The Fresh Express Lean Changeover Project

Mario Borbas

Industrial Technology

Orfalea College of Business

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Abstract

In the current economic turmoil, industry leaders across the globe are resorting to means of increasing efficiency without having a large initial investment. Lean manufacturing principles have been adopted by companies because of its ability to increase throughput, lower overhead, reduce waste, and increase the overall quality of products. The value of lean manufacturing solutions has been increasing in the past decade and continues to increase into 2011.

This project is centered on a current situation regarding a changeover process that has recently been made more efficient. The goal is to create new ways to make this same process even more efficient while experiencing the least amount of diminishing returns. This report will discuss Fresh Express' current situation, some past research, a few solutions recommended for higher efficiency, and a statistical analysis proving why the solutions work.

Acknowledgements

Throughout the duration of the course, this project has involved a few people that collectively aided in its birth. The author insists on thanking the technical advisor Dr. Olsen for his guidance and the company contact Todd Hunter for supplying the necessary resources to accomplish the overall objectives. On behalf of the author, thank you for all of the helpful information, guidance, and the experience working with professionals that have mastered their craft.

TABLE OF CONTENTS

LIST OF FIGURES / TABLES

TABLES

FIGURES

SECTION I
INTRODUCTION

Brief Company History: Fresh Express, a subsidiary of Chiquita Brands L.L.C., has brought fresh and nutritious salads to America's tables for over 80 years. The company began in the produce industry back in the roaring 20's in Salinas, CA. Throughout the twentieth century, the company grew into the juggernaut of what is now known as the ready-packaged salad industry. As of recently, Chiquita Brands L.L.C. had acquired Fresh Express in September 2005 involving a deal worth approximately $1 billion. Presently, with the help of the invention and introduction of the Keep Crisp™ bag, Fresh Express is the No. 1 salad maker and leader in fresh foods. Today, its dedication to providing consumers with healthy, convenient and ready-to-eat spinach, salads, and vegetables has stemmed from the ability to manufacture in-house. Fresh Express covers everything from growing, harvesting, washing, packaging, and delivering the freshest, best tasting products possible.

Problem Statement: In working as an intern at Fresh Express' West Plant located in Salinas, CA, I found that their desire and ambition towards continuous improvement is an attribute that the company pride's itself with. Keeping this in mind, I came to be intrigued by the amount of opportunity within their manufacturing processes, specifically the packaging sector. There are many issues pertaining to the amount of downtime, wasted material, integrity of data, and wasted human capital in the packaging department. The problem consists predominantly around necessary downtimes, particularly associated with a certain type of "changeover" process. A "changeover" consists of a machine operator changing the film rolls of products from domestic to Canadian print rolls **or** switching from one type of salad to a completely different one. These certain types of non-value added processes take a significant toll on the bottom line. Changeovers take place multiple times per day; therefore, the problem has a great deal of weight regarding its importance.

Needs: The Kaizen Project will benefit the employee's of Fresh Express in the long run by reducing the overall production cost of their salads. Moreover, with the savings encompassed by the project, the company will increase its profits and become even more competitive in the market. As a student, the project will allow me to explore the short-term effects of lean manufacturing as they are applied to real-world situations. It will teach me how to communicate and understand the variety of variables experienced while implementing these lean manufacturing principles.

The new packaging standard operation procedures and policies must fulfill the following needs:

Table I. Needs Tabulation Chart

#	Description of Needs	Importance Level
1	Eliminate as many non-value added waste as possible	5
2	Ensure that no safety regulations are compromised	5
3	Successful implementation plan	4
4	Avoid the spending of capital	3
5	Ensure that Quality does not diminish	3

Importance Level Scale: Highest = 5 ; Lowest = 1

Avoiding the spending of capital is labeled as a three because the packaging department has already been "leaned" down during my internship. This project is to research and apply more advanced techniques of lean manufacturing to an already "lean" process in order to establish a point where capital must be spent on a process to increase is efficiency.

Background or Related Work: The Industrial Technology program at California Polytechnic State University, San Luis Obispo has been the foundation of knowledge for the author. Three

years of education under the guidance of the professors at Cal Poly have advanced my understanding of today's industrial sector.

Lean Manufacturing, Industrial Materials, Fundamentals of Packaging, and Polymer science are areas of knowledge that are directly correlated to The Kaizen Project. Lean Manufacturing is especially important because many of the rationale and ideology revolved around the decision making process can be attributed to such things as Kaizen, Six Sigma, 5-S, SMED, and DMAIC. These principles of Lean Manufacturing provide the essential tools in observing, identifying, planning a course of action, and implementation of changes that save Fresh Express money.

During my internship experience extending between the months of July '10 - September '10, I was fortunate enough to participate in a corporate mandated "Kaizen Event." The Kaizen Event revolved predominantly around establishing a new standard operation procedure to cut the downtime of such processes in half. The Kaizen Event ended in a success because the new standard operation procedure cut the time from an average of 16 minutes down to an average of 7 minutes and 54 seconds (See Appendix). Though it was a success, my goal is to use lean manufacturing methodologies and bring that downtime to an average of 6 minutes per changeover.

Objectives: The Kaizen Event shall achieve the following goals in order to be considered a success. Goals are ranked by importance.

1. Cut down the downtime accrued by each changeover by an average of 1 minute 54 seconds.
2. Establish set standard operation procedures for new changes.
3. Compare / Contrast statistical data from the current state to the new state.
4. Create an effective implementation action plan that includes a follow-up.
5. Discover the point in which lean manufacturing principles experience diminishing returns.

Cutting down the time that it takes for machine operators to perform the changeover task is the main engine driving The Kaizen Project's engine. This project is going to delve into the effectiveness of additional improvements after a recent Kaizen Event.

In order to establish an effective and efficient standard operation procedure to the packaging department, one must take into account the labor unions that are embedded within this facility. Not only does it need to pass the union's approval, it also needs to be approved by such departments as Quality Assurance and Safety. There are many barriers within the company that help prevent any variety of premature changes that could have a negative impact on the company or its employees.

The final objective concerning the discovery of when it is time to invest in a solution involving the spending of capital is more of a side objective. This goal is considered to be a side objective because it may be unattainable within the scope of this project.

Scope of the Project: This project is aimed at establishing research as to how effective lean manufacturing tools can be after a recent "Kaizen Event." The goal is to apply more of a variety of lean manufacturing principles to the changeover procedure that was worked on extensively during my summer internship with Fresh Express Inc. In working with Fresh Express Inc., particularly the packaging area, there are many rules and regulations regarding proprietary information that is not allowed off the premises. This poses a challenge because there is no possibility of taking pictures and using them as diagrams to convey my suggestion in an articulate manner. However, I am very anxious to see how the solutions I provide to Fresh Express Inc. will help them during this economic turmoil. I do believe strongly that there is much room for improvement without the need of capital investment quite yet. Working with Fresh Express Inc. over the summer has demonstrated to me that this company is in a transitional period with new leadership that is looking for new innovative ideas to help drive down the cost of goods sold.

SECTION II
LITERATURE REVIEW

The purpose of this project is to find alternate standard operation procedures for Fresh Express' packaging department to reduce the amount of "Muda" (waste). The literature review will contain lean solutions that have been implemented in other manufacturing facilities, particularly Toyota. The mantra behind Lean Manufacturing revolves around eliminating as much non-value added waste as possible without sacrificing quality. Many of the tools offered by Lean Manufacturing have been acclaimed as a means for driving efficiency up while not costing the company any capital. These tools have been used across industries and are considered to be universal in nature.

This section of the report will begin with background information pertaining to Fresh Express and the process they use to package their Salads. Secondly, there will be a discussion of what companies have done in the past in regards to lean manufacturing practices. The tertiary portion of this section will encompass the positive effects lean manufacturing can accomplish in a mass production scenario. Mass production is affected greatly due to the fact that seconds are considered precious; especially in the instance of Fresh Express where they produce roughly 20 million bags of salad per week!

Background: Fresh Express has been the No. 1 salad producing company throughout the latter years of the 20th century and early years of the 21st century. Like many companies between the 1990's and 2000's, the company was experiencing exponential growth. However, since the acquisition of Fresh Express by Chiquita Brands L.L.C. and the recent recession, there has been a downward trend in financial success. Actual data cannot be extracted because Chiquita is the umbrella corporation; therefore, I relied on primary sources like Phil Bradway. Phil Bradway explained that during the year of 2007, when the recession had first arisen, Fresh Express had started to go toward a downward trend. Flash-forward to this past summer of 2010, the company had numerous implications and losses of business that they had to endure. First and foremost,

the loss of Wal-Mart as a loyal customer essentially cost Fresh Express a substantial percentage of business per month. Other problems occurred with salmonella, E. coli, and Listeria accusations that the company had to publically endure. Fresh Express has to reevaluate the way it conducts business from the bottom to the top of the organization. There is an urgent need to bring about higher efficiency within the company through lean manufacturing practices. It's attempting to take steps into the right direction in order to survive the economic downturn that they are experiencing. It still remains to be the market leader with a whopping 24%; however, without the implementation and change of several gaping flaws within their manufacturing process, the company can expect that number to dwindle. Fresh Express has even gone as far as to switch to a 5-day work week rather than a 6-day work week to ensure lower costs of start-up. The machines used in the packaging process for Fresh Express vary in brand name; however, all machines are similar in functionality and operation.

Current Machinery: Machinery located in the packaging sector of the facility is known as vertical form fill seal baggers that are manufactured by Bosch and Hayssen. These baggers use a combination of timers that activate each stage of the machine's process. Specifically, Fresh Express uses the Intermittent Motion Vertical Form Fill seal machines that allow for the machine to stop for fractions of a second to allow for salad to drop into the packaging. Intermittent motion vertical form fill seal machines that are used rely on friction pulling rollers, forming tubes, sealing jaws, photovoltaic sensors, and a machine operator to package the ready to eat salads. The entire packaging process is dependent on timers that are synched down to the millisecond to ensure the highest "bags per minute" without high amount of defects or products to be reworked. The packaging material varies between standard polypropylene, polyethylene, and composites that are exclusively patented by Fresh Express. The film is received as a roll around a paperboard tube to provide a means of attaching the film roll onto the machine. The machine pulls the film through a series of rollers where the expiration and manufacturing information is printed. After traveling through the rollers, the film is wrapped around a forming tube where the bottom of the bag is closed while the product is dropped into the bag simultaneously. The package is then sealed on the top and back seals using Teflon coated jaws that are heated to melt the plastic and ensure complete closure. The packages travel on a conveyor belt to the boxing station where two employees are constantly placing six bags per box

and sending it off to be palletized. This part of the manufacturing process is where the scope of this project lies. Refer to the Appendix B section to help understand the pack-out process.

Recent Studies in Lean Manufacturing: Lean manufacturing's primary objective is to reduce the cost of goods sold while either sustaining the current or increasing the quality of the products / services. Emphasizing the non-value added or "waste" effects of a manufacturing process are keys to understanding the principles of lean manufacturing. "Muda," the Japanese word for waste, is classified under seven different categories that help narrow down the root-cause for inefficiencies. The industry definition of waste is any process or procedure that the customer is not directly paying for when they purchase the product off the shelves. Companies are constantly discovering ways to provide the lowest prices with the highest quality possible at set price. This constant pressure from consumers is the driving mechanism behind lean manufacturing principles. Companies are looking for individuals with knowledge in these lean manufacturing fields because of such high demands. During this project, each of the seven deadly types of waste needs to be addressed and defined.

1. Defects – can be a variety of issues pertaining to the selling of defective products / services. These defects are often attributed to manufacturing, data entry errors, incorrect ordering, and design flaws. It is impossible to manufacture or process every product perfectly because of either human or machinery error. The Six Sigma ideology circles around the issue of defects as its primary form of waste reduction.

2. Overproduction – constitutes for the higher amount of inventory due to a lower than expected demand. Preferably, a company will always overproduce slightly to accommodate any flux in demand; however, too much production causes the inefficient use of human capital and overhead. For example, the production forecast for a given day is to produce 500 television sets but your customer's order changes to 400 because of a recent decline in sales, the supplier is then stuck with 100 extra television sets sitting in inventory. Overproduction can be caused by a number of issues that include the following: a "push" rather than "pull" production line, large batch sizes, and poor allocation of human resources.

3. Inventory – can be directly influenced by overproduction. Having 100 extra television sets may impair the company's ability to allocate floor space for something more beneficial. Inventory can be a costly yet subtle form of waste because of all the hidden overhead, utilities, and resources used to store the products in the warehouse. Major contributors to inventory waste are unfinished products that are still works-in-progress. Inventory and Overproduction usually go hand-in-hand when it comes to the root-cause.

4. Over-Processing – refers to the procurement beyond the standard of what is required by the customer. In other words, this form of waste is primarily attributed to using excess materials when it is not needed. Over-Processing is often caused by outdated standards, resistances to changing the status quo, a lack of innovation, and a lack of standard operation procedures.

5. Motion – consists of employees moving excessively from one location to another to perform his/her job when it is unnecessary. Motion can add to the costs of goods sold because the amount of time a person spends moving costs the employer money. For example, if an employee needs to grab a tool to perform a changeover on a specific machine but the tool is located 50 feet away; the company is subjected to numerous costs. The employee may not realize that he/she maybe have cost the company an additional $.15 for that extra time to walk over to the tool's location. That may seem like a miniscule amount; however, that becomes a multiplicative value throughout the year due to the regularity of such movement. Minimizing the amount of motion during downtime can be achieved by establishing a standard operating procedure, optimal tool placement, and more adequate training.

6. Waiting – pertains to steps in a manufacturing process that exist immediately after a bottleneck. Bottlenecks are processes that take a longer time to perform and cause a snowball effect of waiting down the production line. Bottlenecks are often caused by shortages, lack of human resources, downtime, broken machinery, quality issues, and ineffective production planning. Whenever a person or machine is not performing the task at hand, it is considered a form of waste.

7. Transportation – can also be referred to an issue of conveyance along a production line. It can be described as the unnecessary movement of parts between processes on a manufacturing floor. This is commonly attributed to limited floor space and a poor value stream flow from beginning to end.

The 7 deadly categories for waste have become a landmark in the manufacturing industry today. With more manufacturing being sent overseas to remedy the demand for lower prices, U.S. companies must find innovative ideologies from other countries to maintain its competitiveness globally. These 7 wastes help in narrowing down the scope of companies becoming more efficient. This project will identify some of the current forms of Muda at the Fresh Express facility; moreover, it will aid in the effort to lean-out their changeover process.

One of the largest and more famous companies that have perfected Lean Manufacturing is Toyota. The Toyota Way, introduced in the author's Lean Manufacturing course, breaks down the ideologies of lean through a set of principles. These principles were established after extensive analysis and research through real-world applications that occurred in Toyota's manufacturing plants throughout the 1980's. Jeffrey Liker, one of the author's of The Toyota Way, states that lean manufacturing's basic concepts and methodology can be expressed through the following 14 principles:

1. Evaluate and assess all management decisions based on the long-term even at the cost of short-term financial success. What this entails is investing the time and resources to change flaws within the organization even though it could cost the company a large amount of money in the short-term. For example, initiating company-wide Kaizen Events that involve cross-functional teams to sacrifice doing their normal work responsibilities to participate and create a more efficient environment.
2. In order to indentify problematic areas within a manufacturing process, create a continuous flow in the actual process first. This principle is alluding to having a manufacturing process that does not "stop n' go." This principle helps understand and identify where bottlenecks are occurring within the process.
3. The use of a "pull" system to avoid overproduction, i.e. WIP and inventory. "Pull" systems are primarily characterized as having a "kanban" mechanic to operate

smoothly. "Kanban's" are a basic function or tool that allows for end of a manufacturing process to "pull" the product from its earlier stages. These Kanban's are usually indicators or tools that allow for the previous stage to know when the later stage of the process needs or is waiting for a product.

4. "Heijunka": distribute the workload evenly across. Distributing the workload evenly is a means of improving bottlenecks and relieves stress off of more hectic stages of a process.
5. Establish a culture of stopping to fix problems, to get quality right the first time. One of the main reasons this principle is so important is that Lean Manufacturing revolves around improving efficiency without sacrificing quality by any means.
6. Standardized tasks are the foundation for continuous improvement and employee empowerment. Standardization of procedures allow for workers to become accustomed to performing these daily activities. This will have a positive effect on any procedure because the more a worker performs these repetitive procedures, the faster and more efficient they become. Standardization also allows for better data collection and generally improves the overall quality of the product.
7. Use visual control so no problems are hidden.
8. Use only reliable, thoroughly tested technology that serves your people and processes.
9. Grow leaders who thoroughly understand the work, live the philosophy and teach it to the others.
10. Develop exceptional people and teams who follow your company's philosophy.
11. Respect your extended network of partners and suppliers by challenging them and helping them improve.
12. Go and see yourself to thoroughly understand the situation.
13. Make decisions slowly by consensus, thoroughly considering all options; implement decisions rapidly.
14. Become a learning organization through relentless reflection and continuous improvement.

Through the various principles introduced above, industrial engineering professor at the University of Michigan Dr. Jeffrey Liker believes that his book The Toyota Way provides the essential tools to empower individuals with a means of continually improving their work. Another lean manufacturing concept that gathered momentum in the past 60 years is "Single Minute Exchange of Die" (SMED for short).

SMED came into the spotlight during the early 1960's by a Japanese consultant by the name Shigeo Shingo. Shingo is often considered responsible for the spread of SMED throughout the manufacturing industry. SMED relies on the ratio between the total amount of production time and changeover/setup time; moreover, it additionally counts on a Just-in-time oriented inventory system. Changeover time is classified as when the machinery or process is completely stopped to switch from one product to another. Thus, the lower amount of changeover time, the less amount of lost production due to changeovers drives down the cost of production itself. According to Shingo, Single Minute Exchange of Die can be separated into four distinct stages (Shingo, 1985)

1. Ensure that External Setups are performed while machines are on – Internal setup procedures are characterized as processes that must take place while the machine or operation is off. External setup operations are distinguished as having the capability of being executed while the production process is underway. For example, the die needed in the setup/changeover is fetched while the machine is running to exclude any time wasted while retrieving the die. External setups occurring while the machine is running are extremely inefficient.

2. Separating Internal and External Setup – Identifying which processes are internal versus those that are external provides a means in which improvement can occur through SMED. Conventionally, this step also includes timing each setup procedure step-by-step. Shingo explains that if one is to treat as much of the setup/changeover operation as external setup, then the time needed for internal setup – performed while the machine is off – can usually be cut some 30%-50% (Shingo, 1985). Internal and External procedures are considered to be the founding ideals that drive the SMED methodology of increasing the efficiency of setup/changeover processes.

3. Converting Internal to External Setup – Manufacturing plants often misinterpret the difference between internal and external setup. To help determine whether a process is internal or external, SMED suggests taking into account two important notions. First, re-examining operations to see whether any steps are wrongly assumed to be internal. Second, finding ways to convert these steps to external setup. This step involves the dismissal of previous old habits and to analyze each step of the setup/changeover process.

4. Streamlining All Aspect of the Setup Operation – This stage in the SMED methodology revolves around applying lean manufacturing tools to internal and external setups. Typical tactics for streamlining internal processes involve applying 5S (described below) and reducing the amount of waste from non-value added steps.

Toyota, as mention earlier, has a culture of continuous improvement from the top to the bottom of the ladder. Toyota hired Shingo on as a consultant to help improve their efficiencies and lower the costs of goods sold. What Shingo found was that the bottleneck with the heaviest burden was the changing of the dies for the large transfer-stamping machines used to produce vehicle bodies. The dies differentiated between each model of car, weighed thousands of kilograms, and had to be assembled in the stamping machines with a very limited amount of tolerance. The tolerances had to be extremely small because of the metal acquiring wrinkle and/or melting while experiences such high amounts of heat and pressure. Shingo, and a group of engineers at Toyota, investigated the existing changeover process and realized that it had been littered with non-value added procedures that could be improved on. At that time, the current changeover procedure involved stopping the production line, hoisting dies into position using an overhead crane, positioning the die merely by using the naked eye, and then adjusting as needed while running a few test stampings. The existing process took anywhere between 12 hours to almost three days to complete. To counteract the extremely long changeover procedure, Shingo and the Toyota team implemented a few improvements that helped reduce the time to an hour and a half. The two major changes they used to "lean" out the process were the placement of accurate measurements for die placement and standardizing these measurements by documentation. This tactic greatly resembles principle #6 mentioned in The Toyota Way in that they standardized a component of the changeover process. Upon further research, Toyota managed to schedule the die changes in a standardized sequence as a new model moved through

the factory, made sure to have the necessary tools for the changeover nearby, and scheduled the overhead cranes so that the new die would be in the "bullpen" waiting to be put on. These changes accumulated to achieving an average time of 10 minutes per die thereby reducing the amount of inventory kept at one time. Shingo claims that because of the SMED methodology, he experienced a 97.5% beneficial reduction in setup times from the original time. This creates an environment where low stock levels that drove high inventory turnover rates, a freeing of floor space because of the reduced inventory, and productivity increased or the production time was decreased. Either way, SMED helped Toyota become one of the industry leaders back in the mid 1970s to today. The change pertaining placing the necessary tools nearby the changeover area has to do with a lean manufacturing principle that pertains to all aspects of business; 5S.

5S revolves around the basic ideology that "a clean room is a happy room" in the workplace. It is a systematic process that organizes and standardizes the work environment to enable higher productivity. Each "S" has contributes in a separate yet necessary way in transforming a disorderly area where it takes less time finding and replacing tools, materials, and/or products. The ideal workstation fulfills all 5 of the 5S' to ensure the highest productivity and efficiency as possible. The 5S' are as follows:

1. Sort – Removing all unnecessary or rarely used inventory or tools.
2. Systemize – Refers to the logical organization and orderly nature of how things in a work environment should be to accommodate a greater ergonomically friendly workplace. This enables a faster and more efficient way of acquiring the necessary tools, materials, etc. as quickly as possible.
3. Shine – Utilizes workspace, enhances ability to spot safety hazards, creates sense of ownership for employees.
4. Standardize – Helps in the identification of production defects or non-value-added steps.
5. Sustain – A necessity for upper management to foster employee buy-in to lean manufacturing.

5S provides a means to improve the subtle areas of manufacturing that are often overlooked. There is an obvious logic notion when discovering what each S means; however, the point of 5S is to not introduce a radically revolutionary way of thinking. Its methodology is aimed towards

gearing an individual with a foundation of knowledge that helps focus their attention on continuously improving the workplace.

SECTION III
SOLUTIONS

Assessing the problems associated with the changeover-b requires a critical and statistical analysis of the current situation. Chiquita Brand's Fresh Express Inc. runs approximately 24 pack-out lines throughout a given day. In the duration of a full production day, pack-out lines can experience between 8-10 changeovers categorized as "b-type." B-type changeovers have been one of the largest allocations of downtime accrued throughout a fiscal year. Recently, the company has instituted a Kaizen event that drove the average downtime experienced by a changeover-b from 16 down to approximately 8 minutes. Implementing lean manufacturing solutions require the belief that continuous improvement is an important staple in the company's culture. In order to fulfill this important aspect of the lean manufacturing ideology, this project is designed to determine more lean solutions to drive down the average downtime experienced per changeover-b. This section revolves around the current state versus solutions that can be applied to drive the average downtime closer to 5 minutes. Ultimately, the goal is to expand further upon the lean implementations already experienced at Fresh Express.

Single Minute Exchange of Die:

Stage 1: Currently, Fresh Express has a standard operation procedure for the changeover-b process in place (See Table II. Below). Table 2 merely represents the order in which the procedures are to take place and is not the direct template/copy that Fresh Express uses. Details such as the desired bag weights, personal protective equipment, and the micro instructions for testing "leakers" have been omitted due to their proprietary attributes and irrelevance to the scope of the project. Taking a closer look at the procedure that is currently in place, one can apply the first stage of SMED by labeling what is an internal and what is an external setup operation. Steps 1, 5, 8, and 9 of the current SOP are the forms of external setup hidden within this procedure. Furthermore, step 5 is possible to execute before the previous run ends because the use-by-date and country of origin printing requires the operator to press "confirm" once the new run begins. Step 4 is a mixture between an internal and an external process. The picking up

of the roll from the staging area and installing it onto the spindle is the external aspect of the step. The reason this is possible is because of a second set of spindles on each side of the bagger that are located below the spindles actively feeding the Vertical Form Fill machine. These distinctions provide a foundation for the implementation of SMED to this specified changeover process. A revision of the SOP can now be made involving step 5 being placed after step 1 and step 4 can be split into its external and internal components. This would allow for a lower changeover times by eliminating a whole process while the machine is down.

Table II

Process Steps
Step 1: Notify PMO of upcoming changeover approximately 2 pallets prior to end of run.
Step 2: Stop the bagger when ready to start changeover process
Step 3: Document the box count and enter new SKU
***Step 4:** Cut and remove the film roll of the previous run. Pick up film roll from staging area. Install the new roll onto the spindle for the new run. (Both Sides)
Step 5: Set-Up Markem printers with the next production runs Use By Date and Country of Origin.
Step 6: Confirm the COO
Step 7: Cycle the previous run's film through, change the program as needed, and start the bagger. (Collect an empty bag for Bag Certification and confirm registration position and print alignment)
Step 8: Perform leaker and bag weight check. If poor seals or weights are off, stop the bagger and correct the problems.
Step 9: Complete the Packaging and downtime Monitors.

* Indicates a process that is both Internal and External

External
Internal

Stage 2: Building upon stage 1, the changeover-b procedure needs to be broken down and separated further. External setup processes are to be grouped up together in series while the machine is still producing. Before separating the tasks into separate groups, each step needs to be timed and evaluated. This crucial step will allow for a prediction as to how much more efficient the process can be at its optimal state.

In order to establish the integrity of the time trial data collected for stage 2, different characters of statistics need to be addressed in a proper procedure. The following amounts to the experiment that allows for the time trial data for the current situation:

- Controlled Variables
    - Timing the same 2 operators on the same respective machines. This helps reduce the variability of machine operator performance and expertise and its influence on the data.
    - Use the same stopwatch for every time trial.
    - Time Trials occur only on days with more than 5 changeover type B's.
    - Time trials begin and end when the machine stops and starts up again.
- Variables of Interest
    - Amount of motion occurring each changeover
    - Film bags being thrown out; due to printer alignment
    - Time used up by external setup processes

Once the processes have been mapped out and timed, the weeding out the external setup processes and either placing them prior to the changeover or afterwards. The point of this is to reduce the percentage of downtime attributed to avoidable setup and/or after-process adjusts while the machine is on.

Stage 3: This part of the SMED methodology serves as a checkpoint to re-evaluate any internal processes that can be converted to an external. As mentioned above, step 4 of the original procedure had an external process embedded within. In Table III, the external setup processes are conjoined together and the internal processes are now in a continuous series of operations.

Table III

Process Steps
Step 1: Notify PMO of upcoming changeover approximately 2 pallets prior to end of run.

Step 2: Pick up film roll from staging area. Install the new roll onto the lower spindle for the new run. (Both Sides)
Step 3: Set-Up Markem printers with the next production runs Use By Date and Country of Origin.
Step 4: Stop the bagger when ready to start changeover process
Step 5: Document the box count and enter new SKU
Step 6: Cut and remove the film roll of the previous run.
Step 7: Confirm the Country of Origin
Step 8: Cycle the previous run's film through, change the program as needed, and start the bagger. (Collect an empty bag for Bag Certification and confirm registration position and print alignment)
Step 9: Perform leaker and bag weight check. Start Bagger
Step 10: Complete the Packaging and downtime Monitors.

External
Internal

The new arrangement of internal and external setup process aids in the further improvement in changeover downtimes.

Stage 4: The final step in SMED is the streamlining of the internal and external processes at a micro-level. Implementing 5S and some of the 14 principles of lean manufacturing will aid in the lowering of non-value added steps in the changeover process. "Genchi gembutsu," to go look and observe, serves to work as the cornerstone for understanding why bottlenecks and non-value added steps occur. After much time spent on the floor observing changeover-b procedures, two improvements have been recognized.

Machine operators are adequately familiar with the vertical form filler machines that neighbor them. Furthermore, the fact that machine operators tend to be standing around patiently watching their own machine's for issues, there is an opportunity to create parallel processes in the midst of a changeover. Having a second operator help the primary machine operator with steps in the changeover process would help reduce the downtime. The second operator assisting in the processes of running through the last run's film, installing the new film, confirming the country of origin, aligning registration, and performing the leaker and bag weight quality checks for one side of the bagger creates parallel processes.

The second improvement revolves around the amount of wasted material is thrown away while confirming that the registration and print alignment are correct. Operators are often throwing upwards of 40 bags away resulting primarily to this issue. However, after doing some root-cause analysis and asking machine operators, the problem stemmed further back the changeover procedure. The misalignment is predominantly attributed to the spindles that are holding the film rolls do not have standardized markings to aid in the alignment of the film roll onto the rollers. According to Todd Hunter, a production manager at Fresh Express, the film rolls cost the company $0.08-0.10 per bag. To alleviate the wasted materials, collars or markings need to be installed onto the spindles to help the machine operators save bags.

Test Procedure:

Supplementing lean solutions to a real-world manufacturing environment requires the use of a variety tools. This section will discuss the methodology and process of acquiring the necessary information to prove my solution's worth. Refer to Appendix D for preliminary standard operation procedure that is tested. As depicted, the new experimental SOP will have several changes concerning roles and responsibilities.

Null Hypothesis: The current standard operating procedure for changeover-b provides the lowest statistical downtime and waste possible.

Alternative Hypothesis: By implementing SMED and other lean manufacturing tools, the downtime and waste experienced by a changeover-b will decrease significantly closer to 5 minutes.

Materials Used:

- 2 Operators
- 2 Twin Bagger Vertical Form Fill machines
- Stopwatch (Used for time trials)
- Clipboard / Data entry sheet
- Microsoft Excel and MiniTab (Tables, Graphs, and Statistical Evaluation)
- Microsoft Project (Gantt Chart)

Variables:

A. *Independent Variables*

a. Second operator used for prepping one side of bagger.

b. External setup processes moved to prior / post changeover-b

c. Attaching collars to serve as reference point for lining up film roll on the spindle

B. *Dependent Variables*

a. Downtime

b. Number of bags used while aligning and registering

C. *Controlled Variables*

a. Used same 2 operators and machines from current state time trials

b. Stopwatch reused

c. Time Trials conducted on days with more than 5 changeovers

d. Time begins and ends when machine stops and starts

Document:

A. *Data Collected*

a. Times for each individual step

b. Overall downtime

c. Bags thrown away due to alignment issues

B. *Critical Components*

a. Observed 100 total changeovers

b. Quality Defects were at a minimum

SECTION IV
RESULTS

The purpose of this project is to further improve the changeover-b process that has been previously "leaned" out. In order to accomplish this, techniques that had not been applied to the current process had to be implemented to reduce the downtime. The main objective is to prove that there is still room for continuous improvement in such a changeover. The testing is focused predominantly on the downtime experienced during a changeover and the amount of bags that were thrown away. This project is designed to challenge the current standard operation procedure with one that brings into effect the assortment of external and parallel processes. Single minute exchange of die is the cornerstone for coming up with these ideas. Along with downtime, this project found a way to cut down on the overall waste of bags. This is accomplished by standardizing a micro-process within the changeover itself; yet another SMED technique. The project is limited to the amount of follow-up that can be accomplished in nine months. There is no guarantee that Fresh Express will adapt the suggestions nor is there an assurance as to the amount of buy-in.

Pros / Cons

This section pertains to the advantages and disadvantages to each solution. Furthermore, the needs mentioned in the Introduction of the report are brought forth and measured against how well the solutions suit them. Since all three solutions fit congruently together as a package, there is no recommended best. Fresh Express needs to commit entirely to the suggestions for an impact to be noticed. The advantages out-weigh the disadvantages in the long-run; however, it will take an investment of some money and quite a bit of time.

I. *External Processes Placement*

Table IV

Advantages	Disadvantages

Reduces Downtime	Re-training of employees
No capital expense	Resistance from employees
Reduces non-value added waste	Needs a lot of support from management

II. Two operators during changeover

Table V

Advantages	**Disadvantages**
Reduce Downtime	Needs approval from labor union
Heijunka – Distributes work	Resistance from employees
A second pair of eyes to ensure no mistakes	Issues with root-causing a mistake; who is to blame?
Increase communication on the floor; establishes team mentality	

III. Collar or Marking Reference Point on Spindle

Table VI

Advantages	**Disadvantages**
Reduces Downtime	Capital cost for collars
Increases accuracy of alignment	Makes spindles no longer universal across machines
Reduces bags thrown away	
Employee moral; adhering to ergonomics	

IV. Needs versus Solutions

Table VII

#	Description of Needs	Lean and Collar/Reference Point Solutions
1	**Eliminate as many non-value added waste as possible**	**5**
2	**Ensure that no safety regulations are compromised**	**4**
3	**Successful implementation plan**	**3**
4	**Avoid the spending of capital**	**4**
5	**Ensure that Quality does not diminish**	**5**

Fulfillment Scale: 5 = Highest; 1 = Lowest

Fresh Express' need to reduce non-value added processes has been satisfied due to the external setup processes being placed prior to stopping the bagger. Having two operators executing a changeover proves to be an excellent way of reducing non-value added downtime. There is a rating of 4 in the box next to compromising safety because the second operator must stand near the primary operator to complete his part of the procedure. There is cause for concern when two individuals are in such close proximity when working on machinery. A successful implementation plan seems to be a necessary nuisance to any lean manufacturing solution; however, Fresh Express does institute many lean manufacturing events as is. The avoidance of capital spending could not be attained because the ends justify the means. Purchasing or having the in-house machine shop create the collars for the spindles will be a small investment relative to the size of the company. Quality does not get changed whatsoever by the changes that are suggested.

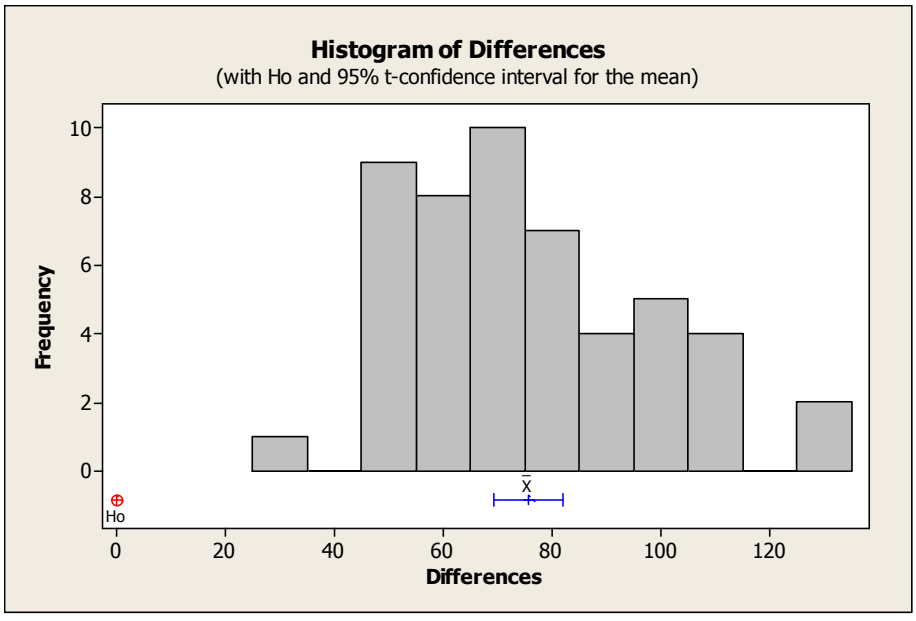
Analysis

The first day of time trials under the new standard operating procedure had promising results from beginning. Not only did the overall downtime get reduced, but the amount of bags lost to

alignment and registration issues was noticeably lower. On top of both of the positives, the machine operators were surprisingly open to trying my newly developed SOP. This section is in regards to interpreting the data collected and statistically analyzed using the MiniTab software.

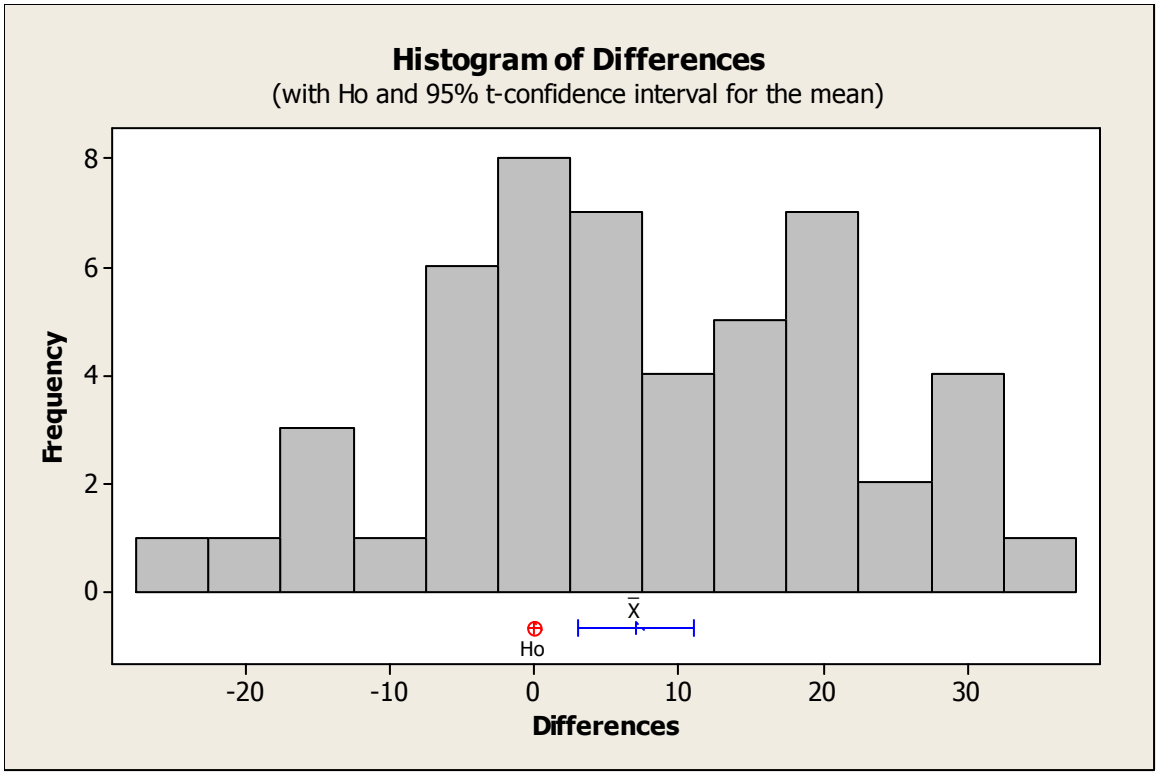
In Data Set II, the results of the parallel and external processes changes proved to be genuinely better than the current state. Using a paired t-test procedure, the sample data shows that the null hypothesis fails under the conditions that the mean difference does not equal to zero. In fact, the difference is superbly gapped by 75.58 with a standard error of the mean at 3.18. Chart 1 below, Histogram of Difference, illustrates the position where the mean difference is located relative to the null hypothesis. Clearly the new SOP falls well beyond the capabilities of the current procedure in place. Also, the time trial data is analyzed with an assurance level of 0.05%. Therefore, the confidence interval of 95% in Data Set II depicts that there is a 95% chance that the mean difference is either less than or equal to 81.97 and greater than or equal to 69.19. The p-value, calculated by the t-value, equaling to 0 reassures that the null hypothesis is void because it is less than the assurance level established earlier. To put these numbers in perspective, the average time for a changeover –b prior to the changes took an average of 7 minutes and 54 seconds. The new and improved solution of parallel processes and external process placement has lowered this value down to 6 minutes and 39 seconds. The 1 minute and 15 second difference can add up to a large lump sum of cash flow in a large-scale manufacturer like Fresh Express.

Chart 1



The attaching of a collar or a marking reference point to aid in alignment and registration did not yield the same magnitude of results. However, through statistical analysis, it is found that the reference points make a difference overall. Again, by using a paired t-test procedure, the resulting numbers indicate that the null hypothesis is proved incorrect. According to Data Set III, the mean difference came out to be 7.04 with a 95% confidence interval between 3.05 and 11.03. This solution did not necessarily solve the problems that exist with alignment and registration; however, it did improve upon it by a significant difference. With a t-value equal to 3.54 and a p-value to 0.001, there is a 0.1% chance that the sample difference could be achieved with the mean difference equal to 0. The histogram of difference, Chart 2, demonstrates a satisfactory normal distribution to ensure a reliable portion of data.

Chart 2



SECTION V
CONCLUSIONS

The following section encompasses an overall summary of the project, after thoughts, learning objectives, problems, and future works for the project. Afterwards, there will be a short section on the implementation of the suggested project solutions.

Summary

The Fresh Express Lean Changeover Project circled around the changeover-b operation. The project's overall goal is to create feasible solutions for continuously improving a process that had recently been "leaned." The identification of the issue proved to be the easier aspect of the project. It was the identification of other forms of waste and researching different techniques used in the recent past to improve upon a lean changeover process. Establishing a foundation of knowledge on subjects like Single Minute Exchange of Die took the help of my technical advisor Dr. Olsen. He guided me to informative research materials and towards a good approach to the problem. Todd Hunter, Production Manager at Fresh Express, supplied me with information at a moment's notice and helped by allowing me to visit plentifully though out the last 9 months.

The project consisted primarily around comparing the current situation with that of the solutions proposed. Through time trials and experimentation with installing a reference point for aligning film rolls correctly, the study found that there are several ways to cut downtime and other non-value added extremities of a changeover-b. The foundation of lean manufacturing is continuous improvement without sacrificing any quality. This project has shown how exactly that is possible through simple techniques. Also, it goes into the statistical analysis portion of the proof.

Conclusion

The studying and observing of processes in any business environment, there are ways to improve up them. Though the changeover-b summer kaizen event had much more drastic results, the degree in which these solutions reduced waste is hopeful. Diminishing returns are often

observed after dramatic growth or improvement. For example, the business life cycle begins with the introduction phase where it leads to the rapid growth part of its life. However, after the rapid growth starts to level off, diminishing returns are expressed by the maturity stage. In comparison to the changes and improvements made in this report, diminishing returns definitely took a foothold.

Learning Objectives

Throughout the course of the project, numerous problems involving external and internal factors occurred. However, through the thick and thin, this projected managed to come to together satisfactory and has enriched my education. Planning and preparation are the key components to being successful in the real-world environment. All of the project deadlines and tasks have shown me this attribute about my future career. I have managed to get past many of the trials and tribulations associated with a major project on my own and hope to carry that into the workplace.

Problems

Issues regarding scheduling and keeping up to speed on outside school-work became a difficult task this quarter. I am currently enrolled in 18 units on top of having a part-time job locally. There were definite times where I planned my time poorly; however, there was a lot on my plate and I managed to push through it. No real issues occurred between Fresh Express and I since they knew me from the summer and trusted that I meant well. Todd Hunter has nothing but a tremendous help throughout the project and I will be hoping to thank him soon enough. I do find a particular flaw in my report; there are no picture descriptions showing exactly what I mean by "spindle" and that I did not include a simulation. Unfortunately, I do not have the time or money to buy expensive software and learn it in a matter of months.

Future Work / Implementation

The steps ahead of this project revolve mainly around the implementation of the new SOP and the collars. There needs to be training on the new SOP for all machine operators and the technicians need to be scheduled to produce and install the collars for the spindles. Further improvements can also be in the future because the true end-goal is 5 minutes per changeover-b.

Overall though, the project is a great learning experience and allowed for me to apply knowledge I learned in the classroom to a real-world thing.

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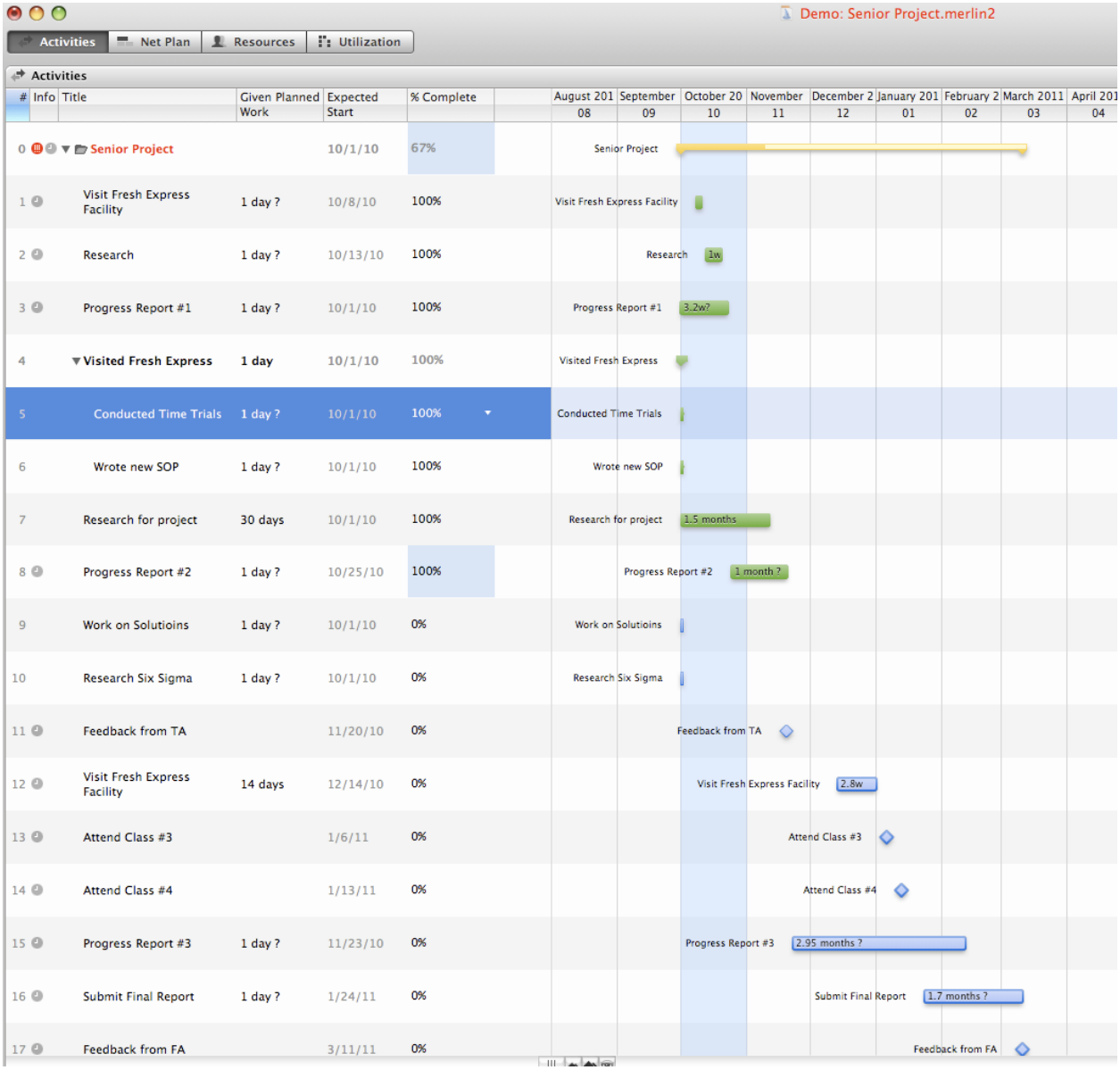
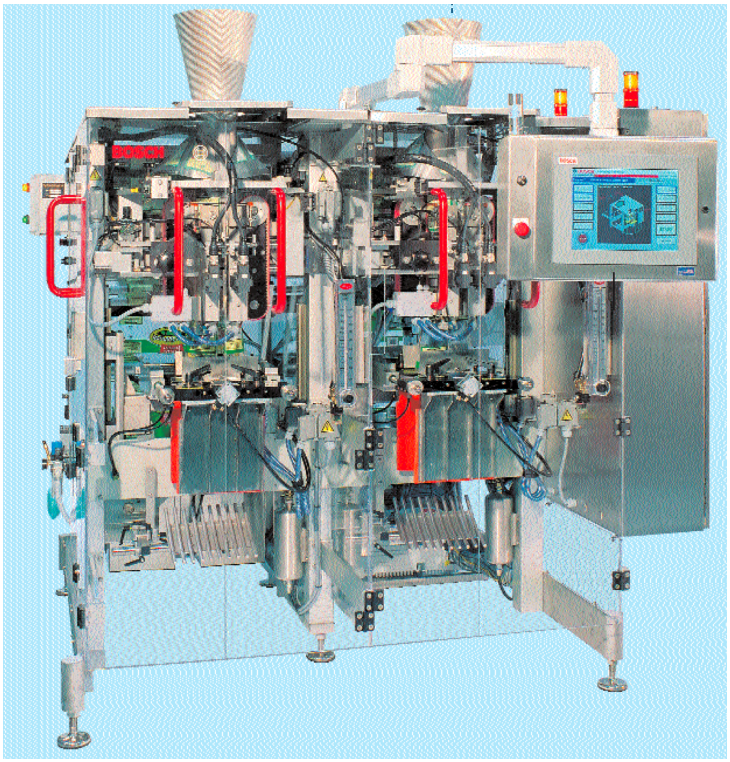
APPENDIX

A. Gantt Chart

Chart 3



B. Vertical Form Fill Seal Bagger Machines



C. Raw Data Tables

Table VIII. Time Trial Data for Current State.

Table VIII

Changeover Procedure Step	Document box count / enter new SKU	Remove old film and install new roll (both sides)	Confirm COO on Markem Printer (both sides)	Run old film, confirm registration and print alignment	Totals (s)
1	54	264	20	154	**492**
2	45	243	27	165	**480**
3	55	280	12	172	**519**
4	**49**	265	12	153	**479**
5	**59**	267	17	124	**467**
6	62	276	14	154	**506**
7	65	265	16	124	**470**
8	61	262	11	134	**468**
9	59	280	12	110	**461**
10	67	267	13	100	**447**
11	51	257	12	124	**444**
12	56	276	14	136	**482**
13	62	269	18	143	**492**
14	47	259	16	190	**512**
15	57	264	11	130	**462**
16	63	274	17	110	**464**
17	65	262	15	132	**474**
18	62	271	14	113	**460**
19	69	264	16	124	**473**
20	63	257	17	125	**462**
21	56	265	13	134	**468**
22	54	303	15	146	**518**
23	63	275	16	134	**488**
24	62	262	15	110	**449**
25	69	279	13	114	**475**
26	62	253	18	152	**485**
27	57	264	15	175	**511**
28	55	254	14	143	**466**
29	63	259	14	138	**474**
30	58	260	14	132	**464**

31	57	263	17	126	**463**
32	63	278	15	145	**501**
33	61	262	17	146	**486**
34	58	280	18	127	**483**
35	57	259	15	145	**476**
36	55	255	17	139	**466**
37	52	241	17	155	**465**
38	52	248	14	138	**452**
39	59	238	18	138	**453**
40	57	254	17	183	**511**
41	51	268	19	158	**496**
42	63	274	15	117	**469**
43	61	270	18	137	**486**
44	57	258	18	145	**478**
45	52	231	15	151	**449**
46	51	233	15	164	**463**
47	56	231	18	157	**462**
48	50	263	15	141	**469**
49	64	245	18	128	**455**
50	59	249	16	131	**455**

Table IX. Time Trial Data for Suggested SOP.

Table IX

Changeover Procedure Step	Document box count / enter new SKU	Remove old film and install new roll; Side: B	Run old film, confirm registration and print alignment	QC: Leaks / Weight	Totals (s)
1	55	100	168	80	**403**
2	56	114	172	70	**412**
3	64	105	152	88	**409**
4	**54**	112	162	85	**413**
5	**58**	108	154	89	**409**
6	61	117	154	68	**400**
7	59	118	132	80	**389**
8	54	115	168	86	**423**
9	52	113	162	74	**401**

10	57	104	160	74	**395**
11	63	101	145	75	**384**
12	56	92	151	85	**384**
13	60	97	163	63	**383**
14	62	111	148	78	**399**
15	59	108	130	74	**371**
16	64	107	153	84	**408**
17	51	120	180	64	**415**
18	52	107	174	72	**405**
19	53	109	171	67	**400**
20	51	104	175	72	**402**
21	49	100	182	86	**417**
22	54	101	163	67	**385**
23	59	112	156	62	**389**
24	52	115	154	74	**395**
25	57	116	132	88	**393**
26	61	111	152	77	**401**
27	68	104	157	84	**413**
28	57	98	178	75	**408**
29	51	107	163	82	**403**
30	52	104	163	63	**382**
31	52	106	178	75	**411**
32	51	100	181	77	**409**
33	50	99	171	65	**385**
34	53	102	159	78	**392**
35	57	115	155	72	**399**
36	62	117	162	74	**415**
37	56	108	158	68	**390**
38	53	102	152	74	**381**
39	63	110	180	66	**419**
40	54	111	148	69	**382**
41	56	118	149	75	**398**
42	51	110	157	82	**400**
43	61	107	163	76	**407**
44	47	100	173	85	**405**
45	49	110	155	88	**402**
46	59	119	132	82	**392**
47	64	123	134	88	**409**
48	62	119	142	94	**417**

49	53	103	142	89	**387**
50	59	104	132	86	**381**

Table X. Bags Thrown Away Data.

Table X

Number of Bags Thrown, Current	Number of Bags Thrown, Collar
25	16
21	22
41	4
35	12
33	8
21	24
26	13
4	17
13	15
8	8
26	7
46	26
7	29
15	16
13	37
19	5
38	9
24	12
21	13
26	23
24	14
7	7
6	11
7	10
7	19
32	12
21	6
29	7
24	5
27	13

23	19
18	18
26	24
41	23
17	24
12	29
11	6
5	4
11	5
16	19
5	18
26	23
39	11
37	6
24	29
22	16
28	15
39	10
24	4
11	6

D. Suggested SOP

Table XI

Process Steps	Changeover Instructions for Changeover - type B (Hayssen Baggers)	
Step 1: Lead will notify Machine Operator of upcoming changeover approximately 2 pallets before the end of the run.	**PPE / GMP**	**Tools Required**
Step 2: Retrieve and prep film for the next production run. Install film on spare spindle. Cut and apply adhesive tape to spare film roll. Prep seal strip and feed through rollers, if needed.	1) Bump cap, steel toed/slip resistant shoes, gloves (cotton & rubber), and ear plugs/muffs. 2) Wear only linen smocks.	1) Scissors 2) Tape 3) Stop watch (timer) 4) 9/16" wrench
Step 3: Set-up Mark'em printer(s) with the next production runs use by date and country of origin. **Do not confirm changes until changeover begins.**	**Important Details:**	**Crew Size Required**
Step 4: Stop the bagger when ready to start the changeover process. Begin timing changeover. (stop watch) Document bag count(s) and then reset to zero.	1) Utilize proper lifting techniques at all times. (when required, ask for help) 2) Film must always be prepped prior to changeover. 3) A 2nd Machine Operator (MO) will be required to assist in the changeover with twin baggers.	1 - Single Bagger 2 - Twin Bagger
Primary MO / **Helper MO**		
Step 5: Primary MO documents the box count and enters new SKU. / **Step 1:** Helper MO will cut and remove the film roll of the previous run. Install the new roll for the new run. (opposite side of Primary)		
Step 6: Primary MO will cut and remove the film roll of the previous run. Install the new roll for the new run. / **Step 2:** Helper MO confirms the COO on Markem printer(s).		
Step 7: Primary MO confirms the COO on Markem printer(s). / **Step 3:** Helper MO will cycle the film through, change the program as required and start the bagger. (Collect an empty bag for Bag Certification and confirm registration position and print alignment)	**PROCESS DIAGRAMS**	
Step 8: Primary MO will cycle the film through, change the program as required and start the bagger. (Collect an empty bag for Bag Certification and confirm registration position and print alignment) / **Step 4:** Helper MO performs leaker and bag weight check. Communicate when good checks are made. Record completion time and start bagger.		
Step 9: Primary MO performs leaker and bag weight check. Communicate when good checks are made. Record completion time and start bagger.		
Step 10: Complete the Packaging and Downtime Monitors.		
Special instructions:		
1) Ensure that the Primary MO and Helper MO are aware of the upcoming changeover. Failure to notify them will result in the changeover being extended beyond the standard time of 5 min.		

E. Data Sets

Data Set I.

One-Sample T: Step3, Step4, Step5, Step7

Variable	N	Mean	StDev	SE Mean	95% CI
Step3	50	58.100	5.504	0.778	(56.536, 59.664)
Step4	50	261.92	13.94	1.97	(257.96, 265.88)
Step5	50	15.660	2.708	0.383	(14.891, 16.429)
Step7	50	139.32	19.19	2.71	(133.87, 144.77)

Data Set II.

Paired T-Test and CI: SOP1 Time, SOP2 Time

Paired T for SOP1 Time - SOP2 Time

	N	Mean	StDev	SE Mean
SOP1 Time	50	475.02	19.16	2.71
SOP2 Time	50	399.44	12.20	1.73
Difference	50	75.58	22.47	3.18

95% CI for mean difference: (69.19, 81.97)
T-Test of mean difference = 0 (vs not = 0): T-Value = 23.79 P-Value = 0.000

Data Set III.

Paired T-Test and CI: Current Bag, Collar Bag

Paired T for Current Bag - Collar Bag

	N	Mean	StDev	SE Mean
Current Bag	50	21.62	11.05	1.56
Collar Bag	50	14.58	8.05	1.14
Difference	50	7.04	14.05	1.99

95% CI for mean difference: (3.05, 11.03)
T-Test of mean difference = 0 (vs not = 0): T-Value = 3.54 P-Value = 0.001