

Project DREAM:
Diverting Refuse through Education and Awareness at Michigan

Team 3

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Executive Summary

With the most recent intergovernmental panel on climate change report, it is now very clear that climate change is a reality and the release of greenhouse gases into the atmosphere is a significant driver of it. Methane is one such gas, one that has a global warming potential 21 times greater than that of carbon dioxide. The United States is one of the worst methane polluters. But nearly 20% of our methane emissions are just from the food waste in our landfills. The University of Michigan recognizes the need to curb our waste production, with a commitment to divert 40% of our waste away from landfills by 2025.

Composting is one major way to accomplish this, with over 30% of the university's current waste stream being compostable. Pilot studies have been performed both here at Michigan and at other universities, and their conclusions always come back to the same problem: most people do not recognize the environmental impact that food waste has and therefore do not take the time to learn how to sort out compostable material from trash. Our team saw a need to increase education and awareness of these issues and developed Project D.R.E.A.M.

Project D.R.E.A.M. (Diverting Refuse through Education and Awareness at Michigan) seeks to improve the campus' ability to adopt a full-scale composting program here at the University of Michigan. This can only be done by demonstrating to students, faculty, and staff the need for the diversion of food waste away from landfills, which in turn will create a culture shift on campus. We take a "baby steps" approach to this problem by proposing a small-scale project in the East Quad dining hall. This project utilizes social media, eye catching signs, and high quality information to capture the attention of those who frequent the dining hall while also allowing students to put into practice what they are learning. Compost bins will be placed in the dining area and student ambassadors will help students sort their waste into the proper containers. Students will not be forced into doing this, but we will still be able to collect the waste of those who do not participate by sorting the waste in the kitchen as well. This will result in roughly 100 tons of waste being diverted away from landfills per year, the equivalent of taking roughly 10-15 cars off the road, depending on the composition of the waste.

This project is believed to be the best solution to the issue of food waste because it is meant to cause a culture shift. We can implement a full-scale composting program on campus, but it will fail due to high contamination rates without education. This project is therefore a sustainable design because it decreases the university's carbon footprint at a low-cost while creating a societal shift towards the adoption of a more environmentally friendly practice. If successful, it lays the groundwork for a full-scale implementation to not fail.

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Introduction

The University of Michigan Waste Reduction and Recycling Office provides pre-consumer food waste composting to most campus dining halls and several campus coffee shops; in addition there are pre- and post-consumer waste composting upon request at campus events. The University does not currently provide post-consumer waste composting other than when requested, and based on a refuse study performed in 2012, where twenty to forty percent (20-40%) of the volume of the total waste collected was compostable material [1]. Post-consumer waste compost collection would go a long way towards reaching the University's goal of diverting 40% of their waste by 2025 [2]. Subsequent to this study, a university student group implemented a three month pilot to quantify the need for post-consumer composting, which demonstrated the students' lack of knowledge for composting [3]. In order to have successful and persistent post-consumer waste composting on campus, education and awareness is the key. This project's aim is to provide students with knowledge so that future campus-wide implementations and attempts of post-consumer waste composting may be made successfully. The stakeholders in this project include any student and faculty present at any educational displays, events, and programs, the multiple university facilities, athletic and dining, where the waste events may be held, and lastly the composting facilities that will receive more business. The goal of our project is to divert refuse through education and awareness at the University of Michigan and when this goal is achieved our negative environmental impacts will diminish.

Baseline

We started this project looking for needs in the University setting, knowing that a typical research institution will generate a significant amount of waste. From that initial mindset, we looked at the University of Michigan's waste stream. We started our research by looking at Plant Operations, where a little background information was collected, resulting in a phone interview with Steve Sinelli, the warehouse manager for Procurement Services, and an email conversation with Tracy Artley, a member of the waste reduction and recycling staff. After looking into different areas of the University waste stream such as electronic waste and furniture, the team settled on food waste as the area with the greatest need to be addressed.

We looked into incineration as a possible way to divert the waste from landfills. First impressions look good - incinerating one ton of waste releases approximately 1 ton of CO₂, compared to landfilling the waste, which results in the production of 1.32 tons CO₂e [4]. Diving a little deeper into incineration, we found an LCA on energy from solid waste, and one of the conclusions from their report was that the waste hierarchy shown below is valid as a rule of thumb [5]. The hierarchy tells us that recycling is better than energy recovery (incineration), which is better than landfilling. The composting process is considered a recycling process, as shown in Figure 1, so from the LCA, we are choosing to tackle composting as the process that will help divert our waste stream most effectively.



Figure 1

It is important to know what composting truly is, and what the benefits of this process are. The term composting is "the aerobic decomposition of organic materials by micro-organisms under controlled conditions [6]." After this process is completed, compost is created, which is stabilized organic material, created by the processes of bacteria and fungi breaking down complex organic material into simpler substances. The byproducts of this process are CO₂, water, minerals, compost, and heat. The heat helps to kill off pathogens that may be present in the virgin organic material.

Composting is not a new technology, so there is a large base of information that is accessible to the public. The most important discovery we came across during our investigation was that the importance and understanding of composting, like recycling in the past, is not apparent to the general population. In discussions with both Adrienne Small at the University of Maryland and Keith Soster at the University of Michigan [7], as well as in pilot and feasibility study reports performed by the University of Michigan, it is clear that education and awareness is the largest obstacle to a successful large-scale composting program. This will be discussed further later in the report.

We looked around at several schools that already have a composting program established, including the University of Maryland, Ohio University, and Clark University. The University of Maryland has a pre- and post-consumer composting program that was established in 2007. Their composting is based in the dining halls, which is collected by student workers. These workers collect all pre-consumer waste in separate bins in the kitchen, and then after students are done eating, the students place the trays on a conveyor, where a trained student worker collects all of the compostable organic waste. At Maryland football and basketball games, there is a large push for composting and recycling, resulting in 41% of the waste stream being diverted from landfills [8].

Ohio University has an in-vessel composter that was installed in 2009, which was the largest in the nation (for a college or university) at two tons. Their initial costs were \$355,570 for the actual composter, but total start-up costs were approximately \$800,000. This covered the composter, a solar array to help power the facility, a cement pad for the compost, a rainwater

harvesting system, and construction of a heated pole barn. This in-vessel composter accepts organic waste, and 14 days later, compost is released, which then sits in a pile for approximately 90 days before it is used [9].

Clark University is important to look at because they have partnered with WeCare Organics. This is the same company that is in Ann Arbor, so we can potentially gain a lot of knowledge with some help from Clark. Clark University creates about 200 tons of organic waste each year, and they have established a relationship with WeCare that gives the university an allotment of 20 cubic yards of their class 1 compost for free. The main roadblocks for Clark University are the cost of biodegradable bags, controlling odor, finding an effective pickup schedule, and managing the compost over the summer [2].

The common theme in our study of what other universities have done and what Michigan has tested in the recent past is this realization that we must do our best to make users aware of the importance of composting. This will result in higher rates of waste diversion but also in lower rates of contamination if a program were to be implemented.

For a baseline, we are looking at the campus at its current state, with most pre-consumer waste being diverted from landfills, but all post-consumer waste being sent to the landfill, other than the Ross School of Business, which has an independent, more complete composting program. This amounts to over 2000 tons of food waste being sent to the landfill each year.

Design Ethnography

In order to come up with the best design for our composting education program, our team has to make sure that we are asking the right questions. We looked at several questions including:

- What are other people and organizations doing related to composting and food waste education?
- How can we implement similar ideas at the University of Michigan?
- Is there sufficient motivation to having a composting education program on the campus?
- How can we integrate our project with existing composting services in Ann Arbor?

When defining the “who” of our project, we brainstormed several potential users, stakeholders, experts and clients. Users of the composting program include college students, staff, and faculty who use dining facilities on campus; grounds staff; and community and campus recipients of our end product. College students, staff, and faculty who use campus dining facilities would be the main users of our program as we are aiming to reduce post-consumer food waste and increase understanding about the impacts of food waste. As the dining facilities on campus are the biggest generators of such waste, focusing our efforts in such places would mean that much of the intended waste comes from people who frequent these areas. Grounds staff and community/campus recipients would also be our users since they would likely make use of our end product. A longer list of the “who” on our project is brought forth when we go over the stakeholders. We were able to identify many stakeholders including Plant Operations, campus dining facilities, outside composting services (WeCare organics, Ann arbor recycling, Tuthill Farms), faculty, staff, and students, manufacturers (for trucks, bins, etc.), and experts within the field of waste management.

These groups are our stakeholders because each one of them has the potential to have a need addressed somewhere in the design process or within the scope of the program. Also if

there may not be a direct need being addressed they may generally be affected by implementation of our program. For instance, landfill owners do not have a direct need to be addressed in our design process, but they are affected by the diversion of waste from our composting program. Our experts include Tracy Artley in the Sustainability Office at the University of Michigan, Director of Operations for the Dining Facilities, Recycle Ann Arbor, and We Care Organics. In addition to the users, stakeholders, and experts we identified potential clients such as Michigan’s Grounds Services and Ann Arbor-area landscapers. However our client depends on if we do our own composting where we could give out the resulting composting or become a client of an outside company where we would send our food waste.

We have collected a significant amount of data pertaining to composting at the University of Michigan. After deciding upon a 40% waste diversion rate by 2025, the university performed refuse sorts in 2007 and 2012 that helped establish a starting point against which progress towards the diversion rate could be measured. In addition, there was already yard waste composting within Grounds Services and pre-consumer waste composting within the dining facilities. A feasibility study from Resource Recycling Systems Incorporated, performed in 2011, showed how the current composting process could be augmented to include post-consumer waste materials. In order to handle all of the estimated 1385 tons of organic waste generated by the University of Michigan, RRSI approximated costs at \$40 per ton of waste and \$1 million for capital. The 2012 refuse sort followed up with these results by showing that an estimated 34% of the university’s waste stream was able to be composted. Additionally, the Waste Reduction and Recycling office conducted a pilot program for composting at the Michigan League during the fall of 2012 that generated about 900 pounds of post-consumer compost materials. Using this research we were able to identify large gaps in university waste management sustainability that our program would be able to address.

Our data collection methods are summarized in the following table:

Who:	Information Provided:	Best way to gather info:
College students/staff/faculty	Waste disposal methods User behavior	Observations
Plant Operations dining facilities	Campus waste management Visual evidence of how much food waste is thrown away and can be diverted	Interviews Observation
Outside composting Services (WeCare organics, Ann arbor recycling, Tuthill Farms)	Practical and applied knowledge of the composting process and how to implement it	Interviews
Tracy Artley in Sustainability Office	How we can make sure to have elements of sustainability in our design	Interviews
Keith Soster in Dining Services	Information about how a program may be implemented, who makes the decision, what has been done in the past, etc.	Interviews

From most of our “who” demographic, interviews were the best way to gather information. However observations are just as useful for gathering information. Within the context of an interview, our group was able to gather information about amounts of food waste, integration of sustainability, best practices, regulations and ordinances to be aware of. Regarding observations, our team was able to gather preliminary information about waste disposal methods from users and direct visual evidence of how much food is thrown away and into which bins.

In terms of interviews, we identified the specific user or stakeholder for our product and developed a battery of test questions that are most relevant. For example, when we decided to do an interview with Tracy Artley, the manager of Waste Reduction and Recycling for the University of Michigan, we had this semi-structured interview as a guide, though the actual interview veered from this:

Introduction:

1. Hello, we are a graduate student team in a Sustainable Design course at the University of Michigan.
2. We are designing a program to increase awareness about composting on Michigan’s campus.
3. I’d like to ask a few questions regarding waste management and composting.

Kickoff:

1. I’d like to speak about your background. How did you get involved with the Office of Sustainability within the department of Waste Management and Recycling?
2. What exactly is your role in the organization?

Build Rapport:

1. Would you be able to tell me what a typical day in your organization is like?
2. How does your organization manage generated wastes?

Grand Tour:

1. Do you know what waste management departments at other universities are doing in terms of waste stream collection? Is your process innovative?
2. What are the biggest contributors to our waste stream?
3. What are the biggest costs involved in waste management?
4. What are some challenges that you encounter regarding composting?

Reflection:

1. Regarding challenges, are there any ways that your organizations sees room for improvement?
2. If there are any ways other departments at the university can improve the process from their end, what are those ways?
3. There was a pilot composting program a few years back, what would you say were the most important takeaways from this pilot?

4. What were some of the drawbacks of the program?

Wrap-up:

1. Is there anything further to add about composting/waste management/challenges/etc.?
2. Thank you so much for your time!

As a result of our ethnographic research, which was ongoing throughout the duration of the project, we discovered a wealth of information. Tracy was the one who put us in the direction of composting after we asked her some general questions about the waste management program at Michigan. She also provided us with numbers and documentation for what the University pays in tipping fees and how much waste goes to which locations.

Adrienne Small at the University of Maryland discussed with us how their post-consumer program in the student union is performing. She stated that a significant amount of waste collected in compost bins at the Student Union is contaminated and cannot be taken to their compost site; though, as she put it, their waste sort showed results that were better than expected. She stated that this was due to the fact that students who will not take the effort to sort will normally throw everything in the bin labeled “Trash” rather than not even take notice at all to signage. This shows some promise that, with proper education, the waste collected will stay below the contamination levels. Adrienne made it clear that telling people how to compost is not enough to accelerate the adoption process. Students need to see why it is important to compost and reduce our food waste before they will actually begin doing it.

Our interview with Keith Soster revealed similar information, though he highlighted some results from pilots that have been performed on campus. These included poor placement of bins, poor placement of signage, and poor communication with users and stakeholders. Therefore, with a well-organized rollout, we should be optimistic that a large scale program could succeed. Keith also gave us additional information that was even more important to the adoption of a composting program at Michigan. Firstly, he made it clear that the majority of projects and pilots that have been implemented in the past and will be implemented in the future are not funded by dining services; they must secure outside funding. Keith mentioned that if a program were to become full-scale, that money would not be an issue. The University would cover costs, and due to its commitment to sustainability, as long as the cost was not exorbitant, it would implement a more expensive waste management program if it was considered to be more sustainable. Second, he told us that Michigan is not looking to implement any full-scale programs; they want to see smaller, short duration projects succeed before they would consider implementing a full-scale one. We also learned from Keith that it would be preferable if the program, at both a small- and full-scale, could relatively seamlessly integrate into the existing program. He would not be looking to hire more staff and there should not be more than “a few” departments needing to work with each other [7].

Description of Persona

Jim is in charge of the waste management department at a large university. As schools across the country continue to “go green”, he is looking for ways to promote waste diversion from landfills on his campus. His campus already uses single stream recycling, which has been very successful, but he feels that his department can do more. He knows that post-consumer composting can make a huge dent in the waste that is currently going to landfills, but he believes that contamination would be too large of an obstacle to overcome since students, faculty, and staff may not know what can and cannot

be composted. He has heard from colleagues at other institutions that implementation of a composting program actually cost them more money than sending the waste to a landfill because of the high contamination rates. Even Jim is not 100% sure what can and cannot be composted; he maintains a compost heap in his backyard, but half the time he goes outside to throw stuff on top his wife yells, “You can’t compost that!” Jim feels that a full-scale post-consumer composting program would be a big effort and have significant costs, especially if contamination rates are high. Before he implements anything on a large scale, he wants to see small-scale projects be successful in diverting waste *and* saving money, meaning contamination rates would have to be low. Jim is already busy maintaining the status quo on campus, as well, and does not want a project that will take up all of his time either.

Project Requirements and Specifications

Our primary focus for the project is to reach the “Jims” of the world, the people who may be aware of the basic types of waste management and recycling, however not so much with the newest mainstream trend of composting. Based on what we understand about Jim, we have divided the requirements of our project into three sections: education, economic viability, and logistical feasibility, where the resulting benefits will be positive environmental impact. Jim is not so much concerned with diverting a lot of waste, but he wants to see that 1) waste is being diverted when given the option and 2) the waste that is diverted is done so properly. Essentially, Jim wants to shift the adoption curve to the left, as shown in Figure 2. This will allow a full-scale project to be successful.

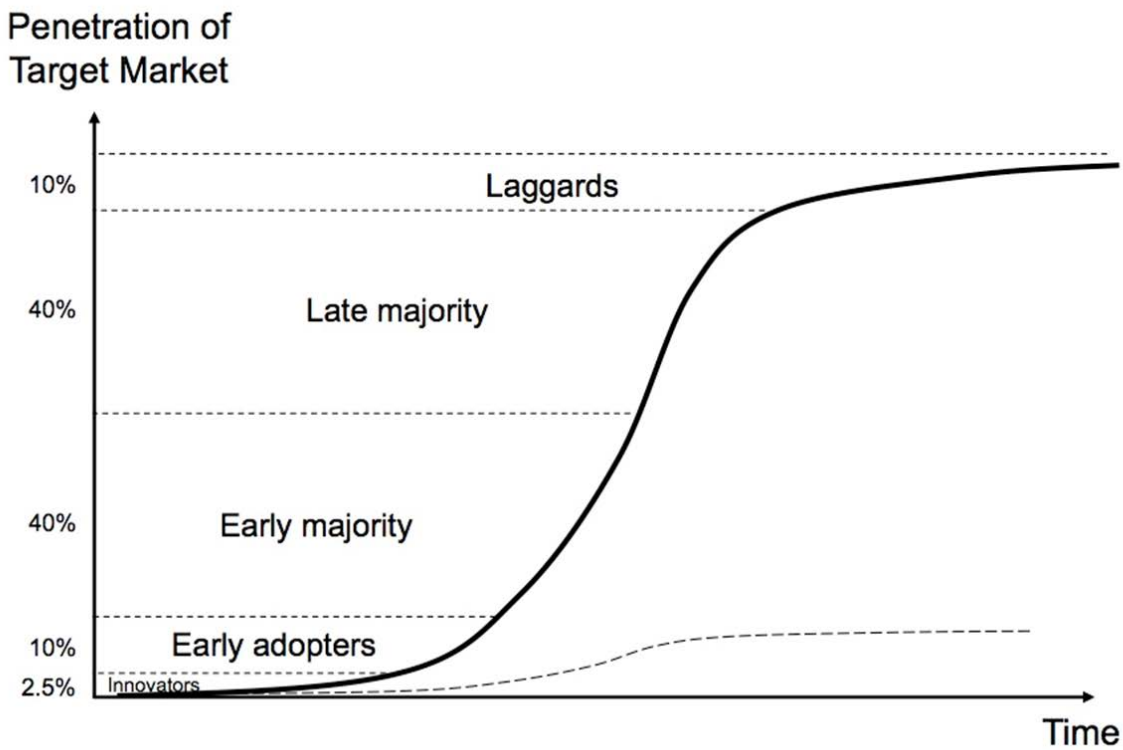


Figure 2-Adoption Curve [10]

Educationally, it is the lack of knowledge about composting that results in fifty percent of our project being geared towards education, quantified into four categories: student population reached, how the information demonstrates what can and cannot be composted, why composting is important, and how often students are exposed to the information. The amount of students reached plays a key role in our success; even if we do not reach a vast majority of the student population, word of mouth is the best and cheapest form of advertisement. We have set a goal of 25% for the percentage of the student population reached based on this assessment. The quality and distribution of information that we provide the students with will be the defining factor of the success; similar to a classroom setting, it is not just the information that we are providing but how we may make it relatable to the audience so that they may have a personal connection and feel “responsible.” Subsequent information reinforcement should have the ability to apply the information that you receive and make the composting ideal stick and potentially grow. This would have to be assessed by both the contamination rate in the waste stream and post-pilot surveys.

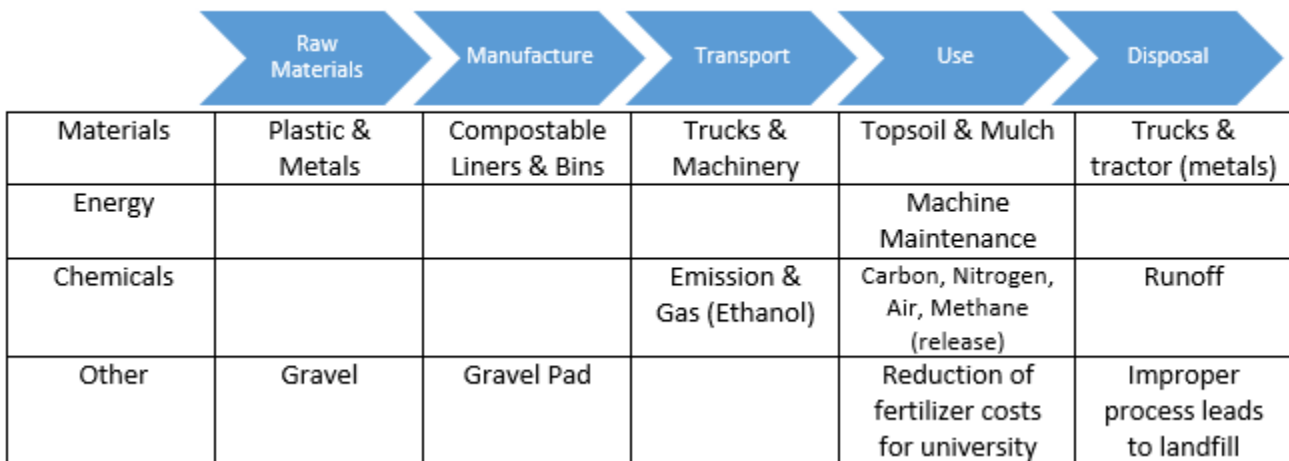
Economic viability, comprising twenty-five percent of the project goals, takes into account how much money we think it will take in order for the program or events to be successful from the capital, operational, and end of life costs. Installation costs for a project vary; however, we felt that based off of the previous pilot project and the amount in which they spent, five thousand dollars (\$5000) was a good target for implementation of a small-scale program. For the ongoing cost, we believe that a successful project would help the university save money every year, by delivering waste to a composting site rather than a landfill, where the difference in tipping fees is in composting’s favor – Tuthill Farms charges less than \$30 per ton whereas the landfill rate is currently between \$32 and \$35 per ton, dependent on fuel costs. Lastly, the end of life costs, which ideally would cost nothing, we set at the amount of one hundred dollars (\$100) for the trash pickup and various small odds and ends, whereas the remainder of the items would either be used until out of stock, repurposed for other uses, or donated.

Lastly, the logistical feasibility, comprising the remaining twenty-five percent of the design consists of four categories: the number of collaborators, the amount of time it would take to plan, training necessity, and frequency of waste retrieval. The target number of three collaborators was established off of the hypothesized amount of groups that we thought would be needed to run a successful program or function. These include but are not limited to the venue where the event is being held, the waste management staff to pick up the compost, and the organizers of the event, such as student groups or managers. Exceeding this would result in increased complexity and would therefore negatively impact the project. The amount of time it takes to plan the event or installation of a new program has a target of one month. Jim would not want to be involved in the planning of a project that takes up too much of his time, so the shorter the better. In order for these events to be successful, the need to train employees or volunteers may also be necessary; training with knowledge of what can and cannot be composted and how to collect the compost to minimize contamination. It is much easier to implement the project if training is not necessary, so project ideas that do not require training would score better in this category. Lastly is how frequently the compost would need to be collected and taken to the companies, estimated at a target of three times per week based on the smell that may ensue from the containers. This would result in roughly half to $\frac{3}{4}$ of a ton per trip. Some project ideas may be one-time events and therefore would be better than the target, whereas others may generate much more waste and would have to be picked up more frequently, increasing complexity and costs.

The major competitor to our projects is the status quo. As stated before, most people are unaware of the environment impacts of food waste and would be hesitant to implement any sort of project in this area since no real economic gains will be seen without any economies of scale and past pilots have resulted in relatively high rates of contamination and no real impact on waste diversion. It is for this reason that we generated concepts that sought to address how we might improve education and awareness, which would ultimately result in increased waste diversion.

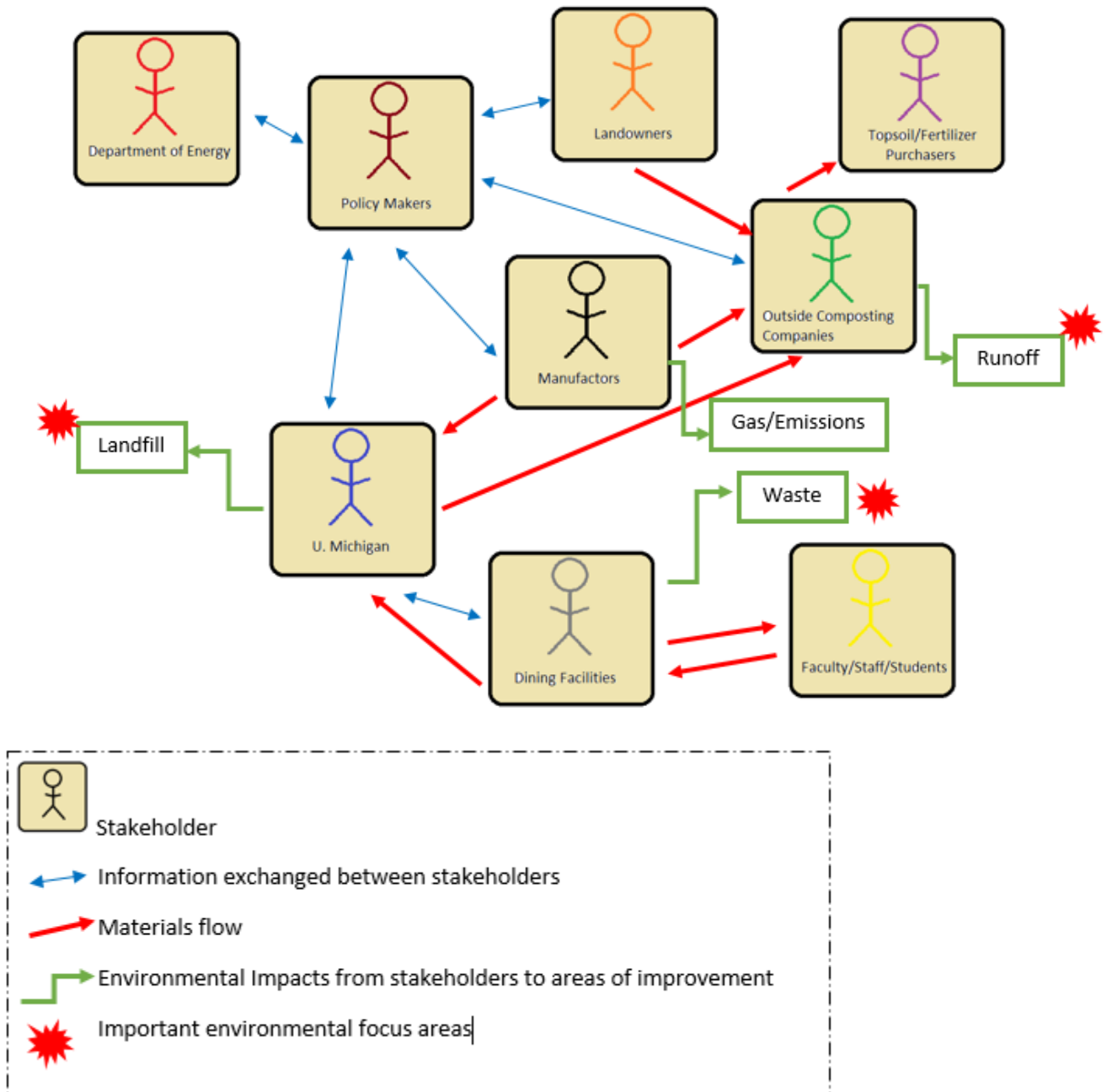
Sustainability Evaluation Process Status

The basis of the composting ideal is to divert unnecessary waste from landfills and to diminish future issues from inorganic fertilizers and pesticides. The purpose for the composting process is for the reuse of items we quantify as waste, such as food scraps, compostable materials, dead leaves, etc., to produce an organic based soil-like end product. The benefits of composting for the University of Michigan- Ann Arbor includes less waste in the dining facilities and the ability to reap benefits from the waste that is produced by using the produced compost for campus wide landscape architecture. The collection of the raw materials for the composting process would be between every three and five days in the university dining halls and facilities. After the collection of the waste, it will be transported to an off-site company who can then perform the compost process, helping to establish a lower economic cost. After which we may be able to purchase the product back at a reduced price that would in total be cheaper than buying our agricultural soil products.



The raw materials that we would need for this service are the plastic for bins to collect the waste, the metal for the turning of the compost so it may be able to aerate appropriately, and lastly gravel for the storage pad. The items that we can either buy or manufacture are the compostable liners and collection bins and the gravel pad to help filter the runoff that may be created during the process. The trucks used to transport the waste, the machinery used to turn the compost, and the gas emissions that they produce are our main concern for the transportation portion. The negative chemicals emitted are the methane while the carbon, nitrogen, and air are needed in order to make the process work. Routine maintenance will be needed in order for the system to be efficient and operate since in large scale composting the amount of waste we are expecting will need to be turned by some form of mechanical device. Since the end product will

be topsoil and mulch the university may contract a deal with an outside composting company so that we may reduce our costs for the agricultural advances the university makes campus-wide. Lastly the primary issue that came about for disposal was a thought of the negatives, i.e. a broken truck, an improper process that could lead to leaks into nearby rivers and streams, or a need for the landfill. From all these possibilities it seems ideal to let an outside company handle the compost process mainly for economic reasons.



The stakeholders were defined as people who would be affected from this process and who could be an influence with the service. The Department of Environmental Quality gives the

information to the policy makers who then produce policies and regulations that the university, car manufacturers, landowners and composting companies have to follow accordingly. For a proper compost process, sufficient land is needed along with the space; therefore the landowners give the land to the compost companies. The car manufacturers provide vehicles to the compost companies, which they need in order to pick up waste, in addition to the university who needs the vehicles for all the waste management services they provide. The university provides the dining facilities the policies they need to follow, the dining facilities then give the students, faculty, and staff food which then provides the dining facilities with waste. The waste is then given to the university for disposal which is transferred to a landfill. The service we would provide would transfer some of that waste to the outside compost companies, who then markets their product to soil purchasers, which could include the university.

Quantified Sustainability Evaluation of Baseline

The University of Michigan has decided that a 40% waste diversion rate from FY2006 is a reasonable goal by 2025, which ends up being 5,268 tons diverted [2]. In 2007 the Waste Reduction and Recycling office performed a "refuse sort" of six buildings on campus - establishing a baseline to help measure progress towards their waste diversion goal. This sorting of the refuse again occurred in 2012, and from those results, it seems very reasonable to establish a composting program university-wide. The 2012 study showed that approximately 34% of the waste stream was considered compostable [1]. Going a little deeper into university composting, we discovered that Michigan already has an established composting process within the grounds team; they currently, and have for many years, compost all of their yard waste, and use the resulting material throughout campus [11]. Several of the dining halls also compost, but on a pre-consumer basis, meaning that only food preparation waste is composted, including but not limited to fruit and vegetable trimmings, spoiled produce, egg shells, etc.

In 2011 a feasibility study was conducted by Resource Recycling Systems Inc. (RRS) to show the University of Michigan what the process would involve to include post-consumer compost in their current composting regimen, along with adding the entire campus' refuse. This study came at a time when Ann Arbor's composting facility was being switched over to a private company, WeCare Organics, so several holes in information existed. With the transfer of control, there was no way to find out what types of compost the new company would allow to be added to their compost. RRS's report estimated that 1385 tons of compostable waste would be generated each year, though this was a conservative estimate [2].

The fall 2012 semester was another helpful year for composting; the Waste Reduction and Recycling office ran a pilot program for composting at the Michigan League, which ran from September 4 to November 21, 2012 [3]. After the study was completed, they found that an extra approximately 900 pounds of post-consumer compost was collected. This seems like a small amount, but we believe their location was not going to create the most post-consumer compost, perhaps a dining hall would have been a better choice. One of the key takeaways from this pilot program was that communication and education are very important aspects for a successful composting program. This starts with the stakeholders, and continues throughout the process to also include the patrons of the establishments. The need to educate the users was evidenced by the fact that the waste collected was divided into two categories, catering and cash business, and the cash business had a significantly higher contamination rate. The catering part was "clean"

because there were only a limited number of people, all of whom were trained, depositing the proper waste into the compost bins.

In the last fiscal year the University trucked about 110 tons of food waste to WeCare Organics, at a cost of \$38 per ton [12]. According to the refuse sort study conducted in 2012, the University currently has approximately 7250 tons of waste generated each year, and 3567 tons of this was considered divertible, either as recyclables or as compostables. Of the 3567 tons of divertible waste, almost 2500 tons was considered compostable [1]. The University has the potential to make a large reduction in emissions in this area, as the anaerobic decomposition of food waste in landfills produces methane, which has a 21 times higher Global Warming Potential (GWP) than carbon dioxide. These emissions from landfills account for more than 20% of all methane emissions in the United States [13]. For every metric ton of waste diverted, 0.3 metric tons of carbon dioxide equivalent will be prevented from entering the atmosphere, meaning the University can prevent over 800 tons of GHGs per year. This is equivalent to taking over 150 cars off the road [2].

Looking at the economic aspect, the University currently spends \$32-35 per ton to dispose of non-compostable waste [12]. According to a study on zero waste at the University of Michigan Football Stadium, the cost of sending organic waste to a different compost facility, Tuthill Farms, would cost approximately \$20 per ton [14]. This cost savings would at least be partially reduced by the added cost of transporting the waste. Tuthill Farms is located approximately 15 miles from North Campus, compared to WeCare Organics, which is only approximately 6 miles from North Campus. University of Michigan's Waste Management Services currently takes all of the waste - both compostable and non-compostable - to the respective dump locations, so transferring some of the waste stream away from the landfill would potentially only cost an extra 18 miles of travel for the dump trucks if economies of scale are achieved. Investigating the previous studies done by University of Michigan, the consistent sticking point between all of them is that communication is the biggest and hardest part to maintaining a successful pilot. The composting pilot done at the Michigan Union discovered that the compost collected by catering services was significantly less contaminated than the compost collected at the cash businesses, emphasizing the point that education is one of, if not the most important part of a successful composting program.

Concept Generation

Our major categories of concepts generated include departmental-focused ideas, eating facility-focused ideas, residential hall-focused ideas, and a few that are in categories by themselves. Going off of the project requirements and specifications we each brainstormed a few ideas that would possibly be a good fit. Given these constraints the group decided to take a couple of days to generate ideas that we could then weigh against our product specifications. Some ideas our group came up with were Compost Wars in the residence halls, compost displays in the Michigan Union, composting bins and changing to compostable cups at Mujo's, and a mobile composting vehicle/service for the University of Michigan campus. Further ideas are outlined in Appendix IV.

Compost Wars would be a competition between each of the residence halls to see who could divert the most compostable material away from the landfill. To implement this idea, we would need to meet with our collaborators -- Tuthill Farms, waste management, and residential facilities -- to make sure that waste would be disposed of properly and picked-up on a regular basis. Resident assistants in the residence halls would inform the students of the competition and

how to participate. We would meet with waste management to set out the dumpsters, provide a means to weigh the waste generated, and arrange the trucks to come pick up the compost. We would also make an arrangement with Tuthill Farms to take our food waste. The beginning of the project would take a few months to roll out, after which the competition is up to the residence halls. The resident assistants would have to make sure the students know of the competition and ensure that the students are participating by having a special event or prize for the residence hall that diverts the most waste. By working with the residence halls, we are reaching approximately 25% of the student body which can have a significant impact on the amount of waste being diverted at approximately 50 tons of waste per year [1].

Displays about composting in University of Michigan Unions would be a fairly easy idea to implement. After meeting with the Director of the Union and discussing potential designs of the composting poster with an artist or graphic designer, we could roll out this project in only a couple of weeks. If we add in compost bins near the displays we would need the help of the university's waste management services and a composting company (Tuthill Farms, WeCare Organics) to pick up the waste both from the bins and receive the compost from the university, respectively. If composting bins are added, we would also need to ensure that Michigan Union custodial services know how to maintain the bins. This idea has good potential to reach our project requirements as it reaches the estimated 30-40% of students that pass through the Union weekly [15]. In addition, we are making sure to educate the people who pass through the Union by having the importance of composting and what can and cannot be composted be the main focus of our posters. This ensures that there will be improvement from the current baseline of limited awareness of post-consumer composting on campus.

Our mobile composting idea consists of using a vehicle that has an attached composting catchment system to ride around the University of Michigan to collect compost and educate the general public. If we decided to choose our mobile composting idea, it may take several months to implement. We have to look at a variety of vehicle options to ensure that we are choosing a cost-effective, efficient, and environmentally-friendly vehicle. We also have to find an appropriate attachment for the vehicle --whether it is a bicycle, electric car, or utility cart-- or a vehicle equipped with a compost storage area. Once we find our vehicle, we simply need to advertise our program on the side of the vehicle and train our volunteers to know the route, composting information, and how the vehicle and attached system work. Having a mobile program would provide us with the possibility of reaching more of the general public in terms of education especially if we spread the word of the composting vehicle among several departments, residence halls, dining facilities, and other areas on campus where post-consumer compostables are generated. Thus we are estimating that about 65-70% of people on the University of Michigan campus can be reached with this idea. The vehicle would follow a few set routes on campus every week, so that we are maximizing the amount of times – and thus reinforcing composting information – the vehicle is seen. The impact from running these routes would be minimal assuming we use a vehicle that is environmentally friendly. Additionally, we estimated that we would be able to capture at least one ton of compostable waste. However this figure is highly variable as it would depend upon how well known the mobile composting program is and if people are willing to bring us significant amounts of compostable waste.

Concept Selection

Our team used a modified Pugh Matrix to assess each project. As outlined earlier, our specifications fell into three major categories: education which was weighed 50%, economic

viability which was weighed 25%, and logistical viability which was weighed 25%. These were weighed as such due to their relative importance to Jim. Clearly shifting the adoption curve to the left is a priority, but cost and feasibility also come into play as well. Within each of these categories, we outlined weights for each of the specifications that would sum to the total weight of that category. For instance, under economic viability, the three specifications of installation costs, ongoing costs, and end-of-life costs were weighed 15%, 5%, and 5% respectively, summing to the total of 25%. Specifications that were “yes/no” requirements had three possible choices: 10 for yes, 0 for maybe (depending on the implementation), and -10 for no. For other specifications with target values, a 0 would be given for meeting the target exactly, positive values up to 10 would be given for doing better than the target, and negative values up to 10 would be given for not meeting the target. All the results were summed, with a perfect score being a 10 and the worst score possible being -10.

Requirements	Weight	Orientation	Compost Wars	Dining Halls	Big House	Displays in Union	Social Media	Zero Waste Events	Mujo's	Field Day	Advertise in Dining Halls to reduce serving size	Compost bins everywhere	mobile composting
Education	0.5	-0.5	2	2.5	-1.9	0.95	3.75	-0.25	0	-2.75	3.5	4	2.75
% of student population reached (25%)	0.25	0	0	4	-2	4	5	2	0	-9	4	10	7
Info demonstrates what can/cannot be composted (yes/no)	0.05	10	10	10	0	10	10	0	10	10	10	10	10
Demonstrates why composting is important (yes/no)	0.05	10	0	-10	-10	10	10	0	-10	10	10	-10	10
Reinforcement of Info (3 times/week for a year)	0.15	-10	10	10	-6	-7	10	-5	0	-10	10	10	0
Economic Viability	0.25	1.4	-1.35	1.05	0.75	1.35	1.85	1	0.45	1.2	1.7	-1.4	-0.8
Installation Costs (\$5000)	0.15	8	-10	6	4	9	10	7	4	8	9	-10	-7
Ongoing Costs (\$0/year net)	0.05	-1	-2	-2	-4	0	0	-1	-3	-1	0	-3	-2
End of Life Costs (\$100)	0.05	5	5	5	7	0	7	0	0	1	7	5	7
Logistical Feasibility	0.25	0.5	-1.7	-0.7	-1.1	1.65	1.5	0.75	-0.7	0.5	2	-0.6	0
How many collaborators (3)	0.05	0	-4	0	-4	5	10	0	0	0	10	-2	5
Time to plan/rollout (1 month)	0.1	0	-10	-2	-8	8	10	0	-2	0	10	0	-5
Necessary to Train Employees (yes/no)	0.05	10	-10	-10	-10	10	0	10	-10	10	10	-10	0
Frequency of waste retrieval (3 times/week)	0.05	0	0	0	8	2	0	5	0	0	0	0	5
Total		1.4	-1.05	2.85	-2.25	3.95	7.1	1.5	-0.25	-1.05	7.2	2	1.95
Legend	Scaling	-10...0...10	under base est.(-10)...base est.(0)...over base est.(10)										

As can be seen in the table above, our top five ideas were advertising in the dining halls to reduce the amount of food students put on their plates, utilizing social media, placing displays in the Unions, implementing a post-consumer composting program in one of the dining halls, and placing compost bins all over campus.

The displays in the dining halls are beneficial almost across the board. Primarily, they allow us to present high quality information to students on a near daily basis at a low cost. The posters would be no more than \$40 each and if each has different information at different stations, students will be provided with a robust education on composting and food waste, even if they only glance at it. Additionally, it would not take a whole lot of coordination and planning to be implemented. The major drawback with this project, though, is that it does not provide students with the ability to put what they learn about composting into practice.

Utilizing social media will allow us to reach out to a much wider audience. Beyond this, it will also provide access to high quality information about composting in food waste by being able to attach links and post pictures. Social media will also cost essentially nothing to implement since the University already has employees that manage social media accounts, so it would be a matter of just integrating some of these ideas into their posts. The major drawback of social media, though, is the same as with the displays in the dining halls: there is no ability to put what you learn into practice.

Placing displays in the Unions with a handful of compost bins would reach a wider audience than the dining halls. By having compost bins near the displays, it will also allow students as they pass to put what they are seeing into practice. The information would also be high quality, and most students would walk past the displays on a relatively regular basis. The main issue with the displays is that they would be short-term, only being up for a few weeks at most. This may be enough to cause a small culture shift among the student population, but it is unlikely.

Implementing a post-consumer composting program in one of the dining halls would be one of the best ways to allow students to put what they learn into practice. The economic impact of this is a bit higher upon installation than the other projects on the list, but if implemented efficiently, it has the potential to save money given that the tipping fee for Tuthill Farms is cheaper than for the landfill. Money savings are doubtful, though, since it would be too small of an implementation to achieve any economies of scale. It also would not be all too difficult to implement this project given that food scraps are already disposed of in the kitchen, so it is just a matter of placing compost bins both in the kitchen and out in the dining area, training employees, and setting up a contract with Tuthill Farms to drop waste off there.

Finally, placing compost bins all over campus would be another good way to expose students to composting, but lacks education initiatives. This would result in contamination and the effectiveness of the program would be reduced. Signs would indicate what should be composted, but students would still be unaware of why composting is important. This project would cost a bit as well, with training of employees, purchase of bins, and frequent waste retrieval. The logistics around the project are difficult as well, with a whole new retrieval schedule being necessary and multiple truck trips per week to Tuthill Farms being required.

Given these five projects, we believe that a combination of a few of them will result in the most effective project. By combining the signage in the dining halls, social media, and a composting program in the dining halls, we will be able to reach the largest amount of students with the highest quality of information while allowing students to put into practice what they learn. This will be at a higher economic cost, but we believe it is well worth it since it is a larger

step towards a campus-wide implementation. This cost could also be very easily offset by acquiring a grant from the Graham Institute, student government, or the Student Sustainability Initiative.

Alpha Design

This program would involve working with Chef Nelson “Buzz” Cummings at East Quad cafeteria to implement the program. Chef Buzz has developed an atmosphere at East Quad perfect for this type of initiative given his focus on vegetarian, vegan, and organic food options with some of the herbs grown in the community gardens right here on campus. His focus on sustainable food products and the “cult” following he has developed, as described by Keith Soster, will be the perfect combination to allow for a successful implementation [7].

The first aspect that will be addressed in this project is reducing the amount of food waste generated. By hanging info graphics above and around the different stations, we hope to provide students with high quality information about where food scraps go and about the greenhouse gasses (GHGs) emitted through food decomposition in landfills. The signs will push students to put less food on their plates, thereby reducing the amount of waste overall that is generated. An example of this can be seen in the figure below.

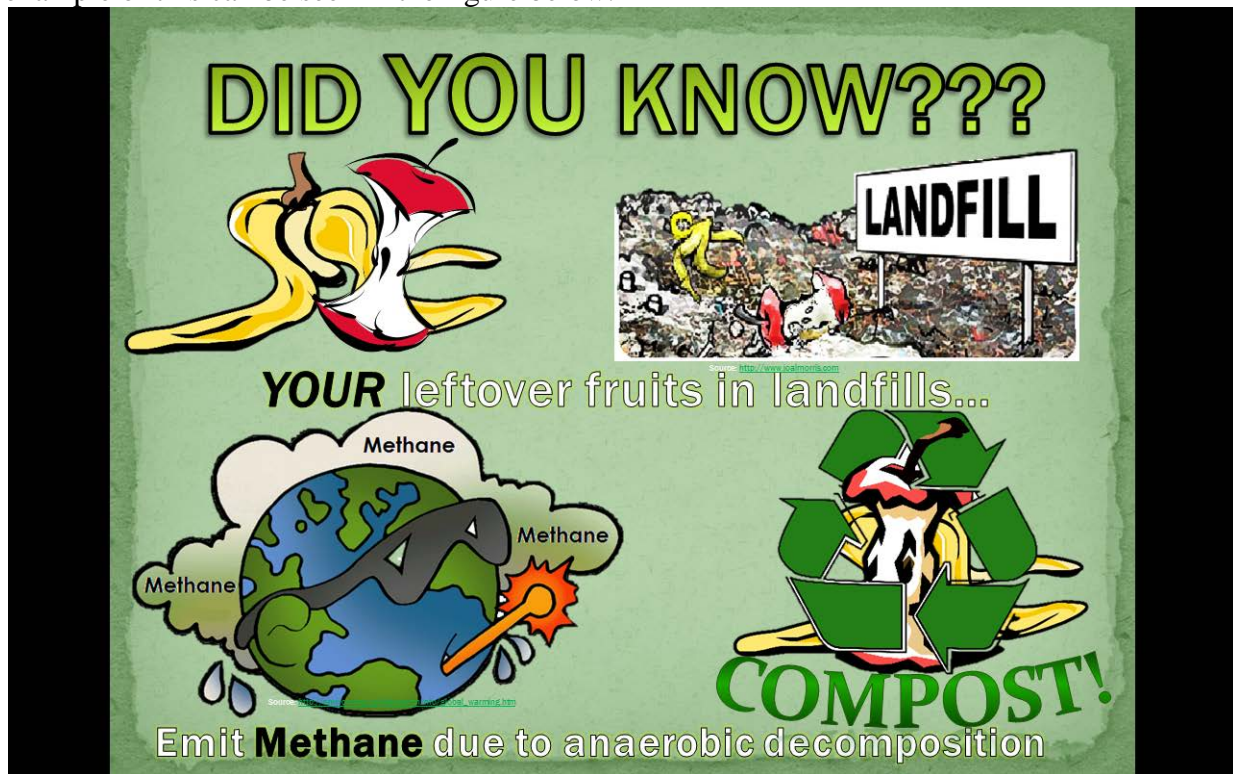


Figure 3 - Sample Poster

Next, we will need to train employees in the kitchen on how to sort the waste left on plates. This should not be all too difficult given that the vast majority of waste coming into the kitchen will be food scraps, but things such as ketchup packets and straws will need to end up in trash bins and not the compost bins. Compost bins are already located in the kitchen as pre-consumer food scraps are collected and sent to WeCare Organics, the city of Ann Arbor’s compost contractor. The problem at present is that WeCare does not seem interested in collecting post-consumer food

waste, so it will most likely be necessary to contract with Tuthill Farms as the Ross School currently does for their post-consumer compost program [2]. This will lead to increased costs as the location is about 18 miles further round-trip than WeCare; though the tipping fees are lower, so the estimated difference in cost could actually be lower depending on the frequency of waste transport.

Next, and most importantly, signage and compost bins will be placed in the dining area to motivate students to compost their food scraps before sending it back into the kitchen. This will reinforce what students read on the signs in the serving area while also teaching students what items can and cannot be composted. Student ambassadors should be in the dining area to help students sort their waste during peak hours and prevent contamination for the first few weeks of implementation. We do not see contamination as being a likely problem, though, since the students not interested in composting will just send their plates back into the kitchen as they normally would, while the students actually interested in making the effort will be more conscious of what goes where.

Once everything in the dining hall has been implemented, we can expect students who use the dining hall to have a much greater awareness of composting and its importance. However, only a small percentage of the student population will actually be exposed to the program at East Quad. Therefore, the final stage of implementation will be a social media effort whereby the University will post useful information and links to composting sites on Twitter, Facebook, Instagram, and other social media outlets. This will enable a much greater portion of the student population to be reached, will inform students of the program at East Quad, and most importantly will allow the dissemination of high quality information.

We feel this will be a large improvement on the current state of composting awareness. As highlighted in the previous composting pilots, the largest obstacle to a successful transition to a full-scale composting program is contamination. There is a very low threshold for the amount of non-compostable materials that may end up in a compost bin before it can no longer be sent to a compost facility. What the pilots found is that many students are completely unaware of what can and cannot be composted, resulting in either the compost being contaminated or a vast majority of the divertible food waste ending up in the trash still. This project will teach students about composting and, if successful, will be an example for implementation at every dining hall on campus. The vast majority of compostable waste that ends up in the trash (roughly 800 tons/year, or almost 50%) comes from the dining halls [2]. The biggest dent the university can make on composting will be in the dining halls, and this project can prove to be the first step in a larger initiative, with an estimated 100 tons/year being diverted from this project alone. This would result in a reduction of 30 metric tons of carbon dioxide emissions per year, the equivalent of taking roughly 5 cars off of the road [2].

Feedback on Alpha Design

We attempted to get feedback on our project from several people and organizations. We reached out to Chef Buzz in East Quad Dining to better understand why the post-consumer composting program they attempted this semester failed, and what input he would have to improve our project proposal based on his experience. We also wanted to get his input on some of the specifics of our project design, such as where we could possibly place compost bins and posters about composting, and whether new employees would need to be hired. We reached out to Keith Soster, the Food Service Director at the University Unions and soon to be director of all dining services, to get feedback about project feasibility and information about project costs,

specifically if there were funds available from Dining Services if grant money could not be secured. We also reached out to the Ross School of Business as it already has a composting program in partnership with Tuthill Farms. We particularly wanted feedback on the structure and success of their partnership, such as how much waste they brought to Tuthill and how frequently. We were also interested in seeing if they would partner with East Quad on their waste routes, since this would shave off significant costs of the project for both sides with decreased fuel expenses as well as a better cost to weight ratio. We contacted the Student Sustainability Initiative in hopes that we could form a partnership if they felt that this project was worthwhile to their goals; we could use their assistance in getting this project started. We met briefly with one of their board members a few weeks back and she had expressed interest in our project. We also reached out to people in dining facilities such as Vicki Ponitz, the Head Manager of East Quad, and Michael Gilbert, the Customer Service Coordinator, to see what the physical limitations of the project might be, including where compost bins may go and whether a training session could be done with employees. We would have liked to survey students in the dining halls about the usefulness of our project, but previous conversations with Vicki Ponitz and Michael Gilbert indicated that we would need to be a registered student group and have to get approval from a couple different authorities, which was too much of a constraint on our team in the time that we had available to us.

Although we attempted to get feedback from these multiple sources, none of the people we contacted returned our inquiries. Even people we had been in direct contact with previously, such as Keith Soster, SSI, and Vicki Ponitz, did not get back to us on follow-up questions. Had SSI gotten back to us, we would have hopefully been able to get feedback from students in the dining hall by working through their group to get permission. We were less surprised at not getting responses from Chef Buzz and Ross given that we had not established contact beforehand, but we would have very much liked to have their input. This was disheartening to say the least, but we felt that given the gaps in our previous design we were able to address at least some of the problems and generate a final concept for the project.

Final Concept Description

The biggest problem we saw in our design was at the crux of the success of our project: the posters. Our team has an understanding of composting, both its importance and its process, but we found that we were not sure how to communicate this information via mass media. Therefore, rather than designing the posters and social media efforts ourselves, we will be enlisting the assistance of students in both marketing and education to develop media that will convey the necessary information in the most effective manner. Another team at the Design Expo from Art and Design developed some nice looking trash, recycle, and compost bins for their project and we hoped to reach out to them for assistance, but were unable to get contact information. It is clear to our team, though, that outside assistance is necessary in this area to ensure that this project is a success.

It was also necessary to set a plan for waste retrieval. We had hoped to piggyback on the Ross School's program, but because they did not respond to our inquiries, we decided that it was necessary to develop an independent plan. The most important issue we wanted to address with the compost was that we did not want a foul odor to be produced as a result of anaerobic digestion occurring in the bin. This requires waste retrieval roughly 3 times a week [2] [9]. Based on our estimates of about 100 tons/year being generated, this would be about half a ton of waste per trip, which is roughly 1 cubic yard of waste. Assuming that diesel gas is running around

\$3/gal on average, the truck earns 5mpg, the driver earns \$15/hr, and tipping fees for half a ton of waste at Tuthill Farms is \$14, this would result in roughly \$40 per trip, or roughly \$7000 for the year. This cost could be significantly reduced by splitting it with Ross, in addition to the fact that the cost by weight decreases with larger loads.

One important aspect of the final design is a training plan for employees. This project can be successful only if we can keep contamination rates low. This means that employees in the kitchens must be trained in which items can and cannot be composted. Given that many of the employees are students who rotate through jobs with relative frequency, we believe that training at the beginning of each semester is the most effective way to ensure proper education. This would be hands on, with workers being provided with different items and asked to sort them into trash, recycle, or compost bins. Given that essentially any food waste, even bones from chicken, are able to be composted at large facilities, the vast majority of what will be coming into the back will be compostable. Therefore, the training should take no more than half an hour, depending on the number of employees that need training. This could easily be piggybacked onto the semesterly training that they already go through. The biggest point to get across to the employees is that if they are unsure if it can or cannot be composted, it is best to be safe and throw it in the trash rather than risk contaminating a batch. We will also have signs hung above the sorting station as a reminder for employees if they ever get confused during the semester. This should work with relative success given the low contamination rates the University has achieved with catering [1].

A summary of our final project description is as follows:

- Promote education and awareness of food waste and composting via social media and visuals in the East Quad dining hall. Posters placed both above food stations and in the dining area. Location chosen for its commitment to sustainability and demonstrated desire to implement post-consumer composting in the dining hall
- Allow students to put into practice what they learn by placing compost bins near where they return their plates and silverware
- Use student ambassadors from an organization such as the Student Sustainability Initiative to help students with sorting their waste during peak hours
- Trained employees in the kitchen will sort whatever waste is not collected in the dining area
- Waste will be stored in compost bin near dumpster and will be retrieved three times per week to minimize odors
- Waste will be brought to Tuthill Farms in South Lyon, MI which is roughly 15 miles north of Ann Arbor
- Assuming a new hourly employee will not need to be hired for sorting, the project will cost roughly \$7000/year (without consulting fees). Cost breakdown is in Appendix V.

Business Plan

Company Description

Project DREAM will result in the formation of an environmental service firm, Green Consulting, working one-on-one with colleges and universities to help promote sustainable practices for the future. Our main focus early on would be education on the merits of composting, but as the company starts to gain traction, we would expand the services that we provide to areas such as alternative energy and public transportation. Our whole focus is in shifting the adoption curve of proven sustainable practices to the left, as shown in Figure 2. Across the nation, there have been over 600 universities that have signed the American College & University Presidents' Climate Commitment. This commitment is made by the President of the university, where they promise to work towards carbon neutrality [16]. There are many other academic institutions that have also made similar commitments independently. One area that many universities do not focus on is waste management, specifically diverting waste away from landfills. Nearly 20% of the United States' methane emissions come from landfills, which is a major contributor to climate change [13]. By focusing on waste diversion through composting, we would help these Universities divert more of their waste from landfills, helping them step closer to a carbon neutral existence. We would do this by reaching out to the waste management professionals at nearby institutions, providing them with a meaningful, personalized proposal that would give them all the information needed to establish a program to inform their students/faculty/staff on composting and food waste, while at the same time providing the users the opportunity to put their education into practice. This will educate the next generation of professionals, resulting in a shorter lead time for the adoption curve and a better environment. As a consulting firm, we also plan to utilize resources provided by the universities we partner with in the form of internship experience for students in marketing, education, environmental policy, and more, decreasing costs on our end while also improving relationships with the schools we partner with.

Market Analysis

As a starting point, we would be looking at any college or university that does not have an established composting policy, but has made an official commitment to head towards carbon neutrality. Since composting has been used for many years in other locations, there is a great deal of information available, and a few institutions have already established a comprehensive composting policy which we can use as a guide when developing proposals for different sized institutions. As a starting point, we would focus on institutions within a small radius of Ann Arbor, to help keep travel expenses low. Over time as our company expands, we hope to reach out to institutions across the United States. The market will continue to grow as more institutions recognize the need to combat climate change, which is an advantage for our company.

Currently there are several other sustainability consultancy firms, but their focuses are different from what we propose. The most comparable existing company is the Association for the Advancement of Sustainability in Higher Education (AASHE), which offers a wealth of information to member institutions. The current rate for membership for an institution the size of Michigan is under \$2000. Their current membership is over 1000 members strong, but there is still room for many more institutions, as well as another business to compete with AASHE [17]. There are several other competitors also, such as Resource Recycling Systems (RRS) and SustainAbility, which have an advantage over our company because of existing reputation and experience. However, their focus is much more on the implementation of sustainable

technologies and not on education. They reach out to institutions which are already further to the right on the adoption curve, whereas we are looking to fundamentally shift the adoption curve. Another big competitor is the status quo; many schools are looking to perform this work internally. This of course is cheaper for the school, and our only hope for competing with this area is by working with schools that either are not working on composting, or have worked on it in the past with no success.

Green Consulting would have an advantage over AASHE because the main goal of AASHE is to spread knowledge about sustainable practices through conferences and existing reports, while our business would go a step further and help the institution establish programs that integrate education with practice. We would use our expertise to develop personalized proposals, rather than the institution having to develop their own plans. To be a competitive business, we need to have a comparable price to the existing businesses, and most likely actually have a lower cost because we do not have an existing reputation of quality or value. To be competitive with firms like RRS and SustainAbility, we need to demonstrate our expertise while achieving a low cost. We hope to do this by using our current professional network in Ann Arbor to penetrate the local market and build our portfolio. Then we can expand regionally and eventually grow to be a larger organization. We anticipate that our consulting rate will be in the range \$80/hour, which is well below the price that RRS charged the University of Michigan for the feasibility study they performed [2]. Our main barrier to penetrating this market is inexperience; we have to hope that our current professional network trusts in our ability enough to get us off the ground, after which we believe we can develop a sustaining business.

Product Description

“As a collegiate waste management professional, I am seeking a project that can demonstrate the viability of a composting program. Our campus has established a need to divert waste through our commitment to decreasing our campus’ carbon footprint. However, we seek a feasible and cost-effective program. After observing previous projects both at our own institution and others, we do not see composting as being viable due to the high contamination rates, which would lead to economic losses unjustifiable for campus wide implementation. What our campus requires is a program that would help shift the adoption curve for composting to the left, decreasing the lead time necessary to adopt this sustainable practice. The service provided by Green Consulting would be useful for our campus because it would educate students about the need to divert waste through composting, it would be economically feasible, and it would provide logistical support in setting up partnerships with local composting facilities. Due to the small-scale nature of their proposals, Green Consulting is significantly cheaper than other proposals we have received from similar consulting firms. Their ‘baby steps first’ approach fits our campus’ need better than full-scale implementation.”

The service that we are providing is a dynamic one which caters to each prospective university, it would not be a “cookie cutter” service provided to each university. The factors that would play a role in pricing would be a base fee, and then additional fees based on the size of the university and program. Next, is the composting pick-up and storage, where we would partner with the closest local composting company; the distance from the university to the composting facility would largely define the cost of implementation for the composting program. The demographics play a key role in this pricing as well; northern schools would potentially need in-vessel composting, due to freezing temperatures, but fewer pickups, while the southern schools have more options for composting but would need more pickups due to the heat. Each campus will also have different locations that would be ideal for implementing a program, whether it be

in the dining areas or in the classroom. By changing these factors for each university, we will be able to meet each of our intended consumer needs, in addition to providing pricing advantage over our competition and the status quo. This project and business plan is currently in the idea phase; after verbal verification from waste management, it may transition into a prototyping phase at the East Quad. Because of the nature of this company, though, most projects will remain in the idea phase until the company is hired and able to do greater ethnographic research on the campus to determine key areas and stakeholders.

Marketing and Sales Strategy

Green Consulting will be first targeting the University of Michigan due to its commitment to sustainability and its early adoption of pre-consumer composting, making it a place receptive to the adoption of this type of project. Additionally, Green Consulting's employees are alumni of the University of Michigan and plan to take advantage of the networking they performed while at the school. After implementing a successful project at the University of Michigan, the company plans to expand to additional schools seeking consultation on how to improve education and awareness of food waste and composting on their campuses. We plan to do so regionally at first, possibly working with schools like Eastern Michigan University, which would allow us to maintain contacts with stakeholders like Tuthill Farms.

The company income at first will be relatively low. It will be necessary to initially invest some of our personal savings or secure funding from venture capitalists to allow the company to get off the ground. Most income will be through hourly wages for consulting, which cannot be too high if we expect to be hired. Hopefully, though, as we begin to expand and work for multiple schools at the same time, we will generate more income. Overall, we suspect that most projects will cost in the range of \$10,000, with an additional \$5,000 to \$10,000 to cover overhead and hourly wages for employees, depending on the complexity and duration of the project. A breakdown of costs can be seen in Appendix V.

We plan to reach our customers through targeted communication. This will include sending informational packets and brochures to waste management professionals at various institutions, and advertising at professional events such as the AASHE Annual Conference. Because the niche market is so small, the company will have to largely rely on word of mouth to get our name out into the marketplace. This will follow naturally from implementing successful projects, so it is imperative that our first few projects do very well.

The company will be prepared to grow once these first projects are completed. The plan is that after implementing education projects related to composting and food waste, that team would move on to another location and perform a similar project while a new team to promote education initiatives on public transit, alternative energy, or water reuse would move in. This would result in the company expanding not only to other clients but also into new areas with the same clients, improving our existing business relationships while making new ones. This "laddering" approach would result in relatively rapid growth over the first couple of years, and then would most likely plateau as we begin to pull out of older business partnerships at the same rate that we take on new ones. At this point, we may decide to change our business model slightly and shift more towards providing technical services like RRS does because at this time we will have hopefully shifted the adoption curve to the left enough that rapid expansion of services will be necessary, not education.

Initial Funds and Breakeven Forecast

The initial intent is to be a nonprofit consulting firm; this decision was made based on the type of impact that we wish to make. We are looking to just cover living expenses for our employees, no more. For the start-up of our firm we would need funds to pay for a website, legal fees to register our business, advertising fees, printing fees, and our living expenses. For the website there would be annual estimated costs for the domain name at \$10, hosting at \$50, maintenance of at least \$500 and online marketing of at least \$750 a month. Concerning the legal fees to register our business, the protocol for a nonprofit company includes filing a certificate of incorporation, then filing for federal tax exemption. For the tax exemption we will need a lawyer so we can contact a public interest legal organization that connects nonprofit organizations with volunteer business lawyers, therefore there is no legal expense. The advertising and marketing fees would include our website and social media, in addition to possible vehicle magnets (\$40/each) for employee vehicles, and brochures (\$1.30/each) which we would send to other collegiate waste management professionals. Lastly, the living expenses fees of the founders would be a factor for the first year or two before there would be enough income to generate a more permanent salary. We hope to make \$40,000/year for each of our four employees.

The revenue to fund our firm will come from a mixture of grants for environmental groups and entrepreneur startup foundations, local support advertised through monthly mailers, the services that we provide, and loans to cover the difference. The decision to combine sources for funding is to make sure that we constantly have income in case grants are nonrenewable. For the company to be successful, we would need to have at least one project operating at all times. Considering that most projects will only last one to two months, our company will have to spend the first couple of years developing very successful projects to build our reputation and then expand to multiple schools in the region.

After the first three years, the best case scenario is that we would have expanded to at least a handful of other universities and are self-sustaining. This is the best case scenario because we will be well on our way to developing into a large business. After three years the worst case scenario would be the bankruptcy of the firm, where we would wind up in the negative, with the most likely consequence being that our employees are not paid their salaries and we default on our loans. This would most likely occur if the company fails to penetrate the market beyond the University of Michigan. We cannot expect the University to continue paying our salary to implement new projects well into the future because the nature of our business model is to be in and out, not to linger more than a year or two.

Given that our annual operating costs are a little less than \$200,000, as seen in Appendix V, we would like to secure loans totaling in the range of \$500,000. This would allow us to cover our expenses for a little over two years while we look to grow. Assuming we are able to expand to multiple schools and operate two projects at a time for roughly a month each, we would be looking at revenue in the range of \$300,000/year. The first year would most likely yield revenues of around \$100,000, with increases each year after that. This would yield a payback period of around 5 to 6 years. To be safe, it would most likely be best to take out a 10 year loan. Hopefully we are able to secure grant money, resulting in a reduced loan total.

Additional Reflections on Project Outcome

Why is this design sustainable?

We feel that our project is definitely consistent with sustainable design. We are making a clear, though small, impact on the carbon footprint of the University of Michigan by helping to reduce the methane it emits through landfilling. Additionally, the implementation of this project does not consume any more resources than the University already does, so if the project were to be discontinued, end of life impacts would be negligible. But the greater focus of this project is on the economic and social side of sustainability. Composting, if scaled up, will be significantly cheaper for the university than taking waste to the landfill as they currently do. The difference in tipping fees is substantial, and the increased driving distance only slightly decreases the improved cost savings. Not only this, but the compost that is generated can be used by Grounds Services in place of the top soil that they currently purchase. There is a precedent of universities successfully setting up partnerships with composting facilities, and it is likely that Tuthill Farms would be open to a similar arrangement to what Clark University and We Care currently have. Most importantly, we are educating the campus population on sustainable practices, forcing the adoption curve to the left and improving society's ability to act in environmentally friendly ways. By developing environmentally conscious individuals, we are creating momentum on campus to pursue further eco-friendly technologies.

The potential for unintended consequences is moderate. For instance, we would like to divert waste from landfills and thus reduce the strain that these sites cause on the environment from greenhouse gas emissions such as methane. However if this project is very successful it runs the risk of increasing landfill tipping fees as landfill owners attempt to make up the money they lose from food waste not coming to their sites. With 17% of waste to landfills being compostable food-waste, our service could put a large dent in landfill revenue [13]. This would impact the residents of Ann Arbor as well as the University. Another unintended consequence would be from our education initiative not being very effective. If our awareness campaign on what can and cannot be composted is overlooked, we could see high rates of contamination in the compost bins. High contamination rates would lead to higher economic costs as we would need to hire and train workers to sort the compost after it is put into the compost bins, or run the risk of having our waste rejected by Tuthill Farms, increasing the economic burden due to transportation as well as having to pay tipping fees at the landfill.

Design Critique

After reviewing our performance over the past semester, there are many things we would have done differently. Looking at the beginning stages of our project, and knowing we would need to have a project that could potentially lead to a business, we all agree that choosing a product rather than a service would have been a better option. We know composting is an important strategy to reduce landfill waste, but we feel that with our list of talents, we should have focused on a product, rather than a service. None of the team members has any experience with trying to design a service, so we were stuck spending a large portion of our time figuring out the best way to do so.

Overall, our project has very few strengths, but in comparison to some of the other projects, we have the benefit of a fairly easy implementation. Since we are providing a service, we do not have to worry about any manufacturing processes, which are typically very time consuming and relatively costly. Our project is better than the baseline because we are diverting more waste from the landfill, reducing the University's carbon footprint. Beyond this, the project

is relatively simplistic and cost effective, so it is likely that the University would adopt this project if we can generate a stronger proposal.

Looking at the weaknesses of our project, there are many. The biggest problem is that there are already many organizations that exist that do what we are proposing. This is a problem because these other companies are better informed and have an existing network of potentially happy customers. The only real difference we were providing was a change in focus towards education instead of implementation of practices. Another weakness of our project is the fact that none of us were very knowledgeable on composting before starting this project. We ended up spending a significant amount of time researching the general practices of composting, while if we chose a subject that at least one of us was familiar with, we could have jumped right into the more detailed ethnographic research. Our ethnographic research, then, was severely lacking. We should have spoken to people in marketing, art and design, and education a long time ago to help develop poster ideas; we should have met with Chef Buzz in person to discuss the failure of their recent post-consumer composting program; and, among other things, we should have maintained contact with Keith Soster and Vicky Ponitz even though we were unsure of the direction of our project. Building off of this, we also received essentially zero feedback from stakeholders. This was partially bad luck and partially maintaining poor channels of communication throughout the semester, as stated before. Our team was often bouncing all over the place with different ideas, so we would speak to one person about an idea and then turn a different direction. But if we came back to that idea, it would have been well after the last time we spoke to that stakeholder. What we should have done was maintained contact with the different stakeholders, even if we did not expect them to be one of the final stakeholders. Finally, our design is simplistic. We really did not do a deep enough dive into this project, and this is mainly due to poor planning in the project selection. We ran into a number of dead ends at the beginning of the semester, and composting was the only viable avenue that came out of our very rough needsfinding. As discussed, we had no experience in this area and wasted a lot of time going down paths that were irrelevant. But poor planning was not the only issue; group morale dropped as dead end after dead end was encountered, resulting in some lackluster results even when we went down a useful path.

Project DREAM is a decent starting point for a campus wide composting policy. If we were able to meet with the necessary people, we could have progressed significantly and potentially put in motion an actual implementation for next semester. Green Consulting as a company, though, would be doomed to fail from the beginning. The service that Project DREAM provides would best be done by an already established company or, even better, by the University itself. An organization like AASHE would probably be best to disseminate the necessary information to universities to get composting programs off the ground.

Recommendations

To launch this service, the following recommendations are suggested; securing funds, finding other majors to participate, composting site coordination, and handing off our information. For securing funds on campus, there are at least two different grant options on campus, the first being from the Student Sustainability Initiative which provides grants for student eco-friendly projects and the second being from the Graham Institute. As mentioned earlier, we also would like to secure input from students in other departments to improve our program. The education majors would know the best and most effective techniques for distributing information, the business majors would know the ins and outs of product development, business proposals, and marketing strategies, while the visual arts majors will

make our visual aids, such as posters and informational displays aesthetically appealing and audience captivating. We would also need to coordinate with Tuthill Farms to discuss the frequency of waste drop-off and whether bulk rates may be available to us to reduce costs.

The most important thing that must be done is to get feedback from our stakeholders, mainly Keith Soster, Chef Buzz, and Vicki Ponitz. They are the ones who are going to give the project the final go-ahead, so making sure that we have covered all the bases that they would need from this project is important. From there, we would hopefully be able to hand off the project to the Student Sustainability Initiative and Dining Services. There is still a lot of logistical work to be done before the project could start, but that work should only be performed once the green light is given. This includes the training of employees, coordination with Plant Operations on waste pickup, final decisions on sign design and placement of bins, and the development of social media accounts to disseminate information.

Project Reflections

Alan - I feel like this class was helpful in understanding how to design in a more sustainable fashion. Our project was not very helpful in reinforcing the information we learned in class though, I feel like the class would have been even more helpful if our project idea was a physical product, rather than a nebulous policy. Having said that, I agree that there should be a pre-requisite class to allow everyone to be more informed generically, allowing more time to dive deeper into the more sustainably minded design processes. I would also try to steer the students away from pursuing projects that aren't policy driven, and this is just because our group chose a policy design, and we have been struggling with getting a hold of the necessary people. I feel like our group was kind of the odd ball out in the fact that we never really had any ideas that all of us liked, and since we were taking so long to find a need, we were kind of forced to do the first project that was available to us. I think if there are other groups in the future like ours, it would be quite beneficial to help steer the students toward a sustainable or eco-efficient idea.

Andrea- I have taken about two to three engineering design classes prior to this course, the one major and most defining factor that the others did not include was the emphasis on needs finding. I do feel like I do have a better understanding of sustainable and integrative designs after taking this course. My favorite portions of this course were the beginning where we viewed the videos of how people were affected internationally with various diseases, environmental injustice, etc. For the project I would recommend that engineers start with what they know, product development. This project seemed harder because we did not have any prior experience with the initial topic of waste management which then transitioned to a more distant topic of policy development. Overall this was a good course and a prerequisite would be helpful in the culmination of better development.

Kevin – I felt that the most important thing I learned from this course was needsfinding. I had never looked at design from that perspective, and it took an adjustment for me to be able to utilize it. I do feel that I understand sustainable design better after taking this course, largely due to needsfinding, but I do feel the structure of the course did not line up well with the project. Timing of assignments did not seem to line up with where we should have been in the design process at that point. For instance, design review #2 was due almost at the end of the semester, yet the main focus of design review #2 was generating concepts and choosing the best idea. This is without doubt an important process, but I feel that having to select so late in the semester resulted in either the process being contrived to fit what your team had already selected or not

leaving enough time to develop a strong final product. The course also felt almost too open ended; I feel that some teams struggled with finding a need early on (ours included), and having examples of past projects will help students have a better understanding of where they should be going and what is expected. I think that having ME499 will absolutely be beneficial because it will help shift the course timing back a bit and leave more room for iterative design at the end of the course.

Ima- I thought that this course was a great introduction to design. I am in the School of Natural Resources and Environment for my Master's and before that my undergrad was in Wildlife Biology. I had not taken any engineering courses prior to this, so I was a bit worried about the course load and what would be required of us. However, I felt that the principles that we went over for the semester were ones that crossed multiple disciplines. I actually had some experience with some topics such as Life Cycle Analysis and Dimensions of Sustainability, so I'm glad that I was able to call upon prior experience. I did think that needs-finding was an important skill –though it was a concept that our group had trouble with as the process was somewhat unclear in the beginning of the project. Although the concept was discussed in detail, emphasizing the importance of needs-finding as well as ensuring groups focus their concepts on all of the dimensions of sustainable design may produce great eco-efficient and sustainably-designed projects. Having ME 499 as a recommend course would be great, but I don't think that this course needs it as a pre-requisite as it may block students from related disciplines such as SNRE from taking the course.

Acknowledgements

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Appendix I – Team Biographies



Kevin Fries is a recent graduate of the University of Maryland, College Park in Civil and Environmental Engineering. While at UMD, he received a minor in Project Management and was heavily involved in the school's chapter of Engineers Without Borders. His work with EWB enabled him to travel to Brazil with a team in 2011 to install a potable/non-potable water system that utilized graywater reuse and rainwater catchment to ensure a sustainable system for the island's school. He served as President of the chapter his senior year, leading the chapter to earn the Premier Chapter Award for the Southeast Region. His work with EWB motivated him to pursue a career in international development, with a focus on developing sustainable water resource systems through the use of intelligent water grids and real-time monitoring of hydrologic systems. His research here at Michigan will be focusing on a similar area relative to the Great Lakes. Kevin's interest in sustainability is related to social and economic impacts of projects in relation to the developing world, especially in areas with limited resources. This project is of interest to Kevin because it has major social and economic aspects in addition to being an environmental issue. He hopes to bring his skills in project management and globally minded thinking to ensure a successful project.



Alan Booth is a graduate from Beloit College, where he studied Physics and obtained a minor in computational visualization and modeling. Alan has had a long and far reaching interest in the automotive industry, and will be getting a masters degree in Automotive Engineering from Michigan. He believes that the world needs more sustainably designed products, and with a strong sustainability factor to his degree, is hoping to help convert the automotive industry into a cutting edge field for sustainability. This project fits in with Alan's outlook because it is a potentially drastic change to the University's waste stream.



Andrea Collier is a May 2012 graduate of North Carolina Agricultural and Technical State University, receiving her Bachelors of Science in Mechanical Engineering. Having an interest for Robotics and spacecraft since a young age she decided to pursue her Masters of Engineering in Robotics and Autonomous Vehicles here at the University of Michigan. Being that these mechanisms long term environmental effects could use the planets resources at an increasingly exponential rate. Therefore, the knowledge gained in this course will aid in the production of more sustainable mechanisms in robotics and vehicles.



Ima Otudor received her undergraduate degree in 2011 in Wildlife Biology. She interned at the University of Massachusetts, Amherst for a year in a microbiology lab under the guidance of Dr. Susan Leschine where she worked on projects dealing with soil bacteria and their potential to degrade non-food source plant matter into ethanol and other by-products. She arrived at the University of Michigan in 2012 as a student in the School of Natural Resources and Environment where her concentrations are Sustainable Systems and Environmental Justice. Her current Master's project research deals with sustainable practices in urban farms and community gardens, barriers to those practices, and ways partnerships in nearby communities can benefit such organizations. This design project fits in with Ima's interests because she wants to address recycling, upcycling, and repurposing post-consumer waste materials and composting is just another side to waste management.

Appendix II - Team Member Prep

Team-Member Information for Alan Booth

Class: ME 589

Team Name:

Date: 10/7/2013

Contact information (<i>e-mail, cell, Facebook, etc.</i>).	acbooth@umich.edu (517) 416-6955 - cell
Preferred contact method and limitations (<i>ex., no calls after...</i>).	email or cell, don't call between midnight and 8am
Availability for meetings (<i>days, times</i>).	M W 9am - 3pm, 6pm - 10pm T R 9am - 10am, 12pm - 10pm F 9am - 12pm, 4pm - 10pm
Preferred meeting times and places.	Any time listed above, willing to meet anywhere.
Preferred work styles relating to teamwork.	Collaboration is good, individual goals that are compiled together before submission.
Strengths related to teamwork.	Good at listening to others
Strengths related to the team's task.	I can research...
Weaknesses related to teamwork.	I've been out of the academic setting for a long while, so getting back in the loop for collaboration might be slow.
Weaknesses related to the team's task.	I have no prior experience with waste/recycling other than a blind participant.
Personal Background (<i>whatever you want to share, such as major, interests, personality characteristics</i>).	New masters student in Automotive engineering, Physics undergrad.
List anything else that you want your teammates to know.	

Team-Member Information for Kevin Fries

Class: ME589

Team Name:

Date: 10/8/13

Contact information (<i>e-mail, cell, Facebook, etc.</i>).	email: kjfries@umich.edu cell: 301-758-0967
Preferred contact method and limitations (<i>ex., no calls after...</i>).	email/text
Availability for meetings (<i>days, times</i>).	Monday evenings, Tuesday mornings and evenings, Wednesday evenings, Thursday mornings, Friday evenings
Preferred meeting times and places.	Anywhere on north campus, anytime I'm not in class
Preferred work styles relating to teamwork.	everybody gets done what they say they will get done, everybody stays on the same page, I'll pull whatever excess weight is needed, but not too much
Strengths related to teamwork.	will take on a leadership role if necessary, diligent
Strengths related to the team's task.	experience with linear programming, optimization, and project management
Weaknesses related to teamwork.	have a tendency to not air grievances when I should, lack of communication at times
Weaknesses related to the team's task.	not a whole lot of prior experience/knowledge regarding waste management
Personal Background (<i>whatever you want to share, such as major, interests, personality characteristics</i>).	working towards a Master's/PhD in Civil Engineering with a focus on infrastructure systems with water security applications, laid back personality
List anything else that you want your teammates to know.	I have high expectations for myself, which translates into high expectations for teammates normally

**Team-Member Information for
Andrea Collier**

Class: ME 589

Team Name:

Date: 10/10/13

Contact information (e-mail, cell, Facebook, etc.).	email: amcollie@umich.edu ; Cell: 215-360-6192
Preferred contact method and limitations (ex., no calls after...).	email/text
Availability for meetings (days, times).	M/W after 4pm. T/Th 1-3 pm, after class-until Fridays after 6pm. Weekends.
Preferred meeting times and places.	Weekdays; North Campus
Preferred work styles relating to teamwork.	Goal Setting (divide and conquer), then a collaboration of final ideas. Everybody pulls their weight and try to keep everyone else on schedule.
Strengths related to teamwork.	Can and will take direction well from an adequate leader.
Strengths related to the team's task.	Versatility.
Weaknesses related to teamwork.	A lot of the time I am a loner, so communication may lack a little.
Weaknesses related to the team's task.	No sufficient background/knowledge in waste management.
Personal Background (whatever you want to share, such as major, interests, personality characteristics).	Working towards M.E in Robotics and Autonomous Vehicles, background B.S.Mechanical Engineering. Open-minded to practical ideas and pretty laid back.
List anything else that you want your teammates to know.	If possible I do not want to waste time if the project is not even close to completion.

**Team-Member Information for
Ima Otudor**

Class: ME 589

Team Name:

Date:10/10/2013

Contact information <i>(e-mail, cell, Facebook, etc.)</i> .	Cell: 404-276-8662, iotudor@umich.edu
Preferred contact method and limitations (<i>ex., no calls after...</i>).	email or text
Availability for meetings (<i>days, times</i>).	Mon/Weds: after 5pm Tues/Thurs: after 4:30 Fri: 9-1 or after 6pm
Preferred meeting times and places.	North or central campus
Preferred work styles relating to teamwork.	Collaboration and bouncing ideas off of each other.
Strengths related to teamwork.	Open to exploring many ideas, can do good write-ups.
Strengths related to the team's task.	Unsure
Weaknesses related to teamwork.	Ideas may be too broad.
Weaknesses related to the team's task.	Unsure
Personal Background (<i>whatever you want to share, such as major, interests, personality characteristics</i>).	2nd year at SNRE with a focus on Sustainable Systems and Environmental Justice. My interests include upcycling, recycling, and repurposing post-consumer materials.
List anything else that you want your teammates to know.	

Appendix III - Team Charter



Team Charter for

Team 3

<u>Team Member Names</u>	<u>Contact Information (e-mail, cell, Facebook, etc.)</u>	<u>Preferred Contact Method / Limitations (ex. no calls after...)</u>
	Email: iotudor@umich.edu Cell: 404-276-8662	Email/text
	Email: kjfries@umich.edu Cell: 301-758-0967	Email/text
	Email: acbooth@umich.edu Cell: 517-416-6955	Email/text
	Email: amcollie@umich.edu Cell: 215-360-6192	Email/text
Member 5	Contact 5	Pref 5
	Contact 6	Pref 6

<u>Team Member Names</u>	<u>Strengths related to teamwork and the team's assigned task.</u>	<u>Weaknesses related to teamwork and the team's assigned task.</u>
	Ready to think outside the box	Procrastination
	Project Management and Optimization	Communication
	Real-world mindset	Knowledge of composting
	Versatile	Communication
Member 5	Strength 5	Weakness 5
Member 6	Strength 6	Weakness 6

1. What are your team's goals for the collaboration?

Our team's goal is to make sure that work is done when it says it will be done. If we set reasonable deadlines for ourselves and dedicate to getting the work done by that deadline, then the quality will follow. Further, we will set deadlines 2 or 3 days in advance when dealing with bigger milestones (such as design reviews) to ensure that we 1) give ourselves some float time and 2) have time to edit

2. Who is responsible for each activity? What roles will each member have?

Kevin will take on the role of project manager. He has a minor in this from his undergrad and understands how to perform scheduling, cost accounting, and optimization via linear programming.

Andrea will take on the role of secretary at meetings. She will take notes on the major developments from the meeting as well as list the tasks to be completed by the next meeting. After each meeting she will send a summary of this to the other team members.

Ima will take on the role of dedicated researcher and logistical planner.

Alan will act as the liaison between the group and several of the other companies/organizations.

3. What is your timetable for activities?

See Figure in report.

4. What are your team's expectations regarding meeting attendance (being on time, leaving early, missing meetings, etc.)?

Team members are expected to show up to meetings on time and leave when the meeting is completed (however long this takes). If a team member knows they will be late or have to leave early, it is asked that notice be given. This cannot become a habit, though, or item 9 will be invoked.

5. What constitutes an acceptable excuse for missing a meeting or a deadline? What types of excuses will not be considered acceptable?

The first acceptable excuse is illness. This does not mean a cold; it means being contagious and a threat to the health of the other team members. The second acceptable excuse would be an emergency such as a trip to the hospital, death in the family, etc. Beyond this there should be no excuse for not attending a meeting or getting work done. As long as we are setting reasonable deadlines/tasks for ourselves, this should not be an issue.

6. What process will team members follow if they have an emergency and cannot attend a team meeting or complete their individual work promised to the team (deliverable)?

This hopefully will not occur, but in the event of an emergency we ask the person to send any work they have completed to the team and the rest of the team will pick up the slack. If this is not a possibility, then the team will make do. Assuming we are maintaining good channels of communication, this shouldn't result in a huge problem.

7. What are your team's expectations regarding the quality of team members' preparation for team meetings and the quality of the deliverables that members bring to the team?

This is graduate school; we expect a high quality of preparation and deliverables. This should not be difficult to achieve, though, if we are reasonable with our deadlines and tasks. For example, if someone is aware they have an exam Monday and we have a meeting Sunday afternoon, that team member should be letting us know at our Thursday afternoon meeting that their task for Sunday cannot be too heavy since they need time to study. As long as we are staying on track and maintaining communication, we should be successful.

8. What are your team's expectations regarding team members' ideas, interactions with the team, cooperation, attitudes, and anything else regarding team-member contributions?

If people have ideas, throw them out there. It is important that we have as many ideas as possible; even "stupid" ones can trigger a great idea in another team member's head. It is also important to debate ideas in a civil manner. No idea will be perfect, so we must be able to talk about the benefits and detriments of each. Whatever ideas we do have, though, should be grounded in facts and should be able to be evaluated through reasonable means.

9. What methods will be used to keep the team on track?

We all like beer, so any members that do not pull their weight will be buying a round of beer for the other team members. The reward of doing well will be in having more free time to do other things instead of picking up slack on this project.

Appendix IV: Concept Generation and Selection

Big House Study

Focusing on diverting waste from the landfill, and thinking of how other schools have achieved higher diversion rates, a study was found, with the help of Professor Skerlos, about the life cycle impact of converting the drinking cups used at the University of Michigan Stadium from a souvenir high density polyethylene cup to a compostable cup made from polylactic acid. This study was done in 2002, and the conclusions are typical of an LCA - it depends. When this was done, there wasn't a lot of information for the precursor to the PLA cups, so the study wasn't complete, but from their results, switching to the PLA cups would help promote a cleaner environment. The study estimated that 64,000 cups were used each year, and by replacing the heavier HDPE cups with PLA cups would help prevent 1500 grams of carbon from entering the atmosphere for the entire life cycle of each cup. This simple change could make a significant impact on the waste stream from Michigan Football games[big house study].

Performance of Specifications:

- Percent of Student Population Reached: roughly 20% of students hold season tickets (-2)
- Demonstration of what can/cannot be composted: depends on the implementation (0)
- Demonstration of the importance of composting: no (-10)
- Reinforcement of Info: 7 times a year (-6)
- Installation Costs: Roughly \$1000 for bins, about \$3000 total (4)
- Ongoing Costs: Cups, transport to composting facility, roughly \$1000 (-4)
- End of Life Costs: nothing (7)
- # of collaborators: athletics, waste management, composting facility, food services (-4)
- Time to plan/rollout: >2 months (-8)
- Necessary to Train Employees: yes (-10)
- Frequency of waste retrieval: once a week (8)

Orientation

Every incoming freshman student has to attend orientation. There they will introduce you to the campus and tell you about some of the unique things our students do on campus. This would be a perfect venue to have a demonstration on food waste and composting. Taking half an hour to an hour out of the orientation to teach students about the impacts of food decomposition in landfills will hopefully convince students to take smaller portions at the dining halls. It would also be possible to do a waste sort with the students to demonstrate which items are recyclable or compostable and which items must be thrown away. This would result in some diverted waste from landfills, but not a whole lot. The economic impact would not be very large, with the largest cost being paying the employees most likely. Planning the event would not take all that much effort either since it would most likely just be a PowerPoint presentation and a waste sort if the venue was suitable.

Performance of Specifications:

- % of student population reached: 25% (0)

- Demonstration of what can/cannot be composted: yes (10)
- Demonstration of the importance of composting: yes (10)
- Reinforcement of Info: none (-10)
- Installation Costs: Only paying hourly wages for preparation (8)
- Ongoing Costs: hourly wages for presentation (-1)
- End of Life Costs: nothing (5)
- # of collaborators: waste management, orientation office, student group (0)
- Time to plan/rollout: roughly 1 month (0)
- Necessary to Train Employees: no (10)
- Frequency of waste retrieval: not applicable (0)

Compost Wars

Compost Wars would be a competition between residence halls to divert the most waste from landfills. Weigh stations would have to be set up either in each residence hall or outside near the dumpsters where students could bring their compostable waste. The amount of waste would be tracked throughout the semester and the winning hall would earn a prize such as a BBQ for their residents. This project would have a bit of logistical complexity, but with proper planning, it would be very successful in diverting waste while teaching students about which items can and cannot be composted. Resident Assistants would have to promote the event in their halls and janitorial staff would have to be trained to make sure the waste is disposed of properly. The University would also have to contract out with either WeCare Organics or Tuthill Farms to have the post-consumer waste composted properly. This project would incur significant economic costs with the necessity for over a dozen new dumpsters, training and potentially hiring of janitorial staff, and addition of trash routes. Performance of Specifications:

- % of student population reached: 25% (0)
- Demonstration of what can/cannot be composted: yes (10)
- Demonstration of the importance of composting: depends on implementation (0)
- Reinforcement of Info: 7 days/week (10)
- Installation Costs: \$1000 per dumpster, weigh station costs, >\$15000 total (-10)
- Ongoing Costs: tipping fees and gas for transport, offset by lower cost (-2)
- End of Life Costs: nothing, most items can be repurposed or resold to offset breakdown costs (5)
- # of collaborators: waste management, housing office, composting facility, residence hall association (-4)
- Time to plan/rollout: >3 months (-10)

- Necessary to Train Employees: yes (-10)
- Frequency of waste retrieval: 3 times/week (0)

Dining Hall Program

It would not be all too difficult to implement a post-consumer food waste composting program in one or more of the dining halls. Most of the dining halls on campus already collect pre-consumer food waste and scrape plates in the kitchen. Instead of throwing the food scraps in the trash, it would be very simple to have these food scraps go into the very same bins that are used for pre-consumer waste. In addition, compost bins could be placed in the dining areas to allow for students to make the conscious choice to compost the food waste on their own if they so choose. This would teach students what can and cannot be composted and reinforce that education through practice. Students not interested in doing so would just dispose of their plates as they normally would, meaning contamination will very likely not be an issue. This would be able to be implemented without too much cost; the purchase of a few bins and training of employees would really be all it takes. A new contract with WeCare or Tuthill Farms may also be necessary since post-consumer waste will be added to the waste stream they are collecting. This program, even implemented at just one dining hall, would also make a severe dent in the University's waste stream that goes to landfill's since dining halls make up a large portion of the compostable waste Michigan produces.

Performance of Specifications:

- % of student population reached: 40% (4)
- Demonstration of what can/cannot be composted: yes (10)
- Demonstration of the importance of composting: no (-10)
- Reinforcement of Info: 7 days/week (10)
- Installation Costs: training of staff, purchase of new bin/dumpster, \$2000 total (6)
- Ongoing Costs: tipping fees and gas for transport, offset by lower cost (-2)
- End of Life Costs: nothing, most items can be repurposed or resold to offset breakdown costs (5)
- # of collaborators: waste management, dining facilities, composting facility, (0)
- Time to plan/rollout: roughly 1.5 months (-2)
- Necessary to Train Employees: yes (-10)
- Frequency of waste retrieval: 3 times/week (0)

Displays in Unions

Temporary displays are placed in the student unions on a regular basis. These can be anything from art pieces to public service announcements to informative posters. One potential way to educate students about composting is by placing information about why composting is important and what items are compostable on display posters in the unions. This would allow for the dissemination of high quality information to a relatively large portion of the student population, even if students just glance at it while passing through. The displays would not be very expensive either and, logistically, it would not be difficult to implement. The largest detractor from this idea, though, is that it would

only be temporary. We would have to hope that a culture shift would result from these displays, which is unlikely.

Performance of Specifications:

- % of student population reached: 40% (4)
- Demonstration of what can/cannot be composted: yes (10)
- Demonstration of the importance of composting: yes (10)
- Reinforcement of Info: 3-5 days/week for only 1-2 weeks (-7)
- Installation Costs: only cost of display, one or two bins, and hourly wage to set up, no more than \$500 (9)
- Ongoing Costs: nothing (0)
- End of Life Costs: just breakdown/disposal plus hourly wage to do so, \$100 at most (0)
- # of collaborators: waste management, Union staff (5)
- Time to plan/rollout: 1-2 weeks (8)
- Necessary to Train Employees: no (10)
- Frequency of waste retrieval: 3 times/week for 1-2 weeks (2)

Social Media

It is not secret that social media has exploded over the last several years with companies like Facebook and Twitter taking over the internet. The University could use this to their advantage to reach a wide audience of students and disseminate high quality information about composting and food waste. This would be an essentially cost-free project and would result potentially in a culture shift on campus with proper implementation. Unfortunately, students would have no way to put what they learn into practice with this project, so much of the information may just go in one ear and out the other.

Performance of Specifications:

- % of student population reached: 50-60% (5)
- Demonstration of what can/cannot be composted: yes (10)
- Demonstration of the importance of composting: yes (10)
- Reinforcement of Info: daily (10)
- Installation Costs: nothing, accounts and employees already exist (10)
- Ongoing Costs: nothing (0)
- End of Life Costs: nothing (7)
- # of collaborators: waste management (10)
- Time to plan/rollout: 1 week at most (10)

- Necessary to Train Employees: maybe (0)
- Frequency of waste retrieval: not applicable (0)

Zero-Waste Events

One way to potentially promote education is to require departments to hold only zero-waste events. Students go to departmental events generally at least a couple times a semester, so seeing the use of compostable materials and having compost bins available may teach students about what can and cannot be composted. The infrastructure is already in place for this, it would simply be a manner of expanding the current zero-waste event program. This would have increased costs on the departments holding the events, though grants are available for these types of events. Unfortunately, it would be difficult to disseminate any high quality information to students, so the effectiveness of this campaign would not be very high.

Performance of Specifications:

- % of student population reached: 30-40% (2)
- Demonstration of what can/cannot be composted: depends on implementation (0)
- Demonstration of the importance of composting: depends on implementation (0)
- Reinforcement of Info: few times a semester (-5)
- Installation Costs: just have to increase what is already existing, \$1500 at most (7)
- Ongoing Costs: cost of events, but most of this cost falls on departments (0)
- End of Life Costs: maybe some disposal of material (0)
- # of collaborators: waste management, composting facility, department (10)
- Time to plan/rollout: 1 month (0)
- Necessary to Train Employees: no (10)
- Frequency of waste retrieval: once or twice a week (5)

Compostable Cups at Mujo's

Mujo's is frequented by many students and is in a highly visible location on North Campus. Having Mujo's switch to compostable cups and placing compost bins around the Duderstadt Atrium would be one way to allow students to learn about composting. Bins would have signage stating what could and could not be composted, and the cups could have information about waste diversion written on the sides as a way to disseminate information. This would come at an increased cost for Mujo's, though, meaning prices would increase for students. The limited extent to which compost bins could be placed would also result in only a fraction of the cups actually ending up in compost bins.

Performance of Specifications:

- % of student population reached: 25% (0)
- Demonstration of what can/cannot be composted: yes (10)
- Demonstration of the importance of composting: no (-10)

- Reinforcement of Info: 3 times/week (0)
- Installation Costs: cups, bins, training of employees no more than \$2000 (4)
- Ongoing Costs: waste retrieval, cups (-3)
- End of Life Costs: disposal of some materials, \$100 at most (0)
- # of collaborators: waste management, Mujo's, composting facility (0)
- Time to plan/rollout: 1.5 months (-2)
- Necessary to Train Employees: yes (-10)
- Frequency of waste retrieval: 3 times/week (0)

Field Day

Holding a field day type event where students could participate in activities that would teach them about food waste and composting is another idea that could disseminate high quality information. There would be events such as waste sorts, trivia, displays, and more to teach students, but it would only be a one-time event, maybe happening on a semesterly or yearly basis. This severely limits reinforcement of the information. This event would not be cheap, either, given that materials and space would have to be purchased or rented, though hopefully volunteers would do most of the organization. The impact from an event like this would most likely be minimal.

Performance of Specifications:

- % of student population reached: 5-10% at most (-9)
- Demonstration of what can/cannot be composted: yes (10)
- Demonstration of the importance of composting: yes (10)
- Reinforcement of Info: once (-10)
- Installation Costs: facility rental, material rental, hourly wages for setup \$1000 at most (8)
- Ongoing Costs: waste pickup (-1)
- End of Life Costs: hourly wages for breakdown, tipping fees (1)
- # of collaborators: waste management, student group, venue (0)
- Time to plan/rollout: 1 month (0)
- Necessary to Train Employees: no (10)
- Frequency of waste retrieval: not applicable (0)

Informational Posters in Dining Halls

In this concept, posters outlining the impacts of food waste decomposition in landfills would be placed at various food stations in the dining halls. These posters would also push students to decrease their serving sizes, resulting in less food waste overall. This project could have a significant impact, as students would be provided with high quality information on a regular basis, potentially resulting in a culture shift in the students that use the dining halls. The project would not come at a significant

cost at all, and posters could be rotated as seasons change to prevent students' eyes from ignoring the posters as time wore on.

Performance of Specifications:

- % of student population reached: 40% (4)
- Demonstration of what can/cannot be composted: yes (10)
- Demonstration of the importance of composting: yes (10)
- Reinforcement of Info: 7 days/week (10)
- Installation Costs: cost of posters, \$200 at most (9)
- Ongoing Costs: none (0)
- End of Life Costs: none (7)
- # of collaborators: dining services (10)
- Time to plan/rollout: 1 week at most (10)
- Necessary to Train Employees: no (10)
- Frequency of waste retrieval: not applicable (0)

Placing Compost Bins All Around Campus

This concept skips the incremental stage and goes for an all out implementation, with the hope that it would shock students into composting. With bins all over campus and signage stating what can and cannot be composted, students would at the very least subconsciously have to absorb this information. This project would come at a significant cost, though, with the purchase of bins and implementation of a new waste retrieval route. Custodial staff would have to be trained, and contamination rates would probably be relatively high. Students also would still not be provided with information about why composting is important, potentially resulting in apathy amongst the student population.

Performance of Specifications:

- % of student population reached: 100% (10)
- Demonstration of what can/cannot be composted: yes (10)
- Demonstration of the importance of composting: no (-10)
- Reinforcement of Info: daily (10)
- Installation Costs: cost of bins/dumpsters and training employees, \$15000 at most (-10)
- Ongoing Costs: new employee wages, frequent waste retrieval, compostable liners (-6)
- End of Life Costs: hourly wages for breakdown, though this will be offset by resale of materials (5)
- # of collaborators: waste management, dining facilities, residential facilities, composting facility (-2)

- Time to plan/rollout: 1 month (0)
- Necessary to Train Employees: yes (-10)
- Frequency of waste retrieval: 3 times/week (0)

Mobile Composting

In this project, we would have a “mobile composting unit” travel around campus. It would be either an electric golf cart or a pedal driven cart that would advertise on its side the importance of composting and the driver would potentially hand out pamphlets with information. He or she would also collect students’ compostable waste and teach students about what can and cannot be composted. This project would be highly visible to students and could potentially result in a bit of awareness, but to be truly successful, multiple drivers would be required. This would lead to steep implementation and ongoing costs.

Performance of Specifications:

- % of student population reached: around 70% (7)
- Demonstration of what can/cannot be composted: yes (10)
- Demonstration of the importance of composting: yes (10)
- Reinforcement of Info: 3 times/week (0)
- Installation Costs: training of employees, cost of cart, roughly \$10000 (-7)
- Ongoing Costs: waste pickup, hourly wages (-2)
- End of Life Costs: nothing, everything can be repurposed (7)
- # of collaborators: waste management, student group (5)
- Time to plan/rollout: 2 months (-5)
- Necessary to Train Employees: depends on implementation (0)
- Frequency of waste retrieval: 1-2 times/week (5)

Appendix V: Cost Breakdown

Project Costs

Item	Amount	Cost/Item	Total	Notes
Training of Employees	2	\$100	\$200	twice per year (i.e. once at the beginning of each semester). If they already train people, this would just be an extra half hour at most
Hire an extra hourly employee	560	10	\$5,600	2 hours per day (peak hours) doubt this would be necessary, but it should at least be addressed
Difference in Gas	432	3	\$1,296	assuming 5 mpg and three trips a week. This cost would be split with Ross if it even falls under our budget
Tipping Fees	200	14	\$2,800	3 trips a week, half a ton each
driver wages	180	15	\$2,700	1.5 hours, 3 times a week, 40 weeks a year
Consulting Rate	160	80	\$12,800	40 hrs a week for a month, \$80/hr
Total			\$25,396	

Annual Company Operational Costs

Item	Amount	Cost/Item	Total	Notes
Web Site			\$600	\$600/year for website maintenance
Advertising	12	750	\$9,000	\$750/month in advertising
Salary	4	40000	\$160,000	Four employees, \$40k salary initially
Miscellaneous Supplies and Travel Expenses			\$15,000	
Total			\$184,600	