MANAGING SIX SIGMA

A Practical Guide to Understanding, Assessing, and Implementing the Strategy That Yields Bottom-Line Success

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PREFACE

In recent years there has been much interest in the application of Six Sigma techniques. Within organizations chief executive officers (CEO) are hearing about the monetary rewards that other firms have achieved through Six Sigma methodology and are eager to cash in on similar benefits. The book *Implementing Six Sigma: Smarter Solutions using Statistical Methods* (Wiley, 1999), by Forrest W. Breyfogle III, was written as a practical guide to help organizations in both industry and academia with the *wise* implementation and orchestration of Six Sigma techniques.

Implementing Six Sigma has been a great success; however, many people have expressed the desire for a book that will help management decide if they should implement Six Sigma and then guide them through the process. To fulfill this need, we wrote *Managing Six Sigma.*

The purpose of this book is to build awareness of the wise application of Six Sigma tools and how they can be important in the "big picture." Because of this focus, there may be references to tools with which the reader is not familiar. To help the reader gain a basic understanding of unfamiliar terms, we provide in the glossary a brief description of most Six Sigma tools discussed in the text. *Implementing Six Sigma* can be consulted for more details about individual tools or applications (see the outline of that book below).

Six Sigma can improve the bottom line of an organization—if implemented *wisely*. An organization can get more with less using Six Sigma; for example, it can use fewer runs and samples and obtain more information. However, if the techniques are not used wisely, there is a considerable danger that the program will be counterproductive and frustrating. Organizations can sometimes get so

involved in how to count and report defects that they lose sight of the real value of Six Sigma—orchestrating process improvement and reengineering in such a way that they achieve significant bottom-line benefits through the implementation of statistical techniques. Six Sigma efforts need to be orchestrated toward achieving Smarter Solutions (Smarter Solutions, Smarter Six Sigma Solutions, and S^4 are service marks belonging to Forrest W. Breyfogle III).

If an organization does not apply Six Sigma techniques wisely, the methodology will fail. When this occurs, there is a tendency to believe that the statistical techniques are not useful, when in fact the real problem is how Six Sigma as a program was implemented or how individual techniques were effectively applied.

This book uses the term "Smarter Six Sigma Solutions (S^4)" to describe our implementation strategy for Six Sigma. Another description for this S^4 activity is "$marter Six Sigma $olutions" assessments, since a major focus is determining that the right measurements and actions are being taken relative to bottom-line benefits. With S^4 activities an environment is created where there is knowledge-centered activity (KCA) focus. KCA describes efforts for wisely obtaining knowledge and/or utilizing the knowledge of organizations and processes.

GE and other companies have used the terms "Black Belts" and "Green Belts" (Cheek, 1992; GE, 1996; GE, 1997; Lowe, 1998; Slater, 1999; Pyzdek, 1999; Harry, 2000) to describe people who actively apply Six Sigma techniques. These people may be assigned to this role either full-time or part-time. in this book we will use the terms "Black Belt" and "Green Belt" along with the term "Six Sigma Practitioner" to describe people who implement Six Sigma techniques.

This book refers the reader to Forrest W. Breyfogle III's *Implementing Six Sigma: Smarter Solutions Using Statistical Methods*, for more descriptions of tools, implementation techniques, and strategies. References to the earlier work appear as Breyfogle (1999), *Implementing Six Sigma,* which contains the following sections:

- Phase 0: S^4 Deployment
- Phase 1: S^4 Measurement
- Phase 2: S^4 Analysis
- Phase 3: S^4 Improvement
- Phase 4: S^4 Control

Implementing Six Sigma contains more than 100 examples within the following chapters:

Phase 0: S^4 Deployment Strategy Phase

1. Six Sigma Overview and Implementation
2. Knowledge Centered Activity (KCA) and Process Improvement

Phase I: S^4 Measurement Phase

3. Overview of Descriptive Statistics and Experimentation Traps
4. Process Flowcharting
5. Basic Tools
6. Probability
7. Overview of Distributions and Statistical Processes
8. Probability and Hazard Plotting
9. Six Sigma Measurements
10. Basic Control Charts
11. Process Capability and Process Performance
12. Measurement Systems Analysis (Gage R&R)
13. Cause-and-Effect Matrix and Quality Function Deployment (QFD)
14. Failure Mode and Effects Analysis (FMEA)

Phase II: S^4 Analysis Phase

15. Visualization of Data
16. Confidence Intervals and Hypothesis Tests
17. Inferences: Continuous Response
18. Inferences: Attribute Response
19. Comparison Tests: Continuous Response
20. Comparison Tests: Attribute Response
21. Bootstrapping
22. Variance Components Analysis
23. Correlation and Simple Linear Regression
24. Single-factor (one-way) Analysis of Variance
25. Two-factor (two-way) Analysis of Variance
26. Multiple Regression

Phase III: S^4 Improvement Phase

27. Benefiting from Design of Experiments
28. Understanding the Creation of Full and Fractional Factorial 2^k DOEs
29. Planning 2^k DOEs
30. Design and Analysis of 2^k DOEs
31. Other DOE Considerations
32. Variability Reduction Through DOE and Taguchi Considerations
33. Response Surface Methodology

Phase IV: S^4 Control Phase

34. Short-run and Target Control Charts
35. Other Control Charting Alternatives
36. Exponentially Weighted Moving Average (EWMA) and Engineering Process Control (EPC)
37. Pre-Control Charts
38. Control Plan and Other Strategies
39. Reliability Testing/Assessment: Overview
40. Reliability Testing/Assessment: Repairable System
41. Reliability Testing/Assessment: Nonrepairable Devices
42. Pass/Fail Functional Testing
43. Application Examples

To meet the needs of a diverse readership, we adhered to the following guidelines in the writing of this book:

- Most chapters and sections are small, descriptive, and contain many illustrations. The table of contents can be very useful to quickly locate techniques and examples helpful in solving a particular problem.
- Equations and formulas are presented only when we believe they are absolute necessary to describe a methodology.
- The symbols and glossary sections are intended as a handy reference that provides fuller explanations whenever a concise definition or an unfamiliar statistical term or symbol is encountered in the text.
- The focus of the book is on manufacturing, development, and service/transactional examples that serve as a bridge between Six Sigma techniques and a variety of real-world situations.
- The details of implementing Six Sigma are not included in this book, since these techniques are described in Breyfogle (1999), *Implementing Six Sigma.*
- Even though Breyfogle (1999), *Implementing Six Sigma,* includes specific information for those undertaking the details of implementing Six Sigma, managers should find the S^4 assessments sections very helpful. These sections, found at the end of most chapters, provide guidance inthe effective orchestration of Six Sigma implementation.

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The terms key process output variable (KPOV), key process input variable (KPIV), and the term used to describe a simplified quality function deployment (QFD) matrix—cause-and-effect matrix—were coined by Sigma Breakthrough Technologies, Inc. (SBTI).

CONTACTING THE AUTHORS

Your comments and suggestions will be considered as we prepare future editions of this book, since we work at practicing what we preach. Also, we conduct both public and in-house Six Sigma workshops from this book and Breyfogle (1999), *Implementing Six Sigma*, utilizing S^4 techniques. Contact us if you would like information about these workshops. We can be reached through the following e-mail address: forrest@smartersolutions.com. You might also find useful the articles and additional implementation ideas at www.smartersolutions.com.

Please send your Table 8.1 survey responses to Smarter Solutions Inc., 1779 Wells Branch Parkway, #110B-281, Austin, TX, 78728, USA

CONTENTS

PART 1

WHY SIX SIGMA

1

HOW SIX SIGMA COMPARES TO OTHER QUALITY INITIATIVES

As the competition gets tougher, there is more pressure on organizations to improve quality and customer satisfaction while decreasing costs and increasing work output. This becomes an increasingly difficult challenge when there are fewer resources available. Peter Senge (1990) writes, "Learning disabilities are tragic in children, but they are fatal in organizations. Because of them, few corporations live even half as long as a person—most die before they reach the age of forty." "Learning organizations" defy these odds and overcome learning disabilities to understand threats and recognize new opportunities. Six Sigma can help organizations learn and excel at the challenges they encounter—if it is implemented *wisely*.

A question we frequently hear from executives is "How does Six Sigma fit with other company initiatives?" We believe that Six Sigma should not be considered just another initiative but should integrate other programs and initiatives at a higher level as part of an overall business strategy. Six Sigma should not replace other initiatives, but instead offer a tactical methodology to determine the best approach for a given situation/process.

Our Smarter Six Sigma Solutions (S^4) business strategy offers a road map for changing data into knowledge that leads to new opportunities. The major components to consider during Six Sigma implementation are "metrics" and "strategy," as shown in Figure 1.1. The upper half of the figure involves the measurement of how well business processes meet their goals. The success of Six Sigma is linked to a set of cross-functional metrics that lead to significant improvements in customer satisfaction and bottom-line benefits. Organizations

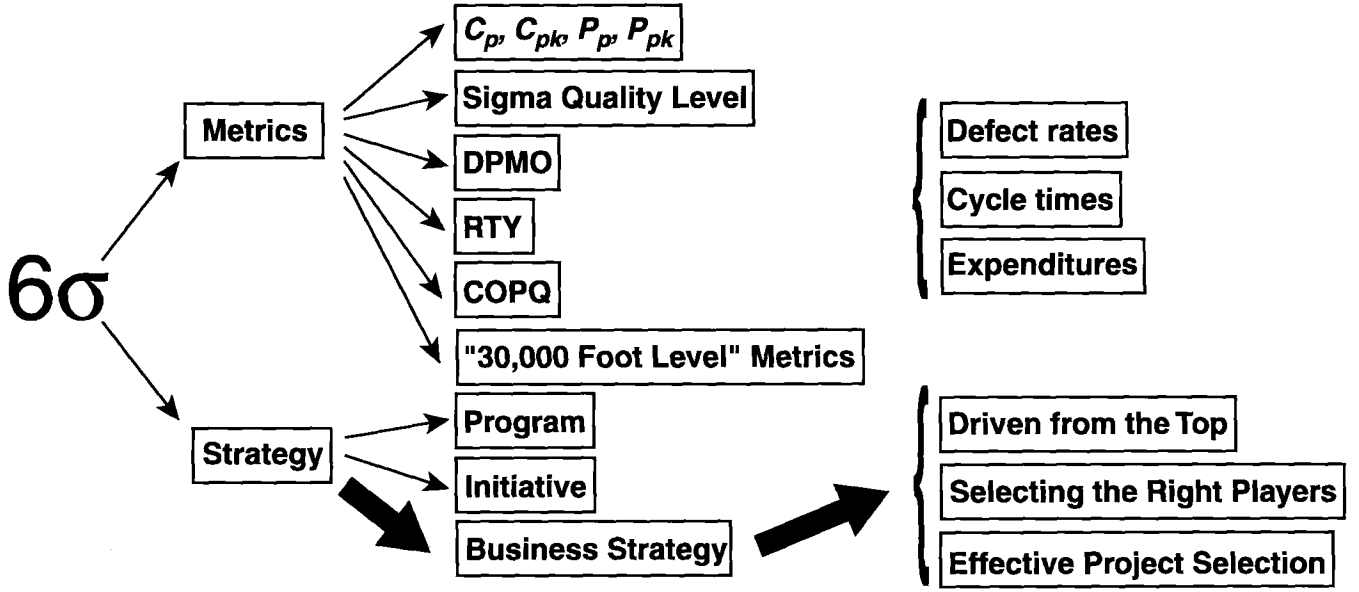

Figure 1.1 Six Sigma implementation considerations

do not necessarily need to use all the measurements listed (often presented within typical Six Sigma programs). It is most important to choose the best set of metrics for a situation, metrics that yield insight into a situation or process.

Our S^4 approach advocates the development of cross-functional teams to provide a holistic approach to problem solving, encompassing all levels of complex processes. We often describe the methodology as a murder mystery, where practitioners are determining "who done it?" or, equivalently, "what is the major cause of defects in a process?" By following a structured methodology, project teams can determine the "biggest hitters" and make substantial areas for improvement that provide real benefits to an organizations bottom line.

Subsequent chapters of this book will provide the details of effective Six Sigma metrics and the importance of implementing Six Sigma as a business strategy. In this chapter, we first discuss current myths surrounding Six Sigma. We then provide a brief history of quality leaders and other quality systems that preceded the creation of Six Sigma. Last, we answer a few of the more frequently asked questions (FAQs) about Six Sigma.

1.1 WHAT IS SIX SIGMA?

Some people view Six Sigma quality as merely a rigorous application of basic and advanced statistical tools throughout an organization. There are a number of Six Sigma consultants and training organizations that have simply repackaged the statistical components of their previous TQM programs and renamed them "Six Sigma." These groups would define Six Sigma quality in terms like those in the upper half of Figure 1.1.

Others view Six Sigma as merely a sophisticated version of Total Quality Management (TQM), as represented by the lower half of Figure 1.1. They see it as an advanced form of TQM in which various continuous improvement systems must be put in place with a small amount of statistical analyses added in for good measure.

The S^4 view of Six Sigma emphasizes an intelligent blending of the wisdom of the organization with proven statistical tools to improve both the efficiency and effectiveness of the organization in meeting customer needs. The ultimate goal is not improvement for improvement's sake, but rather the creation of economic wealth for the customer and provider alike. Our Smarter Solutions approach recommends that Six Sigma be viewed as a strategic business initiative rather than a quality program. This implies, not that Six Sigma replaces existing and ongoing quality initiatives in an organization, but that senior management focuses on those processes identified as critical-to-quality in the eyes of customers. Those critical systems are then the subject of intense scrutiny and improvement efforts, using the most powerful soft and hard skills the organization can bring to bear. The success of each and every Six Sigma initiative is