Chapter 1

Introduction to Essentials of Lean *Six Sigma* (6σ) Strategies

Lean *Six Sigma*: *Six Sigma* Quality with Lean Speed

1.1 LEAN *SIX SIGMA* (6σ) CONCEPT REVIEW

1.1.1 The Philosophy

In any organization customer satisfaction is the number one priority. Customer satisfaction also means profitability. The success of any company depends on the ability to ensure the highest quality at the lowest cost. In the 1980s when most companies believed that producing quality products was too costly, Motorola believed the opposite: "the better, the cheaper." It realized that by producing a higher-quality product, the cost of producing goes down. Motorola knew that greater customer satisfaction generates higher profitability.

Today the competitive market leaves no space for error. It is now necessary to implement the concepts of Lean *Six Sigma*. Lean *Six Sigma* is a business strategy in which the focus is to improve the bottom line and increase customer satisfaction.

Six Sigma philosophies are related to statistical process control, stochastic control (relating to probability), and engineering process control. In addition, it requires process and data analysis, optimization methods, lean manufacturing, design of experiment, analysis of variance, statistical methods, mistake-proofing, on-time and or on-schedule shipping, waste reduction, and consistency assurance. It is a process capability that continuously improves the quality of the product and maximizes productivity. In simpler terms, Lean *Six Sigma* is the following:

1. It is a data-driven approach and methodology to analyze the root causes of manufacturing and business problems/processes by eliminating defects (driving toward six standard deviations between the mean and the nearest specification limit), and dramatically improving the product.
2. It improves the employee's knowledge of business management to distinguish the business from the bottom line, customer satisfaction, and on-time delivery. Thus, *Six Sigma* is not just process-improvement techniques but a management strategy to manage the projects to financial goals.
3. It combines robust design engineering philosophy and techniques with low risks (Lean *Six Sigma* tools: measure, analyze, develop, and verify).

It would be very difficult to achieve this goal without teamwork and proper training of the entire organization to a higher level of competency. During the 1980s *Six Sigma* grew into a distinct manufacturing discipline. It now encompasses a wide range of disciplines, including transportation, administration, manufacturing, medical, and a variety of other operating organizations and processes (by definition a process is any operation that has an input and produces an output).

1.1.2 Lean/Kaizen *Six Sigma* Engineering

Lean speed is a technique as well as a continuous effort that is used to accelerate and minimize the cost of any process by eliminating the waste in either manufacturing or service. Basically, Lean philosophy identifies and removes inefficiencies like the nonvalue-added (waste) cost or unneeded wait time within the process caused by defects, excess production, and other processes to expand any organization. For example, in most cases 95% of the lead time (from the beginning to the end of a process) is the wait time. Further, 80% of process delays are caused by a 20% time trap (activities in the workstation). By improving 20% time trap, it can eliminate 80% of process delays. Hence, Lean is associated with speed, efficiency, and acceleration of the process. Therefore, by integrating elements of Lean enterprise methodology with *Six Sigma*, which lacks tools that control and reduce lead time, the feedback will be faster than planned.

The combination of these two powerful tools, Lean manufacturing and *Six Sigma* strategy, will result in process variation reduction and dramatic bottom-line (language of CEO) improvement. Since all companies are in the business of achieving faster return on investments, particularly for their shareholders, using Lean principles in *Six Sigma* is extremely important. For the company architecting *Six Sigma* philosophy in its infrastructure, Lean manufacturing speed can accelerate the implementation and benefits of the manufacturing process.

Here are some of the basic Lean manufacturing techniques and principles that are used in Lean *Six Sigma*:

1. 5S
   - **S**ort (keep things that are essential), **S**hine (keep everything clean), **S**traighten (make everything visible and accessible), **S**tandardize (implement the first 3S and maintain them), and **S**ustain.
   - The first 3S are actions, and the last two are sustaining and progressive.
2. Value-stream mapping
   - A method of mapping a product's production path from manufacturing facility to customer's door.
   - A visual tool for identifying all steps of operations in the manufacturing process with cost-effective results.
3. Kaizen event
   - Continuous improvement.
4. Mistake-proofing
   - Process analysis and implementation of robust engineering to build quality into an assembly or manufacturing process with cost-effective results.
5. Cycle time reduction
6. Inventory reduction
7. Setup time reduction
8. Waste identification and elimination

In other words, the Lean speed is merged with or is embedded within the *Six Sigma* principles. The integration of these two concepts will both deliver faster results and achieve the best competitive position by concentrating on the use of tools that have the highest impact on the already established performance levels. Another example is the design of experiment that may require about 16 runs to determine optimum factors and reduce variation. Minimizing the lead time by 80% will allow the experiment to be completed five times faster using fractional factorial design. Basically Lean contributes to *Six Sigma* in the following manner:

1. Eliminates all the waste time that slows the project.
2. Maintains customer satisfaction with speed in delivery.
3. Gets the project done under the deadline and possibly under budget.
4. Continuously improves the profitability (e.g., in a shorter period of time than planned).

1.2 *SIX SIGMA* BACKGROUND

Motorola engineering scientist William Smith, known as the father of *Six Sigma*, developed the concept in the 1980s. For many years, he and other pioneering engineers and scientists worked on this or similar concepts to reduce variation, improve quality, and maximize productivity, including Walter A. Shewhart, W. Edwards Deming (see Appendix for Demingr's 14 points for management), Philip R. Crosby, Shiego Shingo, Taiichi Ohno, and Joseph Juran. Each one studied quality from a different angle.

The methodology of *Six Sigma* uses the statistical theory and thus assumes that every process factor can be characterized by a statistical distribution curve. The objective is to free all the defects from every process, product, and transaction. It is a process that provides tools to achieve nearly error-free products and services with maximum profitability. In the 1960s and 1970s, statistical process control limits were based on plus or minus three sigma (±3 standard deviation) from the mean. However, in this concept the process limits are plus or minus *Six Sigma* from the mean.

Just like three sigma, *Six Sigma* is applicable to batch-to-batch process, discrete, and continuous applications. The goal is to produce less than four defects per one million operations. *Six Sigma* will enable a company to capture substantial market share in the competitive global markets. Global competitiveness almost becomes impossible without *Six Sigma*. Every company would benefit by adopting *Six Sigma* concepts and philosophy. Profitability improves tremendously if it is applied to all workforces in every department of the corporation.

1.3 *SIX SIGMA* SUCCESSES

An example of a *Six Sigma* successe is Motorola Corporation, which increased net income from $2.3 billion in 1978 to $8.3 billion in 1988, using the *Six Sigma* program. As a result, Motorola received the Malcolm Baldrige National Quality Award by President Reagan in 1988. The award is presented to the industries that become quality role models for others. GE also implemented *Six Sigma* in the mid-1990s in a five-year program and boosted its profits by a substantial amount. By the year 2002 GE had achieved $4 billion in savings per year. Other companies that benefit from *Six Sigma* are Allied Signal, Inc.; Polaroid Corporation; Asea Brown Boveri Power Transformer Company; and DuPont.

At three sigma the cost of quality is 25 to 40% of sales revenue. At *Six Sigma* it reduces cost of quality to less than 1% of sales revenue. In fact, Lean *Six Sigma* is the epitome of quality and should be adopted by all manufacturing companies to remain in business. Therefore, one must change measurement of quality in parts per hundred (percentages) to parts per million. This has changed the makeup and culture of industries that adopted Lean *Six Sigma*.

Sigma Variation

Mathematically variation and reproducibility are inversely related to each other—for example, as variation increases, producibility decreases due to increase

Table 1.1

Comparisons of 3.8 Sigma and *Six Sigma* Defect Examples

3.8 Sigma (99% Good)	*Six Sigma* (99.99966% 6σ)
• 200,000 wrong drug prescriptions per year	• 680 wrong prescriptions per year
• 5,000 incorrect surgical operations per week	• 88 incorrect operations per week
• More than 15,000 newborn babies accidentally dropped per year	• 5 newborn babies dropped per year
• 2 short or long landings at major airports per day	• Less than 1 short or long landing every 8 years
• 20,000 articles of mail lost per hour	• 7 articles lost per hour

Table 1.2

Comparisons of Old (Traditional) and New (Lean *Six Sigma*) Methods

Problem	Old methods	New methods
Design	Product performance	Product producibility
Analysis	Experience based	Data based
Issue	Fixing problems	Preventing problems
Manufacturing/ Molding	Trial & error process	Robust design process
Inventory level	High production quantity	Low production quantity as needed
People	Cost to company	Asset to company
Management	Cost & time	Quality & time
Employee goal	Company	Customer
Product engineering	Little input from customer	High input from customer
Quality focus	Product	Process
Dominant process factors—selection	Apply one factor at a time	Apply design of experiment
Process improvement	Robotic technique	Optimization technique
Proving	Experience based	Statistically based
Company outlook	Short-term plan	Long-term plan
Customer satisfaction	Production at statistical acceptance quality level	Fewer defects, when and what quantity customer wants
External relationship	Price relationship	Long-term relationship
Layout	Functional	Cell type
Production schedules	Forecast	Customer order
Manufacturing cost	Continuously rising	Stable and decreasing

of nonconformance (in the technical sense called a rejection or defect) probability. Additional workforce, cost, scrap, and cycle time reduce the sigma level where such variation comes from design, process, and material of the finished products. Consequently, sigma variation reduces customer satisfaction and has negative impact in the profitability, which is one of the main focus areas of *Six Sigma*.

It is too difficult to convert any operation from three sigma (3.0σ) to *Six Sigma* (6.0σ) in one step. It will require several steps of improvements from 3.0σ to 4.0σ, 4.5σ, 5.0σ, 5.5σ, and finally 6σ (Tables 2.2 through 2.4 illustrate how as sigma increases, product quality and profitability also increase). This also means that cycle time is reduced, quality checks are minimized, operating cost goes down, variable costs shrink, and customer satisfaction goes up. At *Six Sigma*, all products conform to a worldwide standard and are nearly defect free. In other words, *Six Sigma* determines the capability of the process to accomplish a defect-free work environment. So sigma range dictates how often defects are likely to happen in the system. *Six Sigma* is not twice as good as three sigma but almost 20,000 times better.

Some examples of *Six Sigma* quality for long-term processes are shown in Table 1.1.

Highlights of some of the *Six Sigma* cultural changes are listed in Table 1.2.