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PRELIMINARY EVALUATION FOR LEAN IMPLEMENTATION IN A SMALL  
MANUFACTURING COMPANY

Thesis submitted in partial fulfillment of the requirements for the degree Master of  
Science in Engineering and Technology Management

Department of Architectural & Manufacturing Sciences  
Western Kentucky University  
Bowling Green, Kentucky

By  
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August 2023

PRELIMINARY EVALUATION FOR LEAN IMPLEMENTATION IN A SMALL  
MANUFACTURING COMPANY

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# PRELIMINARY EVALUATION FOR LEAN IMPLEMENTATION IN A SMALL MANUFACTURING COMPANY

Ronald Lynch

August 7<sup>th</sup>, 2023

Directed by: Dr. Cathleen Webb, Dr. Stacy Wilson, and Mr. Brian James

Lean management and tools have many positive effects on a company including increased profitability, and efficiency. Lean tools can be implemented in any type of company with a proper evaluation through the creation of Value Stream Map. This paper will demonstrate how a Value Stream Map (VSM) will provide an easier transition to a lean environment. A local company of about 100 employees will be analyzed to create a current and a future VSM. The areas of opportunity for improvement in a lean environment includes recommended lean implementations and the future VSM. Functions of the company that will be analyzed regarding the implementation of VSM include: shipping, receiving, and operations. This project will demonstrate the gap between the current state VSM and the future VSM.

I dedicate this project to my wonderful and supportive wife for taking care of “life” while I finished school. Also, to my source of motivation on a daily basis, my three daughters.

## ACKNOWLEDGEMENTS

I sincerely appreciate my project committee including Dr. Cathleen Webb, Dr. Stacy Wilson, and Mr. Brian James for their direction and time to help develop my project.

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## Chapter 1

### Introduction

### Background

Lean is a concept that embraces the reduction of unnecessary waste to increase productivity while maintaining or increasing the quality of products. There are many avenues for a company to become lean including using a variety of different lean tools. The lean tools are molded into a purpose for that specific company. This project will demonstrate how a proper Value Stream Map, VSM, will provide a solid foundation to achieve lean in an actual company. The company that has been chosen will be referred to as Company R throughout this project. Company R is a company of less than 100 employees, and Toyota is its only customer.

This topic is unique because most of the research and data found is a generic implementation of Lean. Some of the research does suggest a specific implementation of lean in a process; but it is specific for that individual process. Company R, as stated, has under 100 employees, subjectively making it a small company. A smaller company should pose its own difficulties, but it does present positives as well. Ideally it is easier to implement something with less people involved. This project will expose areas of potential improvement for future projects.

### Problem Statement

The problem is Company R has implemented portions of lean but are not maximizing their potential. Company R does not currently use a value stream map and has no clear way of understanding what is non-value adding to their process. The

solution to this problem is creating a current state VSM. The VSM will expose the areas that need improvement. Then a future state VSM will be created to demonstrate the benefits of implementation of the proposed changes.

### Purpose

The purpose of this project is to optimize Company R by creating a VSM. Lean can be a difficult task for companies but with the right tools and knowledge, the evaluation phase can begin. The primary tool this project will use is a VSM. This project has two objectives: 1) Creating a current VSM, followed by a future state VSM 2) Evaluating the Company's perspective of changes including implementation of lean.

The current state VSM will begin the initial evaluation phase. The evaluation phase will expose issues to create solutions. The non-value adding tasks the VSM is assessing are areas of Muda. The customer will not want to pay for additional processes that are non-needed. The customer will pay for only value-adding processes, reducing non-value-added tasks naturally reduces the costs of the parts and increase profitability. It is critical that any changes not have an adverse effect on the parts and their integrity. Company R parts go onto vehicles and a decrease in quality could cost millions. After the initial VSM, Studies will then be completed to deem the best solution for the problem. Then a future state VSM will be created to reflect on the changes.

Company R will see a future state VSM highlighting the areas that need evaluation and what equipment/processes could be used to achieve a reduction in the

non-value adding tasks. Company R will understand the foundation of lean and begin developing a culture around lean to promote continuous improvements company-wide.

Any changes made to a company must be accepted by everyone for it to be completely successful. Therefore, the employee's attitudes will be assessed in the form of closed-ended questions. It is essential for employees to understand the benefits of leans and how it will benefit them as well as benefit their company.

The second purpose is to assess perceptions of accepting/receiving lean into company R. Acceptance of change is critical to a company's successful implementation of lean. Lean is a cultural change including employee empowerment and increase in communication.

### What is a VSM?

VSMs are comprised of globally accepted symbols as seen below.

Process Symbols	Customer/Supplier	Dedicated Process	Shared Process	Data Box	Workcell
Material Symbols	Customer/Supplier	Shipments	Push Arrow	Supermarket	Material Pull
	FIFO Lane	Safety Stock	External Shipment		
Information Symbols	Production Control	Manual Information	Electronic Info	Production Kanban	Withdrawal Kanban
	Signal Kanban	Kanban Post	Sequenced Pull	Load Leveling	MRPIERP
	Go See	Verbal Information			
General Symbols	Kaizen Burst	Operator	Other Staff	Timeline	
Extended VSM Symbols	Rail Shipment	Air Freight	Expedited	Milk Run	Warehouse
	Cross-Deck	Orders	Phone	Batched Kanban	Control Center

Figure 1. Examples of Globally Accepted Symbols for a VSM (Strategos-International, 2014)

These symbols are used in a flow that generally portrays a cycle. Information is separated into manual and electronic routes of travel. Some information is spoken or delivered in written form known as manual information. Electronic information is delivered via computer interface such as email. The figure below is an example of what a current state VSM consist of.

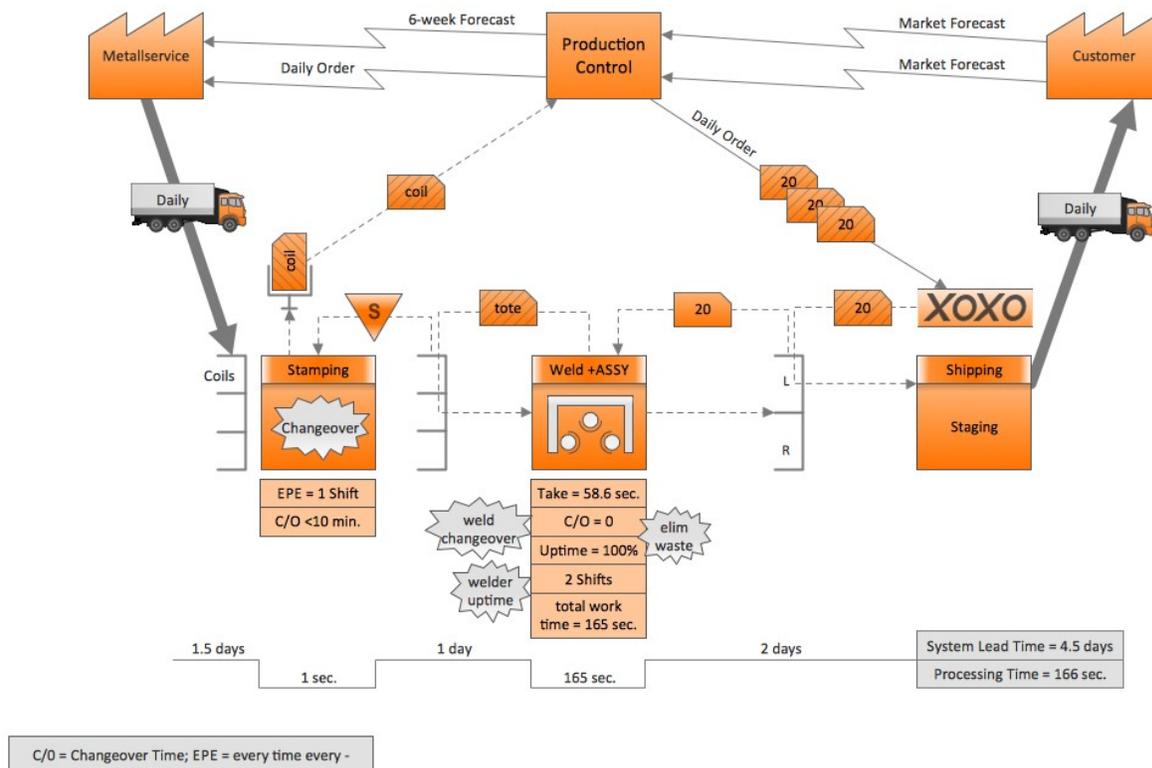


Figure 2. Figure of a current state VSM (Corp, 2017)

One goal is to demonstrate how implementing lean management is achievable. Other companies could implement lean management into their companies to reap the benefits. The overall goal of lean management is to combine “work processes and human relations that determines company's productivity and profitability” (Lipińska-Grobelny, 2012).

## Significance

This project will demonstrate how creating a thorough current state VSM in any company will help evaluate more effectively to improve or implement lean into it. Firstly, this is significant because it has shown in other projects how lean management has positive outcomes including increased profitability and efficiency. It is important for smaller companies to realize that lean is the current and future business paradigm.

This project is significant to Company R because this project is based on their company. They can use this data to further their continuous improvements. Company R can use this actual information to implement lean or at minimum find areas of inefficiencies to correct.

Lastly, researchers have studied the many different lean tools and different ways to reduce waste, also referred to as Muda, but they have not shown the costs of implementation or the projected profitability. This project will demonstrate how vital a VSM is to be evaluating, implementing, maintaining and improving lean tools/principles into a company.

## Assumptions

Assumptions includes:

- 1) The project facilitator will have access to information regarding material pricings, employee wages, and scrap cost.
- 2) Employees will be able to speak freely about potential changes in the company.

3) All information that the project facilitator receives is factual from supervisors without documented proof, if documented proof is proprietary.

4) The researcher would determine what the customer desires and would be correct in that determination.

### Limitations

The limitations of this project include:

- 1) Outcomes are limited to the creation of Future Value Stream Maps.
- 2) Results are specific to one company.

The limitations of this project are the outcomes. Lean tools do not show immediate results, it's a process of continually improving. Lean can take many years to implement but because continuous improvement is such a large factor, lean is never fully achieved. The focus will be on the creation and evaluation of a single lean tool, VSM both current and future.

Results are new because they are specific. The ideas and the steps will be translatable but the results will be specific to a company. Although, the goal is to validate the benefits of a VSM, implementing lean as a whole into the company will result in positive benefits. This project is directly related to one specific company. The implementation of lean management into other companies will have different variables, obstacles and outcomes. This project will analyze the company, and gather all relevant data. The project facilitator will then create a current state VSM. The non-value adding processes will be visible and tools will be implemented to reduce them in a future state

VSM. All companies will have different areas of non-value adding processes, thus different tools to help reduce their area for wastefulness.

### Delimitations

The delimitations of this project include:

- 1) One specific company
- 2) Small non diverse sample size (same race, ages between 30-50 years old)

There are specific parameters for this project including one specific company. Company R has a non-diverse population of the same ethnicity, relative age group (30-50 year-olds) and only supplies one customer. Therefore, their demands are different from a company that has hundreds of customers.

As part of this project, the project facilitator will deliver closed-ended questionnaires for the employees to answer on a scale. The project facilitator cannot suggest any incentive or offer a negative consequence to reinforce the employees complete the questionnaires.

### Definition of Terms

*First in First out*-A system for keeping track of the order in which information or materials are to be processed. The goal of FIFO is to prevent earlier orders from being delayed in favor of newer orders which would result in increased lead time and unhappy customers regarding the earlier orders (Throughput Solutions).

*Just-in-time* (JIT)-A Lean Manufacturing process for synchronizing materials, operators,

and equipment such that all materials and people are where they need to be, when they need to be there, and in the state they need to be there in (Throughput Solutions).

*Heijunka*- “Leveling the type and quantity of production over a fixed period of time. This enables production to efficiently meet customer demands while avoiding batching and results in minimum inventories, capital costs, manpower, and production lead time through the whole value stream” (Friddle, n.d.).

*Kanban*- “a card containing a set of manufacturing specifications and requirements used to regulate the supply of components” (definitions.net).

*Kaizen*- “a business philosophy or system that is based on making positive changes on a regular basis, as to improve productivity” (Kaizen, 2016).

*Lean management*-A management system best characterized as relentlessly eliminating waste from all of its activities and operations (Throughput Solutions).

*Muda* *Muda* is a Japanese word meaning “futility uselessness idleness superfluity waste wastage wastefulness” (definitions.net).

*Mura*- A key concept in the Toyota Production System and means unevenness of work flow (Throughput Solutions).

*Poka-Yoke* -” A methodology of using low-cost techniques to error-proof production processes” (definitions.net).

*Productivity*-The scaled amount of benefit realized as derived from inputs.

## Chapter 2

### Introductions to Chapter 2

Chapter 2 will demonstrate the current literature on lean, different types of lean tools, and other companies that have had success in implementing lean using a VSM. Then, Company R will be evaluated including tool and die, welder's/assembler's area and shipping.

This chapter will review, in-depth, other scholar's views on lean tools, and why lean culture is important to the success of lean implementation. Also Chapter 2 will discuss the other types of leans tools and the results of a company that has successfully implemented lean.

### Literature Review

#### Lean tools

Toyota is essential in the advancement of lean tools. Toyota has become globally synonymous with Lean. They have developed a complete business model, also known as Toyota Production Systems, around lean tools and have become very successful in doing so. Therefore, Toyota will be referred to throughout this project.

Toyota revolutionized many traditional approaches including bringing suppliers closer to the plant to create a Just-In-Time (JIT) system. Supplies arrive just-in-time to the process to reduce the amount of floor space used for inventory. The JIT system saves money; Migliorator states "by receiving parts exactly when needed, a plant can slash inventory-holding costs" (Migliorato, 2012).

Holding inventory can be very expensive, henceforth reducing profits. Inventory costs include manpower, equipment, floor space, and a finished good that has not been sold. Although raw materials and manpower have already been paid for, the company has not received revenue from sales. Decreased shelf life is another negative impact of inventory. As a result, the consumer has less time to consume or use the product.

Toyota uses cross docking as a staple of their logistics. Cross docking is the concept of never having a truck empty. An empty truck is detrimental to profitability because trucks cost money to be on the road with expenses including fuel, maintenance and wages for the driver. This approach allows the same truck delivering products to one area, to receive another load for that same area or a nearby area. This dramatically reduces the shipping and receiving costs.

Toyota also specified seven different types of waste and found ways to help reduce each kind of waste. The seven types of waste include overproduction, delay, transporting, over-processing, inventory, motion and defective parts (Throughput Solutions). This project will implement different approaches to reducing these types of Muda, wastefulness, in the company. Waste cannot be reduced without understanding the different types.

Producing more products than there is a demand for is overproduction. This can be the result of a forecast in demand error or simple miscalculation. One solution to this type of Muda is taking proper calculations for forecasting. Also forecast should be reflected from demand and not sales, because sales fluctuate depending on promotions and current sales.

A delay refers to idle time. Idle time reflects the time a company has to pay for labor but no products are being made. This can result from malfunctioning equipment, machinery that is temporarily out of use, bottle-necking, or a lack of demand for product.

Transporting materials can be inefficient if the facility layout is not correct. If the facility layout is not connected through a continuous computer automated system, it will lead to a loss of profitability. If the processes are not interconnected, it would cost the company vehicle maintenance [semi-truck, fork truck, AGVS (automated guided vehicles), etc.], man power (if the vehicle was manually operated), and potential fault in vehicle causing bottle-necking and creating Mura. Mura is a Japanese term for uneven work flow and is a staple of the Toyota Production System type of wastes (Throughput Solutions, 2016).

Transportation cost will increase because of empty truck loads. The more a semi-truck can haul safely, the more efficient the truck will increase the transportation revenue. Decreasing the transportation costs is one reason cross docking was implemented by Toyota. Trucks need to be full and always moving to maximize productivity.

Over-processing is inefficient also but is different than over production. Over processing means the company or employee are doing more work than needed.

Inventory can be compared to the saying "money laying around". Inventory describes products that have been manufactured and are sitting in a warehouse waiting to be purchased. Inventory will be a result of over production, or a forecasting error. Also inventory must be continuously shuffled to get to certain products or to implement

the FIFO (first-in, first-out) method. The FIFO method ensures that the company sales the oldest product first.

Wasted motion causes inefficiencies in the employees and the machinery. A wasted motion implies that the employee is wasting motions/movements in creating a product, which causes the employee to tire down and become less efficient throughout the day. Wasted motion could include an employee using a screwdriver instead of a battery-powered drill (if applicable). They have wasted manual energy, when there is a device to do the same amount of work for less energy (Yerasi, 2011).

The final Toyota Production System type of waste is the making of defective parts. The parts cannot be sold because they do not meet the standard of the company or the customer. The product must then be scrapped, disregarded or reworked to create a viable product. One way that Toyota has helped reduce the amount of defective parts is through a sensor field. These sensors count how many times the employee's hand breaks the working field. If it's more than the average, the production line will stop, to inspect what the potential problem is.

#### Live Lean

Balle & Handlinger discuss why lean is not a fix all, quick implementation. Lean is a lifestyle and an implementation that heavily emphasizes continuous learning. Thus, lean is never fully implemented because there are always areas and technology allowing companies to become more lean (Balle & Handlinger, 2012).

Simon & Canacari states, "The core idea of Lean is to maximize value for customers while using fewer resources and minimizing waste" (Simon & Canacari, 2012). This article discusses the highlighted areas of lean including continuous

improvement, human development and respect for people. This article is directed on how to implement lean into a health-care facility, but very similar concept to this project.

Lean culture includes leadership, communication, empowerment and teamwork. Leadership is important to give direction but not micro-manage. It is important to empower employees to give them choices. Employees who are empowered have a greater sense of worth, meaning they feel they are more involved in the processes.

Communication is critical within the success and continuous improvement of lean. Communications and feedback aids in maintaining a high quality product while allowing individuals to have a voice. (Rubrich, 2015)

### Different Types of Lean Tools

Eroglu & Hofer's focuses on leans direct correlation to the amount of stock. Lean focuses on reducing Muda, and one form of wastefulness is inventory. Reducing inventory increases the amount of workspace. This article makes the statement that the outcome of less inventory is mixed between companies. According to their chart of multiple companies, all the companies have either not changed or have increased some aspect of their facility (i.e. overhead costs, plant layout, excess inventory cost) (Eroglu, & Hofer, 2011). The next tool possible to use is a VSM.

### VSM

VSM is a critical tool to not only to help implement lean but as a tool for continuous improvement. In 2008, Bob Nelson, the vice-president of purchasing for Honda, discussed how VSMs saved Honda money and is continually saving the company money. The VSM demonstrated how the company is losing freight space

using the current dock equipment. The company could not completely fill the boxes, therefore they purchased equipment to maximize their containers. This means the freight charges are the same but they are able to maximize the freight at capacity. (Winter, 2008)

The next success story is from a HEPA filter producer. The company was able to analyze that cleaning the glue gun creates a bottle neck. Therefore, the company put two employees on the task to promote heijunka. Additionally, operators were given miscellaneous task while waiting for changeover or waiting for the gun to heat to increase efficient use of their time (Aziz, Lina & Zulkifli, 2014).

A former graduate of Western Kentucky University, Kwasi Boateng, discussed the advantages of pollinating Cocoa trees to different areas of the world, Ghana in particular, to create shade for heat stricken areas that are famished of any shade (Boateng, S. K. 2011). He used a VSM to determine the gaps in time it takes to evaluate the pollination process of the Ghana trees. This is an example of a use of a VSM in a specific manner, much like this project. VSMS have a wide range of applications.

Value stream mapping is a visual aid that shows the flow of information and material throughout its process. VSM is a great tool but does not tract accumulation of costs. A more effective tool when discussing the overall costs is cost-time profiling. This is more financially driven but other resources are tracked such as man power as well (Riveria, 2007).

Lean Enterprise Institute is a training institution that has classes for tools in lean including value stream mapping, mixed-model value streams, continuous flow creating level pull, training, and policies. This company builds everything based on Value-stream

mapping. Value stream mapping creates a blueprint to implement other tools (Lean Enterprise, 2004).

Value stream mapping tools include process activity mapping, supply chain response matrix, production variety funnel, quality filter mapping, demand amplification mapping, decision point analysis, and physical structure and is very important to provide a baseline for the other tools. Value stream mapping can be created as simplistic or intrinsic as the company needs (Hines & Rich, 1997). The next tool to discuss is Kiazen, also known as continuous improvements.

The differences and similarities between kiazen and kiazen derivatives such as kiazen events (kaizen blitz, and quick kiazens) are implemented for different purposes. Lean is a mentality rather than tools put in place. Lean tools are docile without proper implementation and utilization. Lean is truly implemented when everyone shares the focus of continuous improvement. There is also a table that describes the benefits of Kiazen, kaizen events and traditional improvements. The main summary from this article is Kaizen involves having a serious commitment to continuous improvements (Manos, 2007).

In this section, inventory, VSMS and Kiazen have been discussed. Shipping can be an area of Muda if not evaluated properly. Blanchard wrote an article to discuss the importance of 3PLS in reducing transportation costs. Reducing costs is vital to reducing wasted money. 3PLS helps companies get their product to customers, in different quantities, efficiently without the company having to use unneeded resources to transport the product or find a company that will transport the product. 3PLS are plentiful and it is important for a company to do their research (Blanchard, 2009).

## What Can Be Achieved?

The utilization of lean was implemented after World War 2 in Japan. The Japanese companies were decimated financially. Therefore, they started to build with finances and quality in mind. The goal was to provide the customer with the highest quality product at the cheapest cost, by reducing waste in the product flow process. This article also gives different statistics that are pertinent to lean results. Defects reduced 20%, 80% reduction in floor space and 50% increase in quality. Then it goes on to discuss some of the tools including Kiazen, and Poka-Yoke (Pavnaskar, et. All, 2003).

Shahram Taj discusses a group of companies in the advanced manufacturing technology category that have implemented lean tools. They did not reach their overall goal, but the article changes that into a positive outlook for the future of the industry. This analysis goes in-depth in all of the areas of research such as maintenance, inventory, suppliers and quality. The main point in this article, there is always room for improvement whether you hit all of your marks or not (Taj, 2005).

Experiments regarding the positive effects of lean management into companies have demonstrated to be beneficial by increasing efficiency (Langstrand, 2012). But studies like this one only tell how beneficial lean can be. Langstrand describes different ways that lean can be positive and the benefits it can bring with it, but it does not specifically implement lean into a specific company.

The purpose is not to tell the readers that lean has positive benefits, but demonstrate how benefits are plausible even in a small company. But implementing lean is not a fly-by-night help, it is a gradually and continually business lifestyle (Barkley,

2005). William Barkely's project implements lean tools into a company. This project will evaluate a real company and improve their process.

### Literature Gaps

Most of the literature, as previously mentioned, include project evaluations consisting of lean tools, their importance and their outcomes. There are many different lean tools that can be implemented, but value stream mapping creates the foundation to implement other lean tools. While researching, many gaps were exposed.

One gap includes literature sources discussing lean in a broad example; but the purpose of this project will be implementing lean tools in a specific company. Their discussions are mostly hypothetical situations whereas this paper will consist of real life outcomes and implementations. Therefore, the project will be more in-depth and in a narrower field.

Another gap filled is the scope of implementation. The focus is a small company to implement a creation of a VSM, whereas the resources reviewed were in separate fields or more of a generic implementation. The scope is very narrow because it focuses on a small company who has begun implementing.

### Expectations

It is expected that some employees may be resistant to change but there will be an overall acceptance within the company to change for the better. Therefore, although people want to resist change, they want change for the better. It is expected that employees will see the benefits of lean, and it will be adopted top down.

## Company Evaluation

A challenging company will be evaluated will be referred to as Company R. This is a challenging task because this is a Japanese based company that only has one customer, Toyota. Toyota is the revolutionary mind behind the Lean Workplace. Company R has begun implementing lean tools but there are others that can be implemented and some that could be modified to be more efficient. This will demonstrate the importance of how the VSM will create a solid baseline, as well as be a critical factor in continuous improvement.

Company R is a company that has been in a rural area in Kentucky for less than a decade. They are a tier three supplier for other Toyota based companies. Some of the other Toyota factories they supply are located in Sumerset KY, Owensboro KY, Canada and Texas. They manufacture brackets and other miscellaneous small parts. The average employee makes \$9.75 an hour and their employee populations consist of 60% fulltime employees and 40% temporary employees to meet the demand of a fluctuating automotive market. They operate with a complete crew of about 40 people on first shift and 15-20 on second shift.

### Tool and Dye

The process starts with the order of metal from local steel mills, typically within a 2-hour drive. It is ordered one day in advance from when it is needed. The steel coils sit in a small coil field until they are needed. The operator on the machine has a list of priorities of what coil and dye to use on their machine next. They gather their materials. Once the machine is set up to run the dye, which takes about 15 minutes between dyes, they begin making their part. The dyes are punched through the sheet metal. This

produces minimal scrap which is ideal but the process of removing the scrap is time consuming. The scrap goes into a bin.

Safety is highly emphasized in this company. Every machine has a failsafe that eliminates any potential harm to employees. On the press, there are electric safety light barrier curtains. These electric curtains detect if something has crossed an area, and it will shut down the machine. Every machine has a light and a horn to notify someone immediately of their issues. This helps maintain kaizen.

#### Welders/Assemblers Area

The parts stamped are reduced to less than 50 different parts that have a specific area they go to all the time with correlating signs above them. This area consists of about 29 temporary employees and 11 full time employees, (the exact number is constantly fluctuating). There are 8 different lines that have direct types of welding equipment. Some weld nuts to pieces of metals and some weld small pieces of metal together. They make very small parts for Tier 2 suppliers of Toyota. The line lead observes the Kanban board and puts orders on each machine.

The line lead must follow an unchanging Kanban board that does not fluctuate with behind orders due to lack of raw materials.

The employee looks at the formula and gathers material and begins working. Each station has certain Poka-Yoke checkmarks. Certain parts are a piece of metal that gets welded to a nut. The part cannot go into a box until the nut is put in a hole that determines if the weld is good. If the weld is good, then a door opens to the tote and the employee slides it into the box. If it does not open, the employee puts it off to the

side and line lead inspects it. If the line lead deems it good it goes into the box if not, it goes to quality. A part cannot be double welded.

Company R only has one customer as previously mentioned and any part that is defective they get charged for it. Therefore, it important defects are obsolete, at least that is the goal.

### Shipping

Orders are arranged in dedicated slots, that are organized from shipping time due. Second shift pull the orders and first shift rechecks the orders. Their shelf life varies; it depends on humidity but rarely do they have a bad part that goes out rusted. It seems they could control the humidity more to prevent rust of parts entirely.

### Conclusion

The literature is written proof of success stories of implementing lean. Lean is culture that can be implemented using a wide range of flexible tools including Value Stream Mapping. Lean cannot be implemented properly without the breakdown of processes, information and material flow. If companies do not know they have a problem or they cannot determine their problem, then any implementations would not be successful. The issue or issues must be evaluated which is the strength of a VSM.

This study is to present the process of creating a current state VSM, evaluating the current state VSM and then creating a future VSM. The literature demonstrates several of these steps, but the goal is to combine these segregated portions of

literature. This would provide all the information to be present to allow a more comprehensible analysis of the implementation of lean using VSM as a critical tool.

Company R, the company being studied, will benefit from this study because it will help determine their areas of strengths as well as their areas that need attention.

The VSM will dissect the flow of information and material to evaluate those paths.

Company R will also have the future state VSM, which will not only show the solutions to potential problems but even the benefits from those implementations.

## Chapter 3

### Methodology

As mentioned in Chapter 1, the company that is being evaluated is Company R. This company is located in a rural area of Kentucky. Company R is a tier three supplier for Toyota, who is their only customer. The project facilitator will be given the opportunity to observe and ask questions. The project facilitator can give suggestions on implementations. This project has two objectives: 1) Creating a current VSM, followed by a future state VSM 2) Evaluating the Company's perspective of changes including implementation of lean.

The first section of methodology will discuss how Lean will be implemented into Company R using a VSM. The current state VSM is based off of actual results from different test that have been given. The future state VSM will be based off of educated expectations of processes and their results.

### VSM Process

#### Product Family

According to "The Lean Handbook" a VSM is divided into four processes: 1) Product family, 2) Current State VSM 3) Future state VSM 4) Establish and Implement a plan. (Manos & Vincent, 2012). The product family within this project will determine which areas within the facility share similar processes that share the same product or equipment. This includes information that is transferred within the company regarding similar process or products.

## Project Approach for Current State VSM

According to Mike Rother and John Shook, authors of “Learning to See”, a current state creation is comprised of:

- 1) Identifying the customer’s needs (removing non-value adding processes)
- 2) Walk through the facility of Company R with a pencil writing left to right on a paper of the visible processes. During this time takt time should be observed, areas of idle, and amount of items that are WIP
- 3) Correlate the flow of information and material in Company R
- 4) Analyze processing times including both value adding, and non-value adding time as well as times and areas of idle.
- 5) Comprise all of the data together in one diagram that encompasses all of the information and product flow on a time lime moving from left to right. (Roth & Shook, 2012).

All of the data will be obtained at the company’s facility. The project facilitator will spend several days observing the process from start to end. The project facilitator will follow the products from Shipping, Welders, Tool and Dye, Incoming and Purchasing. According to “Learning to See”, the process should initially be evaluated from the end of the process to the beginning of the process to understand what processes are “linked most directly to the customer” (Roth & Shook, 2012, p 21).

The project facilitator would assume the customer’s desires by talking with upper management. Upper management would discuss what their customer’s largest concern is and what they are doing to correct the issue. For the value stream map to be fully

successful, the VSM would be created around that value the customer desires. The value the customer desired would measure the success of the VSM.

The project facilitator will spend several hours in each area to determine product and information flow. The project facilitator will also work hand in hand with their team leaders, which is equivalent to most company's supervisors. By observing both manual workers and White-Collar workers, the project facilitator will be able to get a new perspective on how processes are running and how they are supposed to operate. This helps give the accurate data for a more accurate current state VSM.

The project facilitator will, as previously mentioned, will focus on quantifiable data. Quantifiable data will include, takt time, amount of employees, parts per day, and idle time. It is important to understand how often the company fails at meeting its demand. All demands fluctuate and how does the company adapt to that fluctuation.

A base line will be created through visual observations as well as quantitative data. Parts per day and idle time will be two key factors. Every day the tool and dye machines must manufacture a certain amount of items, then the operator changes out the dye. This helps reduce inventory but it increases the amount of idle time between dyes. The current state VSM analyzes all of the data and puts it into a diagram to help analyze the inefficiency of the process.

#### Project Approach for Future State VSM

Once the current state VSM is created, it will be thoroughly examined to find areas of improvements. The VMS will illustrate idles of product and information between departments. The areas of longer idle time will be evaluated to suggest improvements.

Each area of improvement will have a thorough plan how to change that process. Once a compilation of each individual process is completed, a future state VSM will be created depicting the potential changes and their benefits.

### Establish and Implement a Plan

Once a future state VSM is created a plan will be established and primed for implementation. The future state VSM will bring awareness of the changes that will be made to reduce non-value adding processes. A plan will be implemented on how to continually improve the process. Once a future state VSM is created and implemented, it will then become the current state VSM. The nature of lean is an abstract that can never be fully achieved but via continuous improvement companies become closer.

### Workplace Attitudes

This part of methodology will investigate the workplace attitudes in Company R.. Initially, to change the qualitative results from people's opinions to quantifiable data; it must be categorized with numerical data. The project facilitator will analyze collected data to attitudes towards implementing lean management. Therefore, a survey will be created online.

#### Survey Development

A closed-ended questions survey will be developed using Qualtrics software. [https://wku.co1.qualtrics.com/SE/?SID=SV\\_cw5lqqGr7YbmlBv](https://wku.co1.qualtrics.com/SE/?SID=SV_cw5lqqGr7YbmlBv). The survey will use Western Kentucky University's access to Qualtrics. Qualtrics is a program that deciphers data to translate it into descriptive statistics. The questions are written below

for easier accessibility. The survey instrument will be categorized into different areas including bio-descriptive questions including how long the individual has been with the work place and how they feel about their job pre-implementation.

The facilitator will have web addresses and hard copies available. All employees will be given the web address with hard copies available upon request.

How many years have you worked at this company?

Less than 2 years  3 to 5 years  More than 5 years

Are you male or female?

Male  Female  Prefer to not answer

What is your age group?

16-22  23-30  30-40  40+  Prefer to not answer

Highest Schooling Completed?

High school/GED  Some College/ Associates  Bachelors  Prefer to not answer

How many years in industrial work?

0-3  4-8  9+

Note: Answer all questions below using extremely negative through totally positive scale

Do you feel successful at your current position?

Do you believe there is area for improvement within your department?

Do you believe your daily output is equal to or better than others?

Do you have confidence that change in the workplace can be positive?

Do you believe that a large change is more beneficial than many small changes?

Is your position physically demanding?

You would be required to change over-frequently between different parts once lean was implemented to reduce inventory, do you think you have the capability to change between parts and tasks without issue?

Are you more apt to change if it requires less manual labor?

Is your position mentally demanding?

Do you understand Lean as it pertains to a manufacturing setting?

Is flow of material from area to area in the plant sufficient?

Is flow of information within the plant sufficient?

Are work instruction and operating procedures clear and understandable?

Are you pro-change, even if it requires additional training?

Are signs and floor pathways clear and delineated properly?

Are employees accepting of possible lean implementations?

Do you believe your direct supervisor is equipped with the skills to implement lean?

Are there enough ergonomic tools (i.e. air tools, power tools, lift assists) to achieve your work with minimal effort?

Do you believe you are worth more than you get paid?

Do you think your co-workers company-wide would be accepting of lean?

Do you think co-workers within your department are accepting of change?

Do you think your team lead and supervisors would accept lean?

Do you think reducing inventory, helps the company?

Do you think it would be beneficial to the customer reducing scrap?

The questionnaire will be approved by Western Kentucky University's Institutional Review Board (IRB) prior to data collection. Before beginning formal data collection, the questionnaire will be pre-tested to ensure that employees clearly understand the questions and response categories contained on the survey instrument.

### Data Analysis

The data will utilize a cross tabulation program, Qualtrics, as a tool to evaluate the perspectives of individuals and what group of individuals are more for the change or against the change. The challenge faced is the adoption of lean management. The objective is to increase credibility and perceptions to develop true statements about the lean implementation and testing them. The expected results are to show how reducing lead times, production costs, and inventory can greatly decrease a company's overhead, thus increasing profitability. Those savings could ultimately save the customer money and increase customer relations.

The project facilitator will use both descriptive and inferential statistics to analyze the data. The project facilitator will analyze data using different groups, such as age, and factory experience. A frequency distribution table will show categories such as age and group individuals (Brady, 2007). Descriptive statistics (mean and standard

deviation) will be calculated for each variable. T-tests will determine any significant difference in groups receptive to change versus groups non-receptive to change.

The project facilitator will also use the mean, median and mode to collect correlations within statistical groups. This survey not only evaluates the individual's acceptance to change but also exploits the subcategories of individuals who seem most resistant to change. Then a discussion will be given on how to increase employee perceptions. In the survey, a higher percentage may be resistant to change, but the majority of those individuals may be ignorant of lean and its benefits. Therefore, education may increase an individual's level of rejection to lean.

#### Anticipated Outcomes

The company will see the benefits of a VSM as it builds a solid foundation for Lean. It is anticipated the company will take this project seriously as it is a real life application to their processes within their company. The future VSM will suggest ways of improving, or at minimum, highlight areas of concern for bottle necking, information overload, work over load, delays, and more.

It is anticipated that this project will positively affect productivity, safety and efficiencies, by changing the morale within the company positively. It will empower more individuals within the company, provided an increase of self-awareness and value to the company.

## Chapter 4

### Findings

Utilizing Qualitrics quantified subjective questions and correlated employee's current attitudes with potential company strides towards a lean workplace. The general attitude with disregard of age, educations and experience stated their jobs were physically and mentally demanding while being underpaid. The general employee also felt that they would work towards change if it benefitted them such as increasing pay, increasing ergonomics and improving information flow throughout the plant.

Most employees in this sample believe there is room for improvement within the department, and they also believe their peers and supervision can accept lean. The culture is in their right mindset to accept lean and make sustainable improvements.

The original current state VSM is listed below.

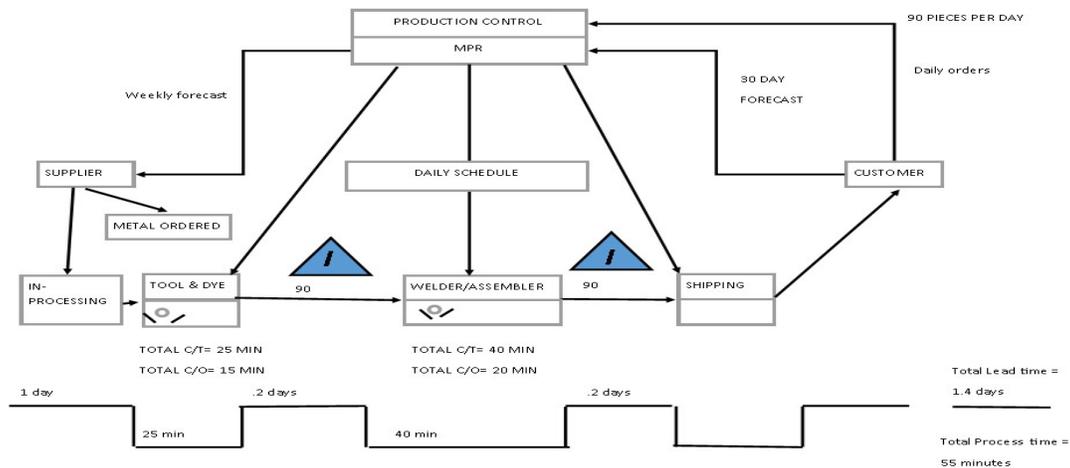


Figure 3. Current State VSM

Evaluating the current state VSM states that receiving raw material is a day process. The lead time is 90 minutes per department. These are two of the areas we

will focus on reducing lead times and non-value-added times to improve product throughput.

The processing time cannot be improved because each piece is stamped at a timed rate. That areas that can be improved include the non-value-added task like transportation, reorder points, more deliveries.

Receiving and reorder points should be evaluated twice a day. Currently they are evaluated once a day for steel/aluminum needed the next day. They could order the twice a day reducing floor space and being more reactive to customer needs and demands. This also increases flexibility to accommodate the customer.

Tool and Dye can reduce their non-value-added time by reducing handling of scrap. The dyes are created to reduce the amount of by product (scrap) but there is still production of scrap. The current process included employees taking smaller bins 4-6 times per shift taking approximately 10 minutes per trip to the semi-truck trailer and dumping the scrap into there. An underground conveyor belt would save each employee about 30-60 minutes per shift per employee in the department. The conveyor belt would run beside the machines directly into the semi-truck trailers already positioned.

Welders/Assemblers face the challenge of changing formulas. When an employee changes formulas they have to find the formula, which includes the bin location, the station they would be working and how many parts are required to fulfill that order. This happens about 2 times per shift with 15 minutes of downtime per changeover. During the day there are approximately 40 employees that work in this departments on up to 8 separate lines.

The best solution to this change over, wasting 20 hours per day per full day, would be to add a changeover person. This person would be responsible for setting up the next workstation for the individual. Therefore, people would not pick up formulas, they would pick up something that said their next work station.

One of the main drivers for the small batch sizes is the shelf life of their product. This is the greatest quality reject they receive and it is because the climate is not controlled and the finished goods are stationed beside the docking doors facing an excessive amount of outside elemental factors. The docking doors should have automatic doors that go up and down instead of always being open. They should also have air curtains to divert the outside factors from reaching the inside of the warehouse. Ideally, but improbably the finished goods should be temperature control to reduce the uncontrollable elemental factors.

With improvements in each department, the future state VSM could look like the figure below.

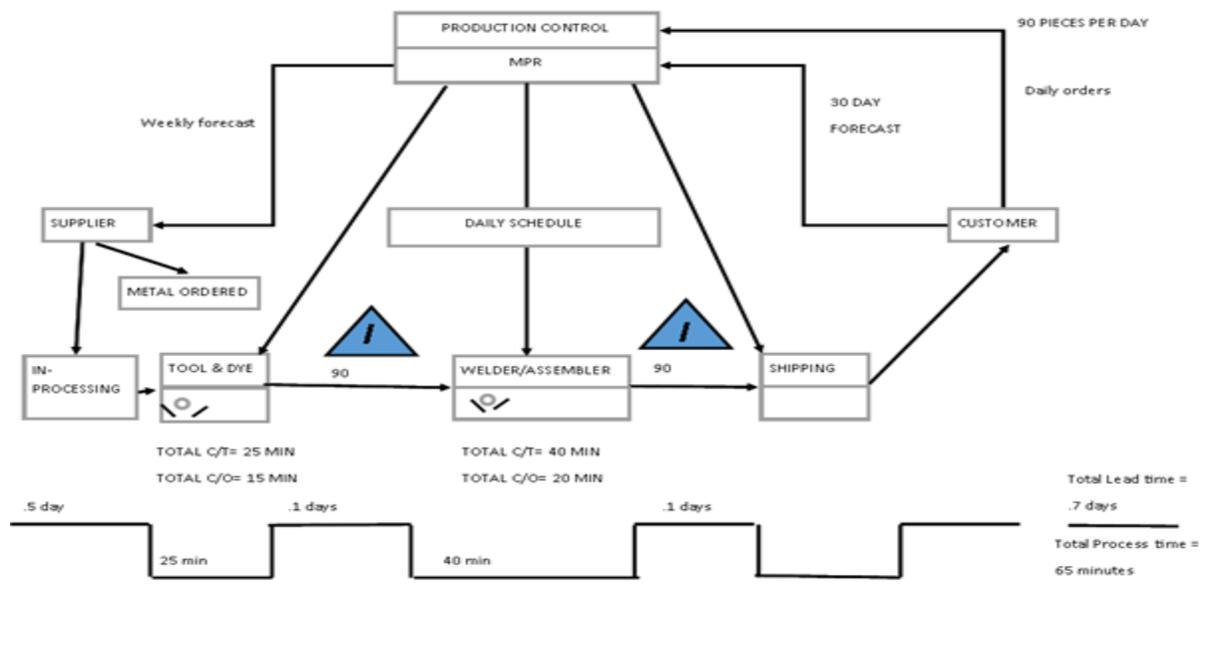


Figure 4. Future state VSM

## Conclusion

In conclusion, continuous improvements derive flaws in the current system and expose areas of improvements. This brief project has exposed many potential improvements yielding great improvements in production, reducing non-value-added tasks and improving quality.

Not only does the improvements show a clear enhancement to the process and the culture at Company R is at a prime position to capitalize on the culture it has created. Employees are hopeful for change and believe the company has the pieces to make lean an actualization at Company R.

These improvements on their own do not prove a company is lean. Once these improvements are made, another current state VSM must be created to be evaluate gaps. Then another future state VSM would be created. The process is cyclical because the idea of perfection is impossible but with each cycle the idea gets closer to reality.

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