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Continuous Improvement Beyond Manufacturing

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CONTINUOUS IMPROVEMENT BEYOND MANUFACTURING

By

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FIELD OF STUDY

PROJECT APPROVAL

I hereby recommend that the project prepared under my supervision by

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entitled _________Continuous Improvement Beyond Manufacturing______________, be

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__________Bachelor of Integrated Studies _____________.

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Abstract

This study examines Six Sigma, Lean, and Continuous Improvement systems in settings outside of it originating atmosphere of manufacturing; examples of these settings include healthcare, construction, and the utility industry. Enablers and inhibitors to successful implementation and sustainability are often challenging to identify for organizations during their infancy stages of continuous improvement. This study aims to clearly identify the enablers and inhibitors to optimize the process of utilizing continuous improvement in alternate industries. Methods used within this study include extensive literature review and interviews of individuals working within manufacturing, healthcare, and utility settings that have adopted and successfully implemented a culture of continuous improvement. Conclusions of the study include that when an organization properly identifies their strengths and weaknesses, capitalizes on the strengths and makes plans to minimize weakness, continuous improvement can be integrated into the culture of the organization. This culture of continuous improvement yields greater efficiency, improved quality, and a reduction in defects within the product or service being delivered to the consumer.

Keywords: continuous improvement, lean, six sigma, implementation

TABLE OF CONTENTS

LIST OF FIGURES

Continuous Improvement Beyond Manufacturing

Continuous improvement and lean systems have become a staple and standard in most manufacturing industries. These continuous improvement efforts stem from the goal of increasing productivity and quality of products being produced; there is a definite growing trend to strive for perfection through eliminating waste, defects, and reducing cycle time in the manufacturing world. Elimination or reduction of these things can lead to significant increases in production and quality, which lead to potentials for higher profits and decreased costs. The utilization of the tools associated with continuous improvement and lean systems, or lack thereof, can have a profound effect on the success of businesses in today's competitive markets. These tools have their roots in manufacturing dating back to Henry Ford's model of assembly lines and have continued to grow and adapt with changing technology and demands. Though these tools are utilized in manufacturing settings, their applicability reaches far beyond that environment. The success experienced by manufacturing companies through the utilization of these principles causes one to ask, how else could these lean and continuous improvement principles be used and in what environments?

This study examines the benefits and applicability of continuous improvement to industries outside of manufacturing. Many of the same tools, principles, and ideas used in production of a good can be applied to service type industries. For example, hospitals have begun using these tools in the admission, treatment, and care of patients. There are several deliverables that can be accomplished from the proper use of these lean systems, such as infection control, improved charting accuracy, and decreased time and errors in admitting or discharging a patient. If used correctly, these tools can be applied to almost any setting. Continuous improvement, including lean and six sigma, will be defined, alternate settings to utilize these tools will be identified, and the enablers and inhibitors for implementation will be identified. Finally, two case studies performed at a mid-size utility company in Evansville, Indiana will be examined for success and potential opportunities for improvement.

Defining Continuous Improvement

The American Society for Quality (2017) defines continuous improvement as the ongoing improvement of products, services, or processes through incremental and breakthrough improvements. Continuous improvement has taken on a systematic approach to improvement by utilizing tools, such as the Deming Cycle, which causes an organization to "Plan, Do, Check, and Act" in regards to proposed changes to further the success of the organization (American Society for Quality, 2017). Continuous improvement can also include lean principles including the 5 S methodology and six sigma which includes the DMAIC system. Through statistical support for the changes implemented during a continuous improvement project, a culture that accepts change can be adopted within an organization and evaluating the need and effects of change soon become a way of life for the organization. The importance of the acceptance of this culture on all levels of personnel is discussed later in the study.

History of Continuous Improvement

When one thinks of the history of continuous improvement, it is easy to think about its rapid growth and popularity seen in the last couple of decades and fail to give credit to some of the earliest examples of continuous improvement efforts. As Burton (2014) identifies, continuous improvement and lean principles can be dated back to as far as 1780 with the Industrial Revolution I and has continued through today. Some even argue that you can find documentation of continuous improvement efforts in the creation of Egyptian structures, such as the magnificent pyramids that were constructed. *Figure 1* shows the evolution of lean and continuous improvement through four phases: engineering improvement, scientific improvement, program-based improvement, and adaptive, systematic management process (Burton, 2014).

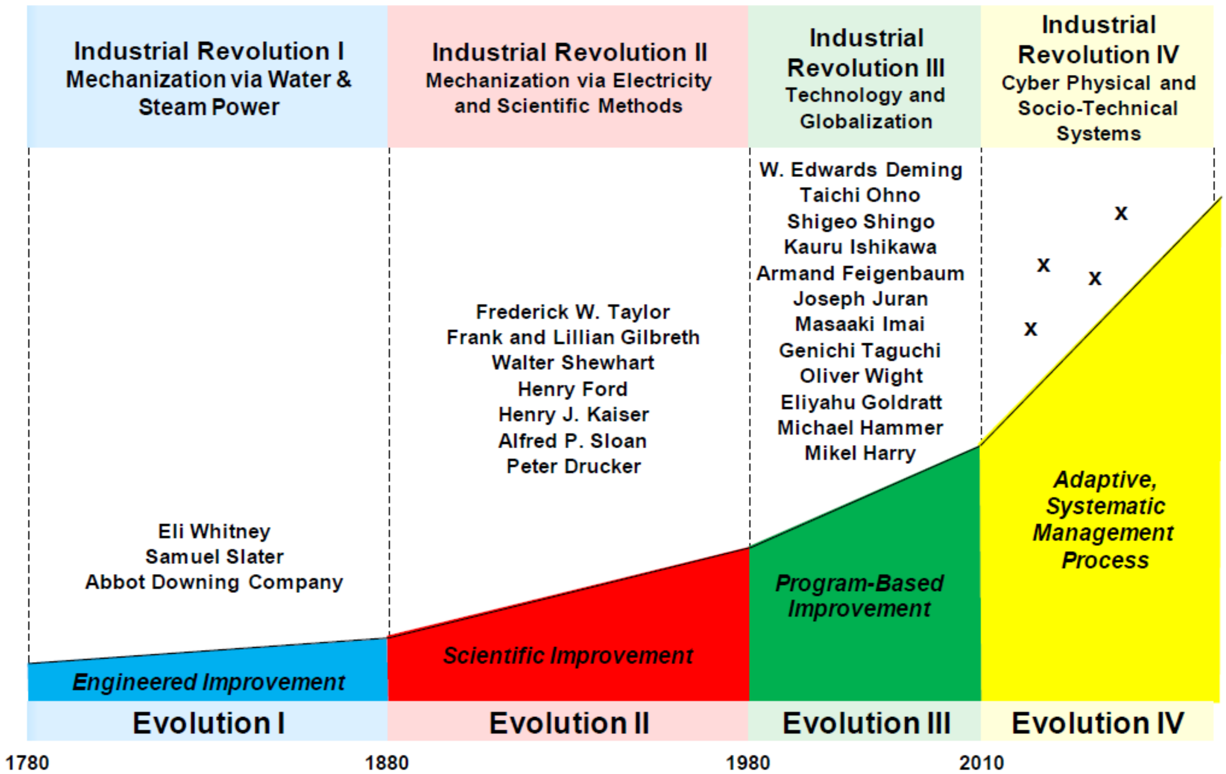

Figure 1. The Generations of Improvement. Adapted from "A history of lean and continuous improvement", by T. Burton, 2014. Retrieved from http://ceobreakthrough.com/wp2016/wp-content/uploads/2015/03/A-History-of-Lean-and-Continuous-Improvement.pdf

Figure 1 identifies some of the great contributors to the youth of continuous improvement. Eli Whitney is credited with the creation of the cotton gin in 1793. This is an example of a continuous improvement effort due the fact that it was created in order to improve the efficiency of removing the cotton that was being picked by hand from its seeds.

While it is important to recognize the evolution of continuous improvement methods throughout early history, this study will focus exclusively on some of the more recent evolutions of process and data based continuous improvement initiatives, beginning in the manufacturing setting. To do this, it is important to mention the involvement of two large manufacturing companies, Ford and Toyota, and the more recent integration into the rapid growing healthcare field.

Ford

Henry Ford had many ideas related to standardization that still hold true today in continuous improvement principles. Interestingly, in an article published in 1986, Dr. Robert Hall quotes Henry Ford stating, “To standardize a method is to choose out of many methods the best one and use it. Standardization means nothing unless it means standardizing upward.” Hall states that this quote dates back 60 years prior to the publishing of the article and that many of Ford’s ideas were the foundation for the ‘just in time’ production method (1986). Ford’s views on standardization of methods still hold true today and are emphasized through all continuous improvement methodologies. It was also Ford’s production lines that were the earliest inspiration for the Toyota Production System that is so famously known for continuous improvement and lean principles (Keller, 2006). Ford had successfully implemented a continuous-flow process with demand pull on the Model T production line; this worked well for Ford Motor Company’s high volume/low mix model and caught the eye of Toyota’s Taiichi Ohno during his visit to a Ford production plant, thus the seeds were planted for Toyota to develop their own model (Keller, 2006).

Toyota

Toyota is the manufacturing setting that is thought of most frequently when speaking of continuous improvement. The Toyota Production System originated with the trial and error efforts of Toyota's second president, Kiichiro Toyoda's "Just in Time" philosophy (Toyota, 2017). The "Just in Time" method developed as an attempt to eliminate waste in the production lines of Toyota; this method ensures efficiency and involves making what is needed, when it is needed, and only in the amount that it is needed (Toyota, 2017). Kiichiro identified four types of waste that were detrimental to Toyota's success: excessive production resources, overproduction, excessive inventory, and unnecessary capital investment. As explained by Monden (2012), excessive production resources could be found in the form of excessive workforce, facilities, or inventory. By having this excessive supply of resources the company would only see an increase in cost, not an increase in value (the definition of "waste"). The second and third types of waste identified by Kiichiro go hand in hand; overproduction causes excessive inventory and was identified as Toyota's most detrimental waste. Finally, the existence of excessive inventory causes the need for unnecessary capital investment. This capital investment is usually seen in the form of a need for additional space to store the inventory, a workforce devoted to the transport and upkeep of the inventory, equipment to move and store the inventory, etc. (Monden, 2012). *Figure 2* shows the two potential routes of either eliminating or allowing the existence of waste and the impact it has on the cost of production.

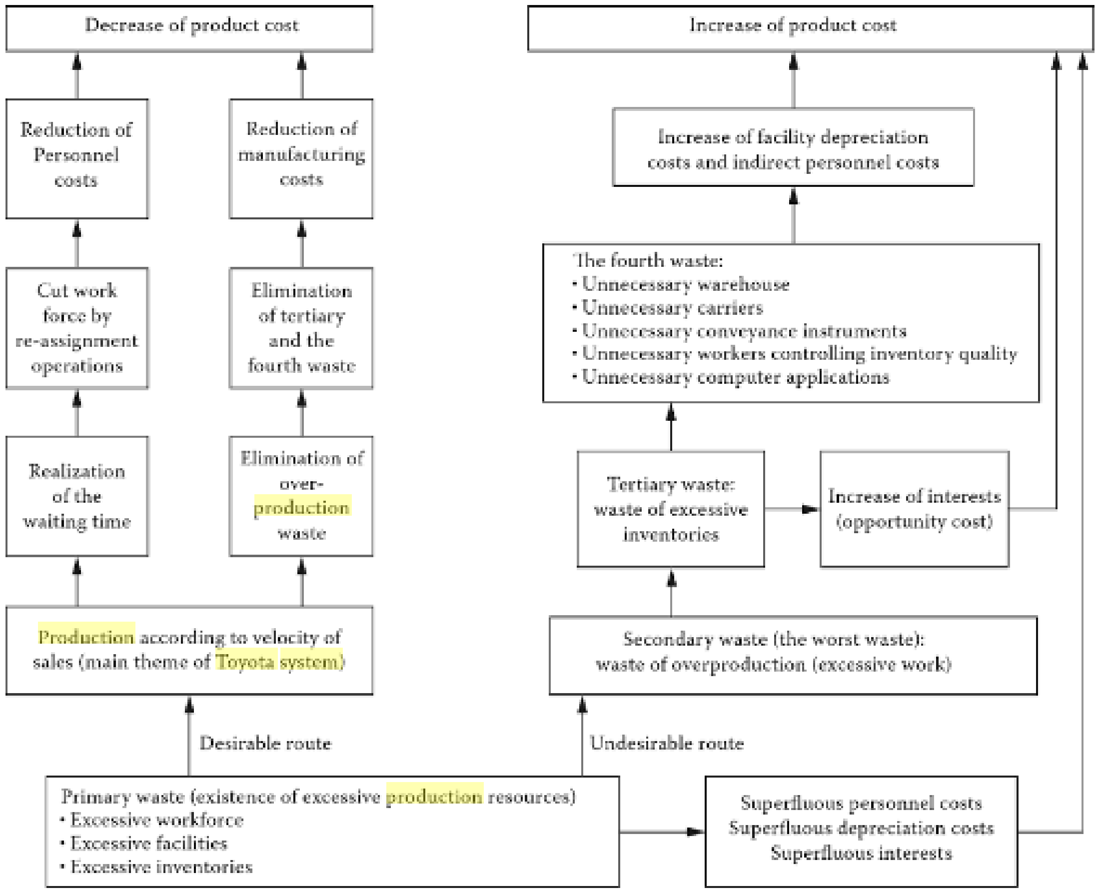

Figure 2. Process of Waste Elimination for Cost Reduction. Adapted from "Toyota Production System: an integrated approach to just-in-time", by Y. Monden, 2012.

The improvement principles developed by Kiichiro continued through the following presidents and continues with the current president of Toyota, Akio Toyoda, and have found their way into other types of industries.

Healthcare

In the last decade there has been a large initiative in healthcare to increase quality of care while decreasing overall costs; this can be widely contributed to the changes set forth by the Centers for Medicare and Medicaid Services that decreased reimbursement for facilities unless they performed at a certain quality level for under a certain cost. In order to stay afloat, healthcare organizations have turned to Toyota's continuous improvement and lean principles in order to define opportunities for cost savings, coupled with higher quality and patient outcome, implementing proposed changes, and evaluating their effectiveness (Toussaint & Berry, 2013). Collins, Muthusamy, and Carr (2015) provide us with a case study that highlights a healthcare organization, Heartland Regional Medical Center, in their journey to implementing a continuous improvement culture. While HRMC was able to successfully implement this new culture and improve quality and reimbursement, the organization experienced very similar hurdles to those of other industries that will be discussed later in the study.

Waste Identification and Elimination

Waste is a term used to identify parts of a process that do not add any value to the desired result, therefore adding waste in the form of additional time to reach a goal or excessive resources and costs along the way. One aspect of continuous improvement involves the identification of waste in processes or production and the elimination of this waste in order to become more efficient. Lean principles focus on this removal of waste; within lean there are a number of evaluation tools for waste that can be utilized to identify and remove waste, create a new way of doing things or improve upon what is already in place, and sustain the new process sans waste.

Lean

Originating within Toyota Motor Corporation, lean is a process that focusses on continuous improvement through the elimination of non-value added steps, also known as "waste." The focus of lean lies in the assessment of a process, improving said process, and then monitoring the progress of sustaining the new process and its success. As lean was refined by Toyota, five sequential steps were developed and termed 5S: sort, set in order, sweep, standardize, and sustain. These five steps are used during the improvement phase of lean and allow the waste to be identified and removed; a new way of doing things is then set in place, standardized for all performing that process, and then monitored for sustainability. In addition to these five steps, rapid improvement initiatives can also be held over a three to five day span to improve a process; these are known as kaizens. During a kaizen the staff members that are most knowledgeable of the process are responsible for defining and redefining the process in order to create a more lean process.

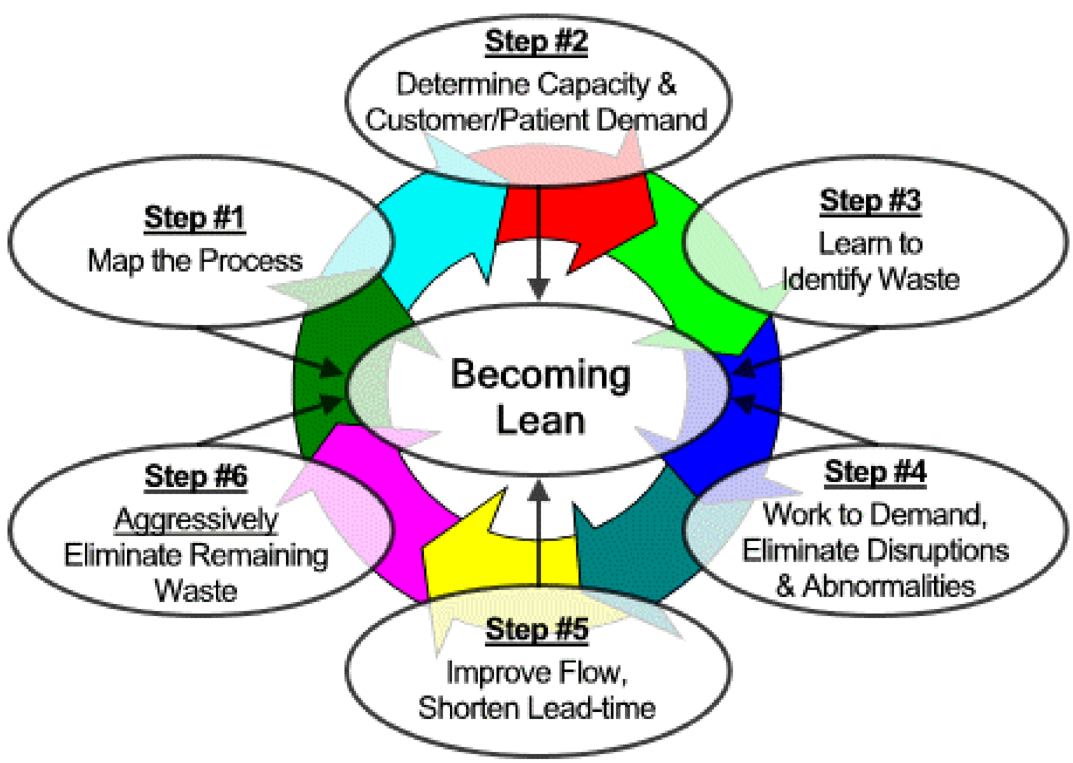

Figure 3. Steps to Becoming Lean. Adapted from http://livelighter.org/the-lean-philosophy-in-healthcare/

7 Deadly Wastes

One of Toyota's chief engineers, Taiichi Ohno, expanded the wastes in production from the initially identified four wastes to seven wastes. These wastes are taught as a part of lean principles. The seven deadly wastes identified and described below were adapted from "The Seven Wastes in Manufacturing" by D. McBride (2003).

Transportation. Transportation of products between steps of production increases cost, workforce needed, and time. All of the transportation between processes is considered as non-value added, therefore making it a waste. Since transportation between processes is needed to a certain extent, mapping process flows is the most effective strategy to identify is there is excessive transportation between steps of the production process.

Inventory. As earlier discussed, excessive inventory is a very costly waste. Excessive inventory results in increased lead time, consumes space for storing the inventory, and makes it more difficult to identify defects or issues with the product. This excessive inventory will also result in unnecessary capital investments to accommodate for this inventory. By utilizing the just-in-time lean methodology and creating seamless workflows, excessive inventory can be avoided.

Motion. This waste is related directly to the motion of the workers participating in the production process. Excessive motion is seen in the forms of excessive bending, stretching, walking, lifting, and reaching by the workers during the line of production. Jobs on the production line that are identified as having excessive motion should be redesigned to be more ergonomically correct and will impact the health of the workers involved.

Wait Time. When products are not being moved or processed, wait time is the result. Wait time is the time spent while waiting for the next step of the production process and can be reduced by ensuring that each process of production feeds into the next and reduces "bottlenecking" during production.

Overproduction. The manufacturing of products before they are actually needed is known as "overproduction". The just-in-time methodology decreases the incidence of overproduction by not producing the product until it is actually needed. Overproduction results in increased lead times, high storage costs, and decreases the probability of identifying defects.

Over Processing. When one looks at the production lines of Toyota, they will find that often there is older, yet well maintained, equipment that is still being utilized; this is because over processing is a waste that involves the use of excessive processing equipment to complete a job. This over processing may be seen in the form of the use of expensive or excessive equipment in the production process when a simpler form could be utilized. This waste can be eliminating by using smaller, simpler equipment and combining steps in the production process.

Defects. This waste has a direct correlation with the bottom line for the company. Not only do excessive defects decrease the quality and reputation of the company, but the cost of reworking the product and the loss of the inventory increase costs for the company as well. Decreasing other forms of waste makes it easier to identify defects and where in the process they are occurring.

Push vs. Pull

Another phrase that describes the "just-in-time" methodology is known as "push vs. pull". To push a product is to have the product ready in anticipation of the customer buying it; the opposite of this is known as pull and is the process of manufacturing the product in response to the customer's request. McDonald's is a franchise that transitioned from the push to pull method and have seen large amounts of success and decreased waste as a result.

McDonald's. There are many lean principles that can be seen when examining the McDonald's franchise, however it has not always been this way. At one point in time, McDonald's operated on a push system. This push system entailed having sandwiches prepared in advance of a customer's order. These sandwiches would sit in the window under a warmer and would be packaged when a customer ordered them. The thought process was that this would provide faster service times for the customer. While the goal of speed may have been met, unfortunately a much bigger goal of quality was being sacrificed. Customers would complain of sandwiches that were either near-cold or had a taste that they were hours old. As a result, McDonald's transitioned to a pull system in response to customer orders. While the buns and patties may be available and partially prepared in advance, the sandwiches are not assembled and dressed until the customer places the order for the sandwich. A second lean principle that can be seen in McDonalds is that of standardization; every store in the McDonald's franchise is set up identical to one another. This means that any employee can go into a McDonald's kitchen and transition smoothly. Having supplies in the same spot every time helps ensure that the goal of speed and efficiency is met.

Boeing. Sally Mounts (2012) discusses some of the numerous innovations that Boeing has implemented in an attempt to cut time off of the production of aircrafts. Boeing is credited with decreasing the production time on their behemoth 777 from 71 days down to only 37 days. In addition to this speed advancement, Boeing also decreased the production time of their 737 model from an initial 20 days to 11 days. Many ask how a company that manufactures such large products could possible decrease their production times by such drastic amounts. The answer is thinking outside of the box and embracing a continuous improvement culture (Mounts, 2012). Boeing owes much of their advancement to continuous improvement teams, such as the "Moonshine Shop". This team got their name because they were known for having many of their gatherings at late hours, under the moonlight. This team of engineers first tackled the issue of seat installation on the 757 assembly line. With the current setup the heavy seats were mounted on wheels, lifted up to the plane with a plane, and the wheels were then taken back off after wheeling into the plane. Start to finish of the seat installation in this 757 model plane took approximately 12 hours. The team of engineers wanted to decrease the time that it took to install these seats and also do away with the use of the cranes that were a part of the current assembly line. Their initial ideas included developing some sort of conveyor system to transport the seats up the door of the plane. The idea of the conveyor system prompted the Moonshine Shop to first study Ferris wheels, ski lifts, and automated roofing carriers. While these types of conveyor systems were close, they did not achieve the goal that the Boeing team was pursuing. Finally one of the engineers suggested studying hay loaders. This system ended up working for the 757 assembly line and resulted in a reduction from 12 hours to install seats to two hours. Another example of Boeing ingenuity is the development of wheel covers in order to protect the wheels on the assembly lines from being punctured by metal pieces scattered throughout the production line. One engineer remembered seeing motorcycle wheels that were covered by canvas wheel casings; he adapted this idea for the aircraft wheels and ended up saving Boeing $250,000 per year at one plant alone (Mounts, 2012).

The above examples of Boeing successes in continuous improvement show the importance of a questioning attitude, thinking outside of the box, and the willingness to try new things in an attempt to improve a process. Boeing embraced a culture of continuous improvement and used everyday innovations as inspiration for their assembly lines and how to improve them; this cut time and costs, and improved overall efficiency of the workers within the plants.

‘5 S’ Process

In order to make processes or work atmospheres more lean, many times individuals are directed toward the “5 S” process. 5 S is an organization process that assesses for extra steps, extra work, or clutter in the workspace or process; by removing this waste, the workplace can become more efficient and create higher quality outcomes at a lower cost or workload. The 5 S’s are described below. Note that they are meant to follow in the order that they are presented.

Sort. The first S stands for sort. This step of the lean process is to identify what is regularly needed within the workspace or process and what is an unnecessary extra. Employees are charged with the task of identifying how often they use items in their immediate workspace. For example, if the goal was to 5 S an office space, that employee would assess how frequently they use items around them. High-use items, such as staplers, pens, tape, a keyboard, etc. would be identified; low-use items will also be identified. Has it been greater than a month since the employee has used certain files that are located in the desk drawer closest to them?

Set in order. Continuing with the example of using 5 S in an office space, now that high and low-use items have been identified, all items should be given a place. For example, a stapler should be in close proximity to the user. By keeping things close that are used frequently it eliminates unnecessary motion by the worker. Things that are now used often should be placed at a greater distance and utilized when needed. If a file is only pulled out of a desk drawer monthly or quarterly, it is probably not appropriate to take up space in the closest drawer to the employee. The worker may also find that there are items that are only used annually. Things such as this may need to actually be placed into an alternate storage area and accessed once a year when needed. The other part of "set in order" includes naming a specific space for each thing. This means labeling a place on the desk that designates where the stapler will be placed each time. By setting the same place for items, it takes much of the thought out of accessing these items for the worker since it is in the same place each time it is needed.

Sweep. The third S stands for sweep, or is also sometimes known as "shine". This step involves cleaning of the workspace. Standards for cleanliness are set forth for workers and the cleaning or "sweeping" phase has two objectives. The first objective of the third S is to physically clean the space that is undergoing the lean 5 S process. The second objective is to take the opportunity to inspect equipment in the workspace while cleaning it. This gives the work the opportunity to identify equipment that may need addressing prior to developing a bigger problem in its function. This is a good time to perform preventative maintenance measures to ensure functionality rather than have something go wrong while the item is actually in use.

Standardize. Standardize is an important step in making sure that all workspaces function in the same manner, making it easy to rotate workers in and out as needed without impeding their workflow, quality of work, or efficiency. For the example of the work area in an office, an organization that is truly serious about standardizing work spaces would assess the most optimal placement of office supplies and set each work space up in the same, standardized way. This means that if the telephone sits to the left of the computer screen and that the tape and stapler sit to the right of the computer screen, each work area would be identical. Hypothetically, if a person calls in ill to work and is replaced with another worker for the day, they will be able to locate everything that they need to perform that job with ease and minimal motion. For production lines, such as those at Toyota, standardizing the work area is much easier than standardizing offices as a big organization; this is due to each person having their own personal workspace that would cater to their roles and responsibilities and would differ between each person. In a production line, however, workers are often switched in and out to accommodate for staffing changes, breaks, and reassignment of duties. By making each space of the production line standardized, the worker will be able to function at full capacity much quicker and without increased anxiety, thus maintaining quality of production, increasing satisfaction of the worker, and preventing increased time that is needed to perform the job.

Sustain. The fifth and final S in the process stands for "sustain". This step involves the processes that will be set forth in order to ensure that the work put forward will continue. Chapman (2005) identifies involvement on all levels of the organization as key to the success of the sustain step. It is important that regular inspections and audits of the area and processes are performed. This will identify if a process is continued to be followed and if it is working well for those involved. By doing periodic audits of the things set in place, opportunities for improvement can be identified and changes made in order to continue the optimization of the workspace. It is also important that there are process "owners" that will be accountable for the sustainment of the 5 S. By identifying who will play an active role in this step it places ownership and accountability on a person and increases the likelihood of sustain being successful.

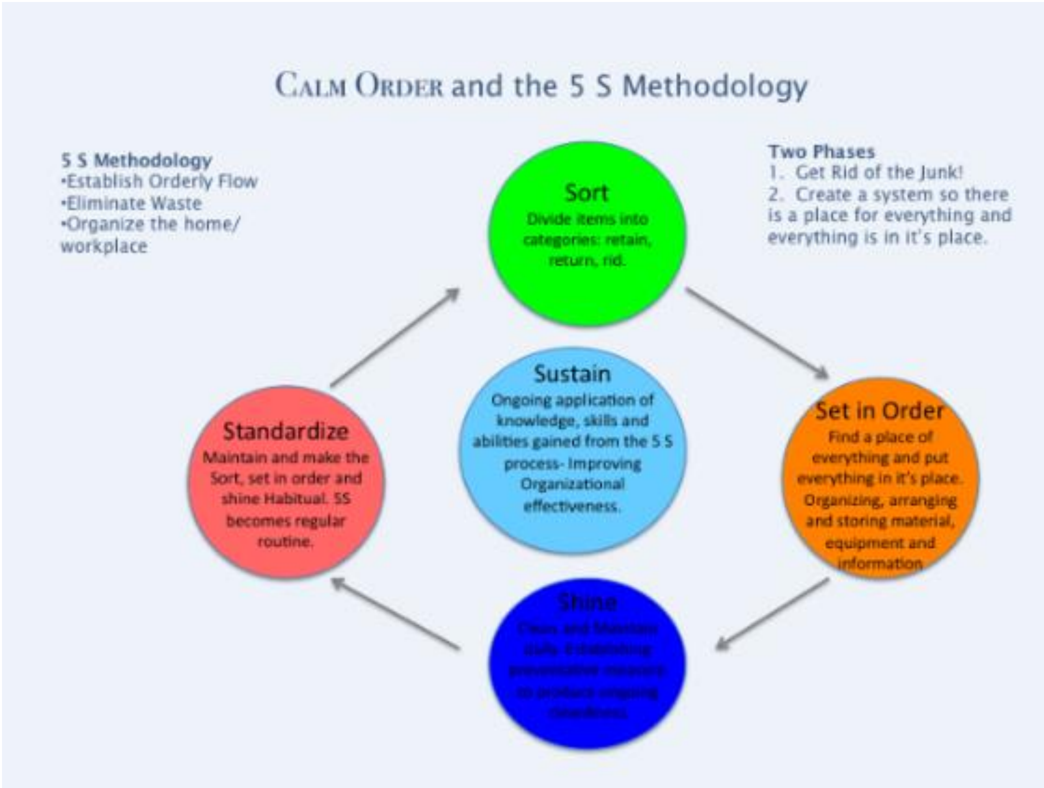

Figure 4. 5 S Methodology. Adapted from https://calmorder.com/5s-methodology/

Six Sigma

Six Sigma is a methodology that strives to decrease the occurrence of defects found within a process or product; a defect is defined as anything that is outside of what the customer expected to receive. In order to achieve “six sigma” the manufacturer must product a defect less than 3.4 per one million products. Businesses have started utilizing six sigma black belts to help lead six sigma initiatives to improve processes. Black belts are specially trained to use tools, such as the DMAIC system, to improve processes and decrease defects within the manufacturing of products (American Society for Quality, 2017).

The DMAIC system is a tool that is often used to outline the process for identifying and eliminating problems within a process that creates product defects or decreases efficiency.

DMAIC stands for "define measure, analyze, improve, and control". Much like the 5 S process, the DMAIC system is followed in a certain order in order to product optimal results and then begin the process over again if needed.

Define

The DMAIC process begins by defining the issue at hand and what the desired outcome would be. Identifying this problem would be the responsibility of the champion overseeing the six sigma project, such as a black belt. There are focus teams established to help throughout the DMAIC process; a good majority of this focus team should consist of subject matter experts or of those that are at least familiar with the current process and what the desired outcome is. For the purposes of this study an example that will be followed through the description of the DMAIC system would be that a company identifies that they have had an increase in their employee injuries on a certain assembly line and wish to identify the cause and decrease the occurrence through implementing change.

After the problem is identified, this is also the part of the process where the champion would create a project charter. A project charter is a living document that will be updated throughout the course of the six sigma project and outlines everything that has been done through that point. The project charter will include important pieces of information such as the problem statement, goal statement, project scope, and cost of poor quality (Carpenter Group, 2014).

Measure

Next in the process is to measure. This step includes measuring the current process performance only and does not place any emphasis on the desired outcome. For the example listed above, the black belt would observe the current process on the assembly line and document the findings.

During this step of the process it is important that the champion and focus team understand exactly how the current process works. Without thorough understanding of how things currently work it would prove challenging to make recommendations for improvement of the process. In order to document the current process and keep track of the findings the team will create a process map. Two steps that are essential in the creation of a process map is to draw the process map exactly as it exists in its current state and to have each member to the team walk the process map to validate its accuracy. This process map is a valuable visual tool that allows the champion and team to also identify areas that allow for bottlenecking, non-value added steps, and other inefficiencies or waste (Carpenter Group, 2014).

Analyze

The third step in the DMAIC system is to “analyze”. This step challenges the black belt to analyze what could be contributing to the production of defects or the issue that we wish to resolve. There are numerous tools that can be used in order to analyze where the problem may be in a process. Tools such as brainstorming or a fish bone diagram are useful when exploring potential issues or causes within the process. *Figure 5* shows what a fishbone diagram looks like. Using the example of the high number of employee injuries, it may be that the black belt notes that the majority of the injuries sustained on this assembly line consist of lower back injuries. This assembly line causes workers to bend over and retrieve heavy parts from a box that is placed on the floor. The worker must then stand back up and mount this heavy part onto the product that is being assembled. This bending motion takes place for each product that comes down the assembly line. The average amount of time between products arriving in front of a worker is 4 minutes. It can then be calculated that a worker would need to make this bending motion 105 times throughout the course of an eight hour work day, minus a 30 minute lunch and two 15 minute breaks.

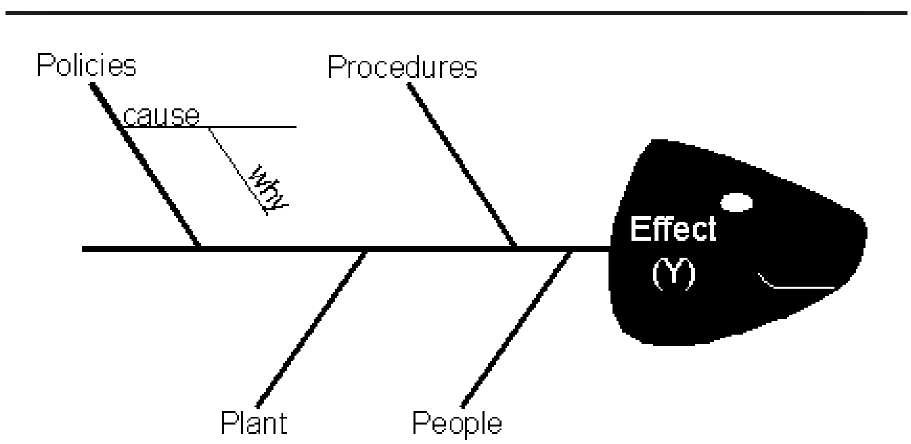

Figure 5. Fishbone Diagram.

Improve

The fourth step of the DMAIC system is to improve the process that has been analyzed. Both the champion and the focus team spend time coming up with a laundry list of potential solutions. This is where it becomes apparent that it is important to include individuals on the focus team that participate directly in the process that is being improve; their insight on what works well and what would not can be of great value when choosing which solutions would be best to attempt to implement. Once the team completes their list of potential solutions, it is important that the team has set a specific set of criteria that are important when choosing the solution to implement. Each proposed solution would then be weighed against these predetermined criteria to see if it would in fact meet all of the criteria set forth. The black belt may choose to have this box of heavy parts placed on a cart beside the worker. By placing the heavy parts at waist height it eliminates the need for the bending motion and allows the employee to transfer the part to the assembly line by lifting the part from waste height. It is important that after the solution is chosen, a future process map be created. This future process map shows what the team intends for the process to look like after implementing the change; it also allows the focus team to walk the new process and determine if it was followed accurately during implementation (Carpenter Group, 2014). This proposed solution would be implemented for a determined amount of time and then the number of employee injuries would be recorded and compared to the numbers prior to the change being implemented.

Control

Finally, if the change that the black belt proposed resulted in a positive outcome, the change would be implemented as a permanent change in the assembly line and the final step of the DMAIC system is to control the improved process and ensure that it continues and does not revert back to the previous process (American Society for Quality, 2017). There should be a process owner that helps ensure that this process does not revert back.

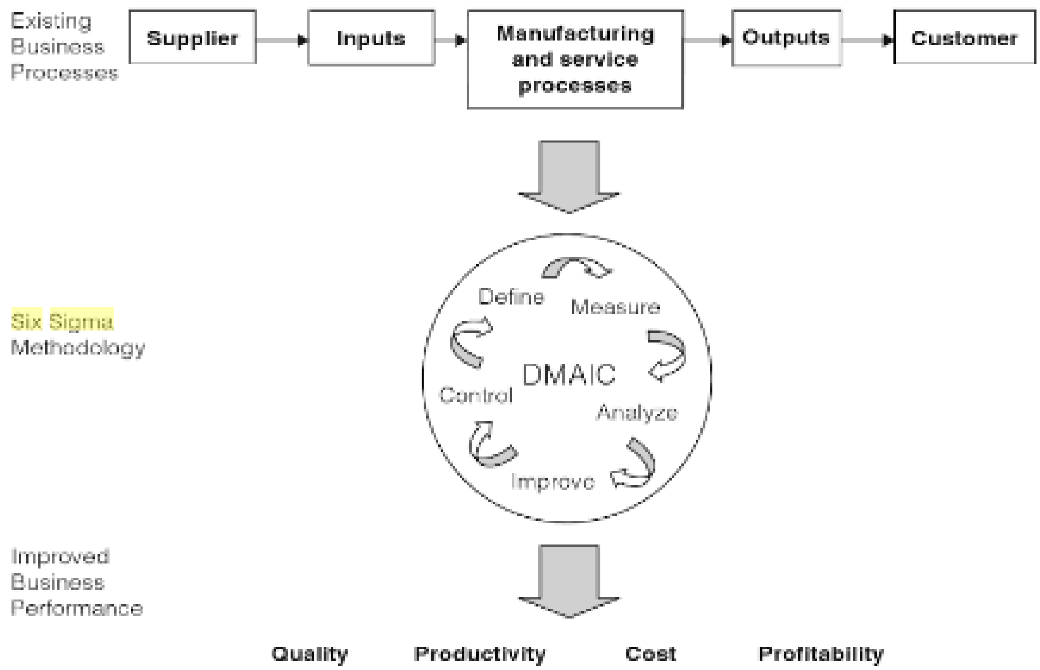

Figure 6. Six Sigma Methodology. Adapted from "An Introduction to Six Sigma and Process Improvement", by J. Evans & W. Lindsay, 2014.

Application in Other Industries

Continuous improvement initiatives have branched out into all types of industries. These principles were once thought of for improving efficiencies on assembly lines and other manufacturing settings, when in all actuality these principles can be applied to any type of business that delivers a service or product. As discussed previously, healthcare does not manufacture a product, however these organizations deliver a service to a customer population. By utilizing continuous improvement initiatives, healthcare facilities are able to maximize efficiency, decrease patient complications and length of hospital stay, and maximize the amount of reimbursement received for the services that they render. Even though there was not a physical "product" that was improved, profits and services can expect to be increased by quite a bit. This trickling into alternate types of industries can also be seen in settings such as utilities, construction, and coal.

Other Types of Industries

Utilities. The utilities industry is a good example of how the principles used to simplify processes in the manufacturing world can be applied to any other type of industry. Working smarter, not harder has become a slogan for many organizations when they are assessing the efficiency of their processes and workers. The utility industry can use continuous improvement efforts to examine things such as what teams they have devoted to what types of projects, who makes up the teams, and the amount of time it takes to complete a project. Another important component of continuous improvement in the utility industry is the reliability of the service being provided to the customer. For example, what is the average number of electric outages per month that are not related to nature events such as a powerful thunderstorm? When there is an outage what is the average amount of time that it takes to restore this service to the customers? Answering these types of questions is valuable when assessing the quality of the product being delivered and whether or not it is meeting the expectations of the customer. Another important aspect of assessing customer satisfaction and overall efficiency is the price that the service is delivered to the customer. If a utilities company constantly has to repair existing structures due to their aging or unreliability they must recoup the cost for the labor in some form; this may be seen by the customers experiencing rate increases on a regular basis. Any time there is a discrepancy in what the customer expects and what they receive there is an opportunity to utilize continuous improvement.

For a utilities company there is also opportunity for continuous improvement that the customer may never recognize. For example, simplifying and standardizing the way things are documented within the company are of essence for the stability of the organization; this can be seen when one looks at the way that gas line infrastructure is documented. Gas line infrastructure is documented any time there is an addition or change to an existing grid of gas lines. It is of the utmost importance that the documentation of changes and the location of these lines be done in a standardized manner so that many difference companies can utilize this information. Any time there is a problem with one the existing gas lines it is important that the team that is repairing the line be able to locate it quickly and without question. The amount of time that it takes for the crew to locate either the line that needs repaired or the access point that is needed to shut the gas off could make the difference of evacuating an area or not, or even the potential of an explosion as a result of the leak of gas into the atmosphere. A standardized way of documenting these locations is one of the key pieces of information that can make this possible and timely. In addition to emergency management, it is important that other companies, such as construction and water companies, be able to know where these lines are located at so that they will not interfere with them while completing their work. This too is a form of emergency management by preventing the potential for an emergency, such as a cut gas line. While the customer may not ever realize that these continuous improvement efforts have been completed, the quality of the product they receive is increased by preventing complications.

Construction. Continuous improvement is also finding its way into the construction industry regularly and is showing successes when the same measures are taken to ensure success as those that are taken in industries such as manufacturing and healthcare. One of the largest areas that continuous improvement has been successful for the construction industry is in safety and efficiency (Duff, 2000).

Safety is a big component of the construction atmosphere; for many workers adherence to safety policies could mean the difference between life and death. In larger construction companies there are employees that are specifically charged with ensuring safety measures are followed and conducting a root-cause analysis when something goes wrong. A root-cause analysis looks at all of the facts and events leading up to an unexpected or negative event. With all of the facts collected, there can then be a decision made of what went wrong and what actions or processes need to be put into place to prevent future occurrence. Unfortunately a root-cause analysis is performed after the occurrence of a negative event; continuous improvement can put processes in place to help prevent safety events from even occurring. An example could be a construction company is having difficulty with employees following the standards that state that they must wear safety harnessing when working above a certain height. By using continuous improvement tools, such as the fishbone diagram mentioned above, it could be determined that the real issue stems from there not being enough harnesses available for the entire crew at the time that they are needed. In response to this finding the safety officer could then purchase additional safety harnesses and using the 5 S system could organize the space in which the harnesses are stored so that it is expected that an employee would find a safety harness in the same spot, every time.

Efficiency on a construction job site is also an important component when thinking in terms of the dollars received by the company for the jobs performed. Most estimates that are performed by construction companies are for the job itself to be performed and not for the amount of time that it will take to complete the job (hourly charging). Keeping this in mind, the longer it takes a construction crew to complete the agreed upon job the less profitability for the company; also, the less efficient the job site, the more frustration that results for the workers. Taking time to standardize tool placement and outline processes may seem tedious and insignificant to some, however by making sure that supplies are in the correct spot each time they need to be accessed would decrease time spent looking for the materials and decrease the frustration felt by those looking for them. By decreasing this frustration, you would also naturally increase productivity for that employee.

Coal. The coal industry has shown evolution through many decades, much of which can be considered continuous improvement efforts. Like the construction industry, the mining industry has been charged with increasing both safety and efficiency in their daily activities. For an industry that is credited with above-average workplace dangers and is constantly under scrutiny, it is important that the mining industry keep their employees safe, their costs low, and their reputations positive.

When one thinks of efficiency in the mining industry, the various types of conveyor systems that have been implemented come to mind. At one point in time the miners would transport the coal in and out of the mine using a manual process that included pushing large carts on a track to the exterior of the mine. One can imagine that this was less efficient and was much harder on the employees performing the work. While it may not have been termed as continuous improvement, the earliest invention and utilization of conveyor systems would be considered a continuous improvement principle. Alspaugh (2003) discusses some of the first integration of a rubber tire driven conveyor in 1974 at Kaiser Coal; he also notes that this was one of the first occurrences that then caused continuous improvement efforts to skyrocket in the mining industry. After the first installation coal companies began to realize the potential in continuing to develop these conveyor systems and lengthen the span of the equipment. Lengthening the span of the conveyor equipment increased the efficiency of the workers since they did not have to move the equipment as frequently (Alspaugh, 2003).

Safety is highly valued in the mining industry and ways to improve safety measures and decrease negative occurrences are just as important as those discussed in the construction atmosphere. Gas monitoring is an important measure that is taken for underground mines. It is important that miners know of the presence of an odorless gas, carbon monoxide, which can be lethal in a confined space. In the early years of mining it was common practice to use a canary to detect even the smallest levels of carbon monoxide in underground mines; the bird would alert to this presence early enough that miners were given enough time to return to safety (Kalwinder, 2012). The practice of using these canaries continued until 1987 when the government finally phased out their use due to a lack of effectiveness (Kalwinder, 2012). A gas sensor known as the Pellistor replaced the use of the canary in a cage to detect this noxious gas and eventually transitioned to the use of infrared LED-based gas sensor. The evolution of this safety mechanism offered a safer, more consistent method of detecting carbon monoxide and protecting the safety of the workers in the mines and is an excellent example of continuous improvement.

Figure 7. A Miner and Canary.

Enablers

Creating a culture that accepts continuous improvement within an organization takes time and persistence on many levels of personnel. There were many factors identified throughout the course of literature review that contribute to the success of the continuous improvement culture. The devotion of leadership during implementation, the buy-in of frontline staff, and adequate training and support for those involved were three important enablers of the creation of a continuous improvement culture (Collins, Muthusamy, & Carr, 2015).

Devotion of leadership during implementation is of utmost importance and is identified by many as one of the most critical enablers of continuous improvement. Leaders are expected to lead their staff by example, therefore if a leader displays an attitude that says “this continuous improvement initiative is not going to be successful or will just be around for a limited amount of time” then it cannot be expected that employees would do anything any different than to display similar attitudes. Leaders should set expectations for the participation in the continuous improvement initiatives and display positive attitudes toward the initiatives that are taking place. It is also a leader's responsibility to conduct follow up to assess how implementation is progressing; when barriers are identified, leadership can assist with getting the resources needed to overcome the barriers. By displaying positive attitudes, this will increase the buy-in of the employees reporting to the leader.

Employee buy-in is essential at the front line level. Many of the continuous improvement initiatives will be started by a champion that is not involved in the process each day, however it will be requested of frontline staff to participate as knowledgeable individuals of the current process. As discussed previously, the input of frontline staff is valuable because it can be used to identify the exact actions that are taking place in the current state and evaluate whether or not proposed solutions or improvements would be possible given the work setting. Without the buy-in of staff it would be difficult to obtain accurate information and sincere feedback on the potential of a proposed change. A strong buy in from staff will also help with longevity of the life of the continuous improvement culture. The current employees will have close interaction with new employees in the future and can help create roots for this new way of approaching things. If a disgruntled worker tells every newly hired employee about the negative outcomes of continuous improvement initiatives, the new employees will not have any faith in the culture that is being created. When this happens, the cycle tends to repeat itself until it becomes nearly impossible to gain employee buy in without starting from scratch.

Finally, Collins, Muthusamy, and Carr (2015) identify accurate training and support at an important component of the success for continuous improvement. Regardless of the type of industry that the continuous improvement initiative is being implemented in, without information that explains what continuous improvement is, what to expect, and how an individual can play an active role in the process, employees will feel uninformed and unable to make a difference. Part of the training should include access to resources, such as the champion and others that are familiar with the goals and processes being pursue. These resources should be visible on a regular basis so that the frontline staff can ask questions as they arise and the resource can evaluate if the process is being followed as designed.

Inhibitors

Inhibitors to a successful continuous improvement program or culture are the opposite of the enablers discussed above. Differing goals between leadership and frontline staff is one of the most detrimental inhibitors to establishing a continuous improvement culture (Collins, Muthusamy, & Carr, 2015). Clear goals and expectations should be established in the beginning of planning and communicated effectively to staff in the beginning of implementation. When developing the goals of the program, staff views and input should be taken into account to ensure that they are in the best interest of the organization and those that contribute to its daily success. Many organizations forget to include a couple of members of frontline staff during the planning. The inclusion of frontline staff from the planning stage helps to ensure practicality in what is trying to be accomplished and also empowers the staff to have their views, opinions, and wishes considered. Expectations should be set for both staff and leadership that address their involvement, commitment, and communication with others in regards to the continuous improvement culture.

Another inhibitor that is a direct reciprocal of an enabler is the lack of appropriate resources and tools to complete the process being implemented. There is a degree of difficulty to implement a new process and avoiding allowing the process to revert back to its original state. If a new process is being trialed and staff does not have the tools that they need to be successful it is nature that the process would revert back to its original. Constant support for the staff performing the task is important to coach them through the learning period and transition and also to maintain a positive outlook throughout the process.

Finally, an underdeveloped continuous improvement program can be detrimental to the building of the culture. An underdeveloped program implies that there is a lack of knowledge from the continuous improvement "experts" or that there was not the amount of care placed into programming that is needed to be successful. An underdeveloped continuous improvement program can be identified by lack of adequate understanding of leadership and champions; this can also be seen when there is a lack of resources present, as discussed above. A lack of clearly defined and communicated goals is another characteristic of an underdeveloped program. It is important that a vision for the program be developed that can communicate the goals of the program as a whole for the organization. Outside of this vision there would also be goals set for each project that is developed. This will allow both leadership and staff to understand how the smaller goals feed into the one large goal for the organization. For example, a vision for a healthcare facility may be "to provide high quality, cost effective care to patients"; goals of individual continuous improvement projects should all work to achieve this overall vision of the organization but will still have a smaller goal. A goal of "decreasing the length of stay for a patient by .5 days" would help achieve the overall goal of providing cost effective care. By allowing leadership and staff to understand and work toward the overarching goal there will be more compliance and commitment to the implementation of a continuous improvement culture.

Case Study 1

Situation

Case study 1 takes place within a mid-sized utility company located in Evansville, Indiana. An opportunity for improvement was identified by both the engineering and operations departments stating that the field documents that depicted installation of natural gas lines were frequently inaccurate, inconsistent between authors, and difficult to interpret when reviewed. These field documents hold great value because they tell the story of the work that was done, what location it was performed at, the staff involved, materials utilized, etc. A request to standardize the form and its completion was made and accepted.

Process

The request for standardization arose from errors in computer mapping systems, interpreting field drawings, and difficulties in locating facilities once field dynamics had changed; the combination of these issues created a safety concern for the location of gas lines to perform maintenance or repair issues. Based upon the inconsistency and safety concern, a high priority opportunity for improvement was identified and a continuous improvement champion was assigned to the project.

The first task of the champion was to put a team together comprised of representatives from field inspection, field employees, engineering, computer data entry, and operations supervisors. The first meetings were a week-long event with an objective of identifying the current state and perform a "waste walk" to identify waste within the current process. The champion chose to have the team create a "current state map." An example of a current state map can be seen in *Figure* 7. This process begins with engineering providing a proposed drawing to field operations for the job that is being started. This drawing outlines what the engineer thinks should be done in the field; inevitably the field operations department assesses the area that is being worked in resulting in a plan that may differ from the proposed drawing. When there is a discrepancy between the proposed plan and the actual plan, the engineer and operations will walk through the job on the site to be performed and take additional factors into consideration, such as tree placement, water line placement, sidewalks, etc. Once there is an agreed upon plan of action, the work is performed and it must then be documented. This document that is completed is meant to tell the story of what took place and where things were installed. The team identified that there were many variations in the documentation of the work performed; this documentation ranged from company-issued forms to hand-drawings on notebook paper. All of the events and factors of the current state were written on various post-it notes and placed in order across the wall in the meeting room. This gave the team a visual aid for understanding the current process and would then be used later for identifying waste and holes in the process.

Figure 8. Current State Map.

After identifying the current state, the team was charged with identifying waste in the process. The team identified the waste as inaccuracies in the computer mapping system, difficulties in locating facilities that were installed in the field, and variances in where the records were captured (company provided forms, notebook paper, engineering grids, etc.). Defining the desired state was also an important task for the team. It was identified that the desired state would be to have a standardized form that was filled out consistently to document work performed. This form would need to be easily understood by the workers completing the form, the computer data-entry specialist, and those that would later interpret the form for the work performed. Engineering would provide the field with a cleaner version of the proposed drawing to be utilized for capturing these installed facilities and their location. In addition to this, there was an outline process on where to measure from and how to document these measurements within the “as-built” drawings. As-built drawings are an interchangeable name for the depiction of where the facilities were installed in the field.

Results

As a result of the continuous improvement project, there was a cleaner and easier to understand version of the form created. This form was created by the team as a whole. Training was provided to engineering, field operations, supervisors, and the computer data-entry specialists and included the correct process for documenting information on this form and how to interpret the drawing that is created. Once the form was implemented check-in meetings were scheduled for 14, 30, 60, and 90-day intervals to assess progress on open-action items within the “newspaper”. A newspaper is a document that documents open and closed actions that were identified and not resolved during the course of the continuous improvement event. Its name originates from being a document that is updated and reviewed on a regular basis; this document includes the proposed and actual completion dates and the party responsible for these action items. All check-in meetings were performed and within the 90 day period there was a training schedule created and completed for both trainers and field employees, and addressed concerns that were expressed by others regarding the new process. The new form is now included in all engineering created work packets and the new process is expected to include the newly created form.

Things Learned

It was learned during this case study that there is an opportunity for large amounts of variation for processes that are followed within an organization. There may also be a gap present between the way leadership believes processes are completed and how they actually take place. The presence of a gap between the perceived process and the actual process is dangerous when the actual process varies from what is outlined in policies and may create a safety concern. The presence of this gap also decreases the incidence of an issue being identified and resolved.

Silos can also be present between departments within the same company. These silos are seen in the forms of lack of communication and lack of understanding of other roles within the process. In this case study, an example of a silo would be field operations not communicating effectively with others involved in the overall process of completing documentation and storing this information. A silo would also be seen by field operations not recognizing how the inconsistency of documentation would affect the "big picture". The importance of breaking down these silos and increasing awareness of the big picture is one of the biggest take-aways from participating in continuous improvement initiatives that involve multiple departments within the same company.

Another lesson learned was the importance of accurate and standardized documentation between workers. The inconsistency in workflows between workers makes things difficult to understand and could even go as far as to open the organization up to legal liabilities. Standardization allows all workers involved to have the same level of understanding and therefore makes them much more interchangeable when needed.

Case Study 2

Situation

Case study 2 takes place within a mid-sized utility company located in Evansville, Indiana. The complaint was made by utility workers that many of the work trucks issued by the company were difficult to locate materials and tools in and these items were often missing all together. In response to the complaint, an operations supervisor for the company proposed a 5 S project that would entail standardizing all the company issued work trucks so that materials and tools would be present in the vehicles no matter what truck was utilized by working crews.

Process

To begin the 5 S project, one company issued work truck was brought in from the field on a designated date. The entire work day was to be devoted to completing the 5 S process on one truck prior to moving on to the other trucks. Workers began emptying the truck; once the truck was emptied of its contents, the 5 S project could begin.

Sort. Once all contents were emptied from the work vehicle, employees started to sort the contents into similar categories. Tools were all placed together and then sorted by type of job they were utilized most frequently for and materials were all sorted into like categories. For example, all pipe fittings of the same size were placed together in a pile. The combined time of emptying the truck and then sorting the materials was approximately two hours.

Set in order. Once all items were sorted into like categories, the operations supervisor, who was also serving as the project champion, had the employees count the number of items in each category. This gave an accurate depiction of the truck’s current par level of materials on any normal workday. After a count was made of the items currently on the truck, a brainstorming session was conducted between the champion and employee participants to determine was par level was considered reasonable to complete a day's work. This determination involved much input from the employees since they are the field experts of the job that they perform each day. An important lesson during this part of the project was that the project champion had to remind the employees that there were limited number of supplies to be distributed amongst all the company issued work trucks, so all materials would not be able to be stored in this one truck. Space within the truck was also a limiting factor. Throughout this part of the process it was also identified what materials were needed on the truck but were missing. A place for these missing items was marked and the expectation was that these missing items would be retrieved from one of the other company issued vehicles. The champion took notes the entire time throughout the brainstorming activity and at its completion could describe a desired state for the work trucks. This desired state was communicated to the employees to ensure it accurately captured their needs. The set-in order phase of the 5 S project required approximately two hours and 30 minutes.

Sweep. After establishing current and future par levels for the truck, the employees were charged with cleaning the inside of the truck prior to replacing the items that had been removed. This part of the process included sweeping the floor of the truck, fixing any broken hangers or storage compartments, and wiping down the walls within the storage area of the truck. Once the truck had been cleaned, the items could then begin to be replaced into the vehicle while paying careful attention to maintain the grouping of items that had been established in the previous step. Most frequently utilized materials and tools were placed closer to the entry door for easier and quicker access, and larger materials that were used less frequently were placed near the rear of the vehicle. Since there were still needed materials that were missing from this work truck, a place was set for these items and left vacant until they could be located. This portion of the 5 S project required approximately three hours to complete. Once all items, minus the items that were deemed to be over par level, were placed back on the truck the 5 S project for this individual truck was complete. The par list that was developed was stored for use in the upcoming 5 S of the remaining work vehicles. Pictures of the finished vehicle were also taken for reference.

Standardize. The next part of the 5 S project was to standardize all company issued work trucks to contain the same par level of materials, however the 5 S project was dissolved and no further trucks underwent the 5 S process.

Sustain. Due to the lack of completion of the "standardize" step, the sustain step was not applicable. If the project would have been completed, the sustain step would include identifying a process owner that would ensure that the company issued work vehicles remained in the same standardized format.

Results

One of the company issued trucks successfully underwent the 5 S process, which included sort, set in order, and sweep, however since the other trucks did not complete the same process the project did not fulfill the standardize and sustain pieces of 5 S. Because of the failed project, the champion attempted to identify the inhibitors present throughout the project. The first inhibitor was identified as a lack of frontline employee buy-in. This lack of buy-in was evidenced by the negative attitudes toward their participation in the 5 S process even despite these participants being those that brought the concern for missing materials forward. The second inhibitor of the project was lack of time. The amount of time required to complete the 5 S process on one vehicle was approximately an eight-hour work day. There were five other vehicles that needed to be completed, which equated to approximately 48 hours of time devoted to the project in total. To complicate this inhibitor, the time spent on the truck project was also time that the crew participating would not be performing daily operations. Finally, the third inhibitor was lack of commitment to the continuous improvement project by leadership. Due to the time constraints placed on the project, the operations supervisor overseeing the project did not actively seek time to complete the remainder of the project.

Things Learned

The results of this case study reinforced the need for important enablers when completing a continuous improvement project. Frontline employee buy-in and leadership commitment are two of the largest identified enablers for continuous improvement projects and the lack of both led to the failure of the project. The importance of a debriefing session for the champion regardless of the project's success or failure is also important. This gives the champion the opportunity to identify what went well and what did not and to share these findings with others involved in continuous improvement efforts. Learning from one another is an important component of continuous improvement and working within a team atmosphere.

Conclusion

When one hears the term "continuous improvement" many think of the Toyota Production System. In reality, continuous improvement cultures have been present throughout history much longer than the industrial period. Manufacturing is frequently credited with being the birthplace of continuous improvement however we see that continuous improvement can be dated back to periods even as far as Egyptian structures and their evolution. A knowledge and respect for the need to advance and improve upon processes helps organizations propel into a better financial position with higher quality outputs.

When adopted and fostered correctly a continuous improvement culture can allow a company to improve efficiency, create safer processes, and decrease overall costs of performance. Efficiency decreases the amount of time required for production of products or delivery of services, decreases the amount of supplies required, and decreases the incidence of product defects. By improving upon these factors decreases in cost and increases in revenue should be a direct correlation to the processes improved and performed.

In order to develop a new culture of continuous improvement acceptance within an organization, key enablers and inhibitors were identified. Significant enablers included the dedication of leadership to the implementation of continuous improvement, the buy-in of frontline staff participating in the processes affected, and adequate training provided to those involved. Inhibitors were the opposite of these inhibitors and also identified an underdeveloped program as a risk for lack of success. Interestingly, these enablers and inhibitors are applicable regardless of the type of industry that is participating in implementation. Continuous improvement efforts have expanded from manufacturing into almost any industry imaginable. Some of the larger organizations identified were healthcare, utilities, construction, and mining.

The opportunity to complete continuous improvement initiatives, such as case study 1, provided an insight of the struggles experienced by those involved in the project, those impacted by it, and the detail of identifying issues, creating proposed solutions, and evaluating change and sustainability of the new and improved process. An increased knowledge of the tools within continuous improvement, such as 5 S, waste reductions, and six sigma, provided the knowledge needed to identify opportunities, adjust, and evaluate progress in any type of situation.

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APPENDIX

Appendix A

Glossary of Terms

6σ (Six Sigma) – a strategy that seeks to improve the quality of process outputs by identifying and eliminating defects. The maturity of the manufacturing process can be described by a sigma rating; a six-sigma process is one in which 99.99966% of the products produced are statistically expected to be defect-free.

Defect – frailty or shortcoming in a product.

Kaizen – Japanese term that means "to make better".

Kaizen Event – focused, short-term event to make immediate improvements.

Lean – systematic approach to identifying and eliminating waste or non-value added steps through continuous improvement.

Pull vs Push – push manufacturing is dictated by a formal production schedule where a new lot is pushed onto the first step of the process. In contrast, pull manufacturing uses a customer order as the start of a new lot.

Waste – anything that uses resources, but does not add real value to the product or service.

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