



Lean and Six Sigma— A One-Two Punch

by Bonnie Smith

To keep profits growing in these days of flat revenues, manufacturers are paying more attention to the advice of Poor Richard (a.k.a. Benjamin Franklin): A penny saved is a penny earned.

Those intimately involved in the quality improvement movement know those pennies are to be found in reducing rework and scrap and creating a smooth production flow.

We can all agree on reducing scrap and rework. The question is, by which ideology? Six Sigma programs are popular, focused and effective, but projects often take months to finish, and the program creates elite Black Belts (BBs), who are frequently disconnected from the shop floor.

Lean initiatives are great for boosting productivity, changing a culture and cleaning up factories, but what tools do they offer when it comes to fixing unseen quality issues?

Companies from across the spectrum—making playground equipment, commercial refrigeration units or washers and dryers—have found the most effective way to eliminate the flaws that lead to rework and scrap, and create one unified idea of continuous improvement, is by combining lean/*kaizen* and Six Sigma.

The resulting one-two punch becomes a formidable tool for attacking the problems that enlarge the difference between annual revenues and the bottom line.

The two initiatives work together, achieving results consistently superior to what either system could achieve alone. It's a classic case of the whole being greater than the sum of the parts.

Lean brings action and intuition to the table. Based on the principals of the Toyota Production System and

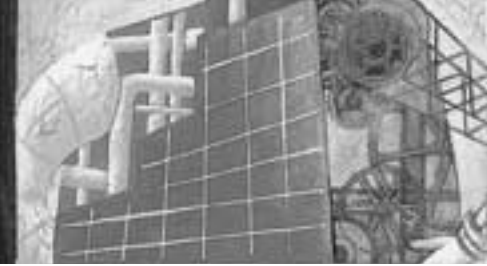
kaizen (continual improvement) breakthrough methodology, lean focuses on creating one-piece flow with just-in-time management of inventory and materials. Using five-day *kaizen* events, cross functional groups improve lead time and reduce inventory on the spot, attacking the kind of quality and flow issues referred to as “low hanging fruit.”

Picking that fruit clears the branches, allowing you to clearly see the kinds of challenges that require a Six Sigma approach using statistical tools to uncover the unseen roots of problems.

Popularized by Motorola and General Electric, Six Sigma has been marketed as a silver bullet, but the approach has a downside. By creating a cadre of Master Black Belts (MBBs), who can spend six months or more on a single project, the approach

In 50 Words Or Less

- Lean brings action and intuition to the table, quickly attacking low hanging fruit with *kaizen* events.
- Six Sigma uses statistical tools to uncover root causes and provide metrics as mile markers.
- A combination of both provides the tools to create ongoing business improvement.



sacrifices the bias for action inherent in lean projects. Momentum for transformation is lost.

By looking at projects through both the lean and Six Sigma lenses, you have the precision, actionable tools needed to find hidden problems while making sure you don't overlook the obvious.

Case Study

Consider the case of a prominent playground equipment manufacturer, Landscape Structures Inc. in Delano, MN. The company had been working on lean techniques for more than a year—cutting lead time in manufacturing by 92%, improving productivity by more than 20% and dropping scrap from 0.8

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to 0.2%—when it uncovered a problem that seemed to need more of a Six Sigma style approach. Pinholes in PVC coated pipes were causing a lot of scrap. The most likely culprits were the temperature, angle or mill thickness at which PVC was being applied. Landscape Structures asked TBM Consulting Group to help, using a method called LeanSigma that combines lean, *kaizen* and Six Sigma.

We set out to understand what we were trying to fix by measuring all the variables. A team made up of a cross-section of operators, engineers and managers from Landscape led by a TMB consultant spent hours on the shop floor observing, both to collect fresh data and to understand the context. Like TV detective Columbo, you can uncover a lot of information just by watching. You can get much closer to a problem if you catch it in action, rather

than just see historical data flash across a screen in a PowerPoint presentation with illustrated charts.

We mapped the entire process. By learning which tubes were processed on which rack at exactly what temperature, we could trace any defects found at the end of the line back to the process responsible. A month later, we scheduled a second event that would allow the same team to analyze, improve and, ultimately, control the process and put improvements into place.

Even though the company had been practicing lean for a year and a half, we found many things that needed mistake proofing (*poka-yoke*). For example, there was the priming system. Some parts got primed, some did not, but all the parts were manually placed on a rack system before the primer bath.

The operator had to know which racks needed to be primed, and some operators were more knowledgeable about this part of the job than were others. Sometimes parts that needed primer did not get it and vice versa.

The company created a standard operating procedure showing which parts should be primed, and put in an electric signal—a *poka-yoke*—to indicate which rack should be dunked into the primer bath.

The idea was to take the variability out in order to assess what was going on in the core process. Once we were able to do that, we could determine the problem was not related to PVC at all. So, we started moving back the line to look for potential causes of the problem.

We found it in welding. We started all over again, measuring and mapping in that department. We discovered there were no standard settings for welders, with every employee having a different idea of what a “good flame” was. Once we created a standard operating procedure and gave new training to the welders, the pinhole problem was solved.

Combining Six Sigma and lean techniques allowed us to discover where the problem wasn't, an important step toward ultimately finding where it was.

Often, we are preconditioned by notions of what has happened in the past. History becomes baggage we bring to solving immediate problems, causing us to blame the wrong culprit—in this case the PVC application process. The precise measuring demanded by Six Sigma gets us past preconceived notions to tracking the real problem, which



can turn out to be quite simple.

We all tend to believe problems are far more complicated than they actually are, simply because they have yet to be solved. The sense of urgency inherent in lean keeps us from dragging out a problem and adding complexity.

A Second Case Study

Sometimes the real problem can be solved best with lean techniques; other times Six Sigma is at the heart of the solution.

That was the case at Heatcraft, a Georgia factory that makes commercial refrigeration equipment. The factory had been using lean for a year to improve production. Still, too many of the units were coming off the line leaking, creating costly rework loops, warranty claims and customer dissatisfaction.

The plant tests units by submerging them in water and running air through the coils while the operator looks for bubbles. Where there are bubbles, a leak has been found. Sometimes, when a coil is retested after rework, new leaks appear from holes too small to be noticed until the bigger leaks are repaired. That means more rework.

The first step was to determine the major causes of leaks. Analysis revealed more than half the leak problems were in the return bend of the coils, the

hundreds of narrow copper tubes the refrigerant passes through to cool off the heat it has absorbed from the air inside a plant. To make the coils, lengths of tubing are cut and connected with a U-shaped return bend.

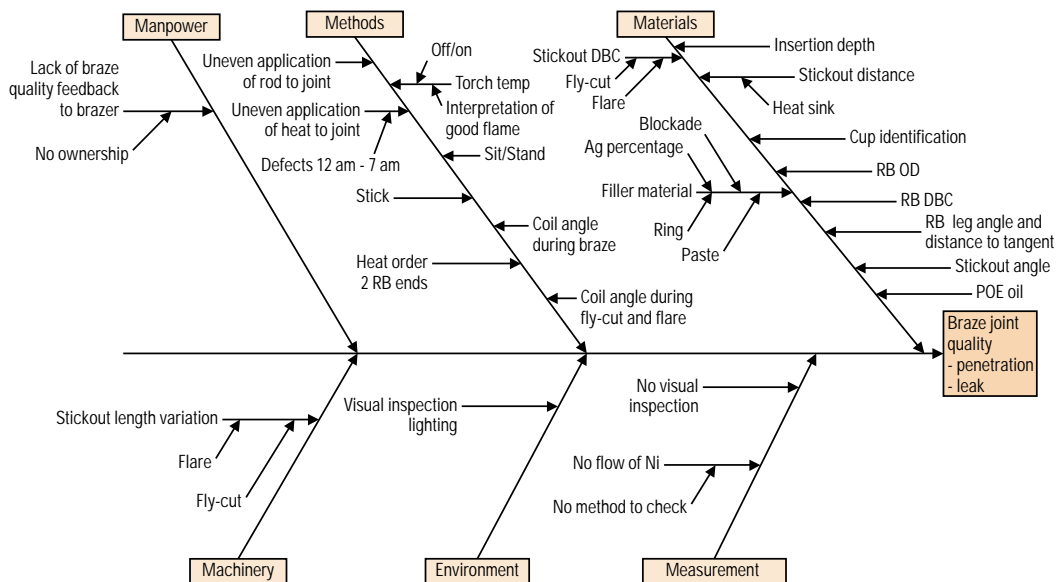
Where the return bend meets the tube, the connection is brazed (a precision cousin to soldering). A brazed joint has a pocket where one tube meets the other. A liquid at just above melting temperature is injected into the pocket, filling it to create a neat joint.

Based on a Pareto analysis, a LeanSigma team led by Doug Bonner, a TMB senior consultant and Six Sigma BB, found 50% of all leaks were springing from the return bend joint and set a goal of reducing the leaks from return bends by 75%.

“Once we knew what to work on, we began to map out the process,” said Bonner. The team started its first *kaizen* event by breaking down the transformation steps, noting each time the product changed state. For example, cutting a piece of tube was one transformation step, and installing it was another. In all, the team found at least 20 transformation steps and collected data at each to find possible sources of variation in the braze process.

The team found dozens of variations in the way the units were made, from how far the coils were from each other to how much the tubes stuck out

FIGURE 1 Sample Diagram of Probable Root Causes



before brazing connected them to the return bend. The torch temperatures were actually very consistent, unlike the situation at Landscape Structures, so that possible cause was ruled out.

Actionable items were marked: red stars for control issues and green stars for measurement issues. “There was a lack of control in the process,” said Bonner. “We needed stability.”

The map created in the first week became a core document that drove the team’s focus. One important clue found in the mapping was that the plant

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made two types of units with the same bend design. They showed drastically different leak rates. Maybe one line could learn from the other.

Team members also created a cause and effect diagram for the process, listing the “five M’s and E”: materials, methods, machinery, measurement, manpower and environment. Flaws in any step could be causing the problem. “All you need is one defect to cause a lot of grief,” Bonner said. Each step had to be carefully measured and, more importantly, its effect on the final product examined more closely.

The team drew plots for each M, similar to trees, with a trunk, main branches and smaller branches. For example, on the machine trunk, one branch was “torch tip bent wrong.” That branch split off into “hole in joint” and “improper mix” of fluids. “Incorrect brazing” branched off into a half-dozen effects. In other words, one problem led to another.

A fishbone diagram, derived from the preceding, is shown in Figure 1.

In an application of a lean procedure in the midst of this combination lean and Six Sigma exercise, the team also noted operators were not receiving any

feedback on joint quality from their co-workers at the test tank. They had no way to know whether their work was high quality or needed improvement.

The lean Six Sigma team corrected that oversight immediately by having each brazer stop to fix quality issues on parts he or she had brazed, resulting in better quality at the source.

The next challenge was to determine which of the variations contributed to leakage. That required analysis, particularly of differences between the two lines.

The team determined whether leaks were coming from the same place on the coil or the same location on the braze joint. Intuitively, the team suspected the problem was with tubes that did not stick out far enough. Team members followed the process through on the shop floor and found that when the tubes were longer with more overlap, there was, in fact, better coverage.

The team learned the joints with greater distance from the end plate were consistently better and those with less overlap between the coil tube and the return bend had a higher percentage of braze material coverage.

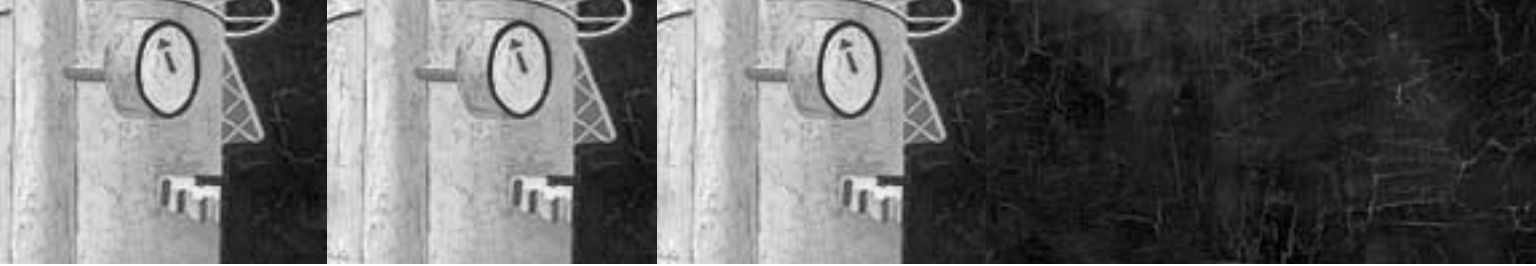
The efforts from that first Six Sigma *kaizen* week yielded a 75% reduction in quality issues and a 40% overall reduction in leak rates.

The team accomplished this by focusing on just one defect. But there were ancillary benefits, too. The team’s efforts and observations also corrected problems with the header—a sort of manifold that stands about 4 inches off the unit. After watching and mapping the process, the team discovered the piece was not being seated properly in the joint. Moving it out 1/4 inch and instituting a standard specification solved the problem. The improvements led to a significant reduction in defects and better flow and throughput.

The results justified the hard work of the *kaizen* team: hours observing and measuring, one day mapping and several days collecting data on each process. Improvements were achieved by combining the best of lean and Six Sigma and making them work together.

The Role of Leadership

In looking at lean and Six Sigma, too many manufacturing companies believe they have to choose



one approach to the exclusion of the other. Those that try both often find they compete for resources or, worse, foster a culture clash.

That clash might seem unavoidable. After all, lean programs center on teamwork and breakthrough events. Six Sigma tends to develop an aristocracy of quality engineers who spend months collecting data and punching it into computers, far from the daily work of the shop floor.

When run separately, such programs will naturally collide with each other. In contrast, a combination of lean and Six Sigma has a positive impact on employee morale, inspiring change in the workplace culture because teams see the results of their efforts put to work almost immediately.

For that positive change to take place, however, management must believe in it. First, executives must develop the vision and deployment strategy to make this powerful initiative work. In TBM's five-day LeanSigma Champion training program, executives assess their current practices and define the business objectives of the combination lean and Six Sigma initiative. Champion training requires time and commitment, but if top level management does not spend time on this cultural change, no one else will, either. "Do as I say and not as I do" will not work.

During Champion training, executives also handpick the first group of BBs, assuring the first projects will have enthusiastic, educated leaders who will get support from both above and below.

In the combination lean and Six Sigma world, BBs are change agents. They receive four weeks of training that culminate in a project demonstrating a substantial financial benefit to the company. BBs lead teams, urge action and ensure all improvements become cemented in the standard operating procedures.

Green Belts (GBs) can be engineers, supervisors, quality control experts or operators. They train half as long and then participate in projects without leaving other responsibilities. In the combination, GBs rely on BBs for mentoring.

Just as important to real, long-term change are the softer issues infused in lean combined with Six Sigma. Improvement must be implemented without placing blame on individuals for the way things used to be done. People cannot understand what they are supposed to be doing unless

processes are in place. Besides, from a practical standpoint, you usually uncover so many separate issues that management, working in a culture of blame, would have to fire the whole company.

Instead, the idea is to implement a culture of continuous improvement. Using the Six Sigma *kaizen* team based approach, results are implemented faster with the participation of teams of employees from the shop floor to the executive suite. Most people prefer to work in that sort of environment.

Link to Employee Satisfaction

Vermeer, a farm and construction equipment manufacturing company in Iowa, found employee satisfaction directly related to participation in *kaizen* events. The company's COO participates in several events a year, showing her commitment.

A survey conducted by an outside agency found employees who had participated in more than six events are 20% more favorable toward the company than those who had not participated.¹ Those who had not participated in any *kaizen* events felt more negative about the company. There is a direct correlation.

Workers feel proud of making better products at the same time they improve their working conditions. Change can be exhilarating—and profitable. A fusion of two proven practices, lean and Six Sigma, can facilitate that outcome.

REFERENCE

1. International Survey Research, Chicago, 2000.

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