THE SIX SIGMA YELLOW BELT PRIMER

WITH A LITTLE HELP FROM MY FRIENDS.

JOHN LENNON/PAUL McCARTNEY

Acknowledgments

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Bill Wortman
Quality Council of Indiana
602 West Paris Avenue, West Terre Haute, IN 47885
Tel: (800) 431-1585, Tel: (812) 533-4215
FAX: (812) 533-4216
qci@qualitycouncil.com
https://www.qualitycouncil.com

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Six Sigma Introduction (Continued)

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

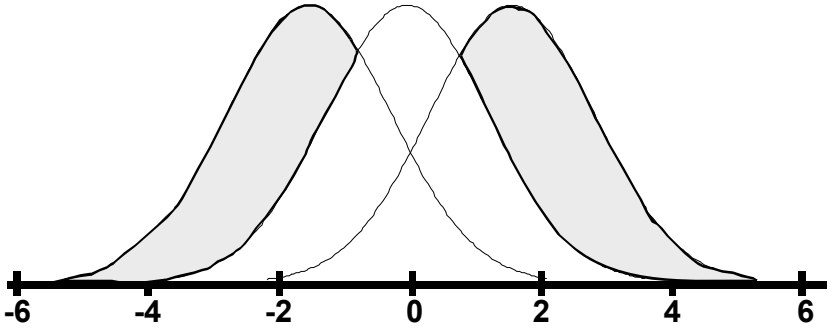

Figure 2.1 The ± 1.5 Sigma Shift

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 mainly upon rounding effects and slight miscalculations. Most of the differences occur at levels less than 3 sigma. However, in looking at this situation objectively, companies with less than 3 sigma capability and with ± 1.5 sigma shifts probably won't be around long enough to undertake a six sigma improvement effort anyway.

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.

Six Sigma Introduction (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)[6]

Harry (2000)[9] proposed that the entire six sigma breakthrough strategy should consist of the following eight elements:

R Recognize the true state 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)[15]

Six Sigma Results

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)[6]

Harry (1998)[7] reports that the average black belt (or green 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)[21] 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 defects 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**

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Six Sigma Leadership

There are several ways to structure a six sigma strategy. However, successful applications share a common core of management support, training, rewards, and reinforcement.

Management Support

Effective six sigma programs do not happen accidentally. Careful planning and implementation are required to ensure that the proper resources are available and applied to the right problems. Key resources may include people trained in problem solving tools, measurement equipment, analysis tools, and capital resources. Assigning human resources may be the most difficult element, since highly skilled problem solvers are a valuable resource and may need to be pulled from other areas where their skills are also needed.

It has been said that there are two occasions when it is difficult to implement an improvement program, when times are bad and when times are good. When times are bad, profitability is low, resources, are tight and "strategic" activities take a back seat to "survival." When times are good, profitability is high, and resources are focused on the current sources of cash flow. Improvement may be last on the list of things to do in order to take advantage of the current opportunity.

It has also been said that there are two times when an improvement program is critical, when times are bad and when times are good. When times are bad, and profitability is low, a company can not afford to continue losing money because of poor quality and performance.

When times are good, and profitability is high, the cost of poor quality and performance is also likely to be high. Customers are not likely to repeat business with a company that delivers a poor quality product or service, when a better option is available. This last condition is more likely to happen in a high margin market. Unfortunately, many companies cruise along like the Titanic thinking they are unsinkable because they are the market leaders.

Management must be willing to make significant commitments in order to implement and support a successful six sigma initiative. Early successes must be exploited to propel the company forward. This includes overcoming the hurdles that appear at the 4.5 sigma, 5 sigma, and 5.5 sigma transition points. At each of these transition points, the low hanging fruit, that was previously available, has been picked and a more advanced analysis is needed to reach the next level. The hurdles get progressively higher. If an organization does not continue to persevere, then it is likely to take a step backwards.

Six Sigma Training

The role of training, in the successful implementation of six sigma, is fundamental. The skills necessary for breakthrough improvements cannot be developed without proper training. Companies that have implemented successful six sigma programs found that training investments return significant benefits. Motorola®, for instance, has discovered a 10 to 1 payback for six sigma training investments. Extensive training is necessary for several levels of individuals and basic training is required for the entire organization.

Potential black belts may undertake a 4 month training program consisting of one week of instruction each month. A variety of software packages are used to aid in the presentation of projects, including Excel or MINITAB™ for the statistics portion. Potential black belts will receive coaching from a master black belt to guide them through a project. The completed project will typically require the trainee to use the majority of the tools presented during the training sessions.

Lesser amounts of training will qualify individuals for the green and yellow belt titles. It should be noted that ASQ's BOK and this Primer are major efforts in attempting to provide a more standardized training.

The diagram below outlines a high level training plan with special training for executives and master black belts. The relative volume of each diagram level represents the relative number of people receiving training.

Figure 2.3 Six Sigma Training Pyramid

Six Sigma Training (Continued)

In some organizations, black belts are full time positions that report directly to management sponsors, who, in turn, assign specific projects to them. These assignments may or may not include a process improvement team. Green belts and yellow belts within the normal organizational structure and are typically assigned to process improvement teams as needed. Black belts have specific mentoring responsibilities, including the development of individuals assigned to them.

In other organizations, black belts continue in their normal assignments and participate in process improvement teams as needed. In this structure, black belts and green belts act as internal consultants and are pulled into teams when their specific skills are needed. Black belts are typically responsible for mentoring 1 to 3 green belts or black belt candidates.

Many organizations have a structure that fits somewhere in between the two previous models. Master black belts are responsible for coaching and training black belts in order to make the best use of their skills. Master black belts also train and coach management in order to help them support the black belt program.

Rewards and Reinforcement

Rewards and reinforcement may be one of the hardest parts of successfully institutionalizing a six sigma program. Black belts, green belts, and yellow belts must have positive career paths in order to encourage the best candidates to commit to the extensive training and development required. Especially now that black belt skills are in demand, it is important to recognize the accomplishments of black belts by tangible and intangible means.

It is also important that yellow, green, and black belts experience the rewards of achieving significant savings for the company. At the same time, all other team members must be recognized for their contribution to performance improvements. To only reward the black belts for improvements that were achieved by teams, creates resentment and isolates the black belts from team members.

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 2.4 Major Contributors to the Six Sigma Knowledge Bank