Chapter 4

Six Sigma Continuous Improvement

"The significant problems we face cannot be solved at the same level of thinking we were at when we created them."

—Albert Einstein

4.1 *SIX SIGMA* CONTINUOUS IMPROVEMENT PRINCIPLES

Advancement to near perfection (maximum profitability) is virtually impossible without integration of proper engineering design, material, process, and control strategies—in other words, achieving higher standard deviations in existing and future production processes. *Six Sigma* tools uncover the unseen root causes of potential problems and attack them to eliminate defect opportunities. This means that *Six Sigma* takes the necessary measurements at the early stages of product or process development before the problem occurs. Alternatively, it will focus on the processes indicating that their sigma level is either too low and cannot improve or a high sigma level (5 or more), which is too challenging to improve. One should keep in mind that the cost of redesign or correcting aftermath problems is extremely high and costly. (See Chapter 8 for more details.)

Six Sigma can be achieved only with cross-functional groups or joint efforts throughout the organization with great intensity—that is, if it is required by corporate culture and deployed firmly. Indeed, *Six Sigma* has to be applied from raw material all the way to the finished product and the shipping department.

Essentials of Lean *Six Sigma*

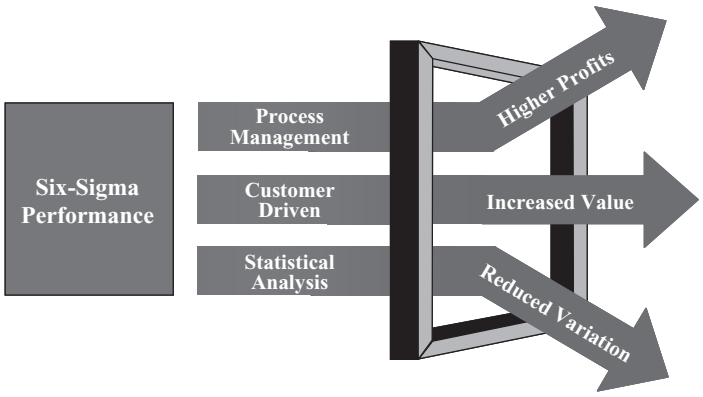


Figure 4.1 *Six Sigma* breakthrough performance model.

The performance of this is shown in Figure 4.1, the *Six Sigma* breakthrough model, with three main objectives: higher profit, increased value, and reduced variation. *Six Sigma* science of continuous improvement concentrates on two processes that each include three steps:

Process Characterization

1. Define project and process measurement (diagnosis)
2. Evaluate existing sigma (capability study)
3. Analyze process data

Process Optimization/Simulation

4. Improve and optimize process
5. Evaluate new sigma (capability study)
6. Control and maintain the process

Or the above steps can be summarized in DMAIC (define/measure [diagnosis], analyze, improve [optimize], control).

4.2 *SIX SIGMA* SYSTEMS

Six Sigma systems include the following concepts:

1. The fastest rate of improvement in customer satisfaction, cost, quality, process speed, and invested capital.
2. A business improvement and growth system, which leads to a new level of performance.

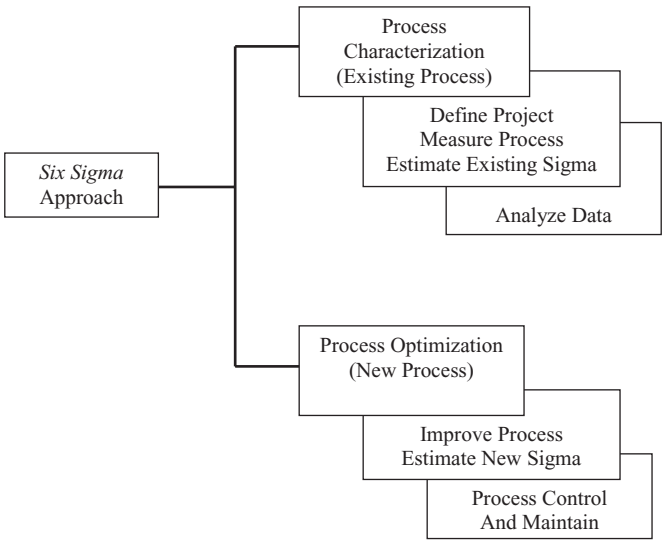


Figure 4.2 Representation of *Six Sigma* define and measure, analyze, improve or optimize, and control (DMAIC) levels.

3. A systematic data-driven approach to analyzing the root cause of manufacturing, as well as business problems/processes and dramatically improving them.
4. Improved decisions based on knowledge and data.
5. A financial results-driven system ($ performance paramount).
6. A project-driven system based on customer needs.
7. A system applicable to all parts of a business.
8. Aimed at the problem where the solution is not known.
9. A system with proven performance.
10. Improve customer satisfaction and supplier relationships.
11. Expand knowledge of product and processes.
12. Develop a common set of tools and improvement techniques.

Figure 4.2 illustrates the graphical representation of *Six Sigma* improvement steps.

4.3 *SIX SIGMA* IMPROVEMENT AND TRAINING MODELS

One may obtain *Six Sigma* training certification by completing the improvement models for Green Belt and Black Belt. These trainings are available through academic institutions, as well as quality societies or other certified organizations.

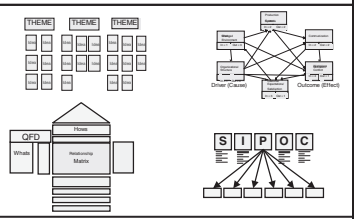
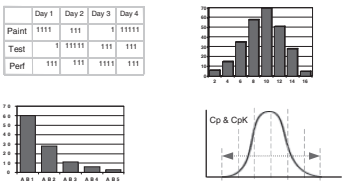
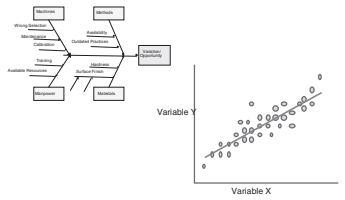
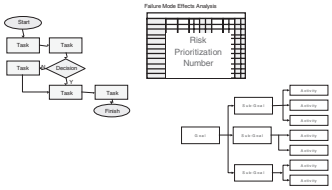
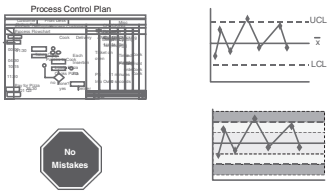
	Objective	Tools and Techniques	
Define	Identify Business Drivers Select Customer Critical Processes Define Projects Develop Implementation Plan	Affinity Diagram/ Interrelation Diagram Quality Function Deployment SIPOC Process Map Project Charter	
Measure	Develop Key Process Measures Collect and Analyze Data Identify the Vital Few that Have the Greatest Impact Estimate Process Capability Measurement Systems Analysis	Data Collection Plan Check/Data Sheet Pareto Chart Gage R&R Histogram Process Capability	
Analyze	Understand Cause and Effects Create Multi-vari Analysis Determine Variance Components Assess Correlation	Cause and Effect Diagram Scatter Diagram	
Improve	Develop and Evaluate Solutions Implement Variation Reduction Standardize Process Assess Risk Factors	Deployment Flowchart Tree Diagram FMEA	
Control	Implement Process Control Implement Control Charts for Key Variables Mistake Proof Processes Evaluate Results	Process Control Plan Control/Precontrol Chart Poka-Yoke Pareto Chart (ongoing) Process Capability (ongoing)	

Figure 4.3 *Six Sigma* Green Belt improvement model.

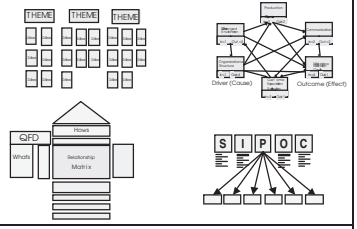
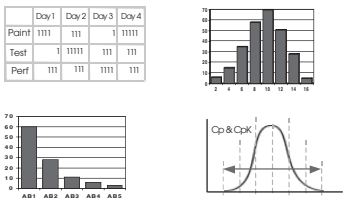
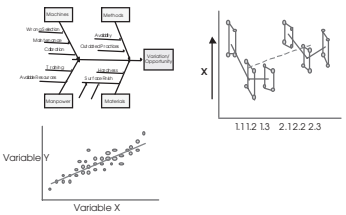
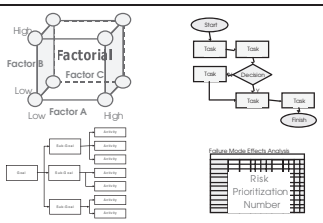
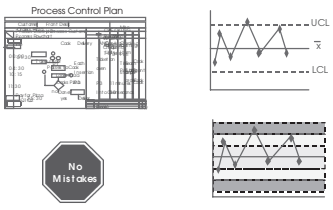
	Objective	Tools and Techniques	
Define	Identify Business Drivers Select Customer Critical Processes Define Projects Develop Implementation Plan	Affinity Diagram/ Interrelation Diagram Quality Function Deployment SIPOC Process Map Project Charter	
Measure	Develop Key Process Measures Collect and Analyze Data Identify the Vital Few that Have the Greatest Impact Estimate Process Capability Measurement Systems Analysis	Data Collection Plan Check/Data Sheet Pareto Chart Gage R&R Histogram Process Capability	
Analyze	Understand Cause and Effects Create Multi-vari Analysis Determine Variance Components Assess Correlation	Cause and Effect Diagram Multi-vari Charts Scatter Diagram	
Improve	Develop and Evaluate Solutions Implement Variation Reduction Standardize Process Assess Risk Factors	Design of Experiments Deployment Flowchart Tree Diagram FMEA	
Control	Implement Process Control Implement Control Charts for Key Variables Mistake Proof Processes Evaluate Results	Process Control Plan Control/Precontrol Chart Poka-Yoke Pareto Chart (ongoing) Process Capability (ongoing)	

Figure 4.4 *Six Sigma* Black Belt improvement model.

On the other hand, you can apply all the procedures and guidelines of this book to any desired projects. Once you have knowledge and experience, you can participate in certified examinations through a quality organization. The training models for the Green Belt and Black Belt are cited in Figures 4.3 and 4.4. The details of these models are discussed in Chapter 8.