Sustainable Penn State University Park Campus

Siemens AG

Fruit and Vegetable Truck

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The purpose of this design project was to create a system that would make University Park a more sustainable community. After collecting information from students and stakeholders, we determined that our area of focus would be to improve student's knowledge and participation in local, more sustainable food production. Students will be educated as to reasons why local farming is more beneficial, more sustainable, and hence should be the best choice. The design will be a long term project at Penn State and seeks to improve upon the concept of sustainable agriculture and food supplies. The project would increases student's involvement in accessing this food source. Throughout the whole process, from specifications to brainstorming to evaluation, we focus on the goals of economic, social, and environmental sustainability.

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Introduction:

Problem Statement:

The problem given to us by Siemens AG, which is a multinational company in engineering and electronics, was to find ways to make Penn State's University Park Campus a more sustainable environment. We first focused on participatory schemes that would increase sustainable behavior among Penn State students. It must be fun and engaging so that students will be compelled to participate. We then narrowed our problem space to concentrate on local food production and consumption. The goal is to identify and promote sustainable agriculture to satisfy the needs of the campus community.

Concept of Operations

A system is defined as sustainable if it makes use of resources in a way that doesn't inhibit future generations' ability to enjoy those same resources. In addition, the system should be economical, environmentally friendly, socially acceptable, and technologically appropriate. Improving student involvement in a sustainable local food practice would be considered sustainable because it eliminates the need for transportation, which decreases the negative environmental impacts. It's economical because it supports local businesses and reduces transportation costs. Additionally, these practices would socially strengthen the Penn State community and educate its members to live more sustainably. It would be beneficial to all parties involved. We determined the stakeholders in this project to include Siemens, residence halls, student organizations such as Engineering for a Sustainable World (ESW), farmers markets, and Penn State students. The time span of implementation of this design would revolve around the farmers markets, which runs from May to November. Products sold at the farmers market

include, baked goods, canned goods, and crafts, flowers, plants, vegetables, fruits, cider, pies, cakes, spices, and fresh made pasta. The prices of these products are determined by each individual farmer at the market. Our design would find a way to either improve this market, increase student participation in it, or associate campus food with food from the market.

Specifications:

In order to verify the success of our design, we determined what our customers and stakeholders want. We created surveys that were sent out to Penn State students to collect that information. Generals findings were that convenience was the most important factor. On campus students prefer dining common because it's easy and on meal plan. Price was also important, but there was a common misconception that farmer’s market goods were more costly. Things that consumers weren’t as concerned abou were quality and various options. Based on what we found, we were then able to construct a list of specifications for our design First, we used a pairwise comparison to determine the most important concepts (see Appendix B). Once we had those important concepts we proceeded to list our specifications.

- Our design will educate students about the importance of buying locally grown food.
- It will gain greater involvement of students in the local farmer's market so that at least 20 percent of the Penn State community participated.

- The product will be manufactured mainly by hand. Therefore, it must be easily constructed by college students, given their resources and abilities. It will also be replicable and adaptable.
- In order to convince students to get involved, our design must be fun and engaging, but it should also be educational to achieve our goal of sustainability.
- Our design must be cost effective. It should profitable to the extent that it exceeds the original cost of $7500 and maintenance costs.

Project Schedule:

Before delving into the whole process, we first established a plan. The project schedule was laid out over the course of about a month and a half. Following the design process, we planned a week for researching farmers markets and students' feelings toward locally grown food. The next step would be to use that information to create our specifications, which would only require a few days. Then, we allotted a little over a week to brainstorm ideas that would achieve our goal and satisfy our specifications. The remaining time would be used to create screening and weighted matrices (see Appendix C and D) to find our best design. The final design report should be completed by April 22. The presentation should then be polished in time for the Design Expo, which is April 25. This whole process is documented in our Gantt chart which can be found in Appendix A.

Concept Development:

Evaluation:

We brainstormed ideas that achieved our design goals. These goals included designing solutions that made the Penn State community more sustainable by educating and involving

students in the local farmers' market. Brainstorming focuses on finding solutions that were fun, engaging, sustainable, practical, profitable, and convenient to Penn State Students, which were attributes we identified from the customer needs assessments. With these characteristics in mind, we generated a wide assortment of ideas which were then narrowed based on practicality (see Appendix C for screening matrix); the five viable solutions were:

- indoor gardens
- a Penn State gardening competition, a student run farmers' market
- a Smart Phone App
- a fruit and vegetable truck.

The indoor gardens would be implemented in residence halls' common areas, and would be maintained by clubs such as Engineers for a Sustainable World, because they would want to increase sustainable practices such as this. These gardens would grow fruits and vegetables that the club would sell at the local farmers market as a continuous fundraiser for their organization. These gardens would harvest small fruits and vegetables that can be easily maintained. This particular solution would also be good for the environment because there aren't any negative impacts and the plants provide more oxygen for the environment. The gardening competition would involve multiple clubs as well as independently formed groups who would spend the year growing fruits and vegetables. They would sell these products at the local famers' market. Each year's competition has specifications as to what can be grown, how much can be grown, and where it can be grown. The winner of the competition is the team that gains the most profit from

the food sold at the market. The costs of this solution are limited because students would fund their own projects. There is a social benefit to this option because students themselves learn how to grow their own food. The student-run farmers' market is similar to the competition in that organizations or individual groups can participate. The fruit and vegetables grown would be sold at an organized on-campus farmer's market. This is more sustainable because it eliminates the transportation costs and pollution associated with large corporations like Walmart. It is also more convenient for students because it is right on campus as opposed to 45 minute ride to and from Walmart. The Smart Phone App would be developed to serve multiple functions, being adaptable to the needs of the customer. The App would educate students about growing and preparing their own food, the importance of buying locally grown food, and provide information about the State College farmers' market. It could also possibly be used to order and purchase food from the market. The final idea is a fruit and vegetable truck. This would be similar to an ice-cream truck or a small mobile kitchen, but would sell fruit and vegetables. This solution involves working with the local market to get their food to on-campus students. There are some extra costs associated with this option. It would cost $5,000 to rent a used diesel vending truck, $600 for licensing, and $1,200 for an engaging paint job that educates students. This money would then be paid off from the profits of selling the products on the truck.

After these designs were fully understood, we decided on a solution to implement. The five concepts were evaluated using the six different criteria obtained from the surveys and pairwise comparisons (Appendix B): educational potential, gained participation in the local farmers' market, aesthetic appeal or appeal of entertainment, cost effectiveness, convenience to students, and practicality or technology. These criteria were not weighted equally, each having a different significance based on the results of our customer surveys. Each concept was ranked on

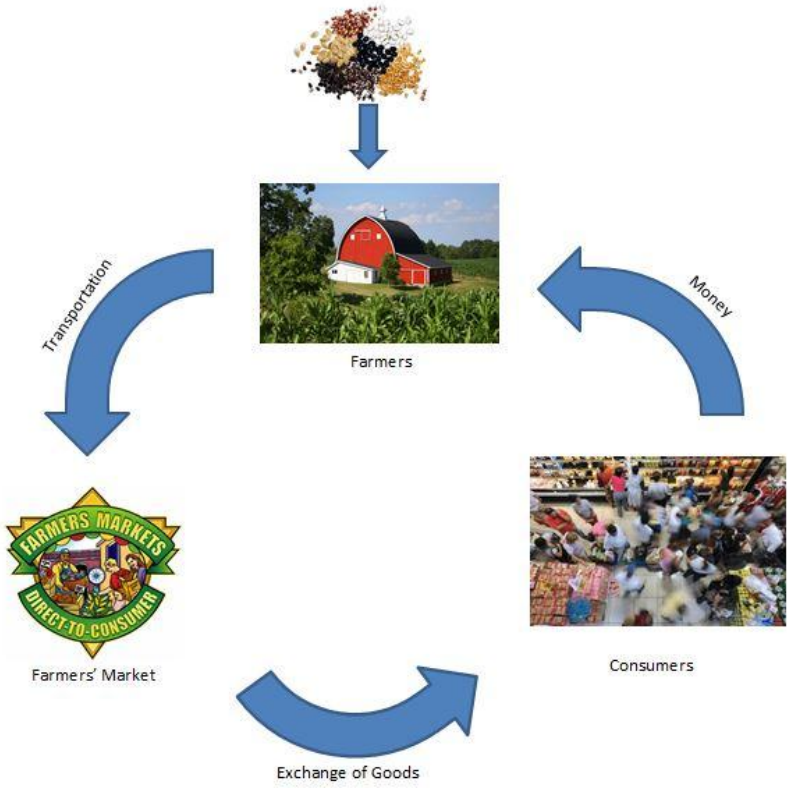
a scale from one to five for each criterion; one meant the solution was ineffective in regards to that criterion, while a five represents complete effectiveness. The results of these comparisons can be seen in the weighted matrix (Appendix D).

Solution and System Design:

The fruit and vegetable truck scored the highest on the weighted matrix. We decided that our solution would be the truck paired with the Smart Phone App. We decided on this solution because it solved the largest problem with the farmers' market system; in this system, food is grown by farmers, transported to the market, and bought by consumers (students) whose money goes to the farmers. This system as a whole is sustainable compared to grocery stores that receive food from around the nation because of reduced transportation costs, less gas used, and the stimulating effect on the local economy. In order to make Penn State community more sustainable, we decided to intervene in the step of getting food to the consumer. This meant making the food more convenient. The goal is not to replace all existing food supplies on campus, but rather to provide a fun and educational means of obtaining food. By adding this truck to the campus, students would be encouraged to support sustainable living. The truck accomplished this because it would sell the fruits and vegetables from the farmers' market at convenient locations on campus. It would be paired with the Smart Phone App for more convenience; the App would act like the Cata Service app here on at Penn State, providing students with a GPS location of the food truck at all times. The app could further be used to inform Penn State students about the importance of

buying locally grown foods. Overall, this solution would improve the most inefficient part of the local farmers' market system, getting the fruits and vegetables to its customers. Additionally,

students would learn about the food production and transportation process, learn about things like when certain foods are in season or what kind of foods can be grown locally, and learn about the benefits of locally grown food. This education builds a more sustainable mindset and therefore a more sustainable community. In summary, our design would implement a fruit and vegetable truck that would drive through campus and allow students to participate in and support the practice of locally grown foods. This would be coupled with smart phone app that would also educate students about exactly what food they're getting and where it's coming from. Our system diagram is as follows (also see Appendix E)



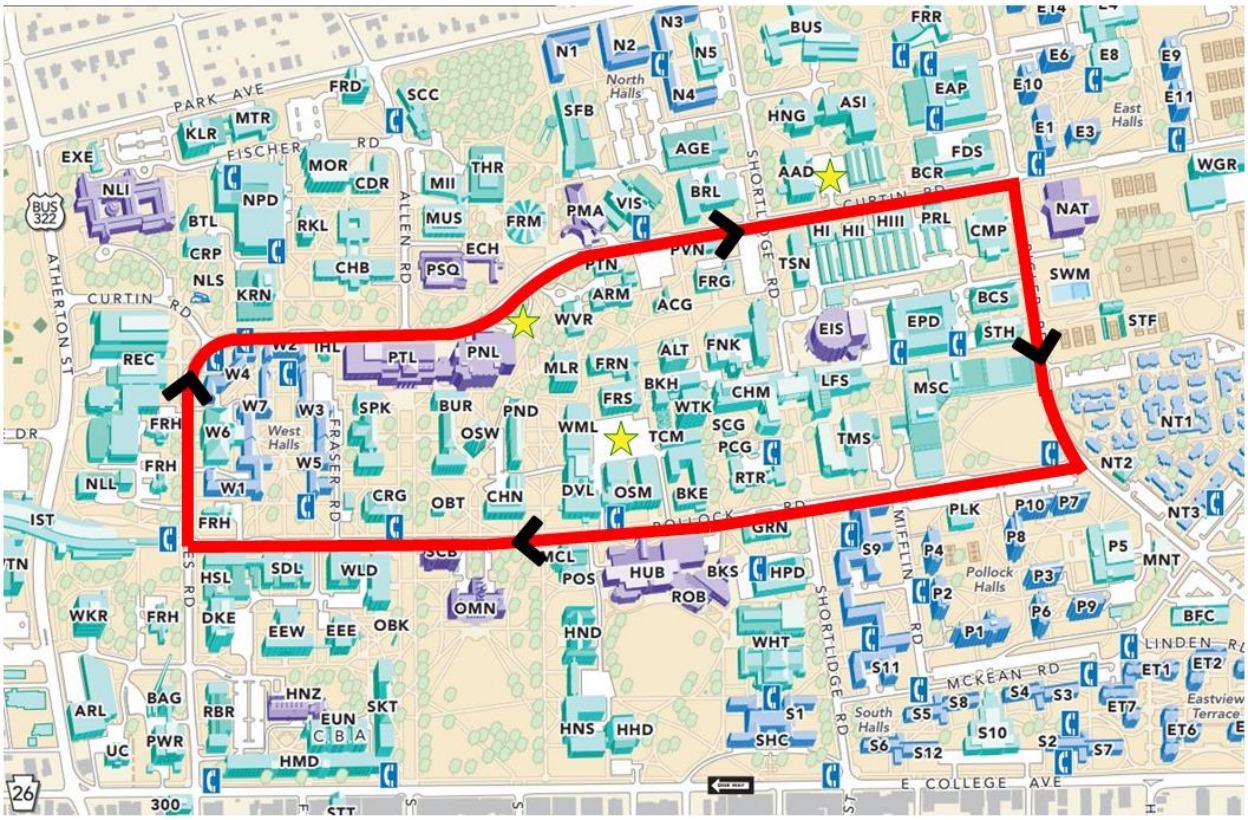
Detailed Concept Development

Design Solution:

Our final design is the to have a fruit and vegetable truck that would drive through parts of campus, supplying students with a convenient way to obtain locally grown food. The whole program would be owned by Penn State and run by Engineers for a Sustainable World (ESW). ESW would then make an agreement with the State College Farmers Market so that they can pick-up food each day to supply the fruit and vegetable truck. Food supplies would be bought from the farmers market and student employees and volunteers, from ESW or otherwise, would prepare simple snacks from those fruits and vegetables to be sold on the truck.

Truck Route:

The truck would then follow a route through University Park campus pulling in a profit from students buying these fruits, vegetables, and snacks. The route would be something like Figure 3 (Appendix F).



Our truck would drive around on Monday through Thursday. It would make main stops at the HUB from 9:30 -10:30 AM, 12:00 -1:00 PM, and 2:00-3:00 PM. Overall, the truck would be in operation for 6 hours out of the day. Between main stops at the HUB, the truck would make 4-5 other stops around campus, each stop being 15 minutes long. Therefore, the truck would only be driving for a total of about 30 minutes. Therefore, though it may seem like there would be a lot of emissions from a 6 hour operation period, in reality there is only half and hour's worth of emissions. The truck would be stopped most of the time so that students have the chance to purchase some fruits and vegetable products.

During non-operation hours, the truck would be parked at the little parking lot in front of the Department of Human Development and Family Studies building. This is located off of College Avenue and is very close to Locust Lane, which is the location of the farmers market. Since this parking lot is along College Avenue, it would be a good place for farmers to drop off their food and then that food would be loaded onto the truck.

Emissions:

The size of our truck ideally would be about 15 ft by 9 ft by 7 ft (l x h x w). This would mean it would require an engine with power in between that of a regular car and a CATA bus. The designated route it will travel during operation hours was calculated to be a total distance of approximately 2.125 miles. Using the Defra calculator, the approximate CO_2 emissions for our truck's total travel was given as 60 grams per mile. This brought our total to 127.5g per truck operation day but we adjusted this to 150 grams total emission to account for the several pedestrian crossings and stops that could delay the truck along its route. In a day, the truck would make 3 round trips, which would mean a total of 352.5g per day and 1,310g CO_2 emissions each week, running from Monday to Thursday.

If students didn't have the convenience of our food truck, they would instead have to make individual trips to the local grocery stores or department stores like Walmart. Assuming a person's weekly trip to and from the grocery store totals a distance of less than 1 mile, the total CO_2 emissions per mile is estimated to be between 380-430g. This would be for a medium sized car. When we average this and assume that about 1500 students make this trip each week, we

estimated total of 615,000 g of CO_2 would be released to the atmosphere. In comparison, this is much less than the emissions of running our truck. Therefore, if students made the switch to our fruit and vegetable truck, Penn State would be more sustainable by saving emissions and supporting local food practices. The following is a graph summarizing our calculations (see Appendix G).

Vehicle	CO_2 Emissions per mile	Quantity runs per week	CO_2 Emission per week
Food Truck	60 g	4	1310 g
Individual Car	380-430 g	1500	615,000 g

Smart Phone Application:

The Smartphone App paired with it would let students know what is available on the truck and where it is located on campus at a certain moment in time. The app would communicate with the truck via GPS system to the point that it accurate within 50 yards of the truck's actual location. The app would allow a user to view product prices and receive information about coupons and flash deals. Users of the app would also be able to learn from which farm there food is coming from. For example, they could click on the product, strawberry smoothie for instance, and then the app would take them to a page about where those strawberries were grown. There could be a picture of the farm and information about the farmer. That way, students would feel less disconnected from their food. This also enhances a sustainable culture and therefore a sustainable community.

Food Products, Logistics, and Exterior Design:

It would cost $5,000 to rent a used diesel vending truck, $600 for licensing, and $1,200 for an engaging paint job that educates students. Some products on the truck would be: fruit salads, fruit smoothies, vegetable and fruit kabobs, veggies with dip, etc. Any scraps at the end of the day would then be sent to Penn State's backyard composting program. If the truck runs out of food during operation, it's done for the day. After a couple months of implementation, we would monitor how much food gets sold each day so that we would be able to better supply the truck. Therefore, we hope that running out of food would no longer be a problem.

The exterior of a truck would be decorated to include information about the farmers market, where the food comes from, and how local food is a sustainable practice. It could include a simple, aesthetically appealing systems diagram that would depict the elimination of the middle man which results in a more sustainable distribution of food. It would also include statistics about economic benefit and emission savings that results from the purchase of one food item. Another statistic we can include is how, over time, continuous support of locally grown food decrease the consumer’s carbon footprint. Thus, not only is our actually program sustainable by conveniently supplying local food, but it also includes a marketing aspect that educates students about the advantages of local food production.

Conclusion:

We successfully conducted the design process in order to find a solution to make Penn State more sustainable. We identified the opportunity to make student at Penn State more aware and involved in buying locally grown food. In order to accomplish this task, we designed a vending truck that would work with the local farmers market in order to deliver and sell fresh locally grown fruits and vegetable at different locations on the University Park Campus in order to make the farmers' market food more convenient to students. This vending truck would be paired with a smart phone app that would track the location of the truck for increased convenience for students. It would also provide information about the benefits of buying locally grown food and the products available at the farmers' market. The pairing of the truck and app would foster the sustainable behavior of buying locally by increasing student awareness of the farmers' market in State College. Through the design process, we learned how to effectively work with team members in order to identify a opportunity and then design a solution for the opportunity. We also learned about sustainability with a cultural/behavioral mindset rather than the business and technical side that is usually studied. Overall, we learned how to successfully use the design process in order to create a solution.

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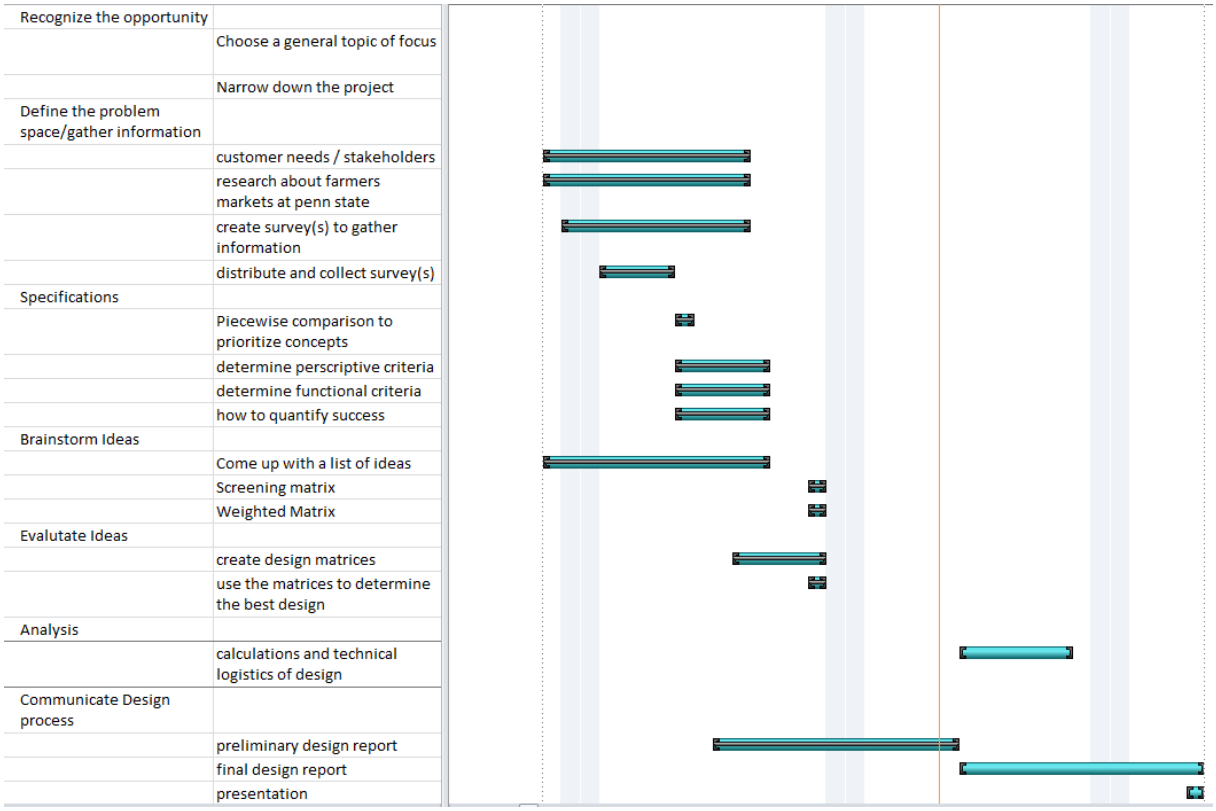
Appendices

Appendix A

Figure 1 – Gantt Chart



Appendix B

Table 1 - Pairwise Comparison

A	Price
B	Convenience
C	Quality/Freshness
D	Options/Variety

	A	B	C	D	Total	%
A	1.00	1.75	2.25	4.00	9.00	43.20
B	0.57	1.00	2.00	2.50	6.07	29.14
C	0.44	0.50	1.00	1.50	3.44	16.53
D	0.25	0.40	0.67	1.00	2.32	11.12
					20.83	

A	Sustainable
B	Practical
C	Economic Return
D	Technology
E	Creativity

	A	B	C	D	E	Total	%
A	1.00	1.50	2.00	3.00	4.00	11.50	37.20
B	0.67	1.00	1.50	1.50	2.00	6.67	21.56
C	0.50	0.67	1.00	1.50	2.00	5.67	18.33
D	0.33	0.67	0.67	1.00	1.50	4.17	13.48
E	0.25	0.50	0.50	0.67	1.00	2.92	9.43
						30.92	

Appendix C

Table 2 - Screening Matrix

Ideas	Educate Students	Involve Students	Fun	Profitable/Cost Effective	Increase Convenience	Practical/Available Tech	Total
Indoor Gardens	1	1	1	0	0	1	4
PSU growing Competition	1	1	1	0	0	1	4
Student Run Farmers' Market	1	1	1	1	1	0	5
On campus farm	0	1	1	0	0	1	3
Green house	0	0	0	1	0	1	2
Smart Phone App	1	1	1	1	1	0	5
Roof Top Gardens	0	1	0	0	1	1	3
Pre-order/online/pickup delivery	0	1	0	1	1	0	3
Fruit/Vegetable Truck	1	1	1	0	1	0	4
Trade Market	0	1	1	0	1	0	3
Revamp Website	1	0	0	0	0	1	2

Appendix D

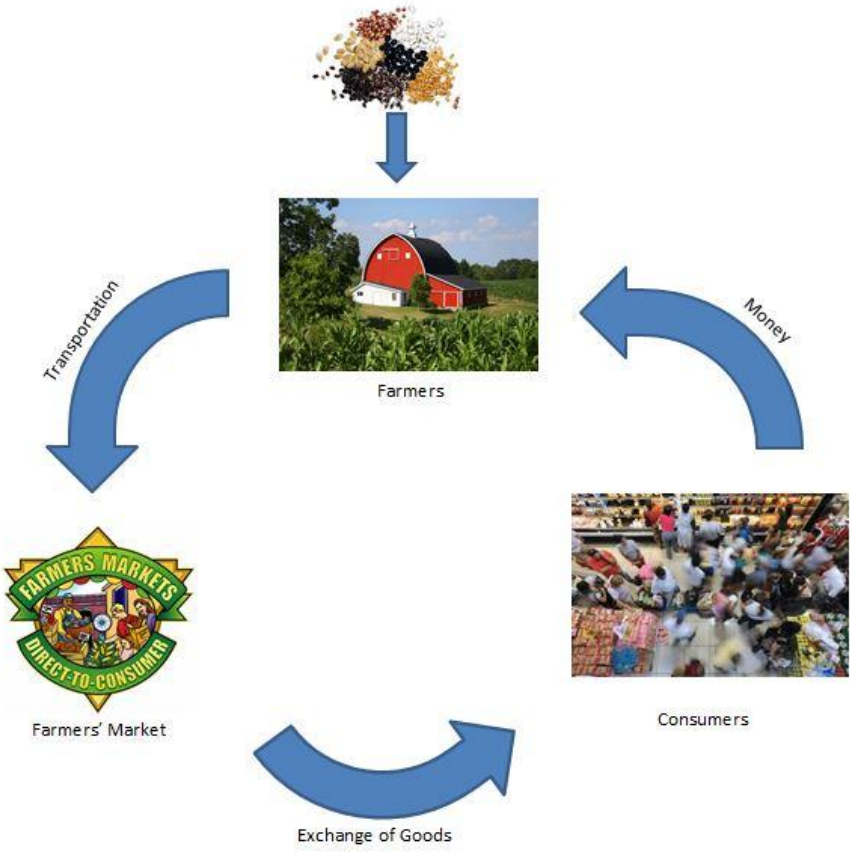
Table 3 - Weighted Matrix

		Indoor Gardens		PSU Growing Competition	
	Weight	Score	Weight Score	Score	Weight Score
Educate Students	22.50%	2	0.45	2.5	0.5625
Involve Students	22.50%	4	0.9	4.5	1.0125
Fun	12.50%	1.5	0.1875	3	0.375
Profitable/Cost Effective	10%	2.5	0.25	2	0.2
Convenience	12.50%	3	0.375	2	0.25
Practical/Available Tech	20%	3.5	0.7	1.5	0.3
Total			2.8625		2.7

		Student Run Farmer's Market		Smart Phone App		Fruit/Vegetable Truck	
	Weight	Score	Weight Score	Score	Weight Score	Score	Weight Score
Educate Students	22.50%	4	0.9	3.5	0.7875	2	0.45
Involve Students	22.50%	3	0.675	2.5	0.5625	4	0.9
Fun	12.50%	1.5	0.1875	3	0.375	4	0.5
Profitable/Cost Effective	10%	3.5	0.35	3	0.3	3	0.3
Convenience	12.50%	2	0.25	2	0.25	3.5	0.4375
Practical/Available Tech	20%	1	0.2	2	0.4	3	0.6
Total			2.5625		2.675		3.1875

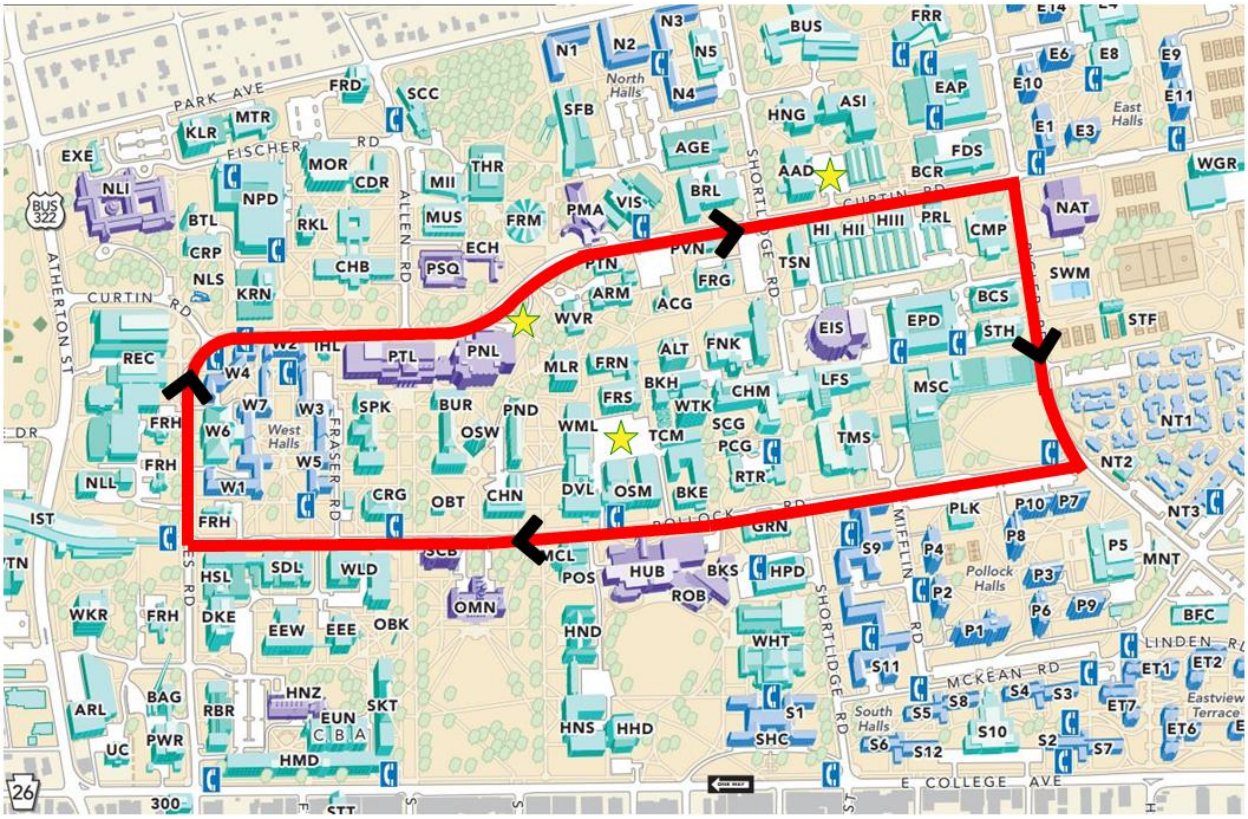
Appendix E

Figure 2 – Systems Diagram



Appendix F

Figure 3 – Truck Route



Appendix G

Table 4 – Emissions Calculations

Vehicle	CO_2 Emissions per mile	Quantity runs per week	CO_2 Emission per week
Food Truck	60 g	4	1310 g
Individual Car	380-430 g	1500	615,000 g