



II. ENTERPRISE-WIDE DEPLOYMENT

**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**



**II. ENTERPRISE-WIDE DEPLOYMENT
ENTERPRISE-WIDE VIEW / VALUE OF SIX SIGMA**

Enterprise-Wide Deployment

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

- **Enterprise-wide view**
- **Enterprise leadership**

Enterprise-wide View is presented in the following topic areas:

- **Value of six sigma**
- **Six sigma foundations**
- **Value and foundations of lean**
- **Integration of lean and six sigma**
- **Business processes and systems**

These topic areas vary somewhat from the wording and sequence of the ASQ BOK but the authors feel the coverage is adequate.



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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.

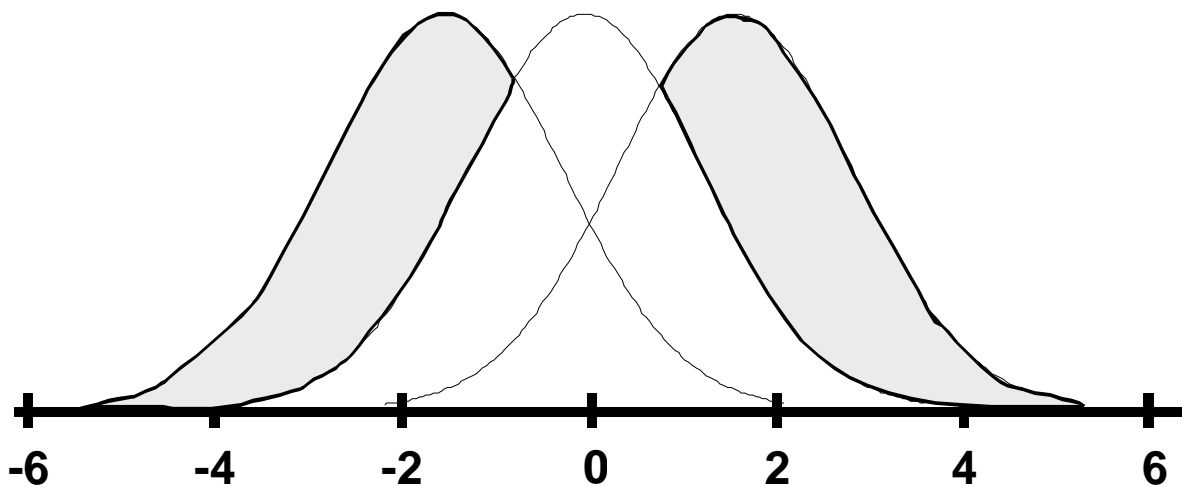
Motorola[®], under the direction of Chairman Bob Galvin, used statistical tools to identify and eliminate variation. From Bill Smith's yield theory in 1984, Motorola[®] developed six sigma as a key business initiative in 1987.



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Value of Six Sigma (Continued)

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.



The ± 1.5 Six Sigma shift



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Value of Six Sigma (Continued)

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

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.



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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.



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Value of Six Sigma (Continued)

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**



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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.

Harry 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.



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Value of Six Sigma (Continued)

Snee 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**
- **Customers and processes are the focus**
- **A sound statistical approach is used**

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.



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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 System improvements Constancy of purpose
Armand V. Feigenbaum	Total quality control/management Top management involvement
Kaoru Ishikawa	4M (cause-and-effect) diagrams Companywide quality control Next operation as customer



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Six Sigma Foundations (Continued)

Guru	Contribution
Joseph M. Juran	Top management involvement Quality trilogy Quality cost measurement Pareto analysis
Walter A. Shewhart	Assignable cause vs. chance cause Control charts Plan-do-check-act (in design) 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 six sigma
Mikel Harry	The main architect of six sigma
Forrest Breyfogle III	Author of <i>Implementing Six Sigma</i>



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Philip B. Crosby (1928 - 2001)

Philip B. Crosby was vice-president of ITT for 14 years. In 1979, he founded Philip Crosby Associates, Inc. in Winter Park, Florida. Mr. Crosby consulted, spoke, and wrote about strategic quality issues throughout his professional life.

The other quality deep thinkers could be viewed as academicians, but Crosby was considered a businessman. This explained the numbers of top management that flocked to his quality college.

Crosby believed that quality was a significant part of the company and senior managers must take charge of it. He believed the quality professional must become more knowledgeable and communicative about the business. Crosby stated that corporate management must make the cost of quality a part of the financial system of their company.



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Philip B. Crosby (Continued)

One of Crosby's most popular statements on quality was,

“Quality is conformance to requirements.”

Philip Crosby preached four absolutes of quality management:

- 1. Quality means conformance to requirements**
- 2. Quality comes from prevention**
- 3. The quality performance standard is zero defects**
- 4. Quality measurement is the price of nonconformance**

The four absolutes of quality management are basic requirements for understanding the purpose of a quality system.



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Dr. W. Edwards Deming (1900 - 1993)

Dr. Deming was an honorary member of ASQ. He was awarded the ASQ Shewhart Medal in 1955. During his life Dr. Deming published over 200 papers, articles, and books.

W. Edwards Deming was the one individual who stood for quality and for what it means. He is a national folk hero in Japan and was perhaps the leading speaker for the quality revolution in the world. At the Hawthorne plant he became acquainted with W. Shewhart and studied Shewhart's statistical methods.

Deming made several visits to Japan between 1946 and 1948 for the purpose of census taking. JUSE invited Deming back in 1950 for executive courses in statistical methods. He refused royalties on his seminar materials and insisted that the proceeds be used to help the Japanese people. JUSE named their ultimate quality prize after him.

His message to America is listed in his famous 14 points and 7 deadly diseases.



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Dr. W. Edwards Deming (Continued)

The Fourteen Obligations of Top Management:

- 1. Create constancy of purpose for improvement of products and service**
- 2. Adopt a new philosophy; we are in a new economic age**
- 3. Cease dependence upon inspection as a way to achieve quality**
- 4. End the practice of awarding business based on price tag**
- 5. Constantly improve the process of planning, production, and service, including people**
- 6. Institute training on the job**
- 7. Institute improved supervision (leadership)**
- 8. Drive out fear**
- 9. Break down barriers between departments**
- 10. Eliminate slogans/targets asking for increased productivity without providing methods**
- 11. Eliminate numerical quotas**
- 12. Remove barriers that stand between all workers and their pride of workmanship**
- 13. Institute programs for education and retraining**
- 14. Put all emphasis in the company to work to accomplish the transformation**



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Deming's Seven Deadly Diseases

- 1. Lack of constancy of purpose to plan a marketable product and service to keep the company in business and provide jobs**
- 2. Emphasis on short-term profits**
- 3. Personal evaluation appraisal, by whatever name, for people in management, the effects of which are devastating**
- 4. Mobility of management; job hopping**
- 5. Use of visible figures for management, with little or no consideration of figures that are unknown or unknowable**
- 6. Excessive medical costs**
- 7. Excessive costs of warranty, fueled by lawyers that work on contingency fees**

Among other educational techniques, Deming promoted the parable of the red beads, the PDSA cycle, and the concept of 94% management (system) causes versus 6% special causes.



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Dr. W. Edwards Deming (Continued)

Deming's Chain Reaction

Deming shared the following chain reaction with Japan in the summer of 1950:

Improve quality → Decrease costs (less rework, fewer delays) → Productivity improves → Capture the market with better quality and price → Stay in business → Provide jobs.



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Dr. Armand V. Feigenbaum (1920 -)

Mr. Feigenbaum is generally given credit for establishing the concept of “total quality control” in the late 1940s while he was at General Electric. His TQC statement was first published in 1961, but, at that time, the concept was so new no one listened.

The TQC philosophy maintains that all areas of the company must be involved in the quality effort. The quality effort has generally only affected the shop floor people, but must extend to all sections of the company. Products must not only be made quicker and faster, but also sold faster. Feigenbaum noted that the quality professional has an opportunity to become more than a functional specialist.



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Dr. Armand V. Feigenbaum (Continued)

The success of TQC includes these principles:

- **TQC is a company wide process**
- **Quality is what the customer says it is**
- **Quality and production costs are in partnership**
- **Higher quality will equate to lower costs**
- **Both individual and team zeal are required**
- **Management must relentlessly emphasize quality**
- **Quality and innovation must work together**
- **All of management must be involved in quality**
- **Use new and existing technologies**
- **Quality is the cost-effective route to productivity**
- **Quality involves both customers and suppliers**



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Dr. Kaoru Ishikawa (1915 - 1989)

Kaoru Ishikawa was involved with the quality movement in its earliest beginnings and remained so until his death in 1989. A review of Ishikawa's training tapes, produced in 1981, contain many of the statements of quality that are in vogue today. Subjects such as total quality control, next operation as customer, training of workers, empowerment, customer satisfaction, elimination of sectionalism, and humanistic management of workers, are examples.

To reduce confusion between Japanese-style total quality control and western-style total quality control, he called the Japanese method the companywide quality control (CWQC).



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Dr. Kaoru Ishikawa (Continued)

CWQC involves the participation of workers from the top to the bottom of an organization and from the start to the finish of the product life cycle. CWQC requires a management philosophy that has respect for humanity.

One of the first concepts that western management took back to their own shores was the quality circle. The quality circle represents the bottom up approach.

Ishikawa also wrote that he originated the concept “next operation as customer” in 1950. Operators concerned about their own defects were considered spies whenever they traveled to the next department to view their original work. The separation of departments was referred to as sectionalism.

Kaoru Ishikawa was known for his lifelong efforts as the father of Japanese quality control efforts. The fishbone diagram is also called the Ishikawa diagram in his honor.

