



# Sick Sigma or Is It Only a Stigma?

DEMING AND SO-CALLED SIX SIGMA QUALITY

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## Six Sigma or Is it Only a Stigma?

There is no substitute for knowledge. W. Edwards Deming

Truth, like gold, is to be obtained not by its growth, but by washing away from it all that is not gold. Leo Tolstoy

Get your facts first, then you can distort them as you please. Mark Twain

### **PURPOSE AND SCOPE/INTRODUCTORY REMARKS**

In the years since Dr. Deming's passing, much has been made about the "new wave" of quality methodology, Six Sigma. This paper will compare and contrast Dr. Deming's philosophy with that of the Six Sigma approach by describing the commonalities, differences, and the effectiveness of each.

### **Operational Definitions**

There is much confusion, it seems, over the meanings of these concepts. Any meaningful discussion must begin with an understanding of how the author is using the terms.

### **Deming Philosophy**

Dr. W. Edwards Deming was a prolific writer in the fields of mathematical physics, statistics, and finally, management philosophy. This paper will primarily consider the "management philosophy" portion of Dr. Deming's teaching.

The management philosophy of Dr. Deming can probably best be summarized by two major components: Profound Knowledge and the Fourteen Points. Dr. Deming's Fourteen Points (and their partners, the Seven Deadly Diseases) first appeared in print in the landmark publication Out of the Crisis in 1986. The Fourteen Points are a collection of advice, warnings, and admonishments for management to use to improve their business.

A more cohesive theory, A System of Profound Knowledge, is presented in The New Economics, (Deming, 1994) and, according to Dr. Deming, "...provides a map of theory by which to understand the organizations that we work in." It is supported by four major tenets: Appreciation of a System, Theory of Knowledge, Theory of Variation, and Psychology. Many themes that are echoes of the Fourteen Points show up in various parts of the System of Profound Knowledge, particularly those relating to organizational purpose, driving out fear in an organization, and understanding the implications of variation.



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Systems theory describes ways in which management can turn their organization into a system, and the advantages of doing so. Optimization of parts of the system results in sub-optimization of the system. Dr. Deming's writings describe as well many obstacles to creation of an organizational system, such as incentives for performance of one aspect of the system, internal competition, and the use of the performance appraisal.

The Theory of Knowledge describes a system for learning, and the importance and use of theory to promote learning. Deming presents the latest version of the Shewhart cycle, the Plan-Do-Study-Act (PDSA) cycle as a model for achieving this goal.

The Theory of Variation describes the need for management to understand variation, and to use this understanding to improve processes and systems. Deming describes management itself as primarily prediction, and an understanding of variation is critical to being able to predict, to separate the signal from the noise, the "common cause" variation from the "special cause" variation.

Psychology comes into play in all aspects of the System of Profound Knowledge model. Management must be aware of underlying psychological influences if the business is ever to approach becoming a true system.

### Various Definitions of "Six Sigma Quality"

Two of the major advocates of Six Sigma, Dr. Mikel Harry and Richard Schroeder, define the term in this way: "... a business process that allows companies to drastically improve their bottom line by designing and monitoring everyday business activities in ways that minimize waste and resources while increasing customer satisfaction." Further amplification is provided in their book, *Six Sigma: The Breakthrough Management Strategy Revolutionizing the World's Top Corporations* (Harry & Schroeder, 1999). Six Sigma is referenced as "... a disciplined method of using extremely rigorous data gathering and statistical analysis to pinpoint sources of errors and ways of eliminating them." As described in the book, a Six Sigma project will follow the principles of RDMAICSI: Recognize, Define, Measure, Analyze, Improve, Control, Standardize, and Integrate. Similar approaches can be found in advanced product quality planning (APQP) introduced in the early 1990s by the Ford Motor Company. It is a very prescriptive approach that focuses on projects that add directly and obviously to a company's bottom line.

Six Sigma is commonly used by many as a synonym for "improvement" or "variability reduction". Additionally, it is used to describe the measurement tracking system for determining six sigma, usually Defects per Million Opportunities (DPMO). Consultants and practitioners push major Six Sigma projects rather than integrate improvement efforts into everyday work life.



## **DEMING APPROACH VS SIX SIGMA: IS IT REALLY AN EITHER/OR?**

As it turns out, it is not necessarily an either/or proposition. Six Sigma, while purporting to be a management philosophy, really seems more closely related to Dr. Joseph Juran's more project-oriented approach, with a deliberate, rigorous technique for achieving a problem resolution or an improvement. Dr. Deming's approach is more strategic, theoretical and philosophical in nature, and does not carry the detailed explicitness of the Six Sigma approach. As such, the Deming philosophy is not necessarily at odds with any approach that is tactically oriented. So can the two coexist? Is Six Sigma just a tactical application of Deming's theoretical models? Or are the two completely incompatible? The answer seems to be mixed: some practices are very compatible, while others are at cross purposes.

### **Practices that Seem to be Compatible**

Undeniably some companies have experienced successes using the Six Sigma approach (although greatly exaggerated in the press both between and within companies). For all its stigma, the Six Sigma approach has had a positive affect, and upon examination, is not appreciably different from detection and corrective action techniques in use in the automotive industry in the late 1980s.

### ***Top Management Commitment***

What has been accomplished in companies that have achieved some success with Six Sigma is management support from the very top levels, and the willingness to stay the course over many years. These characteristics bring to mind things that Deming had been saying for decades. Top management support and constancy of purpose are the cornerstones of the Deming philosophy. "If you cannot come, send nobody," a quote from William Conway, then CEO of the Nashua Corporation, related by Dr. Deming (Deming, 1986, p.21). Mr. Conway was writing in response to a vice president in response to the vice president's request for an invitation to visit the Nashua Corporation. Dr. Deming elaborated for clarity: "If you don't have time to do your job, there is nothing I can do for you." His point, driven home with typical Deming wit, was that there is no real substitute for leadership, for top management support and involvement.

### ***Constancy of Purpose***

Constancy of purpose seems to be an additional common characteristic of those companies that have had some success with Six Sigma. Deming wrote extensively about the dangers of over-adjustment, of lack of constancy of purpose, of succumbing to the lure of the "program of the month" to drive improvement. "There is no instant pudding", was his constant rejoinder. This does not imply that all change must necessarily be gradual; rather, that devotion to the principles of Profound Knowledge should not waver. The principle of constancy of purpose, applied on the



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tactical level with improvement projects, can have some impact as well, as some Six Sigma successes have shown.

### *Mapping DMAIC and PDSA*

Many six sigma practitioners also trace the roots of the DMAIC (Design-Measure-Analyze-Improve-Control) model to Deming's (PDSA) Plan-Do-Study-Act, and this does seem to have a measure of validity. A good case can be made that the two map well together. As practiced, the DMAIC model tends to give the impression that one grand movement through the cycle is enough to achieve sufficient results. The PDSA cycle has more of a "small scale testing" feel with multiple learning and improvement cycles employed before objectives are achieved, and this seems to ring more true to real life experience. That said, it is important to note that these concerns reflect six sigma *as practiced*. There is nothing in the DMAIC model to prevent multiple cycles, it simply is not done very often.

### **Practices that are Clearly in Conflict**

Though some of the Six Sigma theory and practice seem compatible and aligned with the Deming philosophy, there are many more that are not aligned, and some, as will be shown, seem to be in opposition to Dr. Deming's approach. I will address these under two categorical headers: (1) **Technical** (the major engineering and statistical issues that are in conflict) and **Implementation/Cultural Issues** (practices that are destructive to creating a true system with a common aim).

## **1. Technical issues when comparing Deming's approach with Six Sigma**

### *Treatment of Variation*

The Six Sigma approach relies on the histogram as the primary means of describing variation. Diagrams in books and papers written on the subject use the histogram to describe a process, and comparisons are made with specifications to show its "sigma level". Because processes tend to "shift and drift" (Harry and Schroeder, p.143) over time, an allowance for what is termed "centering error for a typical process" is made: 1.5 sigma. The oft-quoted 3.4 defects per million statistic touted by the Six Sigma approach is therefore loosely derived, not from six sigma at all, but from 4.5 sigma, (which does not roll off the tongue as well. )



## Why 1.5 Sigma?

There are several problems with this approach. One might first wonder why 1.5 sigma? How was this figure selected? References to a 1.5 sigma allowance are found in writings by A. Bender (1962) and J. Gilson (1951), but this is in the entirely different context of tolerancing assemblies of components. When designing assemblies, it is helpful to design such that variation experienced in manufacturing or processing does not affect the performance of the system. When estimating worst case system performance, it may make sense (as indeed is suggested by Bender) to inflate the estimation of the standard deviation *for the assembly*. This is fundamentally different from allowing for such a shift in the *process* mean of *individual components*. To allow for this type of shift in the process mean “just in case” seems extraordinarily wasteful, tantamount to keeping large inventories of parts (or anything else), or adding inspection as a substitute for process improvement, to allow for excessive process variation.

## *Detecting “Shift and Drift”*

Besides, detection of such a shift is the job of another tool, one of Deming’s favorite: The Shewhart control chart. Originally devised by Dr. Walter Shewhart in the 1920s, the control chart provided what no enumerative study ever had: a basis for prediction. To be sure, any Six Sigma Quality course on the market will feature the control chart as a course offering. Of grave concern to a student of the Deming approach, however, is how routinely predictions are made about future process performance using only a histogram and an apparent assumption of normality. The histogram is a useful tool for describing the spread of the data in a process; however, this alone is not particularly useful and may be misleading unless the condition of statistical control of the data is achieved. Additionally, the Shewhart control chart does not require the underlying data to be normally distributed, as is required by the Six Sigma approach. Dr. Shewhart’s famous example concerning the elongation data of springs shows a histogram that appears perfectly bell-shaped, normally distributed, and yet when the data are plotted over time, there is a clear downward trend (Shewhart, 1939). Dr. Deming’s comment on this example is particularly insightful, and may perhaps be generalized: “Any attempt to use the distribution [in this example] would be futile. The standard deviation of the distribution, for example, would have no predictive value. It would tell nothing about the process, because this is not a stable process.” (Deming, 1986 p. 313). One could argue that “allowance” is made for any potential changes by the 1.5 sigma shift that is built into the Six Sigma approach, but Deming’s approach again would perhaps counter that the control chart should be used to detect a shift in the process, and would require far less data than if using the histogram. Approaches to improvement described by and derived from Deming would entail improvement in the form of reduction of variation about a target value, and keeping it there using the control chart.



### *Visibility to How Variation Causes Loss*

This leads to the next area of conflict between the approaches: Six Sigma Quality ignores the Taguchi Loss function. Six Sigma approaches generally use either DPMO (Defects per Million Opportunities) or DPU (Defects per Unit) to describe process performance. Both seem to be dressed up versions of the control chart for attributes data known as the “u” chart, but without the control limits. Again, a “sigma level” is calculated for a process and it is so labeled without benefit of any statistical tool that provides a basis for prediction. The major issue here, though, is in the use of defects themselves to describe process variation. There are times on some processes where it is necessary to resort to defect tracking as the best way to gain insight into process performance, but this is not generally the case. Dr. Genichi Taguchi demonstrated with his famous “loss function” how variation generally causes loss even when all parts meet specification (Taguchi, 1983). John Betti, then of Ford Motor Company, captured the idea in 1985: “We in America have worried about specifications: meet the specifications. In contrast, the Japanese have worried about uniformity, working for less and less variation about the nominal value...”. (Deming, 1986 p. 49) As Deming summarized, Dr. Taguchi’s parabolic loss function describes a realistic world, “...in which there is minimum loss at the nominal value, and an ever-increasing loss with departure either way from the nominal value.” (*Out of the Crisis*, p. 141). Of course there are also one-sided loss functions, where loss occurs on only one side (such as metallic hardness). A well-designed assembly or system has components with very few loss functions that are steep (that is, where a small amount of variation causes a large amount of “loss”) and many that are flat, where process variation can be tolerated because of design robustness.

The process insights provided by the loss function are not available from the Six Sigma perspective, because in order to be visible, process variation must produce some defects. Zero defects, the nostrum that describes perfection in the Six Sigma system, cannot detect any process variation that does not actually produce defects. There is no way to recognize loss that occurs from variation that is within specification. This is further emphasized in the tendency in Six Sigma literature to characterize improvement as synonymous with the elimination of errors. This overly simplistic characterization is only one small aspect of improvement. Without the insights provided by the control chart, one cannot tell whether these so-called “errors” belong to the system or are attributable to a special cause, requiring two distinct approaches for resolution or improvement.

### *A Major Problem with DPMO as Commonly Practiced in Six Sigma*

Deming often observed a tendency in American industry for companies to compromise their business system while striving to achieve certain individual or departmental goals that optimized pieces of the system. DPMO (defects per million opportunities) is often used in such a fashion.



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DPMO is a ratio. A business wants to reduce it. There are two ways this can happen: the numerator can be reduced (defects), or the denominator can be increased (opportunities). Often times, higher so-called “sigma levels” are reached by doing the latter: actually *increasing* the opportunity for defects, either in actuality or by creative counting methods. The latter is merely a waste of time; the former could actually make things worse!

### *Problem Solving vs. Improvement*

The Six Sigma methodology uses the same approach for both problem solving and improvement. The issue here is that, depending on one’s definition, fundamentally different approaches may be needed. A problem is, in general, an unusual occurrence that requires intervention in the short term, to return the process to where it would have been otherwise if the special cause had not occurred. There are many good problem solving approaches currently in use (such as the 8 Disciplines approach used by Ford Motor Company and their supplier base). But they all have one thing in common: their objective is to return the process to where it was before the problem occurred. Can this be improvement? Resolving a special cause utilizes an approach called root cause analysis, a standard part of the Six Sigma approach, and corrective action is a required step. But once the problem is solved and corrective action taken, have we really made the process better? Consider the example of an automobile that delivers, say, 25 miles per gallon of fuel on average. Suppose the immediately preceding 8 tanks have yielded between 20 and 23 miles per gallon. This would produce an out of control condition on a Shewhart control chart, and we would be justified in checking some things, trying to solve this problem (air filter, spark plugs and so forth). We find the root cause, fix it, and the process returns to what it had always been before the problem occurred. This is important, and must be done, but is it improvement? Per the Deming approach, this would simply be special cause removal, and not a true improvement. The process has been returned to where it was before the problem occurred. Improvement would be taking a stable, predictable process (that is, one exhibiting statistical control) and making changes to it that caused an improvement, and renewed stability at a better level. What would it take to get 40 miles per gallon from the process? A fundamental change in the process, product, or the system is required to achieve this. Some of the tools of problem solving can be used, but the fundamental approach is different. It requires knowledge of process stability, which cannot be achieved by the limited understanding of variation provided by the Six Sigma approach.

A better methodology is provided by Associates in Process Improvement: the Improvement Model (from *The Improvement Guide*, 1996). This approach is derived from the Deming Cycle (as it became known by everyone but Deming; he called it the Shewhart Cycle. See *Out of the Crisis*, p. 88, and *The New Economics*, 2d edition, pp131-133). Briefly stated, the model asks three questions: (1) What are we trying to accomplish?; (2) How will we know that a change is an improvement?; and, (3) What changes can we make that may be an improvement?. This is followed by the PDSA cycle: Plan-Do-Study-Act. This methodology, described in theoretical



and practical detail in the book, *The Improvement Guide* (1996), has proven to be a robust means of developing a change, testing on a small scale, and implementing the change with the accumulated learning from the test(s).

## 2. Implementation Practices/Cultural Issues when comparing Deming's approach with Six Sigma

Implementation of any improvement strategy must be done with careful planning and execution. Some of the principles of the Six Sigma Breakthrough Strategy are advocated by proponents of Dr. Deming's philosophy, such as upper management support and constancy of purpose (as was discussed earlier). There are, however, a number that are at odds with Deming's approach, to the detriment of the implementing company.

### *Arbitrary Goals*

It is common practice for Six Sigma companies to set targets that appear to be arbitrarily chosen. Most frequent are those relating to the achievement of a "sigma level" and "10-fold improvement" (though the relationship between these is never clarified). Where do these goals come from? Has anything been done to understand the cost or benefit of achieving 10-fold improvement? How will we achieve this goal? "By what method", Dr. Deming used to ask. Additionally, we should ask leadership and management at all levels: "What is the total cost? What are we trying to accomplish? Are we keeping the customer in mind with these improvements?" (I am grateful to Barbara Ward of Motorola's Broadband Communications Sector for insights provided that are contained in this paragraph.)

Dr. Deming had a lot to say about arbitrarily chosen goals that are outside the bounds of the current system's capability without a plan to achieve them. As Dr. Deming put it, paraphrasing Lloyd S. Nelson, "If they can do it next year with no plan, why didn't they do it last year? They must have been goofing off. And if one can accomplish improvement of 3 per cent with no plan, why not 6 per cent?". (*Out of the Crisis*, pp. 76-77)

There is more. "A numerical goal leads to distortion and faking, especially when the system is not capable of meeting the goal." (Deming, *The New Economics*, 2d edition, p.31). Problems occur here when the improvement experts are given numerical dollar improvement targets and are held accountable for achieving them. They are typically provided with monetary incentives that are substantial if these goals are accomplished, causing problems on several levels. The process owners rarely share in the recognition. Savings estimates are routinely grossly inflated, and that which truly *is* achieved is often transitory because of inadequate involvement of the



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process owner. Achievement of these goals is often on paper only, for the purpose of getting recognition for the black belt (the Six Sigma name for improvement tools expert) rather than accomplishing all that could be achieved for the company. There are even some incentive programs that, incredibly, pay and certify black belts based on the number of improvement tools that they have shown that they can use. (This seems a little like paying a plumber for fixing your sink based on how many tools he/she uses to do the job).

The methods for achieving these goals in many companies are also of concern: whipping packs of crazed black belts into a frenzy, unleashing them on unsuspecting process owners, and waiting for the cash savings to pile up. Unfortunately, once the simplest, easiest to solve problems are gone, the turnaround begins to wane. This approach also tends to rob the process owner of something Dr. Deming considered sacrosanct: pride of workmanship and accomplishment. The process owners should be involved and assisted in making improvements, not brushed aside only to have solutions imposed on them by someone without process knowledge that may or may not help or hinder. Frustrated and disillusioned process owners are often left in the wake of these types of efforts, and a rougher row to hoe is found the next time an attempt at improvement is made that involves them.

### *Strategic Focus*

Devotion to Six Sigma as the key to a company's success can also bring about a myopic loss of strategic focus and compromise viewing a business as a system. Six Sigma's emphasis on the bottom line is one major cause of this. Deming had no problem with emphasizing the bottom line, understanding clearly how important this is. "But he that would run his company on visible figures alone will soon have neither company nor figures." (*Out of the Crisis*, 1986, p.121). Deming's concern lay in the belief that the most important knowledge about running a business as a system could not be reduced to visible figures alone (quite a pronouncement from someone who always referred to himself as "... only an apprentice statistician."). Focus on the visible figures alone always tends to focus a business on the short term—this quarter's earnings report and stock price, for example. This often leads to compromise of the long term to accommodate the short term.

Of even more concern long term is the tendency of companies using Six Sigma to substitute Six Sigma Quality for the need for good strategic planning. Deming again: "What business are we in? [To make carburetors?] Yes, the makers of carburetors made good carburetors, better and better. They were in the business of making carburetors. It would have been better if they had been in the business to put a stoichiometric mixture of fuel and air into the combustion chamber, and to invent something to do it better than a carburetor. Innovation on the part of somebody else led to the fuel injector and to hard times for the makers of carburetors." (Deming, 1994, pp. 9-10). Perhaps an even better characterization of this business would be "vehicle acceleration



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devices”, which would create an unbroken chain starting with the buggy whip.

More from Deming: “Efforts on reductions of defects [may be] successful. At the same time, demand for product, sales may slide downward toward zero. Simply to [reduce or] eliminate defects does not guarantee jobs in the future. No defects, no jobs can go together. Something other than zero defects is required.” (Deming 1994 pp. 9-11). He might have added, it takes more than mistake-proofing as well.

The point here, of course, is that improvement in quality, as important as it is, is not enough to sustain a business long term. Reducing defects, continual improvement, none of these will serve long term without innovation and continually asking the questions, “What business are we in? What is the societal need we are trying to serve? How can we do it better for our customers and potential customers?”

## CONCLUDING REMARKS

In conclusion, the answer is both: Six Sigma is *Sick Sigma*, for the reasons outlined above. At the same time, Six Sigma suffers from an unfair stigmatization; to argue that it has brought no value is to risk throwing the baby out with the bath water. It is hoped that this paper has provided the reader with some insight as to the similarities and differences between Dr. Deming’s philosophy and Six Sigma Quality, and will help foster understanding of the underlying principles of each.



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## ABOUT DAVID WAYNE

David Wayne is Senior Improvement Science Advisor and Senior Partner with Corpus Optima. David is a respected Deming authority and master statistician. David holds master's degrees in management science and industrial management, an undergraduate degree in mathematics and history, and extensive experience designing and implementing process management approaches in industrial and business settings for manufacturing and non-manufacturing processes. He has worked with major companies in electronics, technology, telecommunications, aviation, aerospace and defense industries since 1982 including Texas Instruments, Northrop Grumman, Boeing, and Motorola, where he has designed, informed and orchestrated business and process improvement efforts, including the development of hundreds of quality green belts, black belts and master quality black belts. He co-developed and championed an integrated process management and improvement methodology which played a major role in the turnaround of Northrop-Grumman's Commercial Aircraft Division. This resulted in Northrop-Grumman's transformation from lowest level supplier to Boeing in 1989 to winning Boeing's Supplier of the Year award in 1994. David's military service included significant involvement in the design, development, and improvement of the M-1 Abrams, which ultimately became the US Army's primary battle tank. Additionally, while at Northrop-Grumman, he led a team of engineers in solving key production issues with the C-17 transport just prior to the 1991 Gulf War.

David is a member of the adjunct faculty at Temple University's Fox School of Business, Management Science Department, and leads learning in Improvement Science and Quality at the graduate level in the MBA and Executive MBA programs. He is frequently sought after to speak on various topics related to process and system improvement. In 2001, he received the Temple Business School Dean's Award for Teaching Excellence. Most recently, his speaking engagements include chapters of the American Society for Quality, Society of Manufacturing Engineers, and Fordham University.

David is an active member of the Committee of Experts for KEMA Registered Quality, an acclaimed international standards body, and a past president of the Deming Study Group of Dallas, Texas. He has written papers on related topics in the quality sciences field, and contributed book chapters on planned experimentation and measurement system analysis to the *Design for Manufacturability Handbook*, published by the Society of Manufacturing Engineers. He is currently at work on a new book, *You Can Just Stop*, scheduled for publication in the Fall of 2008.

David is also improvement sciences advisor to the Society of Chest Pain Centers, a national registration and certification body whose aim is to improve and upgrade medical care process improvement perspective, including prevention, mitigation, and treatment.



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