The Quest for World Class Quality

"…Six Sigma will be the biggest, the most personally rewarding and, in the end, the most profitable undertaking in our history." - Jack Welch
"Six Sigma is the way we will run our business" - Bob Nardelli

A cornerstone of GE's growth and development in its recent history has been "stretch targets." These have been targets that are beyond doable, beyond reasonable and beyond our capabilities. They are targets that seem superhuman when we set them. Yet, we reach them. Even on those occasions when we fall short, we find that we do much better than we ever believed possible prior to setting the goal. Through stretch targets and stretch thinking employees have developed tremendous self confidence and have achieved tremendous results.

The objectives of Six Sigma training are as follows:

- To link the Vital Few Customer (Critical to Quality) CTQs to each employee's job.
- To develop work group specific CTQs, metrics, and defect areas.
- To increase awareness and understanding of, and day-to-day use of, Six Sigma tools and processes by demonstrating how these tools and processes are being or have been applied to real projects.
- To define specific improvement needs for individual or team action.
- To involve employees in Six Sigma projects and metrics either individually or as a member of a Six Sigma team.

A Six Sigma company is a world class company. It is not just better than its competitors; it is 10,000 times better. It takes a commitment from everyone to reach such lofty goals. That's why we have this training; that's what you are expected to understand.

What is Six Sigma?

> *"Quantitatively, Six Sigma means that the average process generates 3.4 defects per million".*
> *– from "6 Sigma Quality – The Goal and The Journey"*

If you understand the preceding sentence you have the beginnings of a good grasp of the subject. Look at the sentence closely. First, you see the word, "quantitatively." The Six Sigma process is a quantitative process. It is based on measurement. If you can't measure something, you can't improve upon it. Six Sigma materials are heavily analytical. In Six Sigma training, you will learn about defining customer requirements, measurement processes, analytical tools, and improvement and control of key variables. Without a rudimentary understanding of statistical analysis, Six Sigma cannot be realized.

"Process" is another key word found in the Six Sigma definition above. The Six Sigma approach begins with the customer. What does the customer specifically want? Once you find that out, the focus shifts to the **processes** that produce it. What are they? What are the potential defects inherent in them? How can the processes be controlled to eliminate, or greatly reduce, defects? How do you measure the success of your actions?

Next in our definition comes the number of defects: 3.4 per million. That's equivalent to 99.99997% perfect. It means reducing 1,000,000 field complaints to 3.4 per year. It means only one piping defect per gas turbine per ten years. That's quality. That is Six Sigma. In businesses utilizing Six Sigma, every employee has been introduced to Six Sigma. Presuming that you are familiar with Six Sigma terms, like Black Belt, Benchmark, Defect, and Opportunity. If you are unclear, or if you have forgotten some of these basics Six Sigma terms, a glossary has been provided for you at the end of this article.

Organization of the Presentation

Since quality begins with the customer and his/her definition of excellent, the OJT training material begins with our customer perceptions of quality. These are CTQs, or Critical to Quality characteristics.

From there, the question is what needs to be done to turn the customer's wants into your business process how's. Whether your job is producing products or service, there is a highly effective technique for translating CTQs into quality action. The process is called Quality Function Deployment (QFD).

The Six Sigma process involves the collection of data. That means that some care must be taken to collect the right data and to organize the data collection process effectively. The *Six Sigma Methodology* presents a primer in types of data, in normal distribution and how the bell curve relates to what we are trying to accomplish.

A project may use some or all of these tools to meet the goals defined in the project charter. They include: Process Maps, Cause and Effect Diagrams, FMEA, Pareto Charts, Gage R&R, ANOVA, Mistake Proofing, and more.

Phases and Steps in Six Sigma Methodology

The Six Sigma process consists of five phases:
Define, Measure, Analyze, Improve, and **Control.**

What is meant by these phases?

Define: What is the scope of project? What is the defect?
Here the project scope and defects are defined. A business case is made to obtain project approval. Team charter is established with a clear goal statement.
A. Identify Project CTQs
B. Develop Team Charter
C. Define Process Map

Measure: What is the frequency of defects?
Here we select one or more product characteristics, map the process or processes responsible, and make the necessary measurements to estimate the short and long term process capability.
1. Select CTQ Characteristics
2. Define Performance Standards
3. Validate Measurement System

Analyze: When and where do defects occur?
Here key product performance metrics are benchmarked. Then a gap analysis is undertaken to identify the common factors of successful performance.
4. Establish Performance Capability
5. Define Performance Objectives
6. Identify Variation Sources
These first two phases are referred to as characterization phases. They define and quantify the project, characterizing its objectives.

Improve: How can we fix the process?
Here product performance characteristics are selected for improvement. They are diagnosed to reveal major sources of variation. Then, key process variables are statistically identified and performance specifications are established for their improvement.
7. Screen Potential Causes
8. Discover Variable Relationships
9. Establish Operating Tolerances

Control: How can we make the process stay fixed?
This phase insures the new process conditions are documented and monitored statistically. After a settling in period, process capability is reassessed and preceding phases are revisited based upon the results of the analysis.
10. Validate Measurement System
11. Determine Process Capability
12. Implement Process Control System

Not all of the Six Sigma tools for completing these steps are included in this article. Some are used more than others.

Six Sigma Glossary

Analyze: Second phase of the Breakthrough Strategy. Asks, “When and where do defects occur?”

Benchmarking: An analysis of your current performance relative to your competition and the best practices of others.
Black Belts: Full-time Six Sigma Project Leaders. They coach Project Teams and carry out projects to improve processes that influence customer satisfaction.
Black Noise: The "assignable cause" variation present in a process. It is a controllable variation.
Brainstorming: Allows generation of a high volume of ideas quickly.
Breakthrough: Six Sigma methodology for process analysis, optimization **Strategy** and control. Has five phases: Define, Measure, Analyze, Improve, and Control.
Cause/Effect Diagram: Helps identify potential problem causes and focuses brainstorming. Also called a Fishbone Diagram.
Champions: Senior management leaders who approve projects, fund projects and remove roadblocks to project success.
Confidence Interval: A measure of certainty of the shape of a fitted regression line. In general, a 95% confidence interval implies a 95% chance that the true line shape lies within the band.
Continuous Data: Measures value. Includes Regression Analysis and Regression for Tolerancing.
Control The fourth phase of the breakthrough Strategy. Asks, "How can we make the process stay fixed?"
Control Charts: Helps to spot changes in the process mean and range over time.
Cost of Poor Quality: All additional costs to GE resulting from poor quality, such as scrap, rework, rejects, warranties, lost sales, lost customer loyalty.
CTQ: Critical to Quality. A product feature or process step that must be controlled to guarantee that you deliver what the customer wants.
Customer Satisfaction Measurement: Part of the Six Sigma Dashboard. Uses customer surveys to grade our performance, and reports out a quantitative measure of the number of defects multiplied by 1,000,000 survey responses.
Defects: Any non-conformities in a process or product.
Design for Six Sigma Measurement: Part of the Six Sigma Dashboard (applies only to products in the NPI process). Helps to determine how well the design process aids Six Sigma production. Measures the % of drawings reviewed for CTQs, and the % of CTQs designed to Six Sigma.
Discrete Data: Data in which defects are counted by discrete outcomes (yes/no, male/female, red/green/blue, etc.)
DPMO: Defects Per Million Opportunities. At Six Sigma, there are fewer than 4 defects per million opportunities.
DPO: Defects Per Opportunity
DPU: Defects Per Unit
Fishbone Diagram: See Cause/Effect Diagram.
Flowcharting: Displays the actual steps of a process. Used to examine areas of improvement.
Green Belts: Receive the same training as Black Belts, but continue working at their regular responsibilities and work part-time at Six Sigma duties.
Hidden Factory: Re-processing loops in engineering and in the factory (rework loops, etc.).
Histogram: A chart, usually a bar graph, which shows the number of times each measured value occurs.
House of Quality: See QFD.
Improve: The third phase of the Breakthrough Strategy. Asks, "How can we fix the process?"
ITO Inquiry to Order. It begins with the customer request and proceeds to the placement of an order to the shop.
Internal Performance Measurement: Part of the Six Sigma Dashboard. Measures the defects generated by our processes. Compares the number of defects against the number of CTQs.
KQC: Key Quality Characteristics.
Master Black Belts: Full-time leaders, teachers, and coaches with strong quantitative, teaching and leadership skills, who train and mentor Black Belts, and work with Champions to establish project priorities and goals.
Mean: The average of measured data.
Measure: The first phase of the Breakthrough Strategy. Asks, "What is the frequency of defects?"
Normal Distribution: A bell-shaped curve showing a frequency distribution which often occurs in nature.
OJT: On-the-Job Training.
Opportunity For Defect: Any characteristic you measure or test.
OTR: Order to Remittance. The portion of the order cycle including design, sourcing, shop manufacturing, shipment and billing.
Pareto: A process to help focus on the vital few.
Process Capability: A measure of the ability of a process to produce an error-free product, by comparing the variability of the process with the variability acceptable to the customer.
Project Teams: Work on Black Belt projects while retaining their existing job responsibilities. All employees will eventually serve on a project team.
QFD: Quality Function Deployment. A process used to learn what the customer needs and wants, then to translate that into specific product requirements and CTQ features. Also known as House of Quality.

Quality Leaders: General Managers and their direct reports, who establish Quality priorities, review the progress of Customer Focus Teams, and ensure the allocation/dedication of resources.
Sigma: See Standard Deviation.
Six Sigma: A process capability in which variability is reduced so that 6 standard deviations fit between the process mean and the specification limits. This means that 99.99966% of all products fall within the spec limits.
Six Sigma Dashboard: Five standard corporate measurements: Customer Satisfaction, Cost of Poor Quality, Supplier Quality, Internal Performance, and Design for Six Sigma.
Specification Limit (Spec Limit): The tolerance or allowable variation of a characteristic – the "acceptable window."
Standard Deviation: A statistical measure which quantifies the amount of variation in a process.
Supplier Quality Measurement: Tracks defectives – parts returned or reworked, or outside of schedule.
Units: A determined amount or quantity (of parts, sub-assemblies, systems, etc.) adopted as a standard of measurement.
Vital Few: The most independent variables in a process. The things which have the greatest impact on the outcome of the process.
White Noise: The "common cause" variation present in every process. It is not controllable. The variability of a process with only white noise is called the Process Entitlement.

Steven Bonacorsi is a Senior Master Black Belt instructor and coach. Steven Bonacorsi has trained hundreds of Master Black Belts, Black Belts, Green Belts, and Project Sponsors and Executive Leaders in Lean Six Sigma DMAIC and Design for Lean Six Sigma process improvement methodologies.

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