THE CERTIFIED SIX SIGMA BLACK BELT PRIMER

WITH A LITTLE HELP FROM MY FRIENDS.

JOHN LENNON/PAUL McCARTNEY

Acknowledgments

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CSSBB Primer Question Contents

Primer Section		% CSSBB	Questions		
			Exam	Primer	FD
I.	Certification Overview				
II.	Organization-wide Deployment	8%	12	32	80
III.	Process Management	8%	12	32	80
IV.	Team Management	10%	15	40	100
V.	Define	13.3%	20	53	133
*VI.	Measure - Data	7.3%	11	29	73
*VII.	Measure - Statistics	9.3%	14	37	93
VIII.	Analyze	14.7%	22	59	147
IX.	Improve	14.0%	21	56	140
X.	Control	11.3%	17	45	113
XI.	Design for Six Sigma	4%	6	17	41
XII.	Appendix				
	Total	100%	150	400	1000

The solutions to all 400 questions are available through QCI in the *CSSBB Solutions Text*. QCI also offers a CSSBB Exam flash drive which contains 1,000 total CSSBB questions. Included are the 400 Primer questions (which may be excluded), plus 600 additional questions. The flash drive offers a variety of options, including full simulated exams.

Alignment Comparison B/T CSSBB Primer & ASQ BOK

Primer	II	III	IV	V	VI	VII	VIII	IX	X	XI
ASQ BOK	I A & B	II A → C	III A → D	IV A → D	V A → C	V D → F	VI A → C	VII A → C	VIII A → D	IX A → C

* **Note that the CSSBB Authors have chosen to present the measure category in two Primer Sections.**

SIX SIGMA HAS FOREVER CHANGED GE®. EVERYONE... IS A TRUE BELIEVER IN SIX SIGMA, THE WAY THIS COMPANY NOW WORKS.

JOHN F. WELCH
FORMER GE CHAIRMAN

Enterprise-Wide Deployment

Enterprise-wide Deployment is reviewed in the following topic areas:

- **Organization-wide considerations**
- **Leadership**

The CSSBB authors chose to stay with the former enterprise -wide deployment title. Organization wide considerations are certainly covered, as shown below.

Organization-wide considerations are presented in the following topic areas:

- **Six sigma and lean fundamentals and maturity model**
- **Continuous improvement methodologies**
- **Business systems and processes**
- **Strategic planning and deployment**

Value of Six Sigma

Six sigma is a highly disciplined process that focuses on developing and delivering near-perfect products and services consistently. It is also a management strategy to use statistical tools and project work to achieve breakthrough profitability and quantum gains in quality. It has been stated that product characteristics with six sigma process capabilities (C_{pk} > 1.5) are of world class performance. The average American company is at four sigma level. (Harry, 1998)[32]. Snee (1999)[71] describes six sigma as, "A business improvement approach that seeks to find and eliminate causes of mistakes or defects in business processes by focusing on outputs that are of critical importance to customers."

Motorola®, under the direction of Chairman Bob Galvin, used statistical tools to identify and eliminate variation. From Bill Smith's yield theory in 1984, Motorola® developed six sigma as a key business initiative in 1987. Many credit the resulting improvements as a key factor in Motorola® winning the Malcolm Baldrige Award in 1988. Dr. Mikel Harry, who had led the corporate effort, subsequently left Motorola® and later founded the Six Sigma Academy to accelerate the efforts of corporations to achieve world class standards. (Harry, 1998)[32]

Value of Six Sigma (Continued)

Sigma is a statistical term that refers to the standard deviation of a process about its mean. In a normally distributed process, 99.73% of measurements will fall within ± 3.0 sigma and 99.99932% will fall within ± 4.5 sigma. In a stable attribute distributed process, 99.73% of values will fall within the probability of 0.00135 and 0.99865.

Motorola® noted that many operations, such as complex assemblies, tended to shift 1.5 sigma over time. So a process, with a normal distribution and normal variation of the mean, would need to have specification limits of ± 6 sigma in order to produce less than 3.4 defects per million opportunities. This failure rate can be referred to as defects per opportunity (DPO), or defects per million opportunities (DPMO).

Figure 2.1 illustrates the ±1.5 sigma shift and Table 2.2 provides some indications of possible defect levels.

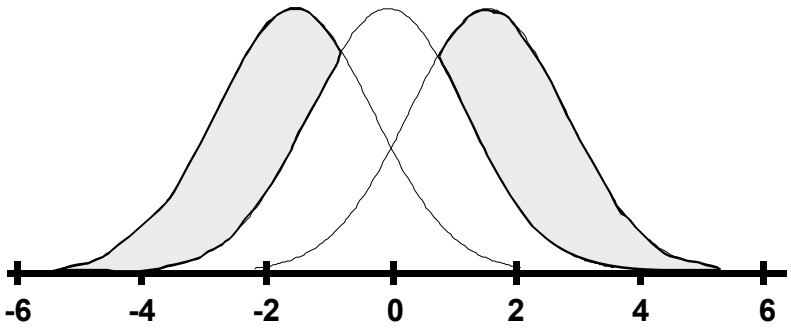

Figure 2.1 The ± 1.5 Sigma Shift

Sigma Level	ppm
6 sigma	3.4 ppm
5 sigma	233 ppm
4 sigma	6,210 ppm
3 sigma	66,810 ppm
2 sigma	308,770 ppm
1 sigma	697,672 ppm

Table 2.2 Defect Levels

Note that Table II in the Appendix provides defect levels at other sigma values. Various authors report slightly different failure rates based upon rounding effects and slight miscalculations.

It should be noted that the term "six sigma" has been applied to many operations including those with non-normal distributions, for which a calculation of sigma would be inappropriate. The principle remains the same, deliver near perfect products and services by improving the process and eliminating defects. The end objective is to delight customers.

Value of Six Sigma (Continued)

The six sigma steps for many organizations are described as DMAIC:

Define: Select the appropriate responses (the "Ys") to be improved.

Measure: Data must be gathered to measure the response variable.

Analyze: Identify the root causes of defects, defectives, or significant measurement deviations whether in or out of specifications. (The "Xs", independent variables).

Improve: Reduce variability or eliminate the cause.

Control: With the desired improvements in place, monitor the process to sustain the improvements.

Modified from (Hahn, 1999)[30]

Harry (2000)[33] proposes that the entire six sigma breakthrough strategy should consist of the following eight elements:

R Recognize the true states of your business.
D Define what plans must be in place to realize improvement of each state.
M Measure the business systems that support the plans.
A Analyze the gaps in system performance benchmarks.
I Improve system elements to achieve performance goals.
C Control system-level characteristics that are critical to value.
S Standardize the systems that prove to be best-in-class.
I Integrate best-in-class systems into the strategic planning framework.

Because of the integration of a number of tools, such as lean manufacturing, DOE (design of experiments), and DFSS (design for six sigma), six sigma has been referred to as TQM (total quality management) on steroids.

The business successes that result from a six sigma initiative include:

- **Cost reductions**
- **Market - share growth**
- **Defect reductions**
- **Culture changes**
- **Productivity improvements**
- **Customer relations improvements**
- **Product and service improvements**
- **Cycle - time reductions**

(Pande, 2000)[53]

Value of Six Sigma (Continued)

Motorola® credits the six sigma initiative for savings of $940 million over three years. AlliedSignal® (now Honeywell®) reported an estimated $1.5 billion in savings in 1997. GE® has invested a billion dollars with a return of $1.75 billion in 1998 and an accumulated savings of $2.5 billion for 1999. (Hahn, 1999)[30]

Harry (1998)[32] reports that the average black belt project will save about $175,000. There should be about 5 to 6 projects per year, per black belt. The ratio of one black belt per 100 employees can provide a 6% cost reduction per year. For larger companies, there is usually one master black belt for every 100 black belts.

Snee (1999)[71] provides some reasons why six sigma works:

- **Bottom line results**
- **Senior management is involved**
- **A disciplined approach is used (DMAIC)**
- **Short project completion times (3 to 6 months)**
- **Clearly defined measures of success**
- **Infrastructure of trained individuals (black belts, green belts)**
- **Customers and processes are the focus**
- **A sound statistical approach is used**

Organizations that follow a six sigma improvement process for several years find that some operations achieve greater than six sigma quality. When operations reach six sigma quality, defects become so rare that when they do occur, they receive the full attention necessary to determine and correct the root cause. As a result, key operations frequently end up realizing better than six sigma quality.

Companies that have embraced six sigma include:

- **Motorola**
- **General Electric**
- **Dupont**
- **Polaroid**
- **Kodak**
- **Sony**
- **Toshiba**
- **AlliedSignal**
- **Black & Decker**
- **Dow Chemical**
- **Federal Express**
- **Boeing**
- **Johnson & Johnson**
- **Navistar**

Six Sigma Foundations

Listed below are some well-known gurus and what they have contributed to the business and technical foundations of six sigma. This list is far from inclusive.

Guru	Contribution
Philip B. Crosby	Senior management involvement 4 absolutes of quality management Quality cost measurements
W. Edwards Deming	Plan-do-study-act (wide usage) Top management involvement Concentration on system improvement Constancy of purpose
Armand V. Feigenbaum	Total quality control/management Top management involvement
Kaoru Ishikawa	4M (5M) or cause-and-effect diagram Companywide quality control (CWQC) Next operation as customer
Joseph M. Juran	Top management involvement Quality trilogy (project improvement) Quality cost measurement Pareto analysis
Walter A. Shewhart	Assignable cause vs. chance cause Control charts Plan-do-check-act (as a design approach) Use of statistics for improvement
Genichi Taguchi	Loss function concepts Signal to noise ratio Experimental design methods Concept of design robustness
Bill Smith	First introduced the term “six sigma”
Mikel Harry	The main architect of six sigma
Forrest Breyfogle III	Author of *Implementing Six Sigma*

Table 2.3 Major Contributors to the Six Sigma Knowledge Bank