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Six Sigma – It Works!

An overview of the basics of the Six Sigma methodology and its implementation approach.

By Praveen Gupta

Introduction

The advent of control charts provided tools for improving process for better quality results. That was the United States' competitive edge in the '40s and '50s. In the 1960s, "Made in the USA" was considered a quality benchmark worldwide. In the '70s, due to international competition, "Design for Manufacturing" tools were widely used, raising the quality bar to new heights. In the early '80s, under pressure from international companies, U.S. companies looked for ways to achieve better quality. They benchmarked best-in-class companies, products, and processes. Motorola, for example, benchmarked manufacturing processes and products to identify opportunities for improvement.

Motorola's quality journey started in 1981, when a goal to improve quality ten times in five years was established. In reviewing performance about five years later, the company recognized a need to establish more aggressive goals to maintain a leading position within the industry. Motorola recognized there was a need for a higher rate of improvement. Based on the customer feedback, market analysis, and benchmarking studies, a new quality benchmark was established. The Six Sigma was born, and a new meaning to quality was defined. Based on the reality in manufacturing, use of control charts, and application of the "central limit" theorem, the Six Sigma corresponded to 3.4 parts per million. It is slightly more than "Zero Defects;" however, it is close to perfection. So, the Six Sigma is not perfection, but it is virtual perfection – an almost perfect work.

Six Sigma Statistics

According to the Gaussian distribution, most of the events in nature are randomly (normally) distributed. When plotted, the distribution of these events tends to approach a bell shaped distribution (normal distribution). The significance of normal distribution is that most of the events in nature can be characterized using the normal distribution statistic. For example, if we plot a distribution of the height of students in a class, a bell shaped distribution may emerge – each person has an equal chance to achieve height independent of other students in the class. If we estimate the average and standard deviation, we can use the normal distribution statistic to learn more about the height of students in the class, or the population on which the class is a part.

By using the normal distribution statistic, one can estimate certain aspects of population beyond or within specified limits. Typically, these limits are process control limits that are correlated to the product specifications or the customer requirements. This is an important piece of information that can be used to predict the process behavior and initiate appropriate remedial action.

Using the standard normal distribution, there are known probabilities of having an incidence beyond a certain value or within certain values. For a process whose upper and lower specification limits are +/- 3 sigma from the process mean, the number of occurrences outside the specification limits will be 2,700 ppm. If the process mean shifts up to 1.5 sigma, the probability of occurrence will be 66,810 ppm. These probabilities are documented in statistical tables. Accordingly, following are probabilities for certain limits:


Table 1.		
Limits (in Sigmas around the mean)	Probability of having a product outside the limits (Centered distribution)	Probability of having a product outside the limits (Distribution shifted by 1.5 Sigma)*
3 Sigma	2,700 ppm	66,810 ppm
4 Sigma	63.4 ppm	6,210 ppm
5 Sigma	0.34 ppm	233 ppm
6 Sigma	2 ppb	3.4 ppm
7 Sigma	2.58 ppt	38 ppb
Shift of 1.5 sigma is utilized to accommodate a normal variation in process means. ppm – parts per million; ppb – parts per billion; ppt – parts per trillion		

Six Sigma Methodology

The Sigma methodology has two components: measurement and process. The measurement aspect relates to the quantification of quality. The quantification depends upon the actual defects observed at a process and normalized to opportunities for creating those defects. Measurements are an important aspect of the Six Sigma methodology to establish goals and measure progress towards achieving a Six Sigma process.

The process aspect of Six Sigma methodology is an implementation of the process aspects, consisting of six steps that relate customer needs to a process, to delivery of product or service, to process improvement, and to measurement. Ultimately, the core of the Six Sigma methodology is an implementation of the process aspects, consisting of the six steps. Once the six steps are implemented successfully, the measurements are utilized to track progress and drive further improvement.

The defect rate for Six Sigma estimation is measured in terms of number of defects created in production or observed at an inspection point, normalized over the number of



opportunities that are found to be the cause of the problems. The normalized defect rate is specified as defects per million opportunities (DPMO).

The first two steps of the Six Sigma methodology are customer-focused, clearly identifying products and services, as well as customers' critical needs. The next two steps are process-focused, as they ensure process needs are identified and a process map has been constructed to perform the task. The last two steps are improvement oriented, as they require mistake proofing the process and measuring the process performance for continuous improvement.

Implementing Six Sigma Successfully


Someone simply taking the Six Sigma methodology and transferring it to a business is a sure recipe for failure. What follows is an analysis of various factors that made the Six Sigma methodology successful at Motorola:

Commitment – Motorola's success in implementing the Six Sigma process required strong commitment from executive and senior management. At the management level, even Robert Galvin, chairman of the executive committee, was talking about Six Sigma to its customers, suppliers, and employees. Senior managers taught the class to their employees to demonstrate their commitment to their people.

Common Language – Some wondered "Why Six Sigma?" This is because it appeared that the same results could be achieved using defects per million opportunities. Translating DPMO to Six Sigma measurements provided a target, a clearer picture of the corporate goal, and a single direction to the company. Six Sigma became a corporate language and culture used by everyone when talking about measuring the process or product performance. Six Sigma crossed various divisions, products, functions, countries, and cultures. It became a common bond among Motorola employees worldwide.

Aggressive Goals – One of the leadership aspects of the Six Sigma methodology is the desired rate of improvement required to reach the 3.4 parts per million goal. Typically, a business sets improvement goals at 10-20% per year in quality and other business measurements. The Six Sigma methodology required improvement of 68 percent annually. This forced everyone to be creative in order to achieve the Six Sigma performance.

Innovation – Setting aggressive goals may be easy; however, realizing aggressive goals requires more than minor adjustments in processes. At Motorola, it required a totally new approach, teamwork, and new thinking. This kept people interested in what they were doing, and caused them to accomplish better results. Conversely, setting goals incrementally makes people think some tweaking will be sufficient to achieve those goals.



Process Thinking -- There is confusion regarding how to apply Six Sigma on different products, services, or functions. The Six Sigma methodology reinforces process thinking, as it requires one to analyze the process of doing work. Six Sigma measurements are established for processes more than for products.

Communication -- Having established Six Sigma as a common goal, it was utilized universally within the company. It was publicized through newsletters, meetings, annual reports, quality policy cards and, of course, training. A company's intent must be to train all employees so they all have common understanding of the Six Sigma process.

Metrics – Six Sigma measurements must be utilized throughout the company and acted upon. The process and product performance goals are set in terms of sigma. Accordingly, the procedures for process and product development must be modified to ensure effective implementation. Eventually, the Six Sigma process is integrated into every aspect of the business, including sales, purchasing, manufacturing, engineering, and management. The most important aspect of Six Sigma measurements is to establish incremental goals to expect continuous progress towards Six Sigma.

Improvement – The last two steps of the Six Sigma methodology are designed to achieve quality improvement. Expecting quality improvement, establishing quality improvement teams in various areas, reviewing quality improvement, and reporting the company-wide improvements are critical steps in achieving results. The executive management must be interested in learning about the process improvement at the process level as well as at the company level.

Rewarding Experience – Initially setting incentives to achieve “small wins” is a great way to get employees' attention and involvement – the journey to achieve Six Sigma is a celebration rather than a painful experience or punishment. Quality awards, banquets, meetings, competition, suggestion programs, encouragement, and recognition are great ways to reward the Six Sigma experience, including success or partial success. There is no failure if one tries.


General Questions about Six Sigma

Why Six Sigma, as opposed to five or seven?

Based on the world-class process performance and statistical analysis of real world processes, the Six Sigma quality level relates better to customer expectations. The five sigma will not meet customer requirements, and the seven will not add significant value; therefore, Six Sigma has been selected. The 3.4 parts per million is close to perfection – making it a more attainable and realistic goal.

Why is Six Sigma important?

The process aspect of the Six Sigma methodology is fundamental to any business process. The process steps are steeped in common sense but arranged in a proven order



to make them effective. If a business is not practicing these six steps, there must be huge disconnects between customer expectations and delivery of products or service.

How can I use Six Sigma in my operations?

In order to use Six Sigma in one's operations, one must first understand its principles before practicing it. Sometimes people jump into the measurement aspect too quickly, believing it will gain some marketing advantage. In reality, that leads to chaos and confusion. Measurements without the right process are meaningless and may cost more than they save your company.

Is it exclusive to manufacturing? Does it apply to service operations?

The Six Sigma methodology is designed for process and product improvement. Any business, whether producing product or providing service, is a collection of processes. Therefore, one can apply the Six Sigma methodology to a process essential to providing a product or service. Applying the methodology to manufacturing operations is a little easier to work with (tangible output versus service processes that do not utilize machines and do not produce concrete products). Applying the methodology to service operations is more challenging – due to more intangible “people involvement” – but could also be easier due to the absence of complex technological issues.

What can I do to successfully implement Six Sigma at my company?


The Six Sigma methodology is not a silver bullet. It is another tool that one must have in one's toolbox – and must be applied where it is economical. In order to implement Six Sigma, one must go through some training to understand principles, measurements, and methodology. Then, select a pilot process to prove the methodology in your environment before institutionalization.

What resources are available to help me implement Six Sigma?

There is plenty of help available through Motorola University and independent companies, as well as an ASQ sponsored Black Belt program. However, one must perform a value analysis before purchasing any products or services.

Why do some people criticize Six Sigma?

There is a lot of misunderstanding about the principles of Six Sigma. Some people believe Six Sigma means just the measurements. No one can improve or manage numbers – they can only manipulate them. It would be very hard to realize benefits with manipulation of numbers without any process improvement. Sometimes, people state that 3.4 parts per million is not a realistic goal. This misunderstanding can exist because these people have not understood the methodology of Six Sigma or experienced significant competition. When one commits to be the best, goals become a reality through innovation and hard work. If we can make space shuttles, rockets, daily airlines flights, telephone switches, and super computers work, we can make Six Sigma work, too. However, the Six Sigma by itself will not do anything for a company. One must plan to use Six Sigma to realize its benefits. Initially, any new idea receives some



criticism, due to lack of understanding, and that is healthy – and may be a way of clarifying the Six Sigma process.

Conclusions

To implement the Six Sigma process successfully, it must be integrated in a company's strategic business plan. Like any project, cost and benefit analysis must be performed to understand the effort required to achieve the desired results. Any criticism of the Six Sigma methodology now is an immature argument. There are still many questions about the counting defects or the opportunities for defects, and these are details that must be discovered and resolved during the implementation.

Several companies have implemented the Six Sigma process. The success or the failure of any project is more dependent on the degree of commitment of a company's executive management than on the methodology. That is even true for Six Sigma.

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Biography

Praveen Gupta, president, Quality Technology Co., has worked at Motorola Semiconductor Sector and Communications Sector in engineering positions. From 1986-89, as a Process Engineering Group Leader, he practiced the Six Sigma methodology and guided others to achieve Six Sigma at the Fixed Products Division. Since 1991, he has taught several courses at Motorola University, including Six Sigma training courses. In addition, Gupta also consults with companies in implementing ISO/QS-9000, ISO 14000 quality and environmental management systems.