SIX SIGMA

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ABSTRACT

The term "Six Sigma" is a statistical term that refers to 3.4 defects per million opportunities or 99.99966 percent accuracy Developed in the 1980's by Motorola, Six Sigma is a measure of quality that strives for near perfection and is a disciplined, data-driven approach and methodology for eliminating defects in any process from manufacturing to transactional and from product to service.

Keywords: *DPMO (defects per million opportunities), Six sigma, Normal distribution.*

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INTRODUCTION:

Six Sigma is a business management strategy . It seeks to improve and minimizing equality of process Outputs by identifying and removing the causes of defects (errors) variability in manufacturing and business processes. It uses statistical process control to relentlessly and rigorously pursue the reduction of variance and standard deviation in all critical processes to achieve continuous and breakthrough improvements that impact the bottom-line and/or top-line of the organization and increase customer satisfaction It uses a set of quality t methods, management including statistical methods .Its process is one in which 99.99966% of the products manufactured are statistically expected to be free of defects (3.4 defects per million).

METHODS:

Six Sigma projects follow two project methodologies:

- **DMAIC**
- **DMADV**

DMAIC:

- **Define** the problem.
- **Measure** key aspects of the current process and collect relevant data.
- **Analyze** the data to investigate and verify cause-and-effect relationships.
- **Improve** or optimize the current process based upon data analysis using techniques.
- **Control** the future state process to ensure that any deviations from target are corrected before they result in defects.

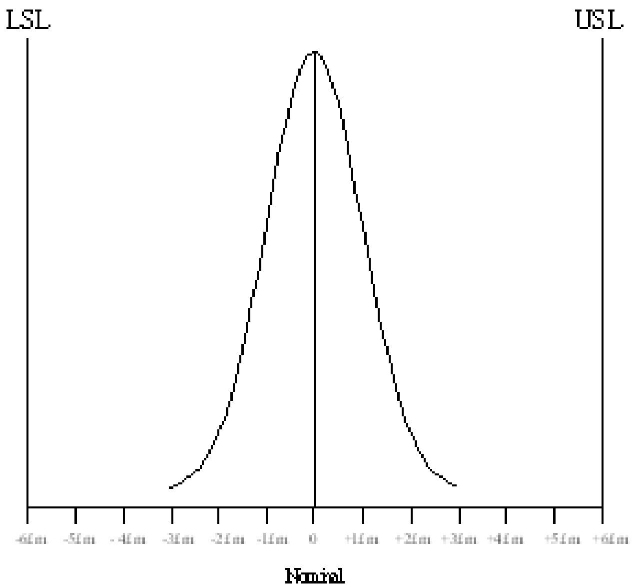
DMADV:

- **Define** design goals that are consistent with customer demands and the enterprise strategy.
- **Measure** and identify characteristics that are **C**ritical **to Q**uality, product capabilities, production process capability, and risks.
- **Analyze** to develop and design alternatives, create a high-level design and evaluate design capability to select the best design.
- **Design** details, optimize the design, and plan for design verification. This phase may require simulations.
- **Verify** the design, set up pilot runs, implement the production process and hand it over to the process owner(s).

ORIGIN OF SIX SIGMA PROCESS:

The Normal Distribution: The term “Six Sigma” is derived from the normal distribution used in statistics. Many observable phenomena can be graphically represented as a bell-shaped curve or a normal distribution as illustrated in Figure 1. with Mean (m=0) and Standard Deviation (s=1)

Figure 1: Normal Distribution
with Mean (m=0) and Standard Deviation (s=1)



- When measuring any process, it can be shown that its outputs (services or products) vary in size, shape, look, feel or any other measurable characteristic. The typical value of the output of a process is measured by a statistic called the mean or average.
- The variability of the output of a process is measured by a statistic called the standard deviation. In a normal distribution, the interval created by the mean plus or minus two standard deviations contains 95.44 percent of the data points, or 45,600 data points per million (or sometime called defects per million opportunities denoted DPMO) are outside of the area created by the mean plus or minus two standard deviations .
- In a normal distribution the interval created by the mean plus or minus three standard deviations contains 99.73 percent of the data, or 2,700 DPMO are outside of the area created by the mean plus or minus three standard deviations. In a normal distribution the interval created by the mean plus or minus six standard deviations contains 99.9999998 percent of the data, or two data points per billion data points outside of the area created by the mean plus or minus six standard deviations.

Six Sigma management promotes the idea that the distribution of output for a stable normally distributed process (Voice of the Process) should be designed to take up no more than half of the tolerance allowed by the specification limits (Voice of the Customer) it is assumed that over time the processes may increase in variation. This increase in variation may be due to small variation with process inputs, the way the process is monitored, changing conditions, etc. The increase in process variation is often assumed for the sake of descriptive simplicity to be similar to temporary shifts in the underlying process mean. The increase in process variation has been shown in practice to be equivalent to an average shift of 1.5 standard deviations in the mean of the originally designed and monitored process.

If a process is originally designed to be twice as good as a customer demands (i.e., the specifications representing the customer requirements are six standard deviations from the process target), then even with a shift, the customer demands are likely to be met. In fact, even if the process shifted off target by 1.5 standard deviations there are 4.5 standard deviations between the process mean (m + 1.5s) and closest specification (m + 6.0s), which result in at worst 3.4 DPMO at the time the process has shifted or the variation has increased to have similar impact as a 1.5 standard deviation shift

Figure 2: Three Sigma Process with 0.0 Shift in the Mean

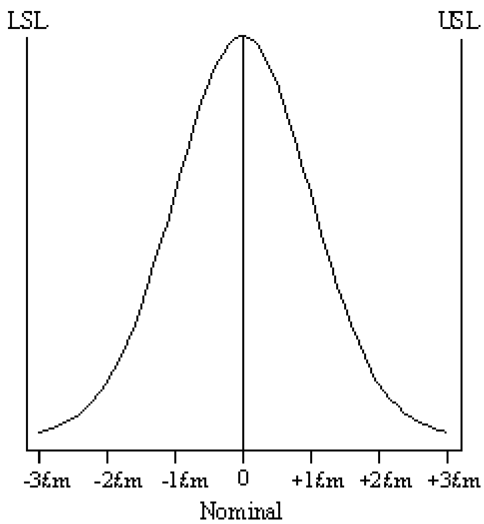


Figure 2 shows that a three-sigma process where the process mean plus or minus three standard deviations is equal to the specification limits, in other terms, USL= $\mu+3\sigma$ and LSL = $\mu-3\sigma$. This scenario will yield 2,700 defects per million opportunities.

Figure 3: Three Sigma Process
with a 1.5 Sigma Shift in the Mean

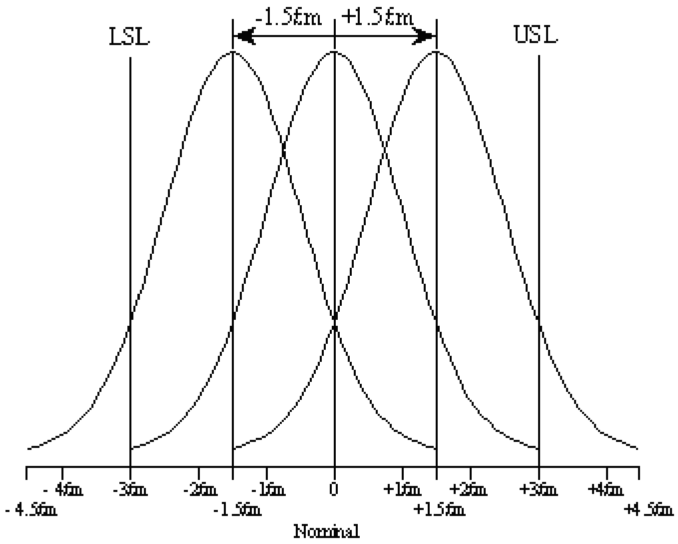


Figure 3 show that the process means shifts by 1.5 standard deviations. The 1.5 standard deviation shift in the mean results in 66,807 defects per million opportunities,

Figure 4: Six Sigma Process with a 0.0 Shift in the Mean

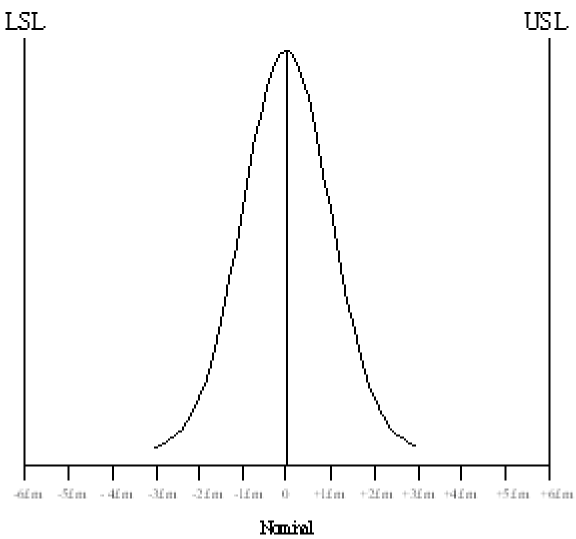


Figure 4 shows the same scenario as Figure 2 except the Voice of the Process only takes up half the distance between the specification limits. The process mean remains the same as in Figure 2, but the process standard deviation has been reduced to one half, through application of process improvement. In this case, the resulting output will exhibit 2 defects per billion opportunities,

Figure 5: "Six Sigma" Process with 1.5 Sigma Shift in the Mean

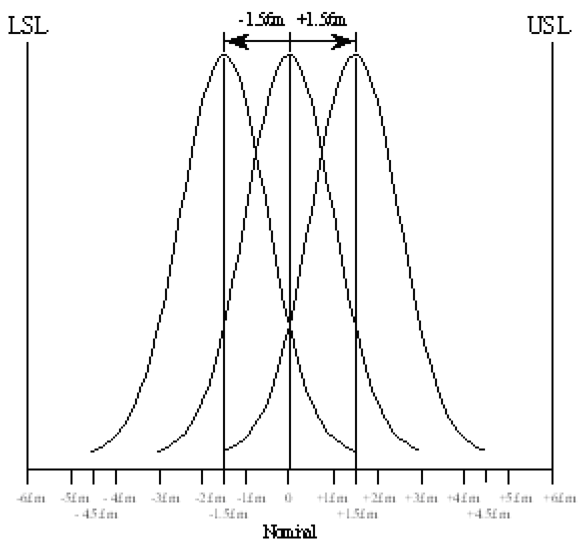


Figure 5 shows the same scenario as **Figure 4**, but the process average shifts by 1.5 standard deviations (the process average is shifted down or up by 1.5 standard deviations. The 1.5 standard deviation shift in the mean results in 3.4 defects per million opportunities.

CONCLUSION:

We have concluded from above research that the increase in process variation is assumed to be temporary shifts in the process mean. It has been shown in practice to be equivalent to an average shift of 1.5 standard deviations in the mean of the originally designed and executed process. The specifications limits represents the customer requirements are six standard deviations from the process with a shifting in original mean.

The Six Sigma model assumes that the process data always conform to the normal distribution. The calculation of defect rates for situations where the normal distribution model does not apply is not properly addressed in the current Six Sigma literature. This specially counts for reliability related defects and other not time invariant problems.

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