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DEVELOPMENT OF OPERATIONAL EXCELLENCE STRATEGIES IN A CUSTOM
MANUFACTURING ENVIRONMENT TO INCREASE PROFITABILITY
AND GAIN COMPETITIVE ADVANTAGE

by

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ABSTRACT

This report discusses strategies used to improve operational excellence within a custom manufacturing company. These continuous improvement strategies were used to identify a tool that would improve overall performance and would allow the organization to be more competitive. The organization was threatened by global competition driving down market prices and weakened by a complacent culture and inefficient processes that resulted in millions of dollars in manufacturing variance. These factors contributed to the company's loss of profit and competitive advantage in some key markets. The objective of this project was to evaluate, select and develop tools and techniques that would increase profitability and competitive advantage by increasing responsiveness, efficiencies and productivity while reducing manufacturing variance. This was to be achieved through the application of continuous improvement methodologies. The project identified nesting software as a tool that could greatly improve the current state of the plate cutting process. This tool allowed the organization to be responsive at the initial stages of the project. It also constructed a plan for optimizing the utilization of material and effectively displayed the nested layouts within the manufacturing documents in order to effectively communicate and execute the plan. Execution of the plan reduces material variance, rework costs and scrap which results in significant cost savings. For a custom manufacturer of this type, the key to increasing profitability and improving competitive advantage is to continuously improve internal capabilities.

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Chapter I

INTRODUCTION

Introduction

American manufacturers in the 21st century have many challenges to overcome in their quest to sustain competitive advantage in today's global marketplace. The author's company, referred to as "BWT" in this report, is a custom manufacturer that is struggling to gain profitability and competitive advantage in some key markets, as a result of both internal and external forces.

BWT operates in a tranquil environment where competitive advantage is gained by achieving the highest efficiency while making the same product as their competitor. Successfully increasing the gap between the customers' perceived value of the product and the actual cost in a manner that impacts the customer's purchasing decision is how competitive advantage is gained.

BWT understands that continuous improvement is vital to their future existence in many markets. Recently, a team of individuals from within BWT was formed to help improve upon the current conditions of the company. The team was part of an Operational Excellence Program that was established to develop individuals into change agents to help transform the culture into one that strives for Operational Excellence. The change agents were focused on organizational effectiveness, and improvement and development of technologies, structures and tasks. In addition, they focused on interpersonal and group relationships within the organization.

This report will discuss continuous improvement methodologies used in a specific Kaizen event that focused on cross-departmental interactions to help improve internal efficiencies and effectiveness for the distributor tray product family. These efforts were applied to help increase profitability and gain competitive advantage in the distributor tray market. The Operational Excellence team aligned with this Kaizen event to help develop the continuous improvement strategies across the entire organization.

Problem Statement

In 2015, the company was threatened by global competition driving down the market prices and weakened by inefficient processes that resulted in \$4 million in manufacturing variance. The company adopted lean manufacturing methodologies in the late 1990s, but had been challenged to sustain this methodology in their high-mix, low-volume environment manufacturing custom products. Consequently, over time the impact from the continuous improvement efforts has greatly declined resulting in rising internal costs. These factors have contributed to the company's loss of profit and competitive advantage in some key markets.

Nature and Significance of the Problem

Technology intensive industries have an extremely fast-cycle which creates a turbulent environment where change is rapid. In fast-cycle environments they are faced with constant threats that force them to rapidly adapt to sustain competitive advantage. On the contrary, BWT manufactures custom products for many industries that have slow cycles of technological change. These slow changing technological cycles create a tranquil environment that is less strenuous and has fewer radical innovations occurring. As a result, there is no need to rapidly change products once the organization has

established capabilities and competitive advantage. The goal for firms operating in either a turbulent or tranquil environment is not only to have competitive advantage but for the advantage to be sustainable or hard to imitate as long as possible.

In a tranquil environment, once the firm develops capabilities, these capabilities can be more durable and enduring than in some other environments. In this type of environment, competitive advantage is maintained by monitoring the industry and constantly modifying and improving existing processes or methods. It is essential in a tranquil environment for the firm to continuously improve its product, production machinery, and processes to maintain a competitive advantage.

BWT had developed many capabilities that have endured in this tranquil environment and had competitive advantage in many markets over the past century. However, as a result of the low pressure for change in this tranquil environment the organization's culture became complacent. The organization over the past decades also struggled to sustain any continuous improvement effort, since the tools and techniques used in common lean methodologies did not seem to directly relate to their high-mix, low-volume, custom manufacturing environment. Additionally, a 2013 acquisition, by a foreign company, resulted in numerous restructures and implementation of a new ERP system which resulted in the loss of access to historical manufacturing data. All of these factors significantly affected the organization's ability to operate efficiently and effectively. The company reported \$4 million in manufacturing variance for 2014.

In the past 3 years, BWT has been struggling to quote jobs competitively in the distributor tray market. This custom manufacturer is the only US fabricator for a custom proprietary product used in a specialized distributor tray process. However, BWT is challenged in this market by global competition driving down the market price. At the

market price, BWT has struggled to win bids or turn profits for this product family. A SWOT analysis was used to help the organization face its challenges and reveal its potential in this market, see Figure 1-1.

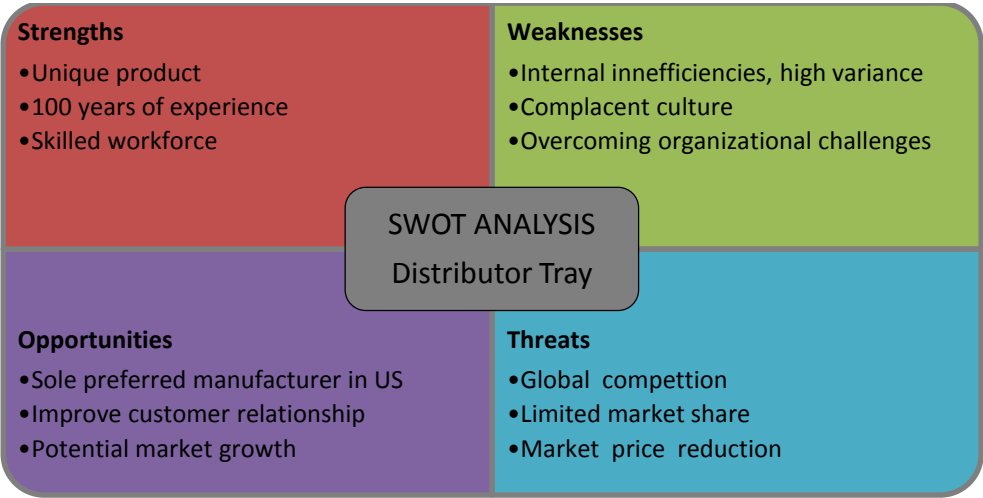


Figure 1-1
SWOT Analysis

The author of this report is an engineer for the distributor tray product family and was motivated to help the company become profitable in this competitive global market. The author realized that alignment with the organization’s new Operational Excellence team could help drive improvements to the current state of the distributor tray product family, which would help alleviate the recognized weaknesses. This motivation to improve propelled the author to volunteer for the Operational Excellence team. The Operational Excellence team was a cross-functional team that included a mix of individual contributors and management from these departments: IT, quality, engineering, drafting, production, project management and manufacturing engineering.

Shortly after the launch of the Operational Excellence Program the company bid on and was awarded a distributor tray project. To date, it was the largest revenue project for this product family. Immediately, through the assistance of the Operational Excellence program, a Kaizen team was constructed to determine continuous improvement efforts for the distributor tray process. The team was to evaluate, test and implement as many continuous improvements as possible into the current revenue project to reach a desired future state for the product family. These continuous improvement efforts were essential for increasing the organization's profitability and to help gain competitive advantage in this market.

This project was beneficial to the company to help extend the continuous improvement efforts, initiated within a specific business unit, across the entire organization. The project highlighted the importance of applying lean and agile methodologies to the current products and processes to increase efficiencies, reduce internal costs and minimize manufacturing variances. The project was also useful in promoting the transformation of the organization's culture from one that was reactive into one that is preventative, but more importantly, to begin to transform it into a culture that strives for Operational Excellence. Focusing on Operational Excellence allows the organization to spend time on activities that will grow the business. These offense strategies help the company stay profitable and competitive amongst its global competition.

Objective of the Project

The objective of this project was to evaluate, select and develop tools and techniques that would increase profitability and competitive advantage by increasing responsiveness, efficiencies and productivity while reducing manufacturing variance. This was to be achieved through the application of continuous improvement methodologies.

Project Questions/Hypotheses

1. What continuous improvement efforts can be achieved in the immediate future that will have the greatest impact on reducing internal variance and cost while improving delivery and maintaining quality for the distributor tray product family?
2. How do you get the other business units, not associated with the distributor tray market, onboard and aligned with the continuous improvement initiatives that could benefit the organization as a whole?
3. In order to sustain these continuous improvement efforts what modifications to the methodologies need to be further addressed to fit with this custom manufacturer that operates in a high-mix and low-volume environment?

Limitations of the Project

The major limitations of this project came from management's lack of involvement. Upper management has never clearly stated the organization's vision, objectives and goals for the distributor tray market. The business unit's top manager was based out of state and therefore had little involvement in day to day operations. He had only vaguely stated, to the business unit personnel, that we need to reevaluate the distributor tray process. These things, combined with the lack of funding for process

improvements confused the individual contributors on what efforts to apply to this product family. Individual contributors on these projects were often left questioning the company's strategy on why they continued to bid projects at market price since historical data had revealed this product family had extremely low to unfavorable contribution margins. A contribution break even chart was used to graphically display how variable costs must be reduced to increase the contribution margin and profitability (Russel & Taylor, 2011, p. 233)

The vague directive from the business unit's top management created misaligned expectations within the business unit. The business unit's sales force turned all their focus to off-shoring the project. At the same time, engineering focused efforts on improving internal capabilities to reduce costs and increase profitability.

With no current order in-house, the other departments had no motivation to apply resources to this project. This led to poor time management since many departments had no pressure and no incentive to improve the internal process of one business unit's struggling product family. Departmental collaboration for internal continuous improvement efforts did not begin until a revenue order was placed in April 2015. This is common practice for this made-to-order, custom manufacturing shop where work on a project generally does not start until an order is placed.

Even after the order was placed the organization faced many challenges in breaking down departmental barriers. Certain departments saw no value in trying to improve the organization's position in this market. Other business units had no enthusiasm to get involved in the cost reduction efforts. They perceived the project to be for another business unit, versus one that had potential to improve the capability of the organization's shared manufacturing resources.

The author had many challenges to overcome that were centered on the organization's culture, see figure 1-2. At BWT, motivated individual contributors were generally the ones to attempt to drive change. This bottom-up management was the basis of the company's culture. However, without the support and involvement of management, the inability to sustain these efforts is a perpetual problem.

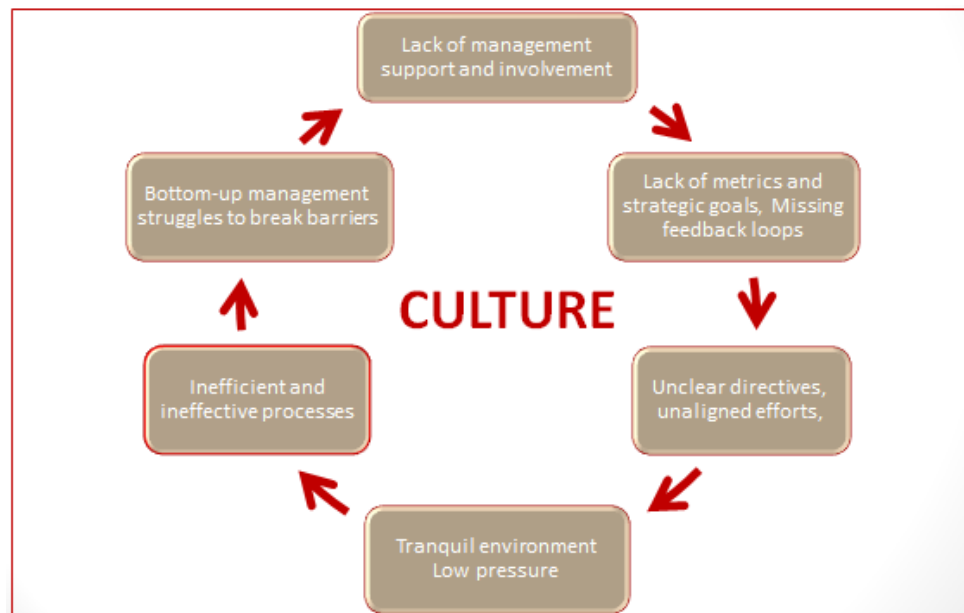


Figure 1-2

Organizational Limitations

Definition of Terms

Agile Manufacturing. A term applied to an organization that has created the processes, tools, and training to enable it to respond quickly to customer needs and market changes while still controlling costs and quality.

Change Agent. A person from inside or outside the organization who helps an organization transform itself by focusing on such matters as organizational effectiveness, improvement, and development.

Competitive Advantage. An advantage that a company has over its competitor that allows them to generate greater sales or margins and/or retains more customers than its competition.

Contribution Margin. A cost accounting concept that determines the profitability of a specific product. It is the product's sale price minus its total variable costs which equals an incremental profit earned for each unit sold.

Core Competencies. Core competencies are activities or practices, such as product development, determined by a company as critical to its long-term success and growth. Core competencies are typically based on skill or knowledge sets rather than products or functions. They provide return on investment and act as a barrier for other companies trying to enter a particular market.

Custom Manufacturing. Manufacturing to customer specified requirements. Generally, a made-to-order, high mix, low volume environment.

Gap Analysis. A technique used to analyze/assess where you are currently are with respect to where you would like to be in the future.

High Mix. Term given when a company deals with thousands of active part numbers but few with active forecasted volume

High Mix-Low Volume. Refers to a manufacturing environment that has hundreds to thousands of active part numbers with few or none of these parts having on-going forecasted volumes.

Job Shop. A manufacturer that might have only one production run before the part or revision changes. It is unknown whether or when there may be further orders for that particular part. Normally, a job shop manufacturer's to customers' specifications.

Kaizen. Continuously improving in incremental steps.

Lean Enterprise. A practice focused on value creation for the end customer by minimizing waste and increasing the stability and predictability of the processes.

Lean Manufacturing. An overall methodology that seeks to minimize the resources required for production by eliminating waste (non-value added activities) that inflate costs, lead times and inventory requirements.

Low Volume. Lot sizes are dependent on customer order, generally involves quantities as low as 1.

Made-to-order. An order that is custom-made to the exact criteria and specifications of the purchaser. Orders are not predictable and planning is safer after a firm order is on hand.

Market price. The economic price that a good or service is offered in the marketplace.

Nesting Layout. The arrangement of parts on a plate of material; laid out in a manner that optimizes material utilization.

Operational Excellence. Is a facet of organizational leadership that emphasizes the importance of applying a variety of methodologies, techniques and tools toward the sustainable improvement of the organization.

PDCA (Plan-Do-Check-Act). A model that provides a framework for the improvement process or system. It can be used to monitor a single task or guide an entire improvement project.

Perceived Value. The worth that a good or service has from the customer's perception.

Product Family. Is a group of products that pass through similar processes or equipment and have similar work content.

RACI Chart. A Responsibility Assignment Matrix that is used as a tool for tracking roles and responsibilities. The four categories are Responsible, Accountable, Consulted and Informed.

Return on Investment (ROI). For a given amount of money, how much profit or cost savings are realized.

Standardized Work. The most efficient method of producing the best quality.

SWOT Analysis. A tool to analyze the Strengths, Weaknesses, Opportunities and Threats.

Tranquil environment. An industry that has a slow-cycle for technological change.

Summary

In today's global marketplace American custom manufacturers have many internal and external challenges to overcome if they are going to be able to sustain profitability and competitive advantage. Companies need to understand their current state in order to develop future strategies (Babcock & Morse, 2010, p. 54). "Traditional approaches to work in the United States that once focused on task specialization, simplification and repetition are being supplemented by approaches that promote higher job skill levels, broader task responsibility, more worker involvement and, most importantly, worker responsibility for quality," (Russell & Taylor, 2011, p.342). Like many U.S. companies, BWT has begun to reevaluate their approaches to improve organizational performance. It was critical that the author's company understood the internal strengths and weaknesses along with the external opportunities and threats, in order to determine what strategies would have the greatest impact on achieving the desirable future state.

Chapter II

BACKGROUND AND REVIEW OF LITERATURE

Introduction

Over the past 3 years BWT has faced numerous challenges that have negatively impacted the company's profitability and competitive advantage. The internal challenges included an acquisition, major organizational restructures, transition to a new ERP system, loss of capital equipment, a disconnected workforce and a futile continuous improvement program. With rising external pressures from global competitors and declining market prices it is essential in this tranquil environment to continually improve internal capabilities in order to maintain profitability and gain competitive advantage.

Background Related to the Problem

In 2013, the author's company was acquired by a German company, who will be referred to as "BSE" for this report. BSE is one of the world's leading water treatment and sewage technology companies. BSE was comprised of four business segments: Industrial, Power, Building and Facility, and Construction. BSE acquired the author's company, then referred to as "JS", an American water technology specialist with eleven locations around the world and headquarters in the United States. The acquisition of JS allowed BSE to diversify into new markets, increased their manufacturing capacities in North America, Europe and Asia-Pacific which were all important growth regions and gave them ownership of a screen manufacturer that fabricates unique products for

numerous applications. This acquisition more than doubled the revenues in BSE's water and wastewater sector; further increasing the profitability of the Building and Facility business segment.

JS had deep roots in many markets. They were founded in 1904 by Edward E. Johnson who invented the first continuous-slot, wire-wrapped well screen. Throughout the 1900s, JS innovatively advanced their screen technology into industries such as surface water treatment, food and beverage processing, pulp and paper, mineral and aggregate processing, oil and gas, refining and petrochemical, and even architecture.

After JS was acquired by BSE the merged companies were renamed BWT and the JS name became a brand of BWT's. The acquisition resulted in multiple restructures and realignment throughout the organization. BWT was divided into four global business units: Refining and Petrochemical, General Industry, Water Well and Water Intake\Water Processing.

The common component across all BWT business units is its unique screen product. Initially the screens are all processed in a similar manner, where a single wire is continuously wrapped around a series of rods and resistance welded to create a cylindrical screen. The diversity between the business units is derived from the transformation of the cylindrical screen into a multitude of configurations to meet the form, fit and function of the desired application. Water Well, BWT's largest revenue generator, provides cylindrical screens to the market with minimal enhancements from the initial screen configuration. The water well screens are made-to-order from configured part numbers and it is BWT's most mass produced product line.

In the other business units the screens undergo numerous secondary processes that allow the cylindrical screens to be transformed into various shapes and sizes.

BWT's ability to transform cylindrical screens into almost any configuration is one of their core competencies. BWT's competitive advantage is gained through their ability to supply custom manufactured products to meet their customer's specific needs.

Additionally, achieving the highest efficiency for the same product as their competitor increases the gap between the customers' perceived value of the product and the actual cost. When this impacts the customer's purchasing decision competitive advantage is further gained.

What makes BWT a custom manufacturer? A custom manufacturer operates in a high-mix, low-volume environment, often referred to as a job shop. Custom manufacturers often specialize in engineered-to-order (ETO) and made-to-order (MTO) products, where operational activity is postponed until an order is received, versus performing the activities in advance and then waiting for orders. Many orders are one-off, meaning production will build only one product before the part, revision, process or technology changes. In custom manufacturing it is vital to be highly flexible and responsive to the customer's needs. BWT's ability to fabricate custom products in this high-mix, low-volume environment is their forte.

The Refining and Petrochemical business unit, referred to as HP for this report, relies heavily on BWT's internal capability to provide their customers with custom products by a defined future date. This is very important to the customer because shutting down a process at a refinery can cause the customer to lose millions of dollars a day. HP manufactures industrial filters and vessel internals for numerous refining and petrochemical processes. They have eight product families: Oleflex Screens, centerpipes and accessories, scallops, regenerators, support grids and accessories, distributor trays and accessories, inlet and outlet baskets, and Parex. Prior to the

acquisition, BSE's Water and Waste Water sector, under which BWT operates, did not have involvement in the Refining and Petrochemical industry. However, in 2014, the HP business unit contributed 36% to BWT's overall revenue.

HP's distributor tray product family had been struggling to contribute to the business unit's revenue growth. BWT has been qualified as a preferred supplier for this critical technology along with two other fabricators and they are the only US fabricator to manufacture these proprietary distributor trays. However, they are challenged by the market price, which has been driven down by their global competition. Historically, BWT has struggled to win bids or turn profits for this product family at the market price. It is believed that the company has quoted projects nearly 50% higher than its global competitors. Additionally, the customer has reported that BWT's delivery dates are nearly twice as long as the competition's.

The HP product portfolio was evaluated to determine if the organization should invest in this struggling product family, see Figure 2-1.

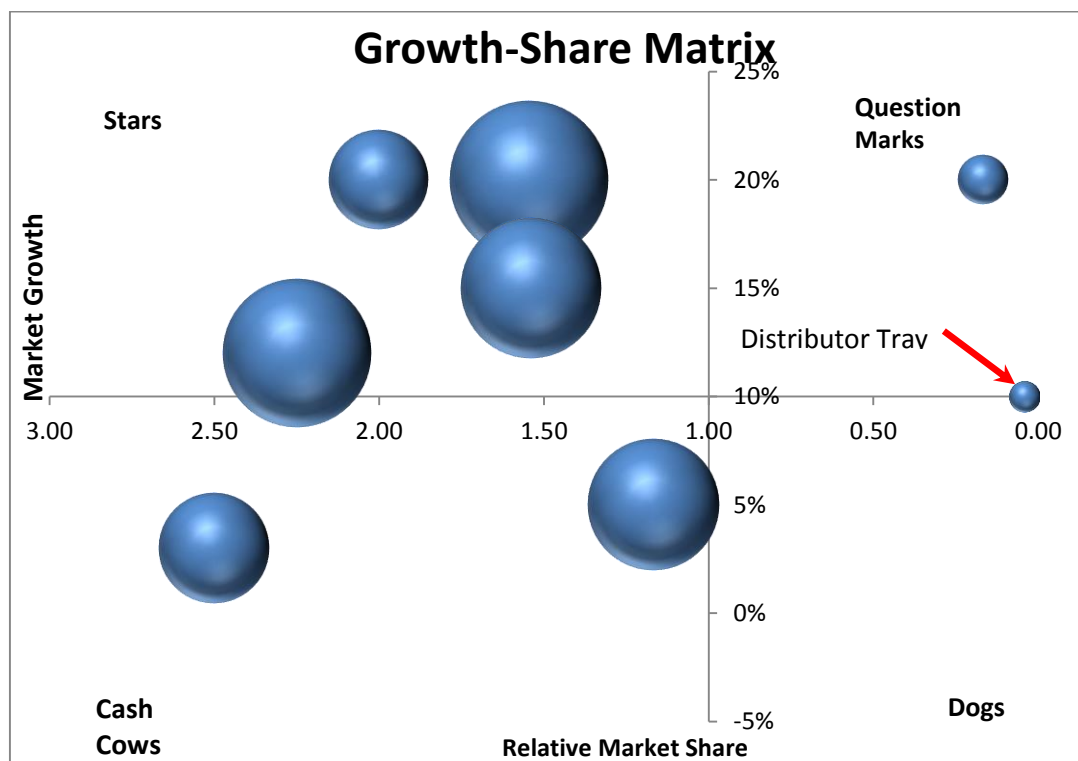


Figure 2-1

Growth-Share Matrix

The Growth-Share Matrix revealed that the distributor tray product family was on the verge of being a dog. The company decided to move forward with evaluating possible continuous improvement efforts to improve upon their status in the distributor tray market due to its market growth potential. The customer has stated that they value their close relationship with this small set of global suppliers, ensuring maximum quality, short delivery times and low cost. The small supplier base allows the customer to work closely with these three worldwide fabricators to custom design each proprietary unit for the individual application to guarantee maximum performance over a desired range of operating conditions, which adds value to their product. Proposing ways to improve

BWT's position in the distributor tray market, and ultimately increase profits and gain competitive advantage, became the focus of this report.

For the struggling distributor tray product family the business unit focused on internal continuous improvement efforts to improve upon their position in the market. BWT chose to focus on optimizing organizational performance to gain efficiencies, reduce cost, increase responsiveness to their customer's needs, gain competitive advantage and ultimately increase revenue and profits. Many manufacturing companies implement lean systems to focus on eliminating waste and streamlining processes but this approach comes with many challenges for custom manufacturing shops. A combination of lean and agile methodologies, known as leagile, was used to improve internal efficiencies and productivity while retaining the ability to be flexible and responsive. These efforts allowed the company to refocus their efforts on value creation to stay competitive in this global market place.

Literature Related to the Problem

The problem of the study focused on external threats and internal weaknesses determined in the SWOT analysis, see Figure 1-1. External factors related to the problem included global competition, low market price and limited market share. Internally, a complacent culture and working in a custom manufacturing environment with a poor continuous improvement system all contributed to the problem.

Global competition is one of the greatest challenges for US manufacturers. For example, the US automotive industry has reported on their loss of profitability and market share due to increased performance from global competitors in the 21st century. "The Japan-based OEMs (primarily Toyota, Honda, and Nissan), with their superior "lean

production” process, were able to produce higher quality vehicles at lower cost. This competitive challenge was the most crucial driver of higher productivity as the Big Three were forced to respond by introducing their own versions of lean production. At the same time, the Korea-based OEMs competed on low cost, intensifying price pressure in the small car segment, and the German and Japan based OEMs provided a strong challenge in the luxury and performance segments. This three-pronged competitive threat took market share from the Big Three and put pressure on their profitability.” (Baily, 2005)

Today, the Toyota Production System (TPS) is world-renowned for their lean production application in their high-volume manufacturing plants that have a limited number of parts and product families. However, custom made-to-order shops like BWT, have struggled to apply Toyota methodology to their high-mix, low-volume environment. “Pursuing such a dynamic mix of jobs presents a number of lean implementation hurdles that would be completely foreign to a large, assembly-type operation. Many parts share relatively few machining resources. Design changes are common, demand fluctuates, and contracts can change from year to year. Delivery dates, lot sizes, equipment requirements and cycle times are also highly variable. As a result of these and other factors, dedicated cells, "pull" production based on Kanban visual aids and other practices designed for continuous flow simply don't translate easily to this environment.” (Danford, 2010)

BWT provides products to industries that have slow-cycle technology changes; therefore, in these tranquil environments there is no external threat to adapt rapidly to new technologies. “The management of technology and innovation in a slow change environment seeks to maintain its competitive advantage by monitoring the environment

and continuously tweaking existing technology for improvement,” (Bruton & White, 2012, p. 316).

Organizations that operate in a tranquil environment have little pressure to change once they have built capabilities that provide a competitive advantage (Bruton & White, 2012, p. 316). In BWT’s case, this lack of need to change and improve to keep up with technology and to stay competitive has led to a culture of complacency. “An organization’s culture is built over time as members develop beliefs, values, practices and artifacts that seem to work and are transmitted to new recruits,” (Bolman & Deal, 2008, p. 277-278). Over time, however, profitability and competitive advantage decline as complacency affects the performance of the organization.

Literature Related to the Methodology

To increase performance and capability within the organization it needed to look at transformation of the culture. “The benefits of a strong corporate culture are both intuitive and supported by social science. As Professor James L. Heskett wrote in his latest book *The Culture Cycle*, effective culture can account for 20-30 percent of the differential in corporate performance when compared with ‘culturally unremarkable’ competitors,” (Campbell, 2011). In the 21st century BWT began to see their performance slipping and realized that their culture had become stagnant due to years of not striving to improve.

The organization’s culture is revealed and communicated through its symbols. (Bolman & Deal, 2008, p. 254) For over a century, the organizational culture at the author’s company has been revealed and communicated through its unique screen product. As one of the only manufacturers in the world of this type of product they have a

lot of pride in it. However, over the years they've become so comfortable with their position as a world-class screen manufacturer with little competition that they've become very complacent. In this tranquil environment, with little focus on continuous improvement, their product and processes began to degrade over time.

The culture needed to transform from thinking that continuous improvement efforts were a specific person's job into one that understood Operational Excellence to be the responsibility of the entire organization. BWT initiated this culture shift with establishing an Operational Excellence program that trained the team members in Lean, Agile, Theory of Constraints and Six-Sigma methodologies to eliminate waste, reduce time and achieve greater efficiency to help the organization increase profitability and gain back competitive advantage. The members of the team were to coach others on how to successfully deploy these continuous improvement methodologies by applying the tools and techniques to BWT's custom manufacturing environment.

There are many American manufacturers in the 21st century that are operating in a high-mix, low-volume environment as a result of retaining projects that require higher skill levels to manufacture and off-shoring the high-volume products that require lower skill levels. In this made-to-order environment it is essential to be responsive to the constantly evolving demands of the customer. According to Jason Piatt, President of Praestar Technology Corporation, "Despite changing needs from customers, manufacturers can make their processes so robust that in fact, they seem like low-variation processes and thus yield the optimization opportunities of high-volume production." Custom manufacturers can improve profitability by utilizing sequential processing of product families, simplifying routings with standard work, implementing a predictable process that displays the manufacturing plan, by maintaining flexibility to

accommodate changing needs and by creating an open environment that communicates effectively (Piatt, 2015).

One aspect of building up the culture is to get everyone aligned and working together to improve. “To create effective teamwork across your organization, you need to break down any departmental barriers to collaboration so that you can draw on the best people,” (Linton, 2015). One of the initiatives of BWT’s Operational Excellence program is to promote teamwork and interdepartmental collaboration.

Ultimately, culture change must be driven by upper management. In the past, upper management has not led continuous improvement efforts. Instead, they’ve taken a hands-off approach and let the efforts be managed from the bottom up. In order for this newly initiated Operational Excellence program to be sustainable upper management had to financially fund the program, support the efforts and most importantly get involved. “For lean to succeed, everyone’s habits and behavior must change. In particular, management’s behavior must change from managing by reports presented in meetings rooms to managing from the shop floor with visuals and real time,” (Lane, 2007, p.198). It’s important to establish metrics, but the metrics must be presented and communicated to the entire organization to improve performance and profitability. “When each and every employee can see the flow of value to the customer and fix that flow before it breaks down this leads to Operational Excellence,” (Duggan, 2011).

Summary

Moving forward the vitality of BWT will directly correspond to how well the company focuses on improving their internal operation. It is critical to the success of the organization that management lead and support these efforts. With management providing the organizational vision, objectives, and goals, the business units can begin to align and the culture can begin to move toward Operational Excellence. The synergy behind this alignment is a key component that will help drive the company to become more profitable and sustain or gain competitive advantage.

To initiate these efforts a Kaizen team was formed to focus on improving the profitability of the distributor tray product family. The team was under the direction of the Operational Excellence Program. This Kaizen event acted as a case study for the entire organization to display how the tools and techniques used to drive continuous improvement efforts for a specific business unit or product family could also be applicable and implemented across the entire organization.

Chapter III

METHODOLOGY

Introduction

In 2015, BWT was focused on developing its Operational Excellence program. The Operational Excellence team was tasked to align with the needs of the business units to help improve group collaboration across the organization. At this same point in time, the declining market price for the distributor tray product family had forced the HP business unit to evaluate how to drastically reduce internal costs. HP's 2015 initiatives were to focus on implementing continuous improvement efforts that would improve upon their position in this market. The success of these efforts was vital for HP's survival in this global marketplace.

A cross-departmental Kaizen team was established to help the HP business unit improve upon the current state of the distributor tray product family. First, the team needed to identify the primary theory. What is the core emphasis of the program or methodology? Six-Sigma's core emphasis is variation reduction, lean's is waste reduction and Theory of Constraints is constraint reduction (Nave, 2002). The entire distributor tray process was evaluated to determine what methodology and framework fit best with the organization. The team was to explore continuous improvement methodologies and tools that would reduce internal costs, increase efficiencies and improve upon their responsiveness to the customer's needs in order to gain competitive advantage in this market.

Design of the Study

The organization and the HP business unit had 2015 initiatives to improve upon the current state of the distributor tray product family. Since the organizational goal was to reduce manufacturing variance and waste and the distributor tray project was to reduce cost, a universal process improvement framework focused on Lean was chosen. The framework was based on Deming's Cycle also referred to as the Plan-Do-Check-Act cycle (PDCA), see Figure 3-1. A key attribute of this framework is that it uses a repeating cycle of Plan, Do, Check and Act to incrementally improve upon the current state of interest.

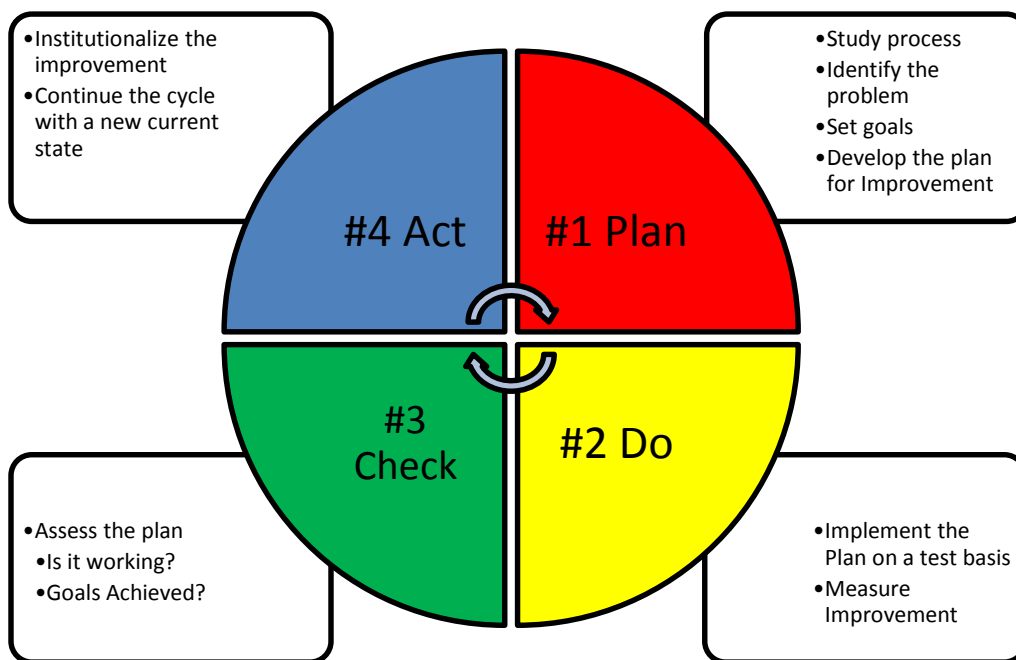


Figure 3-1

PDCA CYCLE, A Framework for Problem Solving

This study involved two PDCA loops to drill down to a focal point that had great potential for improving not only the current state of the distributor trays but also the current state of the organization.

For the 1st PDCA loop an OES problem solving form was written that focused on improving the distributor tray process (see Appendix A.1). To validate the reconstruction of the current distributor tray process a current state map and future state map were created. Data from previous distributor trays projects was used as a baseline. Quantitative and qualitative measurements were used to compare against the organizational expectations to determine what focus had the greatest overall benefit to the organization.

For the 2nd PDCA loop focused on implementing a tool that would help reduce manufacturing costs by designing a robust manufacturing process that minimized manufacturing disturbances (Phadke, 1989, p. 5). An OES problem solving form was initiated to select a tool that would help the organization reduce manufacturing variance and assist the HP business unit at reducing costs (see Appendix B.1). The validation of this tool used material issuing variance data from the ERP system to quantitatively measure against. A vendor survey was also used to qualitatively gather information from outside sources on areas where the organization needed to focus their continuous improvement efforts.

Data Collection

Historical data from past distributor tray projects was used to create a baseline for the distributor tray process and to define the current state. Manufacturing variances and scrap values were collected from the ERP system from July 2014 through May

2015. This data was used as a baseline to measure organizational improvements. Information, knowledge and ideas were gathered through a Kaizen event, meetings and brainstorming with subject matter experts and key players within the organization.

The 1st PDCA loop used the above data along with the data that was collected through a brainstorming session held by a distributor tray Kaizen team. The brainstorming event used past lessons learned from distributor tray projects to generate ideas on cost reduction efforts that would benefit the distributor tray product family. Equally, the brainstorming effort was to look beyond HP and their distributor tray product family to find areas that could be implemented across all the business units to ultimately achieve the greatest organizational success from these efforts. The Kaizen team encouraged involvement and actively brainstormed 92 potential cost reduction areas, these ideas were captured on white boards (see Appendix A.2). An affinity diagram was then used to help sort the ideas into categories (see Appendix A.3). The ideas were grouped by the department that had the greatest ability to drive improvements in that area (see Appendix A.4).

The 1st PDCA loop further collected continuous improvement ideas based on the gap between the current and future state. The ideas collected were aimed at improving the organization's current state. The organization chose to further explore one of these continuous improvement efforts by launching a pilot program to evaluate a tool to help improve the overall performance of the organization. The chosen tool to evaluate was nesting software.

A 2nd PDCA loop involved a team of individuals from each of the business units. The team was formed to help create effective teamwork across the organization. A Responsibility Assignment Matrix (RAM) was used to help collaborate efforts and break

down any departmental barriers (Clements & Gido, 2012, p.111). The responsibility matrix used was called a RACI Chart that designated Responsibility, Accountability, Consultation or Information among different stakeholders (see Appendix B.4). “You need to set clear objectives and define working relationships so that members can work as a cohesive team, and you must provide tools that support efficient collaboration,” (Linton, 2015). The team used the data collected from the 1st PDCA loop along with the information gathered through their brainstorming event, which determined what key features for the nesting software were important to the organization (see Appendix B.2). The team then collected data from ten nesting software suppliers and documented the capability of their software. Each of the selected software company’s presented an introductory demonstration to help the team gather more qualitative data. The team then entered a pilot program to test the software in our current environment. Additionally, pricing sheets were gathered from the nesting software companies.

Data Analysis

The 1st PDCA loop used historical processing data from the distributor trays to evaluate, define and document the current state. The Kaizen team used the collected ideas from the brainstorming event to determine the desired future state for the distributor tray product family. The affinity diagram revealed that Engineering was linked to 41 of the 92 cost reduction ideas and had the greatest ability to drive improvements in 25 of these 41 areas. The author, an HP engineer for the distributor trays and a member of the Operational Excellence team, was assigned to lead the efforts in further analyzing 25 of these potential cost savings.

The author first met with the subject matter experts from the engineering department to determine which ideas had the greatest potential for reducing costs on the current project. The engineering team used a qualitative approach based on historical knowledge to evaluate what areas had the greatest potential for immediate cost savings on the current order. The team then used a voting technique to evaluate “what to work on now vs. later” (Bruton & White, 2012). Fifteen of the 25 cost saving ideas were selected for having the potential to be implemented into the current order. However, implementing 15 continuous improvement efforts to be used on the current order was not realistic in the limited timeframe. Therefore, further qualitative and quantitative data was collected from past distributor tray projects to evaluate cost versus benefit. The information was charted on an Impact vs. Effort Matrix and used as a project selection tool, see Figure 3-2.

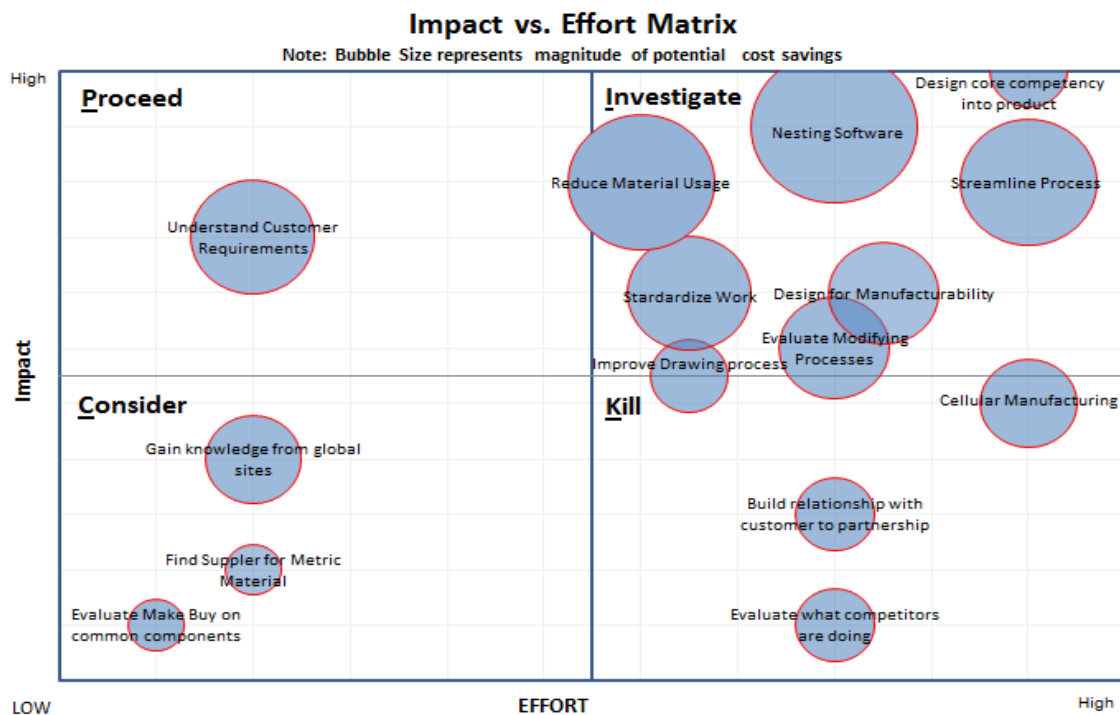


Figure 3-2

Impact vs. Effort Matrix for Distributor Tray Improvement Efforts

The Impact vs. Effort Matrix from the 1st PDCA loop revealed that nesting software had a high potential for cost savings for the distributor tray product family. The quantitative data collected from the ERP system for the manufacturing variance associated to issuing of plate revealed that the nesting software had great potential to reduce plate issuing variance and costs across the entire organization. From this realization the author initiated another Operational Excellence problem solving form to further evaluate the organizational benefits of purchasing nesting software, which became the 2nd PDCA loop.

The 2nd PDCA loop used a scorecard to determine the key features for the nesting software that were important to the organization. The team used an N/3 voting technique to determine the importance of these features (see Appendix B.3). Data was collected on these important features from the ten nesting software suppliers. The collected data was then rated and the top four nesting packages were selected for the nesting pilot program. A trial version of each of the software was tested in-house and its performance was rated both qualitatively and quantitatively against the scorecard. The cost savings from performing a manual nest on the current order was used to justify the software (see Appendix B.5). Even though discounted payback ignores cash flows after payback it was still found useful in this project as a measure of risk (Eschenbach, 2011 p. 220). An AFE from was completed to receive “Authorization for Expenditure” from management (see Appendix B.6)

Budget

There was not separate funding allocated at the outset of this project. The continuous improvement efforts were directed from the organization’s top management. This project’s focus on continuous improvement was considered to be vital for the future health of the organization. Improving the distributor tray process was also essential for HP’s future existence in this market. This project was justified by showing a favorable ROI for the continuous improvement effort and receiving top management’s approval.

Timeline

Custom Manufacturers that operate in made-to-order environments generally do not start work on a project until the order is placed. This was the situation for the current project. The author attempted to initiate continuous improvement efforts for the

distributor tray product family in January 2015, but the culture is very reactive so they could not see the benefits of working on a struggling product with no orders in-house. The internal motivation to improve this product line came in April 2015 when the largest distributor tray order to date was placed. The continuous improvement effort timelines were driven by the deliverables for the current distributor tray order, see Figure 3-3. Evaluating, testing and implementing continuous improvement efforts in parallel with this production order became a major challenge for this project.

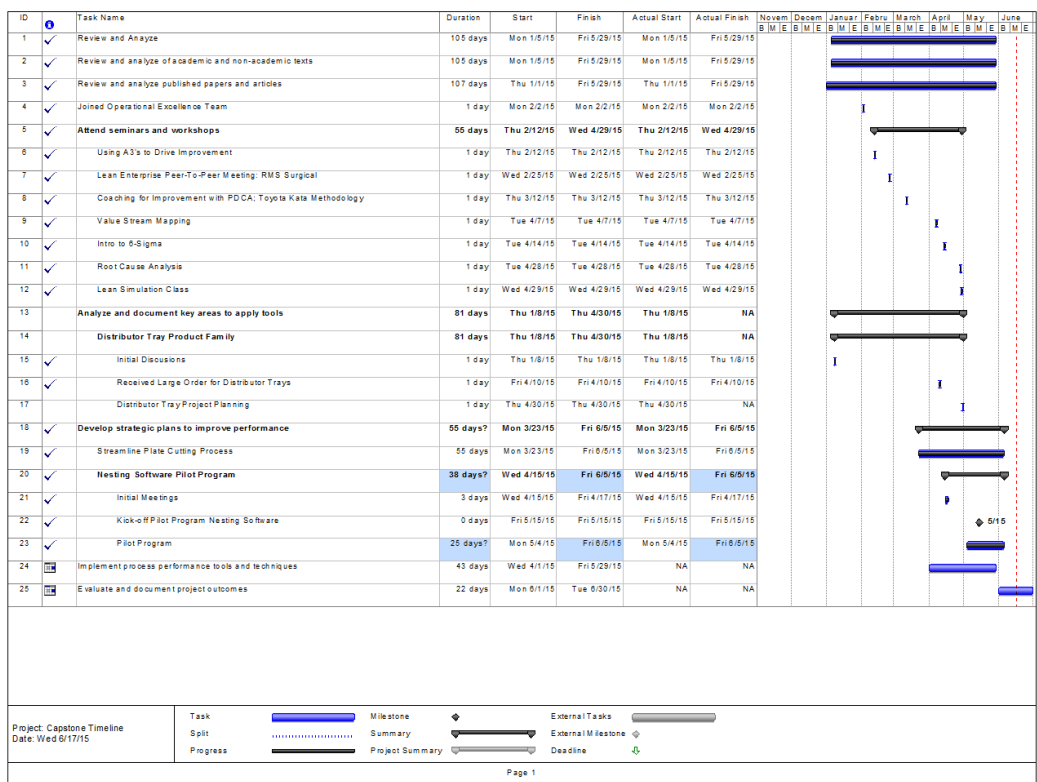


Figure 3-3
Gantt Chart

Summary

The cross-departmental Kaizen team focused on aligning HP's initiatives to improve their current position in the distributor tray market with the organizational goals to reduce manufacturing variance by increasing efficiencies and performance. Using the PDCA cycle as the continuous improvement framework the team was able drill down to a continuous improvement area that had great potential for reducing internal costs, increasing efficiencies and improving responsiveness to the customer's needs. Successful implementation of nesting software was important to helping BWT improve internal capabilities.

Chapter IV

DATA PRESENTATION AND ANALYSIS

Introduction

In early 2015, BWT had been focused on improving the overall performance of the organization. The company was looking for ways to reduce the \$4 million in manufacturing variance. The manufacturing inefficiencies and ineffectiveness that have contributed to this variance were challenging HP's ability to gain competitive advantage in the distributor tray market. Improving the distributor tray process was one of HP's top 2015 initiatives. The current state of the distributor tray process was evaluated and a future state was then developed to assist HP and the organization to determine where to focus their efforts. In the distributor tray process there are three main contributors to cost: material, outside services and labor. Data on plate issuing variance, scrap rates and labor variance were gathered from the ERP system to create a baseline for measuring improvements in these areas. Additionally, BWT sent a survey to their key outside vendors to further understand where the company had opportunities for improving.

Data Presentation

BWT, a custom manufacturer, often fabricates orders that occur so infrequently that they have only one production run before the part or revision changes. Therefore, when a new order is placed the standard hours for the new project are derived from historical data, gathered from previous production runs of products in the same family. Because these products are similar but different it is challenging to accurately predict labor costs.

To evaluate the current state of the organization and to determine how much of the organization’s \$4 million in manufacturing variance was attributed to labor hours information was gathered from SAP on a weekly basis from January 2015 through May 2015, see Figure 4-1.

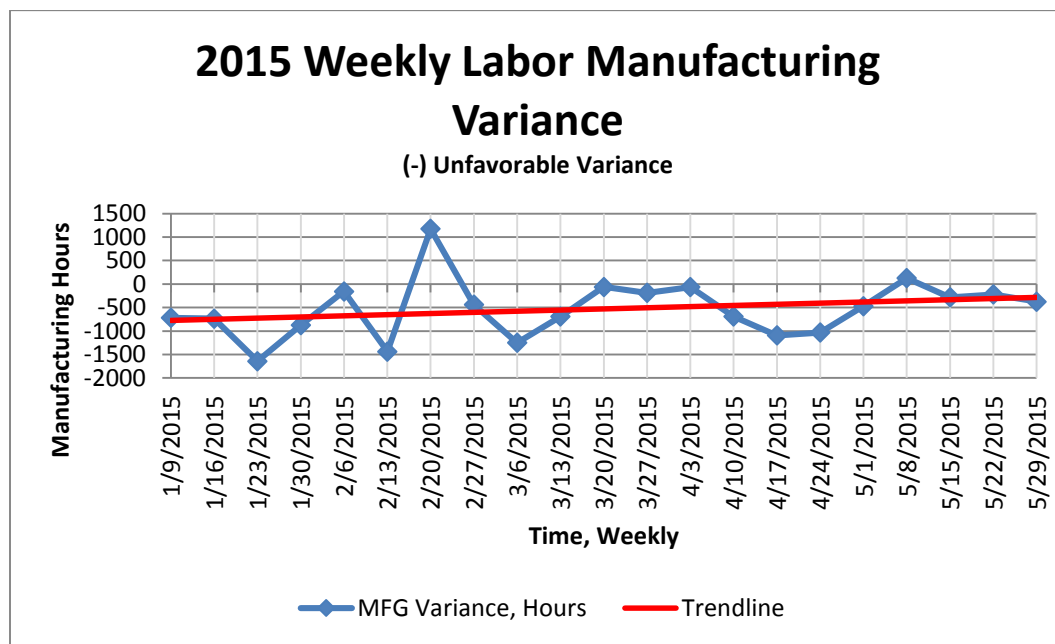


Figure 4-1

2015 Weekly Labor Manufacturing Variance

A vast majority of BWT's products are fabricated from cut plates. Therefore, to further understand the current state of the plate cutting process plate issuing variance data was gathered monthly in 2015 for 0.25" thick, 0.375" thick and 0.50" thick materials, see Figure 4-2. These thicknesses were chosen to be evaluated because they are most commonly used and because these plates generally involve plasma, laser or waterjet cutting.

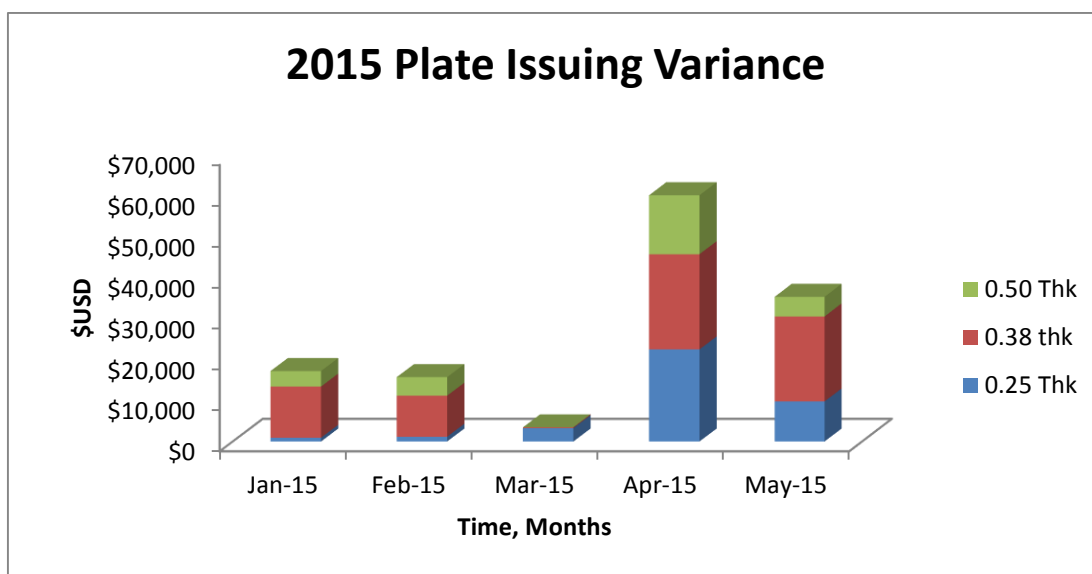


Figure 4-2

2015 Plate Issuing Variance

BWT operates in a made-to-order environment; therefore, it is critical to the schedule to order material soon after receiving an order. It is important to be responsive to the production schedule but it is equally important to the schedule and the organization's profitability to order the plate accurately. When material is ordered without any consideration of what needs to be cut from the plates it creates downstream processing issues. To evaluate how much scrap and rework contributed to the

organizations manufacturing variance, information was gathered from SAP from January 2015 through May 2015, see Figure 4-3.

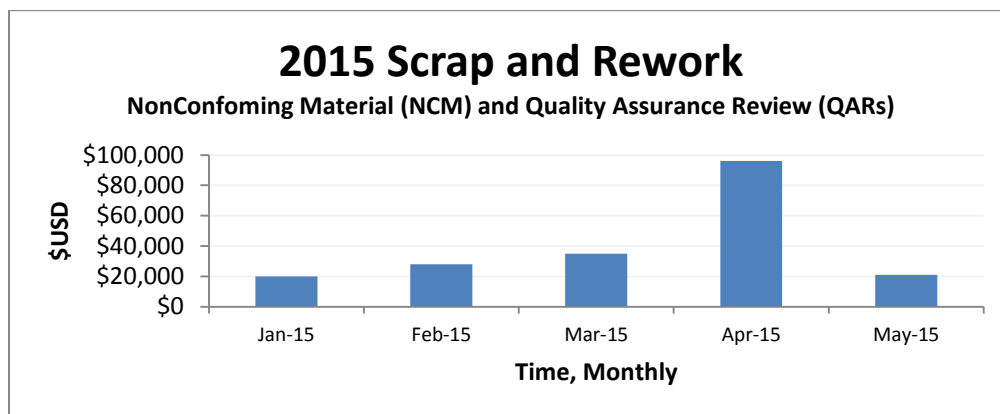


Figure 4-3

2015 Monthly Scrap and Rework Costs

In past continuous improvement efforts the company had focused on Just-in-Time (JIT) to reduce inventory. Currently, the organization loosely follows the JIT methodology but has become very wasteful over the years. There is generally no material in inventory but the scrap bins are full of poorly utilized pieces of plate on a regular basis, see Figure 4-4. Management has directed manufacturing to throw away plate that is less than 24" x 48" regardless of cost or potential future use.



Figure 4-4

Current Scrap Bins

To evaluate how labor variance, plate issuing variance and outside services costs affected the distributor tray process a current state map was created, see Figure 4-5. The current state map also revealed that often times the nesting of plates becomes the responsibility of the vendor performing the plate cutting. A survey was sent to the vendors to inquire on how to improve the plate cutting process.

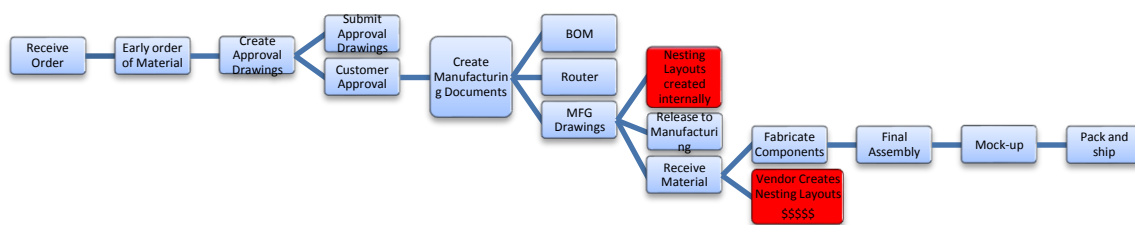


Figure 4-5

Current State Map for the Distributor Trays

A future state map was created for the distributor tray process that positioned the nesting of plate at the beginning of the process so that the process can start with a

defined plan on how to achieve optimal material utilization, see Figure 4-6. This future state would help the organization reduce internal costs and manufacturing variance

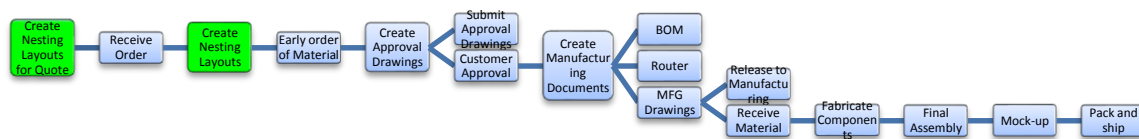


Figure 4-6

Future State Map for the Distributor Trays

Data Analysis

In the initial analysis of the HP product portfolio the Growth-Share Matrix revealed that the distributor tray market had low relative market share and moderate growth. At this position the distributor tray product family's cash need was great but cash generation was extremely low because the market share was low. This product family was a real gamble since historically it returned marginal profits at best. The company needed a solution to reduce internal costs in order to turn around this cash trap if there would be any future existence in this market; see Figure 4-7 (Henderson, 1973).

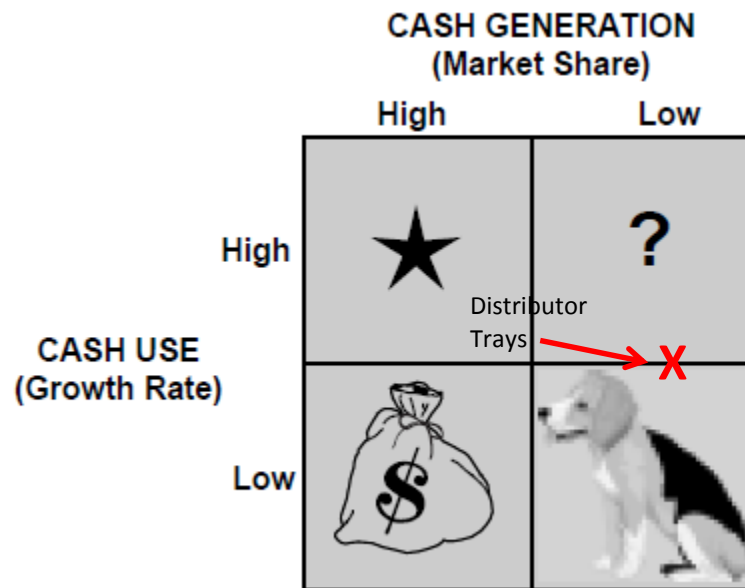


Figure 4-7

BCG Matrix (Growth-Share Matrix)

Even though BWT had a relatively low share of the distributor tray market it is an attractive market with growth potential. In 2015, the organization began to realize that with no significant investment in the distributor tray product family future orders had a high probability of the cash use exceeding the cash generated. The Growth-Share Matrix refers to these products as dogs and they are considered essentially worthless. The company was interested in the future potential of this market and opted to invest in this product family with a goal of increasing the growth rate and market share. This is where the Kaizen team for the 1st PDCA loop was established in pursuit of saving the distributor tray product family from becoming a dog. The team evaluated the current state of the distributor tray process and analyzed potential continuous improvement efforts that would increase profitability and competitive advantage to transform this struggling product family into a star.

Analysis of the current state map for the distributor tray process revealed that there is a high likelihood for variance in the process since the nesting of plates takes place at the time the plates are to be cut, see Figure 4-8. This creates inefficiencies due to the fact that material has already been ordered and manufacturing documents have already been released. Any changes at this point such as reordering more material or splicing plates create manufacturing variance.

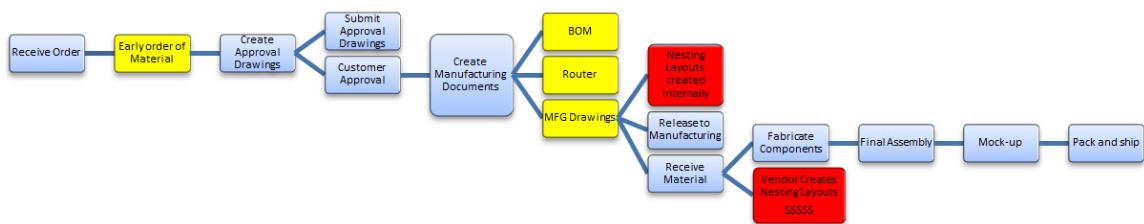


Figure 4-8

Analysis of Areas for Current Inefficiencies for Distributor Tray Process

During the Kaizen event for the 1st PDCA loop fifteen continuous improvement efforts were selected to be evaluated for implementation. However, time did not allow for all 15 efforts to be implemented on the current order. After qualitative and quantitative data was collected from past distributor tray projects the information was charted on an Impact vs. Effort Matrix and used as a project selection tool, see Figure 4-9.

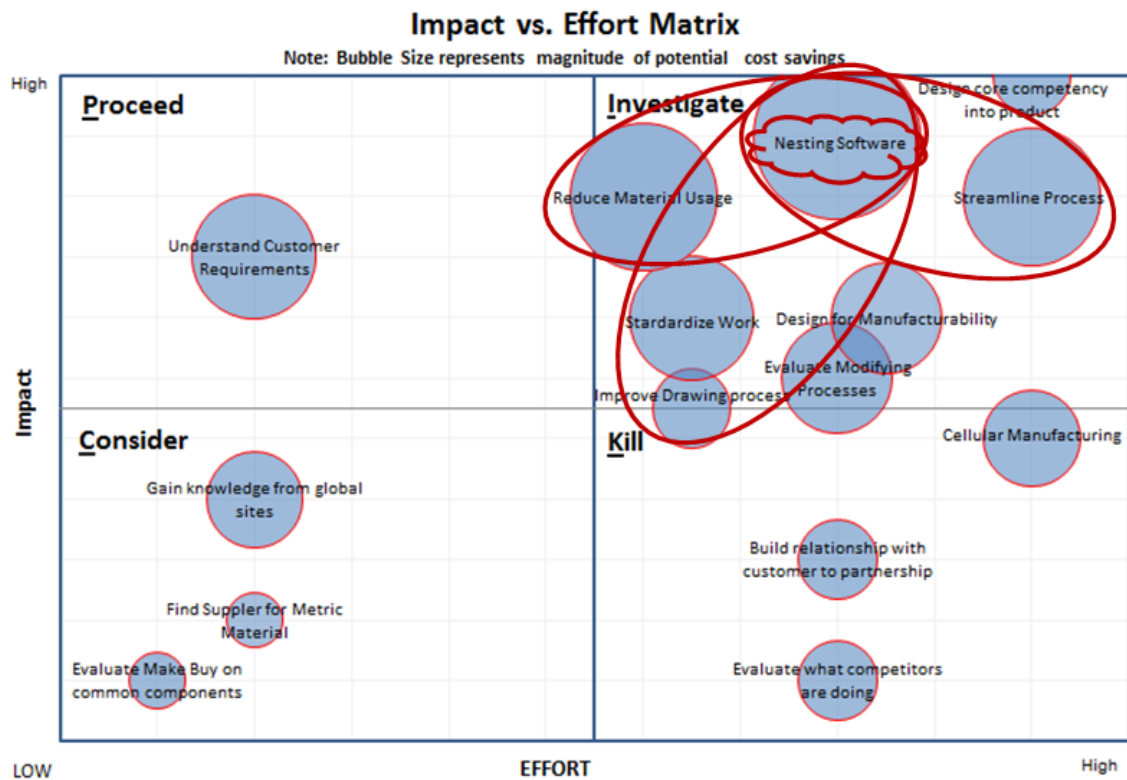


Figure 4-9

PICK Process for Project Selection

To assist the decision making process the “PICK” process was used. PICK is an acronym for Proceed, Investigate, Consider and Kill. The matrix showed that immediately the company should proceed with efforts to further understand the customer requirements. According to the Matrix the ideas that fell in the upper right quadrant should be further investigated, see Figure 4-9. These ideas were to improve the drawing process, standardize work, reduce material usage, evaluate modifying current processes, design for manufacturability, investigate nesting software, streamline manufacturing processes and design core competencies into the product. The bubble size denoted the estimated cost savings the organization could receive for implementing the improvement. The continuous improvement ideas that were chosen to be focused

on were: investigate nesting software, streamline manufacturing processes, reduce material usage and introduce standard work.

The selected continuous improvement efforts were all tied to the plate cutting process. This process was evaluated in detail in order to understand how to reach a desired future state, see Figure 4-10. In the current process an engineer records the minimal amount of material to fabricate the component(s) in each line of the Bill of Material (BOM). The quantities are a logical estimation of how much material it would take to cut the individual component(s). When the order is released to manufacturing, the ERP system evaluates the BOM, consolidates like plates within the BOM and calculates a summation for each specific plate. The shortage report is then presented to the buyer and the buyer orders standard size plates to fulfill the manufacturing requirements. When the material arrives it is sent to a laser, waterjet or plasma machine to be cut. At that time the operator collects all the individual cut files and manually nests them onto the standard size sheets that were purchased for this order. The cut files define the unique and often irregular profile of each of the components. Due to the irregular shape of these parts it is often not feasible to cut the entire assemblage of components using only the minimal allocated material specified in the BOM. Therefore, at this point in the process it is often revealed that the optimal size plate or quantity was not ordered. The discovery of this shortage drives more material to be ordered. The reordering of material, at this point in the process creates numerous issues. First, the delay in waiting for the new material to arrive pushes out lead-times and adds chaos to the internal manufacturing schedules and to the vendor's schedules. In custom manufacturing the level of chaos exponentially increases as lead-times are delayed. Purchasing more material than was initially allocated for the project creates a negative plate issuing variance which increases costs. Additionally, blindly ordering readily

available standard size sheets often results in an excessive amount of scrap due to poor material utilization. This scrap is charged to the project which also negatively impacts the plate issuing variance. Additionally, the vendor survey revealed that often vendors do not receive the correct quantity of material, which results in delays due to reordering material or extra handling as a result of receiving an excessive amount of material. This drives up our outside service costs and spreads our inefficiencies to our vendors.

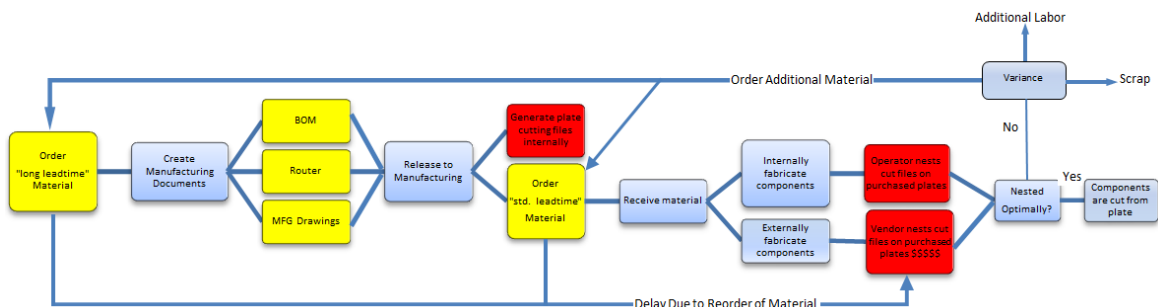


Figure 4-10

Current State Map for Plate Cutting Process

The 2nd PDCA loop focused in on improving the plate cutting process. A nesting software pilot program was established to evaluate the potential for finding a tool that could help the organization reduce plate issuing variance, labor variance, outside service costs and scrap by increasing efficiencies and effectiveness in the plate cutting process. The implementation of nesting software would allow this nesting operation to be performed efficiently at the early stages of the process. Moving the nesting operation to the front end of the plate cutting process streamlined not only the plate cutting process but also improved upon the drawing process, helped introduce standard work into the process and improved material utilization, which positively impacts manufacturing variance, see Figure 4-11.

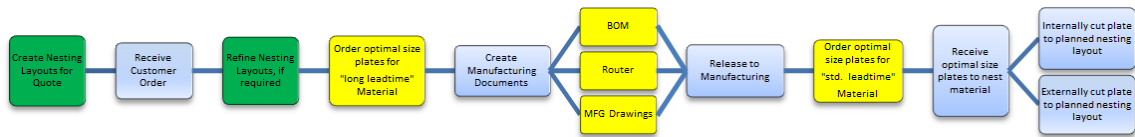


Figure 4-11

Future State Map for Plate Cutting Process

Returning to the 1st PDCA loop for the distributor tray process; the gap analysis revealed that the nesting software tool had a high probability of increasing performance by improving responsiveness, efficiency and effectiveness of the distributor tray process, see Figure 4-12.

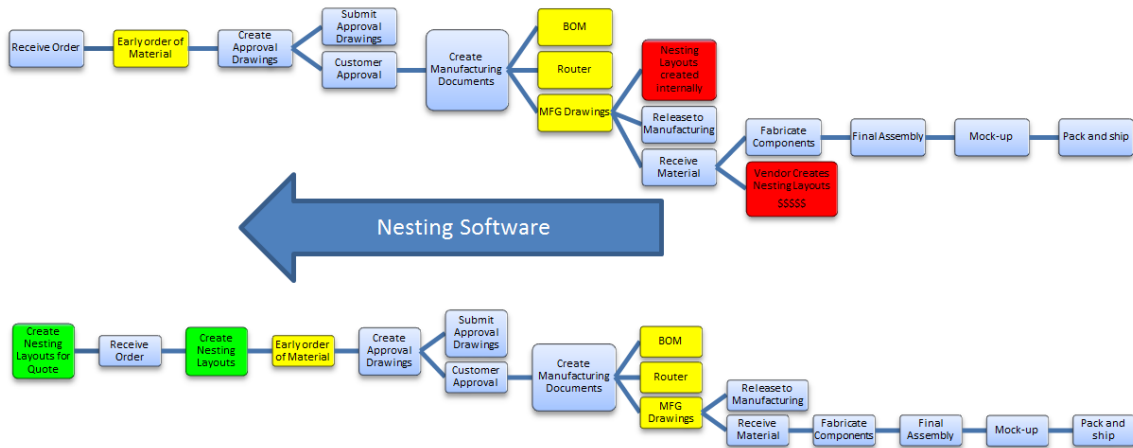


Figure 4-12

GAP Analysis for Distributor Tray Process

Additionally, it revealed that this tool could help the entire organization improve performance, reduce manufacturing variance and increase profitability. These improvements to BWT’s internal capabilities were the key to gaining competitive advantage.

Summary

The data presentation and analysis for the PDCA loops showed that improving the plate cutting process greatly improved the status of the distributor tray product family. Additionally, the PDCA loops revealed that this nesting software tool could be implemented across all of the product families to help the organization as a whole reduce manufacturing variance and internal costs. Performing the nesting at the early stages of the process allowed a plan to be developed and implemented into the manufacturing documents. Using standard work to effectively communicate the plan to all the stakeholders greatly increased the probability of executing the plan. Execution of the plan optimized material utilization which nearly eliminated all manufacturing variance linked to the plate cutting process.

In 2015, HP's initiatives included promoting product growth and increasing market share for the distributor tray product family. Simultaneously, BWT's mission was to focus on continuous improvement to reduce internal costs and increase internal capability across the organization. Market share is a byproduct of pursuing a company's core mission (Leonard, 2004). Market share is the result of a sustainable competitive advantage, not the cause. By focusing on the company's mission to improve internal capability, BWT will improve their odds at increasing profitability and competitive advantage. Furthermore, this improvement of internal capabilities is the key to helping HP gain market share in the distributor tray's tranquil environment.

Chapter V

RESULTS, CONCLUSION, AND RECOMMENDATIONS

Introduction

The proposed continuous improvement strategy to introduce the nesting operation into the early stages of the manufacturing process is being beta tested for the current in-process distributor tray order. The order will not be completed until February of 2016; therefore, the only attainable cost savings to date are baselined from the estimated costs for this project. Nesting was performed at the early stages of the process and effectively communicated to all the stakeholders. The plan for optimizing material utilization was displayed on the manufacturing documents to effectively communicate the plan to the rest of the stakeholders. Implementing the streamlining of the distributor tray process has already provided cost savings in the ordering of material. Therefore, the continuous improvement efforts for these two PDCA loops have already begun to show promising results.

Results

The cross-departmental Kaizen team realized through their evaluation of the distributor tray process that it was important to align their efforts for improving the current state of the distributor tray process with the organizational goals to reduce manufacturing variance by increasing efficiencies and performance. The Kaizen team used PDCA cycles as the process improvement framework to drill down to a continuous

improvement strategy that had great potential for reducing internal costs, increasing efficiencies and improving responsiveness to the customer's needs.

The proposed continuous improvement strategy focused on improving internal capabilities of the plate cutting process, which involves a vast majority of BWT products. The first project question was, "How do you get the other business units, not associated with the distributor tray market, onboard and aligned with the continuous improvement initiatives that could benefit the organization as a whole?" This is answered by the fact that nesting software addresses the needs of every business unit that deals with cutting components from plate on a regular basis. Personnel from the other business units got onboard and aligned with these efforts by having active participation in the nesting software selection process.

The second project question was, "What continuous improvement efforts can be achieved in the immediate future that will have the greatest impact on reducing internal variance and cost while improving delivery and maintaining quality for the distributor tray product family?" Although nesting software was not purchased at the onset of the current distributor tray order the streamlining of the plate cutting process could be implemented immediately. A beta test was performed on this current order to prove out the benefits of moving the nesting operation to the front end of the distributor tray process. Once the distributor tray order was placed the engineering department manually nested the components on the optimal size plates. The desired plate sizes were then passed to the purchasing department to be ordered. Creating a nesting layout plan upfront saved the company \$80,000 in material costs with respect to the quoted volume of plate, which in the past would have been ordered for early order materials. Optimizing material usage upfront allowed the entire plate to be allocated to the bill of material for the current project. Additionally, standard work was introduced

into the manufacturing work instructions and drawings to effectively communicate the plan for utilizing the material to all the stakeholders.

The actual cutting of the plates for the current distributor tray order will not take place until the Fall of 2015; however, if the plates are issued as stated in the bill of material and work instructions and cut to the planned nested layout shown on the drawing all scrap will be eliminated since the minimal material waste was accounted for in the bill of material. Precisely executing the plate cutting plan later this year will result in zero plate issuing variance. Additionally, there will be no added labor costs or outside service costs associated to a recovery plan.

The third problem question was, "In order to sustain these continuous improvement efforts what modifications to the methodologies need to be further addressed to fit with this custom manufacturer that operates in a high-mix and low-volume environment?" This question was answered by showing the flexibility and responsiveness of the nesting software that's available. The nesting software tool does not consider if you are operating in a low-mix, high-volume manufacturing plant or a high-mix, low-volume custom fabrication shop. The nesting software tool has been designed to help optimize material utilization for any manufacturing environment. Custom libraries built with respect to the organization's product families allow quick responsiveness even at the quoting stage.

Conclusion

The SWOT analysis and Growth-Share Matrix shed light on BWT's unfavorable current position in the distributor tray market, but also showed the potential for growth in the market. Due to the slow-cycle of technology BWT had to look to improve their internal capabilities to increase the gap between the customer's perceived value of the

product and the actual cost of the product. Reducing the internal costs and increasing the organization's internal capability is how profitability is increased and competitive advantage is gained. In markets with growth potential sustaining competitive advantage as long as possible is how market share is increased. This is done by continuing to improve internal capabilities. For BWT this study showed that to combat external threats and to capitalize on opportunities the organization must look to continuous improvement strategies to turn their weaknesses into strengths. BWT has proven through the beta test for the distributor tray project that improving the efficiency and effectiveness of the plate cutting process is lucrative, proven by a 20% reduction in plate cost for this project. Implementation and sustainability of these efforts will be essential in gaining competitive advantage and increasing the success of this custom manufacturer.

Recommendations

The recommendation from this study is to further improve the plate cutting process by purchasing nesting software. The nesting software pilot program selected ProNest software as the tool of choice (see Appendix B.6). The purchasing of this tool was justified from the cost savings on the beta test for the distributor tray project (see Appendix B.5). An Authorization for Expenditure (AFE) was written to show that the organization would receive payback within a 2 year period if similar savings were seen across other major projects within the organization (see Appendix B.7 & B.8). Utilizing this tool on two major projects the first year and three major projects the second year would provide the organization a return on investment. These major projects are only a fraction of the work that flows through the organization; there are numerous other projects of various sizes that would benefit from this tool.

A further recommendation is to appoint one person to take ownership of the nesting software. Initially all nesting projects should run through this person for a period of time prior to rolling out the software to other personnel. The candidate will need to work closely with sales, engineering and manufacturing to further improve the plate cutting process and develop standard work and procedures for using the nesting software.

The author advocates that the company's mission stay focused on continuous improvement efforts. As the company closes the gap between the current state and the future state of the plate cutting process they should evaluate expanding the capability of the nesting software to manage plate inventory and organize the flow of work orders through the ERP system.

Last, the author highly recommends that the organization focuses on transforming the culture from one of complacency to one of Operational Excellence. This project promoted a synergistic approach that required employee engagement and team work throughout the entire organization. "To really build a sustainable culture that will benefit your employees and your bottom line, it's important that leaders include their team in shaping the culture and commit to working on it for the long term," (Spiegelman, 2014). The author believes it is vital for BWT to successfully transform the culture into one that understands the importance and value behind Operational Excellence methodologies. This culture shift will be the driving force behind the organizational change required to sustain continuous improvement efforts. By applying these internal Operational Excellence strategies successfully, this custom manufacturer will improve its internal capabilities and reduce costs which will greatly increase their ability to compete against its global competitors.

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APPENDIX A

Supporting Documents for PDCA Loop #1: Distributor Tray Cost Reduction

A.1 OES Problem Solving Form: Distributor Tray Cost Reduction

OES Problem Solving Form		Teams / Department Assisting in Cross Functional Effort: Technical/Sales, Engineering, Purchasing, Manufacturing, Quality, Manufacturing Engineering, Project Management and Management																																								
Team / Department / Area: HP Person Responsible: _____ Date Assigned: April 9, 2015		Sponsor Assigned: _____ Date Due: February 2016																																								
<p>Problem Statement (Describe in terms of the specific negative effect on the process or company)</p> <p>Over the last 5 years, BWT has quoted an estimated \$55M. Of the quoted \$55M, we have won \$1M worth of projects. The margins of the projects won by BWT have been between -5% to 15% based on final financial results After production. Based on past performance and market data, BWT is not able to offer competitive pricing to capture a larger portion of the market.</p> <p>Data Collection - Understand the situation through Data (Document data source and findings)</p> <p>Data from Quoted Project:</p> <ul style="list-style-type: none"> Total Material Cost(\$)=Information removed Total Outside Service(\$)=Information removed Total Labor Cost(\$ for Total job)=Information removed Cost(\$)=Information removed Eng. Cost(\$)=Information removed Contribution Margin(\$)=Information removed Revenue(\$)=Information removed Ext. Quoted Value from Competitor(\$): 27% lower than BWT <p>Objective (Describe in terms of the specific outcome desired for the process or company)</p> <p>To reduce costs by 20-30% based on data collection and apply the technologies developed from current distributor tray project in order to validate the costs savings measures. Develop and record the operational standards (Purchasing, Engineering, and Production) to efficiently manufacture the distributor tray product family.</p> <p>Long term goal is to have a product line with continuous production of the distributor trays. A stable marketplace exists where BWT could benefit from multiple projects per year which would correlate to having a manufacturing cell and dedicated equipment to manufacture distributor trays.</p> <p>Conduct RCA (Root Cause Analysis) (Document approach used and findings)</p>		<p>Action - Specific Action Plan Steps to reach the Objective</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Who</th> <th>will do What</th> <th>by When</th> </tr> <tr> <th>Responsible Person</th> <th>Actions to be taken</th> <th>Target Date</th> </tr> </thead> <tbody> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> </tbody> </table>		Who	will do What	by When	Responsible Person	Actions to be taken	Target Date																																	
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<p>Solution - Identify and select the solution (Document how solution option was selected)</p>		<p>Verify - Analyze what happened (Verify by data findings - "Did the solution solve the problem?")</p> <p>Was the Overall Action Plan Effective? YES <input type="checkbox"/> NO <input type="checkbox"/></p> <p>Was the Root Cause Eliminated? YES <input type="checkbox"/> NO <input type="checkbox"/></p> <p>Was the Objective Achieved? YES <input type="checkbox"/> NO <input type="checkbox"/></p> <p>Standardize - Modify or Create Standards Sustain - Monitor and Sustain over time</p> <p>Controlled Documents Modified? YES <input type="checkbox"/> NO <input type="checkbox"/> Create <input type="checkbox"/> Scheduled Audit Date: (30 days) _____</p> <p>Standard Work Modified? YES <input type="checkbox"/> NO <input type="checkbox"/> Create <input type="checkbox"/> Audit Results: Problem Solving Effective? YES <input type="checkbox"/> NO <input type="checkbox"/></p> <p>Communicate - Problem Solving Results (communicate to learn)</p> <p>Communication Needed? Plant <input type="checkbox"/> Global <input type="checkbox"/></p> <p>Report-Out Held on Date: _____ Form Completion Date: _____ Sponsor (initials): _____</p>																																								

A.2 Brainstorm Ideas for Distributor Tray Process: White Board 1 of 7

- Use Metric plate as standard material
- Fixture for welding the tubes on trays.
- Fixture to weld banding
- Separation of fitup vs. welding
Currently: 95% vs. 5%
- Roles + responsibilities to define the how/what, etc.
- Dedicated floor space.
- Design for manufacturability
- Nesting Program for maximize matrl. usage.

WE GOT IT! WE GOT IT! TO MINIMIZE FLOW INTERRUPTS WITH MANUFACTURING.

- CAN WE BRING IN TO FLOW (UNUSE PIECE) INTO IN CASE HAVE TO PICKUP + CLEAN WHEELS

A.3 Affinity Diagram: Ideas Captured from White Board #1

Cost Reduction Ideas	Technical Sales	Engineering	Purchasing	Quality	Manufacturing	Manufacturing Engineering	Project Management	Management Commitment	Future Evaluation
1 Use Metric Plate as Standard material		X	x						
2 Fixture for welding the tubes on trays					x	X			
3 fixture to weld banding separation of fit-up 95% vs. welding 5%					X	x			
4 Roles and Responsibilities to define how/what etc.								x	
5 Dedicated floor space					x			X	
6 design for manufacturability	x	X							
7 nesting program for maximize material useage		X				x			
8 negotiate with UOP to minimize flow disruptions with manufacturing	x			x			X		
9 Can we break down to flow (single piece) out to		x			X				
10 have to passivate and clean welds	x		X						

A.4 Affinity Diagram: Engineering Department's Areas of Focus

	Technical Sales	Engineering	Purchasing	Quality	Manufacturing	Manufacturing Engineering	Project Management	Management Commitment	Future Evaluation
1 Use Metric Plate as Standard material		X	X						
6 design for manufacturability	X	X							
7 nesting program for maximize material useage		X				X			
9 Can we break down to flow (single piece) out to		X			X				
11 cartoon drawing to reduce drawings		X							
12 ikea drawing (see Mike E.)		X							
13 Plasma cut beam flange	X	X			X				
21 10mm late vs 6mm palte for V/L tray	X	X			X				
22 recreate the drawings (same as #11)		X							
26 understanding customer requirements - do we really un	X	X		X					
27 understand the scop of the project early on	X	X		X					
30 Do we overengineer?		X							
31 Use more material than we need		X							
32 UOP work to optimize / become our partner	X	X			X				
37 tools - parent relation support for products / primary prc	X	X		X					
41 Shear banding vs. laser		X	X						
42 standardize banding / bolting		X							
43 strategy for global purchasing		X	X					X	X
44 Deal with Foundational barriers that negatively impact - leverage bocami		X			X		X		
47 Standarize work - Engineering / Manufactuirng / Quoaotr	X	X		X	X				
49 Positive location of risers		X							
50 do we have to mock-riser beams with trays	X	X		X					
51 plasma template/ etching of truss beam webs		X	X			X			
53 BEI is effective - have we learned what we can?		X				X	X		
54 Laser cut truss beam supports vs. cutting		X	X						
56 why machine pipe stack - can we laser cut/remove machining?		X	X						
58 Reduce amount of upfront paperowk to UOP (not sendir	X	X							
59 make just cut drawings - not entire print		X							
60 laser cut pipe and evaluate outcome	X	X		X					
61 machine risers in house - Mazak		X			X	X			
65 Minimize TIG / Maximize MIG or Alternative Process?		X		X	X				
67 Fuze Weld Pipes (manual, how to handle WPS/PQR)	X	X		X	X	X			
69 Heavy duty spot welder for caps		X				X			
70 plug weld for pipes/cap		X			X				
71 more mechanical joining vs welding	X	X							
72 what are the top 10 things that go wrong from previous p	X	X		X	X		X		
75 reverse engineer - see what competition was/is doing		X							
82 Leverage building in a core competency - not just a job shop		X			X				
83 Get good at critical aspects of the job/product	X	X	X	X	X	X	X	X	
89 J-clips - Purchase?		X	X						
92 get supplier input to assist us - give Baur our prints		X	X						

Appendix B

Supporting Documents for PDCA Loop #2: Nesting Software Pilot Program

B.1 OES Problem Solving Form: Nesting Software Pilot Program

OES Problem Solving Form		Team / Department / Area: Engineering		Sponsor Assigned: Ken Springob		Team / Department Assisting in Cross Functional Effort: Product Designers from HR, GI/Architectural, Water Usage and Application Engineering Departments																																													
Person Responsible: Robin Moore-Savva		Date Assigned: April 20, 2015		Date Due: June 12, 2015																																															
Problem Statement (Describe in terms of the specific negative effect on the process or company) In 2006, the plate cutting process underwent a change in roles and responsibilities, which led to inefficiencies in the process and a lapse on the nesting software license. These factors have contributed to poor transfer of information which has resulted in increased issuing variance and lead times.				Action - Specific Action Plan Steps to reach the Objective <table border="1"> <thead> <tr> <th>Who</th> <th>will do What</th> <th>by When</th> <th>Completion Date</th> </tr> </thead> <tbody> <tr> <td>Product Designer #1</td> <td>Lead the testing of SignaWise</td> <td>6/9/15</td> <td>7/17/15</td> </tr> <tr> <td>Product Designer #2</td> <td>Lead the testing of Striker Systems</td> <td>6/9/15</td> <td>NA</td> </tr> <tr> <td>Product Designer #3</td> <td>Lead the testing of BobCAD</td> <td>6/9/15</td> <td>7/17/15</td> </tr> <tr> <td>Product Designer #4</td> <td>Lead the testing of SubopWise</td> <td>6/9/15</td> <td>NA</td> </tr> <tr> <td>5</td> <td></td> <td></td> <td></td> </tr> <tr> <td>6</td> <td></td> <td></td> <td></td> </tr> <tr> <td>7</td> <td></td> <td></td> <td></td> </tr> <tr> <td>8</td> <td></td> <td></td> <td></td> </tr> <tr> <td>9</td> <td></td> <td></td> <td></td> </tr> <tr> <td>10</td> <td></td> <td></td> <td></td> </tr> </tbody> </table>				Who	will do What	by When	Completion Date	Product Designer #1	Lead the testing of SignaWise	6/9/15	7/17/15	Product Designer #2	Lead the testing of Striker Systems	6/9/15	NA	Product Designer #3	Lead the testing of BobCAD	6/9/15	7/17/15	Product Designer #4	Lead the testing of SubopWise	6/9/15	NA	5				6				7				8				9				10			
Who	will do What	by When	Completion Date																																																
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6																																																			
7																																																			
8																																																			
9																																																			
10																																																			
Data Collection - Understand the situation through Data (Document, data source and findings) Material variance data for .575 Thick Plate was run for production orders completed between 1-1-2015 and 5-31-2015 that led to any of the following components: 249259 PLATE, 0.575 THK SS 304, 118380 PLATE, 0.575 THK 316 SS HR 30215, 244071 PLATE, 0.575 THK SS 316, 246658 PLATE, 0.575 THK SS 321H, 247575 PLATE, 0.575 THK SS 316, 247575 PLATE, 0.575 THK SS 316, 247582 PLATE, 0.575 THK SS 304L, 247608 PLATE, 0.575 THK SS 321, 200215 PLATE, 0.575 THK 304H SS200. There were 89 total component lines. All but 29 had nonzero issue quantity. Of these the total variance was unfavorable by close to \$2000 square inches. Additionally, BobCAD-CAM was found to be last upgraded in January 2008.				Verify - Analyze what happened (Verify by data findings - "Did the solution solve the problem?") The Nesting Pilot Program revealed that SignaWise and BobCAD software outperformed all others. First, choose from each of the nesting software suppliers provided, BobCAD to be the more cost effective option. Pilot test was the selected software. Was the Overall Action Plan Effective? YES <input type="checkbox"/> NO <input type="checkbox"/> Was the Root Cause Eliminated? YES <input type="checkbox"/> NO <input type="checkbox"/> Was the Objective Achieved? YES <input type="checkbox"/> NO <input type="checkbox"/>																																															
Objective (Describe in terms of the specific outcome desired for the process or company) Launch a Pilot Program to internally test and select a Nesting Software. The nesting software is a tool that will assist the Engineer/Product Designer at laying out and displaying nesting diagrams to communicate to Purchasing the optimal size plate to order and it will communicate to our Internal/external manufacturers the plan for cutting the material. Upfront planning and improving the transfer of information for this process will result in a reduction in issuing variance and reduction in lead times.				Standardize - Modify or Create Standards Controlled Documents Modified? YES <input type="checkbox"/> NO <input type="checkbox"/> Create <input type="checkbox"/> Standard Work Modified? YES <input type="checkbox"/> NO <input type="checkbox"/> Create <input type="checkbox"/>																																															
Conduct RCA (Root Cause Analysis) (Document approach used and findings) Team conducted a brainstorming session on important factors to consider for a Nesting Software. The team then voted on the 25 factors to help generate a spreadsheet to assist the selection of a nesting software.				Sustain - Monitor and Sustain over time Scheduled Audit Date: (30 days) _____ Audit Results: Problem Solving Effective? YES <input type="checkbox"/> NO <input type="checkbox"/>																																															
Solution - Identify and select the solution (Document how solution option was selected) Data was gathered on ten Softwares: SignaWise, ProNest, Router-CIM, SoftONE NC from Quessoft, Striker Systems, BobCAD, MyNesting.com, Plus 2D, DigNestRiq and FastCUT. From the (10) software evaluated (4) were chosen to bring in-house for a pilot program. The four softwares are: ProNest, Striker Systems, SignaWise and Router-CIM.				Communicate - Problem Solving Results (communicate to learn) Communication Needed? Plant <input type="checkbox"/> Global <input type="checkbox"/> Reason-Out Held on Date: _____ Form Completion Date: _____ Sponsor (Initial): _____																																															

B.2 Brainstorming and N/3 Voting for Nesting Pilot Program

- COMPATIBLE w/ IN VENTOR + AUTO CUT
- USER FRIENDLY
- USE LAYERS FOR TEXT/ETCHING
- PLASMA/WATER JET/LASER
- NETWORK LIC - V. STANDALONE
- CAN'T BE SLOW/BOW DOWN
- COST JUSTIFIABLE
- EASY TO COMMUNICATE w/ COLLEAGUES
- HARD FOR CUSTOMER TO REPLACE
- OPTIMIZE BEST MTL CHOICE BASED ON PRICE
- SOFTWARE TO BE UNCHANGABLE
- TIME PROGRAM/PURCH IMPROVEMENT
- 1D PARTS PLATED ON PLATE (THICKNESS RECOMMEND)

- USES "DRIPS" FOR BEST MTL UTILIZATION
- NOT RIGID SCREEN
- CUSTOMER SUPPORT
- LOT OF FEATURE UPGRADES
- ADD-ONS AS WE EVOLVE
- ASSIST IN BRINGING MTL ACCURATELY (VARIABLES)
- IN HOUSE DRIP PLOTS - IMPROVE? FROM CUSTOMER?
- ASSESSMENT SCHEM FOR VALIDATION
- EVALUATE w/ DRIPTEST - MOST MTL CHOICE OVER/UNDER 2492
- THIS KNOWLEDGE/SCREEN/PLATE (MATERIAL)
- TRAINING SESSIONS?
- REFINEMENTS - 1/2 HOUR 3000000

B.3 Score Card: Nesting Software

		Nesting Softwares									
Criteria Rating	Important Criteria for Nesting Software	Signanest	Pronest: Hypertherm	Router-CIM	SoftONE NC from onesoft	Striker Systems	BobNEST (BobCAD)	Mynesting.com	Plus 2D	DGNestPro	FastCUT
****	Compatible with Inventor and Autocad	Y	Inventor Module Import CAD	Y	DXF IMPORT	Y	AUTOCAD ONLY	Uses DXF	dxflonly	UNCERTAIN ONLY DXF SHOWN	DXF
****	Customer Support	Y	Subscription	Y	SUPPORT CONTRACT	SUBSCRIPTION	Y	FAQ and e-mail	Y	EMAIL	30 DAY WARRANTY/ SUPPORT FEE BASED AFTER
***	Use Layers for Text/Etching	Y	Y	Y	Y	Y	Y		Y	SHEETCAM	Y
***	Plasma/WaterJet/Laser Auto Pick Correct Plate Size	Y	Y	Y	Y	Y	Y		Y		
***	Time Reduction/Process Improvement	Y	Y	Y		Y	Y	Y		Y	
***	Add-on's as We Evolve	Y	Y	Y		Y			Y	SHEETCAM	DIFFERENT LEVELS OF INDIVIDUAL MODULES
**	Network License - vs. Stand-alone	BOTH	Y			BOTH	STAND ALONE	Free software Download/Nest Credits	Both	STAND ALONE	STAND ALONE
**	Capable with Communication with Columbus	Replaces Columbus	Major Brands/ Manufacturers	APPEARS SO	ESAB COMPATIBLE	DWG	DWG (NC CODE)	Exports to DXF	CUSTOMIZABLE		COMES WITH MULTIPLE NC CONTROLLERS
**	Can Control Rotation of Plate (Grain Constraint Option)	Y	Y			Y		Y	Y		
Software Score:		10	9	6	2	8	6	3	5	2	4

B.4 RACI Chart: Nesting Software Pilot Program

RACI Chart		Responsibility Assignment Matrix (RAM)										
Activity (WBS)		Product Design #1	Product Design #2	Product Design #3	Product Design #4	HP Engineer	Op. Exc. Coach	Sponser	Accounting	Data Expert	IT	Mfg Eng
Define	Define Problem Statement	I	I	I	I	R, A	C	C	I	I	I	I
	Collect Data	I	I	I	I	A	I	I	C	R	C	C
	State Objective	I	I	I	I	R, A	C	I	I	I	I	I
	Develop Team	C	C	C	C	R, A	C	I	I	I	I	I
	Brainstorm Key Factors	R	R	R	R	A	R	I				I
Gather Data	MyNesting.com	C	C	R	C	A	I				I	I
	ProNest	C	C	R	C	A	I				I	I
	Router-CIM	C	C	C	R	A	I				I	I
	SigmaNest	C	C	C	R	A	I				I	I
	BobNest	C	C	C	R	A	I				I	I
	Striker Systems	C	R	C	C	A	I				I	I
	SoftONE NC	C	R	C	C	A	I				I	I
	FastCut	C	R	C	C	A	I				I	I
	DGNestPro	R	C	C	C	A	I				I	I
Plus2D	R	C	C	C	A	I				I	I	
Pilot Program	Create Scorecard for Software	R	R	R	R	A	C					I
	Determine Test Samples	R	R	R	R	A	I					
	Determine (4) Trial Versions	R	R	R	R	A, R	C	I			I	C
	Test ProNEST Trial Vesion	C	C	R	C	A	C				C	C
	Test Router-CIM Trial Vesion	C	C	C	R	A	C				C	C
	Test Stryker Systems Trial Vesion	C	R	C	C	A	C				C	C
	Test SigmaNest Trial Vesion	R	C	C	C	A	C				C	C
Score Nesting Software	R	R	R	R	A	C					I	
Selection	Evaluate Collected Data	R	R	R	R	A, R	C				I	I
	Select Nesting Software	R	R	R	R	A	C	C			C	C
	Present Selection to Management	R	R	R	R	A, R	R	C	I	I	I	I
Key												
Responsible (R)		for Completing the Step in the Process										
Accountable (A)		for ensuring the step is completed (Assigned to 1 person ONLY)										
Consult (C)		prior to the completion of that step for knowledge, information or expertise										
Inform (I)		of the results once the step is completed (Mostly "FYI")										

B.5 Nesting Software Purchase Justification

Objective:

- Request to purchase ProNest nesting software.
- Plasma Package Network License includes: Advance Plasma Machine Post Processor, Automatic Nesting, Collision Avoidance, Skeleton Cut-up, and annual software subscription

Background:

- Nesting software optimizes material utilization, which allows purchasing to order the desired size plates, see Figure 1. Optimizing plate layouts reduces variance, rework costs and scrap associated to inefficient nesting of plates.

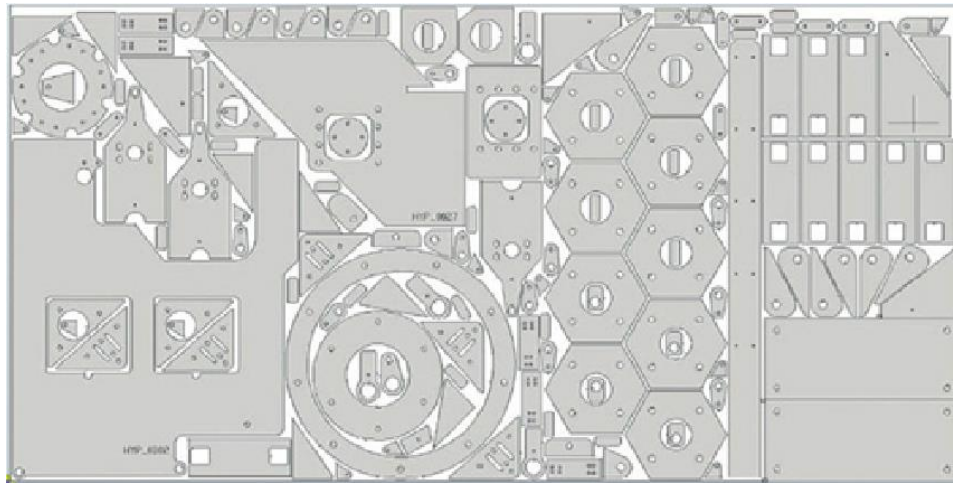
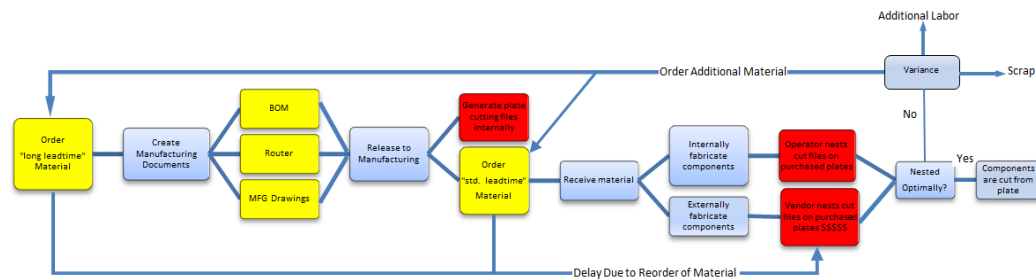


Figure 1: Optimization of material utilization using ProNest Software

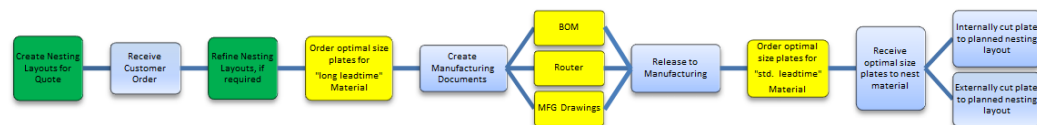
- From January 2015- May 2015 approximately \$150,000 in plate issuing variance was recorded for 0.25", 0.38" and 0.50" thick material.
- Manually nesting 0.25 thick plates for the current distributor tray project resulted in utilizing 140,000 in² less plate than initially projected on project quote. This optimization took 32 engineering hours to save the organization \$20000 in material costs.

Current state:



- The current process nests parts at the point in the process when the plate is being cut.
- Many times the material utilization is poor, which causes rework, scrap and reordering of material.
- The inefficiencies with the plate cutting process drive up costs and cause major delays.

Future state:



- Perform the nesting operation at the front end of the process, prior to ordering of material.
- Performing nesting at the initial stages of the process allows a plan to be developed that promotes ordering optimal size plates. The nesting layouts are then visually conveyed on the manufacturing documents so that the plan can be effectively interpreted and executed.
- An executed plan results in reduced material variance, rework, scrap and delays in the plate cutting process.

Business considerations:

- In 2015, the organization is on course to have approximately \$350,000 in plate issuing variance. Nesting software is a tool that could help the organization reduce cost associated to plate issuing variance by 10% the 1st year with an incremental increase of 5% each following year for a 5 year evaluation period.
- The initial cost of Pronest nesting software is \$35,900. The AFE shows an IRR 63.2% and a payback period of 2 years.

Summary:

- Nesting software is a tool that will help the company reduce manufacturing variance, reduce costs, eliminate delays and increase the overall efficiency of the plate cutting process.

B.6 Nesting Software Line Items for Authorization of Expenditure (AFE)

<i>Line Item Information</i>												
Line Items: (In USD Thousands)												
Product Line	System	Acct Code	Part Number	Description	Qty	Unit Cost	Year Cash Req'd	Qtr	\$ Exp	\$ Cap	Make or Buy	Line Total
35	Pronest Nesting Software			Plasma Package Network License	1	\$ 17.2	\$ 17.2	Q3-2015	\$ 17.2		Buy	\$ 17.2
	0 3D Process Module			Inventor Software Interface, Network License	1	\$ 3.3	\$ 3.3	Q3-2015	\$ 3.3		Buy	\$ 3.3
	0 Enterprise Modules			Nesting System Optimization, Network License	1	\$ 3.9	\$ 3.9	Q3-2015	\$ 3.9		Buy	\$ 3.9
	0 Enterprise Modules			Plate Inventory, Network License	1	\$ 3.3	\$ 3.3	Q3-2015	\$ 3.3		Buy	\$ 3.3
	0 Additional License			10% of above	3	\$ 2.8	\$ 2.8	Q3-2015	\$ 8.3		Buy	\$ 8.3
	0											\$ -
Total Purchase									\$ -	\$ 35.9		\$ 35.9

B.7 Profit & Loss Analysis for AFE

P & L for AFE									
(In USD Thousands)									
Years	1	2	3	4	5	6	7	Total	
Cost Savings	35.0	52.5	70.0	87.5	105.0	-	-	350.0	*Savings 10% of yearly cost due to plate issuing variance. Increased by 5%/yr
Total Savings	35.0	52.5	70.0	87.5	105.0	-	-	350.0	
Repairs & Maintenance	-	1.8	1.8	1.8	1.8	-	-	7.2	
Consumables	-	-	-	-	-	-	-	-	
Labor(Costs)	3.5	5.3	7.0	8.8	10.5	-	-	35.0	*10% of Cost Savings
Other(depreciation)	-	-	-	-	-	-	-	-	
Other(DC) COGS	-	-	-	-	-	-	-	-	
Depreciation	7.2	11.5	6.9	4.1	4.1	-	-	33.8	*MACRS (5-year Compute Software)
Start-Up Expense	15.0	5.0	-	-	-	-	-	20.0	*Implementation and Training
Calculated DC*	-	-	-	-	-	-	-	-	
Total Direct Costs	25.7	23.5	15.7	14.7	16.4	-	-	96.0	
Gross Margin	9.3	29.0	54.3	72.8	88.6	-	-	254.0	
Misc. SG&A	5.3	7.9	10.5	13.1	15.8	-	-	52.5	*15% of revenue
Total G&A and Selling Costs	5.3	7.9	10.5	13.1	15.8	-	-	52.5	
Operating Profit before Other Oper Exp	4.1	21.1	43.8	59.7	72.8	-	-	201.5	
Other Operating (Inc)/Exp (Interest/Other)									
Interest Expense	-	-	-	-	-	-	-	-	
Operating Profit After Other Oper Exp	4.1	21.1	43.8	59.7	72.8	-	-	201.5	
Operating Profit After Tax	2.8	14.8	30.7	41.8	51.0	-	-	141.0	
Investment Amount		\$35.9							
Investment IRR Rate		63%							
Payback Years		1.98							

B.8 AFE Summary for Nesting Software

AFE Summary					
(In USD Thousands)					
Corporate Interest Rate	7.0%	<i>Fixed</i>	Date Equip. Req'd	9/15/2015	Keyed
Tax Rate	30.0%	<i>Fixed</i>	Internal Rate of Return	63.2%	<i>Auto fill</i>
Originator	Robin Moore-Govro	<i>Keyed</i>	Pay Back Period (years)	1.98	<i>Auto fill</i>
Global Business Unit	HPI	<i>Drop dn</i>	EBITDA-7 years	\$235.3	<i>Auto fill</i>
Location	NEW BRIGHTON	<i>Drop dn</i>	Included in Budget?	No	<i>Keyed</i>
Expenditure Type	COST REDUCTION	<i>Drop dn</i>	Budget Year	2015	<i>Keyed</i>
Asset Category	IT SOFTWARE	<i>Drop dn</i>	Purchase/ Lease	Purchase	<i>Keyed</i>
Capital Asset Value	\$35.87	<i>Auto fill</i>	JDE Business Unit/ Cost Center		<i>Keyed</i>
Expense Items	\$0.00	<i>Auto fill</i>	E-Node		<i>Keyed</i>
Total Cash Requirement	\$35.87	<i>Auto fill</i>			