# Soto's True Earth Market Optimization

A Senior Project Submitted
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Bachelor of Science in Industrial Engineering

Presented to:
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## Executive Summary

Soto's True Earth Market is a new organic market startup which is located in a historical facility in the small town of Cambria. The new owner of Soto's Andre Ponce has a vision to create a community revolved around local organic foods and sustainability. Since Soto's is still in the initial startup phase there is a large amount of room for optimization and redesign in order to create a solid customer foundation. Andre presented several opportunities for improvement to the team. With a time constraint of solely two quarters the project team decided to provide the following:

- Old and new deli/smoothie department layouts
- Old and new facility layouts
- Economic analysis of equipment purchases

The overall objective of this project was to provide a concrete layout and operating procedure for the overall facility of Soto's market along with an evaluation of potential equipment purchases for their food service station. The constraints of the project was anything excluded from the deliverables and any further redesign outside of the main shopping area of Soto's market.

In the following report the overall background of the project is described in more detail along with the project scope for optimizing Soto's. Also, an in depth literature review is included to provide a greater insight on how to approach and achieve the overall goal of the project. Through all the research that the project team obtained a proposed methodology for each deliverable was created to streamline the next steps of the project. Included along with the proposed methodology is also proposed schedule to be followed in order to efficiently complete the project.

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# Introduction

Organic foods in recent years have developed an avid and rising market within the confounds of the United States. Among this new market large grocery companies have arisen such as Whole Foods, Trader Joe's, and more. Soto's True Earth Market breaks against the norms of corporate grocery markets and brings together a collective group effort to inform and support the community in regards to organic foods.

The project with Soto's was acquired through a comprehensive list of opportunities made available through the IME department at Cal Poly San Luis Obispo. Andre Ponce, the process owner was in the initial start-up phase of creating the foundation for his market at the start of this project. Due to the fact that the market was still in an initial startup phase, an initial customer base had to be established to further promote Soto's. Andre requested the need for a customer oriented facility layout that would create the ideal shopping experience. Included in this facility layout was also a workstation design for Soto's deli and smoothie section. Moreover, since the market was still under construction there was a need to purchase the necessary equipment for Soto's operations.

In order to provide a solution to the issues presented by Andre, several deliverables had to be provided. First, prior to starting the project a project charter was created to provide Andre and the team with a solid foundation of what was to be achieved. Old and new layouts were necessary in order to gauge the improvements made by the new proposed layout. To obtain a quantitative measure of these improvements, the potential for a simulation model was also proposed, dependent upon time constraints. Multiple criteria decision analysis was used in order to achieve the most economical equipment purchases in regards to Andre's constraints. These several deliverables were the foundation in determining when the project was ready to be closed out.

The main objective of this project was to create a layout for the overall facility of Soto's market as well as provide standard operating procedures and equipment purchasing evaluation for their deli and smoothie department. Any further redesign outside of the main shopping area of Soto's as well as any extra deliverables were not included in this project. The following report goes over the necessary steps we took to achieving these deliverables including but not limited to literature reviews, time studies, and ergonomic analysis.

# Background

As stated earlier the market for organic foods has seen a steady rise throughout the years since the earlier 2000's. With this rise has come the emergence of large corporations such as Whole Foods, Trader Joe's, and others. Soto's True Earth Market was originally a small local grocery market located in the coastal town of Cambria, CA. Andre Ponce, now the new owner of the historic landmark plans to create a new image for the market as a new frontier for organic foods in the small town of Cambria.

Cambria with a modest population of approximately 6,000 residents has difficulties acquiring organic foods within a close proximity of the town. The closest grocery market was about 10 miles away and with all the elderly citizens in the area this made grocery shopping difficult. Andre saw this difficulty in acquiring healthy and organic food after moving to Cambria and decided to create a change in this small town.

Andre, purchased Soto's with a vision to provide the town of Cambria with a reliable source for organic foods to better the health of the local citizens. His vision was to create a community to that inform the general public of the health benefits of eating local and organic. The products and services he provides aspires to withhold his pillars of a healthy individual, society, environment, but does not neglect the need for taste either!

# Literature Review

## Grocery Market Design

Many people generally assume that grocery market layouts have been the way they are just because that's the way things have done for a while now. Little do they know that there are various psychological and scientific methodologies in supermarket layouts. This method is described in further detail in the article "Consumption Universes Based Supermarket Layout Through Association Rule Mining and Multidimensional Scaling". These various floor layouts strongly influence shopping atmosphere, shopping behavior, and operational efficiency (Cil). There are two different methods of creating a grocery layout according to Cil, the traditional approach and the consumption universes approach. The traditional layout is essentially stocking items logically based on their category. The latter approach, consumption universes introduces a new concept of product layout that creates correlations between different products in order to determine the overall product layout. These two previous concepts are only in regards to product placement within a grocery market layout. Cil also goes over briefly the various store layouts such as grid layout, race track layout, freeform layout, and circulation spine layout (Cil). Of the several layout presented, Soto's environment seems most accustomed to using a grid layout with the traditional product placement approach.

There are various tactics that grocery stores use to entice the customers into buying more. Morse describes these methods in her article, "Supermarkets Give You the Runaround for a Reason Grocery Store Layouts Designed to Increase Impulse Sales, Improve Convenience." Certain products are used to initially bring people into the store but causes them to buy more. Objects like cashiers are strategically placed in order to defer the path of the customers to a different section of the store (Morse). Grocery stores will also place expensive goods at the beginning to get people to make purchases before they think about what they put in their cart (Morse). Music can have a profound effect, as a study showed that there is a relation between slow music and increased time spent in the store (Morse).

Soto's is still preparing to open their doors to the public. The owners purchased the store and kept much of the original design and layout intact while only doing some renovations. That being said, they have not had the chance to take into consideration these concepts since they are more focused on the practicality and functionality of the grocery store. By using these marketing and psychology tools, the project can assist the market by designing an efficient facility that is strategically put together to maximize sales.

Looking deeper into the relationship between amount of sales and facility design of a market one can refer to experiment performed by a group of professors at Kansai University in 2009 (Kholod, Nakahara,Azuma and Yada). In this experiment the use of RFID trackers were used to see how customers moved around the layout of the store. After compiling all data they reproduced the locations of the customers using x and y coordinates. They found by looking at the data there were distinct number of routes customers took around the store. In addition these findings helped categorize customers: Wandering customers, Decisive customers and Mixed customers(Kholod, Nakahara,Azuma and Yada 278). In addition to observing wandering degree of customers, they computed the purchasing sensitivity in relation to each area/department of the store(Kholod, Nakahara,Azuma and Yada 279). By understanding these to factors they stated they said they were able to make specific recommendations for certain areas of the store. Soto's will be able to benefit from the findings of this study because it shows a rather high correlation coefficient of approximately 0.8457 (Kholod, Nakahara,Azuma and Yada 275). This correlation coefficient provides reliability that sales and facility design have a rather high positive linear relationship.

## Food Workstation Redesign

Soto's plans to open a deli and smoothie section after their initial opening of the grocery market itself. Prime considerations typically taken into account for food workstation design is ergonomics, efficiency, and food safety. In regards to food safety the article "Tracking Cross-Contaminations Transfer Dynamics at a Mock Retail Deli Market Using GloGerm" is a great reference on how to design sanitary deli workstations. According to the author, Jessica Maitland the likelihood of contamination is higher in deli meats sliced at retail markets than those at a processing plant (Maitland). The case study covers the design criteria created to

simulate the spread of germs in a deli workstation using an abiotic surrogate called GloGerm. The findings from the case study states that the highest degree of spread in their study was through the user's gloves. Other findings also included the levels of contaminations within the slicer and meat chub. These experimental results can assist in creating a standard operating procedure for the deli portion of Soto's market. Not only that, but it also brings insight on how Soto's should handle their supply chain in regards to meats as well as employee sanitation.

In the paper titled "A Simulation Modeling Approach for Process Improvements in a Fast Food Restaurant" by Kadanian Serge, the use of simulation is used to find the optimal solution to a multi-variable problem. Simulation here provides one with a great example of how to deal with an environment that is subjected to a high level of randomness. To validate their findings to be as realistic as possible, the use of historical data from other fast food restaurants was used (Kadanian). The use of historical data in a simulation is a great way to recreate a real life environment. At Soto's True Earth Market the implementation of simulation using historical data from similar environments can be used to produce an accurate time study and flow of work. By the team implementing this type of simulation model they can collect a realistic simulation of the work station design. Calculating in any random variability typically observed in markets.

## Time Studies

Time studies are a valuable tool within Industrial Engineering to validate the method for a process at hand. According to the book, Manufacturing Systems Engineering, "Time study is a systematic procedure for measuring the length of time required and establishing an allowed time standard to perform work, based upon measurement of work content of the prescribed method by an operator of average skill, working with average effort, under normal conditions" (Hitomi 116). Even though Soto's is a brand new business, it is beneficial to pay close attention to important processes so that they can become as lean as possible at an early state. The project will strive to identify a process within the business that requires particular attention. With the concept of continuous improvement in mind, conducting a time study during the project can help establish predetermined time standards to use for comparison in the future as the market continues evolve

(Hitomi 119). In order to accomplish this, a Work Factor (WF) and Methods Time Measurement (MTM) must be done to get a detailed analysis of the entire process (Hitomi 120).

## Sustainability and the Environment

There are various businesses that are similar to Soto's market that have developed ways to maintain a consistent business. Whole Foods is well known for their natural products, but also for their ethical ways of doing business as it relates to the people and environment. The secret behind its success is the way the business has focused on the mission rather than making money. Whole Foods created seven main goals to assist each of the stakeholders of the company. These are the following goals (Whole Foods Market 378):

1. Sell the highest quality natural and organic products.
2. Satisfy and delight customers.
3. Support team members' happiness and excellence.
4. Create wealth through profits and growth.
5. Care about local communities and the environment.
6. Create win-win partnerships with suppliers.
7. Promote stakeholders' health by providing healthy eating education.

By striving to uphold and stay true to these goals, they are able to do business the way that no other groceries have before. They buy locally and have a strict policy on only buying meat from places that treat animals properly (Whole Foods Market 378). Unlike many others, Whole Foods does not charge suppliers to put products on the shelf, but simply makes an assessment about whether or not the product is a right fit for the business (Whole Foods Market 378). Soto's can learn from the success of Whole Foods by implementing similar strategies to the business. Andre Ponce, the owner, stresses the importance of the triple bottom line, especially as it relates to taking care of the environment. The goals mentioned above can help the project with establishing policies for the market that will develop the culture and overall business.

Another strong business that shares similar characteristics with Soto's is Trader Joe's. The article "Trader Joe's Company: Retailing - Company Profile & SWOT Report" provides a thorough analysis of the business. The strengths of this company are the diversity of the products across the locations, and the way the company manages each store as its own unit (Trader Joe's 12). This allows for flexibility in decision making

by the people who are present. A weakness of Trader Joe's is that they do not have online shopping available and are currently limited to just retail (Trader Joe's 12). Some opportunities they have for the future are the trends in people buying organic products (Trader Joe's 13). As always, there are threats to the business. Trader Joe's must make sure to keep up with the evolving interests of the customers, while competing with retail powerhouses (Trader Joe's 13).

Soto's is similar to Trader Joe's in the way the business is setup. They focus on healthy products while maintaining a local atmosphere. Many of the aspects of the SWOT analysis and report can be taken into consideration for the project. As the market is preparing for its opening, they must think of ways to distinguish themselves from the competition to develop a solid reputation. Also, Soto's can see how successful businesses such as Trader Joe's goes about dealing with their SWOTs and assess whether any of them coincide with their current situation.

### 5S Methods

In an environment such as Soto's, it is imperative that 5S principles are used to ensure a clean and organized workplace for the employees and customers. As it originated in Japan, 5S stands for the following terms: Seiri, Seiton, Seiso, Seiketsu, Shitsuke (Michalska and Szewieczek 211). With limited space available, Seiri should be used at Soto's to identify which products are necessary and those that are not. Although it will take a while for employees to get acclimated to the new business, Soto's must make sure that the organization of products and materials follow a standard process as they hire and train new employees. As a market, the majority of the available space is shared between the customers and the employees. It is the responsibility of the business to make sure that they provide a safe and clean place for the people that are there. Perhaps the most difficult aspect for Soto's would be the duty of sustaining the state of the business once they reach an organized state. By keeping these principles in mind, the project will strive to assist the business in creating an efficient environment. (Michalska and Szewieczek 212).

These principles of 5S are essential in any sort of working environment, that being said different industries have different insights on how to approach 5S and the DMAIC process. The article "A Lean Six Case Study: An Application of the "5s" Techniques" go into more detail about each step of the 5Sing process. As stated previously Seiri (Sort) involves the process of red-tagging or removing any unnecessary waste including tangible materials as well as information. The next several steps of 5S are very applicable to the deli and smoothie workstation in maintaining an efficient and effective operation. Seiton (Straighten) is the next step in the 5S process which follows these four rules (Pranckevicius):

1. Decide what things should be put away
2. Determine how many things should be put away
3. Decide where things should be put away
4. Determine the layout for things to be put away

Following Seiton is Seiso (Shine) or maintaining a clean work station from your general work area to the surrounding area along with the tools being used. In conjunction with Seiso is Seiketsu (Standardize) which is pursued at two levels. Level 1 is to create a company culture of organization, while level 2 is the development and implementation of policies and procedures to promote 5S (Pranckevicius). The final step in 5S is Shitsuke (Sustain) which is essentially education to employees and the cooperation of upper management to maintain these habits. By systematically going through the 5S process for their ready foods section Soto's can better serve the local community of Cambria. Moreover, the concept of 5S in a food station leads to more sanitary food which upholds the pillars of Soto's Market.

Although 5s is one of the most popular and widespread processes among process improvement tools a low percentage of companies actually fully implement it (Bayo-Moriones, Bello-Pintado and Merino-Diaz de Cerio). From the article 5s Use In Manufacturing Plants: contextual factors and impact on operating performance, it states that in Japan 5s is seen as a philosophy, while in the US and Western cultures view 5s as just "housekeeping"(Bayo-Moriones, Bello-Pintado and Merino-Diaz de Cerio 218). The way the Western

cultures portray 5s leads to the low importance of upholding 5s in the workplace. Soto's can use 5s as a building block to reaching optimal processes throughout the entire company.

## Ergonomics

The design of workstations in recent years have been influenced by the emergence of human factors engineering which includes the topic of ergonomics. The article, "Ergonomic Evaluation in a Beverage and Food Service Application" goes over some basic questions and concepts that are used in designing ergonomic work cells. Some sample questions include "What slows you down while you work?" and "What things about the design trouble you while working?" (Cohen). The questions can vary in wording and are not limited to these two, but they are essential to determining how to redesign or design a work cell for the better of the user. Some considerations for the design include the frequency of use, sequence, importance-of-use principles, as well as a logical processing line. (Cohen). These several pieces of information can lead to a better workday for the employees working at Soto's. By maintaining healthy employees, Soto's is not only retaining their pillar of health, but also creating happy employees which leads into happier customers.

In the article "Industrial workstation design: A systematic ergonomics approach" by Das and Sengupta, they go into great detail about the correct approach in developing an ergonomic work station. When dealing with ergonomics, once of the most important aspects is the height since it can vary so greatly from person to person. Some results of poor height settings are backaches if it is too low, and shoulder/neck pain if it is too high (Das and Sengupta 158). Even factors as small a eye height can play a major role, as the authors state, "The optimum display height for the normal (slump) eye height is 15" downward gaze" (Das and Sengupta 159). In the article they also include a case study of a designing a checkout stand for a store using ergonomic principles. The steps they took in developing their design as well as their conclusions will be very beneficial for the study of Soto's market.

## Economic Analysis

The economic analysis of the proposed findings from the studies taken at Soto's True Earth Market can be looked at as plausible or implausible depending on the economic analysis results. At Soto's the purchase of new equipment has a huge economic cost for the company. This decision will be made using the MCDA models (Yilidrim, Colin and Ike). The team will be implementing both AHP and Goal programming to find an optimal solution for equipment purchases (Yilidrim, Colin and Ike). Using first the Analytic Hierarchy Process (AHP) to prioritize each goal and then using those prioritization ratings established to plug into the goal programming model to obtain an optimal solution (Yilidrim, Colin and Ike). This idea of using AHP first, then goal programming was derived from the paper written by Yilidrim, Colin and Ike. In this example they used the MCDA in a different application of decision making, although this provided the team with a great reference using both models to reach a conclusion (Yilidrim, Colin and Ike).The decision analysis models can be intertwined with qualitative and quantitative criteria. This makes it a powerful tool when analyzing economic cons and benefits to find an optimal solution.

# Design

## Soto's True Earth Market Overview

During the initial project creation phase Soto's True Earth Market was still undergoing its startup development phase. The owner of Soto's, Andre had a vision of a small yet substantial grocery market that provided the local community with organic farm-to-table foods. With this vision there were an array of tasks the project team could choose from. However, any technical work for the team could only be performed once the store was finally open for business.

By March, Soto's had finally made its grand opening in Cambria as a local organic grocery market. The store was split into several departments from produce, frozen goods, refrigerated goods, dried goods, and packaged goods. Customers walk into the store and immediately find fresh produce grown by local farmers and can either move to refrigerated goods or dried goods. Following their purchase selections there is a single cashier that can check out the customer. A more detailed visual of the facility itself is shown in Appendix H and J. At the time, Soto's deli and smoothie section was still not operational, however the vision was to create something similar to Jamba Juices and Subway on a smaller scale. With its own unique vision, Soto's True Earth Market is a business with lots of potential for growth in the future.

## Project Charter

Following an overview of Soto's overall facility as well as the owner's future vision of the store the team developed a project charter to establish the overall logistics of the proposed project. The project charter itself established and addressed all the stakeholders to be involved in the optimization of Soto's True Earth Market. Also included in the project charter was the problem statement and business case that was apparent to the team after touring the facility and speaking with the owner of Soto's. Following the problem statement, a project scope was also established. The team paid careful attention to make sure that the scope would encompass many of the skills they had learned while also being manageable given the time frame. This aspect

of the charter was discussed thoroughly between the team members in order to create a reasonable yet effective scope for the allocated time provided to them for senior project.

The overall purpose of the project charter was to establish a clear goal for the optimization initiative for both the project team as well as stakeholders. This was not only to have a clear line of communication between all stakeholders but as well as to define what exactly the project team can and cannot do. This prevents any misinterpretation between the project team and client in regards to what is being accomplished throughout the project term. Not only that, but it also defines a clear completion date along with the deliverables for the project. The project charter was an essential initial deliverable for the project team in order to properly start the optimization initiative. Although the project charter defines concrete goals, it was consistently being updated to a certain extent as the project progressed. Overall, the project charter is a valuable tool to keep a team on track in any type of project environment.

## Benchmarking

As stated in the project overview above, Soto's True Earth Market is a local startup organic grocery market. With that current business status there was no initial deli and smoothie layout for the project team to benchmark their design alternatives off of. In order to fill in this information, gap the project team went out to various other businesses to analyze their processes and perform time studies; the businesses ranged from High St. Deli, Gus's Groceries, Lucy's, and more. Though the final product in these businesses were similar, the various processes and designs that are used varied from place to place. The project team created standard times for each business in order to identify standard work times for Soto's. These models and time studies can be found below as well as in Appendix F and G. These work measurements were necessary to determine standard times for the processes of smoothie and sandwich making at Soto's.

The studies taken from the various businesses also provided the team with new outlooks on how to approach their workstation alternatives. Decisions on where equipment should be placed as well as any necessary equipment purchases were quickly realized after studying the processes of similar businesses. Moreover, the

ergonomics and placement of equipment for workstations was also much more apparent after seeing both the effective and poor aspects of each business's workstation. This also showed what can be done given the present constraints at Soto's, such as the equipment, structures, and more. Overall, the benchmarking procedures allowed for a smooth transition into developing the necessary deliverables to the project team's client.

| | Operation: Gus's Groceries | Date: 4/25/2016 | | |
|---|---|---|---|---|
| | Observer: Chris Luong | Start Time: | | Working Conditions: Normal |
| | | End Time: | | |

| | | | Cycles | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | | | 2 (Bomber) | | | 3 | | | 4 | | | 5 | | | Average | | |
| | Element | Notes | OT | PR | NT | OT | PR | NT | OT | PR | NT | OT | PR | NT | OT | PR | NT | OT | PR | NT |
| 1 | Cut Meat | Includes Weighing | 30 | 100 | 30 | 30 | 100 | 30 | 30 | 100 | 30 | 28 | 100 | 28 | 31 | 100 | 31 | 30 | 100 | **30** |
| 2 | Cut Cheese | | 0 | 100 | 0 | 26 | 100 | 26 | 22 | 100 | 22 | 23 | 100 | 23 | 28 | 100 | 28 | 20 | 100 | **20** |
| 3 | Slice Bread | | 0 | 100 | 0 | 56 | 100 | 56 | 45 | 100 | 45 | 51 | 100 | 51 | 50 | 100 | 50 | 40 | 100 | **40** |
| 4 | (Hot) Steam Meat | Only for hot | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 30 | 100 | 30 | | 100 | 0 | 8 | 100 | **6** |
| 5 | Spread Bread | | 16 | 100 | 16 | 30 | 100 | 30 | 27 | 100 | 27 | 20 | 100 | 20 | 19 | 100 | 19 | 22 | 100 | **22** |
| 6 | Layer Sandwich (Meat & Cheese | | 25 | 100 | 25 | 34 | 100 | 34 | 30 | 100 | 30 | 29 | 100 | 29 | 32 | 100 | 32 | 30 | 100 | **30** |
| 7 | (Hot) Steam Sandwich | Only for hot | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 30 | 100 | 30 | | 100 | 0 | 8 | 100 | **6** |
| 8 | Layer Veggies & Etc. | | 73 | 100 | 73 | 49 | 100 | 49 | 57 | 100 | 57 | 61 | 100 | 61 | 50 | 100 | 50 | 58 | 100 | **58** |
| 9 | Cut Sandwich in Half | | 9 | 100 | 9 | 4 | 100 | 4 | 5 | 100 | 5 | 5 | 100 | 5 | 4 | 100 | 4 | 5 | 100 | **5** |
| 10 | Wrap Sandwich | Includes taping | 35 | 100 | 35 | 47 | 100 | 47 | 30 | 100 | 30 | 32 | 100 | 32 | 37 | 100 | 37 | 36 | 100 | **36** |
| Total | | | 188 | | 188 | 276 | | 276 | 246 | | 246 | 309 | | 309 | 251 | | 251 | 254 | | 254 |

| | |
|---|---|
| Total Allowance: | 10 |
| Total Observed Time: | 1270 |
| Total Normal Time: | 1270 |
| Average Normal Time: | 254 |
| Standard Time Per Unit: | 279 |

*Figure 1: Time Studies From Gus's*

## Current State Facility Layout

In conjunction with the benchmarks for the deli and smoothie department of Soto's True Earth market, the project team also created a current state layout for Soto's overall storefront. This included not only the deli and smoothie area, but the grocery portion as well. The project team obtained measurements from Soto's True Earth market and created a rough sketch of the overall facility. Thereafter a Visio model was created for both the grocery area as well as the deli and smoothie area as shown in Appendix H and J. Along with the Visio models a CAD file was also created through the use of a third party CAD software called Sweet Home 3D which is shown in Appendix O. Starting from the right of the model is the entrance of Soto's and going left are its grocery aisles into the deli and smoothie area with the warehouse to the very far left of the model.


*Figure 2: Original State of Soto's*

**Simulation Model**

In order to get a realistic understanding of the new processes, the team used a simulation software called Simio to replicate the proposed workstation redesign for the deli and smoothie area. As mentioned earlier, time studies were collected from various businesses such as High St Deli, Gus's Groceries, and more to be used for this purpose. By developing this model, the team was able to obtain an idea of how efficient the potential redesign could be by running various tests. The simulation model used for the deli workstation is shown below, the simulation model for the smoothie section can be found in Appendix N.

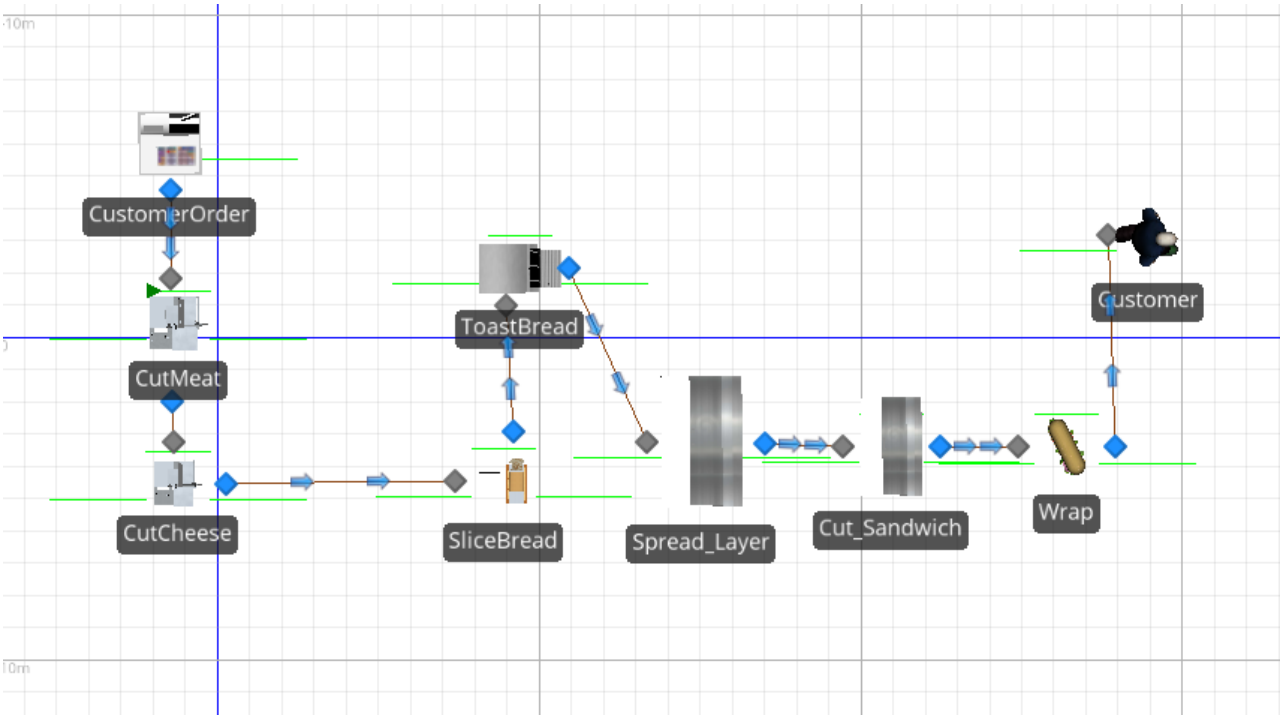


*Figure 3: Simulation Model of Deli*

## Equipment Purchasing

Equipment purchasing for facilities is dependent on many different variables. These variables were obtained by the project team visiting the client site to better understand the goals and background of the company. By conducting interviews of the owners the project team was able to better understand and document the goals that Soto's wanted to target. One of the requirements Soto's required was that every blender model be NSF approved. In addition, the owner did not have any preference on the size of the blenders for the smoothie workstation. The project team continued forward by making an assumption that all blenders were the same size. This assumption was made because the team didn't want this variable to affect the optimal solution. Following the interview, the owner was asked to rank these different variables in order of importance to align with the company's overall goals. These variables were ranked as follows.

1. Company reputation
2. Price
3. U.S. sourced parts
4. Noise level
5. Reliability

| | Reliability | Price | Noise Level | Made in America | Company Reputation | |
|---|---|---|---|---|---|---|
| Reliability | 1.00 | 0.50 | 0.71 | 0.71 | 0.50 | |
| Price | 2.00 | 1.00 | 1.43 | 1.43 | 1.00 | |
| Noise Level | 1.40 | 0.70 | 1.00 | 1.00 | 0.70 | |
| Made in America | 1.40 | 0.70 | 1.00 | 1.00 | 0.70 | |
| Company Reputation | 2.00 | 1.00 | 1.43 | 1.43 | 1.00 | |
| | | | | | | |
| | | | | | | |
| Sum | 7.80 | 3.90 | 5.57 | 5.57 | 3.90 | |
| | | | | | | |
| | | | | | | |
| | Reliability | Price | Noise Level | Made in America | Company Reputation | Averages |
| Reliability | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 |
| Price | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 |
| Noise Level | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 |
| Made in America | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 |
| Company Reputation | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 |

*Figure 4: Criteria for AHP Analysis*

This ranking system was used in the matrices designed for calculating weights for each brand of blender. Once all computations were calculated and adjusted the team was able to run a sensitivity analysis to better understand how pricing affects the results of the AHP model.

### Suggested Future State Facility Layout

Facility layouts incorporate a multitude of different factors that can differ greatly from store to store. Each business will have their own constraints, whether it is the size of the facility, personal preference, budget, and more. There is no such thing as a perfect facility layout, however, a design can be put together that maximizes efficiency while creating an optimal shopping experience for the customers. The team began by taking measurements of the entire store and all of the components (Shelves, equipment, etc.) that were present. Next, the design and measurements were put together to build a current state model of the facility on Visio. With so many different options and perspectives on new designs, the team decided to develop two draft layouts based on different approaches.

Layout 1 located in Appendix K was designed using a theory by professor Paul Harrison at Deakin University. In the grocery market the project team placed the produce near the front, to catch the viewer's eyes as they are walking by.

Layout 2 located in Appendix L was based on the design methods of Sprouts. They have distanced themselves from the traditional design of a grocery store by placing produce in the back of the store as described in the article written by Max Nisen. They understand their customers and realize that these are the primary goods that they look for in the store. Though Soto's is a different entity, the two companies share a similar vision for their customers. Based on the existing layout of the store, the alternative design was developed as seen in Appendix L.

After discussing the various options provided, the team incorporated several aspects from each proposal and put together a final layout for the new facility as seen in Appendix M. Most notably, the produce is expanded and pushed to the back end.

Similarly, the workstation for both the deli and smoothie department was also part of this future state facility redesign. Although there was no initial design implemented into Soto's for these two workstations, the project team utilized research and benchmarking in order to create a data driven design. The final workstation redesign can be found in Appendix I.

# Methods

## Facility Redesign

As mentioned in the design section, two preliminary facility layouts were developed based on two different approaches. In order to get the most optimal facility layout for Soto's True Earth Market we developed a hybrid of the two proposed layouts. We justified placement of products/departments based on sales data found at FMI.org and www.supermarketnews.com. These sources were beneficial in getting an overall perspective on the spending habits of nationwide customers.

## Equipment Purchasing

Soto's True Earth Market needed to purchase blenders for the smoothie workstation. The project team used an AHP (Analytical Hierarchy Process) model to decide which blender should be purchased to align with Soto's Business strategy. The project team visited the facility to interview the owner and workers about what was important to the company when it came to blenders. After compiling the feedback and asking the owner to rank the variables the project team began to organize the data into an Excel sheet as seen in Appendix C, D and E. Using these weights given to each variable the project team were able to form a matrix comparing the different variables associated with each blender model. The blender Vitamix:QO was the best fit for Soto's True Earth Market given the owners ranking system in the AHP model.

## Work Station Redesign

Due to the startup phase of Soto's True Earth market there was no initial baseline for the deli and smoothie section for the market. In order to obtain insight on how both a deli and smoothie workstation should be properly designed the project team examined and performed time studies on businesses of a similar nature. After analyzing several similar businesses, the team collectively extracted pros and cons out of each design in order to create the optimal deli and smoothie department for Soto's. Design methods from IME 443 such as L-shape and U-shape workstation designs were also taken into consideration for the Soto's deli and smoothie

department. A SIMIO model was created in order to justify the optimal layout and resources necessary for Soto's deli and smoothie department. Since no baseline numbers were available to input for the SIMIO model, the benchmarks performed at several facilities were used in order to gauge the standard time for the workstations. Two simulation models were designed one for the deli workstation as well as one for the smoothie workstation.

The simulation model for the proposed deli and smoothie workstation for Soto's is shown in Appendix N and Figure 3. Although the simulation model is not necessarily an exact replication of how the deli would operate it provides ample information to determine key metrics in that department. The processing times, arrival rates, and other metrics for the simulation model were acquired through the benchmarks performed. The steps in the **deli** simulation model are as follows:

1. The customer comes in and places an order
2. Meat is obtained from the deli case and sliced accordingly
3. Cheese is obtained from the deli case and sliced accordingly
4. Operator walks approximately 4 feet and slices the bread
5. The bread is then toasted for 60 seconds
6. The sandwich is spread and layered according to customer specifications
7. The operator then cuts the sandwich
8. The sandwich is wrapped and delivered to the customer

The steps for the **smoothie** simulation model are as follows

1. The customer comes in and places an order
2. The fruit is retrieved and prepared
3. Place the fruit in the blender and blend
4. Remove blender, pour the drink, and hand it to the customer
5. Wash the blender

The simulation model for the Soto's deli and smoothie department was performed during **peak hours from 12 PM to 2 PM** with an average arrival rate of 2 orders every 3.33 minutes. Other metrics in terms of processing times were obtained through benchmark numbers from various other businesses. Through this simulation of the deli workstation at Soto's the project team several key performance indices (KPI) to better understand the baseline performance of the workstation. The KPIs were essential in helping the project team determine alternative scenarios for Soto's in terms of future capacity rates and hires. The KPIs below were the select few chosen by the project team to determine the success of simulation experiments:

- Work Element Utilization Rates
- Number of Sandwiches/Drinks Outputted
- Time to Create Sandwiches/Drinks

These 3 KPIs assisted the team in determining how work elements could be changed to better utilize elements within the workstation. Not only that, but the KPIs were also taken into consideration to consider the potential for higher customers in the near future for Soto's True Earth Market as well. With that the following experiments were conducted in the simulation model as follows:

1. No changes, baseline
2. 20% Increase in customer demand
3. Hire one more employee to work the deli/smoothie area

More information in regards to the specifics of each experiment will be explained in more depth in the results section for the workstation redesign.

# Results and Discussion

## Facility Redesign

After taking aspects from two draft layouts, the final design was developed as seen in Appendix M. The team held onto several theories such as keeping dairy products to the back, and incorporating promotional goods at the front to attract initial customers. However, one major way the team went against the traditional design is by following in Sprout's footsteps by placing produce towards the back of the store. The design fits the goals of the store while also continuing to attract new customers.

With any facility redesign, at the end of the day there are always countless other options based on different interpretations and perspectives. The major limitation was that there is certain equipment such as freezers and refrigerators that are placed in the facility. Though these can be moved or replaced, it will be a costly initiative. The only aspect that is difficult to interpret regarding facility redesigns is that there isn't a strict way to quantitatively backup a design. Small grocery store designs can be very subjective as there is not much space to work with and can be based on a unique vision. In the end, some questions that remain unanswered are:

1. Will there be any renovations in the future?
2. Are there any plans of expansion in the future?
3. Which equipment will be replaced or moved in the future?

Based on the final design layout, the team believes that by implementing similar changes to the current design the business can achieve positive business results. By pulling customers to search for produce and other popular goods at the back of the store, this may positively impact the sales of other goods. In addition, with the development of the deli and smoothie area this can be a great combination to encourage further purchases for a quick snack. However, problems might come up when dealing with which equipment to move/renew, or developing a fresh mindset to try something different. The design should be used as little or

as much as the owner believes is beneficial to the store. The owner can take bits and pieces that align with what is manageable as well as what the current business goals are.

Economic Analysis & Discussion

Currently, the produce section is 27 ft^2 in size. FMI shows that for every square foot of selling space, the weekly sales were equivalent to $11.98. In the final layout of the facility design, the produce section has been expanded to 6ft x 9ft or 54 ft^2. Though the size of the expansion may depend on a multitude of factors, with this scenario the produce section has expanded by 27ft^2 and can expect to make an increase of $11.98 x 27 = $323.46.

## Equipment Purchasing

Using an AHP model the project team was able to define an optimum blender for the Soto's True Earth Market. The Vitamix:QO was established to be the best fit for the companies ranking of variables defined in the prior section. The results were not as expected because prior to researching and running the AHP model the team believed that Blendtec would be the top brand for blenders based on the customer's personal beliefs. The theory/beliefs of the customer did not hold true after further analyzing the different models using the AHP model. The design to use a AHP model to calculate the best piece of equipment was perfect for this situation because many of the variables were not quantifiable. In addition, the team's cost estimates were roughly followed because the exact costs couldn't be put into the model. Rather the price was initially given an overall weight to describe it going through the rest of the model and then each individual model was compared given the retail prices. Based on the fact that the Vitamix:QO received the highest score of 0.257 we can conclude that the designed does not need to be changed to obtain an optimal solution. Although if the customer would like to weight the variables differently one can easily change the optimal solution by accessing the Dashboard provided in the Excel spreadsheet (Appendix C,D,E)

In the method of deriving this solution and testing it there were not any unusual conditions the project team ran into. The results were not difficult to interpret because the final scoring system ranks each piece of

equipment on a scale of 0.0-1.0 with 1.0 being the best. This test provided the project team with the exact answer to the questions the customer wanted, no questions were left unanswered.

Based on the results the project team predicts the customer will purchase this piece of equipment based on the customer defined variables and priorities aligning well. Legitimate problems might crop up during the ranking step. One must make sure to really understand the customer's organization and thinking to properly weigh the variables properly. If these weights aren't a perfect representation of the owner's thoughts the project team could have possibly chosen a piece of equipment that doesn't align with the business. The use of design/theory here might be limited by the need of the customer. In terms of Soto's the project team developed the Excel spread sheet to be interactive including a dashboard to play with the weights of each variable. This allows the customer to actively adjust weights and see how that affects the optimal equipment purchase.

Economic Analysis

An economic analysis was provided here by creating a sensitivity analysis on price of each blender model. In this model the project team was able to see how the effects of price directly affected the optimal solution.

- With "2" points of importance, the preferred blender is the Vitamix: QO with an overall AHP score of .2574 (current client preference*)
- With "4" points of importance, the preferred blender is the Vitamix: QO with an overall AHP score of .2492
- With "6" points of importance, the preferred blender is the Vitamix: QO with an overall AHP score of .2419
- With "8" points of importance, the preferred blender is the Vitamix: VP with an overall AHP score of .2388
- With "10" points of importance, the preferred blender is the Vitamix: VP with an overall AHP score of .2419

This analysis provided Soto's with a better understanding of how the effects of price have on the output of the team's AHP model. As the importance of price increased the preferred blender changed because of the weights defined in the prior interviews conducted.

## Workstation Redesign

The final workstation layouts were determined through a collective consensus between the project team members after a thorough analysis of the benchmarks and layouts obtained from benchmark studies. Both the deli and smoothie layouts were created not only according to IME 443 concepts but as well as visual analysis of other similar businesses as previously stated. In the following paragraphs the results and discussions of the deli and smoothie workstation layouts will be discussed in more detail. The deli section will be addressed first, then followed by the smoothie department.

### *Soto's Deli Workstation Redesign*

Experiment #1

In terms of the baseline simulation model, the metrics outputted were used to compare the hypothetical alternatives that the project team suggested. The key metrics acquired from this baseline experiment are as follows:

- Average number of sandwiches made: 53.8
- Time to create a sandwich: 5.32 minutes

The utilization rates varied from work element to work element but will be discussed in more detail in regards to the other experiments that affect them accordingly. Overall, most of the work elements were extremely underutilized which shows that the deli has potential to take on more demand.

Experiment #2

As stated above low utilization rates equate to potential for higher demand; in order to determine the potential capacity of Soto's deli the project team decided to increase customer demand by approximately 20%. The metrics obtained from this experiment are the following:

- Average number of sandwiches made: 66.1
- Time to create a sandwich: 6.58 minutes

The utilization rates in this experiment increased by approximately 20% following the 20% demand increase. Even with this increase the highest utilization rate is at 89% for spreading and layering the sandwich, whereas the lowest utilization rate is at cutting the sandwich at 5%. With these utilization rate it is apparent that some work elements could be combined.

Moreover, with the results provided above it is apparent that Soto's deli does have the potential to handle extra demand if needed in the future. Although the sandwich creation time increases by approximately 1 minute the amount of sandwiches outputted is still significantly higher than the original. As stated previously in regards to the utilization rate, some elements could be merged together to not only increase utilization rates, but as well as reducing sandwich creation time.

Experiment #3

The project team also considered that hiring one more employee could also significantly impact Soto's deli in terms of sandwiches made. The key performance indices for this experiment are as follows:

- Average number of sandwiches made: 54.8
- Time to create a sandwich: 4.85 minutes

Utilization rates for this experiment essentially stayed stagnant except for the work element of spreading and layering the sandwich. The utilization for this work element essentially went down due to the extra resource provided for the task. The project team agreed that until Soto's achieved higher demands for sandwiches, hiring an extra employee would not be economically feasible in terms of net profit returns for another employee.

Economic Analysis & Discussion

Collectively and separately the experiments presented the project team with a large supply of information in order to justify their deli workstation layout. The baseline experiment used arrival rate metrics that the team had acquired by analyzing the customer base of Soto's over the course of 2 hours on a random weekday. These metrics from the simulation experiment were compared to the next 2 experiments in order to gauge

the potential success of the hypothetical changes that could occur in the near future for Soto's deli. As stated previously the original layout for Soto's deli workstation is heavily underutilized due to Soto's startup status contributing to lower demand at peak hours. The project team wanted to analyze the effects that added demand would have on the layouts utilization rates along with the effects of an additional employee working the deli.

Looking at the KPIs obtained from experiment 2 it is apparent that Soto's has the capacity necessary to meet higher demand at peak hours. Although the flow time per sandwich has increased by approximately 1 minute the deli is outputting more sandwiches than the original design with this 20% increase in demand. Considering that each sandwich averages around $10 this would result in an increase of revenue by about $120/day for the peak hours of 12 PM to 2 PM. This reconfirms the project team's evaluation that Soto's deli could handle a significant demand increase without any additional resources.

Following the demand increase experiment the project team decided to gauge the potential benefit for Soto's to hire an additional employee for their deli. Due to the demand constraint of the original design there was no change to the amount of sandwiches created throughout the peak hours timespan. The additional employee also decreases utilization rates significantly as well. However, the flow time per sandwich as a result of the change was reduced by approximately 8%. Considering that the average hourly wage of an employee is $12, Soto's would save about $0.09 per sandwich with the extra employee. With approximately 54 sandwiches during peak hours the total savings from time would only be about $5.07. With these numbers the project team decided it would be unnecessary to hire another employee for the deli until the demand for sandwiches increases dramatically.

### *Soto's Smoothie Workstation Redesign*

Experiment #1

In terms of the baseline simulation model the smoothie department had a similar simulation design compared to that of the deli workstation. One key assumptions were made in the creation of the smoothie workstation

simulation: fruit was already prepared prior to the peak hours from 12 PM to 2 PM. The results of that experiment are as follows:

- Average number of smoothies made: 54.9
- Time to make a smoothie: 1 minute

The utilization rates, similar to those of the deli section were relatively low for each work element, averaging approximately under 15% for each work element. Also similarly, this shows that the smoothie workstation has potential for handle more demand as well.

Experiment #2

Considering that the smoothie section also has potential to handle more demand the project team decided to increase demand by 20% to see the effects. Similar to that of the deli workstation the smoothie workstation experienced similar results in terms of KPIs. The results from the experiment are as follows:

- Average number of smoothies made: 68.7
- Time to make a smoothie: 1 minutes

In terms of the utilization rates the work elements experienced an increase of approximately 24% for their corresponding utilization rates. This still leaves the smoothie department with a significantly low utilization rate, representing the potential to handle even more demand for the smoothie department.

Experiment #3

Another consideration the project team made would be whether or not adding another employee to the smoothie department would be economically feasible. The results from adding an extra employee are as follows:

- Average number of smoothies made: 54.9
- Time to make a smoothie: 0.88 minutes

Similar to the new utilization rates from the deli workstation, the smoothie department experienced a similar decrease in utilization rates as well. This decline was approximately 50% representing that the smoothie section did not necessarily require an extra employee either.

Economic Analysis and Discussion

Just like the deli workstation, the smoothie workstation was also designed through information obtained through literature reviews as well as benchmarks from other smoothie businesses. These metrics were applied into the simulation model in order to obtain a baseline for the potential that Soto's smoothie layout would have in terms of the corresponding KPIs.

Considering that each smoothie averages around $5 per drink in the current state of the economy, the project team determined the revenue increase from a 20% demand increase. Soto's would make approximately $69 more per day during peak hours which adds up to $16,560 per year considering 5 day weeks. These numbers reconfirm the project team's findings that Soto's smoothie department could handle more demand.

### *Final Overall Workstation Discussion*

Overall, it is prevalent that both Soto's deli and smoothie department has the necessary capability to handle demand. With the current forecasted demand used for the experiment, the simulation model shows that both workstations are capable of handling a significant amount of more demand. This dilemma, although unrelated to the workstation redesign provides the project team and client with data to account for future demand increases at Soto's. Moreover, for both workstation adding one more employee was essentially disadvantageous for Soto's. Although adding an extra resource decreased the processing time for both departments, the economic returns were essentially negative in regards to the time decrease. All in all, the current baseline layout for Soto's deli and smoothie area is ideal considering the prior research and benchmarking performed by the project team.

# Conclusion

All in all, the project problem statement to create a concrete facility and department layout for Soto's True Earth market was essentially achieved. The objectives that the project team set forth was to provide Soto's with a concrete layout, standard operating procedures, as well as an economic evaluation of potential equipment purchases were all provided to the client. The solution approach taken by the project team was essentially in line with the DMAIC process. Referencing the design portion of the report provides a more detailed look at the exact steps taken by the project team to achieve the objectives and deliverables of the project for Soto's True Earth Market.

In terms of results, the final layout for both the grocery and deli/smoothie department were by far the most important results created by the project team. Although the other aspects of the project were necessary as well, it was the collective effort of all those findings that produced the final proposed facility layout. With the data obtained from benchmarking, literature reviews, and the simulation models the project team could confidently justify the final layout as an optimal alternative to Soto's current facility design.

Based on our experimental results the theory behind designing a layout for a grocery store is highly based off psychology and product placement. When designing the layout one must make decisions based on historical data both intrinsic and extrinsic. The theories used to create facility designs for a manufacturing environment are not fully applicable to an environment you are planning for a customer to directly interact with. These facilities have much more variance each time a customer enters the system. In addition, when focusing in on the workstation design and equipment purchasing the theories taught within the industrial engineering curriculum were fully applicable.

In terms of project success, the project team sufficed the objectives stated in the introduction of the project report. Although the strongest deliverable was definitely the facility layout, the standard operating procedures and economic analysis were definitely products of the proposed layout. Standard operating procedures were necessary in order to create the simulation model for the deli and smoothie section. By achieving one

deliverable it essentially provided the knowledge necessary to achieve a future deliverable. Similarly, the economic analysis tied together the workstation redesign to take into consideration the equipment necessary to operate a deli and smoothie bar as well. So in regards to objectives, the achievement of one led to the achievement of the other until the overall project was completed.

In this project the team revisited many topics from engineering economics, operations research, facility redesign, ergonomics, simulation, project management and time studies. If the project team was given the opportunity to continue, they would implement the previous stated recommendations and collect data on the performance. Over a sufficient period of time to collect data on the two workstations the project team would like to make improvements to increase overall throughput and utilization levels. Because these two workstation designs would be baselines for Soto's True Earth Market we could reevaluate and develop better designs to maximize overall net profits. Based on the project team's findings they would recommend that Soto's True Earth Market take into consideration these findings and implement as needed depending on resources and business goals. In addition, Soto's should reach back out to the team to evaluate how the changes have affected the overall system given sufficient time for the effects to take place.

As a whole the overall facility layout of Soto's True Earth Market is bound to have an effect for both the local community of Cambria as well as the environment as a whole. In terms of a system view the facility layout for Soto's has a huge impact for the community. Given that Soto's is a local organic market that also gives back to the local community, providing the company with potential improvements can provide customers with a better shopping experience. With a more pleasant shopping experience the customer base increases which then leads to Soto's being able to give more back to the community; these include charities, delivery services to the elderly, as well as the potential to buy more local produce from farmers. Environmentally, the proposed layout will in theory provide Soto's with higher net profit margins which can lead to higher purchases of organic, non-gmo, local goods. These purchases encourage more farmers to farm using more sustainable methods to brand their goods as environmentally friendly and local. The more local produce there is the less demand there will be for harmful chemicals, genetically modified plants, as well as

poor farming methods. Realistically, the project as a whole will give Soto's the necessary resources in the future to make an impact on the community of Cambria as well as the environment. However, it is not the project deliverables but rather Soto's business model itself that makes it such a sustainable and honest company that people want to shop at.

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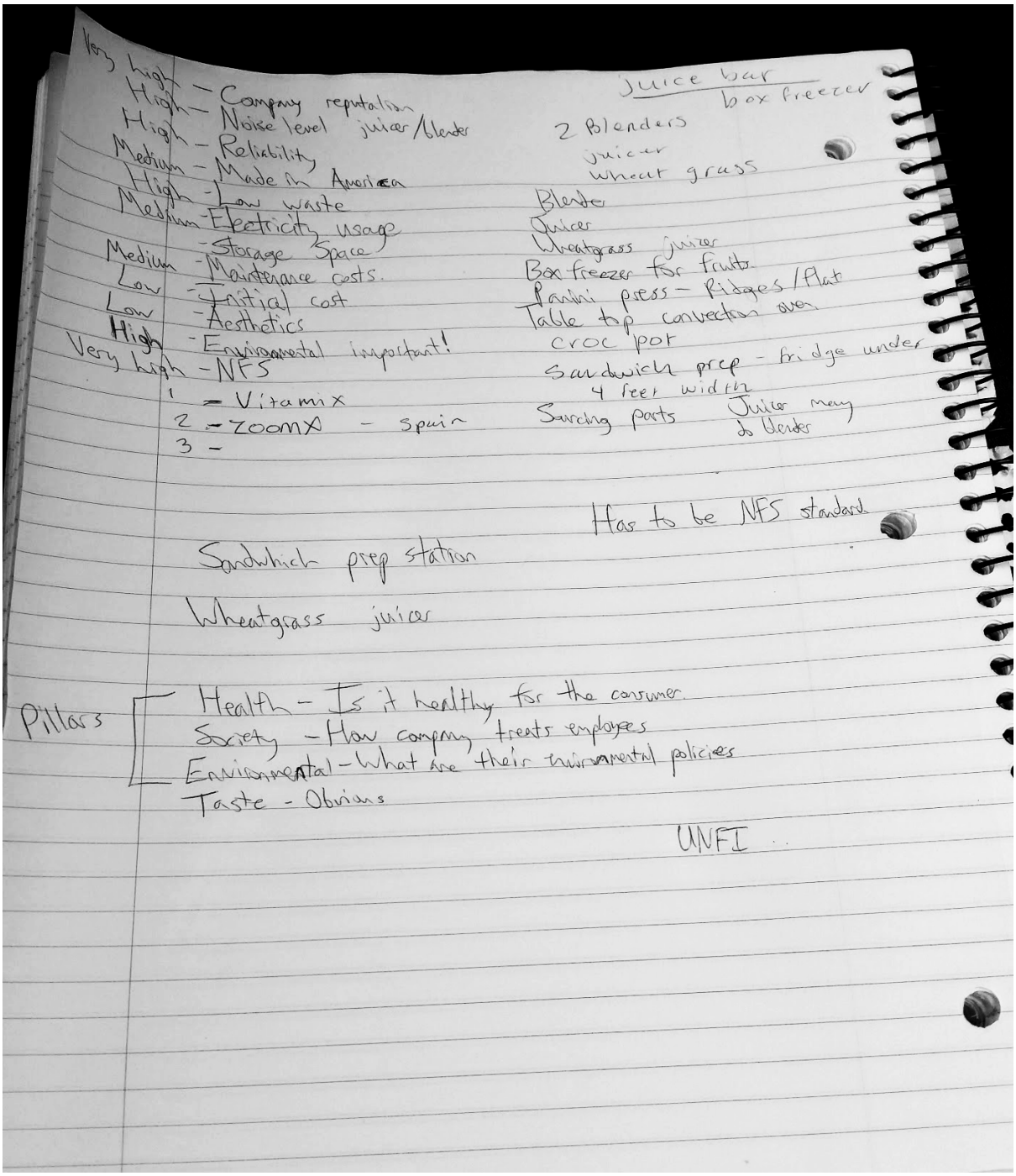
# Appendix

| Task Mode | Task Name | Duration | Start | Finish | Predecessors |
|---|---|---|---|---|---|
| | **Soto's True Earth Market Optimization** | **16 days?** | **Wed 3/23/16** | **Wed 4/13/16** | |
| | **Economic Equipment Purchasing Analysis** | **6 days** | **Wed 3/23/16** | **Wed 3/30/16** | |
| | Research equipment alternatives | 2 days | Wed 3/23/16 | Thu 3/24/16 | |
| | Create goal programming model for alternatives | 2 days | Fri 3/25/16 | Mon 3/28/16 | 3 |
| | Determine alternatives to purchase | 2 days | Tue 3/29/16 | Wed 3/30/16 | 4 |
| | **Facility Layout Redesign** | **6 days?** | **Thu 3/31/16** | **Thu 4/7/16** | **2** |
| | Determine Baseline Facility Layout | 1 day? | Thu 3/31/16 | Thu 3/31/16 | |
| | Create Vizio Model of Facility Layout | 2 days | Fri 4/1/16 | Mon 4/4/16 | 7 |
| | Dedesign optimal new facility layout | 3 days | Tue 4/5/16 | Thu 4/7/16 | 8 |
| | **Workstation Redesign** | **10 days** | **Thu 3/31/16** | **Wed 4/13/16** | |
| | Determine Baseline Workcell Layouts | 2 days | Thu 3/31/16 | Fri 4/1/16 | 2 |
| | Create Vizio Model of Workcells | 2 days | Mon 4/4/16 | Tue 4/5/16 | 11 |
| | Analyze Model Ergonomics & Efficiency | 3 days | Wed 4/6/16 | Fri 4/8/16 | 12 |
| | Determine Baseline SOPs | 1 day | Mon 4/4/16 | Mon 4/4/16 | 11 |
| | Create New Workcell Layouts | 3 days | Mon 4/11/16 | Wed 4/13/16 | 13 |
| | Create New SOPs | 1 day | Tue 4/5/16 | Tue 4/5/16 | 14 |
| | Determine Optimal New Workcell Layouts | 2 days | Mon 4/11/16 | Tue 4/12/16 | 13,14 |

*Appendix A: Plan to Complete Project*




*Appendix B: AHP Model Notes*

| Reliability Comparison | | | | | | |
|---|---|---|---|---|---|---|
| | Vitamix: QO | Vitamix: VP | Blendtec: Stealth | Blendtec: 825 | Waring:MX1200 | |
| Vitamix: QO | 1.00 | 1.00 | 1.00 | 1.00 | 1.80 | |
| Vitamix: VP | 1.00 | 1.00 | 1.00 | 1.00 | 1.80 | |
| Blendtec: Stealth | 1.00 | 1.00 | 1.00 | 1.00 | 1.80 | |
| Blendtec: 825 | 1.00 | 1.00 | 1.00 | 1.00 | 1.80 | |
| Waring:MX1200 | 0.56 | 0.56 | 0.56 | 0.56 | 1.00 | |
| | | | | | | |
| Sum | 4.56 | 4.56 | 4.56 | 4.56 | 8.20 | |
| | | | | | | |
| | Vitamix: QO | Vitamix: VP | Blendtec: Stealth | Blendtec: 825 | Waring:MX1200 | Averages |
| Vitamix: QO | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 |
| Vitamix: VP | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 |
| Blendtec: Stealth | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 |
| Blendtec: 825 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 |
| Waring:MX1200 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |

| Price Comparison | | | | | | |
|---|---|---|---|---|---|---|
| | Vitamix: QO | Vitamix: VP | Blendtec: Stealth | Blendtec: 825 | Waring:MX1200 | |
| Vitamix: QO | 1.00 | 0.30 | 3.00 | 1.00 | 0.33 | |
| Vitamix: VP | 3.33 | 1.00 | 1.00 | 3.33 | 1.11 | |
| Blendtec: Stealth | 0.33 | 1.00 | 1.00 | 0.33 | 0.11 | |
| Blendtec: 825 | 1.00 | 0.30 | 3.00 | 1.00 | 0.33 | |
| Waring:MX1200 | 3.00 | 0.90 | 9.00 | 3.00 | 1.00 | |
| | | | | | | |
| Sum | 8.67 | 3.50 | 17.00 | 8.67 | 2.89 | |
| | | | | | | |
| | Vitamix: QO | Vitamix: VP | Blendtec: Stealth | Blendtec: 825 | Waring:MX1200 | Averages |
| Vitamix: QO | 0.12 | 0.09 | 0.18 | 0.12 | 0.12 | 0.12 |
| Vitamix: VP | 0.38 | 0.29 | 0.06 | 0.38 | 0.38 | 0.30 |
| Blendtec: Stealth | 0.04 | 0.29 | 0.06 | 0.04 | 0.04 | 0.09 |
| Blendtec: 825 | 0.12 | 0.09 | 0.18 | 0.12 | 0.12 | 0.12 |
| Waring:MX1200 | 0.35 | 0.26 | 0.53 | 0.35 | 0.35 | 0.37 |

| Made in America | | | | | | |
|---|---|---|---|---|---|---|
| | Vitamix: QO | Vitamix: VP | Blendtec: Stealth | Blendtec: 825 | Waring:MX1200 | |
| Vitamix: QO | 1.00 | 1.00 | 1.33 | 1.33 | 2.67 | |
| Vitamix: VP | 1.00 | 1.00 | 1.33 | 1.33 | 2.67 | |
| Blendtec: Stealth | 0.75 | 0.75 | 1.00 | 1.00 | 2.00 | |
| Blendtec: 825 | 0.75 | 0.75 | 1.00 | 1.00 | 2.00 | |
| Waring:MX1200 | 0.38 | 0.38 | 0.50 | 0.50 | 1.00 | |
| | | | | | | |
| Sum | 3.88 | 3.88 | 5.17 | 5.17 | 10.33 | |
| | | | | | | |
| | Vitamix: QO | Vitamix: VP | Blendtec: Stealth | Blendtec: 825 | Waring:MX1200 | Averages |
| Vitamix: QO | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 |
| Vitamix: VP | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 |
| Blendtec: Stealth | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 |
| Blendtec: 825 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 |
| Waring:MX1200 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |

*Appendix C: AHP Model Excel Sheet I*

| Company Reputation | | | | | | |
|---|---|---|---|---|---|---|
| | Vitamix: QO | Vitamix: VP | Blendtec: Stealth | Blendtec: 825 | Waring:MX1200 | |
| Vitamix: QO | 1.00 | 1.00 | 1.29 | 1.29 | 2.25 | |
| Vitamix: VP | 1.00 | 1.00 | 1.29 | 1.29 | 2.25 | |
| Blendtec: Stealth | 0.78 | 0.78 | 1.00 | 1.00 | 1.75 | |
| Blendtec: 825 | 0.78 | 0.78 | 1.00 | 1.00 | 1.75 | |
| Waring:MX1200 | 0.44 | 0.44 | 0.57 | 0.57 | 1.00 | |
| | | | | | | |
| Sum | 4.00 | 4.00 | 5.14 | 5.14 | 9.00 | |
| | | | | | | |
| | Vitamix: QO | Vitamix: VP | Blendtec: Stealth | Blendtec: 825 | Waring:MX1200 | Averages |
| Vitamix: QO | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Vitamix: VP | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Blendtec: Stealth | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 |
| Blendtec: 825 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 |
| Waring:MX1200 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 |

| Noise Level | | | | | | |
|---|---|---|---|---|---|---|
| | Vitamix: QO | Vitamix: VP | Blendtec: Stealth | Blendtec: 825 | Waring:MX1200 | |
| Vitamix: QO | 1.00 | 2.25 | 1.00 | 2.25 | 9.00 | |
| Vitamix: VP | 0.44 | 1.00 | 0.44 | 1.00 | 4.00 | |
| Blendtec: Stealth | 1.00 | 2.25 | 1.00 | 2.25 | 9.00 | |
| Blendtec: 825 | 0.44 | 1.00 | 0.44 | 1.00 | 4.00 | |
| Waring:MX1200 | 0.11 | 0.25 | 0.11 | 0.25 | 1.00 | |
| | | | | | | |
| sum | 3 | 6.75 | 3 | 6.75 | 27 | |
| | | | | | | |
| | Vitamix: QO | Vitamix: VP | Blendtec: Stealth | Blendtec: 825 | Waring:MX1200 | Average |
| Vitamix: QO | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 |
| Vitamix: VP | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| Blendtec: Stealth | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 |
| Blendtec: 825 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| Waring:MX1200 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |

*Appendix D: AHP Model Excel Sheet II*

| WEIGHT OF CRITERIA | | 0.16 | 0.06 | 0.23 | 0.32 | 0.23 | |
|---|---|---|---|---|---|---|---|
| | | | | | | | Overall Score |
| Vitamix: QO | | 0.220 | 0.122 | 0.258 | 0.250 | 0.333 | 0.257 |
| Vitamix: VP | | 0.220 | 0.300 | 0.258 | 0.250 | 0.148 | 0.227 |
| Blendtec: Stealth | | 0.220 | 0.092 | 0.194 | 0.194 | 0.333 | 0.223 |
| Blendtec: 825 | | 0.220 | 0.122 | 0.194 | 0.194 | 0.148 | 0.183 |
| Waring:MX1200 | | 0.122 | 0.365 | 0.097 | 0.111 | 0.037 | 0.109 |

*Appendix E: Results of AHP Model*

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Operation: Lassens Deli | | Date: 5/3/2016 | | | | | | | | | | | | | | | | | |
| | Observer: Sean M. & Hiro F. | | Start Time: | | | Working Conditions: Normal | | | | | | | | | | | | | | |
| | | | End Time: | | | | | | | | | | | | | | | | | |
| | | | Cycles | | | | | | | | | | | | | | | | | |
| | | | 1 | | | 2 (Bomber) | | | 3 | | | 4 | | | 5 | | | Average | | |
| | Element | Notes | OT | PR | NT | OT | PR | NT | OT | PR | NT | OT | PR | NT | OT | PR | NT | OT | PR | NT |
| 1 | Get bread | | 10 | 100 | 10 | 10 | 100 | 10 | 10 | 100 | 10 | 11 | 100 | 11 | 10 | 100 | 10 | 10.20 | 100 | 10.2 |
| 2 | Grab meat from back | | 18 | 100 | 18 | 33 | 100 | 33 | 8 | 100 | 8 | 22 | 100 | 22 | 24 | 100 | 24 | 21.00 | 100 | 21 |
| 3 | Add condiments | | 16 | 100 | 16 | 36 | 100 | 36 | 12 | 100 | 12 | 20 | 100 | 20 | 14 | 100 | 14 | 19.60 | 100 | 19.6 |
| 4 | Add vegetables | | 23 | 100 | 23 | 23 | 100 | 23 | 48 | 100 | 48 | 29 | 100 | 29 | 25 | 100 | 25 | 29.60 | 100 | 29.6 |
| 5 | Wrap Sandwich | | 38 | 100 | 38 | 26 | 100 | 26 | 104 | 100 | 104 | 30 | 100 | 30 | 29 | 100 | 29 | 45.40 | 100 | 45.4 |
| 6 | Put sticker with form | | 38 | 100 | 38 | 26 | 100 | 26 | 21 | 100 | 21 | 23 | 100 | 23 | 20 | 100 | 20 | 25.60 | 100 | 25.6 |
| 7 | Hand to customer | | 8 | 100 | 8 | 10 | 100 | 10 | 17 | 100 | 17 | 11 | 100 | 11 | 9 | 100 | 9 | 11.00 | 100 | 11 |
| Total | | | 151 | | 151 | 164 | | 164 | 220 | | 220 | | | 146 | 131 | | 131 | 166.5 | | 162 |

| | |
|---|---|
| Total Allowance: | 10 |
| Total Observed Time: | 666 |
| Total Normal Time: | 812 |
| Average Normal Time: | 162 |
| Standard Time Per Unit: | 179 |

*Appendix F: Lassen's Benchmarking*

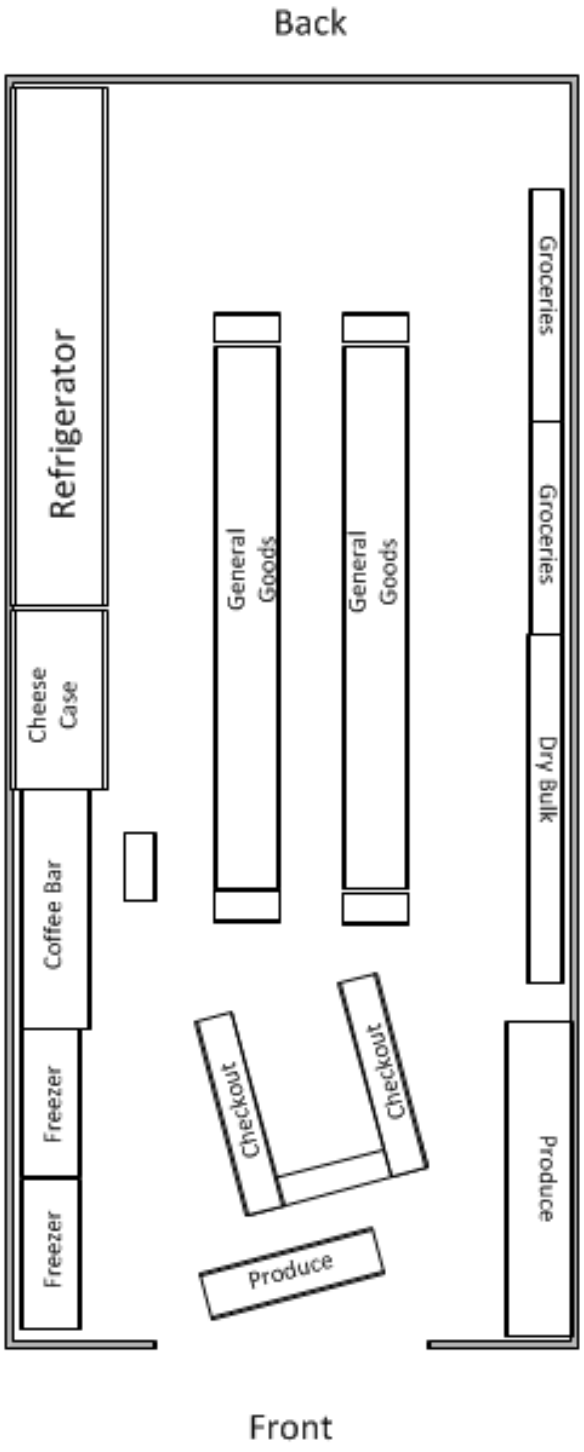
| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Operation: Lucy's Smoothies | | Date: 5/3/2016 | | | | | | | | | | | | | | | | | |
| | Observer: Sean M. & Hiro F. | | Start Time: | | | Working Conditions: Normal | | | | | | | | | | | | | | |
| | | | End Time: | | | | | | | | | | | | | | | | | |
| | | | Cycles | | | | | | | | | | | | | | | | | |
| | | | 1 | | | 2 | | | 3 | | | 4 | | | Average | | | | | |
| | Element | Notes | OT | PR | NT | OT | PR | NT | OT | PR | NT | OT | PR | NT | OT | PR | NT | OT | PR | NT |
| 1 | Collect Ingredients | | 15 | 100 | 14.7 | 29 | 100 | 29 | 50 | 100 | 50 | 34 | 100 | 34 | 25.54 | 100 | 31.9 | | | |
| 2 | Blend Drink | | 13 | 100 | 13 | 7 | 100 | 7 | 12 | 100 | 12 | 12 | 100 | 12 | 8.80 | 100 | 11 | | | |
| 3 | Take Order & Money | | 51 | 100 | 51 | 61 | 100 | 61 | 51 | 100 | 51 | 36 | 100 | 36 | 39.80 | 100 | 49.8 | | | |
| 4 | Pour/Give Drink | | 20 | 100 | 20 | 27 | 100 | 27 | 28 | 100 | 28 | 36 | 100 | 36 | 22.20 | 100 | 27.8 | | | |
| 5 | Get Receipt | | 15 | 100 | 15 | 15 | 100 | 15 | 60 | 100 | 60 | 27 | 100 | 27 | 23.40 | 100 | 29.3 | | | |
| 6 | Wash Blender | | 3 | 100 | 3 | 3 | 100 | 3 | 2 | 100 | 2 | 3 | 100 | 3 | 2.20 | 100 | 2.75 | | | |
| 7 | Put Dirty Blender in Sink | | 11 | 100 | 11 | 13 | 100 | 13 | 10 | 100 | 10 | 11 | 100 | 11 | 9.00 | 100 | 11.3 | | | |
| Total | | | 128 | | 128 | 155 | | 155 | 213 | | 213 | | | 159 | 123.93 | | 164 | | | |

| | |
|---|---|
| Total Allowance: | 10 |
| Total Observed Time: | 496 |
| Total Normal Time: | 655 |
| Average Normal Time: | 131 |
| Standard Time Per Unit: | 144 |

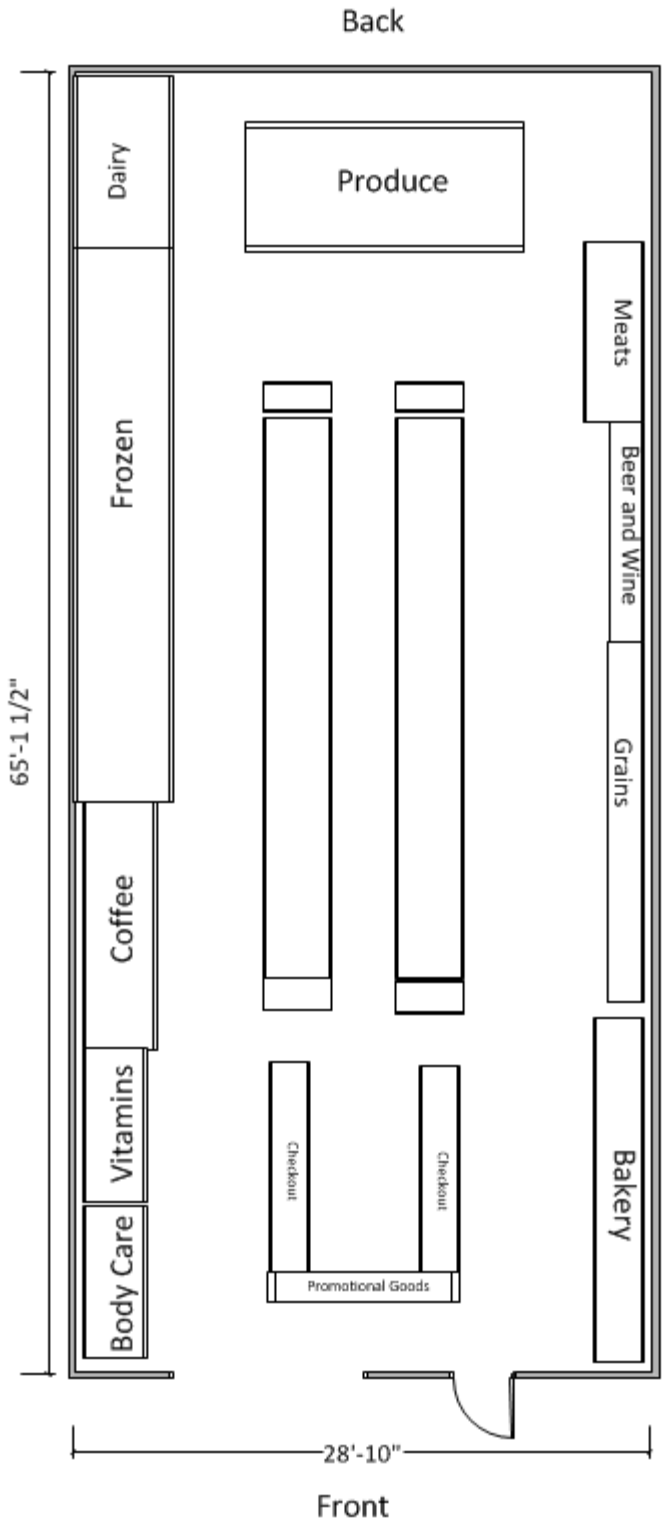
*Appendix G: Lucy's Benchmarking*


*Appendix H: Deli/Smoothie Current State Model*

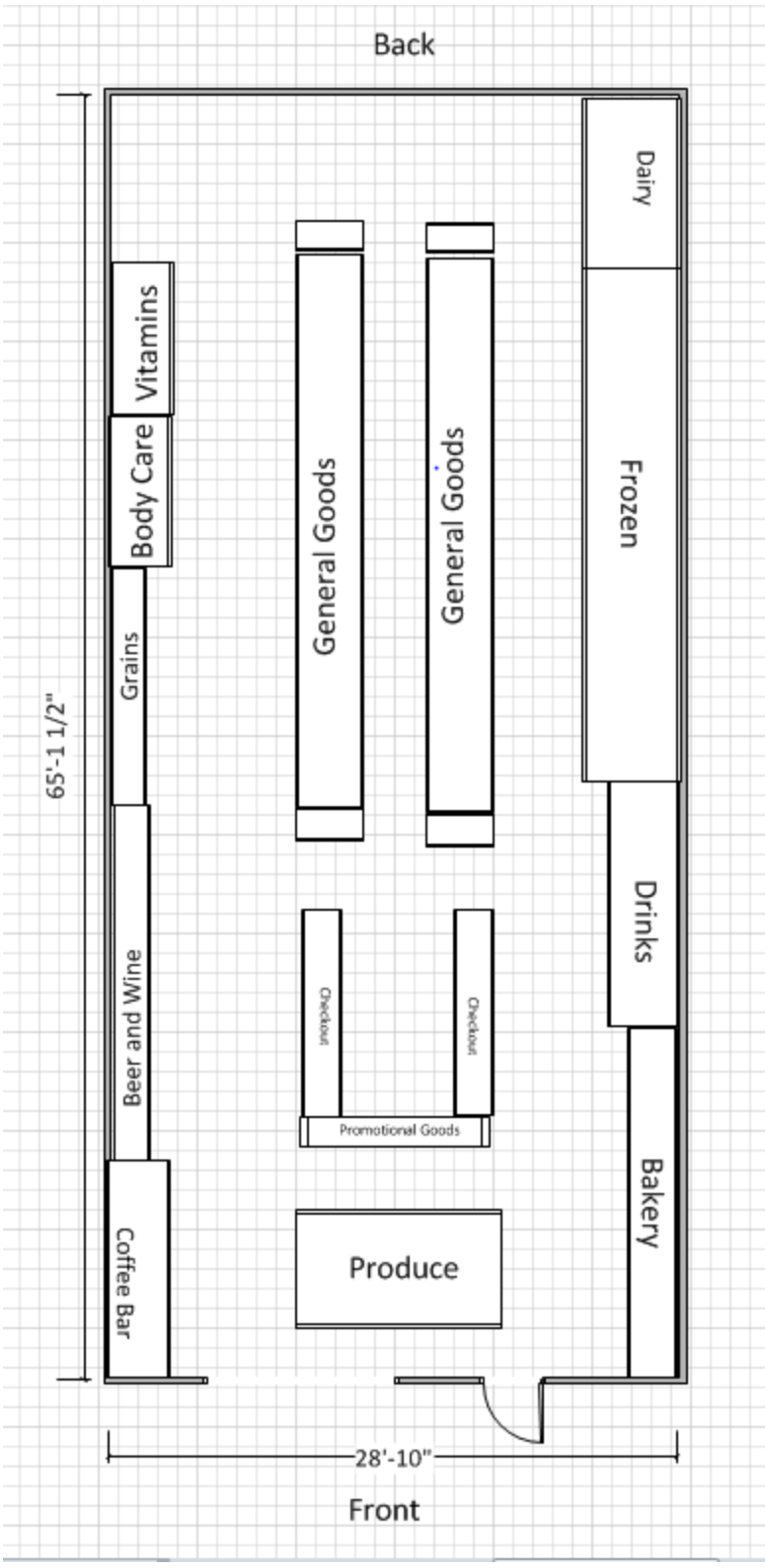

*Appendix I: Revised Deli/Smoothie Area*



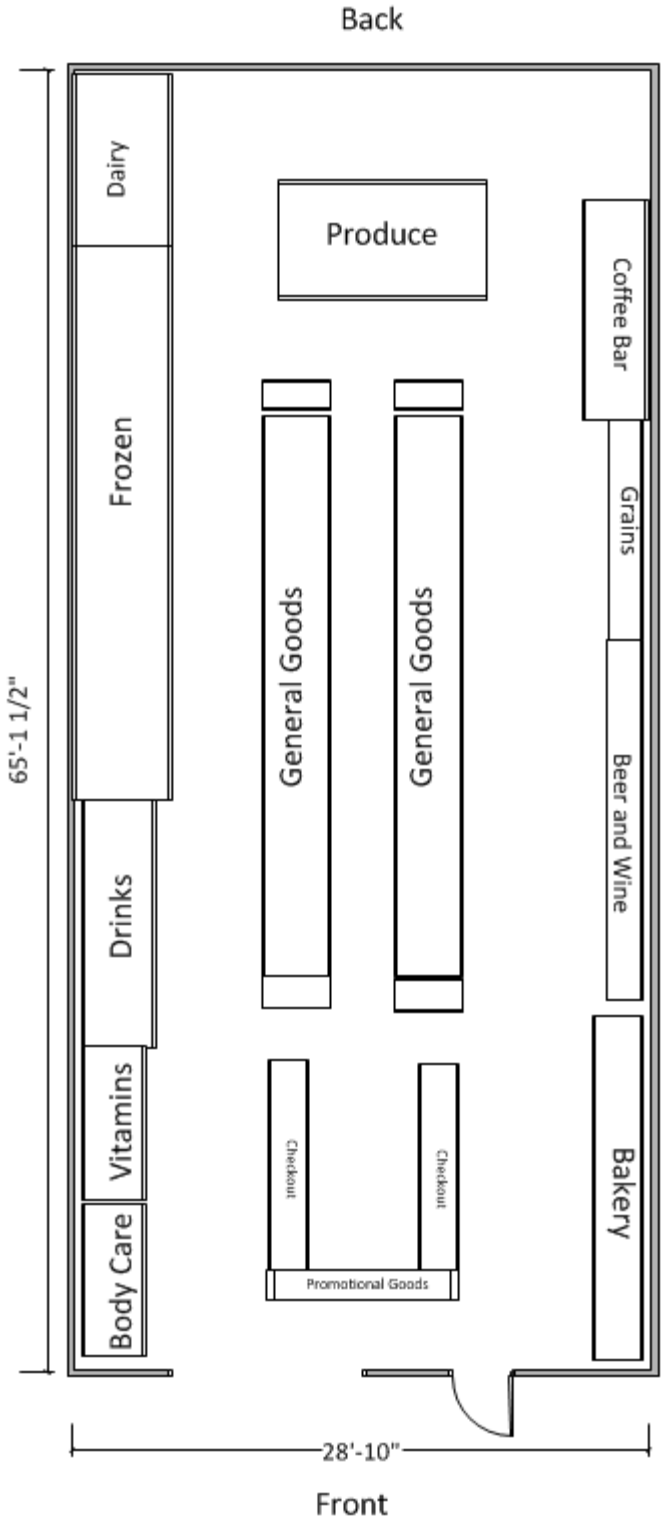

*Appendix J: Grocery Current State Layout*



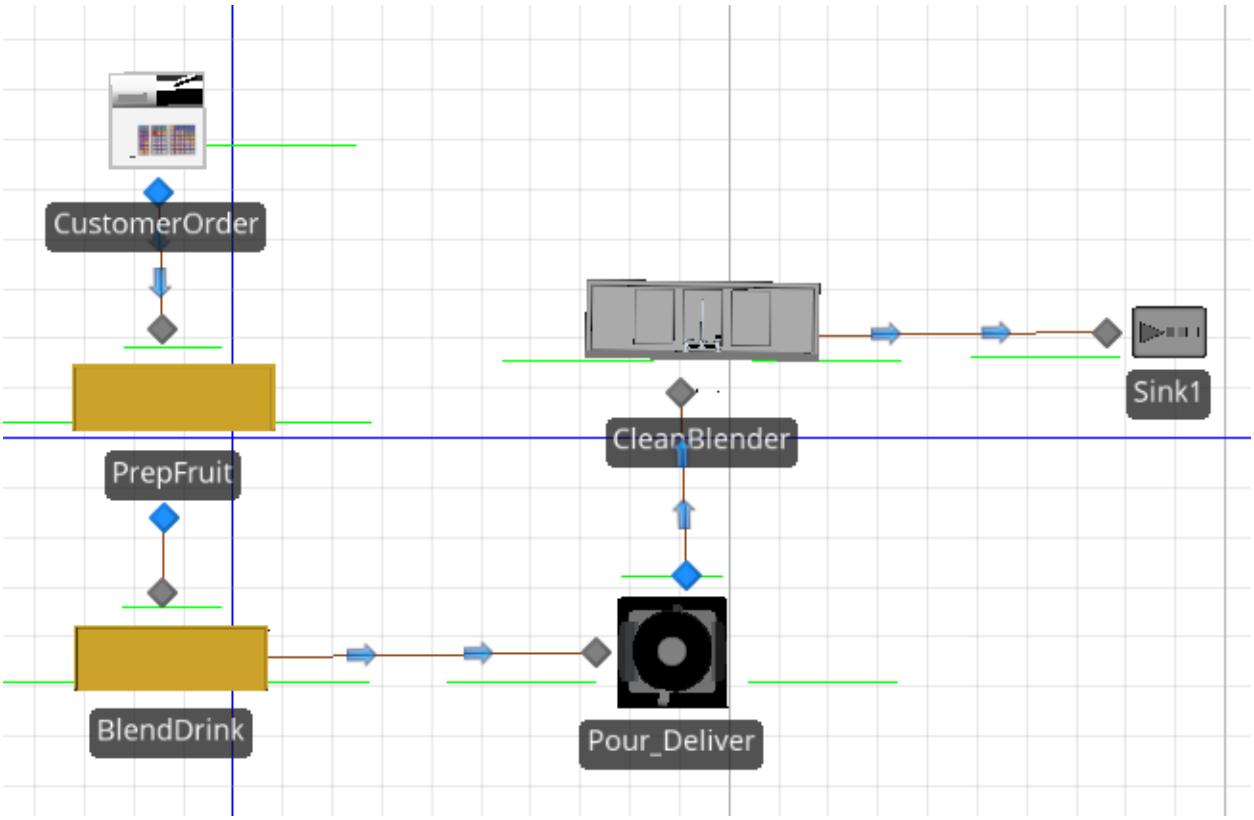

*Appendix K: Grocery Design Alternative 1*



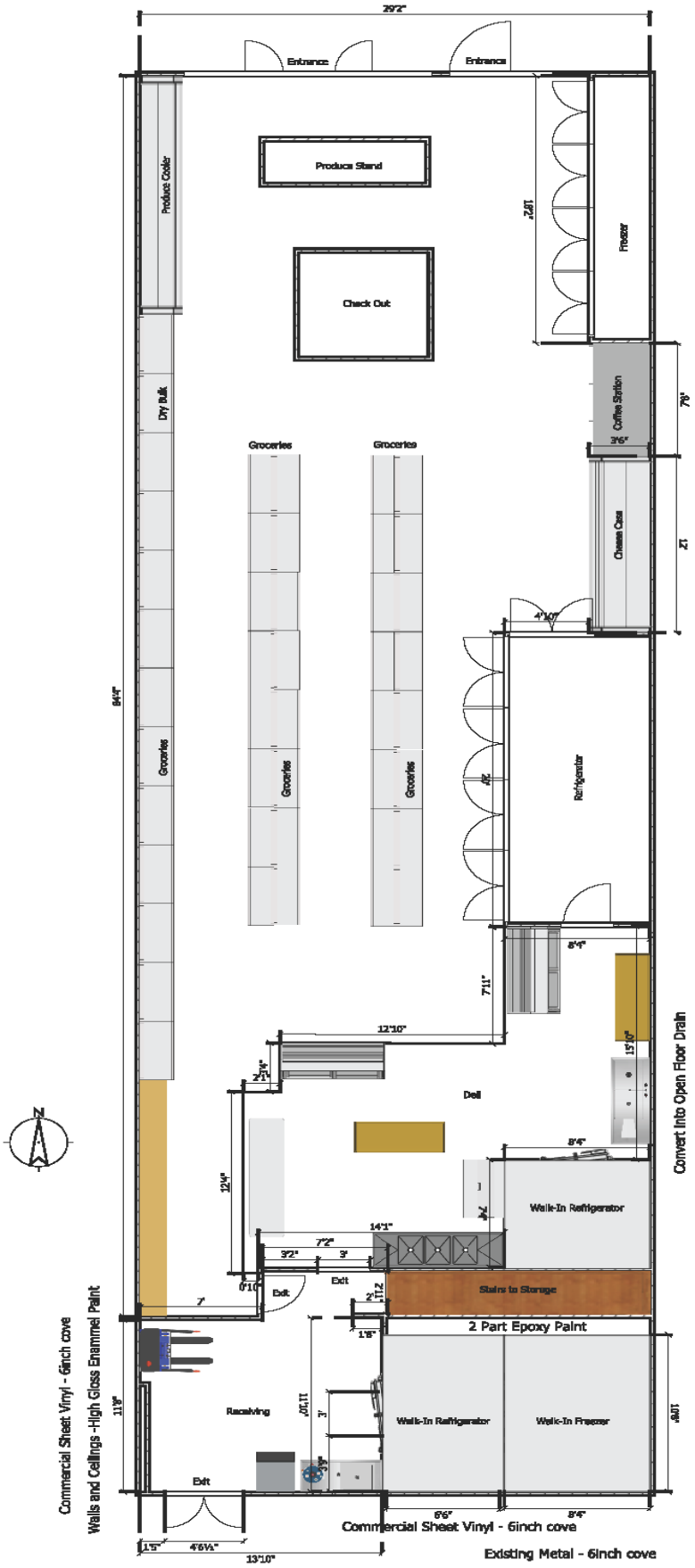

*Appendix L: Grocery Design Alternative 2*



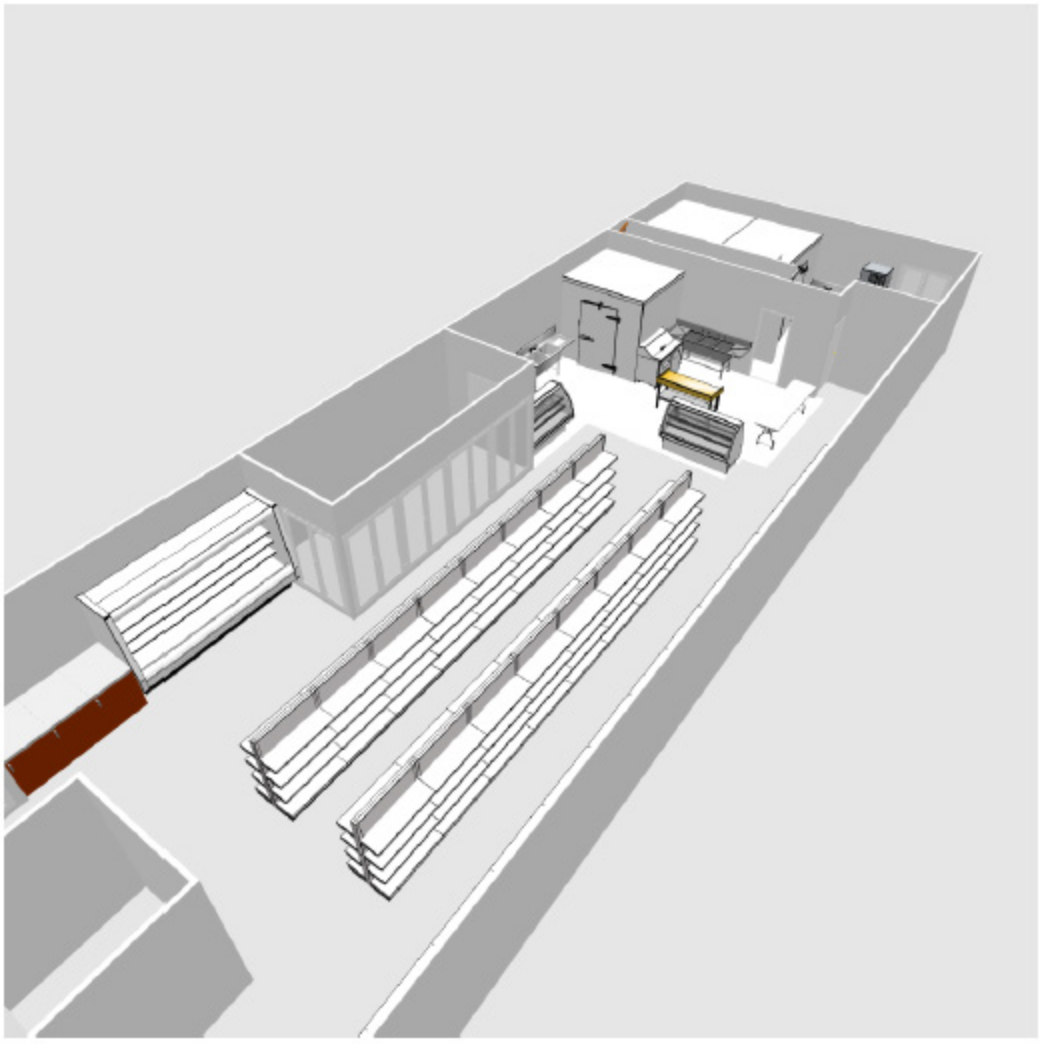

*Appendix M: Grocery Design Final Alternative*




*Appendix N: Smoothie Area Simulation Model*




*Appendix O: SweetHome3D CAD Model*



*Appendix P: SweetHome3D CAD Model II*