Lean Manufacturing Implementation at Food & Beverage Processing and Manufacturing Facilities

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Introduction

In the spring of 2021, ten New England food and beverage processors and manufacturers took part in a Lean Manufacturing 64-hour certification course focused on reducing pollution at their facilities. The case studies in this report summarize the projects six of the participants engaged in at their facilities to achieve demonstrable reductions in transportation emissions, food waste, water use, and chemical use.

The companies learned about and put the following Lean tools into action:

- Seven Wastes – Searching for forms of waste identifies where you are losing money and resources; often referred to as a waste walk
- 5Ss – methods to simplify and organize your workplace: sort out, straighten up, shine, standardize, and sustain
- Visual Control System – a way to develop a virtual facility where information is built into the workflow
- Kanban Pull Systems – signals used to drive production based on requirements as opposed to forecasts
- Kaizen Event/Idea Board – short-term brainstorming and implementation sessions intended to improve an existing process
- A3 – tool used to solve problems, report on project status, and propose changes moving forward
- Jidoka – a way of protecting your company from delivering low quality or defective products based on four principles to immediately fix issues
- 7 QC tools – a set of tools used to identify and analyze quality issues
- CEDAC – Cause and Effect Diagram with the Addition of Cards allows team members to build on other's ideas
- Poka Yoke – a tool used to mistake proof your process to prevent or detect errors that could lead to defects
- Value Stream Mapping – a way of documenting and quantifying material and information flow within the organization

The case studies in this document capture the information typically collected in an A3 Lean exercise, condensing the results and information from several Lean tools put into use.

> "The Lean course helped me to open my eyes and reevaluate my role as the CEO of my company; in order to make any changes, I need to get out of my office and be on the floor in every department – to understand what is going on and to model what it means to care about reducing waste. It all comes back to Lean and understanding what needs to happen to do things better. In every part of the company Lean has made a difference – and I recognize that is a continuous thing that is never going to end. And I love that."
>
> – Karen Collins, Owner and CEO, Bisousweet

Cedar's Mediterranean Foods, Inc.

Location: Ward Hill, MA
Project: Reducing plastic waste by changing storage containers for toppings

Background
Cedar's Mediterranean Foods has been making hommus since 1981. The facility now produces a wide variety of Mediterranean foods, including spreads, salads, and chips. Cedar's has been growing continuously, doubling the company's square footage in recent years. Cedar's has set a goal of reducing solid waste in order to: 1) show continuous improvement within its Environmental Management System and 2) facilitate solid waste disposal compliance by reducing waste that must be separated from regular trash as much as possible (cardboard, plastics, organics).

Problem to Address
Cedar's has different waste compactors and dumpsters for various wastes generated. Employees are trained by their fellow employees and supervisors to separate the wastes appropriately. Employees must separate food waste, plastics, and cardboard from regular trash. The amount of waste Cedar's produces is increasing as more production lines and buildings are added. Waste disposal has therefore been highlighted as an area for improvement under their Environmental Management System.

Cedar's produced 9.5 million pounds of solid waste in 2020. Waste generation continues to increase as the company grows and it is sometimes challenging for new employees to comply with waste separation procedures. Cedar's aims to reduce total solid waste from 2020 to 2022 by 5%.

Analysis and Countermeasures
Cedar's currently uses plastic pails to store hommus toppings (like caramelized onions and roasted red peppers) that are put on top of some hommus products before closing the containers. Once the pails are emptied, they become solid waste at the facility. To reduce this waste stream, it was proposed that thin film bags be used to hold the toppings which can then be squeezed onto the hommus.

Cedar's purchased 114,000 pails for toppings in 2020. Each pail with its lid weighs 18 ounces and costs $2.26. The total amount of plastic associated with the current process is more than 128,000 pounds. In the proposed new process, each roll of film is 2,500 ft. long, weighs 104 pounds, and costs $245.44. The topping bags will be 1.5 feet long. Switching containers from plastic pails to rolls of film will eliminate 121,000 pounds of plastic waste and save $240,000 per year. The new bagging equipment costs approximately $125,000 to purchase and install. A cost analysis has shown that even with startup costs and utility costs the return on investment will be less than one year.

Implementation and Follow Up
The in-house Engineering Department oversaw the installation of the new bagging machine using the thin film. The bag machine was installed in March 2021 and Cedar's ran a pilot study to fill some bags with toppings to run quality-control shelf-life studies. This step was completed with satisfactory results. The topping bagger was up and running in July of 2021.

Initial calculations suggest that replacing the 114,000 pails and lids used in 2020 with film would result in a reduction of 121,000 lbs. plastic or 9.5 million pounds of total solid waste for an overall 1.2% reduction in solid waste at the facility. To ensure the project is continuously successful, the facility will monitor the amount of pails and film purchased to show reductions in waste.

Cedar's Lean manufacturing team plans to continue to find the areas in the plant where most waste is generated by direct observation of plant operations and waste disposal practices. The team will brainstorm ideas using Lean tools where possible (CEDAC, Poke Yoke, 5Ss) to generate other countermeasures and continue to reduce all forms of waste with an emphasis on further solid waste reduction. The team will also look for areas of improvement related to the use of cleaning chemicals and water use.

Cedar's new bagging machine

Coca-Cola Beverages Northeast

Location: Londonderry, NH
Project: Reducing waste and shipping emissions

Background
The Coca-Cola facility in Londonderry, NH, receives flavoring concentrates in 55-gallon plastic drums as well as 30-gallon and smaller plastic containers. Once emptied in the batching process, the containers are sent for recycling. Coca-Cola uses two types of recycling trailers - one for drums (55- and 30-gallon) and one for smaller container recycling. The trailers travel approximately 60 miles, one way, to the recycling center.

Problem to Address
The batching process generates an average of 55 drums per week and fills a tractor trailer load once per month (though this varies seasonally). Coca-Cola also averages 200 pails or approximately 4 pallets worth of small containers per week. These 4 pallets take up approximately 40% of the trailer space for recycling. Coca-Cola ships the small container trailer loads, which are only partially filled, 2 to 3 times per week.

Nearly empty tractor trailer

Because the containers are empty, Coca-Cola is essentially shipping large volumes of air while attempting to recycle the drums and small containers used in the batching process. In addition, per internal requirements, employees must deface each container, which takes time away from production.

Coca-Cola would like to reduce their trailer space footprint and reduce mileage driven, and therefore the related emissions, by one trailer per month.

Analysis and Countermeasures
Raw data was collected on the types of containers used for the concentrate and the space used for shipping as well as the number of shipments as noted above. It was also calculated that it takes an average of 20 seconds per container to deface it, which averages 1.5 hours per week spent defacing containers – a labor savings if this practice is no longer necessary.

Using Lean tools, Coca-Cola researched several possible countermeasures to help with the shipment of their plastic containers. This included a recycler taking baled drums off site (the baled drums are slightly crushed, reducing the space used by 80%), a supplier taking the used containers to use as input for their own processes, or sending shredded containers off-site. The preferred alternative was to purchase a shredder to reduce the shipping footprint of the plastic containers and eliminate the labor time needed for container defacing.

Eliminating one trailer per month (by shredding the 55-gallon drums) would yield significant emissions savings. Each truck leaves the facility and travels approximately 60 miles to the recycling center – 120 miles roundtrip for one truck from each facility to each recycling center. A truckload weighs 44,000 pounds and gets 6 miles per gallon. Estimating the carbon dioxide emitted per US gallon of diesel to be 2.77 KG, the calculation of potential

carbon savings per trip is 120 miles / 6 mpg = 20 gallons of diesel per month, x 2.77 KG/gal = 55.4 KG carbon per trip (a carbon emission reduction of approximately 665 KG annually).

Implementation and Follow Up

Coca-Cola Northeast continues to evaluate its options and hopes to implement a solution soon. They will revisit this issue in an ongoing fashion as suppliers, markets, and situations change. This will ensure the best plan for shipment is put into place.

Kettle Cuisine

Location: Lynn, MA
Project: Controlling and reducing sodium hydroxide used for cleaning

Background
Kettle Cuisine was founded in 1986 as a specialty soup manufacturer. Today, after multiple acquisitions, the company operates 4 facilities throughout the United States, concentrating in the food service and retail markets. This Lean project focuses on the facility in Lynn, MA.

Kettle of soup at Kettle Cuisine

Problem to Address
The facility currently runs a 24-hour/6 to 7 days per week cooking operation with a capacity of 25 kettles. Each operator is assigned to two kettles at a time. The cooks are responsible for cleaning the kettles between all batches, a process for which there is no well-established standard operating procedure (SOP). There is physical scrubbing involved in the cleaning process and, as required by USDA, there is a deep clean conducted every fifth batch which includes all piping.

Sodium hydroxide (NaOH) is part of the formulation used at Kettle Cuisine to clean cooking kettles. Sodium hydroxide is very corrosive and is dangerous to human health. As business grows and production increases, multiple questions have arisen within the company regarding the use of this chemical and its impact on the safety of the employees. The application of the NaOH formulation to clean kettles is consistent across all cleaning processes, meaning that the same amount of chemical is used no matter how dirty the kettle surface is. Using this method, there is overuse of NaOH, as a kettle with less solids on its surface needs less chemical than a dirtier, more cooked on, surface.

The goal of this project was to develop a set of SOPs to direct the operators cleaning the kettles to using the appropriate amount of chemicals for the job at hand. This would lower the overall amount of chemical purchased, thereby reducing cost while limiting exposure of the operators. It was also a goal to maintain food safety and reduce time spent on cleaning kettles.

Analysis and Countermeasures
Using Lean tools, the facility identified questions to ask about their current practices and how to improve them. These are the questions they established:

1. Are we using excessive amount of chemicals (NaOH) for cleaning?
2. What is the correct amount of chemical for each cleaning application?
3. Are we not using enough chemicals (NaOH) to clean?
4. Can we standardize the process?
5. Can we reduce cleaning time between batches and increase turnover rate?
6. Can we reduce physical strains on those conducting the cleaning by reducing excessive brush cleaning?
7. If we make changes to the process, can we meet sanitation guidelines?
8. Can we replace NaOH with a less hazardous chemical?
9. Can we reduce chemical usage overall?

10. What is the correct percentage of NaOH?
11. How do we deal with the fact that all kettles and operators handle cleaning in different manners?

By analyzing the above questions, Kettle Cuisine was able to establish a SOP "Kettle Cleaning Guide" based on the level of cleaning needed, as shown below. The level of cleaning was derived from the amount of residue left on the kettle surface. Now each cleaning scenario for each kettle can be found in the SOP and there is no interpretation left up to the cook doing the cleaning.

Kettle Cleaning Guide

1. Choose kettle # and Size

2. Identify level of cleaning

LIGHT MEDIUM HEAVY

3. Add water and chemicals based on Step #2

1. Add water
2. Turn on agitator
3. Heat water to 140F
4. Add chemicals to water

4. Bring to temperature range 185-200F

5. Wait 15 minutes

6. Shut energy off and drain

7. Scrub pad for additional cleaning (if necessary)

8. Rinse and drain

9. Fill with cold water for flush

Kettle #	Size (Gal)	Water(Pounds)
T8	300	1200
T10	300	1200
T12	300	1200
BT1	330	1300
BT2	330	1300
DCN 1	400	1600
DCN 2	400	1600
DCN 3	400	1600
DCN 4	400	1600
DCN 6	400	1600
DCN 8	400	1600
T5	400	1600

Light	Medium	Heavy
Red chemical w brush only or	1gal brown chemical NaOH	2 gal brown chemical NaOH
1 gal brown chemical NaOH	1cup peroxide	2 cups peroxide

Kettle #	Size (Gal)	Water(Pounds)
T1	550	2200
T2	550	2200
T3	550	2200
T4	550	2200
T6	550	2200
T7	600	2400
DCN 5	650	2600
DCN 7	650	2600
F1	650	2600
F2	650	2600
F3	650	2600
T11-dcn	650	2600
T9-dcn	650	2600

Light	Medium	Heavy
Red chemical w brush only or	2gal brown chemical-NaOH	2-3 gal brown chemical NaOH
1 gal brown chemical NaOH	1cup peroxide	2 cups peroxide

Implementation and Follow Up

The SOP is now posted in the kettle rooms for cooks to reference when undertaking their cleaning tasks. The improvements seen through this implementation include:

- Reduced material handling
- Improved kettle turnover rate and increased total gallons produced
- Improved worker safety, including fewer strains and burns
- Reduced and controlled chemical costs
- Reduced chemicals sent to the wastewater pretreatment system in house

Kettle Cuisine increased soup production by 32% in 2021, but by establishing this SOP through the use of Lean tools, they have done so with a simultaneous increase of chemical use of only 27%.

True North Ale Company

Location: Ipswich, MA
Project: Water usage and water efficiency at brewery

Background
True North is a brewery founded in 2017 that occupies 15,000+ square feet of space with the brewing process, canning, taproom, patio and event space. The brewery has an interest in and focus on environmental stewardship and aims to reduce their water use through Lean practices. The current usage is well above the industry average of 10 to 15 gallons of water used per gallon of finished product.

Problem to Address
The team at True North has begun researching and measuring water usage at the facility. They are making efforts to raise awareness of the staff in the brewery who control water usage. They have also engaged all floor staff in generating ideas on how to conserve water. They have established that about 15% of their water usage is from the front of the house (restrooms and taproom).

The team also quickly established that washing down floors contaminated with drainage water from the kettles represents a large percentage of overall water use.

The goals of the True North Lean project consisted of the following:

- Implement new standards and practices to maintain cleanliness of the production floor while using less water
- Maintain open communication with all workers, staying open to suggestions
- Meter the usage of water in the facility and track the points of major uses
- Lower the amount of water used per barrel (by about 20 gallons) to achieve the finished product

Analysis and Countermeasures
Using Lean manufacturing tools, True North began to look at and design a plan of action to make the brewery a more sustainable facility, focusing specifically on water. In the process, they used a waste walk to discover that there are more locations in the facility that use more water than initially estimated. True North also employed the A3 tool as a combination of other tools such as the 5Ss and QC tools. They introduced the concept of a waste walk to all employees and management to encourage all at the facility to work towards water conservation.

Implementation and Follow Up
The facility decided to pipe the tanks that are furthest from the drain so that they empty closer to the drain and do not contaminate the floor. This means that the floor does not get as dirty and therefore needs less cleaning. True North plans to continue to push conservation and solicit solutions from staff on how to conserve water throughout the cellar and maintain a sanitary facility in the process.

Tank discharge pipe to drain

Bisousweet Confections

Location: Shirley, MA
Project: Food waste reduction

Background
Bisousweet was started in 2005 in the home of CEO Karen Collins, a baker of custom cakes and cookies. In 2009 the company officially got off the ground with its first wholesale account. It is now a wholesale bakery located in Shirley, MA, making everything from scratch and shipping frozen products. They currently occupy 5,000 sf of manufacturing space with 4,000 sf in an ancillary building used to store packaging supplies. The company is in the process of building out an additional 21,000 sf facility in Leominster manufacturing and storage space, which they are expecting to occupy by the summer of 2022. The products are currently shipped to the Eastern seaboard, Southwest, Northwest and some Midwest wholesale retailers. There are 49 employees, 25 of whom are full time. They also have a robust and growing high school team working the second shift.

Problem to Address
Food waste was the largest pollution or waste issue identified at Bisousweet at the time of the Lean course. The CEO felt that the food waste was impacting profit margins. The company makes products that inherently create waste. Biscotti ends, donut muffin waste, and milk solid waste were all identified as food waste streams that could be reduced.

The goals of the Lean work at Bisousweet were to prevent the waste biscotti ends, waste muffin donuts, and wasted milk solids from going into the trash.

Analysis and Countermeasures
To try to eliminate the biscotti ends from being discarded, the production process was evaluated and it was determined that there were no changes to the process that would eliminate the waste. The biscotti dough is extruded onto a tray for baking, and the ends that are cut off do not make weight needed for sale and do not meet the visual standards of having cuts on both sides of the biscotti.


Biscotti ends

Therefore, the company researched other uses for the biscotti ends, hoping they could be consumed instead of wasted. For some time, they sent the biscotti ends to nearby animal farms to be used as animal food. They then connected with Lovin' Spoonfuls, an organization which rescues food, and together they created a program called "Odds and Ends," in which Bisousweet would bag the biscotti ends and give to them to Lovin' Spoonfuls to distribute to food pantries, shelters, and other charity organizations. Unfortunately, with the combination of COVID-19, high demand for product, and staff shortages, the program has not officially launched. Bisousweet also looked into a program in Boxboro called "Freebie Market," which gives out extra food to those in need for free. They have been collecting bags of their biscotti ends and giving them to the Freebie Market for distribution. However, Collins does want to revisit and launch the Odds and Ends program once the company is situated in Leominster.

An analysis was also conducted at the production line for the donut muffins. The donut muffins are baked and then banged out of the muffin tins. Where they were banging out the muffins, there was a gap in the production/packaging line surface, and donuts were being lost into the gap. The company adjusted the work surfaces to close the gap, increasing production efficiency and reducing waste.

The donut muffins are finished by being dredged in melted butter. However, when using regular butter that separates into milk solids and butterfat, it is only the butterfat that is used and the milk solids are wasted. Collins researched different types of butter and landed on using clarified butter (from which milk solids are already removed) in the dredging process.

Implementation and Follow Up

Biscotti ends: Each day the production of biscotti results in about 13 pounds of biscotti end waste. With a production schedule of 5 days per week, approximately 65 pounds of biscotti ends were wasted weekly. By sending the waste biscotti ends to either Lovin' Spoonfuls or Freebie Market, that waste stream is now diverted from trash to consumers as useful food.

Donut muffins: After watching the muffin packing process, it was determined that a piece of tinfoil could act as a cover between the tables to close the gap where the muffins were falling on the floor. The process which used to generate 5 pounds of donut muffin waste now produces only one pound of waste per muffin run.

Milk Solids: Out of every 55 pounds of milk butter used to dredge the donut muffins, Bisousweet estimated they were throwing out 20 pounds of milk solids. Once they tried using clarified butter, they made the switch and now have zero waste. The old method took 18 pounds of butter (including the milk solids) to dredge; the new method uses 10 pounds of clarified butter. The clarified butter is more expensive, but since less is used, it saves some money as well. Using 18 pounds of regular butter, which cost $2.10/pound, Collins was spending $37.80 per run. Changing over to 10 pounds of clarified butter, which costs $3.65/pound, Collins is now spending $36.50 per run.

As a result of the implementation of the changes noted above, not only is less food wasted at the facility, but steps are being made toward changing the culture at the facility. The old culture did not consider the causes and costs of waste. That is now being addressed and the hope is to call attention to waste generation and the benefits of eliminating food waste streams. If this culture shift happens, there are many other opportunities to recognize and stop waste production at the facility.

The biggest next step at the facility will be to improve communication and transparency – Collins hopes to raise employee awareness about waste issues and recognize that even small changes can making a difference to the business. As the company plans their build-out for a new facility in Leominster, they will be designing the layout and production flow to reduce waste.

Plenus Group Inc.

Location: Lowell, MA
Project: Reducing water use through chiller modifications

Background
Plenus is a soup manufacturer that employs 140 people in a 60,000 square foot facility. Plenus uses water as an ingredient in soup, for surface and kettle cleaning, for the facility sanitizing ozone system, refrigeration, and to chill bagged soup. The three-lane chiller at the facility uses the most water; the unit holds 4,250 gallons of chilled water. When soup bags rip or spill into the chiller, the water needs to be drained, replaced and re-chilled. Bags get ripped when they get snagged between the conveyor belt coming out of the chiller and the conveyor belt leading to the next station.

Problem to Address
When the chiller needs to be emptied, 4,250 gallons of water are sent out as wastewater through the sewer system. The facility pays $0.72/gallon for sewer discharge. Using a Check Sheet Lean tool, the facility was able to document the number of bags getting caught in the conveyor belt coming out of the chiller. The chiller was sometimes emptied out six days a week, due to broken bags caught in the conveyor.

The focus of the Lean project was to find a means to eliminate the bag breakage in the chiller and therefore reduce the frequency of draining the chiller. Reducing water change-over and the need to re-chill the water would also result in reduced energy costs.

Analysis and Countermeasures
An idea board was used to collect ideas for how to deal with the ripped bags, and a check sheet, shown below, was used to quantify the issue. Plenus also plans to implement a visual control system in the near future to help with production efficiency in the three-lane chiller.

Defect Types/ Event Occurrence	Dates							TOTAL
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
Bag rip in chiller		1						1
Bag pulled over end of conveyor		2	2	3	1	2		10

Instructions | Check Sheet-Weekly | Histogram | Bar Chart | Pareto Chart

The quality control and maintenance teams at Plenus have implemented the Lean tools to help reduce water being wasted at the facility. The quality control team first initiated the idea of a skirting system for the conveyor belt coming out of the chiller to keep the bags from being snagged. However, the maintenance team did not think the skirting system would work. They then proposed the idea of lowering the angle on the conveyor belt so that bags would more easily drop off the conveyor and not get snagged underneath.

Implementation and Follow Up

The change in the chiller conveyor belt angle was immediately implemented and resulted in an 80-90% reduction in ripped bags.

Conveyor off of three lane chiller

The facility is now changing the water in the chiller three to four times per week instead of the previous six, resulting in at least 8,500 gallons less wastewater discharged to the sewer. They do still have leaking bags that require chiller changeover; however, these are bags with poor initial seals, not bags being caught on the conveyer.

To further reduce chiller water changeover, Plenus plans to implement Lean tools to solve the issue of poor sealing at the pumping stage, which could potentially save an additional 8,000 gallons of water per week. In ideal conditions they aim to change out the water no more than twice per week.