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Our approach to six sigma

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What is six sigma?

- The same questions result in the same answers.
- You don't know what you don't know.
- You won't know until you measure it.
- Until you measure the right things, improvement is not possible.

Six sigma is a system that provides a framework in which to use a variety of measurement, statistical analysis, and change management tools. Most of these tools exist within industry today and some would be familiar to swine practitioners. Six sigma provides a methodology and the discipline to use these tools.

The goals of six sigma are the following:

- To help people measure the processes and products in which they are involved and use data and data analysis to help in their decision-making and problem-solving processes.
- To accurately determine the wants and needs of the recipient of the products of a process or a specific step in the process, whether that is the ultimate customer or simply the next step along the process.
- To quantify the variation in process that leads to variation in the product.
- To reduce the variation in the process so that the product of the process will fall within the range of acceptance by the customer almost all the time.

Six sigma methodologies help people discover where variation exists in their processes which, in turn, contributes to variation in their products. Variation in a product is the biggest source of customer dissatisfaction.

The traditional way of ensuring that customers do not see defective products is to carry out inspections during the production process and a final inspection at the end. There are several flaws in this approach:

- Inspection systems cost money.
- Inspection never detects 100% of the defective product. The better the process, the fewer defects will exist. The inspection process, therefore, needs to steadily improve, usually involving greater cost. It is an exercise in diminishing returns.
- Inspection occurs after the products, or the parts thereof, have been produced. Resources have already been spent on making the defective product. It costs the same to make a defective product as it does a good product.
- What becomes of the defective product? It may be discarded, sold at a discount to reflect its decreased value, or sent back for rework. If a customer receives a defective product, the results could involve warranty costs, or rejection by the customer, which could then lead to losing the customer (and others that the customer talks to).

Six sigma helps to empower each person at each step of the production process to reduce variation using measurement and an understanding of what introduces variation into the process, as well as methods to control these sources of variation. "Doing the right things right—the first time" is one of the pillars in six sigma philosophy. This philosophy strives to reduce waste in all processes. Six sigma focuses on improving the *process* (whereas inspection focuses on *product*). Often the ideas to improve the process come from the people directly involved, so six sigma is a catalyst for innovation within organizations.

In discussing six sigma, most of the illustrations involve examples of manufacturing processes. Six sigma grew from manufacturing, but one of the powers of six sigma is that its methods can be applied to any process. A process is defined as a value-adding activity which takes resources from suppliers and produces an output destined to be used by customers. A supplier can range from an outsource company to simply the previous step in the process. A customer can be the ultimate consumer or simply the next step down the process—and the terms "supplier" and "customer" need not necessarily apply to people; they can be a machine or sub-process.

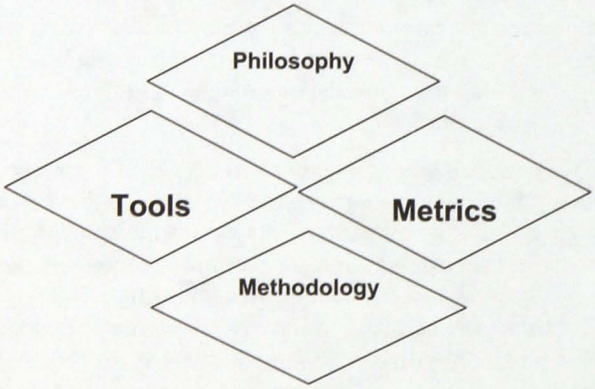
Six sigma methodologies can apply to all processes—manufacturing processes, transactional processes such as sales, budgeting, or invoicing and service processes such as sales calls or deliveries.

What does the term "six sigma" mean?

The term "sigma" in statistics generally refers to standard deviation. The "sigma" in six sigma (or Z-score) goes further than just standard deviation. It is a statistical unit of measure which reflects the capability of a process to deliver an acceptable output relative to customer expectations as shown in **Figure 1**. The range within which a product is acceptable to a customer is contained between two specification points—the upper specification limit (USL) and the lower specification limit (LSL). Anything outside of this limit is not acceptable to the customer and is referred to as a defect. In measuring defects, a few terms are used:

- Opportunities for error: These are the places or steps in a process where a defect can occur. Opportunities for error define the complexity of a process. The more complex the process, the more opportunities there are for defects.

Figure 1



- Defects per unit (DPU): This is a ratio indicating the quality of the output. A unit of work is the output of a process or particular process step.

$$DPU = \frac{\text{\# of defects}}{\text{\# of units}}$$

- Defects per million opportunities (DPMO): This is a way of standardizing the defect rates in order to compare processes of varying complexity.

$$DPMO = \frac{(DPU \times 1{,}000{,}000)}{\text{\# of opportunities for error}}$$

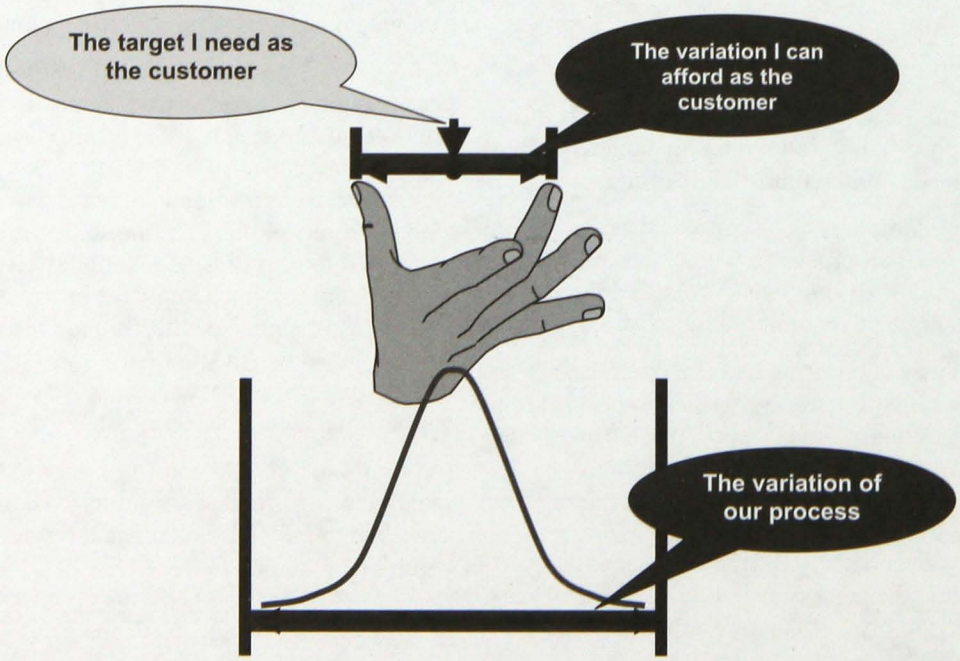
Figure 2 shows the calculation of a six sigma score for a product where the customer has given an upper specification limit of 19 and a mean of the process of 10. The figure illustrates that the variation of the process, even at six standard deviations from the mean, remains mostly within the specification limit of the customer. This means that 99.9997% of the time the process will deliver a product acceptable to the customer.

Why six sigma?

Historically in North America a sigma score of about three has been the goal. More recently, companies are striving for a sigma score of four. A sigma score of four equates to a long-term defect-free rate of 99.38% or 4661 DPMO. Is this good? It's better than a three sigma process, but here are some examples of the results of processes within the United States if they operated at a four sigma level:

- In the postal service, 2000 lost articles of mail each hour

Figure 2



- In public health, 15 minutes of unsafe drinking water each day
- In the telephone industry, no service for nine minutes each week
- In pharmacy, 20,000 wrong drug prescriptions each year
- In aviation, two short or long landings at Chicago's O'Hare (and all equivalent airports) every day
- In human surgery, 500 incorrect operations each week
- In public utilities, no electrical service seven hours per month

Most companies are realizing that four sigma is no longer good enough. They are now setting their sights on six sigma. Why? Six sigma equates to a 99.9997% long-term defect-free rate or 3.4 defects per million opportunities for defects (DPMO). A company working at a six sigma level is considered to be best-in-class.

For the processes given in the example above, a six sigma level of performance would be:

- In the postal service, 1.1 lost articles of mail each hour
- In public health, three minutes of unsafe drinking water per year
- In the telephone industry, no service for 2.6 minutes each decade
- In pharmacy, 11 wrong drug prescriptions each year
- In aviation, four short or long landings at Chicago's O'Hare (and all equivalent sized airports) each decade
- In human surgery, 142 incorrect operations per decade
- In public utilities, no electrical service for nine seconds per month

Where did six sigma begin?

Its genesis lies in a classic stretch target set in 1981 by Motorola's CEO, Bob Galvin, to his people: effect a tenfold improvement in product-failure levels over a five year period. Bill Smith, an engineer at the company, realized that such results could not be achieved without going into the core of what caused defects in the first place. So he conducted a statistical correlation between the field-life of a product and the number of flaws that had been spotted—and corrected—while the product was being manufactured. The correlation, arrived at in 1985, turned out to be positive. In other words, if a product had been found defective and corrected during the production-process, chances were high that other defects had been missed, and would show up later during usage.

On the other hand, error-free products rarely failed in the first three years of customer usage. Evidently, the simplest way to prevent product breakdowns was to ensure that the process prevented defects of any kind, making detection and repair redundant. External support for this argument came from the best-in-class benchmarking that Motorola had been conducting simultaneously. It showed that total quality companies were turning out products that had not been reworked at all. The question became: How could Motorola minimize, and ideally eliminate, defects from the manufacturing process?

At that time, another engineer, Mikel J. Harry, introduced the concept of six sigma to Motorola. The idea was to set a deep quantitative target for all processes, and then parse each process into smaller and smaller sequences, each of which could be examined for their potential for errors and changed to eliminate that potential.

In the early 1990s, six sigma received a strong endorsement when Texas Instruments and General Electric adopted six sigma philosophy and methods. Since then, hundreds of companies (See **Table 1** for a partial list of these companies) have adopted six sigma approaches to their manufacturing and business enterprises, with various levels of commitment and success.

The four dimensions of six sigma

Six sigma *philosophy* is about improving the performance of a business. It empowers people at every level of an organization to make fact-based decisions and accept responsibility for the entire process, not just the part that in which they are involved.

Six sigma is also a *metric*, a way to quantify process, product, and service quality in a way that is correlated to profitability. One of the important breakthroughs achieved by Motorola in its six sigma effort was to establish a measurement of quality that enabled them to benchmark and compare the capability of products, processes, and services of any type, of any complexity and volume, and from any industry. Six sigma supercharges the industry philosophy of "Manage it by measuring it."

Six sigma is also a problem-solving *methodology* that ensures rigor, root-cause analysis, and connection to the customer's needs. Often, companies employ six sigma through an application of projects focused on specific processes. There are two distinct project methodologies in six sigma (**Figure 3**). The main one is the "Improvement" method also know by the acronym "DMAIC," which stands for Define, Measure, Analyze, Improve, and Control and is applied to existing processes. The other project methodology is used to design new processes or redesign existing process and is termed "DMADV," which stands for Define, Measure, Analyze, Design, and Verify.

Table 1: Some companies known to be formally applying the six sigma methodology ("Doing the right things right the first time").

Company name	
Motorola	Dell Computers
Texas Instruments	Seton Medical Centers
AlliedSignal	American Express
General Electric	Maytag
Sony	Pioneer Hi-Bred International
DuPont	Seagate Technology
Ford Motor Company	Millard Refrigerated Services
Polaroid	Canadian Marconi
Dow Chemical	Avery Dennison
Lockheed Martin	BBA Group PLC
Toshiba	Crane
Bombardier	Korean Heavy Industries
Noranda	Nokia
CitiGroup	Pechiney
BMW	Siebe
Xerox	Thermo King
Raytheon	GenCorp
Coca-Cola	IBM
ICI Explosives	Maple Leaf Foods

Six sigma uses a wide range of *tools*. Some general categories and examples of these tools are given in **Figure 4**. While six sigma does use many commonly employed non-statistical tools such as histograms, structure diagrams, and algorithms, its goal is to integrate many statistical, lean management, project management, and process design tools. A large part of six sigma training is focused on helping people understand how and when to use these tools. The tools used range from the basic to the advanced. While a significant number of these tools are focused on technical issues, a significant part of the tool kit is focused on people issues, such as change issues, leadership, and decision making. Six sigma adopters realize that organizations that fail to learn to use a wider range of tools will find that they cannot progress beyond a certain level.

Conclusion

Cause-Effect: Y = f(x)

We can sum-up six sigma with one concept and picture: Y=f(x). This stands for the idea that we must precisely understand and define, in ways we can measure, process outputs or "effect" (the "Y"). It also means we must understand how our processes work (the function "f"), including an understanding of those causes or "x"s that most affect our ability to deliver the "Y" consistently and profitably. It stands for the philosophy that we must not only measure the outcomes (product and/or service—the "Y") but also measure and control the key inputs that drive the process variation (the "x"s).

Six sigma is focused on the processes that create products or services. It is focused on the root causes of defects. It's not enough to find and count defective products. It is necessary to have tools to understand why the defects occurred and to work on the causes.

Is six sigma applicable to biological systems? To date it has been used very little outside the core manufacturing and service based industries. Maple Leaf Foods is among the pioneers in six sigma's application in the food industry. Can it apply to swine production? Anyone who starts down the path of six sigma in biological systems will need to rewrite some parts of the six sigma handbook. Some of the six sigma tools such as process mapping, statistical process control, and other statistical analysis methods are being used within our industry. Much research has been done on the cause and effect linkages in productivity. So, some aspects required by the six sigma approach are being used and applied.

The production systems of today are made up of many processes. Six sigma's ability to influence these processes depend on our ability to measure them, especially the variation within the process as well as our ability to exert some control over the process. Some processes, such as those of management and marketing, can be controlled adequately to allow current six sigma methodologies to operate; whereas, with some biological processes, the ability to improve will likely be incremental over a long time period. Six sigma offers a rigorous, disciplined approach to help in the quest for continuous improvement. It will help us advance towards our goals. Will we succeed? The final chapters of the book are yet to be written.