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A Multiple-Case Analysis of Lean Six Sigma Deployment and Implementation Strategies

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A MULTIPLE-CASE ANALYSIS OF LEAN SIX SIGMA DEPLOYMENT AND IMPLEMENTATION STRATEGIES

THESIS

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Abstract

Lean and Six Sigma are recent developments in continuous improvement methodology that have been popularized by several high-profile companies. The success and complementary nature of these methodologies has led to their combination into a single methodology, commonly called Lean Six Sigma or Lean Sigma. Although there is considerable literature available and many consultants involved with Lean Six Sigma, very little published research addresses the practical experiences of companies that have implemented Lean Six Sigma.

The research question for this research is: How and why are certain private sector implementations of Lean Six Sigma successful or unsuccessful? The investigative questions further focused the research question and identified several factors that appeared to significantly contribute to implementation success. These factors are:

- Fusing business strategy with continuous improvement strategy
- Leadership commitment and involvement in the deployment and implementation processes
- The use of consultants that are proficient and experienced
- A defined organizational model that links the continuous improvement efforts with the performance measurement system and senior leadership
- Defined and standardized personnel selection criteria

This research's purpose is to assist the Air Force structure a continuous improvement program that abates or eliminates the negative effects caused by deployment barriers and implementation challenges.

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A MULTIPLE-CASE COMPARISON OF LEAN SIX SIGMA DEPLOYMENT AND IMPLEMENTATION STRATEGIES

I. Introduction

Background

The role of continuous improvement within organizations has changed and matured throughout history. From the first improvements made through the invention of machines that sped up production to using empirical or statistical methods to analyze processes, individuals and organizations have pursued improved operating methods. Certain industries, such as healthcare and pharmaceuticals, focus the majority of their continuous improvement efforts on maximizing the quality of their products and services. For others, continuous improvement is viewed as a mechanism for driving down cost.

In addition to cutting costs and improving quality, successful continuous improvement initiatives ultimately change the culture of an organization. The culture change focuses on the motivation and desire of the organization's members to continually improve business processes and policies. This fundamental change in operating and managing processes requires the stimulus of a structured method or program of continuous improvement.

Lean Six Sigma is a combination of two popular continuous improvement methodologies: Lean and Six Sigma. Lean and Six Sigma focus typically on improving the production and transactional processes of an organization. Although each uses different methodologies and principles to effect the improvement, both have complementary effects.

Each of these methodologies has been individually popularized by successful implementations at companies such as Toyota, General Electric, and Raytheon. Many companies are now recognizing the powerful synergy that is produced when these two methodologies are combined and have successfully implemented Lean or Six Sigma. However, these implementations were not without some difficulty. The experiences of the first implementations of Lean and Six Sigma methodologies are unique based on leadership and culture. Subsequent implementations of Lean and Six Sigma have benefited from the literature and experiences produced by these pioneering companies. The combination of Lean and Six Sigma is a recent continuous improvement development and the experiences of companies implementing it are fresh areas for research. This research effort focuses on the identification of the barriers and challenges surrounding the deployment and implementation of Lean Six Sigma.

Problem Statement

Although most organizations want to improve quality and cut costs, the deployment and implementation of continuous improvement methodologies is commonly viewed as a daunting undertaking. Many organizations fail to properly structure or support continuous improvement initiatives which ultimately doom them to failure. The Air Force's own experience deploying and implementing Total Quality Management in the mid-nineties is an example of the difficulties in implementing continuous improvement initiatives across a large organization. This research seeks to identify which key issues must be addressed to successfully manage or eliminate the barriers and challenges of implementing continuous improvement initiatives.

Research Question

The focus of this research effort is to answer the research question: "How and why are certain private sector implementations of Lean Six Sigma successful or unsuccessful?"

Investigative Questions

To answer the research question, this research investigates the implementation processes of private sector companies by addressing the following investigative questions:

1. How has Lean Six Sigma been deployed and implemented in the private sector?
2. What are barriers to Lean Six Sigma deployment and how are they overcome?
3. What are challenges during Lean Six Sigma implementation and how are they overcome?
4. How is Lean Six Sigma implementation success defined in the private sector?

Research Objective

The primary objective of this research is to discover how private sector companies succeed at implementing the popular continuous improvement methodology Lean Six Sigma. This research assumes that implementation success is contingent on the ability of the company's leadership to overcome the barriers and challenges of Lean Six Sigma

implementation. By identifying the barriers and challenges and comparing the methods or strategies employed to overcome them, this research will recommend effective strategies to enable Lean Six Sigma implementation success. At a general level, this research will expand the body of knowledge of implementation strategies and sustaining quality management programs. Through the investigation of companies that have implemented an emerging quality program, this research will provide valuable information useful for companies or organizations deliberating such implementation decisions.

Scope and Limitations of the Research

This scope of this research is limited to the deployment and implementation phase of the Lean Six Sigma methodology in private sector companies. Although the data for the research is gathered from the private sector, the barriers and challenges encountered are believed to be generalizable to the management of large organizations in general, and thereby applicable to the United States Air Force. The research specifically focuses on defining the operational model, the management decisions made to overcome the deployment barriers, and implementations challenges faced while integrating Lean Six Sigma into their organization.

Methodology

This research employed a multiple case study design to gather data on the Lean Six Sigma implementation process. The cases were solicited following a predetermined protocol that improved the reliability of the research by standardizing the data collection

techniques. The companies selected for this study were limited to those that have, or were in the process of, implementing an integrated Lean Six Sigma methodology. A cross-case synthesis technique was then used to analyze the collected data. This technique used word tables to analyze specific areas of interest that related to the investigative questions. This research analyzed the Lean Six Sigma operational models, barriers to deployment, challenges during implementation, and internal methods of defining the program's success. This analysis answered the investigative questions and ultimately the research question.

Summary

Continuous improvement has benefited from the contributions and inventions of many in academia and the corporate world. Lean and Six Sigma are recent developments in continuous improvement methodology and have been popularized by several high-profile companies. The success and complementary nature of these methodologies has led to their combination into a single methodology, commonly called Lean Six Sigma or Lean Sigma. Many companies are now turning to Lean Six Sigma to satisfy their need for a structured continuous improvement program. This research's goal is to identify the barriers and challenges companies faced during Lean Six Sigma implementation and discover how they were overcome. Ultimately this research provides knowledge and understanding of how the private sector planned and executed Lean Six Sigma initiatives. This research's purpose is to assist the Air Force structure a continuous improvement program that abates or eliminates the negative effects caused by deployment barriers and implementation challenges.

II. Literature Review

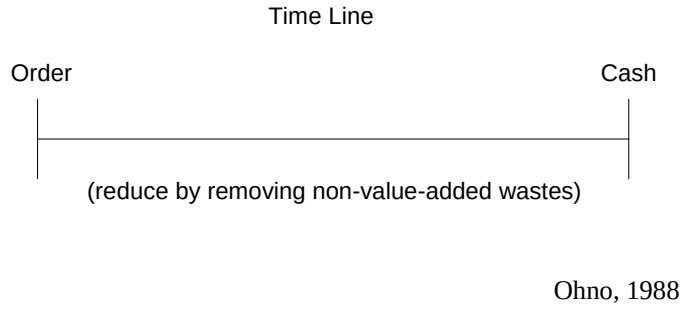
Chapter Overview

The private sector uses Lean and Six Sigma to cut cost and improve the quality of their products and services. Lean and Six Sigma could also be used in the Department of Defense (DOD) for similar goals. The complementary nature of Lean and Six Sigma principles has led the private sector to merge the two into a single process- and quality-improvement method. The current focus of the literature is centered on why these two should be integrated. Little research has been done developing, critiquing, or comparing actually deployed and implemented Lean Six Sigma efforts. This chapter forms the foundation of the research effort by reviewing literature on Lean and Six Sigma, respectively. The chapter then reviews the literature on the integrated Lean Six Sigma methodology.

Lean

Lean is commonly understood in manufacturing to be the elimination of waste from a process in order to increase process speed and improve quality. Lean production methodology was derived from the Toyota Production System (TPS) created by Taiichi Ohno, who is widely understood to be the father of the Lean methodology. Ohno (1988) further emphasized the link between improved business results with removing waste by stating that "The most important objective of the Toyota system has been to increase production efficiency by consistently and thoroughly eliminating waste." The reduction on the order-to-cash cycle is an important goal of production and supply chain

management (Ohno ,1988; Lambert, 2004) "A streamlined process reduces the order-to-cash cycle which frees up capital, and reduces the delivery lead-time which allows for reduced inventory levels" (Lambert, 2004). Ohno used a simple graphical device, shown in Figure 1, to demonstrate the objective of shortening the order-to-cash timeline.



Ohno, 1988

Figure 1. Objective of Toyota Production System

Lean production was brought to the United States by James P. Womack, Daniel T. Jones, and Daniel Roos with their 1990's best seller called *The Machine That Changed the World: The Story of Lean Production*. Womack and Jones introduced the idea of "Lean thinking" which caused significant changes to how US manufacturers operated and managed their production processes. The book chronicles the movement of automobile manufacturing from craft production to mass production to lean production (Womack, Jones, and Roos, 1990).

The popularity and success of Lean in production environments has led to the consideration of Lean for the rest of the supply chain. Once applied solely in the manufacturing environment, the term Lean is now applied to theories, activities, and methods focusing on the elimination of waste to speed up and improve processes in any environment. This expanded application of Lean methodology is commonly termed as the "Lean Enterprise." The Lean Enterprise is based on several constructs.

Lean Principles and Goals

The literature offers several similar descriptions of *Lean* goals and principles. All center on improving processes. A process is defined by *Lean* pioneer James P. Womack as "A series of actions that must be conducted properly in the proper sequence at the proper time to create value for a customer" (Womack, 2004). The following are two examples of *Lean* goals and principles. The first is McAdam's description of *Lean* principles.

1. Specify what does and does not create value from the customer's perspective and not from the perspective of individual firms, functions and departments

2. Identify all the steps necessary to design, order and produce the product across the whole value stream to highlight non value adding waste

3. Make those actions that create value flow without interruption, detours, backflows, waiting or scrap

4. Only make what is pulled by the customer

5. Strive for perfection by continually removing successive layers of waste, as they are uncovered.

McAdam, 2003

The Lean Enterprise Memory Jogger lists *Lean* goals as 1) improving quality, 2) eliminating waste, 3) reducing lead time, and 4) reducing total cost of a process (Maclnnes 2002). The goal of improving quality is to align the process with the customer's needs or desires. Either the processes or the product can be the focus of quality improvement. The goal of eliminating waste is the removal of unneeded process steps, excessive movement of people or materials, and non-value added activities. The focus on the customer drives the determination of what is value or non-value added to a product (Womack and Jones, 1996; George, 2002). The goal of reducing lead times is shortening the time it takes to complete the tasks within a process (Womack and Jones, 1996; George, 2002; Ohno, 1988). These reductions enable the process to become more responsive and flexible to customers or other processes. Reduction of total cost is the expected result of reaching the preceding goals. Total cost consists of both direct and indirect costs of the products or services of the company.

These principles and goals originated from the original *Lean* principles set forth by Womack and Jones in "Lean Thinking" (1996). Womack and Jones's *Lean* principles are: 1) specify value, 2) identify the value stream, 3) smooth process flow, 4) production based on pull, and 5) perfection through elimination of *muda* or waste (Womack and Jones, 1996).

Waste

The literature offers either seven (Womack and Jones, 1996; Maclnnes, 2002; George, 2002; Ohno, 1998) or eight forms of waste (McAdam, 2003). These eight wastes, identified in Table 1, are uncovered through the determination of what the customer values. To uncover the waste and find the value, a lean initiative uses value stream mapping.

Table 1. Forms of Waste

Waste	Definition
Overprocessing	Adding value to a process/product the customer would not pay for
Transportation	Moving raw materials, product, or information unnecessarily
Motion	The unnecessary movement by people
Inventory	Work-in-process (WIP) that is not directly related to a customer requirement
Wait Time	The time that WIP is not directly related to a customer requirement
Defects	Flaws in the WIP, final products, or services that do not meet the customer's requirements
Overproduction	Products and services that are in excess to current customer requirements
Unused Human Resources	Having excess workforce for the process

Womack and Jones, 1996; George, 2002; Ohno, 1998; McAdam, 2003; Maclnnes, 2002

Value-Stream Mapping

The Lean Aerospace Initiative at MIT describes the objective of value-stream mapping as "an important lean practice to eliminate waste and make the value-adding steps 'flow' in meeting customer requirements (Murman et. al, 2002). The value stream is further described by Womack and Jones in *Lean Thinking*:

> "A value stream map identifies every action required to design, order, and make a specific product. The actions are sorted into three categories: (1) those that actually create value as perceived by the customer; (2) those which create no value but are currently required by the product development, order filing, or production systems; and (3) those actions which don't create value as perceived by the customer and can be eliminated immediately" (Womack and Jones, 1996).

The "value-stream" or "value-chain" mapping is a visual representation of all the steps, tasks, or activities in a process and documents their sequence from start to finish (George, 2002). This mapping is done to identify the current state of the process and use it to determine the steps that are *value* and *non-value added*. A value-added step is one that directly impacts the customer's perception of the product's value. One might ask: "If this step was deleted would the customer complain?" (George, 2005). If yes, then the step is value-added; if no, then the step is non-value added. A non-value added step is one that does not add value to the product according to the customer. Some non-value added steps are required to perform value-added work but are not valued by the customer--these steps are called business value added (George, 2002). George (2002) goes on to articulate the questions to be asked to determine what steps are value- or non-value-added and are listed below.

- Customer Value-Added Questions:
  - Does the task add a form or feature to the product or service?
  - Does the task enable a competitive advantage?
  - Would the customer be willing to pay extra or prefer us over the competition if he or she knew we were doing this task?

- Business Value-Added Questions:
  - Is this task required by law or regulation?
  - Does this task reduce the financial risk of the owner?
  - Does this task support financial reporting requirements?
  - Would the process break down if this task were removed?

- Non-Value-Added Questions:
  - Does the task include any of the following activities: counting, handling, inspecting, transporting, moving, delaying, storing, all rework loops, expediting, and multiple signatures?
  - Taking a global view of the supply chain, having made these improvements, to how many factories do we really need to deliver projected volume? Will the faster lead time and lower costs fill up existing facilities?
  - With faster lead times, how many distribution centers can be eliminated?

George, 2002

Although value-stream mapping is the primary measurement tool of Lean and contributes to the improvement of process speed, other tools are needed to implement the knowledge gained through value-stream mapping. George (2002) states that "to improve the speed of the process…Pull systems are one of the most important tools."

Pull Systems

Pull systems require thinking of production flow in the reverse direction: later processes pull on earlier processes to pick only the right part, in the quantity needed, and

exactly when needed (Murman et al, 2002). In production environments, a pull system is a method of managing work-in-process (WIP). WIP describes materials that are in the process of becoming finished products. As raw materials enter the process, the time they remain in the process is calculated. This time is described as the end products lead time. If WIP exceeds the capacity of any individual process step, the lead times of completed products increases. If raw materials continue to be released into the process then lead times continue to increase. A pull system only releases raw materials or WIP once the preceding process step completes the WIP it is currently working on. This method of WIP management is also called a *kanban* which is the Japanese word for card. "The kanban system is said to have been inspired by the supermarket system—instead of using a system of estimated replenishment, the store restocks only what has been sold, thereby reducing defective inventories" (Shingo, 1989).

Lean Summary

Lean focuses on increasing process speed. To increase speed, Lean focuses on removing wasteful or non-value added process steps. Lean assumes that once waste is removed the process not only gets faster, it becomes focused on what the customer values and the quality of the product is improved.

Six Sigma

Six Sigma is a continuous improvement methodology that focuses on the reduction of variation. Sigma represents the standard deviation, a unit of measurement that designates the distribution or spread about the mean of a process (Six Sigma Academy, 2002). Six Sigma as a business initiative was first espoused by the Motorola

Corporation in the early 1990s (Breyfogle, 1999). Six Sigma's roots can be traced back to the 1920's through the contributions of many mathematicians, statisticians, and quality specialists. These efforts cumulated in the analysis tools contained in Statistical Process Control (SPC) and were combined with analysis methods defined and refined by Six Sigma pioneers Dr. Mikel Harry and the Motorola company's Bill Smith (Upton and Cox, 2002; Harry and Schroeder, 2000). Six Sigma is defined as a statistic, a philosophy, and a methodology. As a statistic in the quality paradigm, it is 3.4 defects per 1 million opportunities and is related to the cost of quality (Harry and Schroeder, 2000). Table 2 provides a reference to how sigma levels can affect percent net income.

Table 2. The Cost of Quality

Sigma Level	**Defects Per Million Opportunities**	**Cost of Quality**
2	308,357 (Noncompetitive companies)	Not applicable
3	66,807	25-40% of sales
4	6,210 (Industry average)	15-25% of sales
5	233	5-15% of sales
6	3.4 (World class)	<1% of sales
Each sigma shift provides a 10 percent net income improvement		

Harry and Schroeder, 2000

The philosophy of Six Sigma is the use of data and statistical analysis tools for systematic processes improvement. Process data are gathered and analyzed to determine average process performance and the output quality variation. The Six Sigma methodology is a five-phase, disciplined approach to continuous improvement. The five-

phases are Define, Measure, Analyze, Improve, and Control. These phases are referred to as DMAIC.

DMAIC

During the *Define* phase, projects are organized, improvement goals are set, and the overall value of the project is determined. Project teams and project sponsors use qualitative tools such as fish-bone and affinity diagrams to determine what resources are involved and to design a problem solving process. During the *Measure* phase the process is mapped and relevant data are collected. Process maps are first done at a high level and then continually refined as more quantitative data are collected. Graphical analysis of variation and root causes, such as time-series plots or run charts and Pareto charts, respectively, are also constructed to further enrich the available data. The time-series plots or run charts show the data in the order they occurred and will show how the process changes over time. Pareto charts are a type of bar chart that categorizes the data to highlight the impact of a certain effect. The *Analyze* phase is then used to apply statistical tools to the collected data to determine process capability and sources of variation. The in-depth knowledge gained from using the Six Sigma tools helps the team specifically identify the problems or defects that are contributing to quality variation of the product. This analysis lays the foundation for improving the process. The *Improve* phase uses the knowledge gained from the *Measure* and *Analyze* phases to generate possible solutions. These solutions are then prioritized, piloted, and then implemented. The project then moves into the *Control* phase. During this phase the improved process is validated and handed over to the process owner. The process owner is provided a set

of metrics or other measures they can use to ensure the implemented solution continues to perform as expected. Periodic validations should then be conducted by the project leader to ensure consistent process performance (George, 2005).

The structure of DMAIC encourages creative thinking within boundaries such as keeping the basic process, product, or service (George, 2005). This structure ensures that the project team remains focused on the current problems and provides the leadership with a reliable, consistent result.

DFSS

Design for Six Sigma (DFSS) is an approach to systems design that attempts to increase product quality by addressing it at the system, product, or process design phase. According to Henderson and Larco (2000), "Six Sigma quality is designed into the products and built into the manufacturing process." DFSS is further defined as "a systematic methodology using tools, training, and measurements to enable the design of products, services, and processes that meet customer expectations at Six Sigma quality levels" (Brue, 2002).

Six Sigma Summary

Six Sigma focuses on eliminating the variation within the process. To eliminate the variation, Six Sigma uses advanced statistical analysis tools to investigate and isolate the sources of variation. Six Sigma assumes that once the variation is minimized the process is improved.

Lean Six Sigma

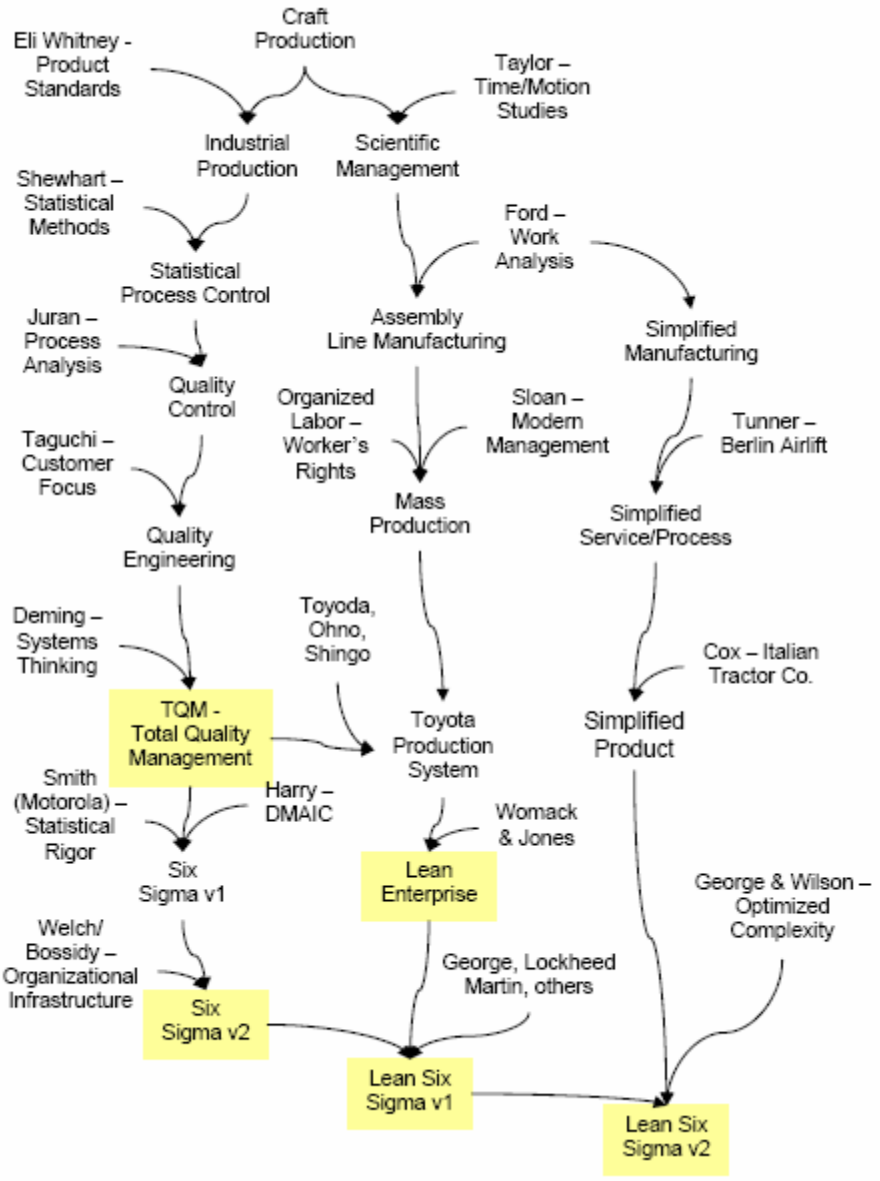
"In a system that combines the two philosophies, Lean creates the standard and Six Sigma investigates and resolves any variation from the standard" (Breyfogle, 2001). A leading Lean Six Sigma advocate, Michael George from the George Group, states that the purpose of Lean Six Sigma is twofold. First, "to transform the CEO's overall business strategy from vision to reality by the execution of appropriate projects," and second, "to create new operational capabilities that will expand the CEO's range of strategy choices going forward" (George, 2002). Alternatively, Lean Six Sigma has been defined as "a defined approach that synthesizes the use of established tools and methods" (Shere, 2003). The tools and methods of the Lean Six Sigma practitioner encompass the tool sets of both Lean production and Six Sigma. Dr. Jiju Antony (2003), a researcher of Lean and Six Sigma at the Caledonian Business School of Glasgow Caledonian University, concludes that "…the disciplined and systematic methodology of Six Sigma combined with the speed and agility of Lean (methodology) will produce greater solutions in the search for business and operations excellence."

Lean Six Sigma Development

In order to explain how Lean Six Sigma was developed, Upton and Cox (2002) show (Figure 2) the historical development of continuous improvement methodologies. Figure 2 specifically intends to show how Lean Six Sigma was created through the combination of the relatively modern methodologies of Six Sigma and Lean Enterprise. The development graph traces Lean Six Sigma's history back to Ohno's TPS and the quality engineering efforts of Deming, Juran, and Taguchi. Although Figure 2 seems to

portray linear development, that would be an inaccurate assessment of continuous improvement methodology development. Figure 2 shows a historical perspective that exposes how continuous improvement methodologies seem to develop through a process of contribution and combination.

New continuous improvement methodology is not usually conceived in isolation from an existing methodology. As Figure 2 suggests, methodology creation is a process that consolidates value from various existing methodologies and applies advancements in technology, science, mathematics, and creativity to create a new methodology.



Upton and Cox, 2002

Figure 2. Development History of Lean Six Sigma

In the case of Six Sigma, TQM principles were fused with advanced statistical process analysis tools developed from Shewhart's contribution to the development of

Statistical Process Control (SPC) and organized using a structured problem solving method (DMAIC). Six Sigma further developed as a methodology when it was applied as both a problem solving and an organizational excellence methodology. This was accomplished through the development of an organizational infrastructure by the popular CEO's of GE and Allied Signal, Jack Welch and Larry Bossidy. Their support and contributions propelled the proliferation of Six Sigma and establish it as both a powerful collection of previously developed problem-solving methodologies and a popular organizational management model. The development of Six Sigma did not eliminate the use TQM or SPC but its popularity has established it as an organizational methodology to drive continuous improvement.

Unlike the development of Six Sigma, Lean Six Sigma consolidates two major continuous improvement methodologies into a single approach to continuous improvement. The principle of Lean Six Sigma is "the activities that cause the customer's critical-to-quality issues and create the longest time delays in any process offer the greatest opportunity for improvement in cost, quality, capital, and lead time" (George, 2002). This principal highlights the strength of focusing on customer needs and shortening lead times. Although Lean and Six Sigma focus on different improvement goals, the reduction of waste and process variation, a thorough analysis of each method shows that the methods complement each other. Table 3 describes the differences between of Lean and Six Sigma.

Table 3. Differences between Lean and Six Sigma

Issues/Problems/Objectives	**Six Sigma**	**Lean**
Focuses on customer value stream	N	Y
Focuses on creating a visual workplace	N	Y
Creates standard work sheets	N	Y
Attacks work-in-progress inventory	N	Y
Focuses on good house keeping	N	Y
Process control planning and monitoring	Y	N
Focuses on reducing variation and achieve uniform process outputs	Y	N
Focuses heavily on the application of statistical tools and techniques	Y	N
Employs a structured, rigorous and well planned problem-solving methodology	Y	N
Attacks waste due to waiting, over processing, motion, over production, etc.	N	Y

Adapted from Antony, Escamilla, and Caine, 2003

"While the fundamental principle of Six Sigma is to take an organization to an improved level of Sigma capability (Table 2) through the rigorous application of statistical tools and techniques, Lean production has a role in eliminating waste and non-valued added activities across the entire supply chain" (Antony, 2003). A further understanding of how Six Sigma and Lean complement each other's approach to continuous improvement can be seen in a more detailed comparison in Table 4.

Table 4. Comparison of Lean and Six Sigma Methodologies

Program	**Lean**	**Six Sigma**
Theory	Remove waste	Reduce variation
Application guidelines	1. Identify value 2. Identify value stream 3. Flow 4. Pull 5. Perfection	1. Define 2. Measure 3. Analyze 4. Improve 5. Control
Focus	Flow focused	Problem focused
Assumptions	Waste removal will improve business performance. Many small improvements are better than systems analysis.	A problem exists. Figures and numbers are valued. System output improves if variation in all processes is reduced.
Primary effect	Reduced flow time	Uniform process output
Secondary effects	Less variation. Uniform output. Less inventory. New accounting system. Flow—performance measure for managers. Improved quality.	Less waste. Fast throughput. Less inventory. Fluctuation—performance measures for managers. Improved quality.
Criticisms	Statistical or system analysis not valued	System interaction not considered. Processes improved independently.

Nave, 2002 (emphasis added)

The theories guiding Lean and Six Sigma methodologies are different but complementary. While Lean concentrates on the identification and elimination of waste, Six Sigma seeks to reduce process variation. "Lean removes the non-value-added and Six Sigma adds value to the value-added step of the process by reducing variation" (Kiemele, 2004). Both seek to improve the process. Lean assumes that waste removal will speed up the process thereby improving business performance. Six Sigma assumes that process variations cause process problems and that reducing process variation will improve business performance. The key to comparing the two improvement methods is not only the focus of each but the secondary effects. As highlighted in Table 4, the

secondary effects of each methodology mirror the primary focus of the other method. The synergy of applying both the Lean and Six Sigma methodologies simultaneously is show in Figure 3 below.

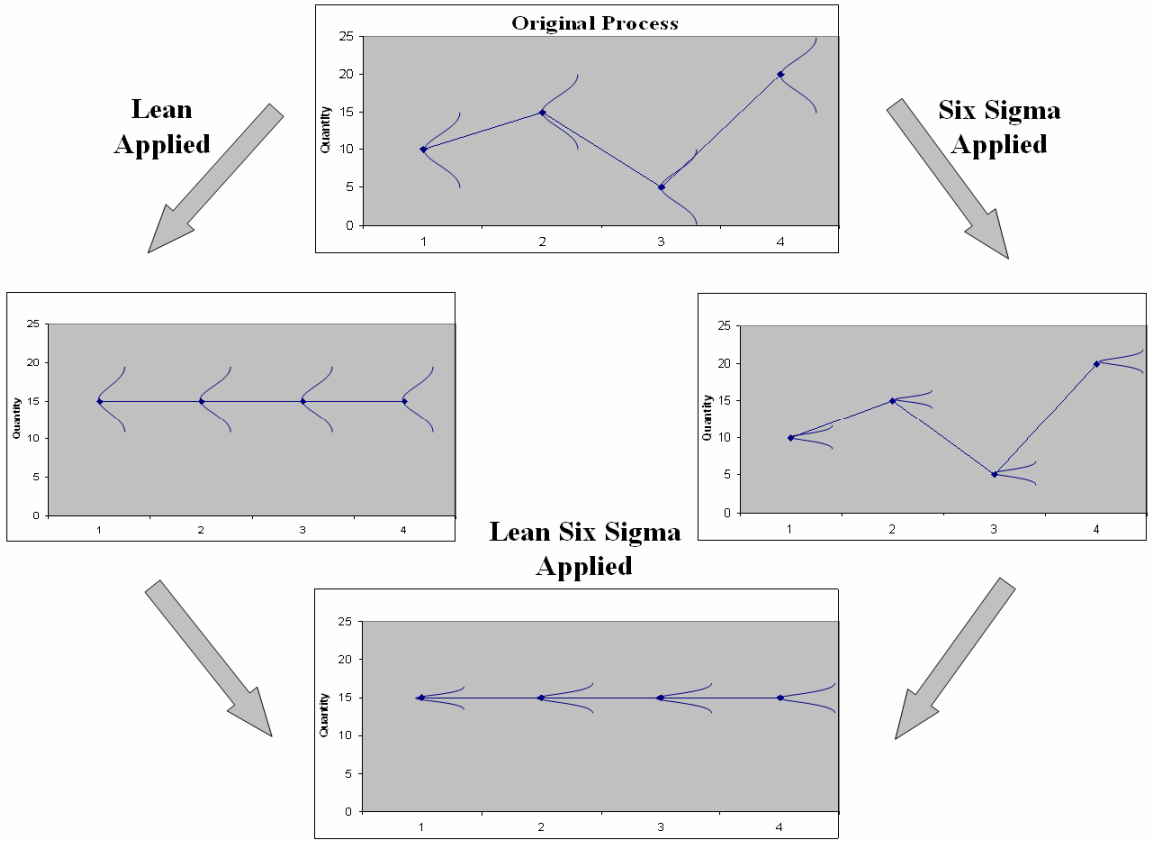


Figure 3. How Lean Six Sigma Attacks Flow and Variation

In Figure 3, a process is shown graphically that is unbalanced and producing high variation (Original Process). This process is out of control and managers have little

control over flow or quality of WIP as it proceeds through the process. George (2002) further describes this situation as "Slow moving inventory must be moved, counted, stored, retrieved, and moved again, and may be damaged or become obsolete…slow moving finished goods must be sold at *promotional prices* at a loss of margin…a larger plant and more equipment and people must be used for a given capacity…these costs are called the *hidden factory.*" Figure 3 shows how applying Lean balances the flow of the process and applying Six Sigma reduces the variation. Finally, Figure 3 shows the application of Lean Six Sigma which combines the effects of both methodologies to both balance and focus the process. The synergies gained through combining Lean and Six Sigma methodologies are further described in Table 5.

Table 5. Synergies of Lean and Six Sigma

Lean Strategy	**Six Sigma Strategy**
Use a project based implementation	Project management skills
Collect product and production data	Data collection
Understand current conditions	Knowledge discovery
Create standard work combination sheets	Process stability and control planning
Time the process	Data collection tools and techniques (Statistical Process Control
Optimal value flow is achieved through aggressive elimination of waste and non-value added activities	Provides the 'how to' template for eliminating process variation
Reduce cycle times, set-up times, equipment downtime, changeover time, among others	Seven basic tools, modern management tools of quality, among others

Adapted from Antony, Escamilla, and Caine, 2003

Lean Six Sigma Operation Models

There are competing views and opinions on how Lean and Six Sigma methods and tools should be implemented within an organization. George (2002) is the leading advocate of the fusion of Lean and Six Sigma, using both the *Kaizen DMAIC process,* rapid improvement method for 5- to 30-day projects, and a *Black Belt DMAIC process*, robust improvement method for 30 plus-day projects (George, 2003). This dual approach to improvement projects identifies that projects vary as to skills required and that their implications can be either enterprise-wide or local. Using integrated Lean and Six Sigma methodologies ensures the approach for each project, either rapid or robust, addresses the primary focuses of each methodology, waste and variation.

In "The Perfect Engine," Sharma (2001) describes the use of Six Sigma tools once the Lean methodology has "reaped all of the low-hanging and intuitive improvements become difficult." This approach describes a concurrent method that blankets the organization or process with Lean to be followed by Six Sigma once improvement productivity slows. Although this limited approach would be defined as continuous improvement, it fails to capitalize on the complementary nature of Lean and Six Sigma methodology. This strategy may be appropriate for organizations that have already implemented Lean and are searching for ways to reenergize their continuous improvement efforts.

Execution of Lean Six Sigma

The execution of a Lean Six Sigma initiative includes three streams of activities: 1) Initiation, 2) resource and project selection, and 3) implementation, sustainability, and

evolution (George, 2002). As shown in Figure 4, these streams are intended to translate a company's strategy into an operational plan.

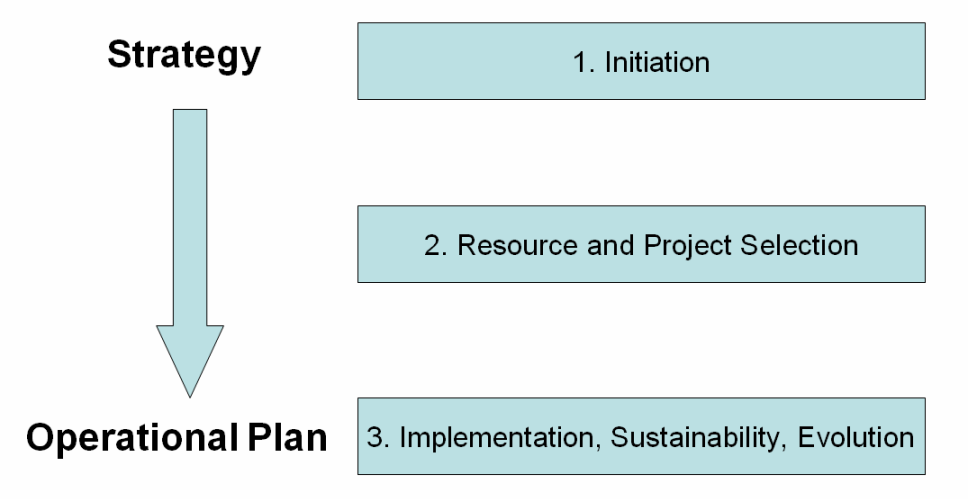


Figure 4. Lean Six Sigma Execution Activities

The *Initiation* stream includes the steps that are necessary to successfully execute Lean Six Sigma. These activities are conducted by the leadership of an organization or company. They include the work done by the CEO and those who directly report to them to implement and support the Lean Six Sigma initiative. These activities lay the foundation for a successful implementation. For this research effort the *Initiation* stream will be considered "deployment."

CEO involvement is widely believed by most professional implementers to be a vital factor to Lean Six Sigma implementation. Lean Six Sigma expert Michael George states, "Over the past dozen years in working with both successful and failed continuous

improvement initiatives, my colleagues and I have learned one hard-and-fast lesson: the Lean Six Sigma effort will succeed or fail based on the engagement and buy-in of the CEO and executives with P&L (Profit and Loss statement) responsibility" (George, 2002). This anecdotal evidence suggests that without the support and engagement of the top-level management of an organization it is impossible to organize and utilize the energy of the entire organization. This lack of support appears to doom a Lean Six Sigma or any quality improvement initiative to failure.

The leadership support of Lean Six Sigma includes three specific activities performed by the CEO in coordination with the executive leadership. First, "CEO/executive engagement, as demonstrated initially by his or her active involvement in the upfront decisions about "where," "how," and "who" of Lean Six Sigma" (George, 2002). As stated earlier in the chapter, most initiatives appear to fail due to a lack of CEO engagement, and engagement must be preceded by commitment. The commitment by the CEO happens once he or she is convinced that Lean Six Sigma is the strategic effort that will address the company's business-critical needs. George refers to these business-critical needs as the "*burning platform* for change" (George, 2002). The *burning platform* analogy comes from the book *Managing at the Speed of Change:*

> A North Sea oil rig worker faced a truly life-threatening situation. The oil rig caught fire and he had to decide whether to stay where he was (and almost certainly be burned to death) or to jump off the platform, falling 150 feet into the cold sea. It turns out that he had the courage to jump and lived to tell the story (George, 2002).

The compelling need or *burning platform* must be identified, believed, and acted on by the CEO in order for Lean Six Sigma to be implemented.

The second leadership activity is "setting long-term (two- to five-year) fiscal and performance goals for the organization that reflect Lean Six Sigma gains in operating profit, ROIC, revenue growth, and intrinsic shareholder value consistent with the overall business strategy" (George, 2002). These goals are intended to connect the company's strategic plan to the Lean Six Sigma efforts.

The third leadership activity is, "commissioning a design/deployment team to champion the design of the Lean Six Sigma policies and architecture for the company" (George, 2002). The George Group's implementation model describes the design and deployment team's initial responsibilities are to "determine the gaps between current and desired performance, determine how Lean Six Sigma can close the gap, and develop a preliminary design for the implementation of Lean Six Sigma" (George, 2002). The gap analysis is a simple process but can be made as complex as required. The gap analysis of present and desired performance gives the CEO the understanding of how much change is required.

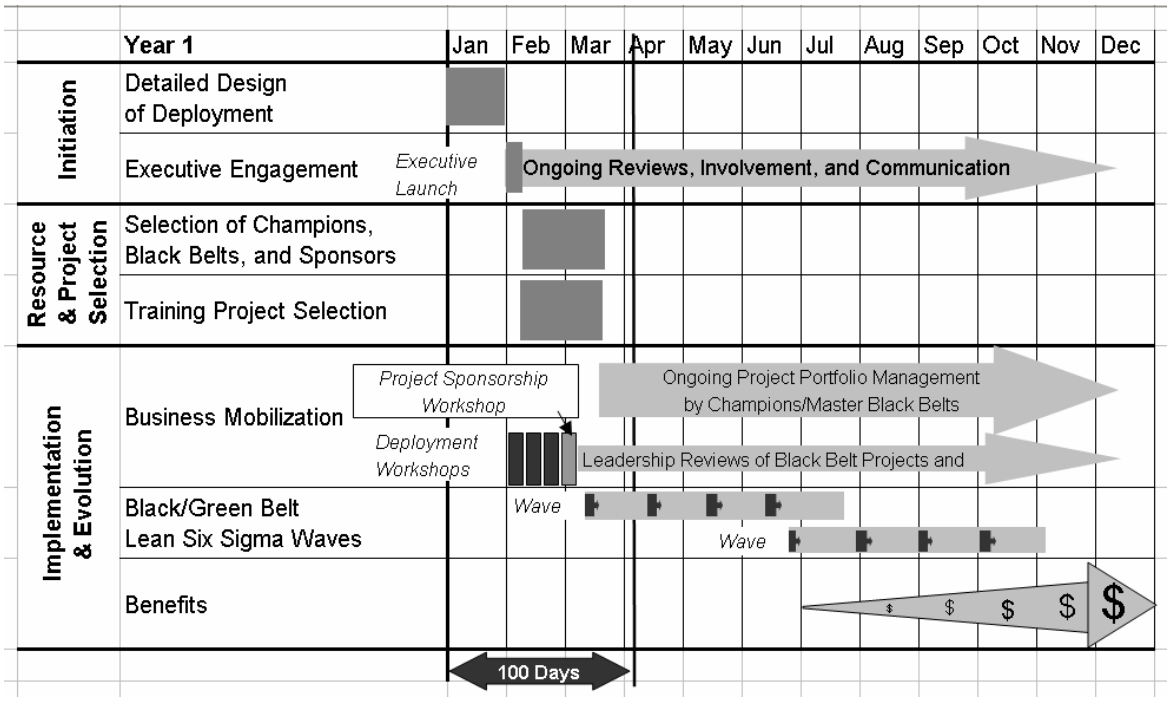
The implementation team's mission is to use the gap analysis to design the Lean Six Sigma plan to address the changes required to meet the desired performance levels. Once the theoretical issues have been addressed the team then moves on to developing the infrastructure that will support the Lean Six Sigma implementation.

With the CEO approval of the goals and the general deployment plan, the design team then sets about to develop a detailed deployment plan. According to George,

"Meticulous planning for the first 100 days of implementation is a prime determinant of the ultimate success of a Lean Six Sigma launch and of your organization's ability to achieve major cost and lead time reductions and quality improvements in one year" (George, 2002). According to George (2002) the detailed deployment plan should include the following components:

A. **Process**: Designing the critical Lean Six Sigma sustaining processes to be part of the normal business mode of operations.
B. **Organization**: Fleshing out the organizational structure by determining the roles, responsibilities, and reporting structures. Developing the criteria and selecting the champions and black belts. Identifying what training will be given to which groups of people.
C. **Measures**: Determining the measures of success.
D. **Rewards**: Establishing mechanisms for collection of information and methods for providing rewards and recognition.
E. **Tools**: Determining requirements for supporting software tools.

An example of a detailed deployment plan is shown in Figure 5 below.



George, 2002

Figure 5. Example deployment timeline

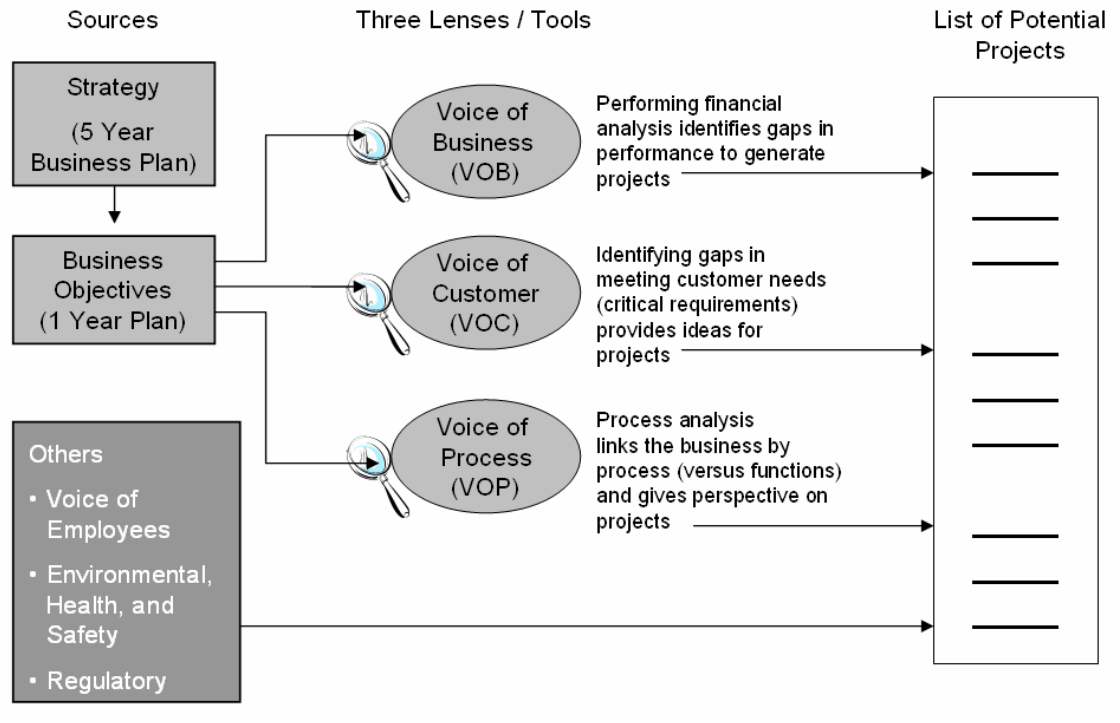
Resource and project selection

The resource and project selection stream centers on personnel selection, training, and initial project selection. This stream is considered the bridge between the deployment and implementation phases. The selection of personnel involves determining who will receive the training required to be the project leaders of Lean Six Sigma projects. George (2002) states that for black belt selection "the best candidates will already be high performers." The selection effort is a collaborative effort between the management, process owners, and the Lean Six Sigma champion (George, 2002). This

group develops position descriptions, selection criteria, interviews candidates, and coordinates training. George furthers articulates the criteria for black belt selection as:

- Team leadership skills
- Project management experience
- Problem-solving training and experience
- Communication skills
- Interest in the process view beyond his or her unit
- Ability to learn financial analysis
- Computer and technical skills, ability to master tools

"Effective project selection is a key factor in determining the effectiveness of a Lean Six Sigma effort" (George, 2002). "Projects should be selected in such a way that they are closely tied to the strategic improvement needs and priorities of the organization" (Anthony, 2004). The organization's strategy and planning begin the process of project selection. Without this linkage the organization will not be able to make "strategic decisions about what is most important to the company and its customers" (George, 2005). This linkage between the organization's strategy and the influence of customer is highlighted in Figure 6.



George, 2005

Figure 6. Project Selection

Implementation, sustainability, and evolution

The implementation, sustainability, and evolution stream focuses on converting Lean Six Sigma from an initiative to a way of doing business. The purpose of this stream is to institutionalize Lean Six Sigma and produce transformational change in the organization. George (2002) states that this change will only happen if "Lean Six Sigma is institutionalized through the CEO's visible commitment, management's resolve to use the Lean Six Sigma infrastructure as a means to improve their business, and the design team's efforts in upfront planning." The ability of the organization to fully embed Lean

Six Sigma into their corporate culture is linked to their ability to overcome the barriers and challenges they face during the deployment and implementation phases.

Deployment barriers and implementation challenges

In the literature, the terms "deployment" and "implementation" seem to be synonymous. This research effort attempts to make a delineation to describe the difference between the activities prior to implementation with the activities during an implementation. Deployment barriers are defined as institutional problems that senior management confronts prior to implementing Lean Six Sigma within their organization. Implementation challenges are defined as specific difficulties during the integration of Lean Six Sigma into an organization. The implementation phase occurs after the executive deployment phase and lasts until Lean Six Sigma is fully integrated within the organization's processes and culture. Whereas deployment barriers are institutional or common to all organizations, implementation challenges can vary depending on how Lean Six Sigma is deployed and implemented in each individual company. Anthony and Escamilla (2003) state that Lean Six Sigma implementation "requires a change in the mindset of employees and strong leadership." Henderson and Larco (2000) identify obstacles to the *Lean Enterprise* as:

- Top management lack strategic understanding of Lean Enterprise
- Lack of specific Lean Enterprise skills, knowledge
- Culture, ego, and organizational inertia
- Management reluctance to empower people
- Fear of change, loss of organizational power

- "Not invented here" syndrome
- Internal systems and hurdles, specifically—
    - MRPII systems
    - Inflexible accounting methods
    - Severely disjointed plant operations

These obstacles encompass both deployment barriers and implementation challenges. Henderson and Larco's (2000) first obstacle, "Top management lack strategic understanding of Lean Enterprise" commonly occurs during both the deployment and implementation phase but should be addressed during deployment. Reluctance to empower, fear of change, and loss of power are also deployment barriers. The internal systems and hurdles listed above by Henderson and Larco (2000) are good examples of implementation challenges. More specifically, Snee (2003) identified the following deployment barriers: uncommitted leadership, top talent not selected to lead efforts, and lack of infrastructure support. Although uncommitted leadership and top management talent not selected to lead efforts would be considered deployment barriers, the researcher would categorize "lack of infrastructure support" as an implementation challenge. Liker and Chio (1998) defined implementation challenges of continuous improvement programs as:

- Entrenched employee resistance
- Line managers' difficulty in managing production and continuous improvement efforts
- Production gets in the way of the top manager's vision of launching continuous improvement projects

- Lack of management to spread continuous improvement throughout the organization
- Lack of management to allow worker participation
- Lack of integration of continuous improvement teams with normal workers
- Internal political tension
- Lack of management support for continuous improvement efforts
- Trying to sell and implement continuous improvement changes without management support

These challenges further articulate those listed by Henderson and Larco. These descriptions help to raise the understanding of what challenges were faced by organizations that decided to implement continuous improvement programs. This research seeks to uncover the successful strategies executed by organizations that aided in eliminating the impediments that frustrate implementation.

Case study research of Lean Six Sigma

Few published examples of research on the deployment or implementation of Lean Six Sigma exist. Research tends to focus on the explanation of Lean Six Sigma theory or advocate its use, with relatively little effort given for analysis of Lean Six Sigma implementation results. This may be explained by its recent emergence as a popular business performance improvement methodology. Additionally, the firms that have deployed and implemented Lean Six Sigma may not have considered the implementation process finished and as such, not yet ready for serious analysis. Although organizational change is a popular research topic, none specifically deals with

the topic of this research, Lean Six Sigma implementation, therefore it is of a general nature and not particularly useful for this effort.

McAdam and Donagan (2003) sought out to determine how high-tech organizations can effectively use business improvement methodologies to aid recovery by critically evaluating the concurrent application of three business improvement methodologies in a high-technology longitudinal case analysis. McAdam and Donagan (2003) researched the use of Six Sigma, lean manufacturing, and self-managed teams by Seagate in Limavady, UK. Their research produced the following conclusions:

- Six Sigma, lean manufacturing, and self-managed teams are compatible
- Six Sigma is highly measurable
- The deployment of Six Sigma has made the largest contribution
- It is difficult to assess the contribution made by self-managed teams
- The rationale changes over time for the deployment of any initiative
- There is no formula for success other than the level of leadership, which is critical to success.

Also noted was the "significant evidence of synergy between the methodologies and a coherent strategy linked to business goals by supporting metrics" (McAdam and Donagan, 2003). They went further to state that "There was a considerable interchange of tools and techniques between lean manufacturing and Six Sigma" (McAdam and Donagan, 2003). Implementation challenges were highlighted in this study and were similar to those previously discussed. The researchers simple stated that "this study has found no recipe for success" (McAdam and Donagan, 2003). McAdam and Donagan

(2003) significant finding from this study was “that three business improvement methodologies of different philosophical origins could all be systematically combined to contribute to organizational goals.” They support this finding by explaining that “there was a distinct lack of evidence, at any level, of complaints of unnecessary overlap and contradictory goals” (McAdam and Donagan, 2003). They recommend further research is this area because “the integration and aggregation of these approaches and their effects would appear to have the potential to produce a coherent approach to business improvement strategy” (McAdam and Donagan, 2003).

Summary

Lean and Six Sigma methodologies have been industry proven throughout the world. As understanding of both methodologies grows, many are identifying the synergies of applying both methods to achieve quality and process improvement. This understanding has led to the formation of the Lean Six Sigma methodology which combines Lean and Six Sigma into a holistic approach to attacking process waste and variation. Over the years, continuous improvement methodologies matured through the combining and refining of different methodologies. This processes latest iteration has produced Lean Six Sigma. By thoroughly analyzing how Lean Six Sigma has been successfully deployed and implemented within various organizations, others may be able to better prepare and overcome deployment barriers and implementation challenges to achieve heightened levels of success.

III. Methodology

Research Design

A research design is "the logic that links the data to be collected (and the conclusions to be drawn) to the initial questions of study" (Yin, 2003). The research project's "logic" is the paradigm the helps us understand the social phenomena (Creswell, 1994). Two of the most popular research paradigms are the qualitative and quantitative studies. Both paradigms shape the process the researcher follows to understand the questions posed at the beginning the research. The qualitative study is defined by Creswell (1994) as "an inquiry process…based on building a complex, holistic picture, formed with words, reporting detailed views on informants, and conducted in a natural setting." Creswell (1994) alternatively defines the quantitative study as "an inquiry process…based on testing a theory composed of variables, measured with numbers, and analyzed with statistical procedures, in order to determine whether the predictive generalizations of the theory hold true."

This research effort focuses on identifying successful strategies for deploying and implementing continuous improvement methodologies. Through the study of civilian companies that employ Lean and Six Sigma, this research strives to consolidate and analyze the management techniques and strategies that led to successful Lean Six Sigma deployment and implementation. The data for this study are qualitative in nature, therefore a qualitative design will serve best to answer the research question of this study. Creswell (1994) lists six assumptions of qualitative research that should be addressed

when conducting qualitative research. The following table lists the assumptions and how this research addressed them.

Table 6. Assumptions of Qualitative Designs

Assumption	Research characteristic addressing assumption
Process oriented	Study of the deployment and implementation of Lean Six Sigma
Focus on meaning	Focus on how management deals with barriers and challenges
Researcher is the primary instrument	Researcher must review published data, conduct interviews with experienced practitioners of Lean Six Sigma
Involves fieldwork	Interviews conducted remotely
Descriptive in nature	Purpose is to characterize successful management techniques and strategies addressing deployment barriers and implementation challenges
Inductive	There is no current theory on how companies have been able to overcome barriers and challenges faced during Lean Six Sigma deployment and implementation

Comparison of Designs

The strategies available to the researcher for collecting and analyzing empirical evidence are varied and have advantages and disadvantages. Yin (2003) criticizes the common misconception of many researchers that the strategies should be arranged hierarchically, commonly regulating case studies as a preliminary research strategy that cannot be used to describe or test propositions. Yin (2003) states that when approaching design selection "the more appropriate view of these different strategies is an inclusive and pluralistic one." To determine which strategy to select, Yin (2003) provides three conditions that guide the researcher's design selection: (a) the type of research question posed, (b) the extent of control over actual behavioral events, and (c) the degree of focus on contemporary as opposed to historical events. These conditions appear in Table 5.

Table 7. Relevant Situations for Different Research Strategies

Strategy	Form of Research Question	Requires Control of Behavioral Events?	Focuses on Contemporary Events?
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival Analysis	Who, what, where, how many, how much?	No	Yes/No
History	How, why?	No	No
Case Study	How, why?	No	Yes

Yin, 2003

For this research, the case study method appears to be the best fit. The case study method seeks to answer exploratory, descriptive, or explanatory "how" and "why" research questions based on single or multiple case studies (Yin, 2003). The case study does not require control over the activity or process being studied and is focused on contemporary events. Lean Six Sigma deployment and implementation is a contemporary event over which the researcher has no control. The source of evidence or data includes analyzing literature and interviews with experienced practitioners.

The application of the other methods from Table 5 (experiment, survey, archival analysis, and history) would not produce appropriate results. The experiment is a quantitative method that requires the researcher to manipulate the variables of a process to test a theory (Creswell, 1994). Because this research is not testing a theory and is instead seeking to explain how companies overcame the barriers and challenges of Lean

Six Sigma deployment and implementation, the case study method is appropriate. Surveys are a quantitative method employing questionnaires or structured interviews of a sample population for data collection to generalize across a population (Creswell, 1994). A survey study could provide general identification of deployment barriers and implementation challenges. However, as each company is unique, correlating how each company managed these barriers and challenges would be difficult. The archival analysis method requires the researcher to collect data from verbal, visual, or behavioral forms of communication (Horsey, 2003). This method precludes the researcher from directly interviewing participants or observing the process (Horsey, 2003). The history method requires that there is no access to or control over the event being studied (Yin, 2003). This research focuses on a contemporary event therefore the history method is not appropriate.

Creswell (1994) adds three other research strategies not mentioned in Yin's (2003) text. They are the ethnography, phenomenological study, and grounded theory study. The ethnography requires observations of an intact cultural group taken over a prolonged timeframe (Creswell, 1994). The phenomenological study also requires a prolonged timeframe during which a small number of people are extensively studied to develop patterns and relationships of meaning (Creswell, 1994). The research is attempting to answer a broad, generalizable research question. Researching a small group of individuals would limit the external validity of the research. Also, both research strategies require more time than the researcher has to complete the research. The grounded theory study proposes to derive a theory through the use of multiple stages of

data collection and constant comparisons and categorization. This research effort is not primarily concerned with new theory development. With the knowledge of characteristics and advantages of employing the case study design, this research will employ the case study approach.

Case Study

As stated earlier, the case study was selected for this research because it is the preferred method when attempting to answer "how" and "why" research questions about contemporary events over which the researcher has no control (Yin, 2003). The research question in this effort is "How and why are certain private sector implementations of Lean Six Sigma successful or unsuccessful?" This research will address this question by investigating how management dealt with the barriers and challenges faced during the deployment and implementation of Lean Six Sigma within their organization. The data for this study will come from private sector companies with which the researcher is neither employed by nor affiliated.

According to Yin (2003), the case study has five components that make up the case study research design: the study's questions and propositions, its unit(s) of analysis, the logic linking the data to the propositions, and finally the criteria for interpreting the findings.

The study's questions, as previously discussed, are based on "how" and "why" the phenomenon or event occurs; therefore the case study design was chosen. The study question for this research aided the researcher in determining the study's design but did not direct where to study. For this direction, Yin (2003) proposes that the researcher state

propositions that "directs attention to something that should be examined within the scope of the study." This study's propositions where clearly stated in chapter one of this document.

The unit of analysis component confronts the problem of defining what a "case" is (Yin, 2003). Defining the context of the case requires that the study's questions and propositions be well defined to ensure that the scope remains in feasible limits (Yin, 2003). Yin (2003) warns that if the "case" is defined as a program, implementation process, or organizational change, there will be problems defining the beginning or end points of the "case." Problems could include variations in program definition based on perspective and program components that preexisted formal program designation (Yin, 2003). This research will address these issues using the following definitions:

Unit of analysis: An organization that has deployed and implemented Lean Six Sigma.

Case timeframe: Begins with the organization's deployment of either Lean or Six Sigma or a combination of the two.

Program description: Deployment and implementation of Lean Six Sigma is defined as deployment of a synergized program containing both Lean and Six Sigma tools and methodologies, simultaneous deployment of separate Lean and Six Sigma programs, or integration of one program into the other creating a Lean Six Sigma program.

The final two components, the logic linking data to propositions and criteria for interpreting the findings, are the least developed components of case studies (Yin, 2003).

This research will employ a data analysis technique similar to one used by Yin (2003) to study transformation called "cross-case synthesis." In this study, Yin (2003) employed a multiple case study design using firms claiming to have undergone transformation. The purpose was to determine whether firms shared a more generic, common transformation process. A further discussion of the researcher's data analysis will be detailed later in this chapter.

Validity and Reliability

Validity and reliability are important facets of any research method and should be addressed. Creswell (1994) suggests addressing the issues of validity and reliability in a qualitative plan and framing the concepts within the procedures that have emerged from qualitative writings. Table 8 describes methods and techniques used in this research to address the issues of validity and reliability.

Table 8. Case Study Tactics for Four Design Tests

Tests	Case Study Tactic	Phase of research in which tactic occurs	Tactics used in this research
Construct validity	Use multiple sources of evidence Establish chain of evidence Have key informants review draft case study report	data collection data collection composition	Data collected from literature and interviews Data analysis and results provided to key informants and advisors for review
Internal validity	Do pattern-matching Do explanation-building Address rival explanations Use logic models	data analysis data analysis data analysis data analysis	Research is exploratory, not causal or explanatory
External validity	Use theory in single-case studies Use replication logic in multiple-case studies	research design research design	Multiple case study design Includes cases from various industries
Reliability	Use case study protocol Develop case study database	data collection data collection	Use of case study protocol Case study database through use of word tables

Yin, 2003

Multiple Case Study Approach

A multiple case study approach increases the external validity of the research through the implied "replication logic" inherent in its design (Yin, 2003). This "replication logic" is analogous to that used in multiple experiments in that when a significant finding from a single experiment is uncovered the attempt is made to immediately replicate this finding in another experiment (Yin, 2003).

This research effort implements Yin's method of studying transformed companies through the use of "cross-case synthesis." Companies selected for the study were chosen due to their self-stated deployment or implementation of Lean Six Sigma methodologies or tools. Including companies from multiple industries and different sizes that have

implemented Lean and Six Sigma will allow for generalizable results and future development of theory.

Case Study Protocol

The case study protocol is a predetermined and documented series of actions the researcher replicates with each case being investigated. Yin (2003) states that the proper use of a case study protocol significantly increases the reliability of the research and guides the researcher during data collection. An appropriate case study protocol should include the following sections: 1) an overview of the case study project, 2) a guide for the case study report, 3) field procedures, and 4) case study questions (Yin, 2003). These sections are specifically addressed in this report.

The overview of the case study project should cover background information, the substantive investigative issues, and the relevant literature about the topic (Yin, 2003). This report addresses the overview in chapters one and two, the introduction and literature review. The requirement to include a guide for the case study report is satisfied through the format for writing this thesis document.

Data collection procedures are the main contributor to the reliability of the case study. The use of detailed field procedures will increase the case study's reliability. Yin (2003) states that field procedures should emphasize the major tasks in collecting data, including: Gaining access, resource planning, procedure for getting assistance, data collection schedule, and providing for unanticipated events. How access and permission was secured is also mentioned by Creswell (1994) as important information the researcher should detail in the report.

A three-step process was used to gain entry into each company. First, research was conducted to determine which companies were implementing "Lean Six Sigma" or a similar combination of Lean and Six Sigma continuous improvement methodologies. This research was conducted using internet searches of company websites, published literature naming companies using Lean Six Sigma, and personal contacts. Once a company was identified by the research as using Lean Six Sigma, an email was sent to either a point of contact listed on the website or a point of contact given through a personal contact. The email outlined the scope of the research and the intent of the research findings. Once a positive response was received a follow-up email was sent summarizing the research effort and explaining the purpose and use of an attached interview guide.

The case study questions work to further articulate the research and investigative questions. The purpose of case study questions is to keep the investigator on track during the data collection process (Yin, 2003). Yin (2003) describes the "levels of questions" the investigator should articulate for data collection purposes. Table 9 describes the five levels.

Table 9. Levels of case study questions

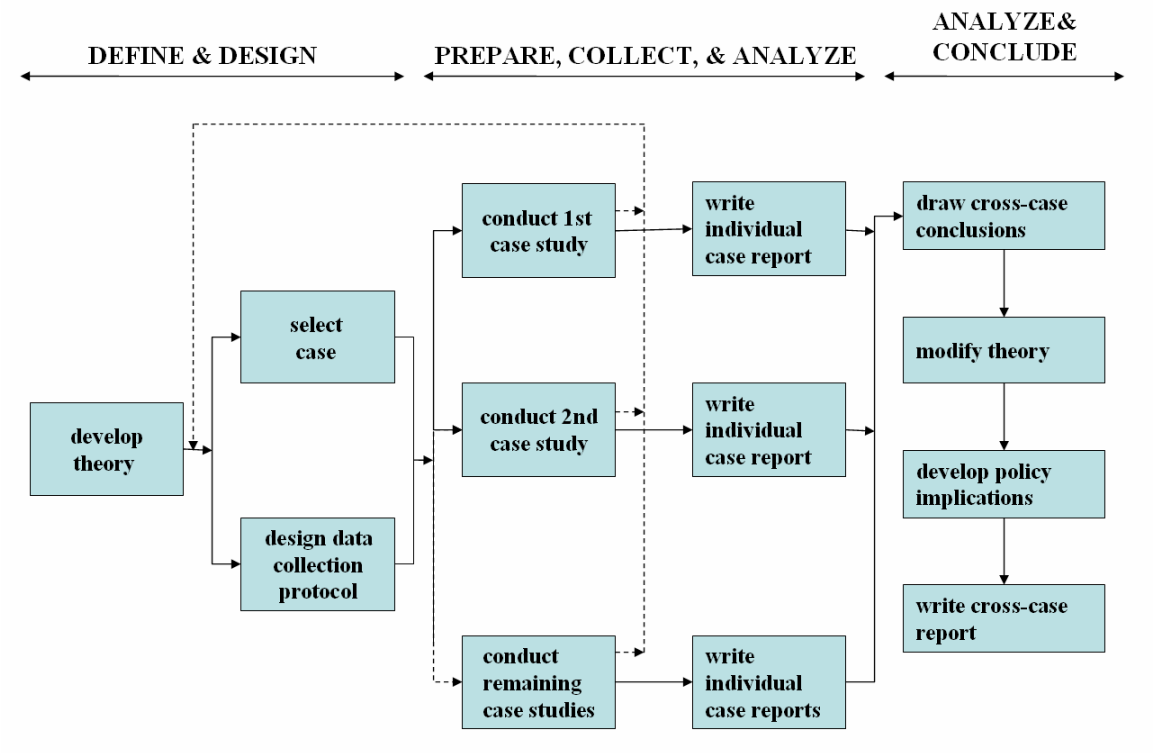
Level 1	Questions asked of specific interviewees
Level 2	Questions asked of the individual case
Level 3	Questions asked of the pattern of findings across multiple cases
Level 4	Questions asked of an entire study
Level 5	Normative questions about policy recommendations and conclusions going beyond the narrow scope of the study

Yin, 2003

Case study questions at levels 1 and 2 only should be articulated for the purpose of data collection (Yin, 2003). Yin (2003) warns against confusing level 1 and 2 questions by assuming each are synonymous. Level 2 questions are those the investigator is asking of the data collected from each case and level 1 questions are those asked in order to withdraw data from the specific interviewees. Yin (2003) describes the difference between level 1 and level 2 questions as a verbal line of inquiry and a mental line of inquiry. Questions for levels 3, 4, and 5 apply only to multiple case study designs and represent questions asked by the investigator of the data previously collected. The level 2 questions for this research are stated inherently in the research and investigative questions. The level 1 questions were developed and constructed as open-ended to solicit all the information the respondent was willing to provide and are listed in Appendix B.

Data Collection

Data collection will follow the Prepare, Collect, and Analyze section of Yin's (2003) multiple case study method described below in Figure 7. Once the case study protocol is designed, each of the case studies is conducted. For this research, the level 1 questions will be sent to each participating company via email. Once the responses are returned and catalogued, each individual case study will be written. Once these case studies are complete each will be reviewed by several key informants and advisors of this research effort to increase the construct validity of the research effort.



Yin, 2003

Figure 7. Multiple Case Study Method

The use of multiple sources of information is one of the major strengths of using a case study design (Yin, 2003). Creswell defines the qualitative data collection techniques in Table 10 below.

Table 10. Strengths and Weaknesses of Sources of Evidence

Type	Options	Advantages	Limitations
Interviews	Face-to-face Telephone Group	Useful when informants cannot be directly observed Informants can provide historical information Allows researcher "control" over the line of questioning	Provides "indirect" information from interviewees' viewpoint Provides information in a designated "place" Researcher's presence may bias responses Not all people are equally articulate and perceptive
Observations	Complete participant Observer participant Participant as observer Complete observer	Researcher has first-hand experience with informant Researcher can record information as it occurs Unusual aspects can be noticed during observation Useful in exploring uncomfortable topics	Researcher may be seen as intrusive "Private" information may be observed that cannot be reported Researcher may lack skills Certain informants may present special problems in gaining rapport
Documentation	Public documents Private documents	Enables a researcher to obtain the language and words of the informant Unobtrusive source of information Saves time and expense of transcribing	May be protected information unavailable to public or private access Requires the researcher to search out information in hard-to-find places Materials may be incomplete or not authentic

Creswell, 1994

This research employs the interview technique as its major method of data collection. According to Yin (2003) "the interview is one of the most important sources of evidence for the case study." The questions detailed previously make up the structured interview guide sent out to the selected companies. The interview guide format ensures that each company is asked the same questions and that the responses are easily transferred into a case study database therefore increasing the reliability of the research.

Although the research will employ a mode of communication that is not mentioned by Creswell (1994), it is not without precedent. Horsey (2003) states that email interviewing has become a pervasive form of communication due to its advantages over traditional forms of written communication. The advantages and disadvantages are listed in Table 9 below.

Table 11. Email Interviewing, Advantages and Disadvantages

Advantages	**Disadvantages**
Easy and immediate access to world-wide samples	Limited in application to users of e-mail
Reduce interviewer bias resulting from visual or non-verbal cues	Difficult to ensure respondent anonymity
"Friendly" to respondent	Lacks "tacit" or non-verbal data
Provides already transcribed data, eliminating any errors in transcription	Messages can be deleted with the touch of a button
Favorable response rates	
Saves time and money	

Horsey, 2003

Experience of the Author

According to Creswell (1994), qualitative research is interpretive in nature therefore, the biases, values, and judgment of the researcher must be explicitly stated in the research report. The researcher of this report is an U.S. Air Force supply specialist and a Six Sigma Blackbelt trained by the General Electric Aircraft Engines division. The researcher managed supply functions at the wing and headquarters level for four years and as a quality and standardization inspector at the wing level. The researcher managed a limited Six Sigma quality improvement initiative and therefore is knowledgeable in quality program management and implementation.

Analysis and Results

The goal of this research is to analyze multiple private sector implementations of the Lean Six Sigma methodology to identify and articulate the strategies employed that led to successful implementation. Interviews, observations, and a literature review provide the data for a case study database (Yin, 2003). The purpose of the database is to develop a "descriptive framework for organizing the case study" (Yin, 2003). The database will be used to analyze the data gathered using the multiple case study approach and to make inferences of how to successfully implement continuous improvement methodologies. The "cross-case" synthesis technique will be used on the database to answer all the investigative questions and ultimately the research question.

Human Subject Information

Human subjects are respondents to the interview and could be observed during the operational site visits (Horsey, 2003). For the interview respondents, information is provided by the interviewer about the purpose of the research and the use of their responses. Participation by the researched companies was purely voluntary and information garnered from the interviews was available and approved for public release.

Summary

This chapter presented, in detail, the research methodology of this research. The research methodology is qualitative and exploratory using a multiple-case study approach. This chapter presented the justification for the selection of this methodology and detailed how the research design addresses validity and reliability. Also presented was a detailed description of the multiple case study method and the case study protocol used in this research. The case study questions were defined and articulated and the levels of case study questions were explained. In all, a complete description of the employed methodology and related topics was described.

IV. Analysis and Results

Chapter Overview

This chapter contains the analysis of the data gathered through the multiple case-study approach. In total, six companies participated in the research. The companies are listed in Table 12 along with the number of major divisions, and total number of employees.

Table 12. Companies Participating in this Research

Company Name	**# Major Divisions**	**Total # of Employees**
General Electric (Transportation)	11	300,000+
Raytheon (Integrated Defense Systems)	7	78,000
Lockheed Martin (Space)	6	132,500
Xerox	6	61,100
ITT Industries (Fluid Technologies)	4	39,000
Solectron	3	57,000

( ) Indicates specific Division contacted for this research

The analysis afforded the researcher the opportunity to synthesize the data, draw inferences, and provide recommendations. The goals of the analysis were to identify and compare the various deployment and implementation strategies and the actions taken in support of these strategies. The data were consolidated into word tables which provided the foundation for the analysis (Yin, 2003). This foundation supported the answering of the four investigative questions that ultimately resulted in the answer to the research question: “How and why are certain private sector implementations of Lean Six Sigma successful or unsuccessful.”

Investigative Question One

How has Lean Six Sigma been deployed and implemented in the private sector?

The first investigative question sought to identify the key issues involved with the formulation and execution of Lean Six Sigma deployment and implementation strategy. Although other issues may exist, this research focused on certain ones by evaluating the following questions. Did historical usage of certain continuous improvement methodologies drive methodology selection? Is leadership integral to implementation success? How are paid consultants utilized during deployment and implementation? What happens to the organizational chart of an organization that implements Lean Six Sigma? And finally, what was the management strategy that led to success?

History's Lesson

Whether or not the historical usage of certain continuous improvement methodologies influenced the selection of Lean Six Sigma was investigated by identifying what continuous improvement methodologies the company had used in the past. This knowledge could lead to inferences based on the similarities and commonalities between the methods. Total Quality Management was identified most commonly among the data. The data also indicated that many companies had been utilizing various continuous improvement methodologies and tools containing many Lean Six Sigma principles. General Electric (GE), famous for their highly successful Six Sigma program, states that:

> *"Lean and Six Sigma tools have been used extensively in the last 10 years at GE. However, the crossover was not always obvious, intentional, or a result of any implementation strategy. Over time with continuous use,*

> *there was growing awareness that the best DMAIC Six Sigma Improve tools were "Lean-Like." Lean was used to varying degrees in Six Sigma projects, with different approaches based on the individual's exposure and training to Lean tools."*

Several companies indicated that their varied use continuous improvement methodologies and tools was linked to past mergers and acquisitions. Raytheon faced this, recalling that they "…underwent a series of business mergers and consolidations (TI, Hughes, Honeywell Aerospace and Defense) since the late 90s." This also affected Lockheed Martin: "With the series of company mergers and acquisitions… an initiative called LM21 (Lockheed Martin for the 21st century) was launched as a means of sharing best practices from the many former companies merging as one." In order to standardize their continuous improvement approach, some companies instituted a process of internal benchmarking. Again, Raytheon stated that "During these consolidations, best business practices from initiatives such as Six Sigma, lean/agile, and Total Quality Management and benchmarked best practices from other companies were rolled into what is now known as Raytheon Six Sigma™." At Lockheed Martin, "The LM21 program itself evolved from a best practice transfer initiative, to one based on the adoptions of Lean and Six Sigma principles." The data seems to indicate that companies that have varied continuous improvement programs are likely to implement the Lean Six Sigma methodology within their organization.

Leadership's Importance

As indicated in the literature, the involvement of the CEO in the execution of Lean Six Sigma appears to be mandatory and is arguably the most important factor of a

continuous improvement initiative's success. The data appears to support this conclusion. GE's leadership recognized the value of Lean Six Sigma and "they put significant energy into fostering the idea into the entire organization." Each company included in this research stated that senior leadership's active support of the Lean Six Sigma methodology was integral to the success of their deployment and implementation. Anne Mulcahy, CEO of Xerox, exemplifies a high-level of executive support that led to a successful implementation of Lean Six Sigma. Her stated position is: "I'm convinced that Xerox Lean Six Sigma is a way for rebuilding value in our company because it is about substance, not form; it's about discipline and infrastructure so projects can produce business results" (Maszle, 2005). She describes her and Xerox's Lean Six Sigma approach as "We've gone at it with a vengeance (ASQ, 2004)." Most companies interviewed for this research specifically identified senior leadership buy-in and their active participation as critical factors of their implementation success. At Lockheed Martin, "Management support is vital to success."

The analysis identified three issues directly related to leadership. These issues are: 1) leadership's responsibility to infuse the business strategy with the continuous improvement strategy, 2) leadership's direct involvement in the deployment design process, and 3) leadership's active engagement in the implementation.

First, leadership's responsibility to provide the vision that directs and shapes the formulation of a fused business and continuous improvement strategy. Raytheon's CEO and President, facing a "lack of a cohesive business strategy and culture" used "Raytheon Six Sigma" which emerged "as the one, cohesive business strategy that Raytheon

employed to focus in on the customer." To successfully deploy and implement Lean Six Sigma, it appears that leadership must lead the strategy formulation process.

The second issue, leadership's involvement in the deployment design process, appears to be as critical as strategy formulation but is focused on designing the organization's implementation management plan. The common theme that arose from descriptions of the deployment design process was that senior leaders needed to play a major role. At Raytheon "The deployment design was conceived at the Raytheon Corporate level, later to be spread into each of the 7 major businesses that comprise Raytheon." Among the data were descriptions of collaborative efforts between stakeholders, steering committees, and strategic planning meetings that were used a vehicles to facilitate the deployment design process.

The third issue, the active engagement of leadership during implementation, refers to the participation of leadership during execution. Solectron states that their Lean Six Sigma program was "driven from the highest of the company's management team." Engagement in culture change, personnel selection, and dispute resolution were some of the common issues identified. The Lockheed Martin continuous improvement program is managed by their Operations Director who designated a "POC" directly responsible for the execution of the program. This management structure ensures that senior management is directly involved with change management and execution issues involved with the program.

In light of these findings, a recommendation of this research is that senior leadership should take a visible and authoritative stance on continuous improvement.

The entire organization's leadership should make a firm commitment to deploy the initiative and show consistent support of the continuous improvement methodology's principles throughout implementation. Another recommendation is that the business's strategy should include the principals of the continuous improvement initiative. This commitment creates an environment that places high value on these principles and ties the organization's and the continuous improvement initiative's success together.

Many of the barriers and challenges identified later in this research were overcome in large part through senior leadership's intervention. With leadership's affirmative commitment leading the change management effort, investing resources as well as words, a significant number of obstacles faced during deployment and implementation could be avoided.

Why Pay For It?

The utilization of paid consultants while deploying and implementing a continuous improvement initiative follows only "leadership involvement" in importance. This conclusion was drawn by analyzing the stated use of consultants during deployment and implementation. The analysis also identified the roles most commonly played by consultants. Xerox stated that: "Consultants played a key role in both the deployment and implementation of Xerox Lean Six Sigma. At the beginning they assisted in formulating the overall approach we should take, provided leadership training to help the senior most executives understand what it is and what they were getting into, and they facilitated some tough conversations on resource allocation and how to select the right people in the right roles." ITT explained how "Our Lean Six Sigma consultants trained

our first Champions, Black Belts and Master Black Belts. They organized and coordinated the program's implementation." At Raytheon "consultants helped devise the initial Raytheon Six Sigma Black Belt curriculum."

Other roles identified in the data were those of project manager, technical expert/advisor, and program advocate. GE employed the author of "Lean Six Sigma" Michael George who "consulted and trained GET Black Belts on the crossover of Lean and Six Sigma."

The recommendation of this research is that consultants should be brought into the deployment design process during its early stages. Consultants should not assume leadership roles, but a qualified and experienced consultant's advice could help an organization avoid the pitfalls inherent in poorly planned implementations. Xerox explains why hiring qualified consultants is important: "The primary lessoned learned is to get support from a consultant who has previously led a large-scale implementation, can assist in the development of uniform standards, and can rapidly deploy required training."

The Two-Room Addition

Simply stated, to get anything out of a continuous improvement program some in the organization must be fully dedicated to that endeavor. Although every organization member should be involved in some way with continuous improvement, a full-time effort must be dedicated in order for the organization's continuous improvement initiative to remain in existence. This level of effort requires that the organization's structure change. ITT describes how their organization changed due to Lean Six Sigma "(Lean Six Sigma) created an entire new organization with a full time focus on continuous improvement."

The majority of the companies researched indicated a significant change to their corporate structure. The data indicates that most organizational structure changes were additional structures or personnel grafted onto the current organizational structure. These new structures were commonly responsible for leading culture change, Lean Six Sigma implementation, training, project selection, and project completion.

Most of these new structures and personnel are led by a senior level executive. Within the data this senior leader ranged from executive staff members to senior level "Champions" who commonly reported to the CEO. Xerox's executive leadership assigned one of their Vice Presidents the leadership role of their Lean Six Sigma initiative. A direct reporting relationship was created between the CEO and the newly created Lean Six Sigma staff of 6 and the "Deployment Managers" within each organization. Other companies also indicated new reporting chains linking their Lean Six Sigma efforts to their senior leaders. ITT described their reporting chain as "…Black Belts reporting to Business Unit (B.U.) Champions and B.U. Champions reporting to Management Company (M.C.) Champions and M.C. Champions reporting to the Head Quarters Champion and he reported to the CEO."

Making up these new reporting chains were newly created positions charged with leading change and continuous improvement projects within the company. The names given to these positions varied slightly among the data but were commonly labled Green Belt (basic practitioner), Black Belt (advanced practitioner), Master Black Belt (advanced practitioner, coach, and teacher), and Champion (senior leader supporting Black Belts and Master Black Belts.) At Raytheon, their Black Belts are called "Experts" and Green

Belts referred to as “Specialists.” Lockheed Martin, Solectron, Xerox, ITT, and GE all referred to their basic and advanced practitioners as Green Belts and Black Belts.

The training, individuals in these positions receive, varied slightly by company. Xerox’s training plan includes a two-day leadership awareness session, three days of project sponsor training, and six day Deployment Manger training. Xerox’s Black Belt training is five weeks while Green Belt training is 40 Hrs on-line plus 1 week in-class. The data generally described Green Belt training as business specific training that included completion of one improvement project. Black Belt candidates commonly received much more training and a more formalized certification process. Training length varied from 4.5 to 7 weeks of classroom training and usually included project completion and/or mentorship of Green Belt training projects. Another common theme was that training was based on uniform corporate criteria leading to formal corporate certification.

The first recommendation from this research is that the new structure created by the continuous improvement initiative should be pre-determined and standardized across the organization to eliminate confusion and limit localized modification. The second recommendation is that selection criteria and training plans for Green Belts, Black Belts, and Master Black Belts should be standardized and centrally controlled. The third recommendation is that the continuous improvement initiative should be recognized as a leadership development program by senior leadership. The advanced training, cross-functional experience, and project management skills acquired by most Black Belts, prepare these individuals for further leadership opportunities within the organization.

Engage!

Once the necessary actions of leadership buy-in, hiring consultants, and developing a deployment design are accomplished, then the implementation of continuous improvement initiative can begin. From the numerous issues involved with implementation, four emerged from the data as keys to success. If poorly executed, it appears that these issues could significantly shackle a continuous improvement effort. These issues were: the implementation model, timeline, proliferation plan, and communication. The implementation model refers to how the day to day management of the continuous improvement plan is executed. The timeline and proliferation plan articulate how quick and how comprehensive the continuous improvement initiative will be executed. Finally, communication describes the methods by which the organization's awareness of the initiative is achieved.

Several implementation management models were identified in the data. Solectron's management utilized "Functional Excellence teams at the corporate, regions, and sites, which are responsible for articulation, training, implementation, and tangible results of Lean Six Sigma." At Raytheon, "Champions were deployed in the Raytheon businesses to create pervasion of the business strategy. After a few years, the Champion role was dissolved, and most Six Sigma leaders (organizationally) are linked into various high level roles in the business." Others centralized the training management and coordination, the tracking of continuous improvement projects, the setting of standards and personnel selection criteria, and the program's communications. This model also decentralized Black Belt candidate and project selection. Xerox followed this model and

developed a detailed "deployment guideline booklet…to guide the work of the deployment managers."

The data revealed that training issues significantly impact the implementation timeline. Descriptions of planned timelines varied from multi-year plans to specific Black Belt training goals. The number of trained Black Belts or training schedules was offered as the milestones of most implementation timelines. Raytheon's timeline developed as their implementation matured:

> *"Deployment started at the Expert (black belt) level with the establishment of Raytheon Six Sigma™ Champions at each of the businesses who then cultivated 1% of the employee population to go through the Raytheon Six Sigma™ Expert program, training held at the corporate level. Raytheon Six Sigma™ was then expanded on a Specialist level (green belt) to some degree of the employee population (mostly those folks who sought out the Qualification). In recent years, with the Business leaders seeing the positive impact of Raytheon Six Sigma™ on the bottom line, goals have been established at various levels in the business of achieving 100% of the employee population becoming at least Specialist level practitioners of Six Sigma. Later, the Master Expert (Master Black Belt) role was developed, and Six Sigma Practitioner tracks have been created to allow employees (Expert and Specialist levels) continued education in such practices as Integrated Supply Chain, Design for Six Sigma, etc…"*

Closely linked to the implementation timeline was the proliferation of the Lean Six Sigma efforts throughout an organization. Raytheon, ITT, and Lockheed Martin all specifically indicated that their leadership decided proliferation would be "organization-wide." Only one company from the sample, Solectron, indicated that they had piloted Lean Six Sigma prior to organization-wide implementation. They described their plan as "3 months for a pilot Lean line (then) 1year for 100% roll-out." Organization-wide proliferation of the Lean Six Sigma initiative was the strategy of most companies in the

sample. The proliferation plans were supported by the communications strategies employed.

Communicating the details of the Lean Six Sigma initiative is a major part of the implementation strategy. The data identified several communications methods. Email, forums, intranet, meetings, and newsletters were listed as informal methods of communication. More formal methods included the annual strategic plan, interactive leadership workshops, and at Xerox, a widely distributed "Deployment Guideline" document.

The first recommendation of this research is that a predetermined implementation model should be followed to implement Lean Six Sigma. This action ensures that a formal plan is followed that is visible to all members of the organization. The second recommendation of this research is that proliferation of the Lean Six Sigma initiative should be organization-wide and that an implementation timeline be agreed upon by senior leadership. By implementing the intuitive organization-wide, the challenges faced are overcome once rather than readdressed each time the initiative is expanded to include other parts of the organization. The third recommendation of this research is that the goals and principles of the continuous improvement initiative should be communicated using both formal and informal methods. The source and control of this communication should be centralized to avoid confusion and misinformation.

Investigative Question Two

What are barriers to Lean Six Sigma deployment and how are they overcome?

The second investigative question sought to identify barriers faced during deployment, and examine strategies employed to successfully remove them. These deployment barriers decelerate the speed at which organizations can move from the deployment phase into the implementation phase. Although "resistance to change" was a common theme, several other unique barriers were identified. Those included were, a lack of cohesive business strategy, budget and time constraints, and fractured organizational cultures. Raytheon faced barriers created by their merger and acquisition strategy. These actions had created an organization that lacked a cohesive strategy and contained many distinct cultures. Their solution contain several strategies, each with the purpose of attacking the barriers is different ways:

> *The cultural barrier was broken in a few different ways. First, at CEO and President level sponsorship, Raytheon Six Sigma™ was to emerge as the one, cohesive, business strategy that Raytheon employed to focus in on the customer. This was to become the one language that we put forth to both our employees and customer community. Initially, Six Sigma Champions were deployed in the Raytheon businesses to create pervasion of the business strategy. After a few years, the Champion role was dissolved, and most Six Sigma leaders (organizationally) are linked into various high level roles in the businesses (some in Quality, Supply Chain Management, Productivity, etc…).*

The data identified several methods to overcome deployment barriers but it appears that the most significant was senior level involvement. Deployment barrier removal appears to be the responsibility of committed senior leadership using a top-down approach. At Xerox: "Two 'barriers' that were experienced to some degree in a few

areas was getting the right people identified as Black Belts and developing adequate management skills to analyze and dissect the business to identify the best Lean Six Sigma project to assign Black Belts." Although these were barriers that were identified by the data as implementation challenges, these issues, it appears, could affect companies during the deployment phase and should be considered. Xerox overcame these barriers by education, good selection criteria and "experiencing business results from successful projects." They addressed the abilities of management to select continuous improvement projects by "continually providing coaching, additional learning experiences and workshops for our management teams."

Investigative Question Three

What are challenges during Lean Six Sigma implementation and how are they overcome?

The third investigative question sought to identify challenges faced during the implementation phase and examine the methods or strategies employed to overcome them. These challenges frustrate the execution of a continuous improvement initiative. Most challenges identified in the data appear to have been unforeseen by the company and required immediate, reactionary strategies to overcome them. Among those identified were negotiating with managers to recruit the "best" and "brightest" employees for Black Belt training, Black Belts contending with disparate cultures within the organization, budget and time constraints, and sustained resistance to change. Xerox faced an internal challenge when each internal organization tried to uniquely implement Lean Six Sigma. Some organizations tried to justify why they were different and required a unique implementation strategy. Xerox's solution was described as:

> *"From the beginning, Xerox Lean Six Sigma was defined as a corporate-wide strategy with clearly defined deployment standards and guidelines. While minor adjustments were made for unique organization needs, the implementation stayed on track, as defined. Getting the right people has been overcome through education, good selection criteria, and experiencing business results from successful projects."*

Raytheon faced the challenge of recruiting Black Belts, which was further compounded by the disparate cultures within their organization. They indicated that "The challenges of getting the best and brightest were dealt with by the executive leadership team and taking a top down approach for initially driving support. The Experts worked hard to replace the many different cultures with the Raytheon Six Sigma™ business strategy, showing people the power of focusing on the customer, and delivering results." The data also identified two other ways to overcome recruitment problems, financial enticement and executive leader visibility and involvement.

Investigative Question Four

How is Lean Six Sigma implementation success defined?

The fourth investigative question sought to define implementation success. The data produced many definitions, several of which reflected the linkages between Lean Six Sigma implementation and the company's business strategy. Xerox responded that "Lean Six Sigma is a significant business strategy and a key enabler in our transformation from good to great." The results of implementation success were defined by some as business benefits such as increasing profits, decreasing costs, business velocity, and increased customer satisfaction. Success was also defined by others as an improvement in performance measurement system indicators. Solectron's success criteria were "Whether

or not we continuously improve key business metrics in quality, productivity, customer satisfaction, sales increase, profitability, cross-functional collaboration, and employee satisfaction." Lockheed Martin defines their continuous improvement progress "as measured by our metrics."

In addition to the definition of implementation success, unexpected results from Lean Six Sigma implementation were described in the data. ITT described an interesting side-effect of the Lean Six Sigma training: "The training sessions consisted of cross-organization classes of people that had never met before. This extensive training built a network across the organization that is very valuable." Raytheon has been surprised as to "how well the customer community has taken our business strategy, in some parts adopting it for themselves under our tutelage." Others unexpected results were culture change and development of an organizational network of Lean Six Sigma trained personnel. Xerox admitted that "the extent of leadership impact and organizational transformation was underestimated."

The recommendation of this research is that a continuous improvement initiative's success should be measured using existing metrics, voice of the customer, and employee satisfaction. Existing metrics will indicate the bottom line business benefits realized. The voice of the customer will indicate the external reaction to the continuous improvement initiative's implementation. Finally, employee satisfaction will further drive culture change throughout the organization.

Summary

This chapter's purpose was to answer the broad research question by answering the four investigative questions. The cross-case synthesis technique was employed to analyze the data gathered using the multiple-case study approach. The research question's goal of determining "how" and "why" certain implementations were successful, led to the identification of several key issues involved in the deployment and implementation process. These issues were discussed in the context of "how" and "why" they led to the successful implementation of Lean Six Sigma in the private sector. Further, the chapter presented recommendations on how future continuous improvement program deployments and implementations could be successful.

V. Conclusions and Recommendations

Chapter Overview

This chapter summarizes this research effort and offers several implementation models based on the research. The chapter begins with the description of three implementation models created by the researcher based on the data and analysis presented in this research. It continues with a discussion of factors that limit this research and recommendations for future research efforts. The chapter concludes by summarizing the research.

Investigative Questions

Several investigative questions were answered in order to answer the research question: "How and why are certain private sector implementations of Lean Six Sigma successful or unsuccessful?"

The first investigative question was: "How has Lean Six Sigma been deployed and implemented in the private sector?" This question looked at several issues relating to the implementation of Lean Six Sigma. The first was the historical use of CI methods and tools. It was determined that there was some prior Lean or Six Sigma use that usually had resulted from mergers and acquisitions. The second issue was the impact that leadership has on implementation. It was determined that strong buy-in and engagement was a significant, if not the most important, factor leading to implementation success. The leader's role in fusing the business and CI strategy together into a single organization-wide strategy was also identified as important to success. The third issue

was the use of paid consultants and their contribution to the organization's implementation success. It was found that the consultants were used to perform benchmarking, training, and curriculum development. The use of competent and experienced consultants significantly contributes to an organization's success. The fourth issue was the organizational structure changes made as a result of implementing Lean Six Sigma. It was found that new leadership positions were created along with a new organization focused on continuous improvement. Also it was highlighted that the Black Belt, common in most Lean Six Sigma applications, is a very important full-time position created to lead Lean Six Sigma projects. The fifth issue was the description of the use of an implementation strategy to execute continuous improvement. It was found that most implementations were model driven and followed a timeline that used training milestones to determine their implementation progress. Also it was found that most companies implemented Lean Six Sigma organization-wide and that communication plans were articulated and contributed to the success of implementation.

The second investigative question was: "What are barriers to Lean Six Sigma deployment and how are they overcome?" The deployment barriers identified by this research were:

- Resistance to change
- Lack of cohesive business strategy
- Fractured organizational culture
- Budget & time constraints
- Getting the "right" people

- Picking the “right” projects

These barriers were addressed by implementing the following barrier removal strategies:

- Demonstration of success
- CEO sponsorship of a cohesive business strategy
- Good selection criteria
- Continuing education
- Coaching and workshops for management

The third investigative question was: “What are challenges during Lean Six Sigma implementation and how are they overcome?” The implementation challenges identified by this research were:

- Resistance to change
- Budget and time constraints
- Unique implementation by internal organizations
- Black Belt candidate selection process

These challenges were addressed by implementing the following challenge removal strategies:

- Leadership visibility and involvement
- A well defined deployment strategy
- Top-down approach for initially driving support
- Financial enticement

The fourth and final investigative question was: "How is Lean Six Sigma implementation success defined in the private sector?" The purpose of this investigative question was to determine how implementation success was measured in the private sector. It was found that the majority of companies measured their Lean Six Sigma success by improvements in performance measurement systems or other business benefits usually financial in nature. This research also determined that certain unexpected results come as result of Lean Six Sigma implementation. Those identified were cross-organizational exposure of personnel participating in Black Belt training and customer interest in implementing Lean Six Sigma. Also identified was an unexpected depth in the level of culture change throughout the organization. This effect was also defined by some as transformation.

Implementation Models

The following implementation models are meant to identify some of the options available if a commitment was made, by the Air Force, to implement Lean Six Sigma. Each model incorporates some of the implementation strategies and recommendations offered in this research. Each model presents three distinct implementation approaches and provides the basis for further research and discussion.

The Consultant Model

The consultant model describes an implementation strategy that is based on the following assumptions: 1) that Air Force-wide implementation is not desirable at this time, 2) the continuous improvement strategy is not yet fused within Air Force strategy, and 3) that leadership decides to pilot the continuous improvement program.

With these assumptions considered, one choice could be to offer the services of the continuous improvement program to all the MAJCOMs in a limited fashion. A small group of Black Belts and Master Black Belts, consultants, and a senior-level Champion, shown in Figure 8, will be formed and used to attack certain projects, selected by the MAJCOM commanders. These projects could be specifically selected in order to affect change on significant metrics that MAJCOM commanders are responsible for.

This implementation strategy should only be considered a temporary strategy that is meant to facilitate the implementation of an Air Force-wide program. Several barriers such as leadership buy-in and strategy fusion would not be addressed by this strategy. This research indicates that senior leadership should set milestones for an Air Force-wide implementation and expressly state that the consultant group's purpose is to introduce the program and facilitate further implementations.

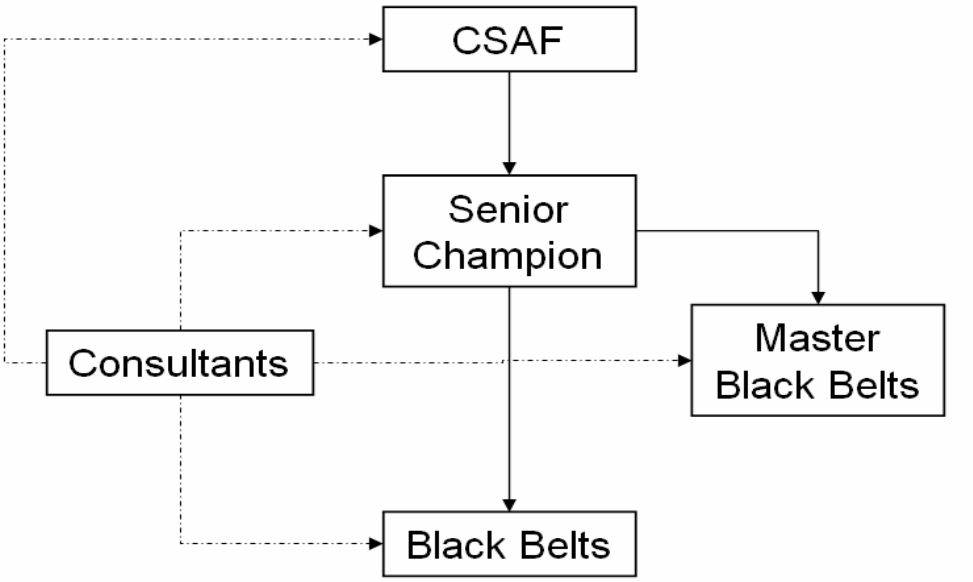


Figure 8. Consultant Model

This structure is not meant to be considered a long-term approach to implementing a continuous improvement program although it might provide value in validating the benefits of Lean Six Sigma within the Air Force.

The Enterprise Model

The enterprise model is an implementation strategy that focuses on the enterprise rather than the organization. It is more robust than the consultant model and requires significantly more in the terms of resources and coordination. The enterprise could be defined in terms of Supply Chain Management (SCM), Communications & Information Management (C&IM), or aircraft operations.

This model proposes the creation of "enterprise" Black Belts and "functional" Black Belts that are focused on a particular enterprise. The "enterprise" Black Belts would focus on improvement projects that affect enterprise-level metrics. The "functional" Black Belts would focus on improvement projects that affect functional-level metrics in support of the enterprise's metrics.

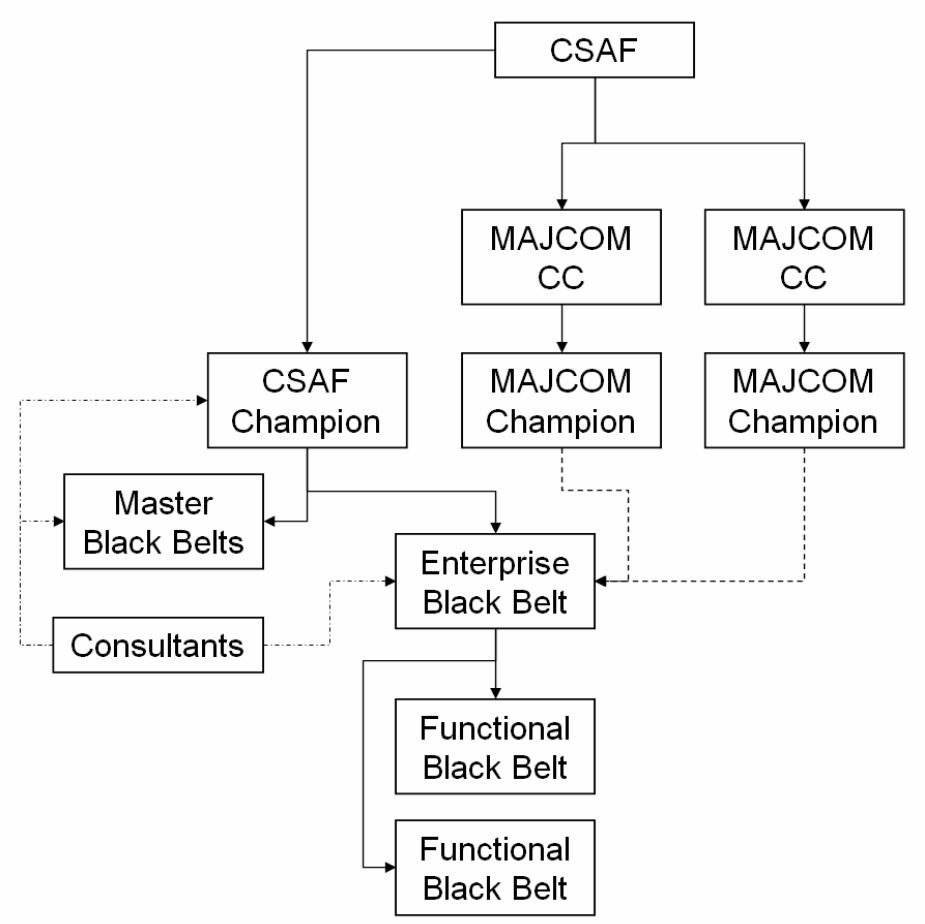


Figure 9. Enterprise Model

As shown in Figure 9, the enterprise and functional Black Belts would be directed by a Headquarters Air Force (HAF) level Champion and would coordinate projects with MAJCOM-level Champions. Master Black Belts and consultants would provide training and expertise to the Champions and Black Belts to facilitate project completion and culture change.

This implementation strategy would require specific enterprise definitions and significant cross-functional cooperation. This model would substitute normal

organizational structures for enterprise and network-centric approaches to understand relationships and processes. This shift would require significant senior leadership engagement and clear communication of the purpose and goals of the continuous improvement team. The value of this model could be the transformational manner at which it aligns continuous improvement with the enterprise or network-centric strategy currently being pursued by the military.

The MAJCOM Model

The MAJCOM Model would be an implementation strategy that centralizes the continuous improvement effort within each MAJCOM. This model resembles the organization-wide implementation strategy that is popular in the private sector. This strategy would integrate the continuous improvement program with the unit's operations. The selection of this strategy would signify a serious commitment by the organization's leadership and should help eliminate several of the barriers identified by this research. This model specifically addresses the leadership development issue through the use of Black Belts and Master Black Belts at both the Wing and MAJCOM level. The individuals selected for these positions would be exposed to the multiple processes and unique relationships of the functional areas. This exposure and the continuous improvement activities would contribute greatly to the individual's knowledge and understanding of complex issues.

As shown in Figure 10, the strategy and direction for the continuous improvement program begins with the MAJCOM commander and flows to the wing commanders. The wing-level Champions would be responsible to their wing commander for the program execution and improvement project management. The training, project tracking, program communication, and selection criteria would be centrally managed by the senior Champion who reports directly to the MAJCOM commander. Consultants would provide training, expertise, and facilitate the initial program implementation by filling the roles of Master Black Belts and Champions. Master Black Belts would be engaged in high-level projects and training of senior leadership and wing-level Black Belts.

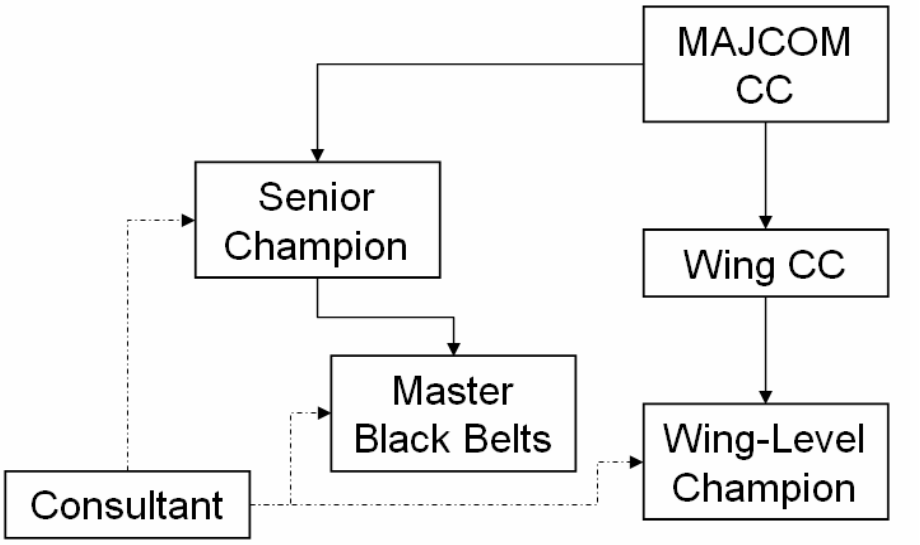


Figure 10. MAJCOM Model (Level 1)

Figure 11 depicts the MAJCOM model at the wing-level. At the wing-level the Black Belts are directed by the wing-level Champion and work on projects sponsored by the group commanders. The group-level sponsorship ensures that projects are linked to performance measurement systems that the group commanders are responsible for reporting to the wing commander.

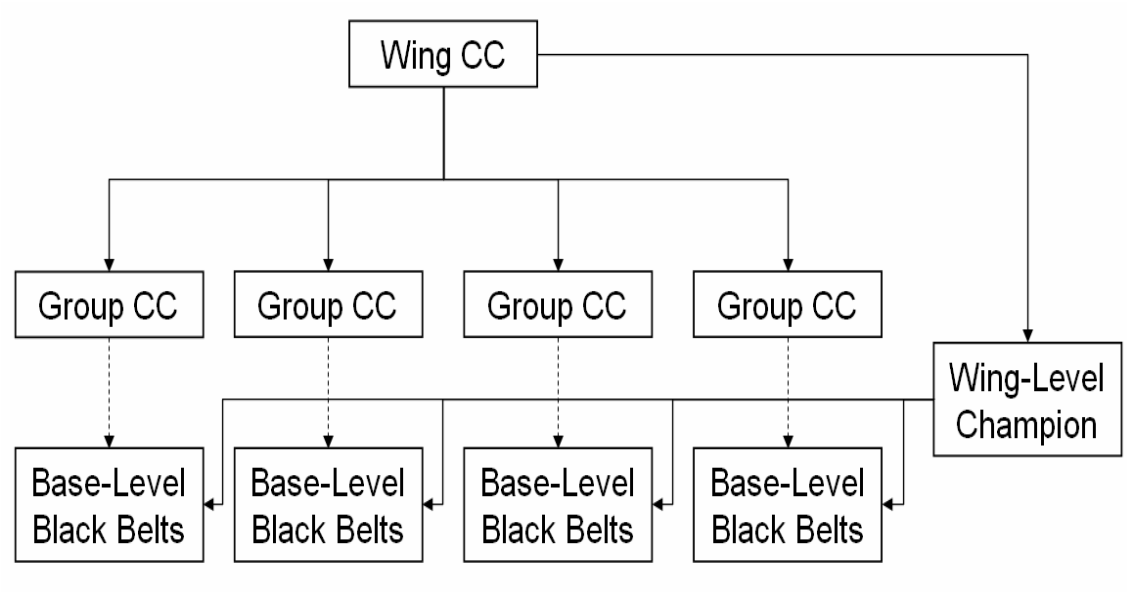


Figure 11. MAJCOM Model (Level 2)

The process of project selection in the MAJCOM model would provide the mechanism by which the continuous improvement strategy is fused with the organization's strategy. Figure 12 illustrates the process by which squadron commanders would identify potential projects that impact squadron metrics. The squadron commanders would then pass these proposals to the group commander who would link the projects to group-level metrics and rank them based on improvement contribution. The group commanders could then present the selected projects to the wing commander who would then link the projects to wing-level metrics and select the highest impact projects. The selected projects would then be passed to the wing-level Champion for coordination and completion. Black Belts could then be assigned and teams formed for each project.

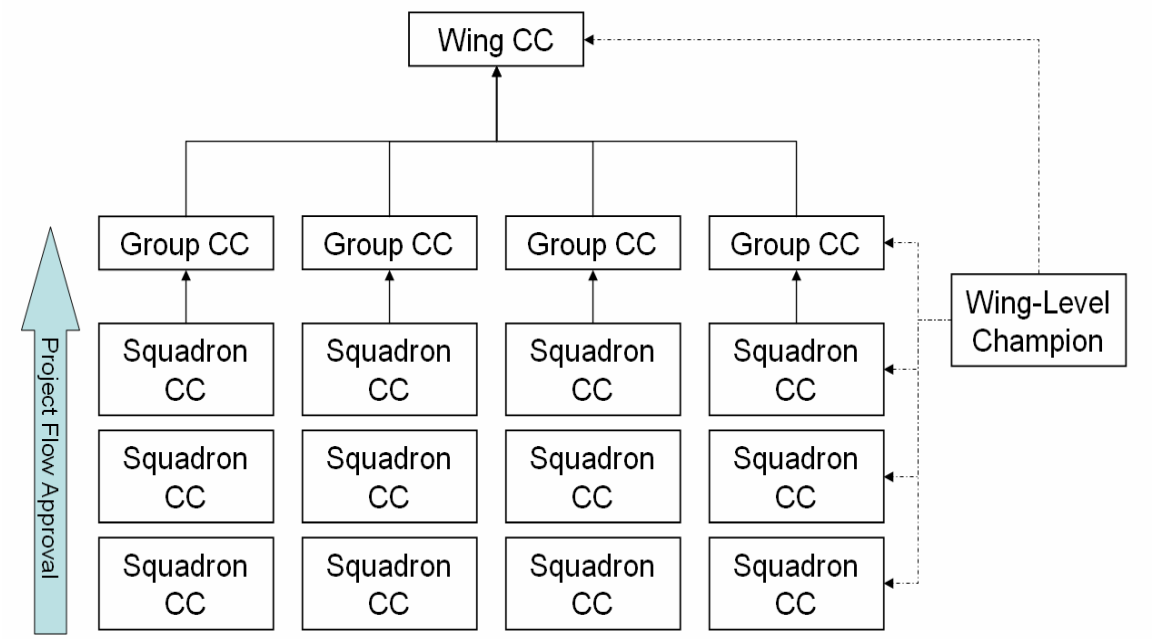


Figure 12. MAJCOM Model (Project Selection)

Personnel Selection Issues

The discussion of implementing any of the models described in this research should include an analysis of the personnel commitment required for implementation. Identified as a significant barrier and challenge to implementation, was the issue of personnel selection. The data indicated that the success of continuous improvement programs was linked to the efforts of the personnel involved in improvement projects. In the book "Lean Six Sigma" Michael George (2002) proposes that 1% to 3% of personnel should be working full-time on process improvement. To understand the numbers this would represent for the Air Force, personnel information was gathered from the Air Force Personnel Center's website to determine how many Air Force personnel George recommends. For this example, the percentage used to determine total number of full-time continuous improvement personnel was 1%. Table 13 shows the total number of personnel (officers, enlisted, and civilians) by MAJCOM and the total is multiplied by 1% to calculate the total amount of Black Belts required.

Table 13. Total Personnel as of February 19, 2005

MAJCOM	AFMC	ACC	AMC	PACAF	USAFE	TOTAL
Officers	7101	12667	9116	4433	3761	37078
Enlisted	15984	78130	44582	29346	25610	193652
Civilian	55697	9441	8742	8193	6240	88313
Total MAJCOM	78782	100238	62440	41972	35611	319043
Black Belts Required	788	1002	624	420	356	3190

The research identified that most companies used their continuous improve program as a vehicle for leadership development. Therefore, this research suggests that Black Belt candidates should be technically proficient and identified as having leadership potential. Candidates should also have longevity and be neither too high or to low in the chain of command. Considering this initial criteria, this research proposes that personnel selected as Black Belts candidates should be assigned from the ranks of the Air Force's middle-level managers and functional experts. This would include Officers, in the rank of Captain and Major, Enlisted personnel, in the rank of Technical Sergeant and Master Sergeant, and civilians, in the grades of GS-9 through GS-12.

Table 14 lists the number of the personnel, by rank or grade, currently in these ranks. Table 14 also lists, by MAJCOM, the percentage of these personnel required to meet the full-time personnel goal of 1% of the MAJCOM's personnel. For example, based on Air Force Materiel Command's (AFMC) total number of personnel; 78,782; it requires 788 full-time personnel assigned to the continuous improvement program. The leadership of AFMC would need to assign 2% of the personnel from the ranks indicated ranks to reach this goal. The other major commands face a steeper challenge with Air Combat Command (ACC) requiring 3%, Air Mobility Command (AMC) requiring 3%, Pacific Air Forces (PACAF) requiring 4%, and the United States Air Forces in Europe requiring 4%.

Table 14. Black Belt Selection Pool from Selected MAJCOMS

To meet a 1% Black Belt training/certification goal						
	AFMC	**ACC**	**AMC**	**PACAF**	**USAFE**	**Total**
CAPT	2148	4468	3512	1814	1541	13483
MAJ	1184	2382	1777	912	829	7084
TSGT	2934	11014	6959	4303	3729	28939
MSGT	1812	7066	4385	2617	2264	18144
GS09	5175	1354	1185	600	492	8806
GS10	7296	942	842	434	144	9658
GS11	9232	1693	1249	537	314	13025
GS12	10183	1194	892	421	285	12975
Total # in pool	39964	30113	20801	11638	9598	112114
Required # of Black Belts	788	1003	625	420	357	3193
Required Percentage	2%	3%	3%	4%	4%	3%

The purpose of listing the number of required personnel is to provide a practical reference for leadership within the United States Air Force. This information in conjunction with the proposed implementation models infers that the level of leadership commitment required to successfully deploy and implement a continuous improvement program is high.

Limitations

Although many limitations are inherent in case study research, three may have had some appreciable impact on this research. First was a lack of control over who within the company provided the answers to the interview guide. Although contact was made with the company's Lean Six Sigma leader, the researcher could not control how the data was gathered to answer the interview guide. It was indicated that most respondents consolidated responses from many internal sources; this fact can not be

verified. Second was the open-ended format of the interview guide. This open-ended provides the opportunity to solicit the widest range of responses but also allows for a greater chance of misinterpretation. Although this generally didn't have a great impact on the data, the risk was minimized by offering clarification if required by the respondent. If additional clarification was not requested none was provided. Third was the level of implementation of each company. The amount of time each company had been involved with implementing Lean Six Sigma ranged from three years to two months. Although one company had only two months experience implementing Lean Six Sigma they had a robust Six Sigma program using Lean tools for 10 years and have now formally integrated the two.

An additional limitation of this research is that the researcher only focused on the identification of the implementation strategy, the deployment and implementation barriers and challenges, and how success was defined. Other issues or confounding variables maybe involved which the research was unable to identify through this research method.

Recommendations for Future Research

During the process of completing this research, the researcher identified many opportunities for further research that applies to continuous improvement and change management.

A timely research effort could advance this research by identifying current continuous improvement programs within the Air Force and conducting analysis of their method, structure, application, among other factors. This research could employ the case

study method and benchmarking to determine the value of the various programs. This research would result in a greater understanding of what continuous improvement efforts are currently in use and provide the foundation for the integration of these programs under a single Air Force-wide continuous program.

Conduct additional case studies using anyone of the companies from this research to gain a further the understanding of their structure, change management issues, culture change issues, and management philosophies among other issues. This research could be conducted using a longitudinal-case study approach to explore deeper into the company to identify and develop key issues to a greater degree than this research did.

A pilot Lean Six Sigma improvement project could be conducted and documented to provide a descriptive account of the issues involved in executing a continuous improvement project. This research could further identify and explain the issues involved with deployment and implementation of a continuous improvement program. This research could also provide the foundation for further use and communication of the applicability of Lean Six Sigma within the Air Force.

An analysis of corporate cultures across the Major Air Force commands to determine the most appropriate methods for implementing a centralized continuous improvement program across the entire Air Force. This research could provide the foundation of future change management decision making and could contribute to the Air Force-wide strategy concerning culture change.

Research providing a gap analysis of the training required by Air Force Lean Six Sigma Black Belts. This research could provide the Air Force with further understanding

of the training Air Force members selected for Black Belt training would require. It could also provide the information required to enhance other training opportunities outside of a continuous improvement program such as professional military education, officer training, and technical training programs.

Research to provide selection criteria for Black Belts based on unique Air Force requirements. This research could provide the Air Force with a set of guidelines or considerations to aid in articulating and developing the criteria used to select Black Belt candidates. This research could be completed though an analysis of industry selection criteria and the Air Force's leadership development strategy.

Research to further articulate the models presented in this research. Research could be conducted that may improve or better articulate the implementation models presented in this research. This research could be conducted through an analysis of present Air Force unit's structures to gage the impact the grafting of a continuous improvement implementation model could have.

Research Summary

Continuous improvement programs have changed and matured throughout history. Several theories and methodologies have been introduced, with some finding wide popularity among private sector companies. The latest methodology, Lean Six Sigma, is a combination of two continuous improvement programs, Lean and Six Sigma, popularized most notably by Toyota Motor Company and General Electric. Although there is considerable literature available and many consultants involved with Lean Six Sigma, very little published research addresses the practical experiences of companies

that have implemented a Lean Six Sigma program. This research's purpose was to investigate the deployment and implementation strategies of private sector companies that have successfully implemented Lean Six Sigma.

The research question of this research was: How and why are certain private sector implementations of Lean Six Sigma successful or unsuccessful? The investigative questions further focused the research question and identified several factors that seem to significantly contribute to implementation success. These factors are:

- Fusing business strategy with continuous improvement strategy
- Leadership commitment and involvement in the deployment and implementation processes
- The use of consultants that are proficient and experienced
- A defined organizational model that links the continuous improvement efforts with the performance measurement system and senior leadership
- Defined and standardized personnel selection criteria

These factors were then used to construct three organizational structures with the purpose of addressing the barriers and challenges that the organization could face.

Appendix A. Initial Contact to Gain Entry

A three-step process was used to gain entry into each company. First, research was conducted to determine which companies had or was implementing "Lean Six Sigma" or a similar combination of Lean and Six Sigma continuous improvement methodologies. This research was conducted using internet searches of company websites, published literature naming companies using Lean Six Sigma, and personal contacts. Once a company was identified by the research as using Lean Six Sigma, an email was sent to either a point of contact listed on the website or a point of contact given through a personal contact. The email outlined the scope of the research and the intent of the research findings. Once a positive response was received a follow-up email was sent summarizing the research effort and explaining the purpose and use of the attached interview guide. The following disclosure statement was included in the follow-up email:

DISCLOSRE TERMS: Your Company's participation in this research is voluntary. At any time, you may withdraw your participation from the research without any advanced notice. If you wish to work under the terms of a non-disclosure statement, that can be arranged. Unless otherwise stated in such an agreement, all information will be treated as for public release. Regardless of any lack of formal agreement, any proprietary information will be safeguarded as confidential information.

Appendix B. Interview Questions

For these questions:

"Deployment" is defined as activities performed in support of executive initiation and program design, or any activities completed prior to program implementation.

"Implementation" is defined as activities performed in direct support of roll-out or execution of the program throughout the company.

Question 1: How did you begin using Lean & Six Sigma methodologies in your organization?

a. What quality and/or process improvement methodologies were in use prior to Lean Six Sigma deployment?
b. How did consultants play a role in your organizations use or development of Lean & Six Sigma methodologies?

Question 2: How was "Lean Six Sigma" deployed within your organization?

a. How was the deployment design developed?
b. How was the deployment design communicated within the organization?

Question 3: How was the deployment of your organization's Lean Six Sigma effort managed?

a. What barriers were identified during the deployment?
b. How were those barriers overcome?
c. What lessons were learned as a result of dealing with those deployment barriers?

Question 4: What was the structure of your Lean Six Sigma implementation plan?

a. How did your organization's structure change due to Lean Six Sigma implementation?
b. What was the training plan for those who led the effort?
c. What was the training plan for those who managed the effort?
d. What was the timeline of your implementation?
e. What was the proliferation plan for Lean Six Sigma? Organization-wide or pilot applications?
    - Why was this decision made?

Question 5: How was the implementation of your organization's Lean Six Sigma effort managed?

a. What challenges were faced during implementation?
b. How were those challenges dealt with?
c. What lessons were learned as a result of dealing with those challenges?

Question 6: How has "Lean Six Sigma" benefited your organization?

a. If goals were set for the implementation period, how were those goals defined?
    - Were they achieved?
    - If not achieved were they modified or reassessed?
b. Were there unexpected results of your organization's Lean Six Sigma implementation?
c. How did your organization define your Lean Six Sigma program's "success" or "failure"?

Appendix C. Case Study: Xerox

Synopsis

Xerox Corporation (NYSE:XRX) is a $15.7 billion technology and services enterprise that helps businesses deploy Smarter Document Management[SM] strategies and find better ways to work. Its intent is to constantly lead with innovative technologies, products and services that customers can depend upon to improve business results.

Xerox provides the document industry's broadest portfolio of offerings. Digital systems include color and black-and-white printing and publishing systems, digital presses and "book factories," multifunction devices, laser and solid ink network printers, copiers and fax machines. Xerox's services expertise is unmatched and includes helping businesses develop online document archives, analyzing how employees can most efficiently share documents and knowledge in the office, operating in-house print shops or mailrooms, and building Web-based processes for personalizing direct mail, invoices, brochures and more. Xerox also offers associated software, support and supplies such as toner, paper and ink.

Headquartered in Stamford, Conn., Xerox is No. 130 among the Fortune 500 with 58,100 employees worldwide, including 32,100 in the United States (December 2004). The company's operations are guided by customer-focused and employee-centered core values -- such as social responsibility, diversity an d quality -- augmented by a passion for innovation, speed and adaptability.

Interview Responses

Question 1: How did you begin using Lean & Six Sigma methodologies in your organization?

Answer: While Xerox originally began using Six Sigma in 1998 in some manufacturing operations, it wasn't until fall of 2002 when the decision was made to implement Xerox Lean Six Sigma worldwide in all business areas. The factors influencing the decision included a strong desire on the part of leadership to make significant improvements in the business, customer pressure to provide lean & six sigma expertise to work seam issues, proof cases for success in manufacturing, examples of success in some of our partner organizations (e.g., GE Capital).

a. What quality and/or process improvement methodologies were in use prior to Lean Six Sigma deployment?

Answer: In the early 1980's Xerox launched an extensive Total Quality Management (TQM) program aimed at educating 110,000 employees worldwide in basic quality improvement methodologies, customer requirements and problem solving techniques. This included many of the same tools used in six sigma today (e.g., root cause analysis, decision making aides, brainstorming tools, pareto analysis, etc.). During the 80's and into the 90's these tools and techniques served Xerox well, but the approach had some major deficiencies now addressed with six sigma. The primary differences in Xerox Lean Six Sigma compared to the TQM

approach of the 80's and 90's is in Xerox Lean Six Sigma a smaller sub-set of the total population is trained to a much deeper depth, these resources are mobilized and dedicated to work major business improvement projects, and they lead teams of experts to get rapid and lasting improvements. Additionally, projects being worked are selected by senior leaders through a fairly rigorous project selection and prioritization process.

b. How did consultants play a role in your organizations use or development of Lean & Six Sigma methodologies?

   Answer: Consultants played a key role in both the deployment and implementation of Xerox Lean Six Sigma. At the beginning they assisted in formulating the overall approach we should take, provided leadership training to help the senior most executives understand what it is and what they were getting into, and they facilitated some tough conversations on resource allocation and how to select the right people in the right roles. Once the implementation began the consultants provided the "Master Black Belt" expertise to train and coach our new Black Belt populations.

Question 2: How was "Lean Six Sigma" deployed within your organization?

Answer: Once the executive leadership agreed and the decision was made to deploy Lean Six Sigma within Xerox, a senior manager was assigned to lead the effort. A reporting relationship was established directly to the CEO and the new Vice President, Xerox Lean Six Sigma was given a budget to staff approximately 6 positions that would lead and orchestrate the deployment and implementation. Additionally, each major business operation identified someone in his or her organization to be the "deployment manager" for that organization. These 25 people would support their management teams in the selection of black belt candidates and assist in prioritizing the business issues to be tackled with Xerox Lean Six Sigma. A detailed deployment guideline booklet was developed, with the help of the consultant, to guide the work of the deployment managers. Once these people were in place the organizations began recruiting black belts with leadership ability. These Black Belts expected to operate in this role for 2 to 3 years and then return to the business operation in similar significant roles they left or roles with increased responsibility.

a. How was the deployment design developed?

Answer: The deployment design was created through a combination of consultant recommendations, internal Xerox knowledge of lessons learned from similar experiences, benchmarking with other companies that had successful deployments and researching industry knowledge on the topic.

b. How was the deployment design communicated within the organization?

Answer: As mentioned above, the deployment design was summarized in a fairly extensive “Deployment Guideline” document. This document contains information explaining the what and how of Xerox Lean Six Sigma, organization structure, project selection methodology, deployment manager and black belt selection criteria, financial guidelines for valuing projects, cultural barriers, training paths, certification standards and additional resources. Additionally, all senior levels on management (approximately 2,500 people) were scheduled to participate in a 2 to 3 day interactive leadership workshop and various presentations were created for communication to general audiences. An internal website was also created to share deployment plans, success stories, expert resources and tools.

Question 3: How was the deployment of your organization's Lean Six Sigma effort managed?

Answer: The overall deployment was managed centrally under the direction of the newly appointed Vice President, Xerox Lean Six Sigma, with the project and people selection managed locally within each business operation. The centralized organization had responsibility for the corporate standards, learning paths, project tracking, Black Belt certification, financial rollup and global communications. The operations were accountable for selecting the right projects, selecting the right black belts to lead the projects, identifying teams, supporting project requirements and capturing the financial benefits of the completed projects.

a. What barriers were identified during the deployment?

Answer: There were few barriers during implementation mainly because this was a strategy fully endorsed, supported and led by the senior most leaders of the company. Anne Mulcahy gained buy-in from her leadership team quickly and leadership training was provided to help remove any barriers that might have been potentially caused by lack of understanding. Two "barriers" that were experienced to some degree in a few areas was getting the right people identified as Black Belts and developing adequate management skills to analyze and dissect the business to identify the best lean six sigma project to assign black belts. Getting the right people has

been overcome through education, good selection criteria and experiencing business results from successful projects. In the area of project selection, we are continually providing coaching, additional learning experiences and workshops for our management teams.

b. How were those barriers overcome?

Answer: See a.

c. What lessons were learned as a result of dealing with those deployment barriers?

Answer: We overestimated the skills of our business managers to dissect the business and define business opportunities that are well developed and scoped. If we were to turn the clock back 2 ½ years, we would have provided more in-depth training for manager in how to do better project selection, provided additional up-front coaching, created a certification standard by which managers would demonstrate these skills and reinforced the sponsors accountability for capturing business results.

Question 4: What was the structure of your Lean Six Sigma implementation plan?

Answer: Implementation plan included training waves for Leaders, Black Belts, Sponsors, Deployment Managers, Green Belts. Also included, were timelines for infrastructure enablers, such as coaching, software, centralized project tracking, on-line learning, communications materials, web-based resources, etc.

a. How did your organization's structure change due to Lean Six Sigma implementation?

Answer: The organization structure changed in a couple ways. First, the Vice President, Xerox Lean Six Sigma was identified as a new position, supported by a small centralized deployment team and cadre of Master Black Belts. Each major operation identified a deployment manager, responsible for assisting management with project selection and leading the newly appointed black belts.

b. What was the training plan for those who led the effort?

Answer: All leaders attended a two day awareness session, Sponsors an additional day of training, and Deployment Mangers and additional 3 days. Black Belt Training is five weeks, Green Belts 40 Hrs on-line plus 1 week, Yellow Belts. DfLSS for new product design and new process design are incremental training.

c. What was the training plan for those who managed the effort?

Answer: See b.

d. What was the timeline of your implementation?

Answer: Implementation is a multi-year process. I'll summarize it from month 0 through month 24. M-0 Decision made to implement and leadership training started, M-1 Centralized team on board, Deployment Managers identified and initial Black Belt Wave identified, M-2 Black Belt and deployment manager training started, M-3 to M-12 ramp-up continued with consultants as primary trainers and projects are executed per plan, M-13 to M-24 training transitions to internal Master Black Belts and Green Belt training accelerates, M-24 Begin ramp up of DfLSS training / implementation.

e. What was the proliferation plan for Lean Six Sigma? Organization-wide or pilot applications?

Answer: Implementation was corporate in all functions around the world. Dedicated Black Belt penetration yielded ½ % of employee population in year one, ramping to a full 1% in year two.

- Why was this decision made?

  Answer: This strategy was selected based on existing proof sources and the need to establish broad competency to execute cross-organizational projects.

Question 5: How was the implementation of your organization's Lean Six Sigma effort managed?

Answer: The implementation was managed at multiple levels. Centrally, the training schedule, tracking system, standards and communications coordinated. Decentrally, the black belt selection and project selection was managed. Leadership, at all levels, inspected the implementation embedded opportunities within core management process for project reviews. Targets were all established for business benefits and Year-end black belt capabilities within each of the management dashboards.

a. What challenges were faced during implementation?

Answer: The biggest challenge faced during implementation was the desire for each organization to implement in their own way. Each organization tried to justify why they were different.

b. How were those challenges dealt with?

Answer: From the beginning, Xerox Lean Six Sigma was defined as a corporate-wide strategy with clearly defined deployment standards and guidelines. While minor adjustments were made for unique organization needs, the implementation stayed on track, as defined.

c. What lessons were learned as a result of dealing with those challenges?

Answer: The primary lessoned learned is to get support from a consultant who has previously led a large-scale implementation, can assist in the development of uniform standards and can rapidly deploy required training.

Question 6: How has "Lean Six Sigma" benefited your organization?

Answer: Xerox Lean Six Sigma is benefiting Xerox in several ways. First, projects completed since the implementation have yielded over $150 million in economic profit. This benefit was achieved through cost savings, increased productivity, increased revenue, customer retention, reduced inventory, etc. Additionally, implementation of Lean Six Sigma has improved our focus on the customer, established a critical leadership development path and last, but certainly not least, transforming the culture.

a. If goals were set for the implementation period, how were those goals defined?

Answer: These goals evolved as the deployment matured. Basic goals for year 1-3 included: Year-1: Year-end Black Belts > ½ %, Bottom-line project benefits > implementation costs, Year-2: Project Benefits > $XXX Million, Year-end Black Belts > 1%, Year-3: Project Benefits > $XXXX Million, Year-end Black Belts sustained at > 1%.

- Were they achieved?

  Answer: All goals were achieved.

- If not achieved were they modified or reassessed?

b. Were there unexpected results of your organization's Lean Six Sigma implementation?

Answer: In addition to the project and customer benefits, the benefits in the form of leadership development and culture change is significant. While the financial results were expected based on external proof sources, the extent of leadership impact and organizational transformation was underestimated.

c. How did your organization define your Lean Six Sigma program's "success" or "failure"?

Answer: First, we never refer to our Xerox Lean Six Sigma deployment as a "program". Programs come and programs go. Xerox Lean Six Sigma is a significant business strategy and a key enabler in our transformation from good to great. By all measures Xerox Lean Six Sigma continues to be a success.

Appendix D. Case Study: Raytheon, Integrated Defense Systems

Synopsis

Our Vision
Be the most admired defense and aerospace systems supplier through world-class people and technology.

Raytheon at a Glance

- Chairman and CEO: William H. Swanson
- Global Headquarters: 870 Winter Street, Waltham, Massachusetts 02451
- 78,000 employees worldwide
- $18.1 billion in 2003 revenues

Raytheon's Strategy

- Achieve above-market growth in our four Strategic Business Areas:
    - Missile Defense
    - Precision Engagement
    - Intelligence, Surveillance and Reconnaissance
    - Homeland Security
- Restore Raytheon Aircraft to preeminence in aviation, showcasing the Beechcraft® and Hawker® brands.
- Be a Customer-Focused Company based on Performance, Relationships and Solutions:
- Performance – Meet commitments to our Customers, partners and each other, driving Customer Success.
- Relationships – Build positive, solid relationships with our Customers, partners and each other. Listen, anticipate, respond, follow-through.
- Solutions – Develop and provide superior Customer solutions, working as One Company.

A Global Leader in Technology Driven Solutions that Provide Integrated Mission Systems for Our Customers
Raytheon is an industry leader in defense and government electronics, space, information technology, technical services, and business aviation and special mission aircraft providing integrated mission systems to meet the critical defense and non-defense needs of its customers.

Businesses

- Integrated Defense Systems – Headquarters in Tewksbury, Massachusetts
- Intelligence and Information Systems – Headquarters in Garland, Texas
- Missile Systems – Headquarters in Tucson, Arizona
- Network Centric Systems – Headquarters in McKinney, Texas
- Space and Airborne Systems – Headquarters in El Segundo, California
- Raytheon Technical Services Company LLC – Headquarters in Reston, Virginia
- Raytheon Aircraft Company – Headquarters in Wichita, Kansas

Interview Responses

Question 1: How did you begin using Lean & Six Sigma methodologies in your organization?

a. What quality and/or process improvement methodologies were in use prior to Lean Six Sigma deployment?

Answer: Raytheon underwent a series of business mergers and consolidations (TI, Hughes, Honeywell Aerospace and Defense) since the late 90s. During these consolidations, best business practices from initiatives such as Six Sigma, lean/agile, and Total Quality Management and benchmarked best practices from other companies were rolled into what is now known as Raytheon Six Sigma™. Raytheon Six Sigma™ has become Raytheon's business strategy (much more than an initiative) and is defined as a knowledge-based process we use to transform our culture in order to maximize customer value and grow our business.

b. How did consultants play a role in your organizations use or development of Lean & Six Sigma methodologies?

Answer: During the initial consolidation phase and beginning of Raytheon Six Sigma™, consultants were brought in to benchmark best in class practices across industry, and bring out the best of what was acquired through Raytheon's mergers. The consultants help devise the initial Raytheon Six Sigma Black Belt curriculum, which was later revamped to

be the Raytheon Six Sigma Expert curriculum. Classic Six Sigma uses a five step process (Define, Measure. Analyze, Improve, Control), whereas Raytheon Six Sigma™ is a six step process (Visualize, Commit, Prioritize, Characterize, Improve, Achieve). Raytheon has realized that the difference between a successful project and wasted heroic effort is in the Commit step, where project sponsorship and team composition is obtained. It is the continuous attention to Commit throughout the project's lifecycle that our folks have helped the business realize the gain it has Achieved. Consultants continue to play a role in our core Expert training curriculum, and on as as-needed basis while we continuously strive to improve our business strategy.

Question 2: How was "Lean Six Sigma" deployed within your organization?

a. How was the deployment design developed?

Answer: The deployment design was conceived at the Raytheon Corporate level, later to be spread into each of the 7 major businesses that comprise Raytheon (Integrated Defense Systems, Missile Systems, Network Centric Systems, Raytheon Technical Services Company, Intelligence and Information Systems, Space and Airborne Systems, Raytheon Aircraft Company). It was developed in conjunction with inside Raytheon Stakeholders and external consultants from industry and academia. Deployment started at the Expert (black belt) level with the

establishment of Raytheon Six Sigma™ Champions at each of the businesses who then cultivated 1% of the employee population to go through the Raytheon Six Sigma™ Expert program, training held at the corporate level. Raytheon Six Sigma™ was then expanded on a Specialist level (green belt) to some degree of the employee population (mostly those folks who sought out the Qualification). In recent years, with the Business leaders seeing the positive impact of Raytheon Six Sigma™ on the bottom line, goals have been established at various levels in the business of achieving 100% of the employee population becoming at least Specialist level practitioners of Six Sigma. Later, the Master Expert (Master Black Belt) role was developed, and Six Sigma Practitioner tracks have been created to allow employees (Expert and Specialist levels) continued education in such practices as Integrated Supply Chain, Design for Six Sigma, etc…

b. How was the deployment design communicated within the organization?

Answer: The deployment design was communicated in a way that has suited each of the Businesses' needs, while maintaining consistency at the Corporate level. All Raytheon Six Sigma™ Experts go through uniform training with the Raytheon Learning Institute, and go through a uniform Certification process at the Corporate level. Raytheon Six Sigma™ Specialists go through Business specific training, sometimes geared towards an employee's specific discipline (e.g. Engineering, Manufacturing). Specialists are Qualified

based upon uniform corporate criteria. Much of the design was/is communicated via emails, forums, and the corporate intranet.

Question 3: How was the deployment of your organization's Lean Six Sigma effort managed?

a. What barriers were identified during the deployment?

Answer: One of the major barriers identified during the deployment was lack of a cohesive business strategy and culture across the businesses Raytheon had come to acquire.

b. How were those barriers overcome?

Answer: The cultural barrier was broken in a few different ways. First, at CEO and President level sponsorship, Raytheon Six Sigma™ was to emerge as the one, cohesive, business strategy that Raytheon employed to focus in on the customer. This was to become the one language that we put forth to both our employees and customer community. Initially, Six Sigma Champions were deployed in the Raytheon businesses to create pervasion of the business strategy. After a few years, the Champion role was dissolved, and most Six Sigma leaders (organizationally) are linked into various high level roles in the businesses (some in Quality, Supply Chain Management, Productivity, etc…).

c. What lessons were learned as a result of dealing with those deployment barriers?

Answer: One of the major lessons learned was that success was dependant upon the height of sponsorship, and the depth of results.

Question 4: What was the structure of your Lean Six Sigma implementation plan?

a. How did your organization's structure change due to Lean Six Sigma implementation?

Answer: In the initial few years, Raytheon Six Sigma™ Champions were deployed at each of the businesses to lead the culture change.

b. What was the training plan for those who led the effort?

Answer: The Business leaders went through initially 5 day training on sponsoring Raytheon Six Sigma™. It's since dropped down to 3 days.

c. What was the training plan for those who managed the effort?

Answer: The Raytheon Six Sigma™ Experts originally went through a 6 week training which has been changed to a 4.5 week training over the last few years.

d. What was the timeline of your implementation?

Answer: There wasn't a timeline as much as a goal to have at least 1% of the Raytheon employee population being practicing Raytheon Six Sigma™ Experts (which we are currently meeting as Raytheon). Some of the Businesses have adopted a 100% Raytheon Six Sigma™ Specialist Qualification goals for their employee populations.

e. What was the proliferation plan for Lean Six Sigma? Organization-wide or pilot applications?

- Why was this decision made?

Answer: Organization wide. Our CEO(s) have realized the business lift that Raytheon Six Sigma™ has helped both the business and our customers Achieve.

Question 5: How was the implementation of your organization's Lean Six Sigma effort managed?

Answer: See question 3.

a. What challenges were faced during implementation?

Answer: Challenges faced during implementation included taking the best and brightest people in the businesses out of their jobs (to become Experts) and getting buy-in from their managers to do so. In the beginning of the implementation phase, the initial Experts had to contend with disparate cultures that were a result of multiple mergers.

b. How were those challenges dealt with?

Answer: The challenges of getting the best and brightest were dealt with by the executive leadership team, and taking a top down approach for initially driving support. The Experts worked hard to replace the many different cultures with the Raytheon Six Sigma™ business strategy, showing people the power of focusing on the customer, and delivering results.

c. What lessons were learned as a result of dealing with those challenges?

Answer: One of the major lessons learned in implementation came from the level of executive support. Those Businesses that had direct and visible support from the top leaders for Raytheon Six Sigma™ had a more successful permeation into their organizations, and measured success based upon results to both the Business and customer community.

Question 6: How has "Lean Six Sigma" benefited your organization?

a. If goals were set for the implementation period, how were those goals defined?

Answer: See question 4 D.

- Were they achieved?
- If not achieved were they modified or reassessed?

b. Were there unexpected results of your organization's Lean Six Sigma implementation?

Answer: Results, by definition, are expected as part of our implementation. What may have been unexpected was how well the customer community has taken our business strategy, in some parts adopting it for themselves under our tutelage.

c. How did your organization define your Lean Six Sigma program's "success" or "failure"?

Answer: Business benefit. Whether it was increasing profit, decreasing costs, increasing business velocity, our organization marks these all as our business strategy's success.

Appendix E. Case Study: General Electric, Transportation

Synopsis

GE is a diversified technology, media and financial services company dedicated to creating products that make life better. From aircraft engines and power generation to financial services, medical imaging, television programming and plastics, GE operates in more than 100 countries and employs more than 300,000 people worldwide.

The company traces its beginnings to Thomas A. Edison, who established Edison Electric Light Company in 1878. In 1892, a merger of Edison General Electric Company and Thomson-Houston Electric Company created General Electric Company. GE is the only company listed in the Dow Jones Industrial Index today that was also included in the original index in 1896.

Interview Responses

Question 1: How did you begin using Lean & Six Sigma methodologies in your organization?

Answer: Lean and Six Sigma tools have been used extensively in the last 10 years at General Electric. However, the crossover was not always obvious, intentional, or a result of any implementation strategy. Over time with continuous use, there was growing awareness that the best DMAIC Six Sigma Improve tools were "Lean-Like." Lean was used to varying degrees in Six Sigma projects, with different approaches based on the individual's exposure and training to Lean tools.

Combined Lean Six Sigma methodologies were not fully realized as one entity until the 2004/2005 timeframe when GE Leadership began building a structure to match the ideas and implementation strategies of Lean Six Sigma proponents.

Lean Six Sigma methodology was a natural progression in the manufacturing environment of GE Transportation. The focus and dedication to Six Sigma process resulted in a natural inclination to streamline production, reduce costs and cycle times, and improve output in addition to reducing variation.

a. What quality and/or process improvement methodologies were in use prior to Lean Six Sigma deployment?

Answer: Six Sigma was the primary methodology across the business while Lean constituted a significant effort on the manufacturing side (Supply chain, warehousing, etc.)

b. How did consultants play a role in your organizations use or development of Lean & Six Sigma methodologies?

Answer: Consultants have been and continue to be used extensively by GE Transportation for major Lean efforts. As business leaders embraced Lean Six Sigma, Michael George, the author and primary proponent of Lean Six Sigma strategies, consulted and trained GET Blackbelts on the crossover of Lean and Six Sigma. The purpose was to create and develop an understanding, interest and motivate individuals to combine the two strategies for elevated performance.

Question 2: How was "Lean Six Sigma" deployed within your organization?

a. How was the deployment design developed?

Answer: First: Leadership buy in. Once top business leaders became aware of the connection of Lean and Six Sigma, drew upon its past successes and established a vision for the future, they put significant energy into fostering the idea to the entire organization. At a meeting of

top business leaders in January 2005, Lean & Six Sigma was strongly supported as a key business initiative.

Justification: Business leaders are heavily engaged in global economic and social trends. Lean Six Sigma strategy parallels the demands and pace of the marketplace for reduced costs, cycle time, and efficiency to maintain competitive edge. Proving and instilling this concept was a major factor in Lean Six Sigma deployment.

Second: Reliance upon the existing organization. The team of Master Blackbelts and Blackbelts who act as the primary change agents were given the task to develop the structure for the business.

b. How was the deployment design communicated within the organization?

Answer: Leadership conferences: Mentioned above. Introduction to Lean Six Sigma as a key initiative. Leadership support for transition to the improved model. Key business leaders expected to create impetus and excitement for Lean Six Sigma strategy.

Activity: Increased emphasis on cross-functional Lean events. Action being the necessity to propelling change, GE Transportation initiated transactional Lean events for 2005 that will require and involve a significant portion of the work force.

Question 3: How was the deployment of your organization's Lean Six Sigma effort managed?

Answer: It was managed from the top level of the Six Sigma organization. The VP of Business Practices and Processes viewed Six Sigma as a dynamic organization that could change as customer needs and business needs changed. Connecting the strategies of both disciplines was a natural fit for GE Transportation. Master Blackbelts within the organization were quick to pick up the message and add additional energy and interest to the benefits of change.

a. What barriers were identified during the deployment?

Answer: The only barriers experienced to date are how to accelerate the transformation. As a whole, the Lean Six Sigma evolution has been culturally embraced which only leaves the natural bumps associated with implementing that change. Organizational issues, work scope, standardization, training, identification and prioritization of projects are natural hurdles that face the management of the Lean Six Sigma effort while confidence remains high that success will result from the new focus.

b. How were those barriers overcome?

c. What lessons were learned as a result of dealing with those deployment barriers?

Question 4: What was the structure of your Lean Six Sigma implementation plan?

Answer: Strategy: Communicate the message Top to Bottom (business leader level), from within (Blackbelt organization, Division, Department leaders, and Bottom up (testimonials, best practices, etc).

Structure: Build and evolve the pre-existing Six Sigma structure:

Master Blackbelt, Blackbelt organization: Exists to support the Business Y's (Major business initiatives). Draw from MBB, BB ranks to identify projects as Lean & Six Sigma projects. Participate in Business Lean event, then become primary trainer and leader of departmental/divisional Lean event.

Department Blackbelts: Support organizational leaders in ongoing initiatives in support of their particular Y or accelerate change/improvement. Assist in the above.

Lean & Six Sigma class: Develop the Lean focus of Six Sigma training to combine the two.

Certification Requirements: Require some level of Lean participation and Lean leadership prior to certification as a Blackbelt.

Training & Education: Education of the entire workforce. Just as Six Sigma had become part of the culture of GE, it was an easy transition to begin to instill Lean Six Sigma. There were many examples of past successes in addition to a natural blending and understanding of the two processes working in conjunction that was easy to develop and instill as a

business initiative that made good sense and that would demonstrate results.

Activity: 2005 focus on increased number of Lean events; requirement for Lean participation and leadership for certification.

a. How did your organization's structure change due to Lean Six Sigma implementation?

Answer: To date very little. Organizational changes were less important than shifting the focus of efforts from Six Sigma exclusively to a more inclusive Lean & Six Sigma approach.

b. What was the training plan for those who led the effort?

Answer: Train Executive team first. Accelerate executive level focus on areas of improvement that are ripe for a Lean event

Train the Six Sigma Blackbelts through participation. Following the identification of Divisional or Departmental sponsored events, the Blackbelts will use those events to train the workforce.

c. What was the training plan for those who managed the effort?

d. What was the timeline of your implementation?

Answer: Milestones for implementation are immediate: First, develop the structure for training Lean leaders, identify likely project candidates, set timelines for training and completion. Roll projects into existing Y organization and expectations.

e. What was the proliferation plan for Lean Six Sigma? Organization-wide or pilot applications?:

Answer: Organization wide: Organization changes implemented to shift focus and accelerate Lean methodology alongside Six Sigma methodology. Use pilot applications in terms of projects to accelerate the understanding of Lean & Six Sigma methodologies.

- Why was this decision made?

  Answer: Lean has been used extensively in the last decade at GE Transportation. Its value was proven and its projects had positively impacted business metrics. Leveraging this success (specifically from Manufacturing) into the transactional process was the natural evolution into a more formalized and broad organizational undertaking.

Question 5: How was the implementation of your organization's Lean Six Sigma effort managed?

Answer: This process is ongoing and the questions will be better answered later in the year.

a. What challenges were faced during implementation?

b. How were those challenges dealt with?

c. What lessons were learned as a result of dealing with those challenges?

Question 6: How has "Lean Six Sigma" benefited your organization?

a. If goals were set for the implementation period, how were those goals defined?

Answer: Goals have been defined as deliverables from the Lean Six Sigma focus. These goals are rolled up in current business metrics and targets. Lean Six Sigma has been the strategy identified as the methodology and process used to achieve these goals.

- Were they achieved?

  Answer: TBD

- If not achieved were they modified or reassessed?

b. Were there unexpected results of your organization's Lean Six Sigma implementation?

c. How did your organization define your Lean Six Sigma program's "success" or "failure"?

Answer: By the targeted business metrics. At the end of the year, business managers should be able to sum up their performance to stated goals and the strategy used to achieve. Identification of successes and failures (metrics) should be able to be traced to the strategy employed to reach them. From this strategy, lessons learned will be considered while adopting the go-forward plan.

Appendix F. Case Study: Lockheed Martin

Synopsis

Lockheed Martin Corporation is mainly involved in the research, design, development, manufacture, integration, operation and support of advanced technology systems, products and services. We have customers in domestic and international defense, civil government, and commercial markets, and over 75% of our sales over the past three years have been to agencies of the U.S. Government. Our main areas of focus are in the defense, space, homeland security, and government information technology markets.

We operate in five principal business segments: Aeronautics, Electronic Systems, Space Systems, Integrated Systems & Solutions and Information & Technology Services. As a lead systems integrator, our products and services range from aircraft, spacecraft and launch vehicles to missiles, electronics and information systems, including integrated net-centric solutions.

Interview Responses

Question 1: How did you begin using Lean & Six Sigma methodologies in your organization?

Answer: Lean and Six Sigma methodologies were introduced in LM Space Systems companies through a series of incremental improvement initiatives dating back to the 1990's. Continuous process improvement featuring process mapping with as-is / to be methodology was part of a 1995 initiative in then Martin Marietta. With the series of company mergers and acquisitions that ultimately formed the present Lockheed Martin Company, an initiative called LM21 (Lockheed Martin for the 21st century) was launched as a means of sharing best practices from the many former companies merging as one Lockheed Martin. The Space Systems Company of LM was very active in LM21 as best practices and incorporated a grass roots Six Sigma program transferred and adapted from a sister division that had formerly been part of General Electric. The LM21 program itself evolved from a best practice transfer initiative, to one based on the adoptions of Lean and Six Sigma principles. Space Systems was in a position to be a leader and developer with the new Corporate direction of LM21 and has maintained a strong Lean and Six Sigma based LM21 Operating Excellence program.

a. What quality and/or process improvement methodologies were in use prior to Lean Six Sigma deployment?

Answer: Quality Circles, IPTs, Best practices transfer, TQM, ISO, CMMI

b. How did consultants play a role in your organizations use or development of Lean & Six Sigma methodologies?

Answer: This answer would be different throughout the company. Corporate provides consultants to "jump start" programs and "train" Black Belts and Green Belts. Space Systems attempts to foster an independent development approach so that change agent talent is developed on and available to the programs were process improvements are executed. Consultants or outside training agencies were used to educate a core group who then internally developed training programs for the company.

Question 2: How was "Lean Six Sigma" deployed within your organization?

a. How was the deployment design developed?

Answer: Originally grass roots and evolutionary, but now has a strategic deployment plan tied to the long range planning cycle for the company.

b. How was the deployment design communicated within the organization?

Answer: Through multiple channels – an annual LM21 Strategic Plan which flows to the Programs who maintain Program Excellence Plans for process improvement. LM21 "POCs" (Points of Contact) have

responsibility for LM21 planning and execution on their programs. Change agents (Master Black Belt, Black Belts, and Green Belts) are deployed for execution for process improvement projects and events

Question 3: How was the deployment of your organization's Lean Six Sigma effort managed?

Answer: Though the Strategic Plan and Program Excellence Plans managed by LM21 POCs

a. What barriers were identified during the deployment?

Answer: Budget constraints, change resistance, time constraints.

b. How were those barriers overcome?

Answer: Training, demonstration of success

c. What lessons were learned as a result of dealing with those deployment barriers?

Answer: Management support is vital to success. Most often top management support is given as the most vital, which is probably true. However, in the tactical execution phase of accomplishing improvement projects, middle management is a vital link. Many barriers can be removed when middle management begins to use continuous improvement methodology as a normal business rhythm set of tools to prevent and solve problems rather that to see them as an added on, extra burden set of things they have to do.

Question 4: What was the structure of your Lean Six Sigma implementation plan?

Answer: Our LM21 Strategic Plan consists of identification of our focus and priority programs, major initiatives, and strategic goals and targets for our continuous improvement efforts. It outlines the metrics to be tracked to monitor and evaluate progress. It also contains a training plan to create the required expertise to execute the plan. From these company wide strategies, Program and Functional level Excellence Plans are created and executed in support of the Strategic Plan that contain goals and objectives and planned projects and events to achieve them. Metrics are reported regularly through management reviews that monitor progress and provide mid course guidance.

a. How did your organization's structure change due to Lean Six Sigma implementation?

Answer: No structure change

b. What was the training plan for those who led the effort?

Answer: Extensive training in Lean and Six Sigma techniques. Both outside and inside sources are used. Green Belt is a one week training program with demonstration of skills required on a project or event. Black Belt adds two additional weeks and requires skills demonstration of three projects and mentoring of three Green Belts to certification.

c. What was the training plan for those who managed the effort?

Answer: LM has LM21 Leadership courses in multiple formats. Instructor led and web based.

d. What was the timeline of your implementation?

Answer: Ongoing

e. What was the proliferation plan for Lean Six Sigma? Organization-wide or pilot applications?

Answer: Organization wide, growing from an original "grass roots" initiative and evolving.

- Why was this decision made?

  Answer: Evolution by continuous improvement applies to the continuous improvement program itself too.

Question 5: How was the implementation of your organization's Lean Six Sigma effort managed?

Answer: Our LM21 effort is lead by an Operations Director designated "POC" for the initiative. The POC has Master Black Belts reporting to him who are responsible for change agent mentoring and overseeing technical execution of events and projects.

a. What challenges were faced during implementation?

Answer: Budget constraints, change resistance, time constraints.

b. How were those challenges dealt with?

Answer: Diligence, perseverance, demonstration of successes, management support, use of metrics to drive results

c. What lessons were learned as a result of dealing with those challenges?

Answer: Success requires diligence, perseverance and strong leadership leading to cultural change.

Question 6: How has "Lean Six Sigma" benefited your organization?

a. If goals were set for the implementation period, how were those goals defined?

Answer: Metrics were established (savings, training, certification, and project and event targets) and tracked through a data base system.

- Were they achieved?

  Answer: Yes

- If not achieved were they modified or reassessed?

  Answer: n/a

b. Were there unexpected results of your organization's Lean Six Sigma implementation?

Answer: No

c. How did your organization define your Lean Six Sigma program's "success" or "failure"?

Answer: In terms of our progress as measured by our metrics.

Appendix H. Case Study: ITT

Synopsis

ITT Industries, Inc. is a global engineering and manufacturing company with leading positions in the markets it serves, generating 2003 sales of $5.63 billion. ITT Industries is the world's premier supplier of pumps, systems and services to move, control and treat water and other fluids. The company is a major supplier of sophisticated military defense systems, and provides advanced technical and operational services to a broad range of government agencies. ITT Industries also produces connectors, switches, keypads and cabling used in telecommunications, computing, aerospace and industrial applications, as well as network services. Further, ITT Industries makes industrial components for a number of other markets, including transportation, construction and aerospace. Based in White Plains, New York, ITT Industries employs approximately 39,000 people around the world.

Interview Responses

Question 1: How did you begin using Lean & Six Sigma methodologies in your organization?

Answer: In my organization we began using lean techniques by working with a consultant that we met through a friendship we an executive. Our lean program started 8 years before our Six Sigma program. Our six sigma program was started after reading about the successes of GE and others.

a. What quality and/or process improvement methodologies were in use prior to Lean Six Sigma deployment?

Answer: Prior to LSS we used most of the LSS tools, since we had a lean program and a TQM program. The LSS program brought a focus to prioritization methods and some additional statistical tools.

b. How did consultants play a role in your organizations use or development of Lean & Six Sigma methodologies?

Answer: Our lean consultant helped us implement a comprehensive lean training program that started us on the lean journey. Converting your business and workforce to lean culture typically takes 4 to 6 years.
Our LSS consultants trained our first Champions, Black Belts and Master Black Belts. They organized and coordinated the program implementation.

Question 2: How was "Lean Six Sigma" deployed within your organization?

Answer: A steering committee with members from our company and the consulting firm guided the program development and deployment. It was a massive undertaking with over 40 Champions and several 100 Black Belts trained within the first 1 ½ years.

a. How was the deployment design developed?

Answer: The basic design was developed by the consultants. Then it was modified to meet the specific needs of our business.

b. How was the deployment design communicated within the organization?

Answer: Rollout meetings were held at business units all over the world. The meetings lasted 1 ½ days and presented an overview of the entire program and the new positions it would create.

Question 3: How was the deployment of your organization's Lean Six Sigma effort managed?

Answer: The steering committee managed the deployment of the program.

a. What barriers were identified during the deployment?

Answer: I was not on the Deployment team. I was a first wave Business Unit Champion.

b. How were those barriers overcome?

Answer: None

c. What lessons were learned as a result of dealing with those deployment barriers?

Answer: None

Question 4: What was the structure of your Lean Six Sigma implementation plan?

Answer: We were organized with Black Belts reporting to Business Unit Champions and B.U. Champions reporting to Management Company Champions and M.C. Champions reporting to the Head Quarters Champion and he reported to the CEO.

a. How did your organization's structure change due to Lean Six Sigma implementation?

Answer: LSS created an entire new organization with a full time focus on continuous improvement.

b. What was the training plan for those who led the effort?

Answer: Black Belts received seven weeks of classroom training and were required to perform two projects for certification.

c. What was the training plan for those who managed the effort?

Answer: Champions received seven weeks of classroom training and four weeks at sites performing analysis of the sites and identifying projects.

d. What was the timeline of your implementation?

Answer: Implementation in the USA took approximately 8 months and Europe lagged by a few months. China and A/P took several more months. Language barriers caused most of the delays.

e. What was the proliferation plan for Lean Six Sigma? Organization-wide or pilot applications?

Answer: There was no pilot, just organization wide implementation.

- Why was this decision made?

Answer: I don't know.

Question 5: How was the implementation of your organization's Lean Six Sigma effort managed?

Answer: The steering committee managed the implementation of the program.

a. What challenges were faced during implementation?

Answer: Since the program could be viewed as high risk, recruiting Black Belts and Champions for this unknown program.

b. How were those challenges dealt with?

Answer: Champion and Black Belt volunteers were given a 5% pay increase immediately and a 10% bonus after certification.

c. What lessons were learned as a result of dealing with those challenges?

Answer: I don't know.

Question 6: How has "Lean Six Sigma" benefited your organization?

Answer: The program has paid for itself many times over and continues to do so. Benefits are measured in operating income, working capital, revenue and above all customer satisfaction.

a. If goals were set for the implementation period, how were those goals defined?

Answer: Black Belts were expected to complete four projects per year at an operation income benefit of $250k per project or one million dollars per black belt.

- Were they achieved?

  Answer: No, but we achieved operating income benefits of over $250 million per year for the last three years.

- If not achieved were they modified or reassessed?

  Answer: Yes, they were reassessed. It was correctly assumed that a Black Belt was capable of leading projects valued over $250k. Organization resource constrains and identifying enough projects of over $250k of operating income were barriers. Black Belts now average $100k per project and 3 projects per year.

b. Were there unexpected results of your organization's Lean Six Sigma implementation?

Answer: Yes, the training sessions consisted of cross organization classes of people that had never met before. The extensive training built a network across the organization that is very valuable.

c. How did your organization define your Lean Six Sigma program's "success" or "failure"?

Answer: The organization describes the program is very successful. The successes can be seen in the satisfaction of our customers. Voice of the customer is the most important feedback.

Appendix J. Case Study: Solectron

Synopsis

Solectron Corporation, founded in 1977, is a leading electronics manufacturing services (EMS) company offering a full range of integrated supply chain solutions. They serve the world's most innovative brand-name companies in industries that rely on high-tech electronics.

With their integrated collaborative design, lean manufacturing and post-manufacturing services they offer customers competitive outsourcing advantages, such as access to advanced manufacturing technologies, shorter product time-to-market, lower total cost of ownership and more effective asset utilization.

Revenues from continuing operations for fiscal year 2004 were US$11.64 billion. Solectron spans five continents and is in more than 20 countries. Solectron has received more than 450 quality and service awards from its customers in addition to winning two Malcolm Baldrige National Quality Awards. Solectron has also recently received customer recognition for its implementation of Lean Six Sigma quality standards. Partnerships with many of the strongest companies in high-tech electronics, including Cisco Systems, Ericsson, Hewlett-Packard, IBM, Microsoft, Motorola, Nortel Networks, Sony and Sun Microsystems.

Interview Responses

Question 1: How did you begin using Lean & Six Sigma methodologies in your organization?

a. What quality and/or process improvement methodologies were in use prior to Lean Six Sigma deployment?

Answer: Malcolm Baldridge National Quality Award Criteria

b. How did consultants play a role in your organizations use or development of Lean & Six Sigma methodologies?

Answer: Solectron uses both academic and hands-on consultants. The academic ones helped articulate Lean Six Sigma methodologies and the hand-on experts help employees apply kaizen methodologies which modeling Toyota Production System with real cases.

Question 2: How was "Lean Six Sigma" deployed within your organization?

a. How was the deployment design developed?

Answer:

1. Driven by corporate, region, and site leadership team
2. Developed and rolled out training program
3. Benchmark internal and external best practices of Lean Six Sigma

4. Started with small – one pilot lean line at every site
5. Conducted Lean Six Sigma workshops
6. Defined stand works for key process elements
7. Rolled out lean lines for entire site
8. Monthly progress review on Lean Six Sigma process and metrics

b. How was the deployment design communicated within the organization?

Answer:

1. Management communication/review at all levels
2. Newsletters (examples attached)
3. Training and workshops

Question 3: How was the deployment of your organization's Lean Six Sigma effort managed?

a. What barriers were identified during the deployment?

Answer: No significant barriers during deployment

b. How were those barriers overcome?

c. What lessons were learned as a result of dealing with those deployment barriers?

Question 4: What was the structure of your Lean Six Sigma implementation plan?

a. How did your organization's structure change due to Lean Six Sigma implementation?

Answer: The most significant organizational change is the creation of "Functional Excellence" teams at the corporate, regions, and sites, which are responsible for articulation, training, implementation, and tangible results of Lean Six Sigma.

b. What was the training plan for those who led the effort?

Answer: Trained by reputed Lean Six Sigma experts including McKinsey consultants, GE Master Black Belts, and Jim Womack (author of "Lean Thinking"). The leadership team also visited Toyota plants in Japan to witness Toyota Production System in action.

c. What was the training plan for those who managed the effort?

Answer:

1. Similar training activities the leadership team went through
2. Trained through hands-on kaizen workshop conducted by external experts

d. What was the timeline of your implementation?

Answer:

1. 3 months for pilot lean line
2. 1 year for 100% roll-out
3. Journey for perfection continues

e. What was the proliferation plan for Lean Six Sigma? Organization-wide or pilot applications?

Answer: Reference to Question 2; Rolled out lean lines for entire site; Monthly progress review on Lean Six Sigma process and metrics; Continuous improvement and refine program

a. Why was this decision made?

Answer: n/a

Question 5: How was the implementation of your organization's Lean Six Sigma effort managed?

a. What challenges were faced during implementation?

Answer: Actually not much since our program is driven from the highest of the company's management team.

b. How were those challenges dealt with?

c. What lessons were learned as a result of dealing with those challenges?

Question 6: How has "Lean Six Sigma" benefited your organization?

a. If goals were set for the implementation period, how were those goals defined?

Answer: Quality, productivity, customer satisfaction, sales increase, profitability, cross-functional collaboration, and employee satisfaction, etc.

- Were they achieved?

  Answer: Yes, in most parts

- If not achieved were they modified or reassessed?

  Answer: Continuously and persistently improve; never give up.

b. Were there unexpected results of your organization's Lean Six Sigma implementation?

Answer: Yes, but relatively minor

c. How did your organization define your Lean Six Sigma program's "success" or "failure"?

Answer: Whether or not we continuously improve key business metrics in quality, productivity, customer satisfaction, sales increase, profitability, cross-functional collaboration, and employee satisfaction, etc.

Appendix K. Analysis Tables

Companies	Use of Continuous Improvement Methodologies Prior to Lean Six Sigma
1	A series of business mergers and consolidations brought best practices from initiatives such as Six Sigma, lean/agile, TQM
2	Quality Circles, IPTs, Best practices transfer (a series of company mergers and acquisitions that ultimately formed the present company), TQM, ISO, CMMI
3	Use of robust Six Sigma, some use of Lean in manufacturing
4	In 1980's extensive use of TQM
5	Both a lean program and a TQM program were in place
6	Malcolm Baldridge National Quality Award Criteria

Companies	The role of consultants in using or developing Lean Six Sigma
1	Consultants were brought in to benchmark best in class practices across industry, bring out the best of what was acquired through merger process, and help devise the initial Black belt curriculum. Consultants continue to play a role in training and on as as-needed basis
2	This answer would be different throughout the company. Corporate provides consultants to "jump start" programs and "train" Black Belts and Green Belts. Company 2 attempts to foster an independent development approach so that change agent talent is developed on and available to the programs where process improvements are executed. Consultants were used to educate a core group who then internally developed training programs for the company.
3	Used extensively for Major Lean efforts, Michael George consulted and trained Blackbelts on the crossover of Lean and Six Sigma. Purpose was to create and develop and understanding, interest and motivate individuals to combine the tow strategies
4	Played a key role…assisted in formulating the overall approach, provided leadership training, facilitated some tough conversations on resource allocation and how to select the right people in the right roles, provided "Master Black Belt" expertise to train and coach our new Black Belt population
5	Consultants trained first Champions, Black Belts, and Master Black Belts. Organized and coordinated the program implementation
6	Use academic consultants to articulate Lean Six Sigma methodologies and hands-on consultants to apply kaizen methodologies

Companies	Deployment design process (leadership)
1	Deployment design was conceived at corporate level in conjunction with internal stakeholders and external consultants from industry and academia
2	Originally grass roots and evolutionary—now has a strategic deployment plan tied to the long range planning cycle for the company
3	Once top business leaders became aware of the connection of Lean and Six Sigma, they drew upon its past successes and established a vision for the future, they put significant energy into fostering the idea to the entire organization.
4	Deployment design created through a combination of consultant recommendations, internal knowledge, benchmarking successful deployments, researching industry knowledge
5	Steering committee managed the deployment
6	Driven by corporate , region, and site leadership team; benchmarked internal and external best practices

Companies	Deployment barriers
1	Identified a lack of a cohesive business strategy and culture across the acquired businesses
2	Budget constraints, change resistance, time constraints
3	How to accelerate the transformation
4	Getting the right people identified as Black Belt candidates and developing adequate management skills to analyze and dissect the business to identify the best Lean Six Sigma projects to assign Black Belts
5	N/A
6	No significant barriers identified

Companies	How deployment barriers were managed or overcome
1	CEO and President level sponsorship of one cohesive business strategy (Lean Six Sigma) focusing on customers. Champions were deployed to businesses to create pervasion of the business strategy.
2	Training, demonstration of success
3	N/A
4	Education, good selection criteria, and experiencing business results from successful projects. Continually providing coaching, additional learning experiences and workshops for management teams.
5	N/A
6	N/A

Companies	Lessons learned from deployment
1	Success was dependant upon the height of sponsorship and the depth of results
2	Management support is vital to success. Most often top management support is given as the most vital, which is probably true. However, in the tactical execution phase of accomplishing improvement projects, middle management is a vital link. Many barriers can be removed when middle management begins to use continuous improvement methodology as a normal business rhythm set of tools to prevent and solve problems rather that to see them as an added on, extra burden set of things they have to do.
3	N/A
4	We overestimated the skills of our business managers to dissect the business and define business opportunities that are well developed and scoped
5	N/A
6	N/A

Companies	Structure changes as a result of Lean Six Sigma implementation
1	Champions were deployed at each business to lead culture change. 1% of employee population trained as Black Belts. 100% of employees trained as Green Belts. Eventually Master Black Belt role developed.
2	No structure change.
3	Very little
4	New VP position identified to lead Lean Six Sigma effort that is supported by a small centralized deployment team and cadre of Master Black Belts. Each major operation identified a deployment manager responsible for assisting management with project selection and leading Black Belts.
5	Lean Six Sigma created an entire new organization with a full time focus on continuous improvement. Black Belts reporting to Business Unit Champions reporting to Management Company Champions reporting to Head Quarters Champion reporting to CEO.
6	Creation of "Functional Excellence" teams at the corporate, regions, and sites which are responsible for articulation, training, implementation, and tangible results of Lean Six Sigma

Companies	Executive Leaders Training
1	5 day training on how to sponsor Lean Six Sigma
2	N/A
3	Trained executive team first. Accelerate executive level focus on areas of improvement that are ripe for a Lean event
4	2 day awareness session for leaders, 3 days for sponsors, 6 days for deployment managers
5	Champions received seven weeks of classroom training and four weeks at sites performing analysis of the sites and identifying projects
6	Leaders were trained by Lean Six Sigma consultants, GE Master Black Belts, and Jim Womack. Leaders also visited Toyota plants in Japan to observe TPS.

Companies	Practitioner Training
1	All Black Belt candidates go through uniform training and certification process at the Corporate level 6 week training which has now been reduced to 4.5 weeks. Green Belts go through business specific training geared towards an employee's specific discipline and are qualified based upon uniform Corporate criteria.
2	Extensive training in Lean and Six Sigma techniques. Both outside and inside sources are used. Green Belt is a one week training program with demonstration of skills required on a project or event. Black Belt adds two additional weeks and requires skills demonstration of three projects and mentoring of three Green Belts to certification.
3	Train the Six Sigma Blackbelts through participation. Following the identification of Divisional or Departmental sponsored events, the Blackbelts will use those events to train the workforce.
4	Black Belt training is five weeks, Green Belt training is 40 Hrs on-line/1 week in class. Also incremental training in Design for Lean Six Sigma for new product design and new process design
5	Black Belts received seven weeks of classroom training and were required to perform two projects for certification
6	Similar training activities as leaders. Training through hands-on kaizen workshop conducted by external experts

Companies	Implementation Timeline
1	No specific timeline but a goal set to have 1% of employee population as Black Belts
2	Ongoing
3	Milestones for implementation are immediate: First, develop the structure for training Lean leaders, identify likely project candidates, and set timelines for training and completion. Roll projects into existing organization and expectations
4	A multi-year process—first year; leader training, deployment managers and Black Belts identified and trained, Green Belt training—second year; internal Master Black Belts begin training Green Belts, Green Belt training accelerates—second year+; Design for Lean Six Sigma training and implementation ramps up
5	USA implementation took approximately 8 months, Europe lagged a few months, China and A/P took several more months due to language barriers
6	3 month pilot—1 year for 100% roll-out

Companies	Lean Six Sigma proliferation--why
1	Organization-wide—CEO recognized business lift of Lean Six Sigma
2	Organization wide, growing from an original “grass roots” initiative and evolving. Evolution by continuous improvement applies to the continuous improvement program itself too.
3	Organization-wide: Organization changes implemented to shift focus and accelerate Lean methodology alongside Six Sigma methodology.
4	Corporate in all functions around the world—strategy was selected based on existing proof sources and the need to establish broad competency to execute cross-organizational projects
5	Organization wide implementation—n/r
6	Training followed by pilot line at every site followed by Lean Six sigma workshops followed by site-wide roll out—n/r

Companies	Internal Communication of Lean Six Sigma
1	Communicated in a way that has suited each businesses needs while maintaining consistency at the Corporate level. Communication methods; emails, forums, and corporate intranet.
2	Communicated through multiple channels—an annual company strategic plan which flows to the Programs who maintain Program Excellence Plans for process improvement.
3	Communicate the message Top to Bottom. How: through leadership conferences and reliance upon existing organization of Master Blackbelts and Blackbelts who act as primary change agents.
4	"Deployment Guideline" document developed containing information explaining the what and how, organization structure, project selection methodology, deployment manager and Black Belt selection criteria, financial guidelines for valuing projects, cultural barriers, training paths, certification standards and additional resources. All senior levels of management were scheduled to participate in a 2 to 3 day interactive leadership workshop. Various presentations were created for general population. An internal website to share knowledge.
5	Rollout meetings help at business units all over the world that lasted 1 ½ days and presented an overview of the entire program and the new positions it would create
6	Management communication/review at all levels, newsletters, training and workshops

Companies	Implementation Management
1	Champions located within businesses led culture change and cultivated Black Belt development—Champions were eventually phased out as Black Belts and Master Black Belts became linked into various high level roles in the businesses
2	Our effort is lead by an Operations Director designated "POC" for the initiative. The POC has Master Black Belts reporting to him who are responsible for change agent mentoring and overseeing technical execution of events and projects.
3	Process ongoing
4	Management/coordination of training, the tracking system, the standards, and communications was centralized—Management of Black Belt selection and project selection was decentralized
5	The steering committee managed the implementation of the program
6	N/A

Companies	Challenges faced during implementation
1	Taking the best and brightest people in the businesses out of their jobs to become Black Belts and getting buy-in from their managers to do so. Black Belts having to contend with disparate cultures due to multiple business mergers.
2	Budget constraints, change resistance, time constraints.
3	N/A
4	Desire of each organization to implement in their own way—each organization tried to justify why they were different
5	Recruiting Black Belts and Champions for this unknown program
6	Not much since our program is driven from the highest of the company's management team

Companies	Management strategies for implementation challenges
1	Active participation of executive leadership team and a top down approach for initially driving support—replaced disparate cultures with Lean Six Sigma business strategy of focusing on the customer and delivering results
2	Diligence, perseverance, demonstration of successes, management support, use of metrics to drive results
3	N/A
4	Lean Six Sigma was defined from the beginning as a corporate-wide strategy with clearly defined deployment standards and guidelines—while some adjustments were made for unique organization needs, the implementation stayed on track, as defined
5	Black Belt and Champion volunteers were given a 5% pay increase immediately and a 10% bonus after certification
6	N/A

Companies	Implementation lessons learned
1	The level of executive support—businesses that had direct and visible support from the top leaders had a more successful permeation into their organizations and measured success based on results to both the business and customer community
2	Success requires diligence, perseverance and strong leadership leading to cultural change.
3	N/A
4	Securing support from a consultant that has previous experience leading large-scale implementations, that can assist in the development of uniform standards, and that can rapidly deploy required training
5	N/A
6	N/A

Companies	"Success" definition
1	Business benefit. Whether it was increasing profit, decreasing cost, increasing business velocity, our organization marks these all as our business strategy's success
2	In terms of our progress as measured by our metrics
3	Goals have been defined as deliverables from the Lean Six Sigma focus. These goals are rolled up in current business metrics and targets
4	Lean Six Sigma is a significant business strategy and a key enabler in our transformation from good to great. By all measures Xerox Lean Six Sigma continues to be a success.
5	The organization describes the program is very successful. The successes can be seen in the satisfaction of our customers. Voice of the customer is the most important feedback.
6	Whether or not we continuously improve key business metrics in quality, productivity, customer satisfaction, sales increase, profitability, cross-functional collaboration, and employee satisfaction.

Companies	Unexpected results of Lean Six Sigma implementation
1	Results were expected. What may have been unexpected was how well the customer community has taken our business strategy, in some parts adopting it for themselves under our tutelage
2	No
3	N/A
4	In addition to the project and customer benefits, the benefits in the form of leadership development and culture change are significant. While the financial results were expected based on external proof sources, the extent of leadership impact and organizational transformation was underestimated.
5	The training sessions consisted of cross organization classes of people that had never met before. The extensive training built a network across the organization that is vary valuable
6	Yes, but relatively minor

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Vita

Captain Peter M. O'Rourke was born in Encino, California. After graduating from High School, he entered the United States Navy and served as an F-14 Plane Captain, and airframes and hydraulics mechanic from 1990-1994. After being honorably discharged, he attended the University of Memphis and the University of Tennessee graduating in 1998 with a Bachelor of Arts in Political Science. On 25 September 1998, he was commissioned into the United States Air Force through Officer Training School.

In his first assignment, he served as Commander, Combat Operations Support Flight, at Shaw AFB South Carolina. In 2000, after being deployed as Chief of Supply, 16th Air Expeditionary Wing, he was assigned as Commander, Fuels Management Flight Royal Air Force base England. After being deployed to the Third Aerospace Expeditionary Task Force staff, he was selected to be Deputy Chief, Wing Inspections and Readiness 100 Air Refueling Wing Royal Air Force base England.

In August 2003, he entered the Graduate Supply Management program at the Air Force Institute of Technology. Upon graduation, he will be assigned to the Logistics Staff at Air Force Materiel Command (AFMC), Wright-Patterson AFB Ohio.

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14. ABSTRACT

Lean and Six Sigma are recent developments in continuous improvement methodology that have been popularized by several high-profile companies. The success and complementary nature of these methodologies has led to their combination into a single methodology, commonly called Lean Six Sigma or Lean Sigma. Although there is considerable literature available and many consultants involved with Lean Six Sigma, very little published research addresses the practical experiences of companies that have implemented Lean Six Sigma.

The research question for this research is: How and why are certain private sector implementations of Lean Six Sigma successful or unsuccessful? The investigative questions further focused the research question and identified several factors that appeared to significantly contribute to implementation success. These factors are:

- Fusing business strategy with continuous improvement strategy
- Leadership commitment and involvement in the deployment and implementation processes
- The use of consultants that are proficient and experienced
- A defined organizational model that links the continuous improvement efforts with the performance measurement system and senior leadership
- Defined and standardized personnel selection criteria

This research's purpose is to assist the Air Force structure a continuous improvement program that abates or eliminates the negative effects caused by deployment barriers and implementation challenges.

15. SUBJECT TERMS

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