

APPLICATION AND EFFECTIVENESS OF
LEAN PRINCIPLES WITHIN
COMPANY XYZ

By

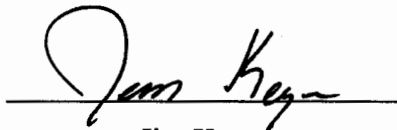
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INMGT-735 Field Problems

A handwritten signature in black ink, appearing to read "Jim Keyes", is written over a horizontal line.

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ABSTRACT

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The operational function of any manufacturing organization requires the tools and knowledge to make continual improvement decisions. Along with these tools, various leading philosophies have paved the way to manufacturing excellence. These tools and theories gain companies the competitive advantage by reducing bottom-line costs. Taking note from the auto industry, primarily Toyota Motor Corporation, this research project focuses on Lean Manufacturing and the tools that accompany it. The project serves two functions: (1) The principal function is to introduce readers to the tools and thought processes that comprise the foundation of Lean Manufacturing, and (2) secondly, to provide a working knowledge and implementation practice to instill confidence in the application of the tools and impart insight into the true significance of implementing lean ideas in the workplace.

The research paper begins with an overview of lean principles, including a definition of Lean Thinking. It then continues to an explanation of tools and resources companies should focus on to reduce waste within their shops. Demonstrated techniques of Value Stream Mapping, Single Minute Exchange of Die, and 5-S organization are depicted in this project, which is based on leading manufacturing experts such as James P. Womack, Daniel T. Jones, Shigeo Shingo, John Shook, and Eli Goldratt.

Once the various tools are explained, the project depicts the practices through Company XYZ, a fictitious meat-processing plant specializing in sliced lunchmeat.

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CHAPTER I: INTRODUCTION

Statement of the Problem

As businesses strive to improve, they must learn to run efficiently in every function. The continual improvement towards operating a lean business while maintaining internal and external customer satisfaction is critical in today's competitive environments. To effectively achieve this level of operation, companies must attain the knowledge and adopt a vision to create and implement a strategic plan to achieve higher efficiencies at every level. To transform a plant into a world-class manufacturing facility, various tools must be utilized and shared at all levels. From the production floor to supporting functions, all facets of the operation need to be evaluated to ensure waste is reduced and efficiency is increased.

The XYZ plant currently has limited knowledge and assessment tools to transform itself into a lean operation. A thorough understanding of the value stream is not defined, downtime sources are not monitored regularly, and internal operational inefficiencies are not monitored to an appropriate level. Overall, the company has made strides in working towards becoming a world-class manufacturing organization, with a certification through the International Organization of Standards (ISO) on the way. Additionally, with the construction of a Process Operating System to guide statistical process control, the XYZ Company is gaining stride. Aside from this, further knowledge and tools to increase overall efficiency are required for the Company to become a true lean organization.

Research Objectives

The objective for this project is to provide further knowledge and insight into how plant XYZ can take one more step towards becoming a world-class manufacturing facility. The study will attempt to fulfill the following:

1. Construct a value stream-mapping tool with the ability to identify forms of non-value-added activities and improve on the plant's current value stream.
2. Apply the Single-Minute-Exchange-of-Die (SMED) technique to the stuffing department.
3. Seek to standardize work times for the foundation of a time-based management system.
4. Capture and identify primary sources for downtime to aid in the elimination of non-value-added activities.

The Value Stream Map is intended to provide an overview of the current process and illustrate operational inefficiencies. The map also imparts the knowledge required to reduce bottlenecks that, in turn, lead to an increase in capacity. The application of SMED will be used to introduce a systematic technique to applying this practice within Company XYZ and will include the benefits of doing so. Developing standardized work times and procedures will form the bedrock from which managers lead their employees and improve the process. Finally, a formal downtime reporting system will be created to track production obstacles and quantify them in order of occurrences. Aside from these four components, the project will also provide information on current, world-class manufacturing theories and practices creating an awareness to enable the plant and researcher to improve on their current state.

Assumptions of the Studies

This study assumes a vision for Company XYZ to run more efficiently through increased knowledge of the product flow throughout the value stream. It will identify bottleneck areas based on product mixes for mid managers to improve on and eventually accomplish continual product flow from initial receiving to finished goods with nominal buffer stock. It also seeks to

form the foundation for minimal direct labor through standardizing and improving work methods along with balancing machine uptime and utilization with demand. Finally, it will strive to achieve at least 80 percent overall efficiency throughout the entire value stream of the plant. This is dependent on machine uptime, decreasing yield losses, and reduction in rework.

Definition of Terms

5-S – A Japanese-originated system that focuses on workplace organization.

Blast – A piece of equipment that chills racks of meat down to the proper temperature. It does this by forced or blasted cold air.

Combos/Vats – Containers that hold meat and other ingredients for making the product.

Flow Manufacturing – A production system, which allows product to move continuously throughout the value stream from receiving to finished goods.

Grind Plate – A plate with holes in it that attaches to an industrial-sized meat grinder.

The size of the holes determines the size of the grind.

Just-In-Time (JIT) – A planning system for manufacturing processes that optimizes availability of material inventories at the manufacturing site to only what, when, and how much is needed.

Kanban – A Japanese term meaning "signal." It is one of the primary tools of a JIT system. It signals a cycle of replenishment for production and materials and maintains an orderly and efficient flow of materials throughout the entire manufacturing process. It is usually a printed card that contains specific information such as part name, description, quantity, etc.

Lean Manufacturing – An initiative focused on eliminating all waste in manufacturing processes.

Lean Thinking – An ideology developed by James P. Womack and Daniel T. Jones, which focuses on doing more with less by eliminating non-value-added activities throughout the entire organization.

Muda – A Japanese term for wasteful activities – non-value-added.

Poka-yoke – A Japanese term for mistake proofing a process. Making it impossible to produce a defect.

Rollstock – A piece of machinery that packages product using roll-stock-packaging film to do so.

Screw Loader – A piece of machinery that moves material through the use of an auger system.

Single Minute Exchange of Die (SMED) – A system found within the Toyota production system designed to focus on improvements on setups/changeovers to increase machine uptime.

Theory of Constraints – Theorized by Eli Goldratt whereby the slowest/weakest point in the system will dictate the speed or strength of the system.

T-Sizer – A piece of machinery that stuffs liquids into a pre-formed casing.

Vacuumizer – A piece of equipment that extracts air out of a mixture of ground meat and liquids.

Value Stream – All the steps (both value-added and non-value-added) in a process that the customer is willing to pay for in order to bring a product or service through the main flows essential to producing that product or service.

Value Stream Mapping – A tool used to view and understand the flow of material and information as a product or service makes its way through the value stream. It is

especially helpful when working to reduce cycle time because insight into the decision making flow is gained in addition to the process flow. It is classified as a Lean Tool.

Limitations of the Study

The focus of this project significantly relies on the extent of implementation and the degree to which the company embraces the tools and practices. This paper provides an initial knowledge base but must be accepted, trusted, and driven by all levels within the company to accomplish the promised outcomes.

CHAPTER II: REVIEW OF LITERATURE

Lean Manufacturing – A Definition and Understanding

Peterman (2001) defines Lean Manufacturing as “a systematic approach to identifying and eliminating waste (non-value-added activities) through the continuous improvement by flowing the product at the pull of the customer in pursuit of perfection.” The objective of Lean Manufacturing is to eradicate the eight wastes of production. They are: over-production, motion, inventory, waiting or queue time, transportation or material handling, defects, underutilized people, and extra processing. Seven of the eight wastes were recognized by Taiichi Ohno, a Toyota executive and guru of waste reduction. The eighth waste, producing goods that do not meet the customer’s demand, was founded by James Womack and Daniel Jones, researchers from the Massachusetts Institute of Technology (Womack and Jones, 1996). Through the implementation of various tools and techniques, companies can reduce these forms of waste and gain organizational-wide efficiencies.

Lean Manufacturing in Relation to Competitive Advantage

“To hell with your competitors; compete against perfection” (Womack and Jones, 1996, p. 49). Benchmarking has always played an important role in any manufacturing environment, but as we move into the next generation of manufacturing, it is slowly fading. Companies must start to compete against perfection rather than themselves or benchmarks set by others. Womack and Jones, in their book *Lean Thinking*, explain that every organization has one thing in common but not necessarily to the same degree. This commonality is waste. Throughout the value stream, waste lurks in many forms and must be dealt with to stay competitive. Management must develop or implement tools to identify waste and remove it permanently. They must be conscious of the value stream and know what they need to do next to stay ahead. A continual

analysis of the value stream, material flow, and demand environment must be established with emphasis on reducing the number of resources required to produce the final product. This mindset is categorized as Lean Thinking and is what has kept Toyota Motor Corporation and many other leading companies ahead of their competition for the last 40 years (Womack and Jones, 1996). This project will set the stage for Lean Thinking ideology and continue paving the way for the XYZ plant to maintain the journey of transforming itself into a world-class manufacturing facility.

Before the lean transformation can begin, an understanding of why the XYZ Company must change and the importance of becoming lean must be recognized. Answers must be discovered to questions such as, “What are the business drivers that have caused this intrusion of lean manufacturing into our lives, and why should we participate?” (Feld, 2001, p. 7). Due to the commitment involved, a self-assessment must be completed as well as an analysis of what really is the difference between a true lean company and one of mere mass production. Womack and Jones (1990) in their book, *The Machine that Changed the World*, prove the difference between lean production and mass production. A facility fully embedded in lean activities operates with half the human effort, half the manufacturing space, half the time spent on engineering hours, half the investment tools, and half the amount of time developing new products. The savings in these areas enable companies to gain headway and become extremely competitive within their markets (Womack and Jones, 1990). Once a full understanding of the power lean manufacturing can offer, along with a strong commitment level, the journey can begin.

Waste and Lean Thinking

Muda, or the Japanese term for waste, is one word of which every production manager should be aware. Muda is simply any human activity that absorbs resources but creates no value

(Womack and Jones, 1996). Unnecessary processing steps, excess inventories, transport of goods for no value-added purpose, and employees standing around waiting for upstream material are all types of muda. To overcome these barriers, managers must adapt a new way of thinking.

In the early 1990s, two participants in a study that identified the lean manufacturing paradigm, James Womack and Daniel Jones, tried to help companies implement lean production systems. They realized lean production was not a quick fix or a one-time project for a company. Instead, lean production was a different way of thinking, a different way of approaching the culture, organization, and operations of a company. (Jordan 2001, p.17)

Their formalized set of principles, entitled "Lean Thinking," has proven its effectiveness and now has moved beyond production lines to entire organizations. Embracing the Lean Thinking philosophy provides the tools and methodologies to overcome barriers. It provides a way to specify value, align value-creating activities to the best configuration, carry out these activities without interruption and only when needed, and finally, continually fine tuning the already improved flow of goods. Lean Thinking provides a way to do more with less: less manpower, less time, less equipment while still producing the same or a greater amount of products in a given time period. Jordan and Michael (2001) go on to state that the lean manufacturing paradigm is simple. Take any process and focus on its objective. Eradicate all components of the process that do not contribute to meeting the objective or do not create value. Once that is completed, review the process again and work continuously to decrease its cost, make it more expeditious, and improve the quality of the outcome.

Lean Thinking can be applied to all organizational functions, not solely on the manufacturing floor. Reducing waste throughout is the true intent of Lean Thinking; therefore, companies attempting to improve efficiency and output must strive to grasp the concept in its

entirety. Firms that initiate a lean transformation are headed for remarkable rewards.

Characteristic benefits of a lean system include: lower production costs, shorter cycle and customer lead times, greater flexibility, higher quality, improved customer service, and greater profits (Standard and Davis, 1999).

Specifying Value

Womack and Jones (1996) explain the initial step in Lean Thinking is gaining awareness of actual product value. Although companies strive to create value through their products, processes, and ingenuities, value is ultimately and solely defined by the end customer. Therefore, value must be ascertained from the viewpoint of the customer rather than through the eyes of the producer. Once this is acknowledged, managers must ignore existing assets and technologies and rethink their companies on a product-line basis using committed teams to identify value. Specifying value accurately is the vital first step in Lean Thinking. Due to ever-changing demands of customers, companies must focus their attention on those demands. With the focus on the customer being first, companies must operate by the Just-In-Time (JIT) principle by providing products and services to customers who want them, when they want them, and at a price they will pay (Jordan, 2001). Preventing the creation of unwanted value for the customer should be the primary objective as the company moves towards the new operating approach.

Understanding and Recognizing the Value Stream

Once value is recognized and direction is focused, managers must become aware of the current value stream and how it needs to be improved to increase value-added activities. When asked the question, "How can manufacturing firms increase the sum of value-added work?," the traditional answer is to do more of everything: hire more people, speed up the lines, add a shift, purchase another machine, and so on. This does, in turn, increase the amount of value-added

activities, but it also increases incidental work and wasted effort. According to Standard and Davis (1999), the lean answer is to decrease non-value-added activities by reducing insignificant work and eliminating wasted effort. Time and effort are spent on non-value-added activities should be redirected to value-added activities after eradicating the non-value-added activities. Therefore, while the operation stays the same size, the employees work smarter rather than harder with no added equipment, additional shifts, or extra people hired. The end goal is for the plant to run lean and as efficiently as possible.

Techniques Associated with Lean Manufacturing

Once a commitment towards lean manufacturing is accepted, companies must acquire the tools to efficiently implement lean manufacturing practices. The various techniques of lean manufacturing include Value Stream Mapping, workplace organization, quick changeover or setup time reduction, pull scheduling, use of visual management, point-of-use storage, standardized workforce procedures, and the philosophy of quality at the source (Chaneski, 2002).

The Value Stream Map

Value Stream Mapping allows companies to envision clearly the entire manufacturing process in both its current and future state in order to prioritize and plan improvement activities (Womack and Jones, 1996). The initial objective for Value Stream Mapping should be to identify every action required to design, order, and make a specific product and then sort them into the following groups: (1) those actions that actually create value as perceived by the customer; (2) those that create no value but are currently required by the product development, order filling, or production systems; or (3) those actions that do not create value as perceived by the customer and can, therefore, be eliminated immediately. Once results from the mapping process are categorized and the non-value-added components are pulled from the process, improvements can

be made on the actions that create no value but are necessary for the current production process. These may include scheduling techniques, shop-floor reporting, and material ordering.

Value Stream Mapping is a fundamental tool that enables managers to fully understand the manufacturing process and make the transformation to a lean environment. This tool allows managers to view the current state of their entire value stream in order to identify areas needing improvement. It also provides key insight as to where improvement activities should be focused to reach the planned objectives. Value Stream Mapping is a paper-and-pencil tool that aids management to see and understand the flow of material and information as the product travels through the value stream. (Rother and Shook, 1998). It provides an overview of the product's manufacturing life cycle and identifies each individual step throughout the conversion process from raw materials to finished goods.

Rother and Shook stated, "To get away from the isolated islands of functionality, you need one person with lead responsibility for understanding a product family's value stream and improving it" (1998, p. 26). This individual plays the role of a Value Stream Manager and, optimally, should report to the plant manager directly. The mistake of splitting up the tasks of mapping among various managers should be avoided. Instead, at least one person should fully grasp all aspects of the mapping agenda in order to see across organizational boundaries to ensure identified changes are appropriately implemented.

Once the individual is selected and the role is defined, a product family must be selected for mapping. Mapping out all products at once is too complicated to be useful and should be avoided whenever possible. Rother and Shook explain, "A family is a group of products that passes through similar processing steps (material and information) for one product family from

door to door in your plant” (1998, p. 6). Once the product family is selected, all finished product numbers should be listed as well as customer demand and frequency recorded for each product.

Authors Rother and Shook (1998) recommend the following tips that should be adhered to in order to increase the overall effectiveness of the Value Stream Map.

1. Always collect current-state information while personally walking along the actual pathways of material and information flows.
2. Begin with a quick walk along the entire door-to-door value stream to get a sense of the flow and sequence of processes. After the quick walk through, go back and gather information at each process.
3. Begin at the shipping end and work upstream instead of starting at the receiving dock and walking downstream. Observing the flow in this direction will facilitate monitoring of the processes that are linked most directly to the customer, those that ultimately set the pace for other processes farther upstream.
4. Rely on a stopwatch rather than on standard times or information.
5. Personally map the entire value stream.

Once the process is mapped and specific areas are identified for necessary improvements, problem areas stand out and work can begin (Chaneski, 2002). The foundation for beginning lean improvements rests on work standardization and workplace organization. Organizing the workplace is a base for standardization, which is mandatory for continual improvement and the next step in designing a lean environment.

Workplace Organization and the 5-S Philosophy

Historically, many manufacturing sites have been unorganized and congested. In early job shops, materials and supplies were stored on site for every process. As a result, the array of

seldom used tooling and materials created a disorganized and cluttered environment. It also has been suggested that unorganized manufacturing environments serve as deterrents for bright and young skilled workers (Vasilash, 1996). If a company can effectively organize work areas, a great amount of non-value-added time can be eliminated. This mentality serves as the backbone for Lean Thinking. An organized shop floor complies with the 30-second rule, which states that anyone should be able to find anything within 30 seconds (Chaneski, 2002). To achieve this level of organization, a systematic approach known as the 5-S Philosophy must be introduced. 5-S serves as the foundation of lean pursuit. Once the workplace is cleaned up and organized, the existence of *muda* can be observed (Jusko 2002, p. 44). The 5-S system seeks to create a visual workplace, which is self explaining, self ordering and self improving. When everything has a proper location, any item out of its position easily and quickly will be identified (Dennis, 2002).

Originating from the five Japanese words Seiri, Seiton, Seiso, Seiketsu, and Shitsuke (Womack and Jones, 1996) the 5-S system has become a standard in today's Lean Manufacturing facilities. Each word, beginning with the letter "S," signifies a different phase of organizing the workplace. Although the words vary by author, the 5-Ss in the English definition describe: Sorting, Straightening, Shining, Standardizing, and Sustaining.

Seiri or sorting - The first step in organizing the workplace is to sort and identify what is needed and what is superfluous, leaving only the tools and materials that are necessary to perform daily activities (Lean Manufacturing Solutions, 2004). By getting rid of various unused items, space is freed up, and the number of visual observable and physically obstructing items is reduced (Womack and Jones, 1996). Once sorting is well implemented, both product quality and productivity are increased along with improved employee communication. One technique of sorting is through the use of red tags. Once employees identify what they need to meet

production requirements, everything else is cleared out. A straightforward tag includes the following information: item identification and quantity, item classification, reason for red tagging, work section, and date. A completed tag is attached to each object. Once all unnecessary objects are tagged, they are removed to a central location. It is recommended that the results of the tagging be recorded to determine room gained throughout the process (Dennis, 2002).

Seiton or straighten – This phase of 5-S relates to housekeeping and properly organizing tools and materials. All items should be properly stored at or near their intended area of use. During this phase, ergonomics are taken into consideration to ensure commonly used items are placed within easy reach, reducing the need for bending and excessive walking (Womack and Jones, 1996). This phase concentrates on organizing the environment and making it easy for the employee to perform his or her job.

Seiso or shine – Once all unnecessary items have been removed and tools and other items have been organized and stored in convenient locations, the third or shine phase is initiated to ensure cleanliness of the work area. This includes cleaning the floor, disposing of trash, and organizing equipment. Shine refers to clarifying what will be cleaned, how it will be cleaned, who is responsible for cleaning, and how clean it is to be. Once this is communicated, employees understand who is responsible, what is expected, and how and when the clean-up processes will be carried out (Dennis, 2002).

Seiketsu or standardize – The fourth stage revolves around creating the discipline or a consistent approach for maintaining a clean work environment. Once the three previous areas are implemented, a formal procedure or system must be established to maintain the clean environment. This phase is often underestimated and has proven to be problematic for many

manufacturing firms. Random, detailed audits of areas are helpful in maintaining the defined standards (Womack and Jones, 1996).

Shitsuke or sustain – The final phase is to move forward and continuously improve workplace organization. This is accomplished by persistently identifying various forms of waste and their root causes. Eliminating these root causes reduces the redundant clean-up time thereby implementing one more facet of Lean Thinking.

The 5-S philosophy should be included as an integral part of any lean training that is implemented throughout an organization. It serves as an investment with a quick payback (Dennis, 2002). The benefits of implementing a 5-S strategy far outweigh the downfalls. Improvements in safety, downtime reduction, rise in employee moral, expeditious identification of problems, and employee empowerment to improve the workplace are just a few benefits that can be realized. The 5-S approach not only makes the workplace more organized, it furthers the journey of running lean. The 5-S philosophy can be applied almost anywhere throughout an organization. Standardization does not only apply to the production floor.

Once the work stations and equipment are organized, and employee training and understanding is achieved, another step to increasing efficiency through downtime reduction can take place. This next phase involves evaluating current setup practices and improving on them.

History of Single Minute Exchange of Die (SMED)

Known as Dr. Improvement in Japan, Shingo is the originator of the SMED system, the Poka-yoke defect prevention system. Shingo also is one of the developers of the Just-in-Time production system, which has facilitated Toyota in becoming one of the most productive automobile manufacturers in the world. In his book, *A Revolution in Manufacturing: The SMED System* (Shingo, 1985), Shingo explains the birth of the effective system he developed.

In the spring of 1950, Shingo was asked to conduct an efficiency improvement survey at Toyo Kogyo's Mazda plant in Hiroshima. Toyo wanted to eliminate bottlenecks caused by a large, body-molding process. Shingo immediately conducted an on-site inspection and asked to follow the inspection with a weeklong production analysis to be timed with a stopwatch. After some reluctance on the part of upper management, Shingo was allowed to conduct the study. The section manager thought it would be a waste of time. Since he had the presses working around the clock, he felt that the only way to improve capacity was to purchase new machines. Shingo was soon to prove the flaw in the section manager's contention. On the third day of the study, a die change was required on an 800-ton press (Shingo, 1985). Workers began removing the old die and subsequently discovered one of the mounting bolts for the new die was missing. As a worker scurried around trying to locate the missing bolt, Shingo sat by patiently. The worker returned and stated that he could not find the part and had to fabricate a bolt from another die. Shingo asked the worker if this happened often. He replied that it did not, a remark that prompted Shingo to conjecture that setup operations were comprised of two fundamentally different components:

1. Internal Setup (IED), such as mounting or removing dies, that can be performed only when the machine is stopped.
2. External Setup (OED), such as transporting old dies to storage or conveying new dies to the machine, which can be conducted while the machine is in operation.

He pointed out that preparing the bolts was an external operation. It didn't make sense to stop the operation of the 80-ton press because a bolt was missing. All that had to be done was to establish an external setup procedure to ensure the necessary bolts were ready for the subsequent setup.

Shingo eventually witnessed other processes to which the same philosophies could be applied. In 1969, Shingo visited the Toyota Motor Company's main plant (Shingo, 1985). A divisional manager explained they had a 1,000-ton press that required four hours for each setup change. Volkswagen in Germany had been achieving setups on similar equipment in two hours; therefore, Toyota's management wanted it done in less time. Great pains were taken to identify the IEDs and OEDs of the process. After six months, they were able to reduce setup times to 90 minutes. On a return trip, Shingo was surprised by the request from top management to reduce the setup time to less than three minutes. For an instant, Shingo was stumped. Then it occurred to him to convert IED to OED. After three months of working, the team was able to achieve the setup in under three minutes. Shingo named the concept, Single Minute Exchange of Die (SMED) and predicted any setup could be achieved in less than ten minutes. SMED was later adopted by all Toyota plants and continued to evolve as a principal element in the Toyota Production System (Shingo, 1985).

One of the main objectives in Lean Manufacturing is to reduce the lead time of a product or material as it moves through the shop floor. Through decreasing setup and changeover times, lead time for products can be decreased along with a reduction in inventory levels. The SMED practice consists of three distinct implementation stages that revolve around internal and external movements. The first and most important step in implementing SMED is to distinguish between external and internal setup. By performing apparent tasks such as preparation and transport while the machine is running, the time required for the internal setup or operations required while the machine is stopped can usually be reduced by as much as 30 to 50 percent (Productivity Press Development Team, 1996). The second stage revolves around investigating if the claimed internal setups or changes that need to be performed while the machine is off can be replaced

with an external setup or the ability to perform the setup with the machine running. The final stage involves streamlining all aspects of the setup. This includes all movements, tool placements, and all other processes that might decrease the time required to perform any operation. It is essential to point out that it may not be possible to reach the single-minute range for all setups; however, SMED significantly does reduce setup times in almost every case (Productivity Press Development Team, 1996). Reducing setup and changeover times allows companies to become more competitive in their operation.

Evaluating every setup within an organization is critical in reducing labor dollars and increasing machine capacity. Many times, machine capacity is required to eliminate constraints or bottlenecks found through the use of the Value Stream Map. The reduction of bottlenecks within the system should be every manager's goal.

Theory of Constraints

When addressing goals and bottlenecks, the reputable and noteworthy Mr. Eliyahu M. Goldratt must be mentioned. In 1985, Eliyahu M. Goldratt introduced his book, *The Goal*, which paved the way for the Theory of Constraints. In Goldratt's book, *Theory of Constraints* (1990), he wrote about the process of change and how to implement change within an organization. The book opens with a recap from *The Goal* by reiterating that the reduction of constraints can be summarized into the following five steps:

Step #1. Identify the system's constraints – The Value Stream Map allows this to be accomplished. However, Goldratt mentions that identifying the constraints also means to prioritize them according to the established goal. In other words, question and define the true goal of the organization.

Step #2. Decide how to eliminate or remove the constraint – The reduction or elimination of the constraint should be accomplished, if possible, through the use of non-constraint resources. A key example of this is labor. By shifting labor from non-constrained areas into constrained areas, the constraint can be surmounted.

Step #3. Subordinate everything else to the above decision – Once a decision has been made to exploit the constraint, all attention should be spent in that area. Given the complexity of today's manufacturing floors, it is often difficult to see the forest for the trees. By concentrating efforts on the constraint, the goal can be accomplished.

Step #4. Elevate or break the constraint – To achieve the goal of constraint reduction, continual improvements should be made until the constraint is no longer viable. This process of continual improvement will prove effective in resolving ensuing constraints as they occur.

Step #5. If, during any of the previous steps, a constraint is resolved, the process is continued by returning to step one. Goldratt emphasizes and cautions that managers need to be aware that established policies or the way things have been done in the past can create new constraints. Breaking this debilitating mindset and developing new procedures and policies is the key to success.

To better explain the Theory of Constraints in *The Goal*, Goldratt also uses various symbols to explain the philosophy. He developed the idea of a drum, buffer, and rope to explain how a production system should come together. The drum symbolizes the steady synchronizing beat of the production floor. All machines should run at the same beat of a drum and in synchronization with each other. To achieve this steady rhythm, buffers are placed between uneven operations to level them out. The rope symbolizes the "pull system." To be a true lean

organization, products must be produced in accordance with customers' demands. In other words, the product should be pulled through the lines only when it is needed.

Pull System

By definition, in a pull system, no operation upstream will produce goods or services until the customer downstream requests it (Dennis, 2002). The pull system allows organizations to produce only what is necessary with the customer, ideally, creating the demand. A pull system is built from the JIT philosophy, whereby material is requested only when it is needed. The use of kanbans or a system of visual tools, which orchestrates and provides instruction to suppliers and customers both inside and outside of the plant, allows this to be achieved. Once a system is in place to trigger production, scheduling must make up for fluctuations in demand. This can be achieved through production leveling. The objective of production leveling, which supports standardized work and continuous improvement activities, is to build at the same pace every day to minimize the peaks and valleys in the workload (Dennis, 2002).

Both kanban systems and production leveling rely heavily on quick changeovers, organization through 5-S, and the insurance of capable processes. Capable process means standardized work, capable workers to perform the tasks accurately, and capable machinery to produce on a consistent basis. Overall, consistency in the process is what drives the pull system.

Once the process has been mapped, various tasks standardized, setup and change-over downtime decreased, non-value-added activities removed, multiple constraints eliminated, and improvement-on-demand signaling and scheduling has been accomplished, it is time to make the entire system flow as one. Managing the process to flow smoothly as a single-unit operation presents one of the most difficult struggles a manager faces in the quest for lean perfection.

Managing Flow

Managing flow requires an entirely new mindset for many managers. It necessitates a different way of thinking, a new paradigm. All too often, managers and employees get caught up in a web of categorizing areas of an organization. Departments are created; specific steps of the process are perceived to be done only one way; and producing products in batches is believed to be the best method of operating. Managers must steer away from these limited thought processes and observe the company in its totality as a single functioning machine whenever possible. Until this occurs, the most effective flow for an organization will not be realized.

The following ten major opportunities for flow manufacturing were excerpted from Flow Alliance's February 2002 newsletter, a consulting firm specializing in lean manufacturing:

1. Start with a master plan: Flow Manufacturing Baseline Analysis: Any project of this magnitude must start with a strategic and tactical plan, quantifying the expected benefits, resources required, approach to be followed, and timeline. Some of these issues may be difficult to assess and require specialized expertise.
2. Combine training with doing: Training and implementation should go together, and implementation should be fast. The combination of formal training with implementation activities results in superior understanding and retention by the participants and in immediate bottom-line benefits. Training is tailored to customer needs, not "one size fits all."
3. Get up the learning curve fast: Experienced guidance is the best way to reduce risk and get up the learning curve quickly.

4. Achieve complete buy-in from the operators: Everyone needs to be involved in the Flow Manufacturing effort, and the key to buy-in and execution at the process level is complete and interactive operator training and participation. Classroom training alone is often ineffective. At the operator level, training is best conducted in the form of a mini-Kaizen or rapid-improvement event. Both skills and practical results are achieved simultaneously, and participant buy-in is virtually assured.
5. Understand dynamic systems thoroughly: Implementing a Flow Manufacturing process without modeling it first is like designing an aircraft without using a wind tunnel. Don't do it. Test your designs first, for throughput, bottlenecks, and flow. Understanding complex flow is difficult or impossible without modeling tools.
6. Revamp your planning system: Changes to your planning methods can be a critical success factor for your implementation efforts. Traditional MRP-based planning tools don't support Flow Manufacturing and can be a road-block. The planning tool of choice is APS (Advanced Planning and Scheduling). APS provides sequencing, optimization, and finite capacity planning needed for Flow Manufacturing.
7. Connect all processes: Flow Manufacturing is not just for the factory. The low-hanging fruit in many companies is the planning, administrative, support, customer-service, and product-design processes. The same implementation tools that we used in the factory can be applied to these areas. Flow all of your processes.

8. Adapt existing computer systems: Chances are excellent that your existing manufacturing system was not designed for Flow Manufacturing. You're not going to throw it out either; you need to make the best use of what you have. Understand the data and formalization needs of Flow Manufacturing and extend the useful life of your existing systems while meeting Flow Manufacturing requirements.
9. Model your supply chain: Up to 80 percent or more of your product cost is in purchased material: supply-chain management is not a minor detail. Those companies making a profit, even in troubled times, are those that are doing an excellent job of supply-chain management Use dynamic simulation models to test supply-chain relationships, and drive the improvement process.
10. Avoid backsliding: The risk of losing your hard-won gains over time is very real. Management must have a long-term strategy that can maintain a Flow Manufacturing culture in the face of changes in the economy, in leadership, in products, and in technology. A never-ending training and rapid improvement effort is at the heart of the maintenance strategy (Flow Alliance Newsletter, 2002).

Managing the value stream to flow requires great efforts and persistence. Machine downtime is one source for interruptions in the flow and requires added attention to decrease these disturbances.

Necessity for Downtime Tracking

Both JIT and Lean strategies rely on machine uptime to successfully decrease work in process and inventories and streamline the flow. Although these strategies primarily impact

equipment utilization, they do not necessarily require the equipment to be functioning 100 percent of the time. Rather, the strategies require machines to be available for action immediately when needed (Maskel, 1991). Maskel stated, “The implementation of Just-In-Time manufacturing is often accompanied by the introduction of a thorough preventative maintenance program” (p. 165). Along with mechanical downtime, other sources of downtime exist. *Lean Production Simplified*, a lean manufacturing primer, defines the six big losses that create downtime as: equipment breakdowns, setup and adjustment delays, idling or minor stoppages, reduced speed, process defects, and reduced yield from machine start-up to stable production. These sources of production losses must be tracked and analyzed for prior to initiating improvements.

The desire to implement continuous improvements requires managers to determine what is restricting the operation from achieving its goals. Without the proper metrics in place to do this, it is virtually impossible to identify where to focus attention.

Standardized Work

Dennis (2002) stated, “The bedrock of production is standards – what is supposed to happen. The bedrock of excellence is the adherence to standards” (p. 27). Standards must be put into place to both define the expectation and provide the guidelines for improvement. John Shook, a leader in implementing Toyota production methods in the United States, writes about and educates management on the importance of standardized work. Following his Toyota experiences in 1983, he helped to train leaders at the New United Motors Manufacturing, Inc. (NUMMI) plant located in Fremont, California. While implementing lean methods, he explained that each job should be organized to ensure it is always done in the most efficient manner (Shook, 1998). Through standardizing the job and doing it in only one fashion no matter which

employee is performing the task, the product's quality remains consistent and the work is efficiently completed (Jordan, 2001). Through developing standards for all work and training employees to comply with those standards, efficiency and quality both can be maintained.

While standardizing work, a great deal of effort is spent conducting time studies and creating time standards. A time standard is simply the time required to produce or perform a function at a workstation. Three important criteria must be met to conduct an accurate time standard. First, the standard must be measured with a well-trained and qualified operator performing the task. Second, the operator must be working at a normal pace, and third, the operator must be doing the specific task, which was defined prior to the study. A qualified and well-trained operator is a necessity considering the goal or outcome sought. Experience is what usually develops a well-trained operator, so sufficient amounts of time and training must be invested in the operator before setting the standard (Meyers, 1991). Ensuring a normal pace is also critical in developing the standard. Many times, feelings of anxiousness overwhelm employees to work faster than usual, especially when they are being timed. It is important to ensure this does not happen. Examples of common standards for a normal pace include walking 264 feet in one minute, dealing fifty-two cards into four equal stacks in thirty seconds, and filling a thirty-pin pin board in twenty-six seconds (Meyers, 1991). Accurately communicating the established pace to the employee will help ensure consistency in the development of the standard.

Summary

Although only selected techniques have been explained in this thesis, the number of tools and philosophies available for improving the workplace are endless. Managers should be encouraged to seek out available tools and become aligned with the workforce that carries out

those principles. Implementing lean principles is only the beginning of continual improvement and education. Machines, methods, and mindsets all must be changed to maintain the voyage to perfection.

CHAPTER III: ELUCIDATION OF PLANT XYZ'S MANUFACTURING PROCESS

Overview

Plant XYZ's complete process can be broken down into three primary areas: manufacturing, cooking and chilling, and packaging. The manufacturing process consists of receiving the de-boned meat into the facility, grinding it up, mixing it with non-meat ingredients, and stuffing it into preformed casings. The cooking and chilling process begins by placing a rack of stuffed casings, known as logs, into an oven and heating them to a specific temperature. Once the proper temperature is reached, the logs are removed from the oven and placed into a refrigeration unit to chill. The final process involves packaging where the logs are sliced, packaged, and prepared for shipment to the customer.

Scheduling

Every Tuesday, the production plan for the following week is created. Demand is generated from company-owned distribution centers and outside customers. Once the demand is finalized for the following week, the production plan is created by the materials manager. Each day of the week is represented on the plan along with the products to be produced (see Appendix A). Within each of the daily columns, the number of batches to be manufactured is entered. Based on the weekly production plan, two daily schedules are generated: the stuffing schedule and the slicing schedule.

The stuffing schedule dictates the activities for the manufacturing side, and the packaging schedule drives the packaging side (see Appendices B and C). Both schedules are produced the previous day and are based on the weekly production plan, manufacturing upsets, and priorities.

Receipt of Raw Materials

Dependent on the weekly processing schedule, both meat and non-meat ingredients are ordered. The date the meat is received at the facility is targeted for the day prior to production due to both Just-In-Time philosophies and space limitations within the receiving cooler. The material arrives in plastic-lined, corrugated containers containing 2,000 pounds of material. The containers are removed from the truck, weighed, temperature tested, inspected, wrapped in plastic, and placed in various staging locations separated by type. Although the raw-receiving cooler has various staging areas, the level of organization varies based on manufacturing efficiencies, on-time deliveries, and demand requirements. Therefore, continual monitoring and making improvements within this area would lead to more efficient retrieval of goods from the raw-receiving cooler.

Grinding

The grinding operators direct their work from the blending schedule (see Appendix D), which is dependent on the stuffing schedule. Once the requirements are known for the day, the operator can commence grinding. There is a formulation sheet (see Appendix E) for each product. The formulation sheet provides a list of all ingredients and the critical information required to produce the product up to the stuffing process. Included in the formulation sheets are the specific grind sizes required for that particular product. Referencing these sheets, the grinders determine the size of the grind. The various grind sizes range from three thirty-seconds of an inch to one and one-half inches in diameter and are changed by replacing a steel plate within the grinder.

Once the grinder operator ascertains the requirements and ensures the grinder is set up properly, he or she retrieves the meat from the raw-receiving cooler. After the container of meat

is removed from the raw-receiving cooler, it is loaded into a lift that empties the container of meat into the grinder. The meat is then run through the grinder and ground into a stainless steel vat to proper weight according to the formulation sheet. Next, the vat of ground meat is moved to an open location on the production floor. No specific staging areas are designated on the production floor.

Blending

The formulation sheets are designed to produce batches in both 6,000- and 8,000-pound quantities. However, batches can be proportioned to demand if necessary. The appropriate ground meat is pulled from storage locations and transported to the blenders via a motorized hand truck. The vat is placed into a vat lift and emptied into a large blender along with various spices, preservatives, and other ingredients. Once all ingredients have been added, they are mixed for a specific time period under vacuum and subsequently transferred from the blender into approximately four stainless-steel vats. From there the mixture is staged for stuffing. Again, there are no set staging areas.

Stuffing

The blended mixture is pulled from its staging area using motorized handcarts. The full vat is placed into the vat lift that empties the ingredients into a hopper with a screw auger located in the bottom of it. The mixture is augered into a vacuumizer, which removes the air from the blend. The mixture is then pumped into a stuffing machine where it is stuffed into a four-inch-diameter round casing approximately 72 inches long. Once the mixture is stuffed into the casings, the ends are clipped and cut, then manually placed onto racks. Each rack holds 55 finished logs or stuffed casings. Once a rack is filled, it is weighed and loaded into an oven for cooking or staged until an oven is available.

Cooking Process

Each oven has a maximum capacity of twelve racks, which are filled entirely to increase utilization. Products are cooked for a specific amount of time based on the diameter and variety or until they reach 160 degrees to ensure food safety, a regulation set by the United States Department of Agriculture (USDA). Both time and temperature are charted and recorded to comply with USDA regulations. Once the meat inside the oven has reached its required temperature, it is showered with warm water to begin the chilling process.

Chilling Process

After the product has been cooked to temperature and showered, the oven load is transferred to a chilling air-blast system. The blasts will begin lowering the temperature of the meat. Products are chilled to appropriate slicing temperatures and are required to reach 50 degrees within a six-hour time period to meet the USDA's food-safety regulations. Once the chill process is completed, it is recommended the meat be tempered in the holding coolers. This process ensures temperature equilibration throughout the logs to ensure higher yields during slicing. The meat remains on the racks until the slicing process.

Slicing

Each slicing and packaging line is equipped with a slicer, which is capable of slicing at multiple, high rates of speed. As soon as the racks of meat have been equilibrated to slicing temperature, they are transferred from the holding cooler to the slicing line. The slicing schedule dictates which line will slice which product. This is usually based on historical data matching the best line for the best product relative to yield, quality, and speed. The logs are fed into the slicer and sliced to a specific weight and slice count depending on the type of product. After the product has been sliced, it is transported down the line to the packaging equipment.

Packaging

Once the meat is sliced, it travels to a packaging machine that forms plastic roll stock film into individual pockets into which the meat is manually placed. It then travels through the packaging machine, which applies a top layer of plastic film to create the enclosed package. The atmospheric air trapped within the package is then evacuated, and replaced with an inert gas. This prevents spoilage and ensures a longer shelf life. The package is cut to size and transferred via conveyor belt farther down the line. The plastic package is placed into a cardboard carton, which is glued shut. The filled cartons travel down the line and are placed into a corrugated box and palletized for shipment. The finished pallet is transported to the shipping area.

Warehousing/Shipping

When a pallet is fully loaded, the appropriate documentation is filled out, and the pallet is moved to the shipping area via a hand jack. Once in the shipping area, the pallet is checked in by entering information about its load into an inventory database. From there, it is either placed on a truck for immediate delivery or stored in the warehouse for future transport.

Summary

The process is fairly similar for all product lines. The receipt of raw material, grinding of the meat, addition of non-meat ingredients, stuffing of the meat into a casing, cooking and chilling the product, slicing, packaging and finally shipping. With no interruptions the lead time is approximately 26 hours.

CHAPTER IV: METHODOLOGY

Generation of the Value Stream Maps

Based on the improvement requirements, two primary Value Stream Maps (VSM) will be created. The first VSM will model the grinding, blending, and stuffing processes within the manufacturing department taking a look at the times and necessary requirements associated with those particular areas. The second VSM will depict a particular line used to manufacture bologna up to cooking and the processes associated therewith. Both maps will be used to illustrate bottleneck areas for improvements. The maps will be generated through the use of Microsoft® Excel, and a template will be designed to be used for other mapping. The underlying technique was extracted from the book, *Learning To See* by John Shook and Mike Rother (1998).

To represent the various functions of the process, boxes and inverted triangles will be used for illustration purposes. The first map will depict the grinding area and continue downstream following the product flow through blending and stuffing. Each function (grinding, blending, or stuffing) will be represented by a rectangular box encompassing all of the required information for the analysis. Triangles separating mapped functions will represent queue or hold times within the process. These are placed in accordance with the various process steps throughout the map. Within each rectangle, the required information associated with that individual process will be indicated. Included in these boxes are the average cycle times per batch, setup and changeover times, number of changeovers, percentages of uptime, number of shifts, minutes per shift, total minutes, and batch capacity per number of shifts. The second map will model a segment of the bologna production line, which is comprised of blending, vacuumizing/emulsifying, and stuffing. Within these separate functions, the same information included in the former VSM will be included.

After the spreadsheet is generated and the cells are labeled with the above-stated information, data will be entered into the spreadsheet. To capture this data, time studies will be conducted and appropriate information collected and calculated. The required data will include, but not be limited to: grinding -time requirements, blending times, stuffing times, stuffing-equipment-setup times, various queue times, number of batches scheduled, total blend time required for schedule load (seconds), total weight (pounds) per batch with ingredients added, total weight (pounds) required to be stuffed per scheduled load, number of bags of ingredients, number of bags per scheduled load, gallons of liquid required, gallons of liquid per scheduled load, number of combos/vats to be lifted into the blender, and number of combos/vats to be lifted into the blender per scheduled load.

When the VSM is completed, the production capacities and setup times for the stuffing processes will be evaluated for potential improvements to increase efficiency. Bottlenecks will be identified through the completed VSM and addressed. A detailed explanation of the VSM will be written to provide a working understanding on how the VSM format specifically was generated to apply it elsewhere throughout the process or to other companies within the corporation.

Application of Single Minute Exchange of Die Methodology

The stuffing equipment is comprised of three machines. The first is a screw loader, into which the vat of meat is dumped, and that transports the blended meat into the downstream machine. Second is the pump/vacuumizer that removes trapped air within the meat. Third is the T-Sizer that stuffs the meat mixture into casings. One operator completes the setup of these three machines. The setup will be videotaped to provide the researcher with the current setup procedures. Through the use of the timer/counter on the camera, the tasks will be segregated, and

the date will be entered into a spreadsheet. The researcher, along with the operator, will view the videotape and apply 5-S and SMED practices, mentioned in the Review of Literature section, to reduce overall setup time. Once the videotape is viewed and changes applied, the setup will again be videotaped, and the time recorded in the spreadsheet to calculate a reduction in time measurement.

Creation of a Standardized Work Card

Following the final video taping of the reduced time setup, the individual tasks will be delineated in an Excel spreadsheet. Times will be broken down for each task and laminated and labeled as Standardized Work Cards. This information on this card will be communicated to the employees to establish the expectations. Time sheets will be used to monitor deviations from these expected times.

Construction of the Downtime Monitoring Sheets

Creation of the downtime sheets to be used within the grinding, blending, and stuffing areas will be created using Microsoft® Excel. Common causes of downtime for each area will be listed on the individual sheets for ease in documentation. Columns, including line downtime and line uptimes, will be used to calculate the total amount of downtime for each incident. Once the downtime sheets are created, they will be distributed to the operators for reference. After the downtime sheets are filled out, they will be entered into a database to establish the most common sources for downtime. This process will lead to improved management knowledge of where to focus attention.

CHAPTER V: EXPLANATION/INSTRUCTIONS FOR USE OF THE VALUE STREAM MAPPING TOOL

Value Stream Map Outline

The specific areas mapped were chosen based on previous knowledge of the process. If solid previous knowledge of the process is unknown, it is suggested the entire process be mapped out. This guide will describe the Value Stream Map (VSM) and provide a basic understanding for application elsewhere. The viewable portion of the VSM includes the following as mentioned in the Methodology section: average cycle time per batch, setup time, change-over time, number of changeovers required per scheduled load, percent uptime, number of shifts, minutes per shift, total minutes available, and batch capacity per number of shifts.

Average Cycle Time Per Batch

To determine the proper cycle times for each area, time studies are required. The Cycle Time spreadsheet drives the average cycle time per batch information within the spreadsheet making it critical to ensure all required tasks are listed and timed accordingly. The average cycle time per batch for each of the three processes, grinding, blending, and stuffing were set up the same way; therefore, grinding will be used for the explanation and instructions. Through observation, all direct tasks required to perform the grinding function were recorded on the spreadsheet. These tasks include:

1. Retrieving meat from cooler with pallet jack.
2. Removing plastic from combo and placing vat in lift.
3. Retrieving empty vat with pallet jack and placing on scale.
4. Lifting vat.
5. Lowering vat.

6. Walking around to front side of grinder to get lift.
7. Wrapping, labeling, and moving vat to staging area.
8. Changing grind plate to appropriate size.

Once all tasks are listed, indirect tasks also must be included. Up to this point, all movements required from the employees should be timed. The remaining time to be added to complete the process is the actual machine processing time. To capture this time, the Scheduled Load sheet must be completed. Since this project references the grinding, blending and stuffing processes, those will be used to illustrate the Scheduled Load Sheet.

Scheduled Load Sheet

The Scheduled Load refers to the product mix, batch quantity, or schedule demand that is inputted into the spreadsheet. The Scheduled Load spreadsheet reflects the information about how many bags of material are needed for each batch, how many grinds sizes, the volume of fluids to be added, and the grind times for each size and variety. Based on the batch sheet used in production, each product contains an exact quantity of meat and non-meat ingredients and is ground to the specified sizes. The batch sheet also indicates the blend time required for each batch. In other processing environments, other variables can be inputted. Since grinding sizes result in different grind times, each grind size had to be separated to represent an accurate grind time. The times required for each grind size were obtained through direct time studies. The number of grinder plate changes depends on the number of grind sizes required for the scheduled load. The number of batches to be ground determines how many plate changes will be required. Under this scenario, it has been determined only to have a two-batch WIP; therefore, the number of plate changes is calculated accordingly.

Once all pertinent information regarding batch requirements are entered into the Scheduled Load spreadsheet, the average cycle time per batch for the scheduled load or product mix can be calculated.

Setup Time

The setup-time data is also generated through time studies. The setup is videotaped, and once completed, the time on the video counter is used to track the movement times. As the video is viewed, the various steps are recorded on the spreadsheet along with the video time. The spreadsheet is designed to run the calculations that show the required time to perform each step. This serves as a tool when applying SMED practices to display areas for improvement and can be used as the Standardized Work Card. Once completed, the total time is summed and transferred into the Value Stream Map.

Changeover Time

Changeover times are similar to setup times; however, unlike setups, changeovers do not always have to occur. On the other hand, changeovers may be much more frequent than setups based on product mix, so they are separated for this project.

Number of Changeovers and Shifts

Both of these values are manually inputted into the VSM. However, the number of changeover functions could be automatically calculated based on the scheduled load and the type of washout/changeover requirements. The number of shifts also can be considered a constant.

Uptime

This value, expressed as a percentage, is the average mechanical uptime for the specific piece of equipment. Because historical data is not available to input into this map, 100 percent efficiency will be used. However, through the implementation of a downtime tracking system,

data will be generated for future use. Through incorporating the historical machine efficiencies, a closer representation of the process is gained.

Minutes Per Shift

The minutes-per-shift value was calculated based on 7.75 hours of actual production time. The workday is 8.5 hours long with an unpaid 30-minute break and a paid 15-minute break. The 15-minute break is included in the minutes per shift, but the 30-minute unpaid break is not. Both the grinding and stuffing processes are equal to 465 minutes per shifts. Since most batches require a blend time of at least 30 minutes, employees can take breaks during the mix time. Therefore, if timed properly, 45 minutes can be added to the minute per shift time increasing the blending area to 480 minutes per shift. It is important to break production times down to individual processes for both constraint reduction and worker efficiency.

Total Minutes

The total-minutes value is equal to the “Shifts” box multiplied by “Minutes per Shift” box.

Two-Shift Batch Capacity

The resultant calculation provides the quantity of batches that can be produced in two shifts and is generated in the bottom box. This calculation is as follows: Two Shift Batch Capacity = ((Total Minutes – Changeover Time – Setup Time) / (Average Cycle Time/Batch) X (% Uptime))

Queue Time

The amount of time WIP remains in between the different processes is the value placed under the triangle. It is represented in minutes, as is the entire VSM portion. This project will not

focus on queue time reduction, although it must be considered when analyzing the efficiency of the entire system.

Using the VSM as a Tool to Improvement

Once the entire Value Stream Mapping tool is completed, a bird's-eye view of the complete manufacturing process is generated. Looking at the process results, managers can make specific improvements to the process knowing the map was created objectively. In addition to focusing on constraints, the tool also allows managers to examine cost savings both in labor and throughput throughout the different steps in the process. Although Value Stream Mapping begins as a pencil-and-paper tool, the advantages of creating the Excel template with all times included are that future state conditions can be easily and very quickly displayed. This tool should be used as a dynamic document and should constantly be updated and examined for continuous improvements throughout the entire value stream.

CHAPTER VI: APPLICATION OF LEAN MANUFACTURING TOOLS WITHIN
 COMPANY XYZ

Implementation and Analysis of the Value Stream Map

Based on the daily production schedule, the scheduled load was recorded in the Scheduled Load spreadsheet of the value stream map workbook. The data entered was acquired from a second shift schedule with a batch load of eight batches. Based on that schedule, the following product mix was entered (batches):

- 1. (1) - Smoked Turkey
- 2. (2) - Deli Thin Honey Roasted Turkey Breast
- 3. (2) - Deli Thin Fat Free Smoked Turkey Breast
- 4. (3) - Deli Thin Fat Free Honey Roasted Turkey Breast

Capacity Planning

Since the Value Stream breaks out the requirements for each individual product formula, it can be used for Rough Cut Capacity planning. Based on the scheduled load requirements, the results are displayed in the following figure:

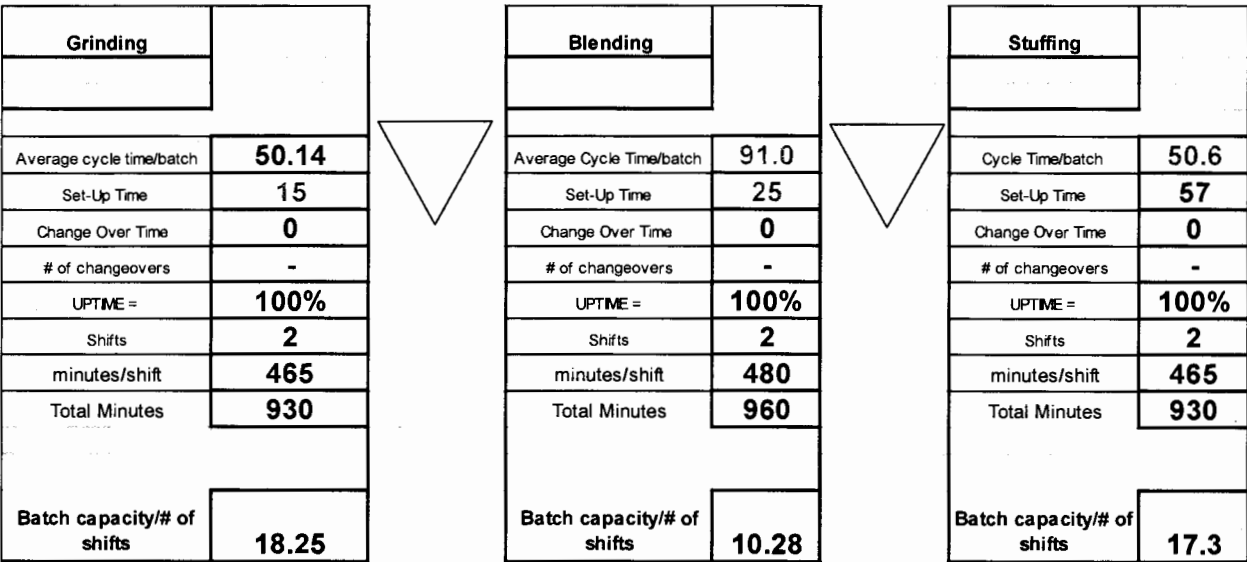


Figure 1 – Current State Value Stream Map

Reviewing the batch capacity per number of shifts, the blending process will create the constraint. As pictured in Figure 1, the two-shift capacity is 10.28 batches. Proper capacity planning is critical in producing a consistent product. The researcher has observed that when an overloaded schedule is handed to the employees performing the job, many times they will reduce mix times or take shortcuts to fulfill the schedule. This affects both product quality and performance of downstream processes. To preclude this from occurring, the scheduler for this product mix should not schedule more than ten batches without allotting more production time.

Establishment of Operator Expectations and Baseline for Magnitude of Downtime

Based on the current state VSM, the production expectations or standards can be established. In Figure 1, the VSM for the scheduled load inputted returns a process capacity of 10.28 batches per day with the specific product mix. Since the times recorded were created through direct-time studies, it is reasonable to conclude that 10.28 batches is possible throughout the day's production given no production barriers are encountered. This baseline can be used as a benchmark against downtime and the number of problems the operator may face in a given day.

Creation of Staging Areas

In keeping with the Theory of Constraints, the bottlenecks within the blending operation must be reduced. By referencing the Cycle Time Sheet, bottlenecks within the process can be identified. As shown in Figure 1 of the VSM, the grinding operation has almost double the batch capacity of shifts compared to the blending operation. When the time studies were conducted, it was observed that when the grinders removed a finished vat of ground meat from their scales, they would not place it into a staging area. Instead, they would transport it to any convenient location. This was a common occurrence with all grinders. Through time studies, it was found

the grinders took approximately 70 seconds to move a vat to a location and more than 162 seconds for blenders to retrieve it.

To address this problem, the researcher designed staging areas for each blender. Grinders were required to bring the meat to the staging areas located near the blending equipment. This allowed blenders to retrieve the vats of meat quicker and reduced the excess capacity at grinding. Figure 2 visually depicts the results of implementing staging areas as shown in the batch capacity per number of shifts box. Analyzing the change in capacities, there is an increase in the blending area in Figure 2 compared to the 10.28 capacity in Figure 1. Also note, the grinding function has decreased in batch capacity; however, based on the Theory of Constraints, this will not impact the outcome of the entire system.

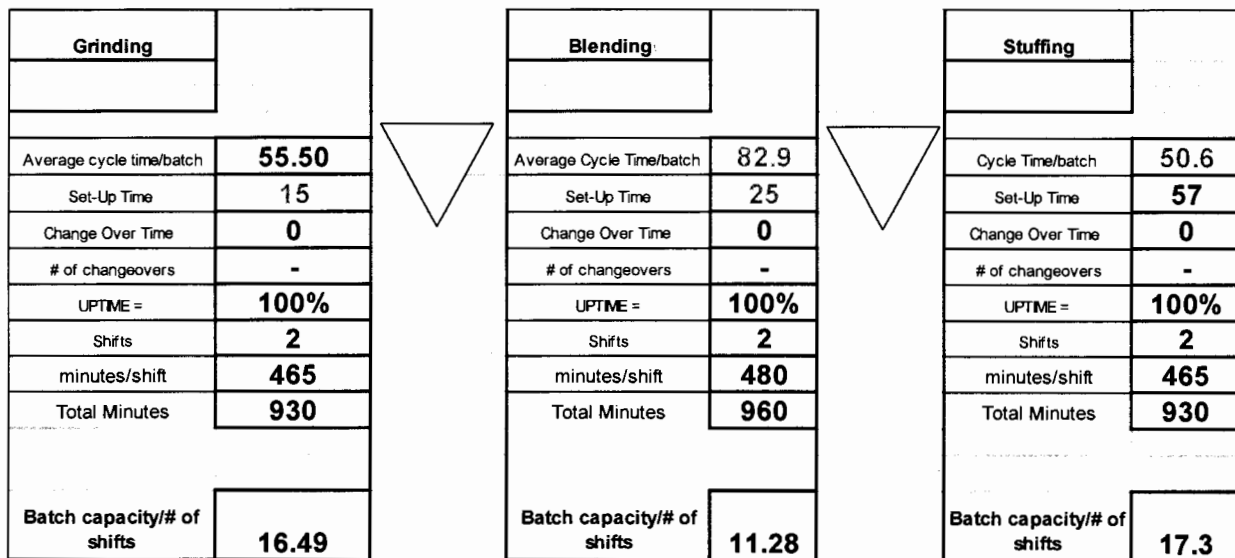


Figure 2 – Value Stream Map Following Implementation of Staging Areas

Comparing the current state before the staging areas and the future state once the staging areas were implemented, the following pound increases in Figure 3 were recognized. The pre-existing blending capacity was 10.28 batches, it has now increased to 11.28 batches. Comparatively, the pre-existing grinding capacity was 18.25 and is now 16.49 batches.

Current	10.28	Batch capacity/# of shifts
Future	11.28	Batch capacity/# of shifts
Difference	1	More batches/day
Lbs/Batch	8000	
Additional Pounds	8000	More pounds/day
Additional Pounds	40000	More pounds/week
Additional Pounds	2080000	More pounds/year

Figure 3 – Before and After Capacity Analysis

Elimination of Water Constraint

Over time, it was demonstrated that adding water consumes a large segment of the available time. Since water can be run while adding spices, the time required to add spices is internal to the addition of water. Therefore, 8,279 seconds are required for adding water and 5,016 seconds to add spices for the scheduled load resulting in a variance of 3,263 seconds. A more efficient and expeditious method of adding water would, in turn, increase capacity.

Increasing Water Capacity

The current flow rate for the water available at the blending operation is 10.9 gallons per minute. The water pipe transporting water to the processing machine is three-quarters of an inch in diameter from the main with a half-inch-necked-down hose. The first attempt to increase flow involved removing the one-half-inch hose and replacing it with a three-quarter-inch hose. This resulted in an increased water flow of 15 gallons per minute. When this was entered into the Cycle Time Sheet, the water-adding time was reduced to 6,016 seconds for the scheduled load, which raised blending capacity to 11.96 batch capacity per number of shifts. Although capacity is increased, the blending process continues to present a bottleneck for the scheduled load, with water still being a constraint.

The second attempt to increase flow entailed running another hose, with a flow rate of approximately 15 gallons per minute, from a neighboring blender. Quick connects were added to the hose for easy removal, which allowed the hose to be shared more efficiently. The resulting

water flow was equal to 30 gallons per minute and took 3,008 seconds to add the required amount of water. This results in increasing the blending capacity to 12.29 batches per number of shifts. Although the modification did not diminish the blending bottleneck, it did eliminate the water flow as a constraint. This is illustrated in the following figure:

Grinding			Blending			Stuffing	
Average cycle time/batch	55.50	▽	Average Cycle Time/batch	76.1	▽	Cycle Time/batch	50.6
Set-Up Time	15		Set-Up Time	25		Set-Up Time	57
Change Over Time	0		Change Over Time	0		Change Over Time	0
# of changeovers	-		# of changeovers	-		# of changeovers	-
UPTIME =	100%		UPTIME =	100%		UPTIME =	100%
Shifts	2		Shifts	2		Shifts	2
minutes/shift	465		minutes/shift	480		minutes/shift	465
Total Minutes	930		Total Minutes	960		Total Minutes	930
Batch capacity/# of shifts	16.49		Batch capacity/# of shifts	12.29		Batch capacity/# of shifts	17.3

Figure 4 – Elimination of Water Constraint

Although the preceding procedure did not eliminate the blending bottleneck, the last two constraint reductions will potentially increase yearly capacity by more than four million pounds per year as shown in Figure 5. It must be emphasized this is one production line with no additional resources. The researcher surmises that further improvements and refinement to the blending station will easily overcome the blending constraint and allow managers to move forward to observe the grinding operation.

Current	10.28	Batch capacity/# of shifts
Future	12.29	Batch capacity/# of shifts
Difference	2.01	More batches/day
Lbs/Batch	8000	
Additional Pounds	16080	More pounds/day
Additional Pounds	80400	More pounds/week
Additional Pounds	4180800	More pounds/year

Figure 5 – Before and After Capacity Analysis

Use of Liquid Corn Syrup in Lieu of Dry Corn Syrup

Currently, the blending process uses dry corn syrup, which requires time for moving, opening and dumping the bags. A nearby line has a liquid-corn-syrup pipe running to it, which could cost effectively be used to feed this line as well. When using the Value Stream Mapping tool to view gains in capacity, the following is observed. The total time required to add the dry bagged materials is 5,016 seconds. Through the use of liquid corn syrup, the total time would be reduced to 2,076 seconds. This would produce the following capacity increases:

Current	11.28	Batch capacity/# of shifts
Future	13.01	Batch capacity/# of shifts
Difference	1.73	More batches/day
Lbs/Batch	8000	
Additional Pounds	13840	More pounds/day
Additional Pounds	69200	More pounds/week
Additional Pounds	3598400	More pounds/year

Figure 6 – Capacity Increases Due to Liquid Corn Syrup + Staging Areas

As shown in Figure 6, the use of liquid corn syrup would result in an increased capacity of almost 1.5 million more pounds per year.

Increased Yearly Capacity

Based on the requirements for the scheduled load before the modifications, two shifts would be capable of producing an average of 10.28 batches. After the implementation of staging areas, the water flow was increased and the use of liquid corn syrup increased the average number of batches to 13.01. This results in an increase of 5,678,400 pounds per year.

Current	10.28	Batch capacity/# of shifts
Future	13.01	Batch capacity/# of shifts
Difference	2.73	More batches/day
Lbs/Batch	8000	
Additional Pounds	21840	More pounds/day
Additional Pounds	109200	More pounds/week
Additional Pounds	5678400	More pounds/year

Figure 7 – Final Capacity Increase from Current to Future

Application of a Value Stream Map to a Bologna Production System

Due to seasonal demand, an analysis of a production line producing bologna was required. Utilizing the previous format, a VSM for the required line was generated. The map included formulation requirements, movement times, and machining times. For the three individual processes: blending, vacuumizing/emulsifying, and stuffing, the following results shown in Figure 8 were observed:

St. James Bolo System Value Stream Map

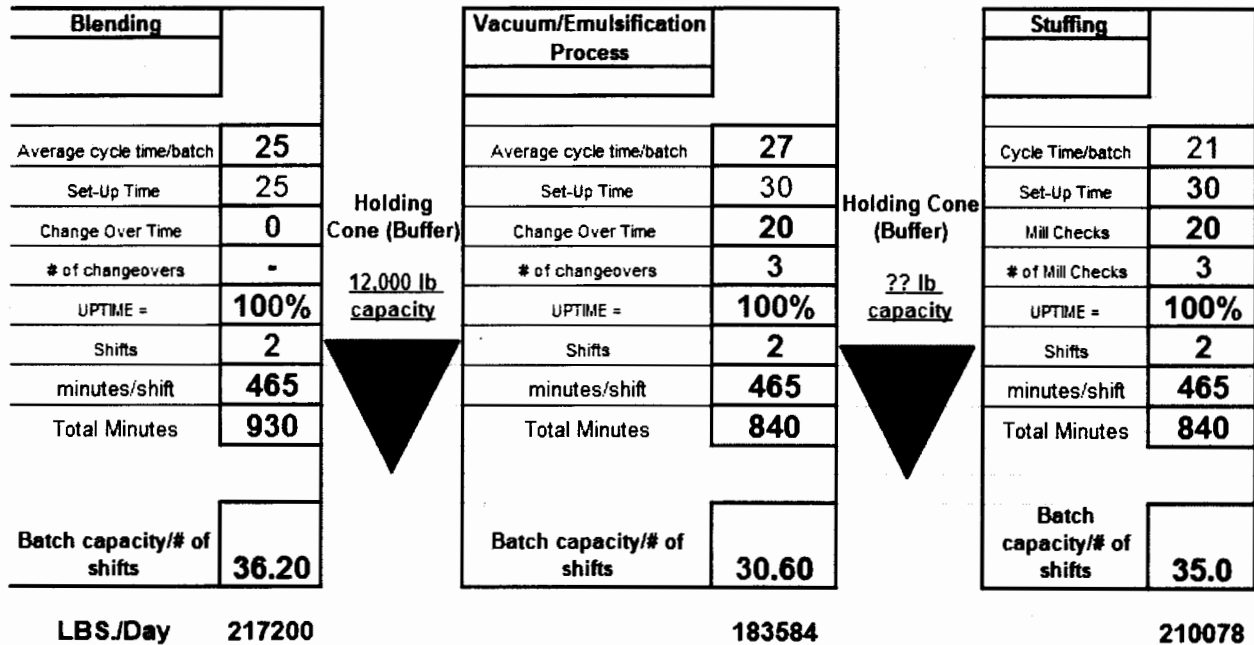


Figure 8 – Three Process Value Stream Map

After completion of all of the time studies, it was discovered that the vacuum/emulsification process was the bottleneck of the system. To ascertain how to eliminate this constraint, the Cycle Time spreadsheet for this specific map was referenced and analyzed.

Examination of the Vacuum/Emulsification Process

The vacuum/emulsification process is comprised of four separate stages that cycle one after another. The first stage comprises the time it takes the vacuum hopper to build vacuum

before the transfer of the blend. Once the vacuum builds, the second stage commences with the transfer of the blend from a holding cone into the vacuum hopper. During the third stage, the vacuum hopper holds the blend for continued vacuumizing. The fourth and final stage results in the transfer of the blend through the mill, after which it is moved to the stuffing process. Since these systems are dependent on each other, the system can be viewed as one entire process. As a result, any decrease in time during any one stage will result in an increase in the overall output. To detect potential capacity for increased output throughout the entire system, the Value Stream Mapping tool was used to display future states for potential capital investments. The four solutions proposed by the researcher and presented to senior management are depicted on Figures 8 through 11.

St. James Bolo System Value Stream Map

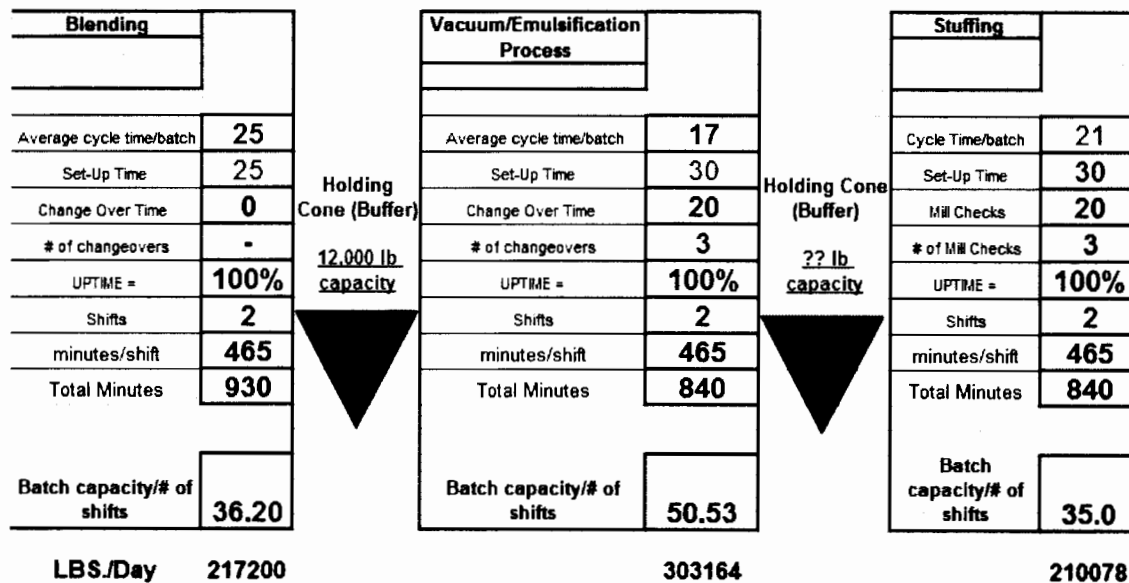


Figure 9 - Future System with Same Milling Capacity but with Continuous Vacuumizer

Through the purchase of a continuous vacuumizer, capacity can be increased by 26,494 pounds per day. Approximate Capital Investment = \$85,000.

St. James Bolo System Value Stream Map

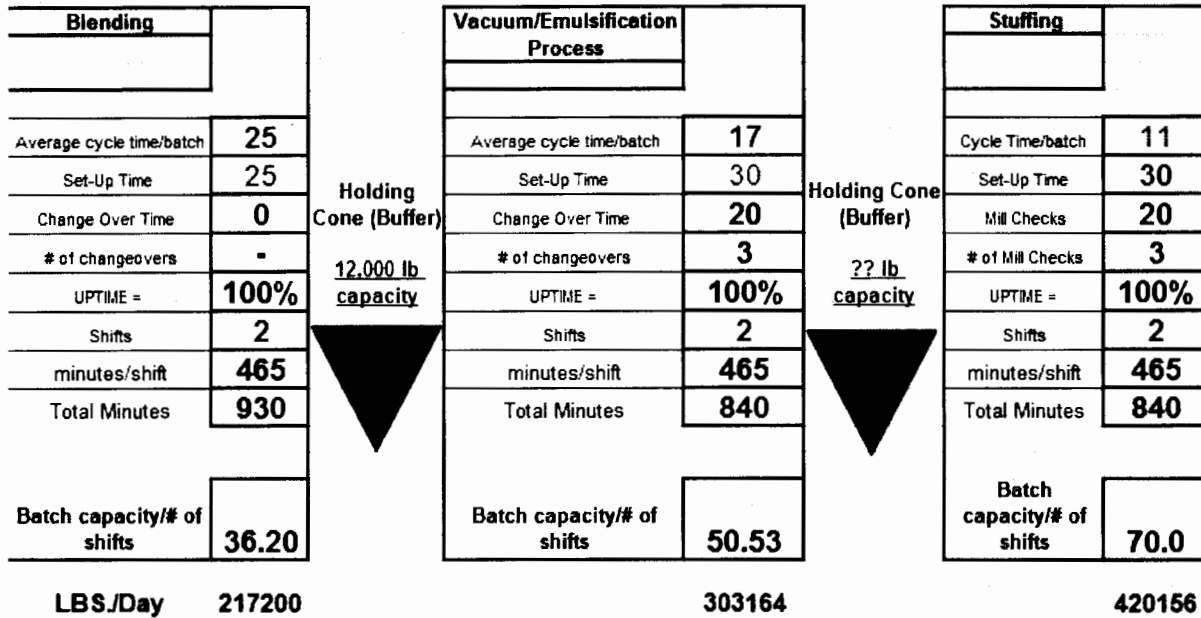


Figure 10 - Future system with Same Milling Capacity, No Vacuumizer Constraint and Additional T-Sizer/Vemag

Through the purchase of a continuous vacuumizer and additional T-Sizer, capacity can be increased by 33,616 pounds per day. Approximate Capital Investment = \$160,000.

St. James Bolo System Value Stream Map

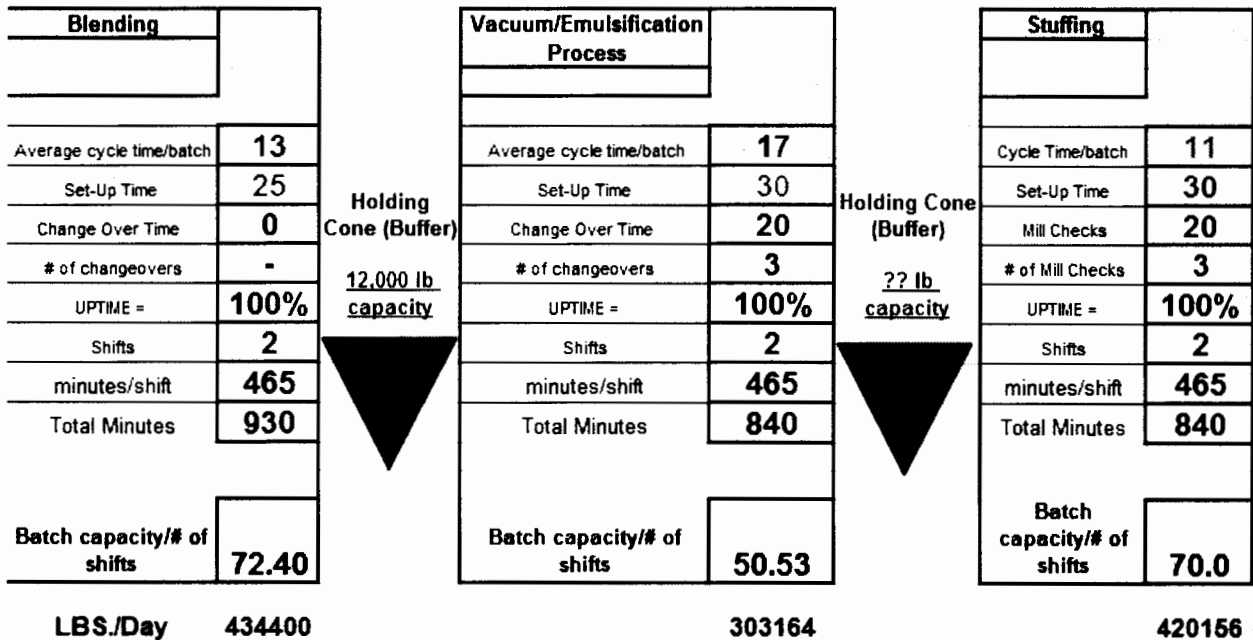


Figure 11 - Future System with Same Milling Capacity, No Vacuum Constraint, Two T-Sizers,
Dual Mixers

By purchasing a continuous vacuumizer, additional T-Sizer and mixer, capacity can be increased by 119,580 pounds per day. Approximate capital investment = \$210,000.

Application of Single Minute Exchange of Die (SMED) within Company XYZ

The researcher observed several setups, recorded the findings through videotaping, and concluded that three significant factors affected the setup on the particular equipment.

1. Disorganization of machine parts, which caused employees to search for them during setups resulting in production downtime;
2. The amount of time used to fasten the clamps and accompanying bolts; and
3. The order in which the individual setup tasks were performed.

SMED – Application of 5-S

To reduce the amount of time used to search for parts during the morning equipment setup, the researcher developed an organization system, which identified specific locations for the machine components based on the 5-S philosophy mentioned in the Review of Literature section. Sorting preceded any activities, and unused equipment was removed from the shop floor. Numerous items were found, some of which were unfamiliar to any of the operators. There were no organizational systems in place; therefore, the researcher had to develop one. Pictures of the components were taken and scanned into Word software program to create labels, which were printed and laminated. The labels were affixed at the proper locations for each component to ensure visual recognition by employees. In addition to labeling the locations of each component, pocket-size flash cards were created with the identical pictures and distributed to mechanics

responsible for machine tear down as well as to the nightly sanitation crew for training and reference.

Once the implementation of the labels and flash cards system was completed, auditing of the area commenced. It was concluded that continual auditing would be required and ongoing communication essential. Three weeks after developing the system, individuals were trained and made aware of the proper locations for all components. Monitoring still remains active in the area, although a substantial amount of downtime was eliminated. To accomplish the Shine component of the 5-S system, the operators were instructed on proper cleanliness of their work areas. Due to the operators' tendencies toward disorganization, work areas were efficiently rearranged. Training operations to standardize and sustain systematic work areas was being accomplished to ensure operators were knowledgeable about how their work areas should be maintained and left in order when the shift was over.

Reduction of Fastening Times

A large portion of the setup time was consumed by inefficient types of tools used by the operators to fasten the necessary nuts and clamps. Prior to the application of SMED, operators used open-ended wrenches to tighten the nuts and clamps. The operators were issued pneumatic wrenches to decrease this time. Nuts also were attached to clamps allowing pneumatic wrenches to be used for tightening. As mentioned by Shingo (1985) in his book, *A Revolution in Manufacturing: The SMED System*, the only turn of a nut that counts is the last turn. All turns in between the first and last are a waste. Although a clamp may have worked more quickly and efficiently than the air wrench, the tools given to the operators decreased setup times overall.

Standardizing the Order of Setup

During the observation of the setup, it was discovered that numerous wasteful movements were being performed. To correct this problem, a standardized method had to be developed to establish a baseline for performance improvements. The researcher practiced the setup and developed a more efficient way of setting up the particular equipment. Once this was accomplished, a step-by-step routine was documented.

Once everything was in place, including the organizational system and the appropriate tools, and the standardized motions were documented, the researcher was timed while performing the actual setup without working any faster. Times were established for each task, and the Standardized Work Card was created (see Appendix F),

Creation of the Standardized Work Card

Although standardized work cards or charts can vary in complexity, the work card created by the researcher was very simple. Included on the 8.5" x 11" card were all tasks required for the setup, listed in the proper order, with their corresponding demonstrated times. The cards were then distributed to each operator for review and feedback and appropriate changes were made with expectation sets. Since Company XYZ is currently in the process of ISO 9000 certification, the required work instruction for each process can serve as standardized work cards in the future.

Downtime Reduction through the Application of SMED and 5-S

Once the operators were given the proper tools, parts were organized, and a standardized setup was created, the time reductions shown in Figure 13 were realized.

	Minutes	
Previous setup time	57	
Setup after application of SMED, 5-S, and Standardized Work	30	
Reduction in downtime	27	
Similar production lines in manufacturing department	3	
Total downtime reduced per day	81	
Average pounds per minute for 3 lines		375
Increase in stuffing capacity for 260 days		7,897,500

Figure 13 – Increase in Stuffing Capacity after Application of SMED, 5-S, and Standardized Work

Implementation and Effectiveness of the Downtime Tracking System

Previous to this study, the manufacturing area was not utilizing downtime sheets to track downtime trends. Downtime sheets were created for each area: grinding, blending, and stuffing (see Appendices G, H, and I) to monitor both setup time deviations and production downtime throughout the day. Three-digit codes were assigned to an assortment of known downtime causes such as mechanical problems and material shortages. The operators were trained to fill out the sheets properly on a daily basis. Once the downtime sheets are filled out, they are entered into a database. Each area is then charted to provide decision-making data to management.

CHAPTER VII: OBSERVATIONS AND CONCLUSIONS

Initially this project set out to meet four primary objectives.

1. Construct a value stream mapping tool with the ability to identify forms of non-value-added activities and improve on the plants current value stream.
2. Apply the Single-Minute-Exchange of Die (SMED) technique to the Stuffing department.
3. Seek to standardize times and order of setup for the foundation of a time-based management system
4. Capture and identify primary sources for downtime to aid in the elimination of non-value-added activities.

Construction of the Value Stream Map – Initial Observations and Challenges

The researcher initially set out to construct a Value Stream Map (VSM) that would allow a user to input the mixed load and in turn, have it automatically generate the expected capacity of the value stream. In order to do this, families had to be created based on processing similarities. Due to the numerous formulations and process steps, this task could have been very time intensive if the proper documentation or guidance wasn't available. Once the families were outlined, the researcher created the Microsoft Excel template where all of the various actions could be entered. Although the products were all grouped in the same family, they all differed in mix times, gallons of liquids and number of spice bags added along with batch size. A separate worksheet was created for this data input which, directly linked to the time it took to add and mix the components. The spreadsheet template also allowed for additional product families to be added for future ease. This template could serve as an irreplaceable tool as the studies extend to the other product lines.

Time studies were completed over a number of weeks with the operators performing several of them. Due to the vast number of materials ground and different grind sizes, operators help was a necessity. In order to preserve the integrity of the data, multiple time studies were taken for the same product and an average calculated. Examining the variation within identical products, grind sizes and equipment used, the researcher was surprised to find the material grind times varied immensely. In some cases the variation was over one hundred pounds per minute. This was later attributed to moisture content of the meat. It was noted that this would directly influence production time if large quantities of this specific material were to be ground. Machine times were also observed in multiples to ensure accurate information was captured. During the timing of the non-continuous vaccumizer used on the line producing bologna, variations in transfer speeds were detected. After investigation it was found that the variable speed drive was not locked into maximum drive speed. This directly affected the output capacity for the entire system. Parts were ordered for the pump to maintain maximum velocity.

Grind times, liquid flow rates and mix times were obtained effortlessly through time studies. The various work steps for each process was much more difficult. During the timed observations, no form of standardized work existed. This made it extremely difficult for the researcher to capture data that was accurate to the current process due to the variation in work habits. This however, provided excellent insight to potential process improvements. An example of this was when an employee was dumping a 50 pound bag of salt into a blender. One operator's methodology was one minute quicker per salt bag than another operator timed on a different shift. From this observation the researcher gained first hand experience in the necessity for best practice implementation and standardized work. A second example was when an operator did not have a utility knife with him which, was used to open a salt bag. He proceeded to tear the bag, a

practice that was later found not be considered a best practice through the Quality Control department due to a potential paper contamination.

After the collected data was entered into the spreadsheets for the various materials and processing requirements along with the processing steps and times, the two were linked through the actual VSM spreadsheet. This spreadsheet appears as Figure #2. Due to its design, the user is able to enter the mixed schedule load which activates the spreadsheet to display the cycle times and outputs in pounds. The ability for the spreadsheet to measure capacity based on a mixed load is the advantage to this VSM. Uptime percentages, number of changeovers and shift requirements can also be simply entered to display actual process capacity.

Value Stream Mapping – The Captured Benefits

Through mapping out the process the researcher was able to visually see the constraints throughout the areas mapped along with providing information on capacity planning.

As stated previously, the VSM was used to evaluate and improve two production lines. First, a line that produces turkey breast products and second a line that produces bologna. The results from applying the map to the line are as follows:

Analysis of turkey breast production line:

- Based on the product mix, the Blending function will present the bottleneck. Management or engineers must develop a way to either reduce mix time or add ingredients quicker.
- The current operation will only be capable of ten batches per day. If ingredients are allowed to be added quicker an operator could produce more than ten batches per day.
- Based on the observed time studies the implementation of staging areas will allow one more batch per day or eight thousand additional pounds. This is generated from balancing

the work load between grinders and blenders. Currently blenders are overloaded in comparison to grinders.

- Based on the product mix, increasing water flow will increase the capacity by one more batch or eight thousand additional pounds. The operator spends more time adding the water than any other ingredient.
- Based on the product mix, the use of piped-in liquid corn syrup will increase capacity to an additional batch or eight thousand additional pounds daily if the water constraint is reduced.
- Overall potential capacity increase for this particular line and product mix is 3.6 million pounds per year if staging areas, increased water flow, and liquid corn syrup are implemented.
- The reduction of this bottleneck will result in an increase of five batches per day or 40,000 additional pounds per day. Which, based on this product mix is achievable.

The financial impact of this specific map is volume dependent although, through reducing the constraints and producing more products in less time in turn, reduces labor burden. If demand is great enough, this increased capacity could guarantee this production line not to work weekends resulting in a labor savings of in excess of \$40,000 annually along with increasing service levels to the customer.

Analysis of the bologna production line:

- The Vaccumization/Emulsification process is the constraint within the value stream. The addition of a quicker vaccumizer will directly affect the output.

- Based on the product mix, a capacity of only thirty batches is possible per day. This is critical for resource and downstream planning. Prior to this, a mixed schedule could not be predicted accurately.
- The addition of a continuous vaccumizer will result in five more batches per day or an additional 30,000 pounds.
- The Bologna production line would be balanced if a continuous vacuumizer were installed to replace the current model. The next constraint is a human constraint due to the way the process is designed.
- Continued improvements should be focused on operational efficiencies and/or a completely new bologna production system for further capacity. Any additional individual equipment purchases will result in an unbalanced production line.

Through value stream mapping the bologna and turkey breast production lines, various scenarios were presented to senior management for review. A capital request was submitted and a continuous vacuumizer was purchased for the bologna line. This resulted in accomplishing a production increase by over 26,000 pounds. of product daily or over five million additional pounds annually, reducing weekend labor burden. The production line continues to produce three to five batches more per day dependent on operational efficiencies.

The financial impact of this change is again volume dependent but through reducing the constraints and producing more products in less time the savings is estimated at \$80,000 annually.

Application of the SMED Technique to the Stuffing Department and Creation of Standardized Work Cards - Initial Observations and Challenges

The first step in better organizing the work area was to remove unused items from the production floor. Due to the many items that were present, two maintenance personnel and two operators were assigned to the task. The number of items that were removed from the floor was astonishing. A large gondola of parts and other articles were found to be not in use and removed. At the time of the clean-up, a large stainless steel cap was accidentally fed into a grinder creating severe damage and downtime to the machine. Through sorting and removing the unnecessary parts the plant was able to confirm that all unused equipment was accounted for to avoid further accidents. Also, due to the quantity of equipment components removed from the floor, it created a substantial amount of replenishment parts that were restocked into inventory, a true surprise to the researcher.

Preliminary observations by the researcher reinforced the notion that something needed to be done to better organize the current methods of morning machine setup. Employees were aimlessly scrambling to set up equipment in between the search for parts. To be capable of subjectively evaluating the setup the operator spent several days learning first hand the setup procedure for the specific machines. Several setups were performed solely by the researcher. The researcher believes this action alone created a sense of respect from the operator. Once the researcher knew the setup, it was video taped for later analysis. Allowing the operator to review this video also built a sense of partial ownership to the project. This was displayed in the increased cooperation received from the operator to the researcher. Once the setup was observed, it became blatantly clear that searching for parts was the number one reason for downtime. It was found that the shift that removed and tore down the machines at the end of the night for cleaning

were not held accountable for their actions, along with a third-party cleaning service providing sanitation duties for the plant. These two factors alone contributed to the vast amount of downtime experienced every morning. Once the root sources were established the researcher developed part reference sheets and held a meeting with the two parties involved. Ownership was acknowledged and an audit system was put in place by the researcher.

The result of the audit process showed an initial improvement in the part locations after tear-down of the machines. This was sustained for approximately one week. Once the attention shifted, the parts began to be placed in improper locations even with the reference sheets. The researcher found himself constantly bringing the deficiencies to the appropriate managers. Employee training and department management accountability were determined to be the source of the problem. The local area supervisor assigned a person to document all deficiencies on a daily basis and presented it to senior management. While the deficiency reports were being handed in, sustainable actions were continued.

Once the part location sheets were developed, the researcher moved onto the organized setup of the equipment. Through the researcher learning the setup and previous knowledge of streamlined processes, he was able to devise the ideal order of operations. The order of operations was created and documented. Once everyone was issued the documentation, the setups were reviewed for implementation. Although many of the steps were completed in the correct order, many were not. The operator remained in habit, conducting certain tasks like he had always done. This was peculiar in that the operator had been given the card and was allowed to follow it verbatim. The researcher worked with the operator guiding him but over time it was not sustainable. After speaking with the operator's supervisor, it was clear that the supervisor did not understand the reasoning behind standardization. This observation made it apparent that in

order to sustain process changes the effected individuals need to understand the necessity of the change and deem ownership. Due to the methodology used in this project, the process change did not instill ownership within the supervisor and operator. This proved to be detrimental to sustaining standardized work.

Although not all implementations were sustainable over the long run, the following improvements were proven through time studies and actual observation of the setup completed correctly.

- Over 1.5 hours per day of increased of machine uptime. Resulting in a potential increase of 7.8 million pounds. capacity annually within the stuffing department. It must be noted that again, blending is the system bottleneck not stuffing. Therefore, increased capacity would only benefit through a reduction in labor or when the blending constraint is eliminated. The time reduction of this endeavor did gain enough capacity to eliminate one employee from the stuffing department. Although this employee's resources were used for another plant initiative, the cost savings of potentially is approximately \$50,000.
- Through providing the operators with pneumatic wrenches to reduce fastening times the researcher was able to sustain reduced setup times.
- The reference cards continue to serve as excellent training tool for employees responsible for ensuring proper part locations after tear-down and cleaning. Accountability for employee actions and continued auditing are required to ensure sustainability.

The application of SMED and 5-S was able to reduce a setup time from 57 minutes down to 30 minutes reducing setups by almost 50%. This in turn lead to a capacity increase of over 7 million pounds annually for these particular pieces of equipment. Along with capacity increases,

creation of training guides, and better tooling, the enhanced setup reduced frustrations amongst employees.

Observations and Benefits of Capturing Downtime Sources

Through capturing downtime, production outputs could be compared to actual downtime. The VSM displayed actual capacity based on the schedule load. Therefore, the researcher was able to compare output, recorded downtime, and expected capacity. This allowed the researcher and area supervisor to track the operators work throughout the day. Many times it was found that the operator did not record all of the downtime or work as efficiently as expected.

The Review of Literature section states managing flow is one of the most difficult tasks for all managers, especially within a batch and queue system. Through capturing the downtime within the entire department the number one source for downtime was found to be flow of material. The stuffers simply did not have the meat to stuff when they needed it. It is important to note that the researcher chose the stuffing lines to apply setup time reduction. If he had known that the number one source of downtime was upstream of stuffing, the reduction of setup times would not have been initially focused at stuffing. The processes upstream presenting the bottleneck (blending) should have been evaluated. This served as an important reminder that one should never assume the process and only go by data gathered from the VSM.

The downtime tracking system continues to focus management's attention on specific areas allowing them to make critical decisions. Without this system, they would only have hunches and experience to drive improvement from.

Conclusion

This project has served as an irreplaceable bank of knowledge for the researcher and Company XYZ. Although not all goals and actions were implemented and sustained over the

duration of the project, many benefits were captured. The project has systematically revealed and implemented a capacity increase of 18.2 million pounds for two production lines, a 45% capacity increase for the two lines or a 23% overall increase in total manufacturing capacity for the plant. The project exposed inefficient lost times which lead to reducing setup times by 53% without the operator working any quicker. The project has developed a tool that will continue to display constrained areas for additional capacity increases.

Along with the financial contributions the information and examples included in the previous sections have enhanced the researcher's knowledge, provided awareness to the existing processes and offered further explanation to why things are the way they are. The researcher believes that if this knowledge was understood and embraced by the entire organization, systematic process improvements would be accelerated. This knowledge base hopefully will serve as a milestone leading to a different paradigm for Company XYZ. Only until it is learned and embraced by all will it truly be effective.

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APPENDIX A

MFG.F.003
 Issue Date: 8/18/03
 Revision Date: 10/30/03

ST JAMES HAM PROCESSING SCHEDULE

Week Ending: _____

UPC #	PRODUCT	MON	TUES	WED	THU	FRI	SAT	SUN	TOTAL
17754	HC BAKED	8							
17759	HC SMOKED		8						
33339	DE SMOKED				4				
36121	DE HOT HAM								
17879	HC HNY MUST								
17768	HC HONEY DT						3		
17771	HC SMOKED DT								
17772	HC COOKED DT								4
17766	HC BAKED DT								
17869	HC HNY MAPLE								
950	ECK CKD SQ								
17760	HC COOKED SQ								
17749	HC HONEY SQ								
TOTAL									

HAMS

APPENDIX B

MFG.F.004 Issue Date: 8/18/03 Revision Date: 10/29/03					
DATE _____ DAILY BLENDING AND STUFFING SCHEDULE					
INOX	V - MAG #1	AMFEC #2	MEPACO #2	MEPACO #3	MEPACO #4
<h1>Page 1</h1>					

APPENDIX C

WELLPACK SCHEDULE

DATE: _____

UPC#	PRODUCT	CASES	SPEC CODES	CODE DATE	SPECIAL INSTRUCTIONS
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Line 11

LINE 12

LINE 13

APPENDIX D

MFG.F.060
Issue Date: 8/27/03
Revision Date: 10/17

Blending Schedule

Shift

1st

Date

9/12/2004

LBS.		FTD

North Mixer

LBS.		FTD

Turkey Mixer

LBS.		FTD

West Massager

LBS.		FTD

East Massager

LBS.		FTD

Cozzini

APPENDIX E

BATCH SHEET

BLD.F.002
Issue Date: 8/22/03
Revision Date: 08/14/04

CHICKEN/TURKEY FORMULA
FAT TARGET 36.5%- 5000# TOTAL MEAT BLOCK DATE _____ SHIFT _____ BATCH # _____
PRODUCT: ALL MEAT BOLOGNA W/CHK & TKY
UPC: 47 F.N. 220065

<u>INGREDIENTS</u>	<u>STANDARD WEIGHT (1000# RED MEAT BLOCK)</u>	<u>ACTUAL BATCH WEIGHT</u>	
INITIAL MEAT WEIGHT			
	34# BEEF 50'S	_____	SD TAG# _____
	850# EXTRA FAT PORK TRIM AND/OR PORK 50'S	_____	SD TAG# _____
	_____	_____	SD TAG# _____
	1000#		
	1200# MSC (PRE-BLEND)	_____	SD TAG# _____
	1200# MST (PRE-BLEND)	_____	SD TAG# _____
		5000#	
WATER TEMPERATURE	(115°F ± 5°)	_____	
WATER	70 GAL (583#)	_____	
DEXTROSE	100# (LOT # _____)	_____	
SALT	25# (LOT # _____)	_____	
CORN SYRUP (M250)	150# (LOT# _____)	_____	
MIRA-CLEER 340 MODIFIED FOOD STARCH	150# (LOT# _____)	_____	
NITRITE MIX X113	1 BAG (1.725# salt) (.155# nitrite)	_____	Attach Label to back.
MASTER MIX Q25010	5 BAGS (105.2#)	_____	Attach Label to back.
TOTAL	6165.08#	_____	

NOTE: USE 117# OF
CORN SYRUP SOLIDS &
74 GAL. OF WATER
PER BATCH (5000#
MEAT BLOCK) IF CORN
SYRUP IS NOT USED

NITRITE CHECK _____
TIME OFF/INITIALS _____
TRANSFER PUMP CHECK _____
REWORK (10%) --- PRODUCT USED _____
SLICING DATE _____
LINE NUMBERS _____
WEIGHT (MAX. 616#) _____

Allowable Rework: 046 - Garlic Bologna 29015 - Butterball Bologna
047 - All Meat Bologna * 00508 - Eckrich Lite Bologna

PREPARATION:

1. Grind red meat 1/4".
2. Add meat, MSC and MST to mixer.
3. Add nitrite mix and salt slowly by hand.
4. Add water to mixer.
5. Add master mix, corn syrup, dextrose, corn starch and rework while mixing.
6. Mix 3 minutes. (Blend temperature 48 degrees +2.)
7. Unload to Cozzini. Emulsify through 3.2mm plate, 5 arm knife and 1.4mm plate, 5-arm knife.

NOTE: 1. CHECK THE TRANSFER PUMP UNDER THE MIXER AFTER EACH BATCH FOR FOREIGN MATERIAL.
2. PERFORM COZZINI MILL INSPECTION PER WORK INSTRUCTION MFG.F.027 FOR FOREIGN MATERIAL.

• Denotes change

Amounts may be adjusted for least cost formulation. The order of predominance will not change.

APPENDIX F

MEPACO 2, 3, & 4 SETUP (SWC)

	seconds
1. Lock out the Mepaco	22
2. Move T-Sizer into position	10
3. Move stuffing table into position	53
4. Place auger in screw loader	26
5. Place hood seal and vacuum hose in hot water	37
6. Remove T-Sizer Check Valve from small mesh basket and assemble on table	112
7. Screw T-Sizer pipe extension to 90-degree angled pipe	14
8. Screw T-Sizer check valve onto T-Sizer	16
9. Screw pipe extension/90-degree pipe onto T-Sizer check valve	34
10. Apply shortening/Crisco to stuffing horn, turret jug, and necessary areas on Mepaco	Not Timed
11a. Retrieve delron plug w/white O-Ring and attache to mepaco	20
11. Retrieve hood seal from water and place hood seal on Mepaco	195
12. Close Hood	14
13. Retrieve auger gaskets, auger plate, 3 bolts w/washers & nuts	23
14. Place auger gasket, auger plate and 2 nd auger gasket in place	28
15. Retrieve Mepaco auger gasket, (1) 4' clamp and Auger cone	19
16. Attach 4" auger gasket to Mepaco, attach auger cone and place clamp around – lightly tighten	79
17. Align auger cone screw loader and attach bolt w/washers	108
18. Tighten all nuts	64
19. Retrieve (2) 4" clamps, (2) 4" gaskets, view port, fill probe holder	22
20. Attach the view port and fill probe holder to Mepaco	94
21. Retrieve vacuum hose from hot water and attach	44
22. Apply shortening/Crisco to required areas	95
23. Remove lock out from Mepaco	26
24. Turn on machine and pull vacuum	20
25. While machine is pulling vacuum retrieve turret jug pins, insert and insert turret jug into T-Sizer	68
26. Insert stuffing horn and tighten holding pin	32
26a. Insert stuffing horn adapter in clip head	13
27. Align Horn	8
28. Perform static check on Mepaco	74
29. Retrieve (2) white plastic gaskets and large clamp, insert into Mepaco out-flow	25
30. Attach 90-degree pipe to Mepaco and tighten clamp	52
31. Close all safety doors and shields on T-Sizer	12
32. Plug in air and electricity	65
33. Cycle, oil and inspect for possible mechanical issues	Not Timed
34. Retrieve casings & Clips	120
35. Lock out machine	45
36. Attach casings, insert clips, begin stuffing	120
Minutes	30

