

(Published in July 2001 issue of Circuits Assembly)

The Birth of Six Sigma

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Let's travel back to 1981, the year I joined Motorola's Semiconductor Products sector. Competition was intense, layoffs were feared, interest rates were 18 to 20 percent, and semiconductor chips were selling for less than the cost of manufacturing. Qualifying a loan to buy a two-bedroom house was a challenge, and the U.S. dream of owning a home was just that -- a dream. Charges of dumping chips were levied against foreign companies. To top it off, Motorola's financial reports were not looking very rosy in those years.


That era was the age of manufacturing 512 bits; 1K, 4K and 16K dynamic random access memory (DRAM) chips were the latest technology. As with any state-of-the-art technology, the list of problems was a continuous one. However, Motorola was a leader in the communications industry, and the company's reputation was solid as a manufacturing company in the U.S. The company was perceived as knowing how to manufacture effectively in the States, while other companies were exporting their manufacturing offshore.

Although times were tough, Motorola was still known to outperform competition during this particular economic downturn. However, Motorola leadership realized that something different had to be done to survive the challenging times. Pressure to perform better, faster and cheaper was present, and Motorola leadership set the company's quality improvement goal as 10 times improvement in five years (10 x 5).

With any new technology initiative, awareness and understanding through education is the first step. Motorola University became the vehicle to transform Motorola into a high performance company. In this "university," managers were trained in change management to create a work culture that adapted to a challenging and competing environment. A strong management review process was also established. Some managers felt as though going to their management review meetings was like going to war because it was so thorough and tough. This management review was performed weekly, not monthly, as some experts suggest today.

During the first five years of this quality initiative, significant progress was made; however, economic conditions were still challenging. Visionary leaders at Motorola, looking ahead through the maze of competition and manufacturing technologies, realized that just this quality program was not enough. The leaders' measure was consumer products like calculator and watches. As fast as manufacturers of calculators and watches saw their market eroding due to miniaturization and competition, Motorola's leaders could see personal phones, televisions, two-way radios, and other products becoming like watches and disappearing.

Motorola's desire to be a leader in manufacturing in the core areas of communication, semiconductors, and industrial electronics led to a comprehensive benchmarking process for which best practices were searched. Phil Crosby's Zero Defects crusade was going on, with little success and challenges in implementation.



Its biggest obstacle was opposition to achieving perfection because no one would commit to a perfect performance due to of fear of failure.

During one feedback session from our quality management, I was told that "Motorola's corporate leaders were doing something more than Three Sigma." I started looking into that concept and creating a measurement method beyond Three Sigma using normal distribution. Using Four Sigma limits, the defective parts per million (ppm) becomes 63 ppm. Knowing that the number of steps to manufacture semiconductor chips was about 200, Four Sigma appeared to be a satisfactory level of quality. With Four Sigma, cumulative yield was about 99 percent vs. about 67 percent using standard Three Sigma limits.


When I later moved to a division of Motorola in Schaumburg, IL, I met Bill Smith, Communications Sector Quality Manager. I had been waiting to meet with him, validate my Four Sigma model and learn about his model beyond Three Sigma. Bill had been contemplating a measurement method in a more realistic manner by allowing a shift of 1.5 sigma due to the assumption that processes behave normally and could fit Walter Shewhart's control chart theory. Accordingly, for a subgroup size of four, the control limits are set at 1.5 sigma. Therefore, for a normally controlled process, if the process average shifts by 1.5 sigma or more, the process must be shut down, which limits the maximum shift to 1.5 sigma.

Further discussion led me to learn more about Bill's work. He had already established a correlation between field failures and internal failures and concluded that most field failures were escaped internal failures and estimated to be in the ratio of 10 to one (10:1). Bill's dilemma was that manufacturing and design departments had improved their performance significantly; however, the results in product performance did not correlate. In addition, Motorola's benchmarking studies had shown that, to survive in the future, the customer expected almost a perfect product. With these two issues in mind, Bill conceived and integrated the Six Sigma measurements and design for manufacturability (DFM) methods. While developing these new methods, he had the total support of Bob Galvin, then-CEO of Motorola.

Once the Six Sigma concept was documented and developed for implementation, projects for trial were selected. The initial projects were for establishing aggressive goals for improvement. The first four projects, called Small Wins for Six Sigma, were in product development and manufacturing. The Six Sigma measurement methods were applied to establish accountability that drove the improvement. Expectations were built at a high level. The first departments to implement the Six Sigma methodology were graphics and a new product development team.

On the cultural change side, all product managers were trained in Six Sigma and then trained their employees. As Six Sigma progressed, the quality expectation for each process and product was to obtain Six Sigma by achieving an annual quality improvement goal of 68 percent. The strong weekly, monthly and quarterly quality reviews drove the performance to higher levels. Not every process or product achieved the 3.4 ppm defect level, as it was a moving target due to changing customer requirements; however, the goal of implementing Six Sigma methodology at each process was almost achieved.

While measurements were used to drive performance, employees' participation, leadership's interest and higher awareness toward a common goal, and a drive to



achieve higher expectation by management and by the outside world were key factors in institutionalizing the Six Sigma methodology.

Motorola had announced to the world that it would achieve Six Sigma by 1992, and, by that year, the overall sigma level for the corporation was about 5.4, a little less than Six Sigma. The amazing aspect was that a corporation of Motorola's size had successfully established a corporate-wide measurement system to measure quality performance. Not many companies, of any size, have an integrated quality measurement system. Besides the measurement alone, Motorola had institutionalized the philosophy of Six Sigma through the concepts of striving for perfection, creativity, dramatic improvement and teamwork. Receiving the CEO award for achieving dramatic quality improvement from Bob Galvin was a great incentive for teams besides bonuses and other forms of recognition.

The first five years of Six Sigma at Motorola were very rewarding for the company. Sales grew dramatically, better products were introduced with higher manufacturing capability and a focus on quality, and the company's reputation soared. As a Motorola executive once said, "Our Motorola badge could be used as a credit card." Such benefits of Six Sigma could not have been realized by just focusing on a few projects. Instead, Six Sigma was an organization-wide, leadership-driven, process-oriented, middle manager-led and employee-owned initiative.