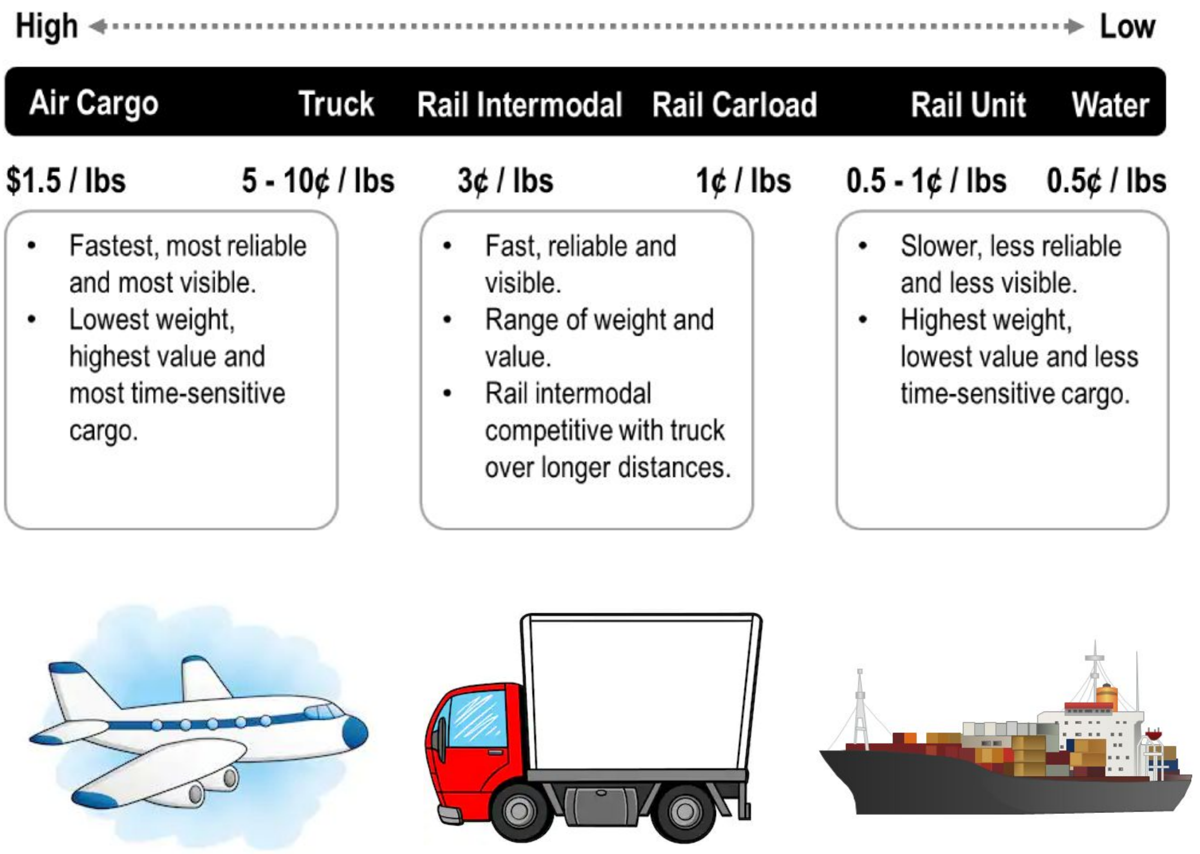




Share of Baltimore neighborhood grocery stores with low availability to healthy food, by income

Problem Statement

- Current food system is very taxing on environment due to transportation
- 10 Kcal of energy from fossil fuel per 1 Kcal of energy from food
- Transport leads to lesser quality, more chemical influence, and higher cost



Vision Statement

The GrowingGreen system is a fully automated, energy efficient, in-house growsite with focus on supplying the grower edible vegetation with minimal effort. Our goal is to increase the availability and desire of home growing by simplifying the process through the automation of manual processes, lessening of power consumption, and use of a user console with alerts to keep growers engaged and on schedule. By growing in-house, users will decrease their environmental impact by reducing their carbon footprint and pesticidal use on plants.

Design Alternatives

FarmBot
- Requires outdoor space
- Dependent on environment
- Seasonal growing only
- Growth will be inconsistent

Carter-Hoffmann GardenChef
- Not using efficient means of light, non-LED
- High power consumption (300W)
- >$10,000, too expensive to justify

Typical Greenhouse
- Requires location with full sun
- Lots of time and knowledge still needed to grow
- In-efficient when it comes to energy use

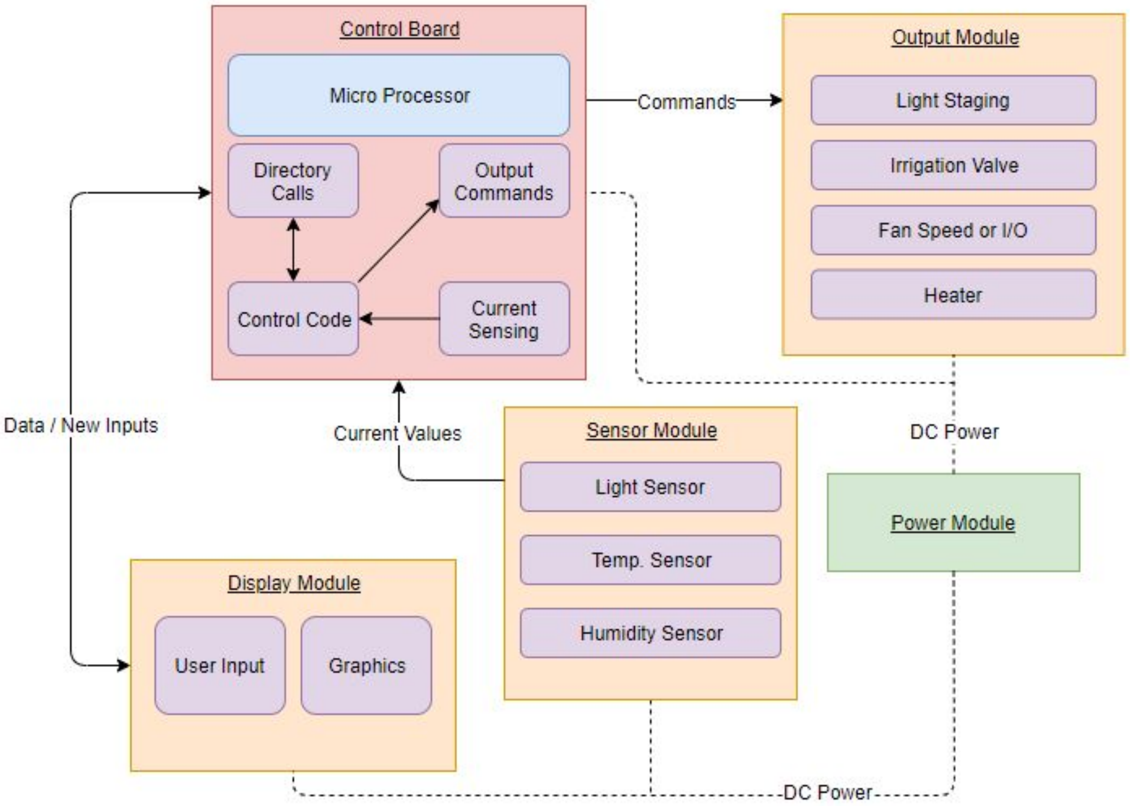
System Specifications

- Reduce power consumption by 3 times the standard
- Produce 24 ounces of product per cycle
- Simplify process of growing so even engineers can grow plants
- Automation through feedback control:
  - Lights
  - Temperature/Humidity
  - Irrigation
- Functional year round
- Data available to user at all times
- Must fit against typical window frame

Greenhouse Power

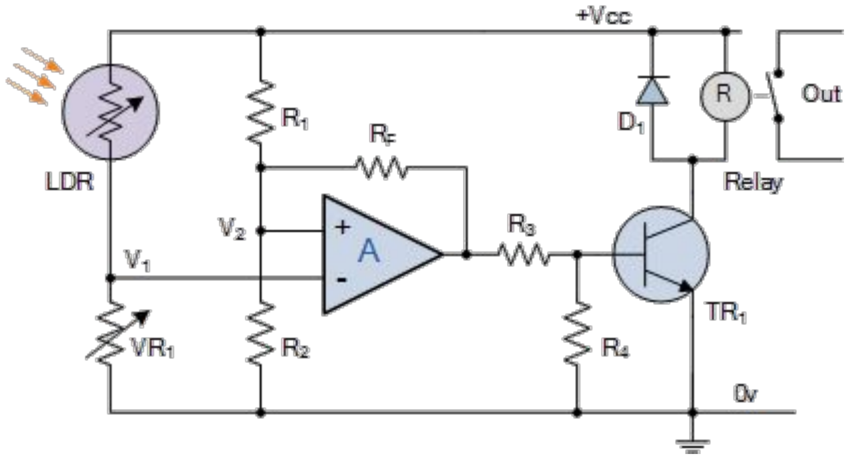
- Power use of commercial microgreen device is 300W
- Residential indoor grow sites monthly lighting demand is 30-40 W/sq.ft.
- Heating ~ 10W
- Sensors <1 W
- Fans ~ 4 W
- Control Box ~ <10 W

Block Diagram



Subsystem 1: Sensors

- WIll use sensing devices to measure humidity, temperature, and insolation
- Insolation sensor will be an LDR
- Temperature and Humidity will be measured with a single sensor.



Subsystem 2: Outputs

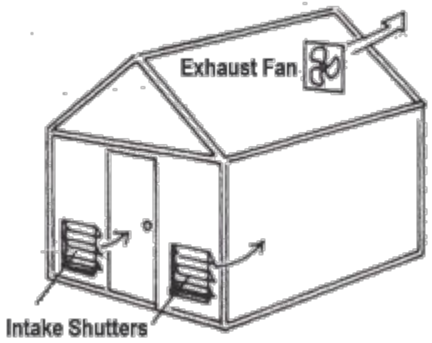
- Control will generate outputs in 3 categories
    - Light
    - Temperature/Humidity
    - Irrigation

Subsystem 2: Outputs

- Light
  - Two LED grow light bars ensure uniform lighting throughout growing tray
    - LED is best for:
      - Low power consumption
      - Has needed UV rays to mimic natural sunlight
      - Longest life span
  - Variable voltage to allow for light dimming

Subsystem 2: Outputs

- Temperature/Humidity
  - Heat - Insulated resistive cable
    - Will supplement ambient heat to allow for year round growing
  - Humidity - Controlled via temp & air control
    - Air control and heating cables will work together to maintain ideal humidity
  - Air Flow - Low V DC fans with variable voltage & damper/louvre control
    - Fans will cycle air out of enclosure while the dampers/louvres will allow air into the enclosure

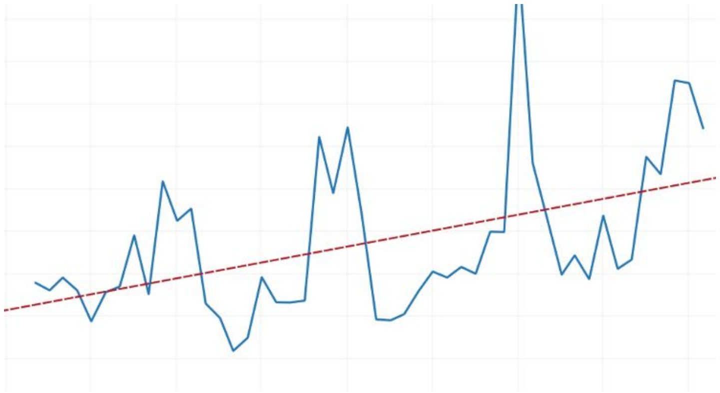


Subsystem 2: Outputs

- Irrigation
  - Tray-in-tray irrigation system to water microgreens from below
    - Most effective way to ensure soil stays moist without over watering
    - Ensure health of leaves by removing the risk of soil contaminating leaves
  - Timed watering cycle based on equation derived from:
    - Field capacity
    - Quantity and quality of received sunlight
    - Plant species' needs
  - Reduce overwatering

Sub System 3: Console Interface

- Input: User chooses specific plant to set up variable conditions in greenhouse
- Display: Most recent conditions and trend lines of the greenhouse conditions
- Output: Alerting feature when water reservoir is low or reporting erroneous data



Control Code

- Sensor fed data used for comparison of current vs ideal environment to alter enclosed space
- Mostly threshold base decisions with predetermined cutoffs and proper setpoints stored in a directory of plant types
- Output signals call for specific function of mechanical parts to alter the environment to allow year round use and proper conditions conducive to growth

Printed Circuit Board

- Designed to allocate space for all I/O components; i.e. sensors
  - All sensor will have wired connections
- 32 bit Microcontroller for computations
- Slow clock cycle
- USB connectivity for console interface

MDR Deliverables

- Prototyped enclosure with working sensors and output components
- Control and sensor feedback controlled through dev board
- Automation of manual processes (dev board)
- Successful grow cycle
- Data available for manipulation

Problems We Expect to Face

- Providing uniform light to prevent reaching
- Maintaining environment all year with low R-value structure
- Variable irrigation needs
- Controlling variables with fan circulation
- Maintaining plant health

Team Member Roles

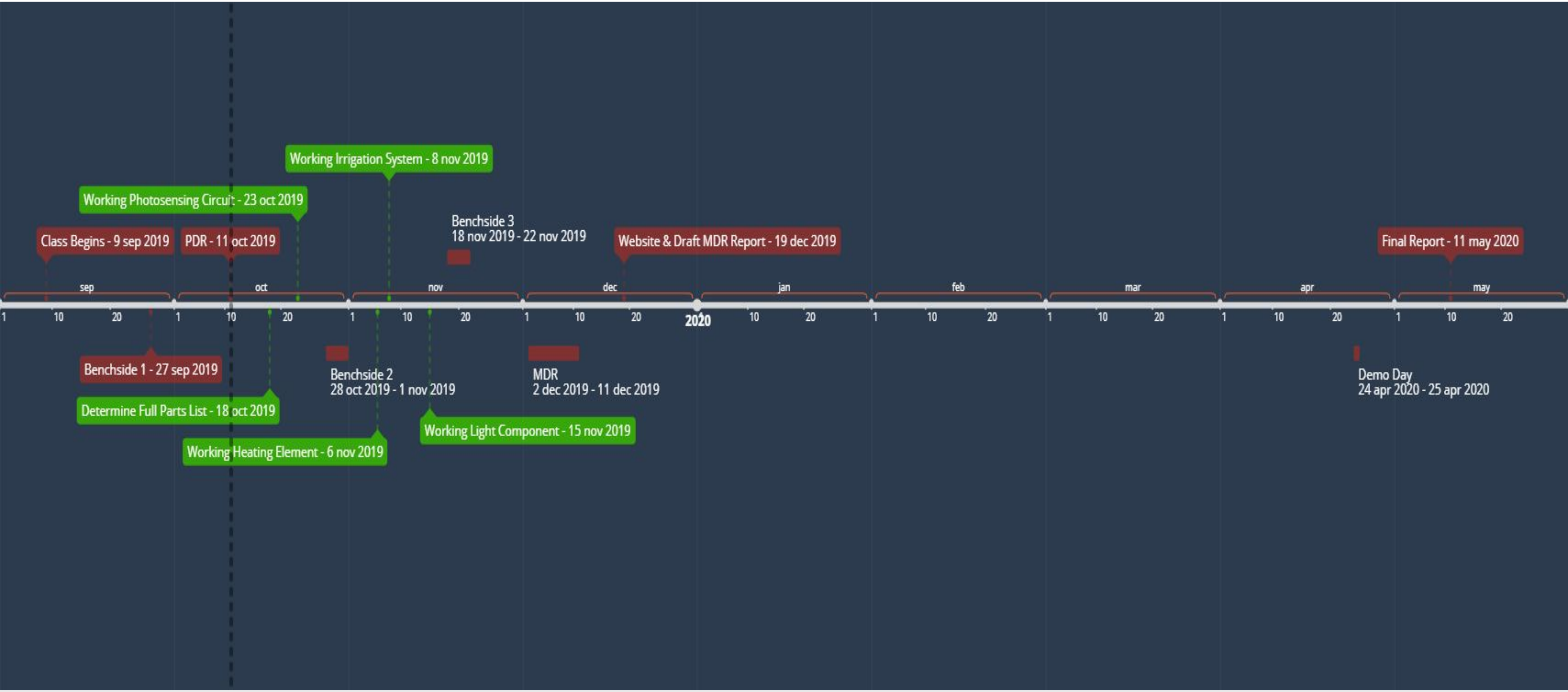
Austin: PCB, Console Interface, Data

Jason: Control Coding, Outputs to Components, Directory for Plant Specs

Nate: Testing, Website, Irrigation, Lighting, Air Flow

Matt: Sensor Design, Power Distribution, Heating

Timeline

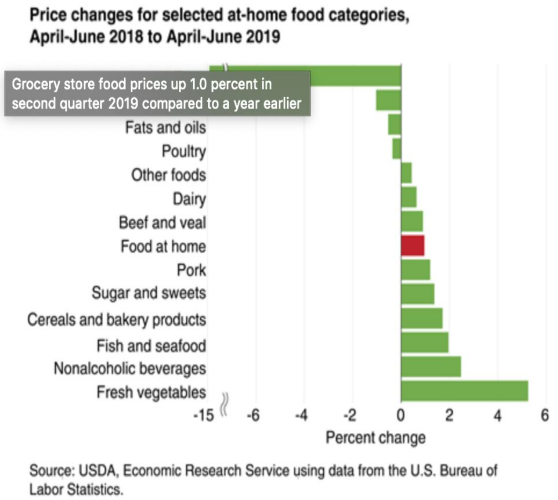

Working Irrigation System - 8 nov 2019
Working Photosensing Circuit - 23 oct 2019
Class Begins - 9 sep 2019
PDR - 11 oct 2019
Benchside 3
18 nov 2019 - 22 nov 2019
Website & Draft MDR Report - 19 dec 2019
Final Report - 11 may 2020
sep
oct
nov
dec
jan
feb
mar
apr
may
2020
Benchside 1 - 27 sep 2019
Determine Full Parts List - 18 oct 2019
Working Heating Element - 6 nov 2019
Benchside 2
28 oct 2019 - 1 nov 2019
Working Light Component - 15 nov 2019
MDR
2 dec 2019 - 11 dec 2019
Demo Day
24 apr 2020 - 25 apr 2020

Budget

- Greenhouse Unit box ~ $ 75 - 125
- Sensors
  - Hygrometers ~ $15
  - Photosensitive elements ~ $5
- PCB ~$60
- microcontroller 3 x 10 ~ $30
- Materials for growing 15 cycles x ~ $3 =~ $45
- Heating cable ~$9/ft x 2 = $18
- Fans ~ $5
- Lights ~ $30
- Irrigation ~ $50
- Miscellaneous ~ $50
- Total estimate ~ $385-435

User Grocery Cost Analysis

- Fresh produce is becoming increasingly expensive per capita
- The average american spends ~ $4000 on groceries annually
  - ~$400 on vegetables
  - ~$700 on miscellaneous
- GrowingGreen can produce 24 ounces of fresh produce/ week
- This can cut down cost on vegetables by over 50%
  - also reduce miscellaneous by 20%
- Supplement users diets with increase in nutrient value



COSTS

Fixed Costs	10" x 20" Trays	$1/Tray
Variable Costs	Seeds	<$15/lb ($1/Tray)
	Soil	~ $1/Tray
	Water	Negligible for small crops
	Packaging	Varies
Total		$2-4/Tray

Questions?

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