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Continuous Improvement of a Food Pouch Production Line

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Abstract

The purpose of this project was to increase the overall equipment efficiency of a food pouch production line at a United States Company. It will be called Alpha company. Alpha company is a large provider of shelf stable foods to the U.S. military and well-known food companies. The factory has a wide variety of lines, but the focus of this study will be a food pouch production line. The line will be called Line 1. Line 1 makes shelf-stable food pouches for major companies. The daily target overall equipment efficiency (OEE) is 60%, of which the line consistently falls below. This is due to low availability and performance of the machine. Case studies from research papers concerning the OEE of food production lines were studied to see areas Alpha company might be lacking in and how they could improve. A cross functional team met every Tuesday and Thursday of the week to define problems and to discuss action steps and problems they had with completing the assignments. There is no one problem Line 1 experiences that would greatly improve efficiency on the line, so the team divided up tasks and worked individually and together to improve the line. This project focused on the period of November 1, 2022, to January 31, 2023. At the end of the study Line 1 was still not consistently hitting the daily goal but due to the nature of continuous improvement the team will continue to meet and address problems as they occur until the line is discontinued.

List of Figures

Table of Contents

1 Introduction

Alpha company is a manufacturer and supplier of high-quality shelf stable foods of major branded food companies, food service providers, retailers, and the United States Department of Defense. The company is proud to support the community through social initiatives such as the Wounded Warriors Foundation, Race for the Cure sponsorships, American Heart Association Go Red sponsorships among many others. Current products made include meals-ready-to-eat (MRE's), cauliflower rice, coffee shots, condiment cups, baby food, and chicken pouches.

1.1 Objective Statement

The objective of this project is to:

Increase the overall equipment efficiency (OEE) of the production line at Alpha company through continuous improvement to the target value of 60%.

1.2 Process Design

This project is an example of process design. Process design is creating and implementing systems that convert inputs to outputs. It includes:

1. Define the Problem
2. Analyze the Problem
3. Generate the Alternative Solutions
4. Evaluate the Alternative Solutions
5. Select the Preferred Solution
6. Implement the Design

Since the production line had many problems, this process was used frequently throughout the time of this project.

1.3 Stakeholders

Stakeholders include the company, Alpha company, and the engineers, maintenance workers, and operators working on the production line.

1.4 Report Overview

The remainder of the report will include what overall equipment efficiency is and how it is used to measure manufacturing production line performance of a specific food pouch production line at Alpha company known as Line 1. Insights from literature were used to determine some potential steps to fix the efficiency of the line. Data was collected through software called Redzone and analyzed to determine how to improve the overall equipment efficiency score. Some steps team members took to reduce the problems were discussed and the progress made on the machine. Finally, lessons learned, and future steps were mentioned since this is continuous improvement and there is no end date for this type of project.

2 Background

2.1 Motivation and Need

Alpha company, located in the United States, is one of the largest providers of Meals Ready-to-Eat (MREs) to the U.S. Military as well as shelf-stable, thermo-processed food to well-known food companies. Several products besides MREs include chicken packets, baby food, cat food and coffee shots. Alpha Company's goal is to provide safe, high-quality products on schedule at the lowest cost possible while following relevant federal, state and local laws.

One line in need of improvement is Line 1. The motivation for this project is driven by the fact that the OEE of Line 1 in November of 2022 consistently hovered around or below 40% which is low for manufacturing productivity. The line has decreased availability and levels of performance that could be fixed by accurately collecting downtime information and addressing the problems causing the downtime. The result of low OEE means the engineers have trouble keeping the line running and meeting demands the company requires. The typical OEE of most manufacturing plants is a daily value of 60% which is a good beginning goal for Line 1.

2.2 Important Terms

Important Terms used throughout this report include:

2.2.1 Overall Equipment Efficiency (OEE)

The gold-standard for measuring manufacturing productivity. OEE considers three factors: availability (A), performance (P) and quality (Q). These factors are multiplied together to get OEE. 100% is considered perfect with zero waste while 85% OEE is world class with only 15% waste. 60% OEE is a typical value in manufacturing plants while 40% OEE is on the low end with over 60% waste.

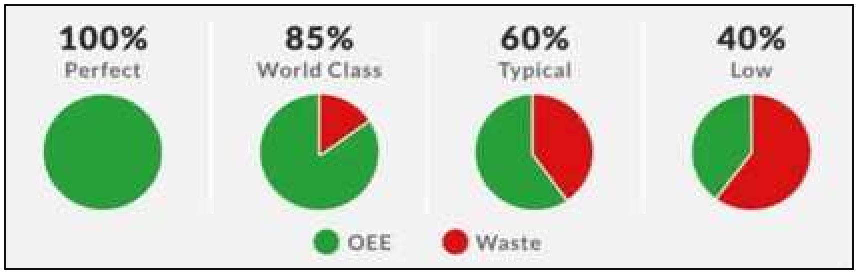


Figure 1: OEE Standards of Measurement

2.2.2 Line 1

This machine seals food product in various sized pouches such as 2.6oz, 4.6oz, and 10oz. A German company makes the machine and Alpha company has taken to calling machines by who manufactures them. Two products that the line makes are shown below in Fig. 2. On the left is a 10 oz packet and the right is a 2.6 oz packet in product 2 (redacted for confidential reasons).

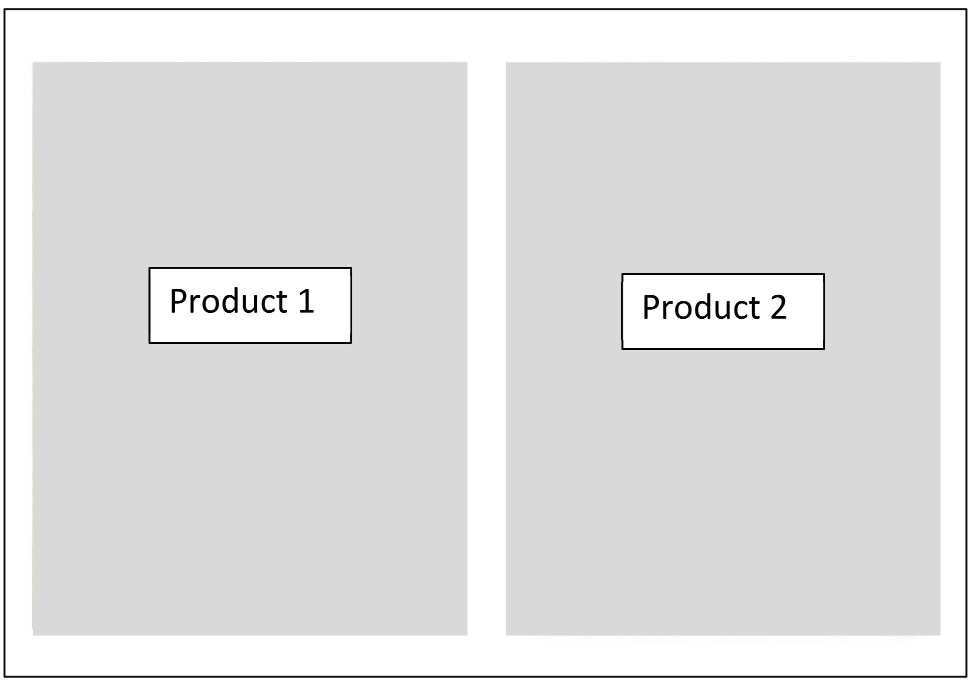


Figure 2: Products from Line 1

2.2.3 Baseline Documents

This usually consists of a word document with pictures documenting the different settings of the machine when the machine has been running for a week with relatively low downtime. When the machine experiences downtime higher than normal maintenance can look at the baseline documents to see if the settings are correct.

2.2.4 Standardized Work Element Sheets (SWES's)

These are created in Excel sheets to document processes the operators, maintenance, and engineers use when operating the machine or fixing a problem on the machine. These are useful so if all personnel leave the company that know how to do the process new employees can look at the document to understand how to interact with the machine. These are also used as training tools.

2.3 Engineering Problem

Line 1 line was designed for pumpable food products with pouches of varying sizes. Lack of accurate data collection, lack of communication, faulty equipment, and lack of proper training contribute to high downtime and low overall equipment efficiency (OEE). Preventative maintenance is not getting done due to lack of discipline in the maintenance department or no clear instructions for preventative maintenance. Lack of communication occurs between departments such as the batching area and kitchen area or between operators, engineers, and maintenance. The operators do not know how to communicate problems to engineering or maintenance and the engineers do not train the operators how to communicate what the problems are. These issues were found by talking to the line operators and engineers that work on the line.

2.4 Constraints

One type of non-engineering constraint includes cost. Sometimes the problem will not be big enough to justify the cost. Managing operators and coworkers in other departments could be another struggle or there may not be enough people to help carry out the suggested operations. People may not agree with the procedures and be unwilling to carry out the proposed steps. If parts need to be ordered for the improvements the vendors may be slow in delivering them.

Engineering constraints of this project will mainly deal with OEE. The three parts of OEE include performance, quality, and availability and make up OEE by being multiplied together. Quality is already close to perfect so instead of focusing on improving quality it is more important to fix the availability and performance factors. The space given in the factory is another constraint that cannot be easily changed.

2.5 Past Projects

Similar issues were reviewed to provide insight into how OEE could be improved. There was no situation the same as Line 1, but other factory operations could be studied to inspire change at Alpha company. The following studies deal with OEE of food production lines that discuss what the factories are doing wrong and how they improved.

2.5.1 Study of OEE of a Croissant Production Line

This line studied over a 15-month period was from one of the largest European manufacturers of bakery products with 13 processing lines for croissants. The purpose of studying OEE on the automated croissant line was to determine which area needs the most improvement for availability (A), quality (Q), and performance efficiency (PE). World-class performance is considered A>90, PE>0.95 and Q>0.99 to give an overall OEE>0.84. There were eight workstations in series subject to external failures and a ninth workstation with infrequent but significant failures affecting the whole line. The types of failures included mechanical, electrical, hydraulic, and pneumatic [1]. The same failure mode could occur in different workstations.

The line operates 24 hours a day in three 8-h shifts. Over the period 88.14% was successful production while 5.53% of the downtime was due to scheduled interruptions and 6.33% due to unscheduled interruptions. To reduce the unscheduled downtimes, one suggestion was to implement total preventative maintenance (TPM) during the operator's coffee and lunch breaks since the machine is scheduled to be down at that time already. Other ideas include part replacements earlier than failure, training and education programs for operators and having back up spare parts in inventory. Workstations 2, 3 and 7 had the highest maintenance time ratios meaning the maintenance strategy needed to be reviewed and changed [1]. By collecting OEE data, areas of improvement can be identified and acted upon.

2.5.2 OEE Evaluation for an Automated Ice Cream Production Line

The goal of this study was to compute OEE in an ice cream production line to evaluate the current operations management. A European dairy manufacturer made ice cream on 11 processing lines but only one line was focused on for the study. The movement of material was done automatically by machines and production was scheduled in one or two consecutive shifts a day. Once the machine starts it must produce continuously or the ingredients will spoil or not meet specification. Scheduled interruptions by management are not included in the shift time and meal breaks are done by staff turnovers.

468 failures were documented during the 199 working days or eight months [2]. The line produced 89.48% of the time while scheduled and unscheduled interruption accounts for 3.54% and 6.97%, respectively. The most frequent problem was reduced speed (42.4%) caused from exhausted equipment, tooling wear, blocked sensors, operator inexperience and other factors. These can be fixed by planning maintenance programs, identifying constraints in the process or training and education programs for operators, workers, and technicians. Unscheduled interruptions contributed 34.6% of all the losses. These result from downtime caused by unexpected breakdowns, tooling damage, equipment failure and unplanned maintenance. A TPM program could fix this. The third largest loss was scheduled interruptions at 17.6%. These are attributed to: changeovers, setup, process warm up, adjustment, material shortage and operator shortage and can be fixed by scheduling changeovers earlier in the day or having setup during the workers' break. The last problem with 5.4% of losses was related to defective products and can be fixed by having operators clean the equipment before starting production [2]. The conclusion was that TPM would fix many of the problems and increase OEE. The study did not tell if the company implemented TPM or if it was successful.

2.4.3 Total Productive Maintenance Framework for Alpha Company

Alpha company, located in the United States, is a leading manufacturer of common personal care products such as toothpaste, laundry detergent and packaged food products as well as other items. The goal of this research was measuring the impact of TPM on unplanned downtime and other losses caused by underperforming equipment and people. The line studied was operated by three workers and five semi-autonomous machines.

Brainstorming exercises involving the operators, a swim lane process map, a pareto analysis and stability analysis of the line were guides to find sources of productivity waste. An important aspect was involving the operators in the decision-making so they would be less resistant to change in the procedures.

One step to fix the line includes training and education programs for the operators to educate them on the problems that result from speed losses. Another possibility is a TPM program involving lubrication, adjusting conveyor belt tension, tightening bolts, cleaning, and carrying out inspections. The result of the study caused a reduction of 39.62% in unplanned downtime and even though it was not the focus of the research, OEE improved by 26.67% [3]. A pitfall of the study was not all eight TPM pillars were implemented, and this could have increased the OEE by a larger percentage. However, the OEE still increased, and production line workers became empowered and motivated because of the changes implemented.

3 Insights from Literature

Summarizing the findings from the three studies, even though the production lines made different products OEE can be increased by following the same steps. Implementing TPM during scheduled downtime, replacing parts before failure, having backup spare parts in inventory when something goes wrong, and training and education programs for the operators would apply to all three production lines. This is a comparable situation to Line 1. Through weekly meetings it was determined TPM is not getting done, parts often fail and there are no replacements in stock and training of the operators is not as effective as it could be. The operators are not empowered, and maintenance complains there is not enough time in the day to complete all work orders for TPM. Ways to improve the line will be considered in Section 4.

4 Process Design

4.1 Data Collection

To begin this process, the team needed to define the problem. The problem was low OEE due to decreased availability from unplanned downtime and low levels of performance that could be reduced by accurately addressing documented problems. A key tool the company already had in place to track OEE was Redzone software. Redzone uses real-time, mobile communication so team members from different departments can see what the OEE looks like for that day and the causes of low OEE. How it works is an operator on the line has an iPad with the Redzone app and when downtime or a problem occurs the operator enters in how long the line was down for and what caused the problem. Engineers and other members of connected production lines can look at the data and see when downtime is happening on the line and the cause of the downtime.

If the machine is running at a lower rate than normal, team members can also see this and the reason why.

Figure 3 is an example of the beginning of an end of shift report Redzone generates for January 12, 2023. There are two shifts, and this was shift A on Line 1 at the Alpha company site. The start time was 8:00 am and the finish time was 4:08 pm. A total of 88,132 pouches were produced and 88,249 pouches were put into the machine leaving a total of 117 pouches lost. Man hours during the shift were 48.82 with a total of 6 workers. OEE for the day was 60.2% which was 0.2% above the target. Performance of the machine was 79.9%, quality was 99.9%, and availability was 75.4%. The total uptime was six hours and eight minutes while the downtime was two hours. The name of the lead operator is listed but is crossed out in this report to conceal the identity of the operator. The start of the machine was delayed by three minutes.

Shift Report Redzone

W2 • Jan-12-2023 8:00 AM

Shift	A.	OEE	60.2%
Site	Foods	OEE Target	60%
Area	W2 Area	Power Hour	63.3%
Location	W2	Performance	79.9%
Start Date	Jan-12-2023 8:00 AM	Quality	99.9%
End Date	Jan-12-2023 4:08 PM	Availability	75.4%
Produced	88,132 Pouches	Units Lost	-117
In Count	88,249	Uptime	6h 8m 12s
Out Count	88,132	Downtime	2h
Units/Man Hr	1,805.24	Lead Operator	[redacted]
Man Hours	48.82	Start Time	On Time
Avg Crew Size	6	Ramp Up Time	3 Minutes Late

Figure 3: End of Shift Report from Redzone

Equation 1 shows how Redzone calculates quality from the data given by dividing the out count by the in count. The out count is 88,132 pouches while the in count is 88,249.

$$Q = \frac{out\ count}{in\ count}$$ Equation 1

Using these numbers, the result is:

$$Q = \frac{88{,}132\ pouches}{88{,}249\ pouches} = 0.999 = 99.9\%$$

Equation 2 shows how availability is calculated using uptime and downtime on the machine. The uptime is six hours and 8 minutes which is 368 minutes total. The downtime is two hours which is 120 minutes.

$$A = \frac{uptime}{uptime + downtime}$$ Equation 2

Availability can be calculated as follows:

$$A = \frac{368\ min}{368\ min + 120\ min} = 0.754 = 75.4\%$$

Equation 3 shows how performance is calculated using total count divided by run time divided by the ideal run rate. The total count for the day was 88,132 pouches while the run time was 368 minutes (about 6 hours) for the day. The ideal run rate is not listed in the end of shift report but can be found in the Redzone software with a value of 300 pouches per minute.

$$P = \frac{(total\ count)/(run\ time)}{ideal\ run\ rate}$$ Equation 3

Performance can be calculated as follows:

$$P = \frac{(88{,}132\ pouches)/(368\ min)}{300\ pouches/min} = 0.799 \text{ or } 79.9\%$$

Once quality, availability and performance are calculated, OEE can be found using Eq. 4.

$OEE = Q \times A \times P$ Equation 4

OEE is then calculated by:

$$OEE = 0.999 \times 0.754 \times 0.799 = 0.602 \text{ or } 60.2\%$$

By having this number, the factory can judge how well the line is doing and areas in which improvement can be made. Quality is close to 100% so there is not much improvement to be made there. The problem areas are performance and availability.

Also included in the report is what product is being run. In this case it was the 4.5 oz packet. Listed next are the problems the line experienced during the day, where the problem is located, and if the problem was due to performance, quality, or availability. The downtime experienced is listed in minutes and/or hours and the number of pouches lost are also mentioned.

4.2 Data Analysis

4.2.1 Fixing Redzone

To address the problems of Line 1, a cross functional team met every Tuesday and Thursday to discuss how the line could be improved. The team used a downtime pareto generated from Redzone to see where the biggest issues were coming from. Figure 4 shows an example downtime pareto from November 28 – December 3, 2022. A new pareto was created every week so the downtime data could be updated, and the team could see what the largest issues of the week were and if they needed to be addressed.

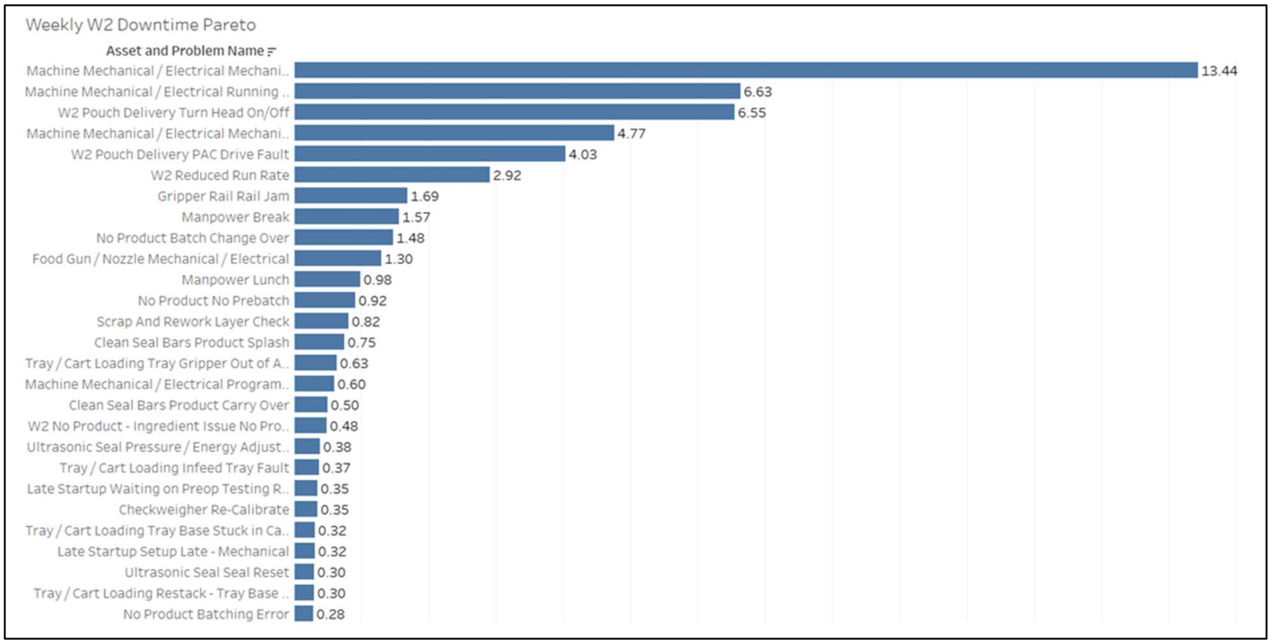


Figure 4: Downtime Pareto for Nov 28 - Dec 3, 2022

One problem from the downtime pareto are the asset and problem names. Over the given time machine mechanical / electrical mechanical error caused 13.44 hours of downtime. A machine mechanical / electrical mechanical error is not a specific problem. When the team looked at this in the meeting there was no clear way to fix this problem because it is not clearly defined. This error could happen on any part of the machine and the operator entered it in this way because they did not know what the real problem was. To increase OEE the team needed clear data collection so the root of the problem could be found and then fixed.

A group of engineers got together to look at the list of possible downtime options the lead operator could select on Redzone and determined which ones were used as a catch-all for problems experienced on the line. The vague ones were eliminated, and new specific options were entered into Redzone. The team met with operators to see if the new options would work and to train the operators to be able to find out what the problem is and select the correct downtime option. This was an important step in tracking OEE and improvement.

4.2.2 The Meetings

A cross functional team met every Tuesday and Thursday at 11:00 am to discuss Line 1. At the beginning, if there were any large problems that occurred during that day or over the weekend those were discussed, and an action item was added to a list, and someone was assigned to it and a due date was tentatively scheduled. Figure 5 shows the meeting template.

Starting on the left in Figure 5 is the meeting date when the action item was assigned. To the right are the problems that prompted an action item to be assigned. Next is the action item and to the right is the person responsible for completing the task. High, medium, or low priority is assigned, and a due date given. Finally, the status of the action item is stated as, on hold, in progress, or complete. The team would start with the first item and discuss how it was going and if the person responsible for it was experiencing any problems getting the task done and what could be done about the problem the person responsible was experiencing.

	Meeting Date	Notes	Action Item	Responsible	Priori	Due Date	Status
4	10/25/2022	Having extra downtime due to having tro remove pouches from checkweigher to re-zero	Check programming and make edits	[redacted]		20-Dec	on hold
9	10/25/2022		Create training guide for W2 operator	[redacted]		1-Jan	In Progress
11	10/25/2022	1880 Videojets are down	Add 1880's to videojet contract list and ensure they are getting PM's completed	[redacted]	High	9-Jan	In Progress
12	10/25/2022	1880 Videojets are down	create standard for videojet setup for each product (stk, USDA, etc)	Lauren		17-Dec	In Progress
14	10/25/2022	Not many standards for machine	Create centerlines and base settings for machine	Lauren			In Progress
17	10/27/2022	Suction cups need to be a bit longer	Trial new pouch pickup suction cups when they arrive	[redacted]		1-Feb	In Progress
18	10/27/2022	When will vacuum pump be moved out of W2 room	Moving vacuum pump to north east corner of the room	[redacted]		24-Jan	
20	10/27/2022	Need spare parts for heat seal station	Provide list of heat seal parts that are needed from updated drawings and send to Austin Ingram	[redacted]		29-Nov	In Progress
24	11/1/2022	Finding a lot of parts that we do not keep stocked	Review parts list from machine and make note of what needs to be stocked. Follow up with Warren	[redacted]		24-Jan	In Progress
25	11/8/2022		Need to go through the job of the final on this line and remove non value add and see what this does to manpower requirements	[redacted]		16-Jan	In Progress
26	11/8/2022	Op check sheets are currently being sent to Ryan D. for review. How can we have these sent to supervisors instead	Can we add supervisors to Redzone	[redacted]		22-Nov	On Hold

Figure 5:Line 1 Meeting Excel Sheet

4.3 Important Steps Taken by the Team

As seen in the downtime pareto, there was not just one problem that would be the fix to improving OEE. Multiple projects would need to be taken on and each individual task would help with the improvements. Various important projects attributed to increasing OEE are discussed in the sections below.

4.3.1 The Carrier Plates

One of the major problems impacting performance was the carrier plates. The object circled in Figure 6 holding the blue pouches is the carrier plate.

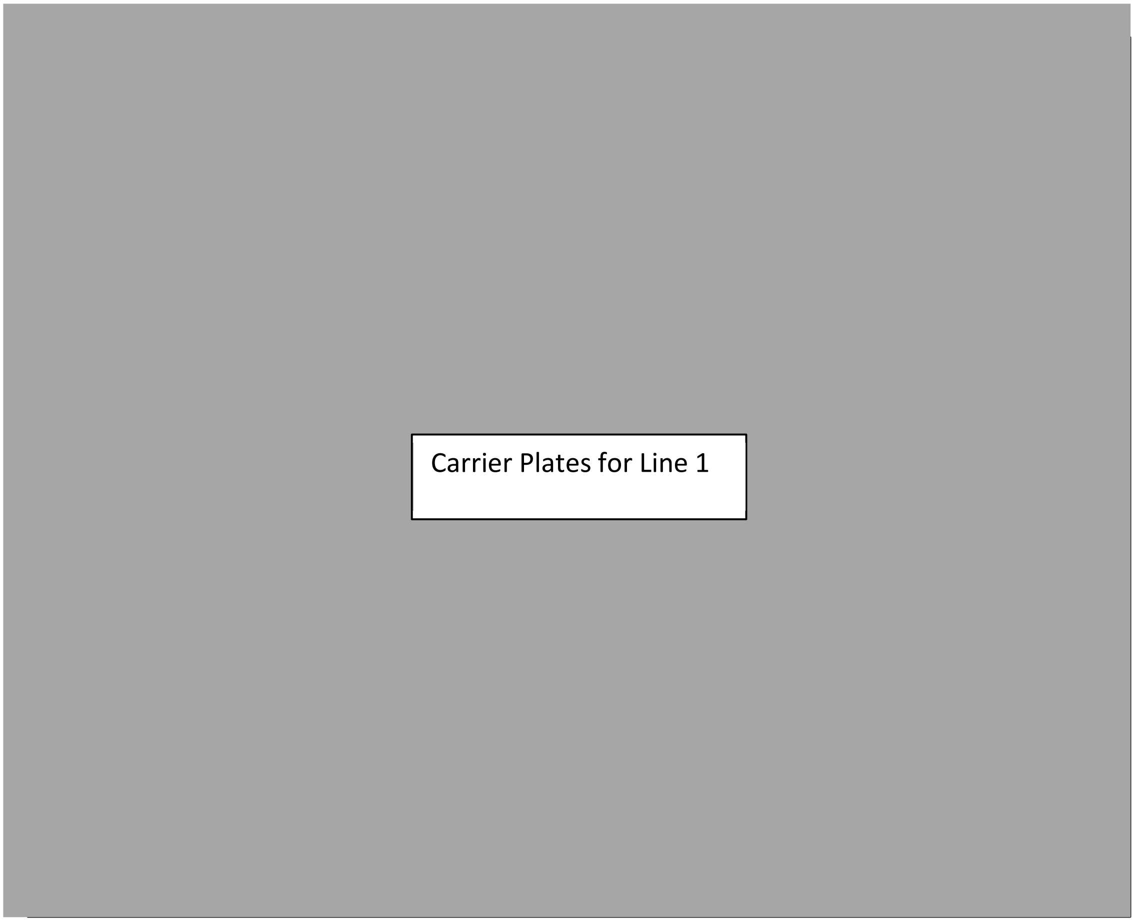


Figure 6: Carrier Plates [7]

The carrier plates consist of metal rods, springs, plastic, screws, and other metal pieces that helped open and close the pouches. They can hold pouches of varying sizes. The one on Line 1 could hold eight pouches. The carrier plates moved down the machine on a conveyor belt.

The problem with these carrier plates was that empty pouches would fall from the machine and get stuck in the conveyor belt system and jam the pouch carriers. The metal rods would then bend, and the machine would stop. The carrier plate would have to be taken off the line and then the machine would not be able to run at full capacity.

The temporary solution the team developed was to buy extra carrier plates to keep in storage to replace the broken ones. At one point there were more than ten carrier plates missing from the machine which reduced the performance percentage for the OEE calculation. This occurred because while new carrier plates had been ordered the lead time resulted in them not being received until the middle of December.

Once the new carrier plates arrived and were placed on the machine there was a noticeable jump in OEE. However, this was only slapping a band aid on the problem. The engineers then started the design of a new foot on the carrier plate that would push out the empty pouches that were causing the problem, but this will not be completed until after the time frame of this project.

4.3.2 Broken Tray Identification and Process

Another important problem experienced on the machine was broken trays. An example of broken trays is seen below in Figure 7. The machine would stack the trays from one conveyor belt to another, but the trays would not stack correctly and cause the machine to shut down. To fix this problem the line operator needed to be trained in what a bad tray looked like and how to remove it. This problem occurred in the infeed/outfeed station which is described in Appendix A.3.

A training document was created and posted on the wall to describe to the line operator what a bad tray looked like. A SWES document was created on where to put the broken tray when one was found, and a process was implemented for someone to come pick up the tray when a stack of fifty trays were placed on a pallet. The spot was marked with signs in English, Spanish, and Haitian Creole since there are many workers who do not speak English. The engineers then figured out how they would be disposed of and how often a full pallet would need to be replaced.

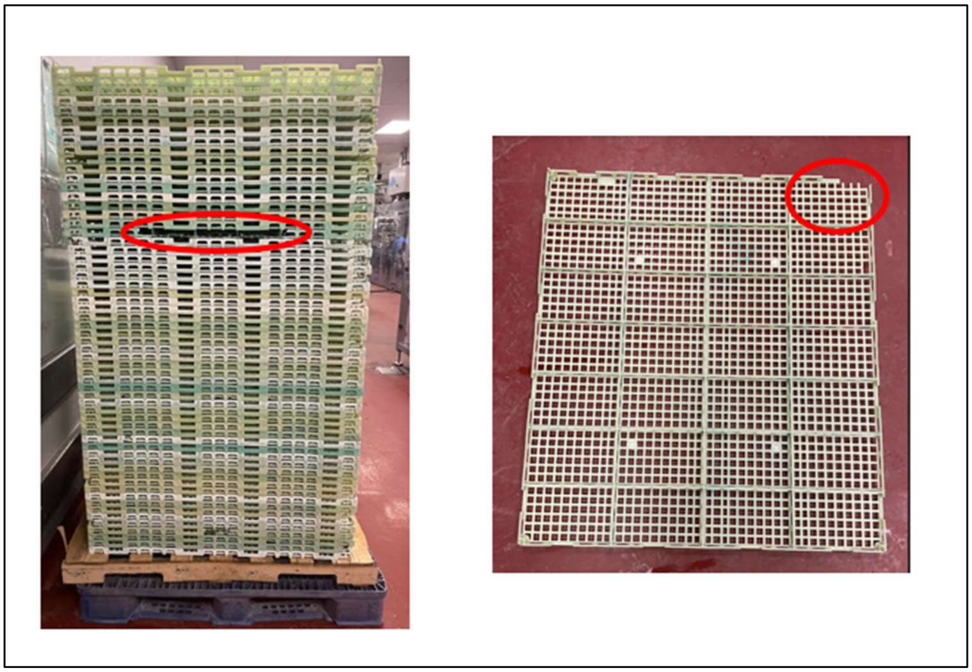


Figure 7: Broken Trays

Once most broken trays were out of the system it decreased the amount of downtime and increased the availability percentage for the OEE calculation.

4.3.3 Baselines and Centerlines

Baselines and centerlines for the machines were critical items that needed to be created. Centerlining is part of total productive maintenance that reduces product and process variability while increasing machine efficiency. At Line 1 this was mainly documenting the zero-point locations and compiling their locations in a word document in a shared drive so maintenance and engineers could see where all of them were located and if they were in the right place. Figure 8 shows an example of one of the baselines that were documented. There were two types, for the one on the left two edges of a metal piece needed to be aligned with one piece connected to the moving machine and the other on a stationary piece of equipment. The one on the right needed two arrows to line up. Once these were all documented their location was also physically marked on the machine in an orange paint marker.

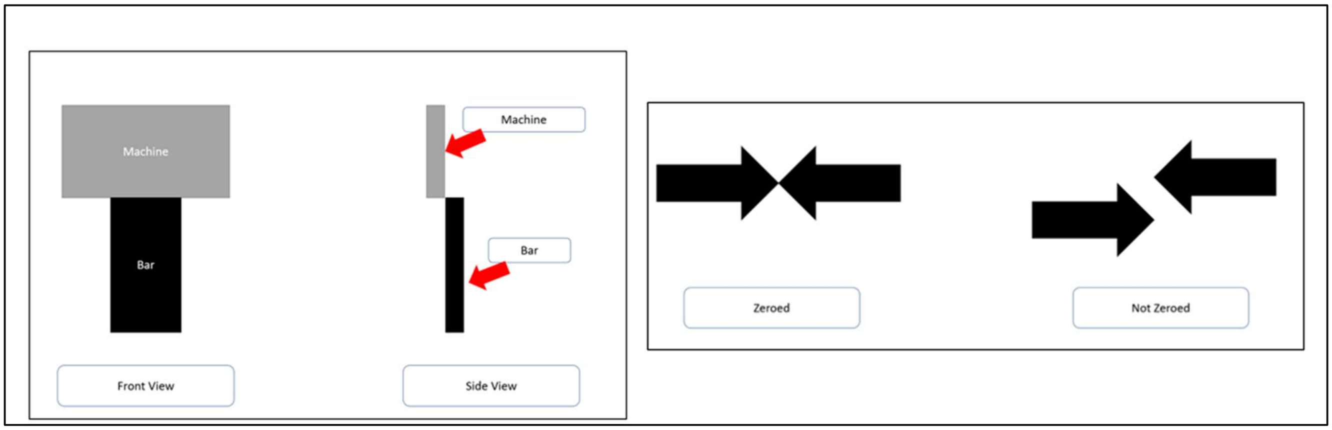


Figure 8: Zero Point Settings for Line 1

Center lining is another way to increase the quality of a product and minimize waste and delays in manufacturing facilities. There are four steps involved. Step one is identifying the important variables in the process; step two is determining an acceptable range for the variable; step three is identifying how these affect the process and product and step four is ensuring the center lined settings are being used during the production process. To do this on Line 1 the following were determined to be important variables:

•Cam & cam profile settings
•List of which stations need to be turned on for each product
•All settings on the HMI's
•Vacuum pressure settings/acceptable range
•Mechanical setup requirements for Videojet
•Incoming air pressure requirements
•Heat seal air pressure requirements
•Ultrasonic seal air pressure requirements.
•Hot water loop temperature range

To get these values the machine needed to be running at an OEE higher than normal for the day (usually around 60% at the time of this study) and then the settings could be taken from the human machine interfaces (HMIs) that surrounded the machine. The settings were then documented in an excel sheet and placed in a shared drive for maintenance members and engineers to look at for when changeovers between different products occurred or to check if the machine was not running as well as it could be on a certain day. Employees were notified where these documents were in the shared drive.

4.3.4 SWES Documents and OPL

One thing done on the line was the creation of SWES documents. SWES stands for standardized work element sheet. These documents set the standards that employees follow for processes on and off the production line. SWES documents can be used to help train new employees to do the same task and it prevents different trainers from telling employees how to do the same task in different ways. Doing so reduces defects and allows for better quality control. Standard work helps everyone an understanding of how future improvements affect the workflow in other processes if the current process needs changed.

Figure 9 shows an empty SWES document. In the upper row left corner the process name is documented and beside it is the name of the line, the area the SWES is for and how often the process in the SWES needs to be carried out. Under work element states what needs to be done, under key points states how it will be done and under reason explains why it needs to be done. To the right under team member motion are pictures of the equipment or area that show visually what the words are describing if there is a chance it will be confusing. Once completed, the document is uploaded to a shared drive and checked over by whoever oversees the department it falls under. If it passes the check, it will be used by trainers to train new employees. Some SWESs documenting key processes will be posted on the machine so employees have easy access to seeing what they are supposed to do. If something is wrong with it, the creator of the SWES will go back and fix what was wrong.

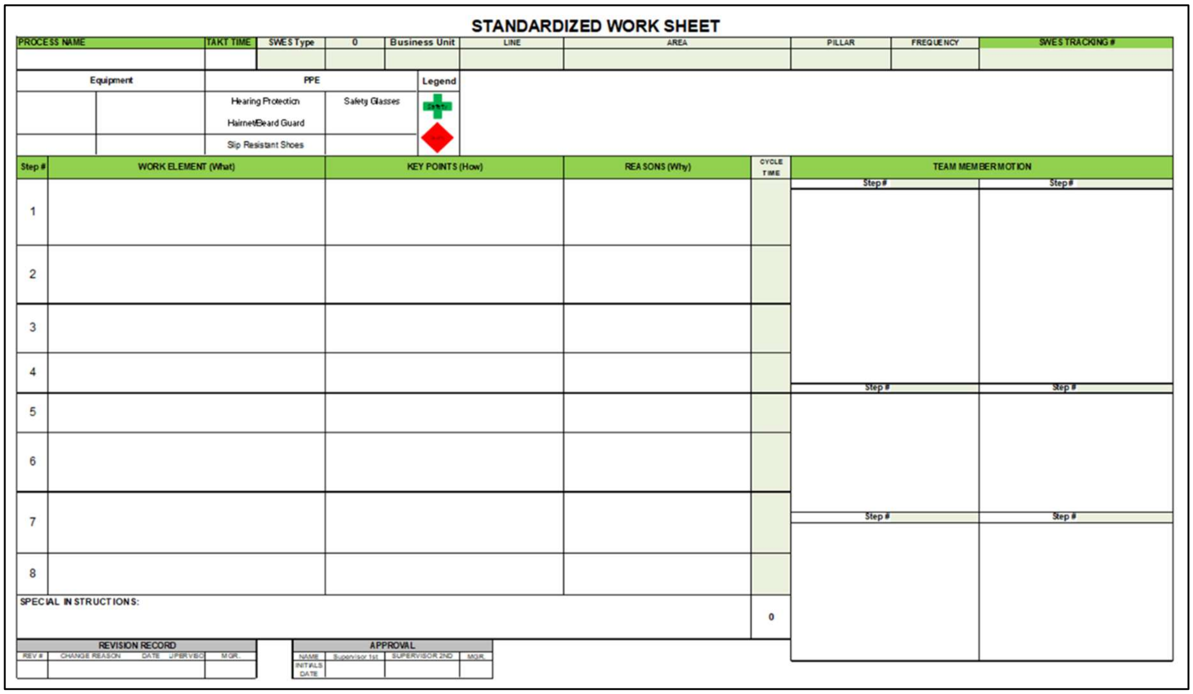


Figure 9: SWES Sheet

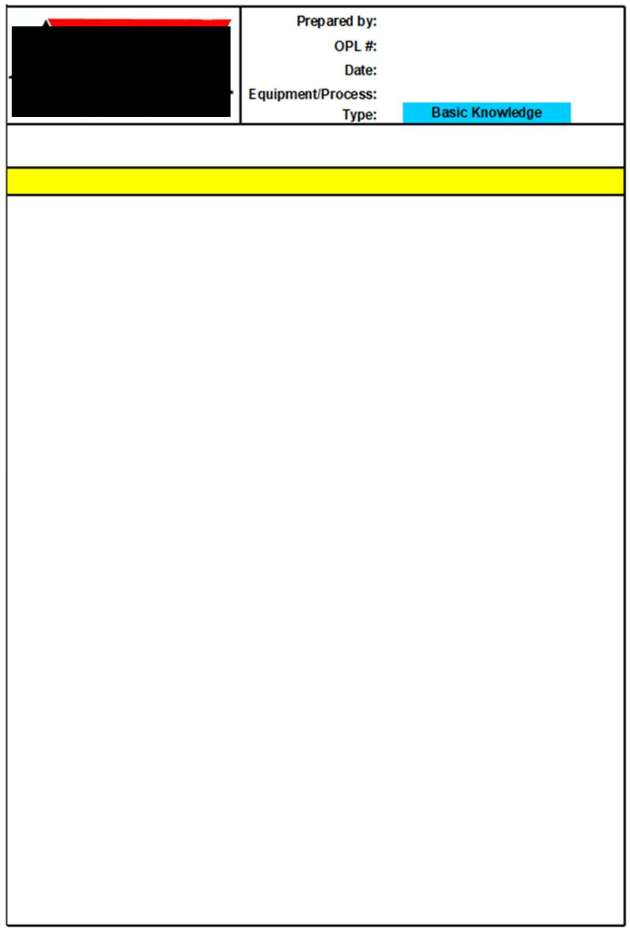
The process to create a SWES is to determine a need for one. A need could result from a new process that needs to be created or existing processes that are already in place but have not been documented. If a new process needs to be created, then a meeting will be held between the people involved in the new process and it will be determined what the new process will be, and a SWES document will be created. Employees will be trained to follow the new standard. If something is wrong with the new process another meeting will be held to determine how it can be better implemented and the SWES document will be updated.

If an existing process is already in place but has not been made into a SWES document the process of creating one is much simpler. The employee in charge of creating the SWES will go to where the process is carried out, find who completes the process (an engineer, maintenance member or line operator) and document the steps needed and take pictures of steps that may be confusing. The following were new SWES documents created for Line 1:

- double pouch sensor verification
- various startup recipe selection
- startup recipe creation

- Line 1 machine setup for the different products
- adjust weight on the HMI screen for the checkweigher
- nozzle flush for the Videojet
- serial setup for the Videojet
- alignment for the Videojet
- set ultrasonic power and energy settings
- checkweigher setup for first and second shift
- SWES documents for another line which affects Line 1

Seen in Figure 10 is a one-point lesson (OPL). This is like a SWES document except it describes processes that are not as complicated as what would go into a SWES document. The process of making one is the same as a SWES document with pictures and words describing what needs to be done. After it is checked the OPL is then printed out, posted on the line, and the employees trained to follow the steps in the OPL.



[redacted]

Prepared by:
OPL #:
Date:
Equipment/Process:
Type: Basic Knowledge

Figure 10: One Point Lesson Template

Some OPLs created for the Line 1 include:

- editing code for the Videojet
- jet alignment for the Videojet
- stopping the Line 1 safely
- identifying broken trays

An important one that decreased downtime on the line was identifying the broken trays. These would cause the machine to be stopped because the trays would not stack correctly, and the machine would stop because they could not be moved down the line. The OPL helped employees determine what the broken trays looked like so they could take them out of the production process and reduce downtime.

4.4 Other Steps Taken by the Team

There were plenty of other steps taken by team members to raise OEE. Some problems only caused insignificant downtime which still needed addressed but did not deserve its own section in this report. Some problems that decreased OEE on the line did not directly occur on the line. Manufacturing is full of interrelated processes and for example if something goes wrong in the kitchen area before Line 1 it could cause a late startup time. The late startup time would reduce the availability of the machine, but the problem did not stem from Line 1. The sequence of operations can be seen in Appendix D.

5 Conclusion

5.1 Progress Made and Future Steps

The problems discussed in this report happened during the time frame of November 1, 2022, to January 31, 2023. OEE was still not consistently above the daily goal of 60% but a steady increase can be seen represented by the yellow line in Figure 11 below. Performance is represented by the blue line and some of its increase can be due to the fixed carrier plates and other smaller problems the team fixed. Availability is represented by the gray line and one of the problems that helped the value of it increase was reducing the downtime in the machine from broken trays. Quality was represented by the orange line, and it was already close to 100% so this project largely focused on availability and performance. Due to the fluid nature of manufacturing, there will always be problems on the line affecting availability and performance. The engineers in charge of the line will need to continue meeting to discuss the problems and what processes can be implemented to fix them. Employees will need to be trained on the new processes. Continuous improvement does not end if the line is still in use.

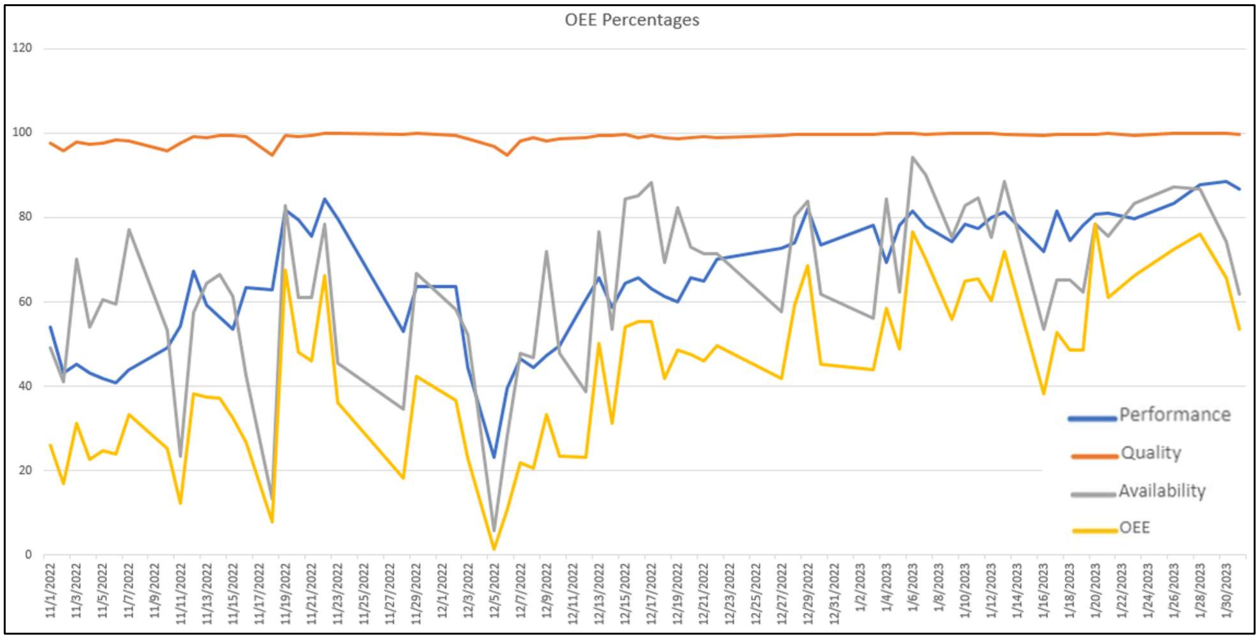


Figure 11: OEE Tracking from Nov 1, 2022 to January 31, 2023

5.2 Work Collaboration with Alpha Company

Working at Alpha company has given me the opportunity to work with people from all walks of life. I was the engineering intern who worked with the Director of Operations and Capital Projects. Working with him I have learned about the continuous improvement process and the collaboration it takes between departments to successfully run a production line. I also worked with a Continuous Improvement Engineer, who worked on the line and other production lines in the facility. He demonstrated the importance of receiving feedback from the operators since they know the machine better than anyone from being down on the line everyday working closely with the equipment. The Maintenance Manager, who I worked with when I had questions on baselines and centerlines. There were several line operators and maintenance members who helped me create and check over SWES documents who I only spoke with briefly but were a huge help in completing work for this project.

5.3 Lessons Learned

There is no one project that boosts the value of OEE. It is a cumulation of small and large projects worked on by individuals and teams to increase the overall equipment efficiency of a production line. The important thing is for the engineers to keep meeting to discuss what the current problems are and how the problems can be fixed. Since new processes will be implemented training will never stop for employees. It is necessary for the processes to be standardized to reduce variability and increase the performance and availability of the machine.

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6) Taken out for confidential reasons
7) Line 1 manufacturing citation

Appendices

Appendix A: Concept of Operations for Line 1

A.1 Top View
A.2 Side View from Operators Perspective
A.3 Top View of Infeed and Outfeed Station

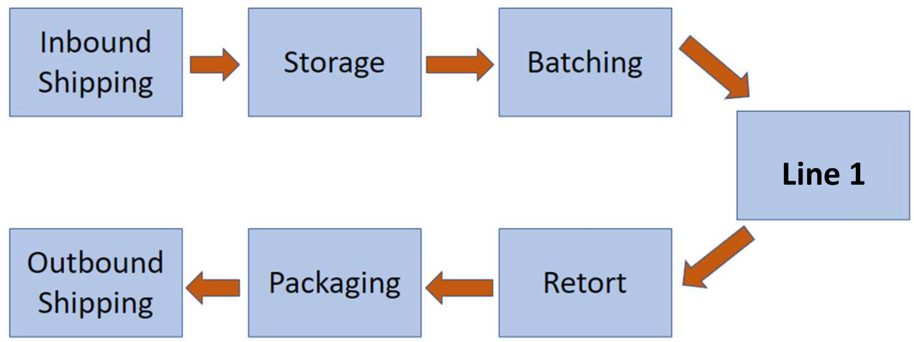
The information given for the steps was taken from the production line machine manual [6] and from the operators and engineers working on the line. The information from Appendix A was taken out due to company confidentiality.

Appendix B: Budget and Schedule

When a budget from Alpha company was requested, no definite answer was given. The engineer explained if the proposed improvements are cost effective, Alpha company will spend the money. Cost effect analysis can be carried out to determine if a proposed cost is worth the benefit. Increased benefit is a loose term, however, if the improvement will pay for itself in a few years by increasing OEE and is safe for the workers, Alpha company has no reason to not carry out the improvement.

Due to the nature of continuous improvement, there is no set schedule for this project. Manufacturing processes are constantly changing with new problems happening randomly throughout the life of the production line. Based on the severity of the problem a due date will be assigned to the team members but no long-term schedule can be made in advance.

Appendix C: Sequence of Operations in the Factory



Appendix D: ABET Outcome 2, Design Factor Considerations

Table D.1, Design Factors Considered

Design Factor	Page number, or reason not applicable
Public health safety, and welfare	1
Global	5, 6
Cultural	14
Social	4, 11, 12
Environmental	N.A. No environmental problems were discussed.
Economic	30
Ethical & Professional	N.A.
Reference for Standards	2, 3