PURDUE UNIVERSITY

EPICS PURDUE

Urban Farming

EPICS

EPICS

Team Members

Alyssa McNarney- Chemical Engineering

Harley Clark- Biomedical Engineering

Claire Bhamani - Environmental and Ecological Engineering

Tasha Geisler - Civil Engineering

Juliana Brustolin - Agricultural and Biological Engineering

Haritha Ramadorai - Senior, Biomedical Engineering

Madeline Moisio - Humanitarian Engineering, Senior Design Student

Troy Weber - Environmental and Ecological Engineering

Anjas Kapur - Senior, Electrical Engineering

Aaron Nunes - Civil Engineering

Jieun (Grace) Lee - Agricultural and Biological engineering

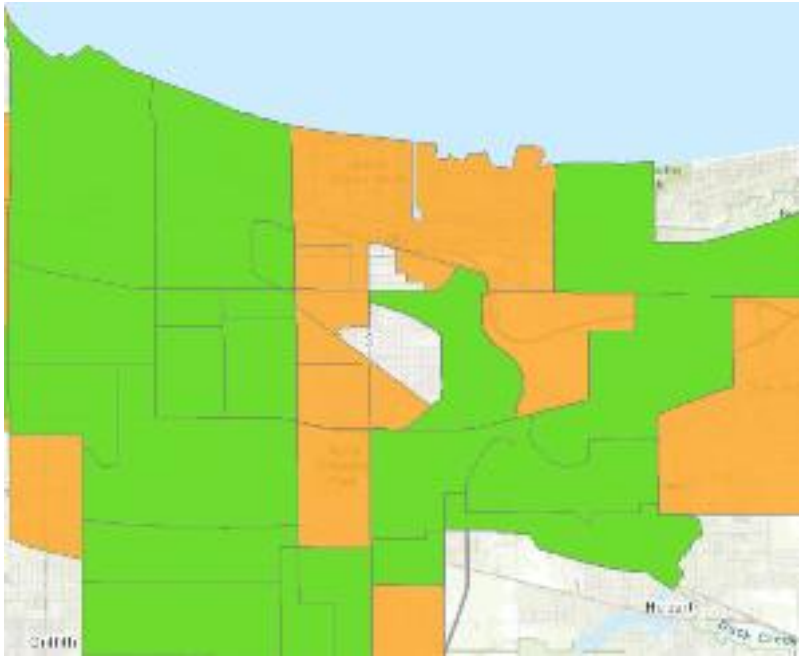
Agenda

- Framing the issue
- Project Details
- Mobile Market
- Questions and Comments

Framing the Issue - Food Desert

- Communities underserved by quality grocery stores
  - Distance to store over 1 miles in urban areas 10 miles for rural areas
  - Disproportionately in low income communities
  - 55% found in communities with median income less than $25,000 per year
- Limited Options on healthy food
  - High calorie, processed unhealthy food available
  - Creates poor diets and health effects
    - High Blood Pressure, Diabetes, Heart Disease, etc.

Framing the Issue - Food Desert

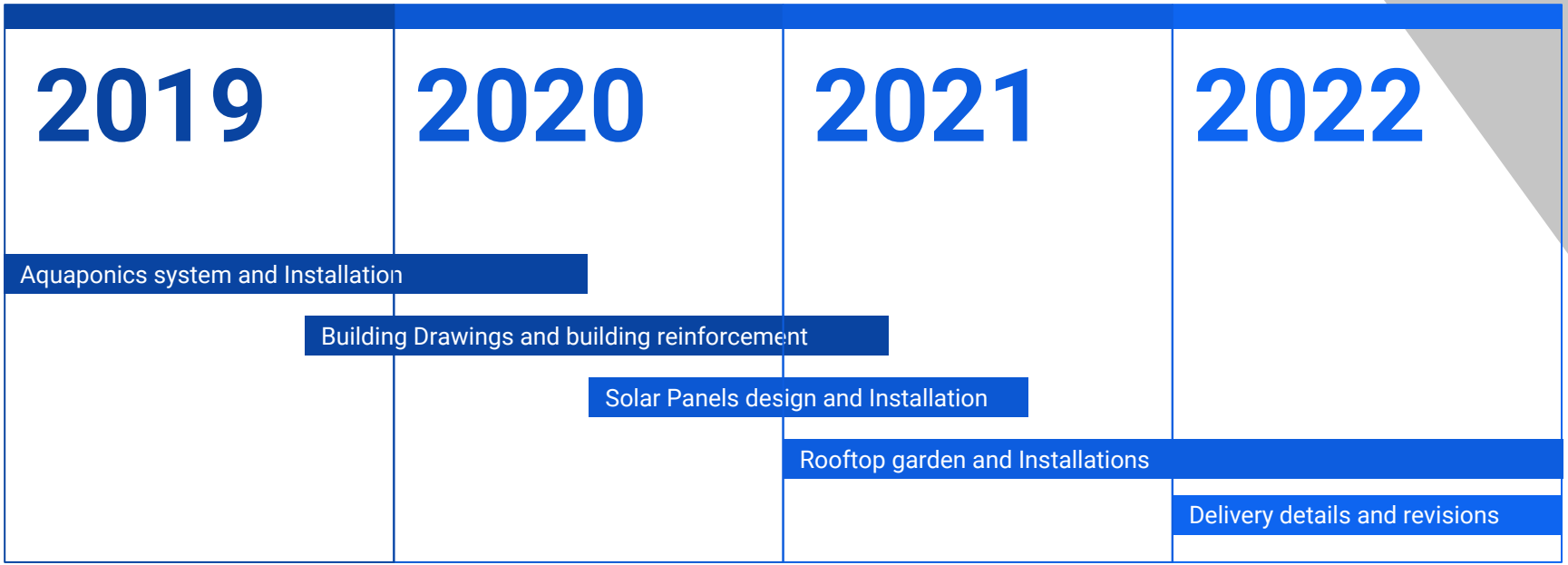


Orange = ½ mile from nearest grocery store
Green = 1 mile from nearest grocery store

Scope of Project

- EPICS part
  - Aquaponics
  - Rooftop Garden
  - Solar Panels
  - Mobile Market
- Other parts
  - Convenience stores
  - Farmers Market
  - Food Delivery

4 Year timeline for project

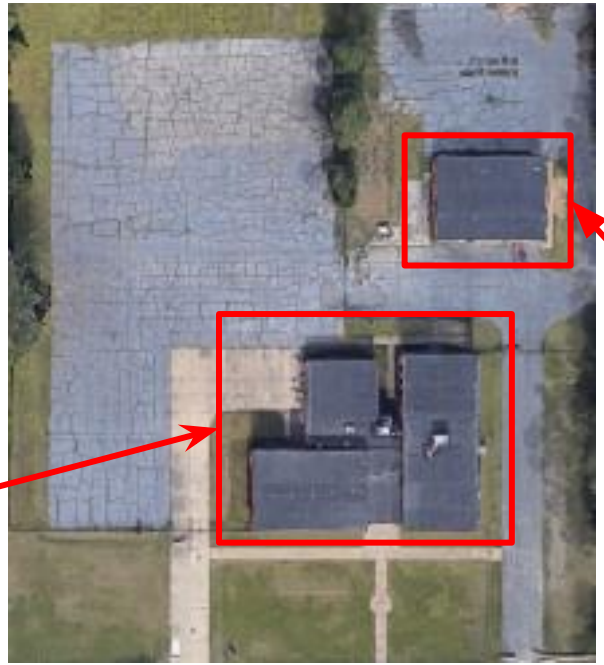


Where EPICS Helps

Our goal is to build a garden that is both beneficial and accessible to those who need it in Gary, Indiana.

Project Partner - Peace Garden & Farms

- 4 workers
- 6.2 acres of land
- Grows food for 85 families



Building

- Built in the 1950s
- Needs updates

Stakeholders

- Marty Henderson
  - Master Gardener
  - Senior Pastor at Peace Baptist Church
- Gary Youth
- Members of community
  - Healthier food provided
- Re-entry of justice served individuals
- Local grocery stores

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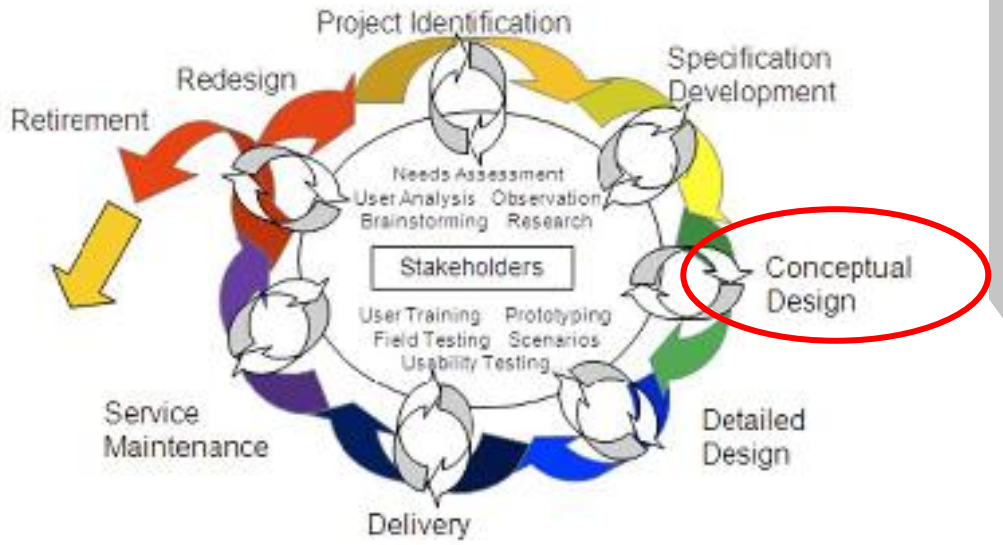
Project Details

Problem Statement

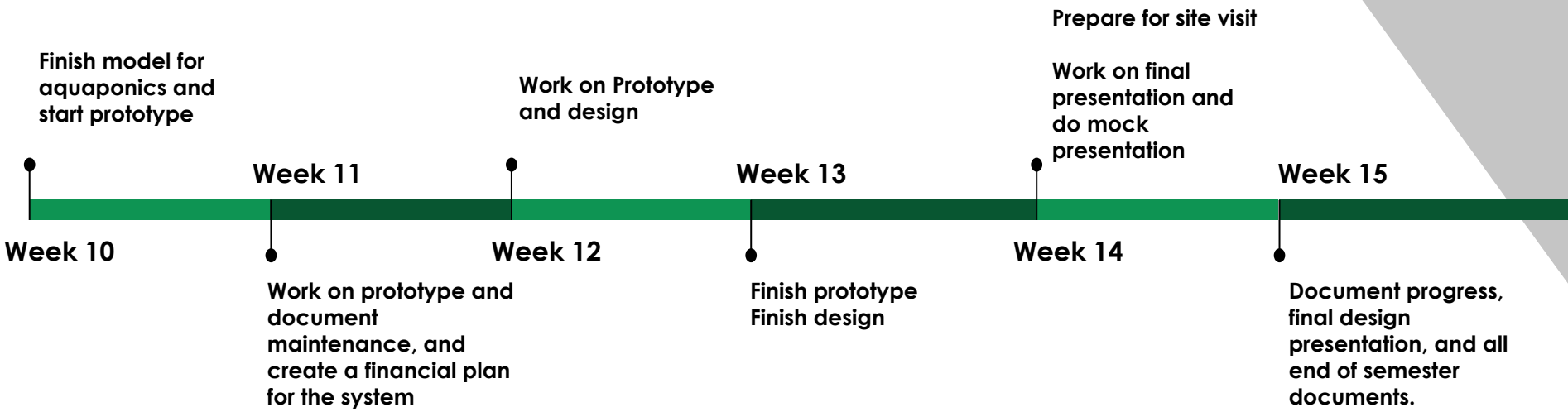
Our goal for this semester is to determine the garden type we want to focus on and create a prototype of this garden to serve the needs of the Gary community.

EPICS Design Phase

- Conduct Functional Decomposition
- Brainstorming
- Create prototypes
  - Get feedback from users
  - Refine design
- Evaluate feasibility



Semester Timeline

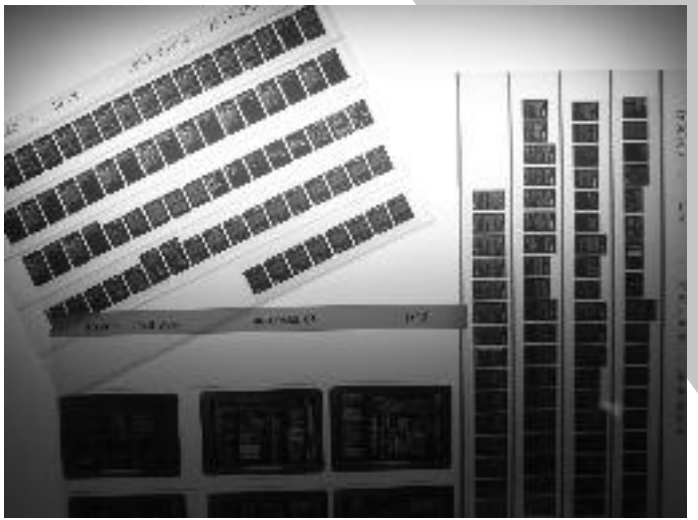


Summary of Last Semester

- Focused on Rooftop garden and did a lot of research
- Didn't have correct building drawings
- Realized there are a lot of problems associated with rooftop gardens
  - Weight of Garden
  - Reinforcing structure
  - Safety on the roof
  - Heat and wind on roof could damage crops

Building Drawings

- Submitted FOIA
- Drawings at USACE Headquarters
- Copies are not readable



Rooftop Garden

System

- Soil added across the whole roof
- Can grow almost any crops
- No need for lights or electricity
- Can grow from May-October depending on crops

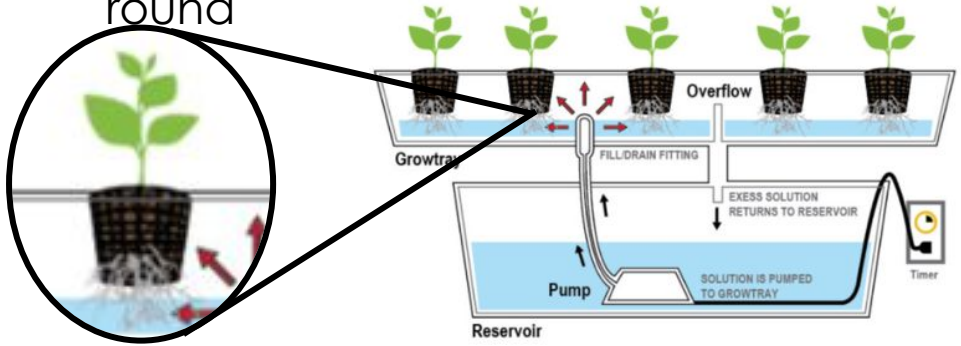
Rooftop Cost Breakdown

- Cost estimated for 3,100 sq ft.
- No exact cost on building reinforcement.

Materials and Installation	Cost
Irrigation	$8,525.00
Drainage System	$4,000.00
Safety Railing	$5,300.00
Soil and Plants	$15,000.00
Rooftop Access	$2,500.00
Total	**$35,325.00**
Maintanance Cost (per year)	**$2,000.00**
Reinforcement cost	**Upwards of 100k**

Hydroponics Garden

- Water based
- Accessible oxygen
- Nutrient rich solution
- Can grow year round
- Vertical farming
- High yield in small space



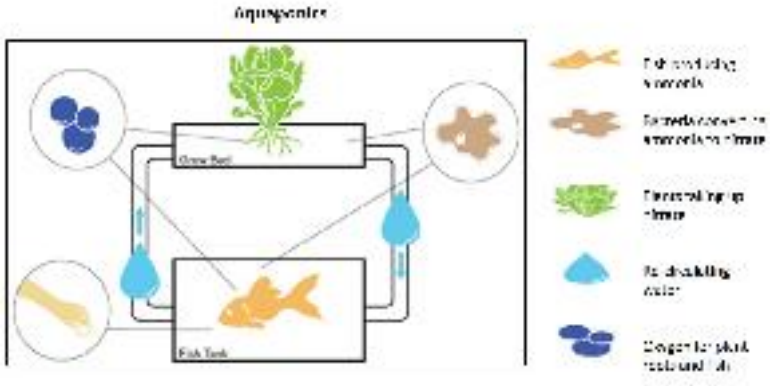
Hydroponics Cost Breakdown

Item	Unit cost ($)	Units	Total ($)	Comments
Shelf	150.00	1	150.00	Avg price
Reservoir (40gal)	100.00	1	100.00	
LED lights (2'x4')	300.00	2	600.00	Avg price
Grow trays	35.00	2	70.00	
Net pots	5.00 (50units)	1 pack 50units	5.00	Will have leftovers
Tubing	1.50 (foot)	10 (foot)	15.00	
Pump	15.00	1	15.00	100gph
Styrofoam sheets	18.00	1 (box 20 sheets)	18.00	Will have leftovers
Surge protector	10.00	1	10.00	
Total Cost per shelving unit			1013.00	With leftover material for other units

*one shelving unit with three trays with 17 lettuce heads per tray (in current prototype)

Aquaponics Garden

- Water based
- Accessible oxygen
- Fish involved (add nutrients)
- Can grow year round
- 3 gal / lbs of fish
- Additional $3000 for fish and food every 5 years



Aquaponics Cost Breakdown

The cost would be about the same as the Hydroponics except for:

- the cost for changing the smaller reservoirs to a bigger one that fits the fish
- added cost for biofilters, sensors and warmers for water temperature/quality control
- added cost to continuously supply the fish and fish food (~$3000.00)

Controlled Environment

- Indoor gardens
  - Hydroponics
  - Aquaponics
- Add an HVAC System
  - Cool during summer
  - Heat during winter
  - Additional $11,025
- Automated system
  - Unknown cost

Decision Matrix

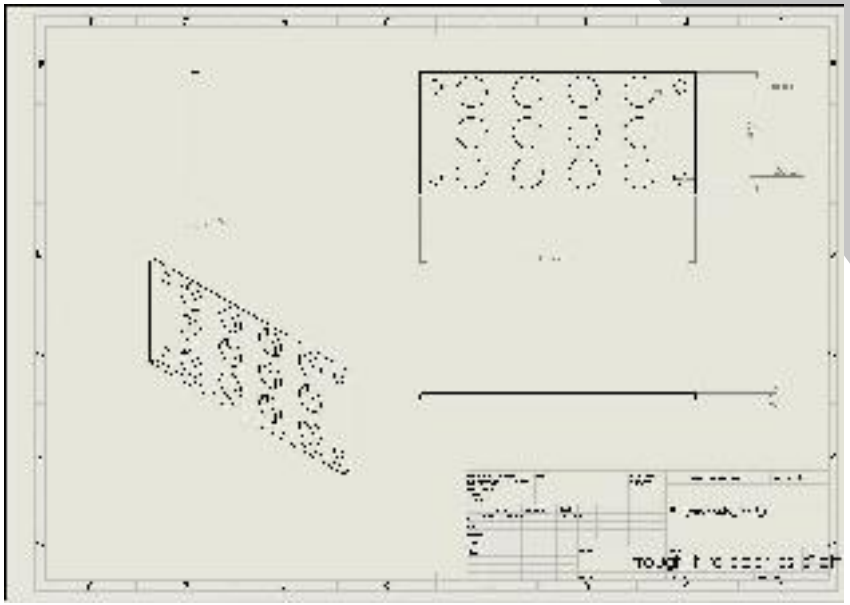
Criteria	Weight	Hydroponics	Aquaponics	Rooftop Garden
Time	x1	4	3	1
Cost	x5	3	3	1
Ease of Maintenance	x3	3	3	3
Ease of Installation	x2	5	3	1
Stakeholders Preference	x6	3	5	3
Stability of Production	x4	5	5	3
	Total	**76**	**83**	**47**

Recommendation

Aquaponics

- Produces food year round
- Lowest cost
- Low maintenance
- Project Partners favorite

Model of Shelving Unit



Design Rationale

- Bed growth area of each shelf = 2 racks * (2 * 5ft) = 20 sq ft.
- Number of shelves = 30
- Total Bed Growth Area = 600 sq ft.

Design Rationale

- Ratio rule = 1 lb (.5 kg) of fish for every 1 sq ft (.1 sq m) of grow bed surface area
  Fish weight = 600 lb
- 1 pound fish per 5 – 10 gallons of fish tank volume
  Fish Tank Volume = 3000 - 6000 gallons
- Total Fish Tank Volume = 5000 gallons
- Fish Tank Size = 15 * 15 * 3ft

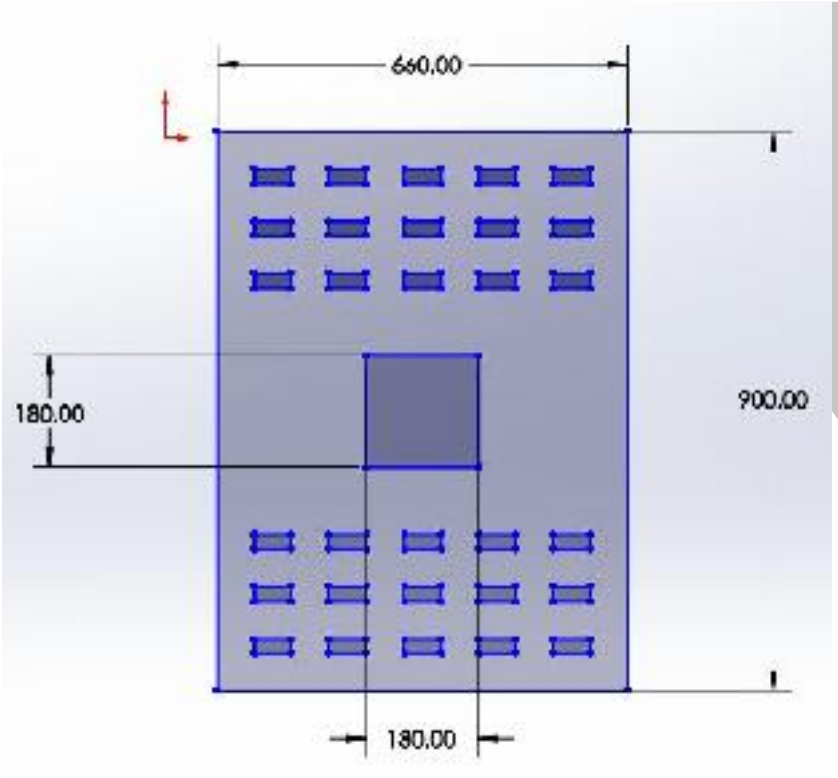
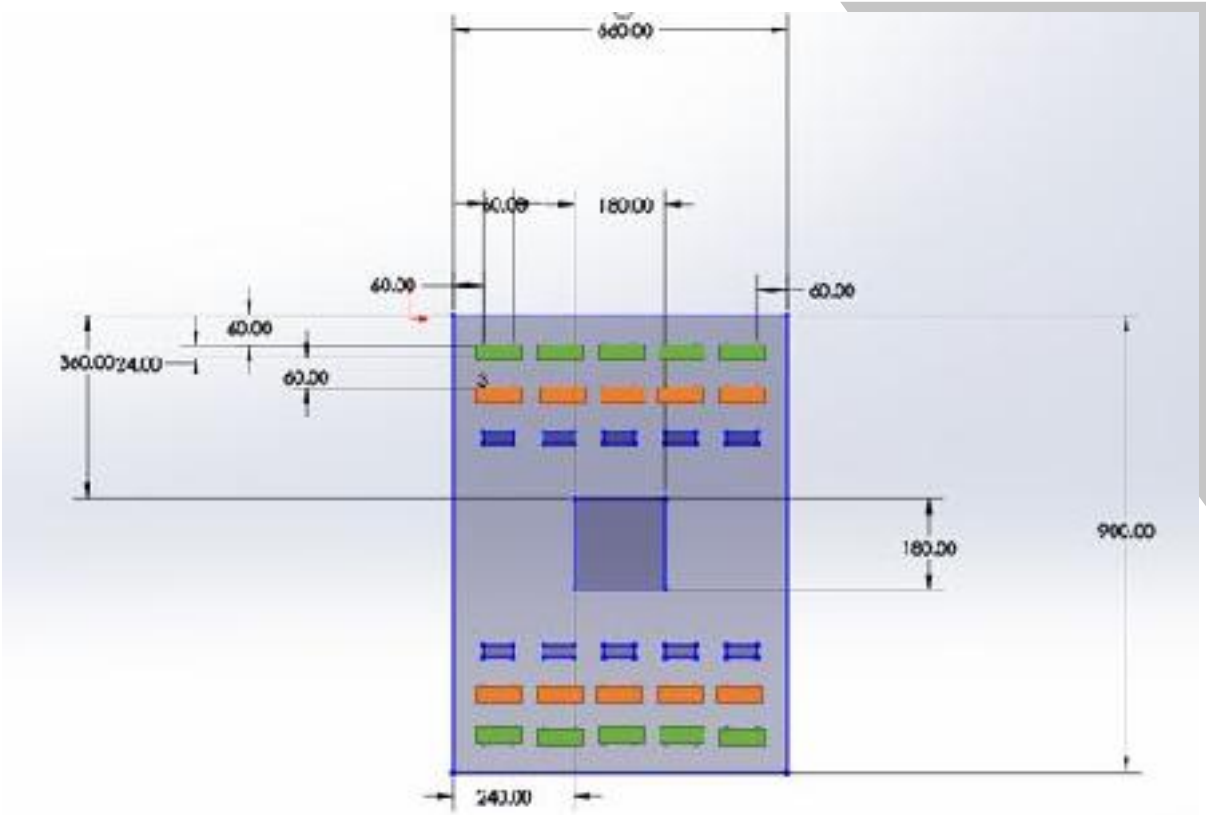


Figure: Motor Pool Layout (top view); Units: in

Layout of Motorpool

3 Phase Build and Testing

- Phase I - 1st with 1st row on each side of the fish pool
- Phase II - 2nd with 1st and 2nd row on each side of the fish pool
- Phase III - 3rd with all shelving units



Recurring Costs

Variable Cost	Prototype	Unit (1 shelf)	Phase 1	Phase 2	Phase 3	Final
Fish						
Bluegill	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Lake Perch	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Catfish	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Tilapia	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Plants						
Lettuce seeds	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Basil seeds	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Other Herbs	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Food						
Bluegill	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Lake Perch	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Catfish	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Tilapia	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Heating						
	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Nutrients						
	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Labor required						
	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Start Up Cost

Fixed Cost	Prototype	Unit (1 Shelf)	Phase 1	Phase 2	Phase 3	Final
Shelves	$175.00	$0.00	$0.00	$0.00	$0.00	$0.00
Trays	$92.00	$0.00	$0.00	$0.00	$0.00	$0.00
Lights	$300.00	$0.00	$0.00	$0.00	$0.00	$0.00
Tanks	$75.00	$0.00	$0.00	$0.00	$0.00	$0.00
Water Heater	$40.00	$0.00	$0.00	$0.00	$0.00	$0.00
Water Pump	$40.00	$0.00	$0.00	$0.00	$0.00	$0.00
Aerator	$40.00	$0.00	$0.00	$0.00	$0.00	$0.00
Timers	$18.00	$0.00	$0.00	$0.00	$0.00	$0.00
Hoses	$20.00	$0.00	$0.00	$0.00	$0.00	$0.00
Ph Testing Kit	$10.00	$0.00	$0.00	$0.00	$0.00	$0.00
Oasis Horticubes	$8.00	$0.00	$0.00	$0.00	$0.00	$0.00
PVC Pipe	$56.00	$0.00	$0.00	$0.00	$0.00	$0.00
Sensors	$22.54	$0.00	$0.00	$0.00	$0.00	$0.00
Shipping	$200.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total	$1,096.54					

Productivity

Productivity	Prototype	Unit (1 shelf)	Phase 1	Phase 2	Phase 3	Final
Fish						
Bluegill	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Lake Perch	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Catfish	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Tilapia	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Plants						
Lettuce	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Basil	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Other Herbs	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Prototype

Prototype 1 - Takeaways

- Getting smaller net cups so we can increase the amount of plants
- Adjust spacing between plants
- Add more levels (see how many levels would be cost efficient)
- Change the lights to a commercially viable and efficient model
- See how we can decrease the cost per unit
- See how much price per unit will decrease by buying larger quantities of items

Procedures

- Need to find building for prototype
- Procedure
  - Water
  - Lighting
  - Size
  - Management
  - Risk assessment
  - FMEA (Failure Mode and Effective Analysis) table
- Sending it to Jorge(EPICS), ABE(Department), Bob Rode(Forestry), Nathan Deppe(Greenhouses)

Permits

Fish Hauler's and Supplier's Permit

- Indiana DNR
- Produce and sell fish
  - Bluegill
  - Yellow Perch
  - Tilapia
  - Goldfish

*still need to obtain PACUC permit

Site Visit

- April 20th
- Obtain measurements of Motorpool
- Note drains, outlets, and doors
- Check the heating, electricity and lighting
- Visit the local food pantry

Surveys: Stakeholders' Opinions

- Gary Food Council & Farmers Market Group
  - Advice on farming techniques
  - Success with different produce items
- Food Pantry Participants
  - Preferences for produce items

Next Steps

- Finish Prototype and begin testing
- Finalize operational cost
- Update designs with details from site visit
- Summarize results from the surveys

MOBILE MARKET

Madeline Moisio | Senior Design Project

EPICS PURDUE

Goal of the Mobile Market

work with leaders and stakeholders in Gary, Indiana to address the issues and everyday realities of a food desert by creating a process for fresh produce to be delivered to members of the community that do not have access to it

Resources + Contacts

Marty Henderson	Peace Gardens & Farms Master Gardener Senior Pastor – *Peace Baptist Church* President / CEO – *For the Love of Children of NWI* Education Committee – *Gary Chamber of Commerce*
Vanessa Pacheco	Office of Civic Engagement & Leadership Development Ace Campus Food Pantry
Dean Fallis	Bloomers Greenhouse West Lafayette, Lafayette, Purdue, + Zionsville Farmers Markets
Wendy Medbourne	Starke County Mobile Raised Beds Initiative

Access to Fresh Food

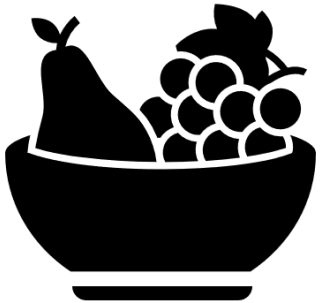
BARRIERS

Ability
Availability
Child Care
Cost
Health

Location
Reliability
Safety
Time
Transportation

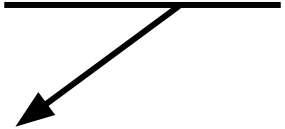
Project Components

Deliver **Produce** **to** **Users**



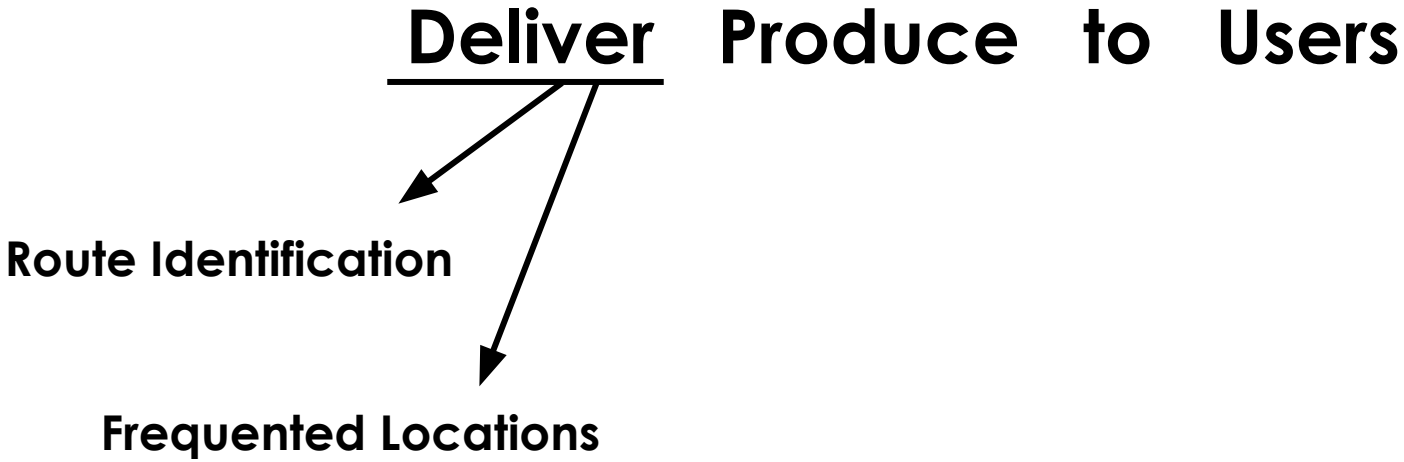
Project Components

Deliver Produce to Users



Route Identification

Project Components



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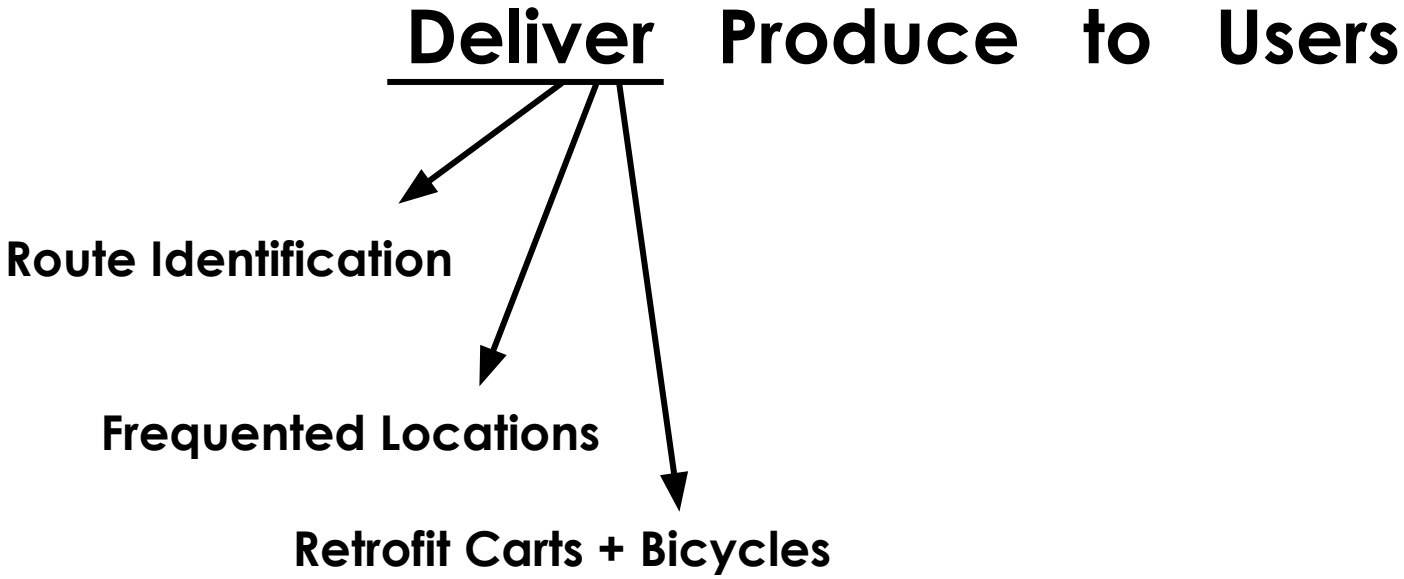

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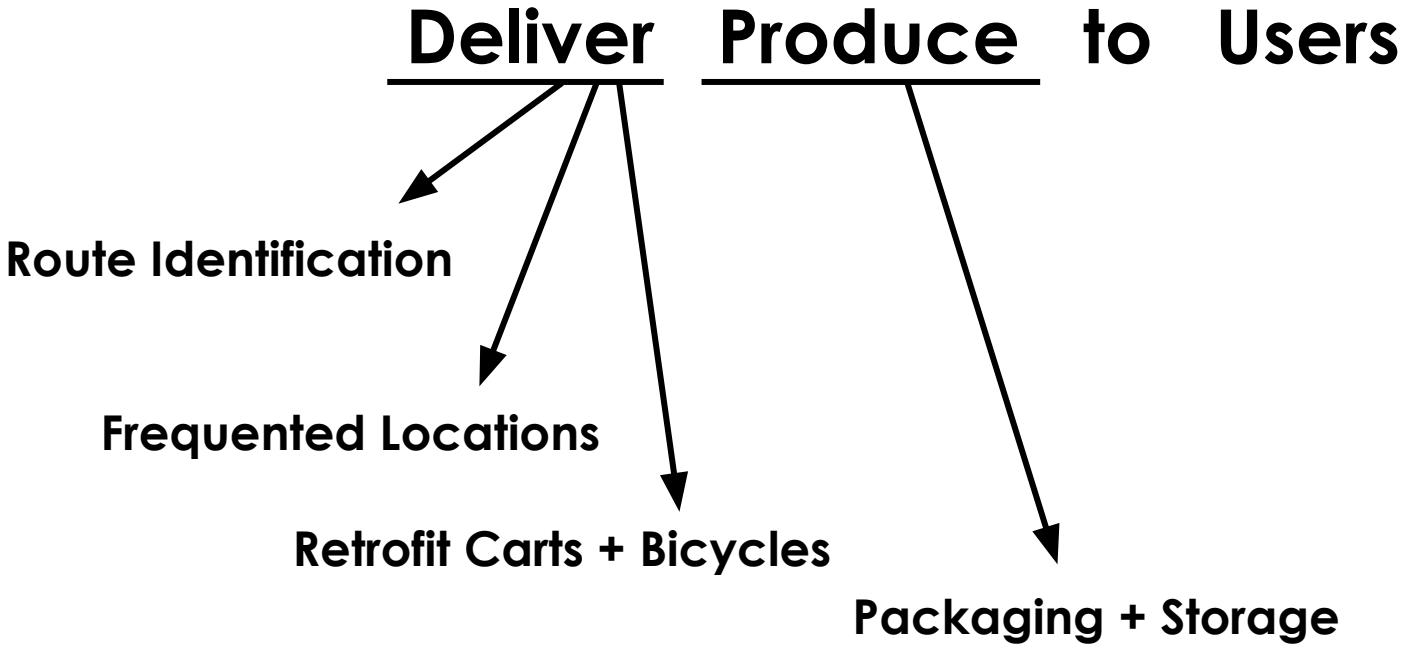

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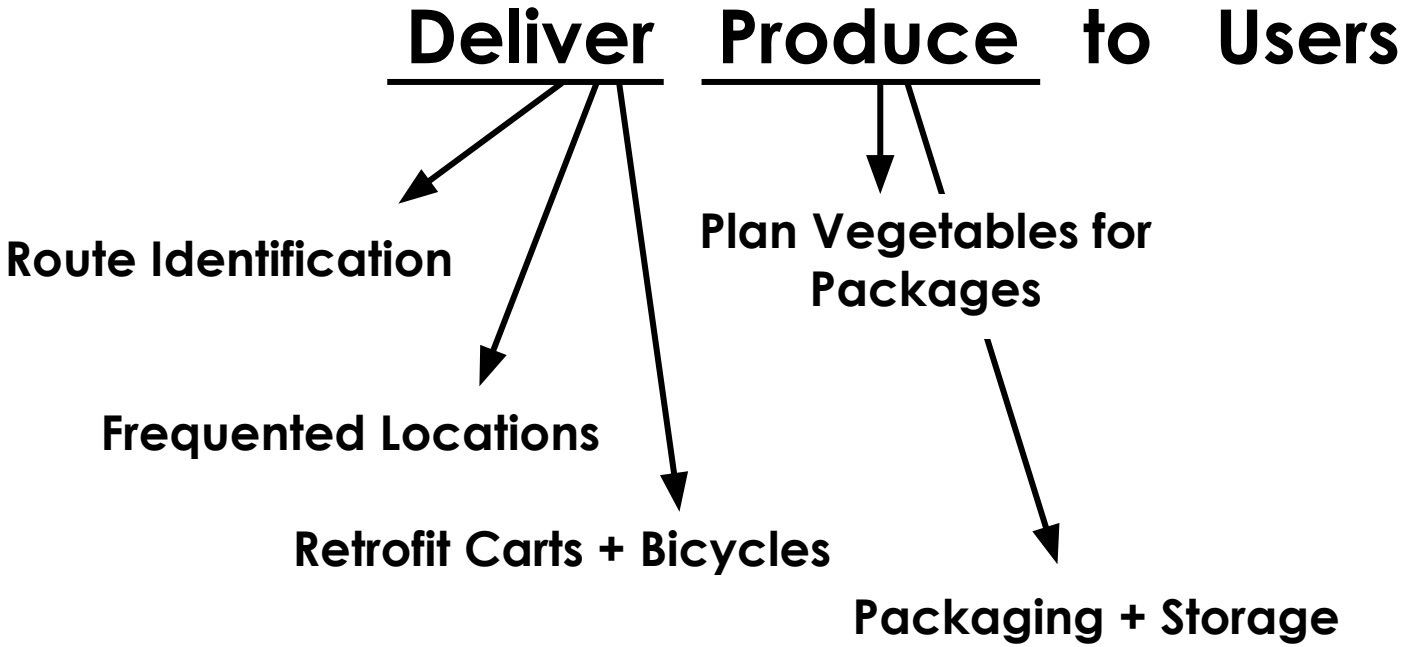

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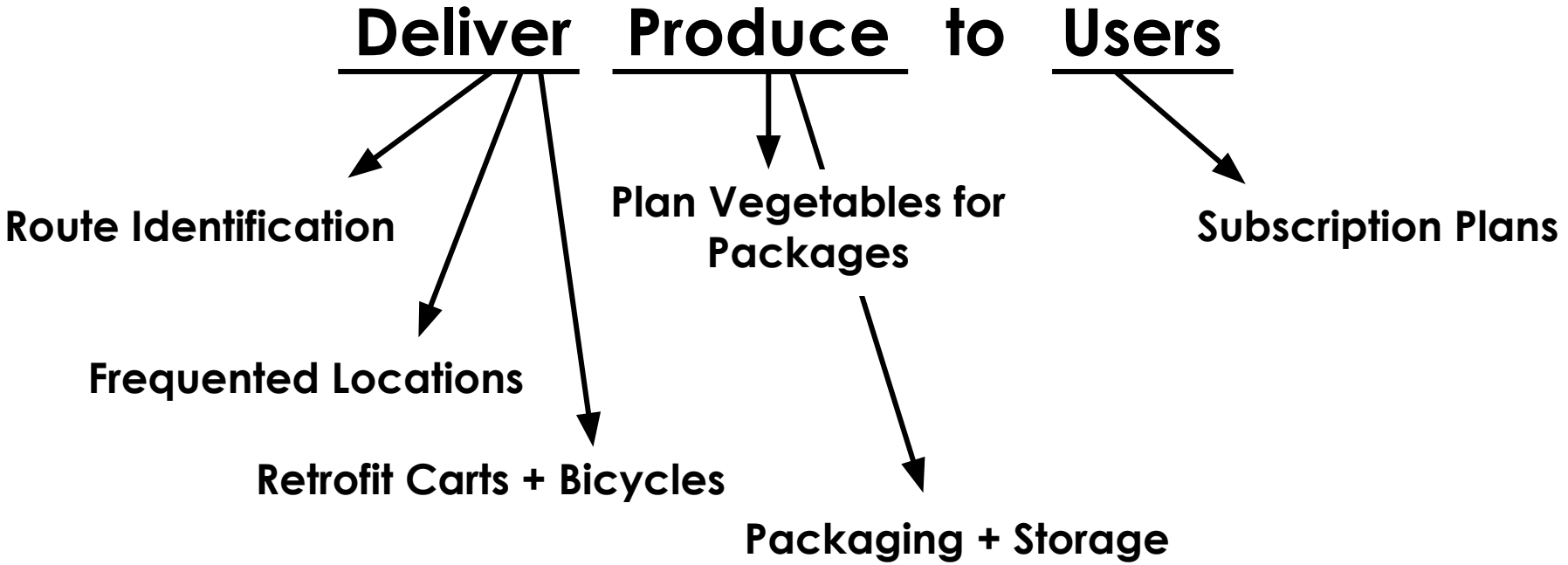

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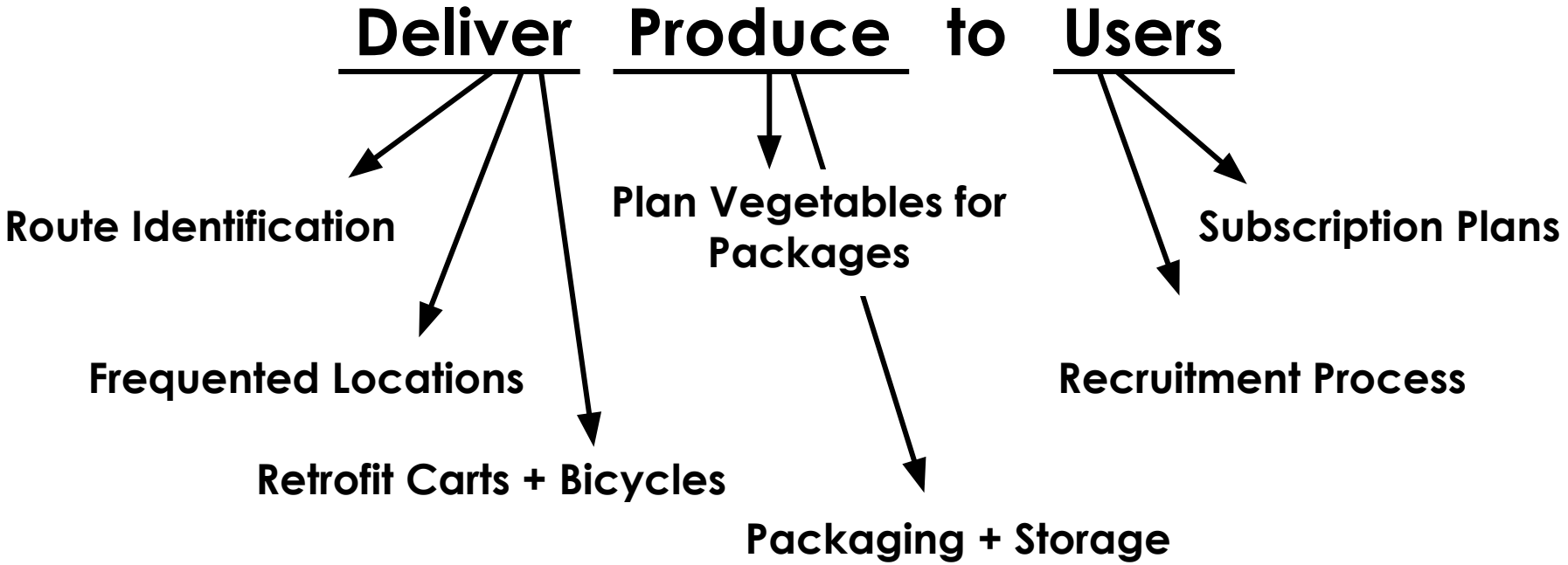


Delivery Process

Frequented Locations

Target Audience

- Single Parents
- Elderly
- No Vehicle Households

Crossover

- Specific Neighborhoods + Apartments
- Bus Stops
- Churches
- WIC Locations

Delivery Process

Route Identification

GIS Heat Map

Consulting with Marty + Advocates for the Community

Identify Area for Pilot Program

Use Material to Develop Route Model from:

IE 335 Operations Research – Optimization
IE 336 Operations Research – Stochastic Models
IE 383 Integrated Production Systems I

Delivery Process

Retrofit Carts + Bicycles + Winter Transportation

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
33°/ 20°	37°/ 23°	60°/ 42°	67°/ 52°	71°/ 52°	80°/ 61°	84°/ 66°	82°/ 65°	76°/ 57°	64°/ 46°	50°/ 36°	37°/ 25°

VAN ***BIKE*** ***VAN***

Produce Process

Plan Vegetables for Packages

Surveys Deployed to

→ Farmers Market Group + Gary Food Council

→ Food Pantry

Please select the leafy greens (pictured above) that you enjoy cooking with or would like to eat more of:

Cabbage Kale Lettuce Spinach

☐ ☐ ☐ ☐

EPICS PURDUE

Produce Process

Plan Vegetables + Packaging and Storing Produce

Integrate **Aquaponics System** + **Mobile Market**

→ determine what will be grown

→ schedule maintenance and harvesting

→ create procedures for storing and packaging of produce

IE 386 Workplace Design

Users Process

Subscription Plan

- Basing Model on Material from
  - ENTR 200 – Introduction to Entrepreneurship + Innovation
  - IE 343 – Engineering Economics

- Create Packages
  - Using Data from Surveys
  - Feasibility of Produce
  - Diets + Family Size + Frequency of Deliveries

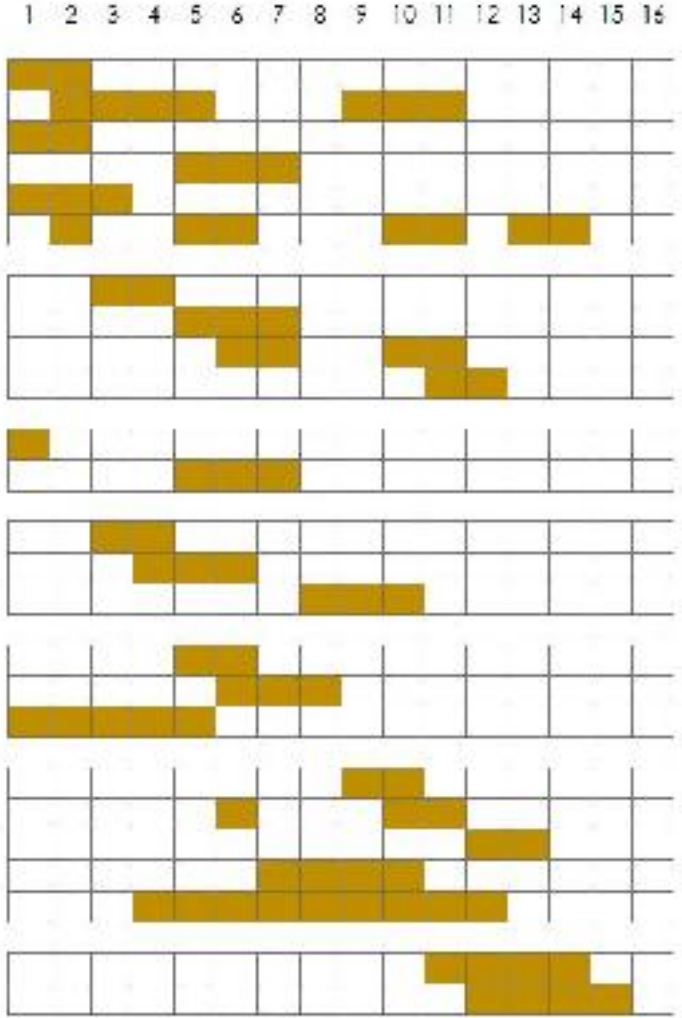
Users Process

Recruitment

Registering Users + Updating Orders + Storing Data

Advertising Program { Corner + Convenience Stores; Churches; Bus Stops

Mobile Market Gantt Chart



QUESTIONS | COMMENTS | CONCERNS

THANK YOU