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Energy Management and Six Sigma

Manufacturers have seen huge changes in the last 20 to 30 years. There are few aspects of business that have not been affected by information and technology, and the dynamics of product development, deployment, and customer relations have been forever changed. Thirty years ago consumers did not have the option to choose from hundreds of manufacturers and suppliers via the Internet; they had a very limited availability, and so often had to deal with sub-par products because they had no alternative. Today, however, there is no excuse for a shoddy product, and in most cases an unsatisfied consumer can easily find a comparable replacement. These factors have been the driving force behind the renewed emphasis on product and process quality over quantity.

World business leaders such as Motorola, General Electric, Owens Corning, DuPont, Raytheon, and Ford have all adopted doctrines in recent years that seek to improve the bottom line by improving their manufacturing processes and the quality of their products. One of the most widely successful quality control techniques is known as Six Sigma. As defined by Six Sigma Qualtec, an organization that specializes in Six Sigma products, services, and training, "the Six Sigma approach identifies and eliminates defects with a structured, data-driven, problem solving method of using rigorous data-gathering and statistical analysis." In addition to using Six Sigma to improve manufacturing processes and product quality, many companies are applying its method to energy management. There are some benefits and a few common-sense points to keep in mind in this application.

According to Six Sigma Qualtec, most organizations operate at 3 to 4 sigma, or approximately 6,200 to 67,000 defects per million. To achieve Six Sigma, a process (such as transactions, or fabricated parts) must not exceed 3.4 defects per million. A defect can be defined as any source of customer pain—that is, anything outside of customer specification or expectation.

At its most basic, Six Sigma diverges from some traditional performance improvements because of its focus on input variables. While some improvement strategies emphasize the measurement of outputs and establishing control plans to shield customers from defects, the Six Sigma methodology demands that problems be addressed at their source. This eliminates the need for unnecessary inspection or rework. In essence, Six Sigma can help a company, system designer, or even facility manager move from fire-fighting mode into fire-prevention mode.

Six Sigma Methodology

There are two different types of Six Sigma methodologies that are implemented: one for developing new products or process lines and the other for maintaining existing processes. This article is more focused on maintaining and improving existing processes than developing new ones, and as such will only consider the latter methodology. Although Six Sigma can significantly alter facility operations, it is not meant to replace existing tools, but rather, DMAIC—which stands for Define, Measure, Analyze, Improve, and Control—is designed to augment existing maintenance processes.

To implement Six Sigma the team goes sequentially through the DMAIC methodology and works through each phase completely before moving to the next. Robson Quinello, maintenance manager and black belt at Ford Motor Co. summarized the DMAIC process in a recent article for the November 2003 edition of *Maintenance Technology* magazine:

Define. The first phase is the starting point of Six Sigma and involves identifying problems, assembling a team, setting goals, and organizing the various aspects of the project into a clear and coherent plan. Processes are sometimes difficult to identify, but by using a simple formula, Y=f(X), where the output, Y, is the result of the input, X, undergoing the process, f.

Measure. Once processes have been identified for improvement, relevant characteristics of each must be measured and benchmarked in order to gauge improvement. Some of the common indexes that are measured are downtime, maintenance costs, frequency of preventative maintenance, and number of corrective occurrences.

Analyze. Once the data has been measured, the team uses a variety of graphical tools to determine the root cause of problems or inefficiencies and where improvements can be made.

Improve. The team makes recommendations on how to improve the processes to achieve Six Sigma.

Control. The gains of a Six Sigma project will never be fully realized if the project is not maintained and sustained once the improvements have been made. The control phase usually involves the team working with other departments, troubleshooting problems as they arise, and providing support throughout the organization.

Six Sigma in Energy Management: Challenges and Opportunities

Because energy expenditures are often significant for large corporations, there are many opportunities for saving money by improving energy use. For companies that have already been converted to Six Sigma, applying the methodology to tackling energy projects may seem like a natural extension. For other companies, there may be something to learn from the Six Sigma methodology without formally adopting it in its complete detailed format.

Although the backbone of any Six Sigma initiative involves data collection, those new to the methodology should avoid jumping into detailed data collection before using good common engineering sense to identify potential energy improvement projects. As Terry Foecke, managing partner of Materials Productivity LLC, a small manufacturing improvement consulting firm in Minneapolis, stated, “The barrier with Six Sigma is that it creates a priesthood of black belts who worship data over all else, and it is not good at targeting.” Terry explained that once you do develop a good target, then the Six Sigma statistical tools can be helpful.

Most facilities track energy usage on a macro level, but few have accurate data collection systems on the micro level, which is where process improvements are identified. Bob Sample, who is in charge of Six Sigma global deployment for Owens Corning, states that although the team has good data on total facility energy usage, it has been difficult to pinpoint specific energy usage within individual facilities. Despite this shortcoming, energy-efficiency projects are growing in momentum with the current gas and electricity price escalations, and Sample says that there are likely to be increased efforts to integrate highly detailed energy-measurement devices at Owens Corning facilities in the future.

Thomas Pezzino, Six Sigma master black belt at DuPont, agrees that gathering energy usage data and developing collection systems for capturing utility consumption is key in order to uncover energy-efficiency opportunities. He also states, however, that another potential stumbling point for Six Sigma is making the bridge between the improvements and the control plan. Pezzino, who recently led a stream-trap performance efficiency project with annual savings of nearly half a million dollars, stated that an essential component to the project’s success was ensuring that the process owners assumed responsibility for properly managing and monitoring the improvements once they had been implemented, thereby completing the Six Sigma methodology. DuPont completed a number of other Six Sigma projects to reduce energy consumption, such as preventative maintenance for distribution systems and optimizing steam generation.

Case Study

The W.R. Grace Curtis Bay Works facility in Baltimore, Maryland, has thousands of production lines spread over 90 acres in 10 separate facilities, and it employs more than 700 workers. Its management used Six Sigma to identify four projects that saved 96,000 million Btu of fuel and 4.8 million kilowatt-hours of electricity, resulting in $840,000 of annual savings. A fifth project was also identified that, if implemented, could use landfill gas to run a cogeneration plant and save an additional $1 million annually in avoided energy costs.

The Six Sigma team originally identified 23 processes for potential energy savings, and then narrowed the list down to four desirable projects: a wastewater heat recovery system, a waste gas heat recovery system, a flue gas heat recovery system, and a compressed air distribution system upgrade. The team successfully followed the DMAIC methodology by defining end users of energy; measuring both the energy consumption and losses of each process; analyzing the process map with a cause-effect matrix that rated projects on customer importance, among other things; implemented the recommended improvements; and established control mechanisms to track and measure the monthly energy savings and resource consumption.

Six Sigma Deployment

The level of an organization's involvement with a Six Sigma program can vary considerably depending on its size, business vision, product lines, and financial situation. A large corporation may have entire departments of Six Sigma professionals dedicated to identifying and implementing projects throughout the corporate hierarchy, and a small business may try to implement some of the concepts by asking employees to learn and apply the basics of Six Sigma in addition to their current tasks. Regardless of the strategy that a company chooses, it is imperative that there is a direct initiative from upper management that flows down and is embraced by the entire organization. There are five levels of Six Sigma deployment listed in order of importance below:

Champion. Regardless of the project size or scope, it is crucial to have a project champion who coordinates project selection and implementation, maintains control over the entire process, and is responsible for the unimpeded progress of the project.

Master black belt. Unlike a champion, not every organization needs a master black belt. The master is responsible for teaching and leading black and green belts within the organization as well as overseeing large projects that have many team members and may alter the company's business structure.

Black belt. Aside from the champion, the black belt is the most critical component of a Six Sigma team, serving as the team leader and trainer as well as the liaison to the rest of the organization. In most companies, this is a full-time dedicated position that has ultimate responsibility over a number of Six Sigma projects.

Green belt. This is a part-time position, the responsibilities of which include performing small interdepartmental projects utilizing Six Sigma strategies.

Yellow belt. These are a supporting members of a larger team; they will incorporate the Six Sigma methodology and tools into their everyday positions.

Keys to Six Sigma Success

According Six Sigma Qualtec, there are three key characteristics of a Six Sigma program:

1. *Leadership commitment.* A significant allocation of resources is required to successfully implement a Six Sigma strategy. In order to achieve desired results, management must be willing to apportion the necessary funds and man-hours and to commit to implementing the recommended changes. Essentially, the executives need to be on board all the way or the project will eventually disintegrate.

2. *Managing decisions with data.* A poker player might get lucky by making a gut decision, but for sustained success, he needs to let the percentages dictate his playing style. It is commonplace for top executives to make decisions based on past experience or gut feelings as opposed to analytical decisions based on the facts. This practice must be eliminated; leaders must base their decisions on data and analysis tools for a Six Sigma methodology to work.

3. *Training and cultural change.* As important as it is for leadership to commit to Six Sigma, it is worthless if the other employees in the organization do not embrace the methodology and the change it brings. For a business to succeed at Six Sigma, management needs to stress the importance of a unified effort, and then enforce the changes it needs to make.

For more information about Six Sigma methodology, deployment, or training, please visit www.isixsigma.com, www.sixsigmaqualtec.com, or www.6-sigma.com.

In Brief:

Process Heating Assessment and Survey Tool

Manufacturers in the U.S. and Canada use more energy for process heating than for any other end use. In addition, low thermal efficiencies are common in many types of process heating equipment, making process heating a prime candidate for energy-saving improvements. The U.S. Department of Energy's (DOE) Office of Industrial Technologies (OIT) has developed a tool called the Process Heating Assessment and Survey Tool (PHAST) that can help facility energy managers identify energy-efficiency opportunities in this area. PHAST can perform three primary tasks: survey all process heating equipment and create a detailed energy use report; analyze the energy balance of a specific piece of equipment and make recommendations for improvements; and calculate the benefits of specific energy-efficiency upgrades.

PHAST has been tested in large industrial applications with great success. For 13 large facilities in the aluminum, steel, mining, and petroleum industries, PHAST was able to identify process heating improvements resulting in average energy savings of over $1 million per year per facility. This program is available for free from the OIT, and specialized training and certification courses are also available.

The PHAST software can be downloaded from:
www.oit.doe.gov/bestpractices/software_tools.shtml#phast.

EPA Expands Energy Star to Include New Commercial Buildings

The U.S. Environmental Protection Agency (EPA) recently announced that it has expanded its Energy Star program to include new commercial buildings. The new 'Designed to Earn Energy Star' designation will allow architecture firms—which have strong influence over the environmental footprint of new buildings—to identify the newly constructed commercial buildings that are most efficient. Only those new building designs that are expected to qualify for the Energy Star label once it is in operation are eligible for the new designation.

Research conducted by the EPA reveals that newly constructed buildings are not substantially more efficient than buildings constructed in years past. The EPA states that it hopes to call attention to building design practices that are expected "to deliver high quality and energy-efficient commercial building space."

According to the EPA, the more than 14,000 existing buildings that have received the Energy Star label use an average of 40 percent less energy than those without the label. For an existing building to qualify for the label signifying 'superior energy performance,' it must score at least a 75 on the EPA's 100-point national energy rating scale and be in operation for a minimum of 1 year.

For more information, please visit www.energystar.gov/index.cfm?c=new_bldg_design.new_bldg_design_benefits.

The DOE Announces Plantwide Assessment Financial Opportunity

The DOE's Office of Energy Efficiency and Renewable Energy (EERE) Industrial Technologies Program (ITP) recently announced that it is looking to enter into public-private partnerships to facilitate plantwide assessments (PWA) for energy-intensive U.S. industrial plants. The focus of the solicitation process is to recognize, access, **//SWT: assess?//** and evaluate cost-effective energy-reduction strategies for industrial plants by compiling a suite of energy assessment methodologies.

Each company awarded a PWA can receive up to $100,000, and the project period for each award is generally in the 1 year range (all awardees must provide at least 50 percent of the assessment's costs). While the project is limited to fiscal year 2005 funding availability, the DOE hopes to secure $1 million for solicitation funding.

According to the DOE, "Priority will be given to sites in the following energy-intensive industries: agriculture, aluminum, cement, chemicals, food processing, forest products, glass, metal casting, mining, petroleum refining, and steel." However, the DOE states that it will also consider proposals from other energy-intensive industries as well.

To learn more about PWAs, please visit www.oit.doe.gov/bestpractices/plant_wide_assessments.shtml.

To learn about companies that have been awarded PWA cost-share funds, please visit www.oit.doe.gov/bestpractices/pwa_awardees.shtml.
