Lean Implementation During a Plant Consolidation

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ABSTRACT

Company XYZ in Wisconsin is the world wide leader in commercial laundry equipment. The equipment, washers and dryers, range in size and capacity from small residential to large commercial. There are currently two plants, one in Wisconsin and the other in Florida. Company XYZ's current plan is to consolidate its Florida plant and add the production to the Wisconsin facility. The Florida plant is 220,000 square feet and the Wisconsin plant is 850,000 square feet prior to consolidation. Since there is no room in the current Wisconsin plant, Company XYZ has signed a 6-year lease with the owner of a vacant 125,000 square foot facility. The main reason behind the transition is to eliminate personnel duplication. The quality levels are within acceptable ranges. Productivity needs to be improved.

Company XYZ has implemented Lean into three of its four main production lines. Many productivity, quality, monetary and safety improvements were realized upon completion. During two of the Lean implementations, no line consolidation occurred.

The Lean implementation occurred in conjunction with a line consolidation. If Company XYZ decides to implement Lean during the Florida transition, the risks would be much greater. In the transition from Florida to Wisconsin, two rules must be followed:

1. Quality levels must not be affected.

2. No customer shipments will be missed.

This research paper will analyze the decision variables and choices associated with attempting to implement Lean during a plant consolidation.

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Chapter I: Introduction

Company XYZ is a leading commercial laundry manufacturer in North America. This includes equipment used for Coin Stores, Multi-family housing dwellings, On-premises and institutional laundries, and drycleaners. In addition to an extensive network of distributors and route operators, Company XYZ exports to over 90 countries around the world. Manufactured under many brand names including Ajax, Huebsch, Speed Queen and UniMac, Company XYZ has a reputation for innovation and excellence in product design and services. They accomplish this through their ability to change design quickly to fit the customer's needs and still maintain high quality levels. "Customer One" is the credo at Company XYZ. It is a way of thinking that is reinforced by top management throughout the organization.

Company XYZ currently has two manufacturing facilities. Their headquarters and main plant are located in Wisconsin with a second plant in Florida. The Wisconsin plant manufactures the company's small chassis top load and front load washers and dryers. Large chassis tumbler dryers are also built at this site. The Florida plant builds washer extractors which are large industrial washing machines.

The facilities at the Wisconsin plant have 850,000 square feet of manufacturing space under roof. The plant is very organized and has little space to grow without adding buildings. In 2001, the company decided to close the Kentucky plant and build the tumbler product in Wisconsin. The move was successful. One year after the lines were up and running, Lean was implemented to further increase productivity and quality. Lean is a tool that management utilizes to decrease time between customer order and shipment of product. Many forms of Lean exist in the world. The results that come with a successful

Lean implementation include:

- Reduced inventory of finished goods
- Shortened time between order and shipment
- Higher quality of parts as well as finished product
- Improved organization
- Elimination of parts shortages due to scheduling
- Increased ability to bring new products to production

After the successful implementation of Lean on the new line from Kentucky, Company XYZ decided to implement Lean in conjunction with combining two product lines. These two lines, the small chassis dryer and small chassis front load washer, use similar components for the outer cabinet and completely different components on the inside.

Because of the successful Kentucky consolidation, Company XYZ is planning to close the Florida plant and begin manufacturing the Washer Extractors in the Wisconsin plant.

Statement of the Problem

Deciding to consolidate a plant is always a difficult decision. Many questions must be answered. The following are a sample of these questions:

- When could Company XYZ take the manufacturing equipment targeted for the transition out of service and reinstall it at the new location?
- When should production cease on the lines being eliminated?
- What quantity of inventory should Company XYZ build to support the business during the transition to the new facility?

- What overall time table should be used?
- Will any new distributors be needed?
- Should Lean be implemented during the transition?

These are just a few of the questions that must be answered in order to successfully complete a plant consolidation. This research paper will focus on the question of Lean implementation and answer the question, "Do the benefits of Lean implementation outweigh the risks involved in process change during a plant consolidation?"

Purpose of the Study

The purpose of this study is to determine if Company XYZ should implement Lean practices during the consolidation of its Florida plant to Wisconsin. Company XYZ has experienced the benefits of Lean in their Wisconsin plant.

The risks are also great when implementing Lean. They include the inverse of all the benefits. When a company changes a process they risk losing control of the production line. That can mean disaster to a manufacturing company. The main objectives of the study are to:

1. Review past plant consolidations
2. Review past Lean implementations
3. Review past Lean implementations during an assembly line consolidation
4. Determine if a Lean implementation should coincide with a long distance plant consolidation

Assumptions of the Study

This research assumes that the decision of plant consolidation has already been made. Management has set the following parameters:

- Quality levels must not be affected.
- No customer shipments will be missed.

Definition of Terms

Lean. A shortened name for Lean/Flow Technology. Lean is a tool that management utilizes to decrease time between customer order and shipment of product. Many forms of Lean exist in the world. More explanation of Lean will follow in the Review of Literature.

Kanban. A method of inventory control, originally developed in Japanese automobile factories, that keeps inventories low by scheduling needed goods and equipment to arrive a short time before a production run begins.

In Process Kanban. A spot on the assembly line that is between operations reserved for a unit that is complete and waiting for the next operation.

Tact Time. The time given to an operator to complete the specified work at their work station.

Standard Operating Work Instructions (SOW). A written description of work to be done at a specific operation. SOW's are model unique.

Maximum line design. The number of finished good units that a manufacturing assembly line is capable of in an eight hour period with a standard schedule.

End of Line Yield. A quality number used to determine number of rejects compared to number of units produced.

Endgame. A term used to describe a merger or consolidation. An Endgame represents the most important action a company can do in order to outgrow the competition. The Merger Endgame is inevitable for companies that want to grow. For a complete description of Endgames see the Literature Review.

Small Chassis. A group of machines you would find in a home, hotels, or small units at a Laundromat. Includes dryers, top load and front load washers.

Tumbler. A large chassis dryer you would find in a commercial or industrial setting. Tumblers can dry between 25 and 170 pounds of clothing.

Washer Extractor. A large chassis washing machine you would find in a commercial or industrial setting. Washer Extractors can wash between 20 and 250 pounds of clothing.

Plant 2. A 120,000 square foot building located near the main plant in Wisconsin. The building is vacant but needs extensive modifications to become usable as a highly industrialized manufacturing facility. Company XYZ will lease the building instead of buying at this point.

Limitations of the Study

Due to the space constraints at the current facility in Wisconsin, Plant 2 will be utilized. This will reduce the extent that Lean will be utilized. A 12,000 square foot addition onto Plant 2 will not be completed in time to use initial Lean set-up. The results of the study are limited to Company XYZ. The data given in this research paper are representations of the true data and not actual.

Methodology

The research methodology for this field problem includes a review of literature, a review of Lean implementations at the Ripon manufacturing plant, and review of plant consolidations to the Ripon plant.

The goals of this study are to:

1. Review past plant consolidations and relate them to the Literature review.
2. Review past Lean implementations and relate them to the Literature review.
3. Review past Lean implementations during an assembly line consolidation.
4. Determine if a Lean implementation during a plant consolidation is beneficial to the company and does not reduce shareholders value.

The methodology for this field problem began with a literature review of various books and journals dealing with manufacturing in today's global market place. The literature review also covered written works on plant consolidations and mergers.

Following the literature review, a compilation of data was conducted to relate the literature review to real life instances at Company XYZ. This includes the benefits of lean implementation on the Department 57 and Eagle lines. For instance:

- Reduced lead times
- Reduced part shortages
- Quality End of Line Yield
- Reduced injuries
- Increased productivity

Data was collected from various sources. Most were collected during the projects by Project and Quality engineers. This data was then compiled into a report prepared for the Board of Directors. The exact results have been modified per the request of Company XYZ but the trends and change directions are represented. Also reviewed were the direct circumstances and decision reasoning behind the implementations.

The plant consolidation risks were developed and factored into deciding if Lean Implementation was the right thing to do during a plant merger. The largest of these risks being:

1. Missing customer shipments
2. A degradation in the quality of the finished product

Chapter 2: Literature Review

The purpose of this project is to answer the question "Do the benefits of Lean implementation outweigh the risks involved in process change during a plant consolidation?" This chapter will give background information on Lean manufacturing processes and tools as well as information on plant consolidation and the risks/benefits involved.

Lean Manufacturing

In today's global economy, manufacturers are constantly looking for ways to do more and more with less and less. Their customers are demanding higher quality, shorter lead times and lower costs. Lean manufacturing has taken the value stream for the entire product and improved on the Just in Time (JIT) method of stocking parts. The elimination of waste in all aspects of the manufacturing value stream is the key to Lean Manufacturing. Costanza (1996) states that "Its (Lean Manufacturing) primary objective is to build a high-quality product in the shortest production time and at the lowest possible cost" (pg 24). The supply chain is where Lean Manufacturing can be implemented to its greatest extent.

Lean manufacturing drives at reducing waste in products and processes that the customer believes are important and for which they are willing to pay. The use of Lean enables manufacturers to allow customer demands to pull products through the process instead of pushing the products they build onto the customer. Lean thinking in the twentieth century will boost productivity in manufacturing while reducing costs, space requirements, lead times and production errors. (Womack, Jones and Roos, 1990) When the value stream is driven by customer demand, a proactive condition is present and is

based on market conditions that are current. A pull system that is based on forecast is much less responsive.

Value streams are product specific (Costanza, 1996). From toy dolls to airplanes, value streams are individualized to the product as well as the manufacturing conditions. Mapping the value stream begins with identifying of what the customer finds value in, finding a finished good price, and working back from that point. This must take into consideration all of the elements in the manufacturing process that will see value for the customer. The value stream takes all of the activities needed to provide the customer with the product they desire, from idea to design, raw material to finished product, and start-up to actual delivery; this must include all information flows for each step. Before production start-up can commence, a value stream must be defined for each specific product manufactured. The supply chain of the product is defined in order to maximize the goals of the value stream as the value stream materializes. The technology used in the supply chain management must be a focus to ensure that the objectives of the value stream are met. One tool Lean Manufacturing uses is kanban.

Kanban

Kanban is one of the most important tools used during Lean implementation. (Womack, Jones and Roos, 1990) Like most of the Lean tools, kanban is a visual system. Kanban controls inventory using signals that can be seen by an operator, lead person or manager. It controls production inventory and movement. Kanban is a system that can be implemented without starting any other forms of Lean.

The U.S. Environmental Protection Agency web site states the following:

Kanban are a critical part of a JIT (Just in time) system. In implementing a kanban system, organizations typically focus on four important "rules".

- Kanban works from upstream to downstream in the production process (i.e., starting with the customer order). At each step, only as many parts are withdrawn as the kanban instructs, helping ensure that only what is ordered is made. The necessary parts in a given step always accompany the kanban to ensure visual control.
- The upstream processes only produce what has been withdrawn. This includes only producing items in the sequence in which the kanban are received, and only producing the number indicated on the kanban.
- Only products that are 100 percent defect-free continue on through the production line. In this way, each step uncovers and then corrects the defects that are found before any more can be produced.
- The number of kanban should be decreased over time. Minimizing the total number of kanban is the best way to uncover areas of needed improvement. By constantly reducing the total number of kanban, continuous improvement is facilitated by concurrently reducing the overall level of stock in production.

(Lean Manufacturing and the Environment, 2003, Method and Implementation Approach section, ¶ 6)

There are two basic types of kanban systems, one bin and two bin. One bin system is used for slower moving material. They have a trigger point (not an empty

kanban) for replenishment. The two bin system uses two or more bins that are identical in size and quantity. One bin signals material is required. The second bin is used to cover the operator until the first bin is replenished. This is the most common type of material kanban.

Material in a kanban system should always be consumed in a first in-first out system. This eliminates the potential for obsolete parts staying in the system and reduces quality issues of parts getting excessively dirty. What can cause kanban to fail?

- Unaddressed changes to volume or mix
- Lost or misplaced cards or material containers
- Excessive machine downtime

5S

The 5S approach is a relatively simple, but powerful, method for shop floor improvement (The Productivity Press Development Team, 1996). Companies all over the world have benefited from 5S implementation. The concept of 5S goes hand in hand with the ideas presented in Lean. 5S focuses around five areas of shop floor improvement including: Sort, Set in Order, Shine, Standardize, and Sustain.

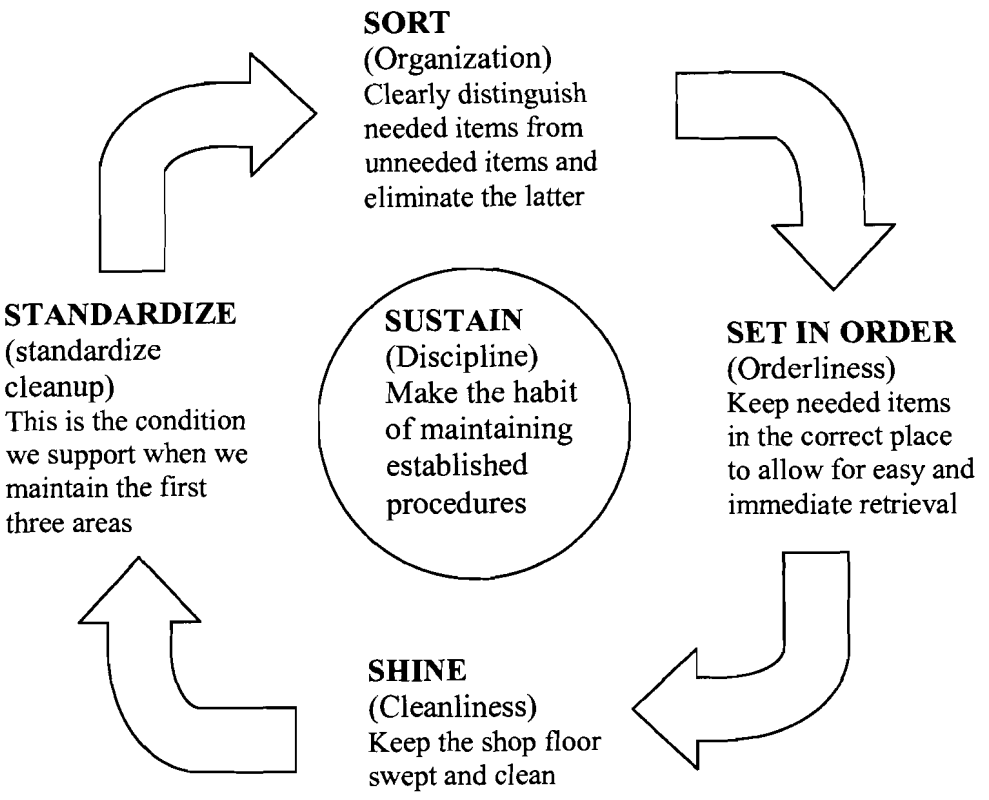

Figure 1: Model of 5S

Sort is the area of 5S that deals with the removal of all things that do not directly deal with the object of the current operation. Many times this is misunderstood. In the beginning it may be difficult to distinguish between what is needed and what is not. This is very apparent when the operation is mature and has not changed in the recent past. Many times the operator sees a machine or tool as a necessity though they have never used it or only used it on a temporary basis during a time of nonconformance. Thus an operation can accumulate useless inventory, equipment and clutter the area. This can lead to build up of waste factory wide. There are many examples of waste including:

- Defective or excess quantities of small parts and inventory
- Outdated or broken jigs and fixtures

- Worn-out bits
- Outdated or broken tools and inspection gear
- Old rags and other cleaning supplies
- Electrical equipment with broken cords
- Outdated memos, notices, and schedules

These items must be dealt with right away before they are forgotten and become a permanent part of the area.

Set in Order means that everything needed at the operation is arranged and labeled so that objects can be found as well as put away. By setting things in order, waste is reduced. Waste here is defined as motion waste that an operator has when they cannot find a tool or part, or wasted energy of the operator. Set in Order begins with identifying, labeling and making sure there is a specific location to store an object. Confusion is reduced for new operators if the item needed is in the same location every time. Shadow boards and tools that are on retractable cords can greatly help in this endeavor. Keep often-used parts and tools closer to the point of use than those that are seldom used. Color coding the tool to its storage location is also useful.

Shine is the third area of 5S and concentrates on keeping things clean and tidy. Dirt and grime must be kept away to establish an environment in which everyone would like to work. Another key purpose is to keep everything in top condition so that when someone needs to use something, it is ready to be used (The Productivity Press Development Team, 1996). A clean work place can relieve stress and strain and should not be an annual event such as "spring cleaning." Cleaning should be practiced daily and

should not require a lot of time. Keeping things tidy also reduces safety issues like spilled liquid that can cause employees to slip and fall, possibly causing a lost time accident. A clean factory is brighter and thus inspectors can see defects on a more repetitive basis. Cleaning also means the inspection of machinery and tools. If an employee is consistently wiping a machine down, they are more likely to find problems with the machine before it becomes a major issue.

Standardize is the fourth area of 5S and is the result of properly maintaining the first three areas – Sort, Set in Order, and Shine. The first step in implementation is making a habit of the first three areas. There are three steps for implementation:

1. Assign personnel the job responsibilities of the first three areas. This may include a check sheet that is filled out at certain time intervals. Each person must know exactly what they are responsible for doing and exactly when, where, and how to do it.
2. Integrate these new job responsibilities into the daily work routine. Management must provide time and resources to accomplish the tasks assigned. The work must be brief, efficient, and habitual.
3. Audit the previous two steps. Managers must show that it is important and thus check on the progress of the employee. Tell the employee they are doing a good job and if they are not, then show them how to improve to the standard necessary.

The final area of 5S is Sustain. It means to make a habit of properly maintaining correct procedures over time. Most companies have the drive to initiate 5S. The largest reason for failure is due to the inability to sustain the first four areas. Unlike the first four

areas, the Sustain function can not be implemented by a set of steps and rules, nor can it be measured. It exists in the hearts and minds of employees and management. All levels of employees must develop Sustain skills in order to truly maintain a 5S system. If a plant is actively pursuing a 5S system, it is much easier to make changes. One such change is a plant consolidation.

Plant consolidation is very risky (Deans, 2000). There are many factors for management to weigh before that decision is made. All employees are affected by it. There are four main points concerning plant consolidations:

1. Company size is not a factor in consolidation. There is no maximum or optimal size for companies to attain. A company must grow in order to survive.
2. In order to grow faster than the competition, companies must merge with other companies and consolidate; it is inevitable.
3. Niche markets are unpredictable. Companies in niche markets will be consolidated.
4. Mergers and consolidations determine profitability, market share, and stock prices. Consolidations are the cornerstone for growth.

Companies all over the world consolidate in the same way. Consolidation is unstoppable. Deans, (2000) found that, "After watching and participating in the growth of mergers, acquisitions, and divestitures across the globe for years, one thing is certain: the pace of corporate combinations may ebb (as it did in 2001) or flow (as it did throughout the 1990's), but consolidation is unstoppable; its progress is continuous and inevitable" (p.1). The global market place is interlinked with regards to mergers and consolidations.

If one industry becomes less productive, another wave of consolidations begins. This in turn drives other market to restructure in order to grow shareholder value. Mergers and consolidations can be described in five different sections:

1. All industries consolidate and follow a similar course.
2. Merger actions and consolidation trends can be predicted.
3. The Endgame Curve (see Figure 8) can be used as a tool to strengthen consolidations strategies and facilitate merger integration.
4. Every major strategic and operational move should be evaluated with regard to its Endgame impact.
5. Endgame positioning offers a guide for portfolio optimization.

Deans, (2000)

1. All industries consolidate and follow a similar course. In the beginning, when an industry is formed, it starts on the Endgame curve and will end up at the end if it is successful. Currently an industry takes 20 to 25 years to complete the entire consolidation process, from the Opening Stage, through the Scale and Focus Stages, and the final, the Balance and Alliance Stage. Specific strategies and operational steps (Figure 8) are imperative to a successful consolidation. They will bring new benefits ultimately bring the company to the top of the market. By ignoring these steps, a firm can fall behind and finally fail.

2. Merger actions and consolidation trends can be predicted. Research enables the prediction of mergers and future consolidations. Long term predictions believe that

industry consolidations will correlate around 80% with future upswings in the global stock market. The following are two examples of specific industries:

- The auto industry will see the dominance of more significant global players, such as Volkswagen, GM, Ford, or Daimler-Chrysler.
- Banking will continue to consolidate in North America and Europe, and then across the globe.

3. The Endgames curve can be used as a tool to strengthen consolidation strategies and facilitate merger integration. A company must first determine their current Endgame curve position. After determining the position, the curve can identify the company's core competencies that will help during a merger. If a company becomes successful at consolidating, it can be much more profitable and gain power and market share in its industry. History shows that the past practice for larger companies was to buy up smaller firms, national companies would only merge with firms within the country; and consolidations occurred when a company wanted to grow their core business. That is not the case today. The success of a merger now depends on where on the Endgame curve the company exists at that time.

4. Every major strategic and operational move should be evaluated with regard to its Endgame impact. The benefits of a successful company consolidation include increased competitiveness of the newly created, larger firm in the industry in which it exists. Also, the company will see shareholder values rise and generate a move up on the Endgame curve. Chief Executive Officer fees and investment bankers' fees should not be included. These increases should send up a flag to shareholders that the acquisitions are

made solely for the benefit of the people personally benefiting and not with the shareholders best interests in mind. Measure of value should be advancement on the Endgame curve alone. An example of a multiple merger failure is of a German company that was 150 years old. Philipp Holzmann, a German construction company, began acquiring companies in Germany as well as local companies from other countries. They did not have a good strategy and did not progress past the second stage. Germany's leader, Chancellor Gerhard Schroeder, bailed out the company by giving the company's creditors 250 million marks (US $130 million) and asked other banks to put up an additional 200 million marks to further help the company. Those banks then sold off the major chunks of the company to its competitors. Philipp Holzmann then filed for bankruptcy in 2002. They did not take into the account the impact the restructuring had on the Endgame curve. Deans, (2000)

5. Endgame positioning offers a guide for portfolio optimization. Companies need to plan out their growth on the Endgame Curve. Top management should spread out their portfolio assets across different stages. If the companies and sub companies are at differing stages on the Endgame curve, the ruling firm can better maneuver funds and resources. If one company is ready to grow into more, attention is given.

The global healthcare industry is right in the middle of moving from Stage 2 to Stage 3. Growth is difficult during heavy consolidation. This is the problem of Bristol-Meyers Squibb and Schering-Plough. These two companies decided to merge with companies that concentrated on the pharmaceutical sub industry and the over-the-counter sub industry. These two sub industries are also in the transition from Stage 2 to Stage 3.

The result of this is extremely difficult growth and the parent companies are experiencing losses to shareholders and loss of market share.

On the opposite side of the coin, Johnson and Johnson, despite the problems facing its industry has many good prospects, a steady share price, and gaining market share. This is due to its knowledge of the Endgame curve and being sure to buy firms different than theirs. This concept is much like the theory "don't put all your eggs in one basket." Diversification is the key. Johnson and Johnson has reached out to the medical equipment industry (Stage 2) and the biotechnology industry (Stage 1). Make sure your company is looking at different companies and industries that are at varying Stages on the Endgame Curve. By adding these industries to its core business of pharmaceutical, over-the-counter drugs and consumer products, Johnson and Johnson has positioned its overall portfolio at a much earlier point in the Endgame curve. This gives Johnson and Johnson many opportunities to grow when its core business industry reaches the end of Stage 4. That offers a very attractive story of forward thinking for investors.

Stages of the Endgame

Deans, (2000) discovered that there are four main Stages in which companies exist. They are:

- Opening Stage: There is little or no market concentration and the first consolidators may appear. Newly deregulated, start-up, and spin-off sub industries occupy this space.

- Scale Stage: Size begins to matter. Major players begin to emerge and take the lead in consolidation. Concentration rates can be as high as 45% in some industries.
- Focus Stage: Successful players extend their core businesses, exchange or eliminate secondary units, and continue to aggressively outgrow the competition.
- Balance and Alliance Stage: A few players will dominate industries, with consolidation rates as high as ninety percent. Titans of industry reign, from tobacco to automotive companies and engine producers. Large companies may form alliances with other giants because growth at this stage is challenging. (p. 6)

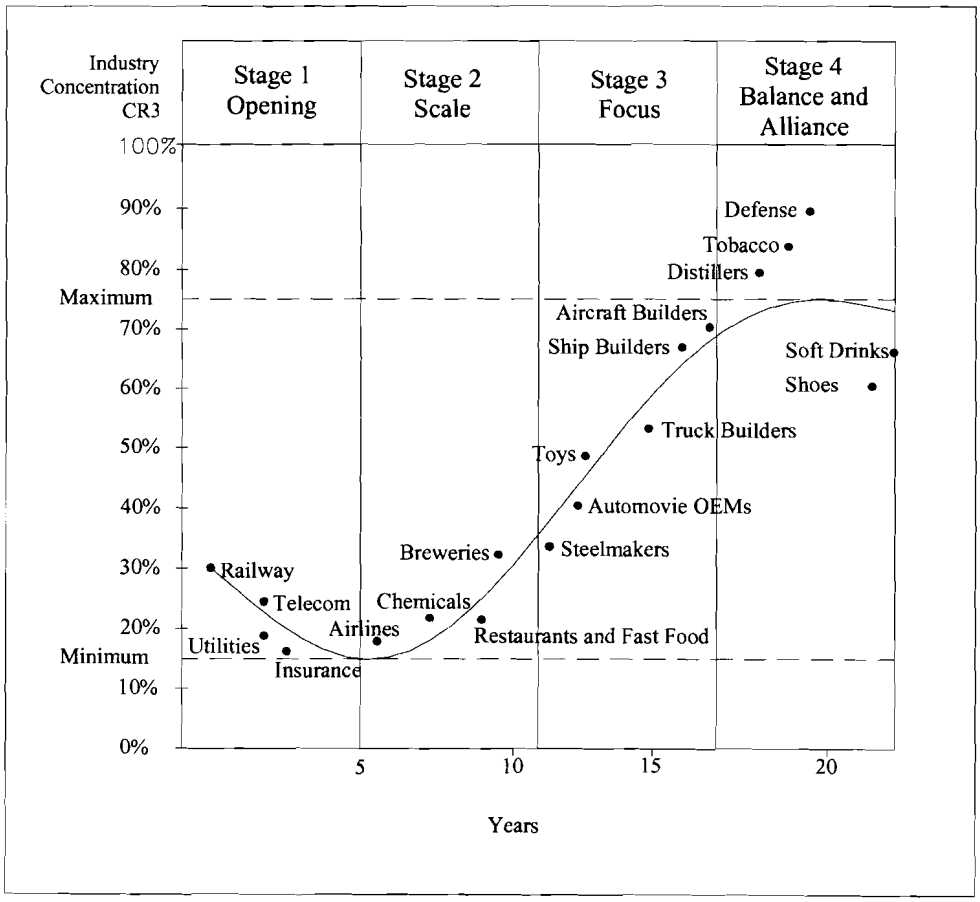

Figure 2: Endgame Curve

Mergers must be properly planned to insure success (Grubb, 2000). The benefits are realized sooner, operational confusion and financial losses are reduced, thus prevention of employees leaving occurs. If a company can become a top merger specialist, it gains the respect of competitors and thus reduces the chance of an attack during the next consolidation.

Chapter 3: Methodology

The research methodology used for this paper includes the following:

1. Review of literature
2. Study of Lean implementations at the Ripon manufacturing plant
3. Discussion of recent plant consolidations to the Ripon plant.

From these three areas of discussion, the decision whether to implement Lean manufacturing during a plant consolidation from Florida to Wisconsin will be made. The Company must create the most value for the owners and shareholders.

The literature review covers topics on Lean manufacturing, 5S, flexing, kanban systems, and plant consolidations which are important when trying to attain the research goals. The in-depth review of these topics will provide the necessary background information to objectively perceive the past results that Company XYZ has had in each area.

After the literature review, data was collected during the three main projects reviewed; Plant consolidation from Kentucky, Lean implementation in Department 57, and Lean implementation during a manufacturing line merger. All data has been modified at the request of Company XYZ. Trends and relationships between the data will be represented. Data was collected before the projects began and then again after project completion. This data, collected by Project and Quality engineers, was compiled and presented to the Board of Directors. Along with the data collected, a review of all decisions made prior to project sponsorship will be discussed.

Decisions involving the plant consolidation centered around two major areas:

1. Customer shipments
2. Quality levels of finished product.

Production output was a concern but not a major factor in the decision making. Management believed that we would be able to ramp-up with enough inventories of finished goods. That inventory would be built-up to increased levels in order to provide a buffer to the customer during the actual move of the assembly line and equipment.

Data collected on the Lean implementations included three areas:

1. End of line yield quality level
2. Production line finished goods output
3. Headcount of all hourly and salaried employees associated with the production lines.

This data was collected before the Lean implementation and after. An impartial team was formed to collect the data so that there were no conflicts of interest.

After all of the data was collected, it was correlated with the literature review. This relationship is the major part of the discussion in chapter 5.

Chapter 4: Results

The purpose of this study is to determine if Lean should be implemented during Company XYZ's Florida/Wisconsin plant consolidation. There are many risks involved with both the implementation of Lean practices as well as plant consolidations. In this chapter, results of past Lean projects and plant consolidations will be addressed. These include:

1. Plant consolidation of the Kentucky plant to Ripon.
2. Lean implementation in Dept 57.
3. Lean implementation during the Eagle Line consolidation.

The plant consolidation from Kentucky to Wisconsin occurred in 2001. The main reason for the consolidation was to reduce duplicated manpower in middle management. Another reason was to gain buying power of steel and other purchased items. The duration was one full year from the start of the project to reaching full production in Wisconsin.

The decision to consolidate was a difficult one. Company XYZ's customers were relatively happy with the lead times and quality of the finished product out of the Kentucky facility. Customers were very concerned about trying to move the plant without any problems. A plan was needed to reduce the possibility of failing the customer. The following steps were taken during the project:

1. Determine the time frame needed for the project
2. Decide what equipment moves and when
3. Analyze process and develop a training schedule

4. Decide on location in Wisconsin plant and implement needed infrastructure including electrical power, plumbing, overhead structure, compressed air, lighting, heating, and ventilating
5. Train new work force in Kentucky
6. Build-up inventory to allow more time for the physical moving of the operations, machinery and conveyor lines
7. Move lines
8. Ramp-up production and verify quality
9. Build at full production

The project was a difficult one at best. Having never done it before, Company XYZ had to be extra cautious during each phase of the project. At the time, Company XYZ did not consider a Lean implementation since there was enough to worry about with the plant consolidation alone. The project was a success and the people involved gained a vast amount of experience in plant consolidation. The benefits realized on the production side were negligible. Quality levels rose over the last few weeks of the ramp-up stage from 91% to 95% end of line yield. The ultimate goals behind the merger were met; middle management was reduced and the purchasing agents gained power through greater quantities of goods bought.

One year after the successful consolidation project, Company XYZ decided it was time to try a Lean implementation. Lean has many benefits and has become more and more popular worldwide. Companies of all sizes and differing product lines have seen successful implementations and have become much more profitable. Company XYZ had never attempted an implementation such as this so they hired a consulting firm to help. Before choosing, many firms were interviewed. When the field was narrowed to three

consulting firms, Company XYZ representatives went on plant tours and spoke with many references to become more comfortable with one firm. Company XYZ chose a Lean consultant from Colorado. First, the consultants recommended the company go through an intensive three-day training session. During the training, employees at all levels were involved in learning about value stream mapping, Kanban, 5S and other aspects associated with Lean implementations. The group was split into smaller factions and given a section of the factory they were not familiar with and asked to complete a value stream of the area, determine if and where a kanban system could be implemented, and develop a 5S program for a small section. An example of one of the group's results is shown below.

Machine shop value stream:

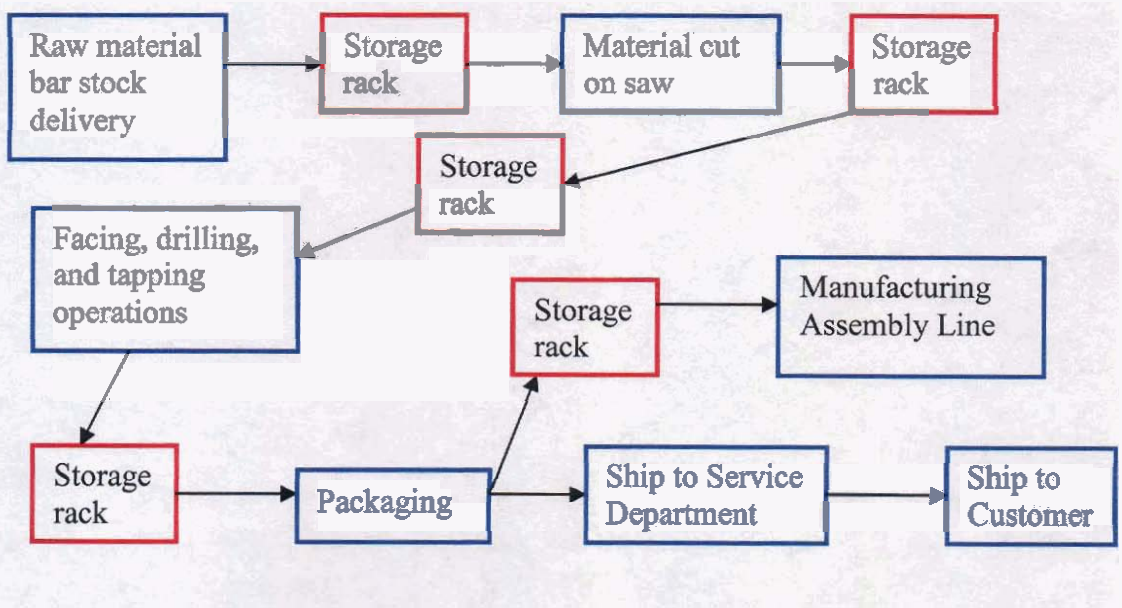

Figure 3: Machine shop value stream

Squares in blue are Value Added operations and the squares in red are Non-value Added steps that must be reduced or eliminated. There are two red squares of rack

storage between the Cutting process and the Facing operation. One should be eliminated. By only storing parts in one location, employees can better manage the inventory visually. A kanban system will be installed on the part creating useable stock that is not in excess. The production control department will determine the amount of inventory needed to support a standard schedule at every stage of manufacturing. Kanban cards will be implemented at each stage. Floor space is a premium at Company XYZ and the reduction of parts in racks creates more space for other parts or new products.

A 5S program starts with Sort. This is fairly easy in the machine shop department, except for the extra tools that are lying around. These tools are either broken, dull, or spares. All of these tools must be removed and stored in a central location. If broken tools cannot be repaired, they are thrown away. The Set in Order phase comes next where everything is labeled. All necessary tools must have a home that is labeled with easy access for the operator. The Shine step is next and is critical in a machine shop. The floors are wet with cutting oil and very slippery. The machines were covered in grime and hadn't been cleaned in some time. The group decided that a one-time, 4 hour cleaning would get them in the shape they need to be in to make the upkeep easier on a daily basis. Standardize will give the operators the tools and the time to keep up with the machine's cleanliness. The floors will have to be professionally cleaned. Once per week an outside company will come in to clean the floors. The Machine shop department will Sustain these first four areas of 5S by auditing them on a weekly basis. This will, in turn, show support of the program and give direct feedback to the operator responsible for the cleaning.

Later in the training, the class went through an exercise involving the manufacture of mini cannons. The class was split into two main assembly lines and each line was

given an operation to complete. The work was divided up evenly and the operations were closely balanced. The results were recorded and the work was split up into more operations, less work at each. The class was told to flex into an operation if they were done with their work and were waiting for an operation that was empty or an operator that was still working. The following three scenarios will depict the basic fundamentals of flexing and IPK (In Process Kanban).

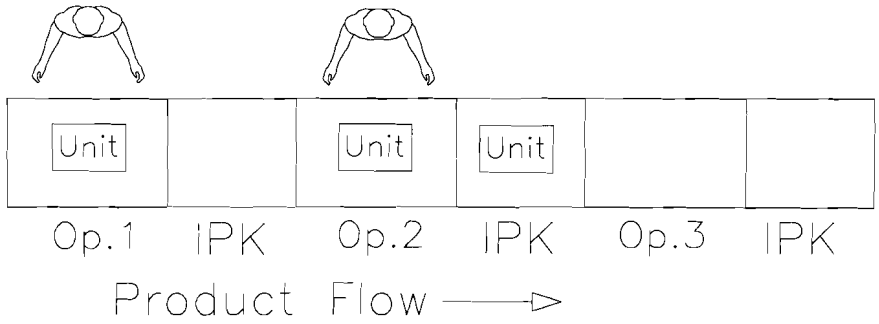

Figure 4: Flexing Model A

In this scenario, operator 2 should flex to operation 3 since the operation and IPK are full. The bottleneck is at operation 3. Operator 1 should finish working on the assembly in the work cell, move that unit to the IPK and begin on a new assembly. If an operator moves to a new operation, that operator should stay there until the IPK's show them to move.

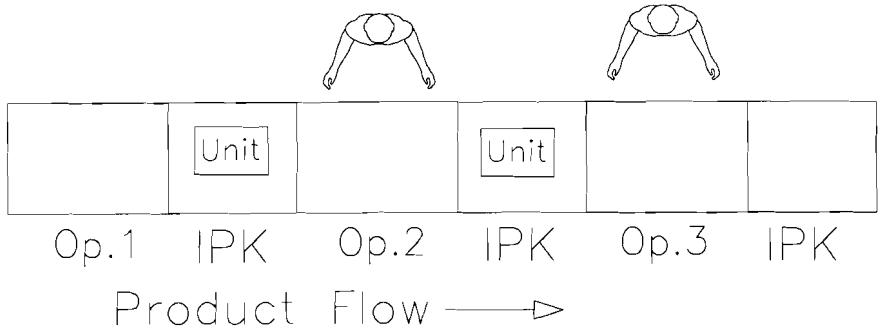

Figure 5: Flexing Model B

In this instance both operators have no work in their operations and both have units in their customer IPK. Operators should stay at their operations, pull the units from the previous IPK and keep working. This is a typical situation that occurs during a normal day on an assembly line.

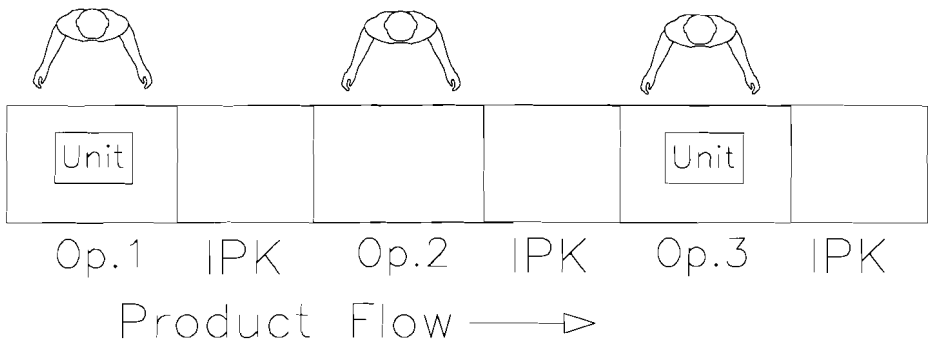

Figure 6: Flexing Model C

This time, there are three operators and only two have units in their operations. Operator 2 should move to the first operation and bump the operator there. The bumped operator then moves to the upstream operation if there is one. If no operation is present, operator 1 should stay to aid and assist operator 2. Once operation 1 is full and the IPK is full, operator 2 should move back to operation 2 and continue working.

These fundamentals ultimately tell the operator to flex to the bottleneck that is currently affecting the output of the line. By following these basics, a line manager can easily and quickly understand if there is a problem. Eventually all of the operators will be in one area. If the bottleneck happens in the same location time after time, a closer look needs to be taken to determine the problem. The problem could be as simple as a work balance issue or as difficult as conveyor problems. Most issues can be solved with little work. In the beginning, balancing issues are the culprit most of the time and can be corrected quickly.

After the training was complete, work began on the Lean implementation in Department 57. A team of two manufacturing engineers, one quality engineer and two project engineers were assigned to the project. With the help of the consultants, a game plan was formed. Quality levels, production output, and headcount was benchmarked.

1. Quality Level was at 92% End of Line Yield with a 97% Audit level
2. Production Level was at 150 units daily average
3. Total production line employees equaled 53

The first step was to time study the entire line. All aspects of all models were to be timed. Once complete, the team determined the quantity of operations. This was done by looking at the space available and the size of the largest machine and conveyor to be used. The number of stations used in the calculations was fourteen. This is the number of operations per side of the conveyor. At maximum line design, all operations would be used. This is only a picture of the main assembly line. There are 25 sub assembly areas that support the main assembly line with parts and assemblies that are too intricate or large to handle at the line. Many times an online operator must flex to a sub assembly area if they need parts from that sub assembly area.

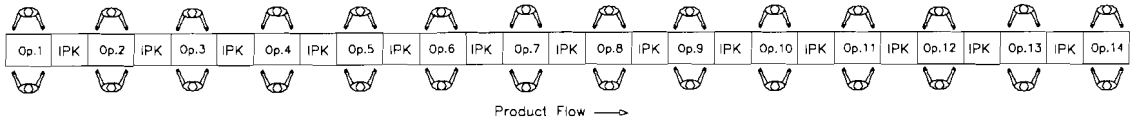

Figure 6: Department 57 Assembly Line

Once the number of operations was determined, tact time could be established. Tact time is an amount of time given to an operator to complete specific tasks at their work station. The tact time is needed to set-up and balance all the work between all the operations. Department 57 has over two thousand different models so line balancing was extremely difficult. All the models were broken up into 10 base models into which most of the models fell. Minor differences were taken into consideration as needed. Once the line balancing was complete, two things happened:

1. The work instruction team was brought in to write visual work instructions for every model at every operation.
2. All the times, models, and operations were put into the algorithm. The algorithm is an Excel spreadsheet that helps determine output by inputting the schedule.

The visual work instructions were developed from written work instructions called SOW's (Standard Operating Work Instructions.) See Appendix A for an example of a Standard Operating Worksheet. The visual work instructions were developed using Microsoft Excel. Pictures were imported and assembly instructions were written explaining the specific work to be done. See Appendix B for an example of a Visual Work Instruction. A Visual Work Instruction book is placed at all operations where work is being done. The book must be easily accessible and easy to understand.

Once the work had been defined for each operation, 5S implementation was started. The team began at the front of the line. Each operation was looked at individually. Operations 1 through 5 on both sides of the line were fairly straight forward, only needing a few large parts and one type of rivet. The next operations posed more problems with many smaller parts and needing a lot of organization. Spare racks and shelves were eliminated. All parts bins were identified with a label that identified the part and also where more parts could be found upon running out. The lead people were responsible for replenishing the line with parts and fasteners out of the storage areas.

Cleaning is done once a day for the operations on the line and weekly for the general aisles and storage areas. Operators have access to brooms and dustpans as well as vacuums and rags. A check sheet is filled out whenever cleaning is done. The coordinator in the area does regularly scheduled audits of the areas and unscheduled audits occur at random throughout the week. The plant manager also completes audits periodically to show support for the program. Finally, there is a semi-annual party for the line if they receive better than 98% approval on all audits.

Kanban is then implemented on all manufactured parts produced in the factory that are used on the machines produced in Department 57. These parts include stampings from the Press Shop, wire harnesses from that department, and also sub assemblies from elsewhere in the plant. The kanban system was set-up for maximum line design and each part was given specific attention. The parts were given a kanban card that identified the part and showed the progression through the factory. Each department has its own card system that is unique to that part. For instance, a Side Panel Mounting bracket journeys through three separate departments before reaching the assembly line.

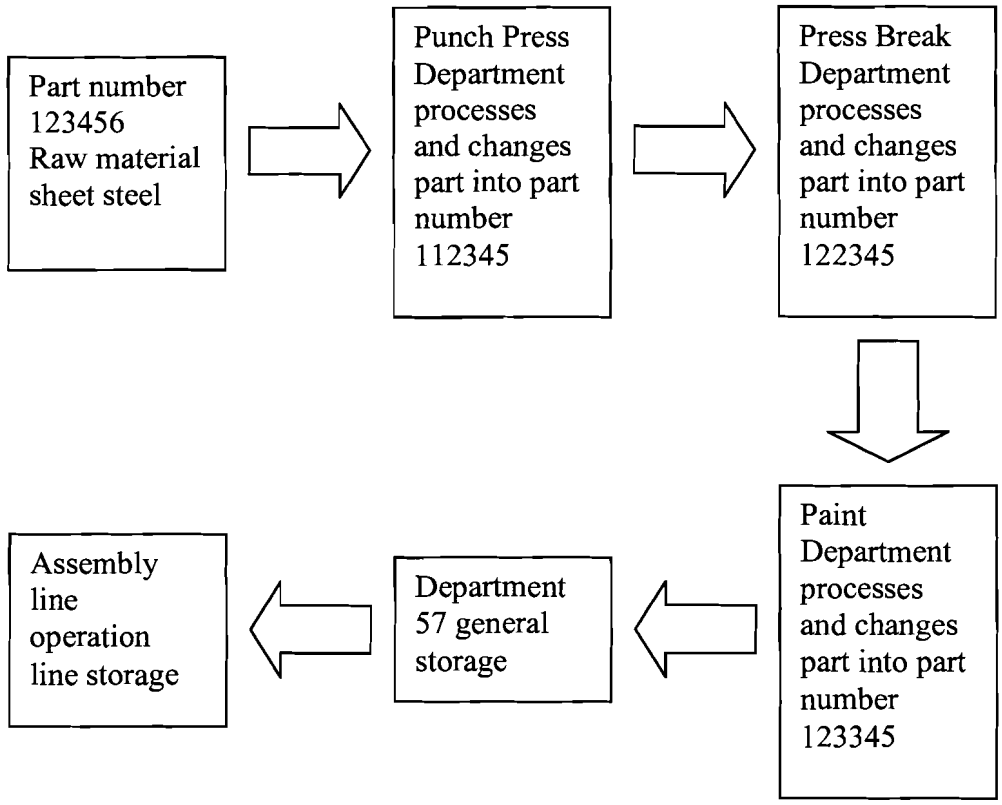

Figure 8: Kanban System

Each arrow represents a storage location in the previous department where it is located until a kanban card comes in to retrieve it. Once that part is removed, the kanban card that was attached to it goes back into the system in that department to be scheduled again.

Success of this project was determined by headcount reduction, production output and quality levels.

1. Quality Levels rose to 95% End of Line Yield and 98% Audit level
2. Production output stayed steady at 150 units
3. Employee headcount was reduced by three employees down to fifty

After this success, Company XYZ decided to expand Lean into other areas. The next project would include the combining of two separate assembly lines and a Lean implementation.

The Musky and Badger assembly lines were completely separate lines in totally different parts of the plant. The Musky line produced the small chassis front load washing machine. The Badger line manufactured the small chassis dryer. The units do share some similarities and parts, but very few. The driving reason for combining the lines was the problem with fluctuating build schedules. The Musky line was unpredictable due to its product age of five years. Sales staff were able to make sales, but on an inconsistent basis. One week the line would be on overtime and the next week it would get shut down and the employees would not have work. The Badger line was larger and producing ten times the amount of dryers as the Musky line. It was relatively stable and sales were very steady. The decision to implement Lean at the same time was difficult. The company proceeded with the project due to shop-floor product knowledge and design engineering's close involvement.

Since the dryer line had more space, the new Lean line would be installed at that location. A new powered conveyor would be needed since the existing conveyor line was a synchronous line and would not support flexing. All sub assembly areas would be laid out to accommodate running Musky parts as well. Once again, time studies were conducted in order to generate Standard Operating Work instructions. This time the visual work instruction books were very large due to having two different product lines running down the same assembly line. Each book had tabs for each model group. Six model groups were identified for both the small chassis dryer and small chassis front load washer. These groups were the same for both products:

1. Home style single rear control
2. Home style single front control
3. Rear control commercial
4. Front control commercial
5. Home style stack
6. Commercial stack

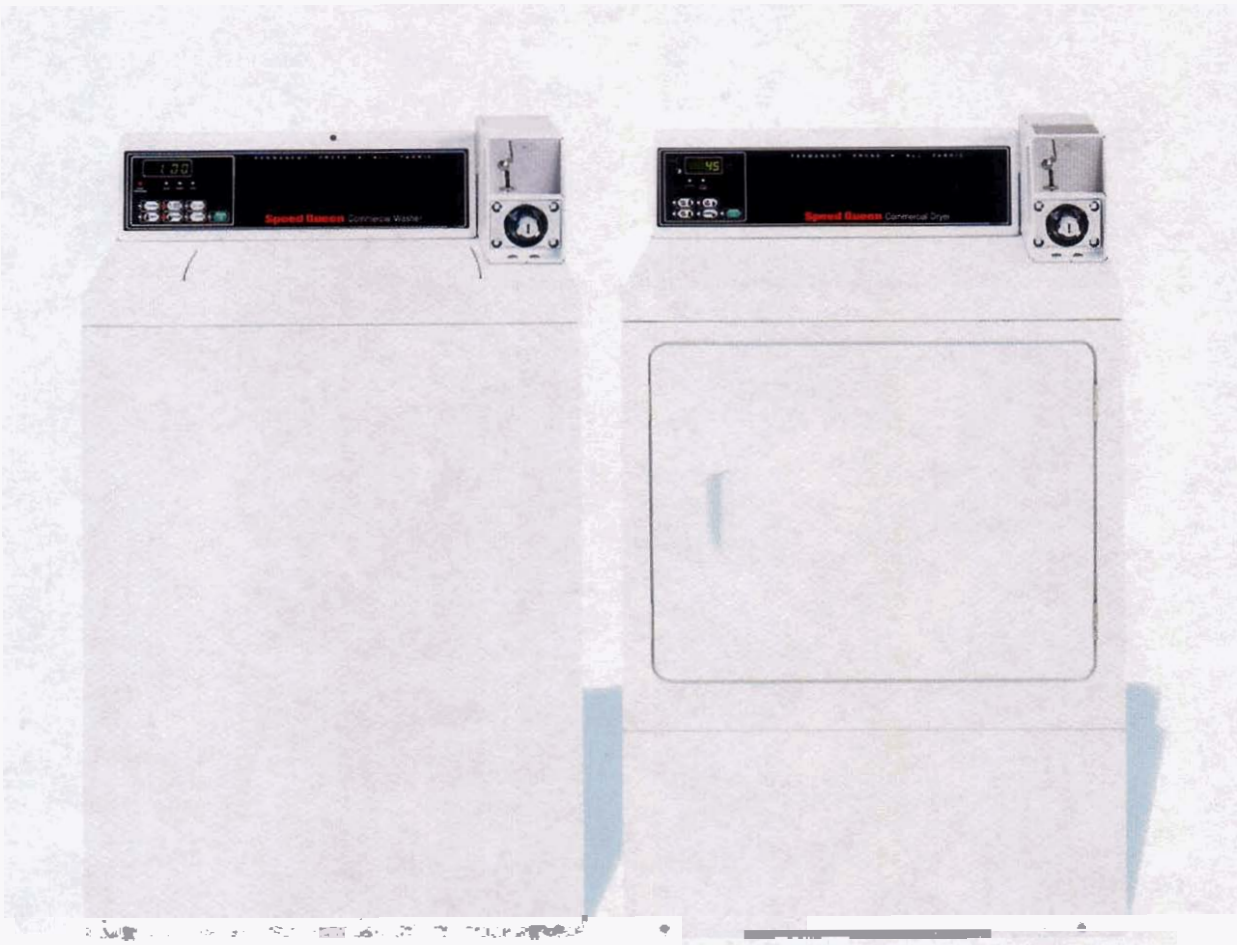

Figure 9: Example of a small chassis product pair

The visual work instruction books were given tabs to help the operator locate the correct models when the line is running. This reduces wasted time and energy of the operator trying to figure out what to do when a unit arrives at their work station. When a

unit moves into the operator's work station from the upstream IPK, the operator first looks at the schedule to find out which model it is. The next step is to find the corresponding work instruction for the model's list in the visual work instruction matrix. Once the model is determined and the visual work instruction is found, work can begin. If the model has a unique part or operation, the visual work instructions call it out for that model. An uncommon parts list is referred to. The uncommon parts list is a list printed on a daily basis with the most up-to-date bill of materials used for each model. No part numbers are referenced in the visual work instructions to eliminate the need for updates when there is a design change related to the part number. All these tools were used in the implementation of Lean during the line consolidation.

Just before the actual merger, the following statistics were recorded to measure success:

1. Production output: Musky line 50 units
   Badger line 400 units
2. Quality level: Musky line 98% end of line yield
   Badger line 97% end of line yield
3. Number of employees: Musky line 15 shop hourly, one supervisor
   Badger line 40 hourly, one supervisor

The following charts show the production and quality levels of the Musky and Badger lines in a time line of one year before the merger and one year after.

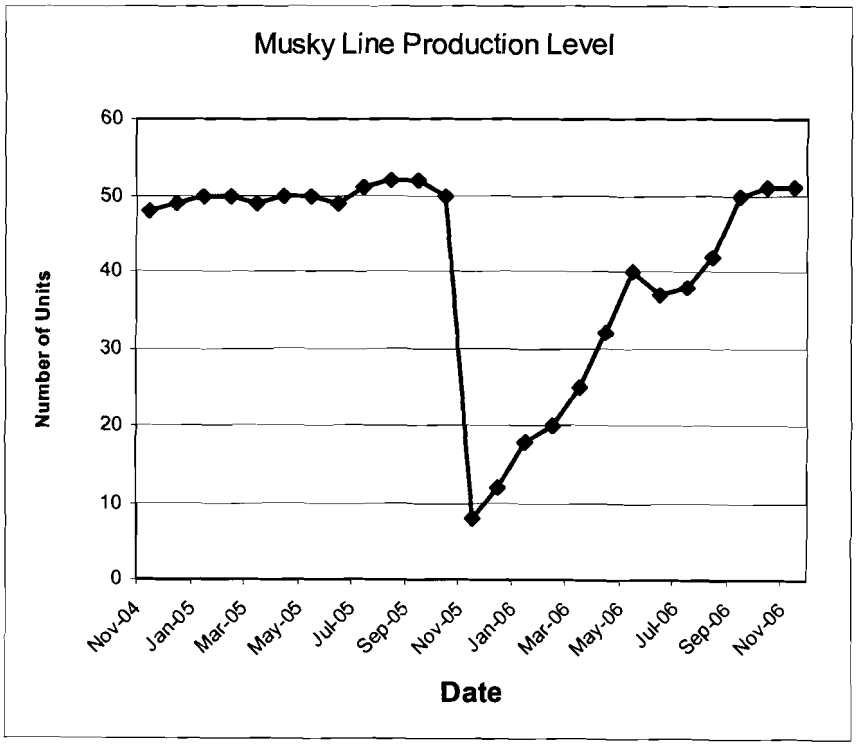

Figure 10: Muskie line production level with Lean implementation in November 2005

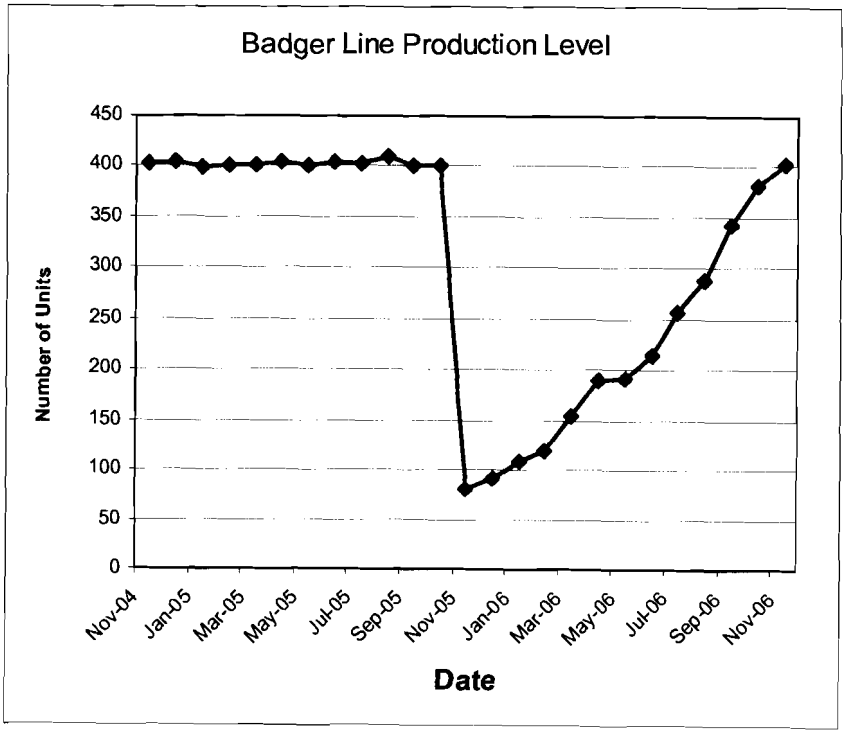

Figure 11: Badger line production level with Lean implementation in November 2005

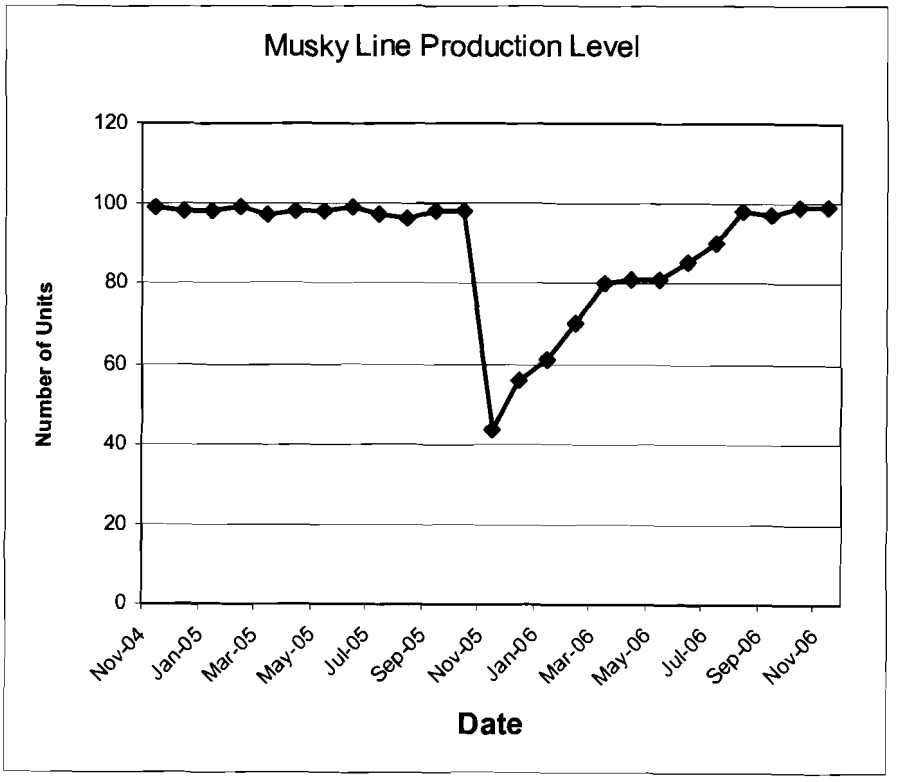

Figure 12: Muskie line quality level with Lean implementation in November 2005

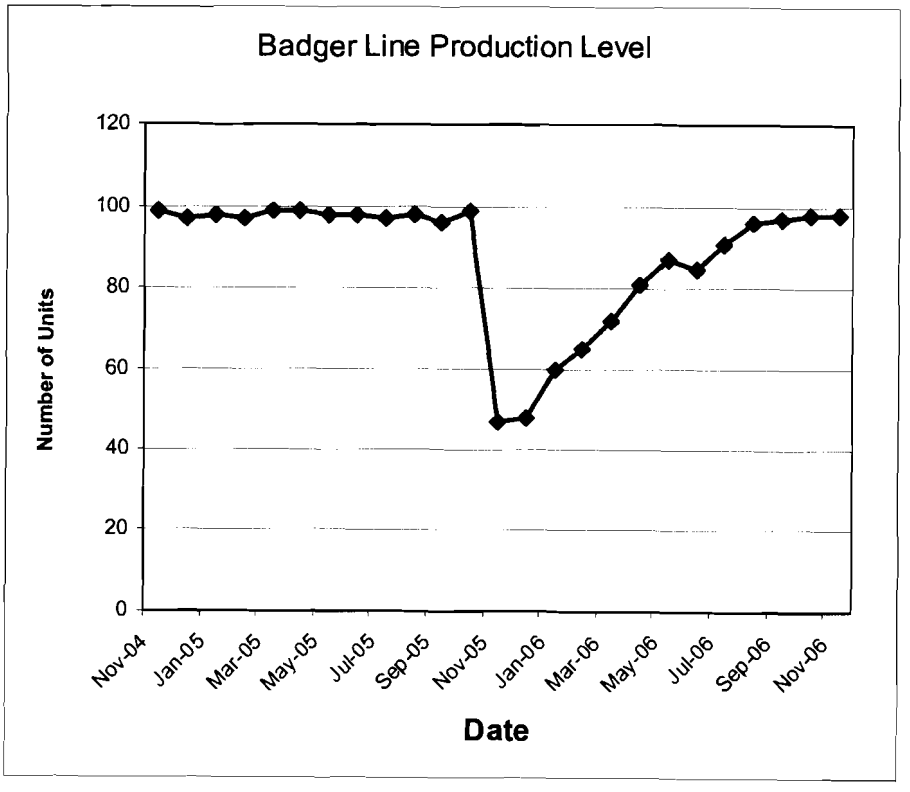

Figure 13: Badger line quality level with Lean implementation in November 2005

As one can see, both lines suffered for approximately one year on both production and quality levels. The one thing that did change right away was the man power needed to attain the results just discussed. Employee head count was reduced by 5%, including one supervisor, with the two lines combined.

This merger was a success. Implementing Lean during this line merger benefited the company by reducing the wage costs of the positions eliminated. Most employees whose positions were eliminated were absorbed by other lines whose production schedules were rising. Some of the main reasons the line consolidation was a success include:

- This Lean initiative was supported by all management.
- Employees manning the line after the merger were very skilled and had expert product knowledge.
- The time table was long enough to see results.

Chapter 5: Discussion

Company XYZ is trying to determine if the benefits of a Lean manufacturing implementation outweigh the risks involved with a plant consolidation. The introduction of this paper describes the company as a worldwide leader in commercial laundry equipment. When competing in the global workplace, a company must be at the top of its game. In a manufacturing arena, Lean manufacturing is the way to go. It provides many benefits and few drawbacks. Some benefits include:

- Reduced inventory of finished goods
- Shortened time between order and shipment
- Higher quality of parts as well as finished product
- Improved organization
- Elimination of parts shortages due to scheduling
- Increased ability to bring new products to production

These benefits coincide with the results found during two separate Lean manufacturing implementations at Company XYZ.

Limitations of the Study

Due to the space constraints at the current facility in Wisconsin, Plant 2 will be utilized. This will reduce the extent that Lean could be utilized. A 12,000 square foot addition onto Plant 2 will not be completed in time to use initial Lean set-up. The results of the study are limited to Company XYZ. The data given in this research paper are representations of the true data and not actual.

Summary

Plant consolidations are difficult decisions even for the most seasoned manager. There are many reasons to merge plants that have similarities. The main reason is to

move up the Endgame Curve. By advancing within a stage, and more importantly transitioning to the next stage, a company can gain market share and thus create value for its shareholders. This is happening all over the globe, thousands of times a year. Company XYZ wishes to advance faster than its competitors. That means consolidation is in the future. There has been one plant consolidation and one manufacturing line merger at Company XYZ. Both are viewed as successes. This alone has allowed the company to grow and cut costs related to headcounts and also gained buying power over raw materials.

Cutting costs on purchased parts is only one way that Company XYZ has lowered its operating costs. Lean manufacturing has been implemented on two of the production lines. The results were impressive. Lowering headcount, while maintaining production and quality levels, was the primary improvement.

5S implementation occurred simultaneously with the Lean implementation. This organized and cleaned up the areas, gained production efficiencies, and improved operator morale. 5S was pivotal in that it showed all employees that top management was in favor of the project and would give the necessary tools to achieve the full benefits from all of the areas of 5S. Those five areas include: Sort, Set in Order, Shine, Standardize and Sustain.

Another entity that is associated with Lean implementation is operator flexing. Company XYZ implemented flexing on both lines that moved toward the Lean way of manufacturing. Flexing is the primary signal system operators use to become more efficient. They know what to do and when to do it just buy looking at where the work is. Operators flex to the work that needs to be done. After a three day training session,

workers can become highly capable flexing operators and increase output by nearly thirty percent.

Lean implementations at Company XYZ have been successful. The plant consolidation, along with the line merger, has given owners and shareholders value by advancing the company up the Endgame Curve. Both of these project groups benefit the company. Should Company XYZ attempt to implement Lean manufacturing practices during the plant consolidation from Florida to Wisconsin? Using the information presented during the previous portions of the research paper, the answer is, yes, the company should attempt to implement Lean during their next factory merger.

If given enough preparation time and capital spending is adequate, the project should be a success. The Florida plant will need to build up inventory to provide the needed time to complete:

1. Time Studies
2. Standard Operating Worksheets
3. Visual Work Instructions
4 Floor layouts, including the purchase of a new conveyor system to accommodate Lean manufacturing

Production will suffer for about one year. So the company will need to build enough units to allow time for production ramp-up. These extra units should be stored off-site due to space restrictions in the current warehouse. No customer shipment will suffer because of the transition.

In conclusion, Company XYZ completed its plant consolidation from Florida to Wisconsin recently and did not implement Lean manufacturing practices. Two main reasons were given:

1. The aggressive schedule given by upper management did not allow adequate time to complete all the steps for a successful Lean implementation. If the time table was at least six months longer a full Lean implementation would have been possible. The project size was simply too large for the number of resources available at the time.
2. Project leaders felt that if the company decided to implement Lean during the plant merger, the operators that went to Florida to train would only know how to build the product the way they were trained. If Lean was implemented after the move, the work the operators learned while training would be very different. That risk was too great to consider. If there was enough time to implement Lean at the Florida location and then move the lines, the decision would have been to do just that.

The overall decision not to implement Lean during the transition from Florida to Wisconsin was the right one. Lean is a powerful tool for manufacturing companies, however, if not implemented correctly, can be disastrous. This instance would have turned out badly for all involved; project leaders would have failed with missed schedules, decreased cash flow. Shareholders would lose faith in the Lean manufacturing philosophy and been wary of future Lean projects.

Company XYZ plans to implement Lean within the first year after reaching full production levels. A team will be assembled just like prior Lean projects. All the necessary steps for a successful implementation will be taken. Company XYZ has many opportunities for Lean implementation and will approach each in the same way. Building knowledge and experience through successful projects will refine the steps so that Lean implementation will become second nature for those involved.

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Standard Operation Work Content Sheet-5 FLOW							page 1 of 1		
Process Name-- Lint panel--station 700								Product(s) SINGLES	
Written by Ed Werch 9/19/2006								Checked by	
Work Seq-uence	Waste (X)		Work Content	could be off line	Labor Time-		Mach. Time	Elapsed Time	Tool Exchg. Freq.
10			Check schedule		0.1000				
20			Get materials		0.2333				
30			Position lint panel to bench, visual inspect		0.1731				
40			Position two (2) guide lugs and screws and drive to panel		0.3265				
50			Change air tool, position plate		0.1180				
60			Position six (6) rivets, and drive rivets into plate and panel		0.4012				
70			Turn panel over		0.0590				
80			Position kickplate		0.1023				
90			Drive six (6) screws		0.3265				
100			Position right side roller assembly, align with gage, drive one (1) screw		0.2871				
110			Position left side roller assembly, align with gage, drive one (1) screw		0.2478				
120			Peel foam gasket and apply to perimeter of panel (6 ft of gasket)		0.4759				
130			Assembly aside to IPK		0.1967				
140			miscellaneous-stickers, etc.		0.2360				
			Move cardboard out from panels (1/4), misc materials		0.1000				
				Totals	3.3834	0.00	0.00	0	

Standardized Work Chart

Document Number: 36M150(C)-V | DATE: 11/12/2003 | REV: 4 | Page 1 of 1

Maintained by Manufacturing Engineering | QUALITY CHECK | SAFETY | STD PROCESS | Approved by: Jenon Smolarek

STEP	Work Center 150 Front Load Washer, Tab #5
1	DOUBLE CHECK DEFINED WORK FROM PREVIOUS OP
2	HELP LOCATE BELLYBAND [A] ONTO UNIT.
3	INSTALL (2) WIRE CLIPS [B] TO UNIT.
4	ROUTE HARNESS AND INSTALL (1) GROMMET [C] TO SHIELD [D].
5	SNAP PUSH MOUNT WIRE CLIP [E] INTO SHIELD [D].
6	INSTALL (2) SCREWS [F] TO FRONT OF UNIT AND (2) SCREWS [F] TO BELLYBAND [A].
7	PLUG IN (1) BLOCK CONNECTION FOR HEATER UNIT.
8	CHECK YOUR WORK AND RELEASE PRODUCT TO IPK

PARTS DESCRIPTION	
A	BELLY BAND
B	WIRE CLIP
C	GROMMET
D	SHIELD
E	PUSH MOUNT WIRE CLIP
F	SCREW