Using Six Sigma to Drive Energy Efficiency Improvements at DuPont

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ABSTRACT

Since 1999, DuPont has been applying the *Six Sigma* problem-solving methodology to a broad array of business, technical, transactional, and process problems across the corporation. One benefit of this culture change has been the way that business units approach energy efficiency. The structured Six Sigma approach, with its strong focus on statistics and data and a proven method for controlling improvements long after they are made, is ideally suited to help drive energy efficiency excellence.

Using Six Sigma tools to analyze energy *conversion* processes such as steam boiler, turbine generator, central refrigeration, compressed air, and HVAC systems, DuPont has been able to capture and sustain remarkable energy savings. Six Sigma has also been applied to energy *utilization* processes such as manufacturing process heating and refining. Individual Six Sigma energy project savings of over $250,000 per year are not uncommon. To further boost the savings from energy-related Six Sigma projects, DuPont's Energy Technology Network has aided the global sharing of successes by sponsoring routine "virtual workshops" over the DuPont wide area network.

This paper will briefly discuss the Six Sigma methodology and present case studies of several energy efficiency projects that used Six Sigma to succeed. The virtual workshop concept for leveraging successes and key learnings will also be presented.

Introduction

DuPont's Commitment to Six Sigma

In 1999, DuPont adopted *Six Sigma* as the primary problem-solving methodology across the corporation. Six Sigma is a disciplined, fact-based methodology that drives teams to apply statistical problem-solving tools to deliver practical solutions to problems. The ultimate goal of Six Sigma is to improve a process so that it performs at a level that is as close to "perfection" as that process can statistically achieve. DuPont was not alone in its decision to adopt Six Sigma. Many companies, including General Electric, Honeywell, Ford and Sony, are also using Six Sigma to transform the way they enhance productivity and grow revenues.

Since beginning this journey, DuPont has trained over 12,500 employees on the Six Sigma tools. By the end of 2003, one of every four employees will be participating in Six Sigma projects. Total validated financial benefits exceeded $2 billion as of mid-2002, with more than 10,000 projects completed or in-progress. Six Sigma has not only enabled DuPont's businesses to deliver significant bottom-line impact, it has also fostered a new culture that better defines how employees do their work.

Six Sigma and Energy

One benefit of this culture change has been the way that business units approach energy efficiency. Six Sigma provides discipline and tools to help identify, implement and sustain improvements. This structured problem-solving approach, with its strong focus on statistics and data and a proven method for controlling improvements long after they are made, is ideally suited to help drive energy efficiency excellence.

DuPont's adoption of Six Sigma happened to occur within a few months of the announcement of its 2010 Energy Efficiency Goal. In September 1999, the corporation established a goal to hold total global energy use flat from 1990 to 2010. Six Sigma has been critical to identifying and realizing energy efficiency improvements in pursuit of the goal, and will also play a vital role ensuring that these gains are maintained well into the future.

Using Six Sigma tools to analyze energy conversion processes such as steam boiler, turbine generator, central refrigeration, compressed air, and HVAC systems, DuPont has been able to capture and sustain remarkable energy savings. Six Sigma has also been applied to energy utilization processes such as manufacturing process heating and refining. The average Six Sigma energy efficiency project saves over $250,000 per year.

Spreading the News: Sharing Success Stories

One challenge faced by a large, diverse company like DuPont is the effective leveraging of energy efficiency successes. How can a power engineer in Singapore, for example, become aware of improvements made on a similar system at a plant in the US? How can engineers in separate business units be enlightened to energy reduction opportunities on similar process systems?

DuPont's Energy Technology Network (ETN) recognized the need for sharing across the energy community and began a series of "virtual workshops" to showcase energy-related Six Sigma projects. These workshops are conducted over DuPont's wide area network using Microsoft's NetMeeting™ conferencing software. Participants at facilities worldwide connect to the workshops from their desks and view the presentations over the net while listening to the presenters over the phone. A typical workshop highlights four or five recent projects and will last two hours. Presentations are structured to highlight how Six Sigma enabled difficult improvements to be identified, implemented, and sustained.

To further enable broad leveraging of energy efficiency successes, the ETN has assembled a database of over 75 energy-related Six Sigma projects that can be searched by employees globally and has begun to build "templates" of those projects that can be readily applied at multiple sites with minimal effort.

An Overview of Six Sigma

A fundamental overview of the Six Sigma methodology is necessary to fully illustrate DuPont's approach to energy efficiency projects. The following discussion provides a basic primer on Six Sigma as it is used at DuPont.

Six Sigma Philosophy

Six Sigma is a structured, data-driven methodology that aims to eliminate "defects" (e.g. waste, bad quality, poor control) in any type of manufacturing, transactional, or management process. It is based on a marriage of well-established statistical quality control techniques, data analysis methods, and systematic training of personnel at all levels of the organization involved in the activity or process targeted by Six Sigma.[1]

The Six Sigma philosophy stresses two tenets for achieving world-class performance: *Focus* on the customers' needs, then *Eliminate* defects. Without an understanding of the customer perspective, any attempts to improve a process run the risk of being simply "shotgun approaches" to a perceived problem. If a defect is not important to the customer, then it might not be worth expending resources to find a remedy. Identifying the "voice of the customer" to determine what the customer considers "critical to quality" is the most important first step that any project team can make in seeking to improve a process.

Once the customer's needs are defined, the Six Sigma methodology offers an array of problem solving and statistical tools that can be brought to bear on a process. These tools are designed to enable the project team to learn about and improve the process in a way that reduces the process's variability and shifts its mean performance to levels deemed critical to the customer.

DuPont Six Sigma Core Values

At DuPont, the Six Sigma philosophy has been captured in a list of core values that is reviewed by all Six Sigma trainees:

- "Customer focus"
- "Delight the customer" by eliminating defects
- "Variability is the enemy"
- "Act on fact and data"
- "Measurement is the key to beginning"
- "Maintain the gains"

These core values emphasize the underlying principles of customer focus and defect elimination. They also speak to another characteristic of the Six Sigma process: data, data, data! In all phases of a Six Sigma project, the team uses real data on the process being targeted to draw conclusions, make decisions, formulate corrective actions, and assemble control plans to ensure improvements are sustained long-term. In fact, this data-intensive attribute is the root of the name, "Six Sigma."

"What Is a Sigma, and Why Do I Need Six of Them?"

"Sigma," σ, is the Greek letter used to represent the statistical measure of variation called "standard deviation." Standard deviation is the distribution or spread around the mean or average of a process. If the standard deviation in a process can be reduced, then more of its product can be produced within specification limits and less of that process's product will

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[1] *All Six Sigma: Your Six Sigma Resource*, February 17, 2003. <http://www.all-six-sigma.com>.

be defective. By definition, Six Sigma is a quantitative statistical measurement meaning fewer than four defects per million opportunities. Performing at the Six Sigma level means that products and processes satisfy the customer 99.99966% of the time!

The metric used in Six Sigma, called the "Sigma Score," is used to count the number of standard deviations between a process's average performance and its upper and lower specification limits. If a process's Sigma score is 6, for example, there are six standard deviations between the target performance and the specification limits of the process. This translates to defects per million opportunities (i.e. parts produced, items shipped, etc.) as follows:

Sigma Score	Defects per Million (short term data)	Defects per Million (long term data)
6	0	3.4
5	0.3	233
4	32	6,210
3	1,350	66,807
2	22,750	308,537
1	158,655	691,462

Note that there is a difference in Sigma Score depending on the type of data that is available. This is due to the "shift" that occurs over time in all processes. Collection of data over a couple of days will show less variability, and reveal less defects, than data gathered on the same process over a much longer period of time.

To put the Sigma Score concept in more practical terms, consider these examples of everyday processes:

3.8 Sigma (99% Good Quality)	6 Sigma (99.99966% Good Quality)
20,000 lost articles of mail per hour	7 lost articles per hour
Unsafe drinking water for almost 15 minutes each day	1 unsafe minute every 7 months
5,000 incorrect surgical operations each week	1.7 incorrect procedures per week
2 short or long landings at most major airports each day	1 short or long landing every 5 years
200,000 wrong drug prescriptions each year	68 wrong prescriptions per year

Not all processes will achieve a Sigma Score of "6." At some point in every Six Sigma project the cost to further reduce variability exceeds the next increment of improvement. Yet another strength of the methodology is that it offers tools to assist teams in deciding when this point is reached.

The Six Sigma Toolbox

DuPont employs the *DMAIC* improvement process as the "way" it solves problems on existing processes. DMAIC is an acronym for the five major phases of this Six Sigma methodology: Define, Measure, Analyze, Improve, and Control. Each phase has a well-defined set of steps and tools that the project team uses to organize the problem and the problem-solving strategy.

In the *Define* phase, the team focuses on identifying the product and/or process to be improved and ensures that resources are in place for the improvement project to begin and ultimately succeed. The key deliverables from this phase are an understanding of the customer's "critical to quality" (CTQ) requirements, a team charter that describes the purpose and goals of the Six Sigma project, and a high-level process map that graphically displays the major events or steps in the process being studied.

Armed with this detailed definition of the problem and process, the team enters the *Measure* phase. During this phase, the team defines the defects in the process, gathers baseline data about the product and process, and establishes the improvement goals. The team will decide on a "Project Y," which is a clearly defined output measure of how well the process is satisfying the project CTQ. They will also define performance standards for the Project Y as well as formulate a data collection plan and validated measurement system for obtaining the data that will be used in the project.

Next, the *Analyze* phase of the project examines the data collected in the Measure phase and generates a prioritized list of the sources of variation in the process. The team asks the question: "Which input variables, or 'X's,' influence the variation in the Project Y?" This phase then whittles the list of X's down to the "Vital Few X's" that account for most of the variation to the Project Y. It is during this phase that the myriad of statistical tools available in Six Sigma is called upon.

In the *Improve* phase the team develops a solution, based on the data analysis, to improve the product or process performance. They then confirm that the proposed solution will meet or exceed the quality improvement goals of the project. Often a piloted solution is used to test the proposed solution on a small scale.

The *Control* phase is the step in the DMAIC methodology that really sets Six Sigma apart from other statistical improvement processes. In this phase the solution is implemented and controls are put in place to ensure that the solution is sustained. The entire Six Sigma improvement project is documented so that others can see exactly what was done to get from the problem statement developed in the Define phase to the control plan. An audit plan is created and the lessons learned during the project are captured and shared.

The DMAIC methodology provides a structured and rigorous problem-solving process. Project teams trained in the Six Sigma DMAIC steps can attack complex problems in an organized fashion so that improvement solutions can be discovered and implemented quickly and effectively. The various steps and tools keep the team focused by helping them weed through all of the potential variables and concentrate only on those that have a significant contribution to the process or product variability.

A Simple Example

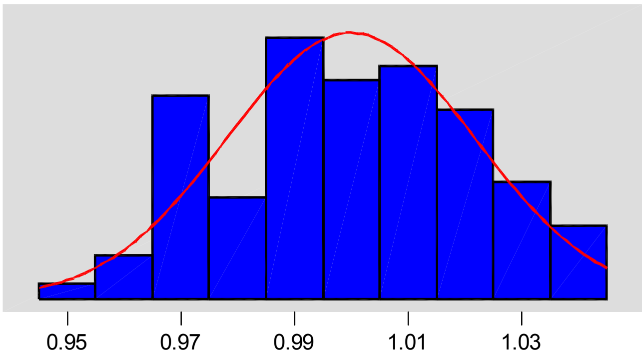
As a final illustration of the power of Six Sigma, consider this example of a packaging process that is designed to fill bags with one pound of product. The customer is happy if the weight is between 0.97 and 1.03 pounds. The target is therefore 1.00 pound, the upper specification limit is 1.03 pound, and the lower specification limit is 0.97 pound.

The process operates for 100 batches and the following data is collected:

- Average bag weight = 1.00 pound
- Standard deviation = 0.02 pound
- 95% confidence interval on the average = 0.996 to 1.003 pound

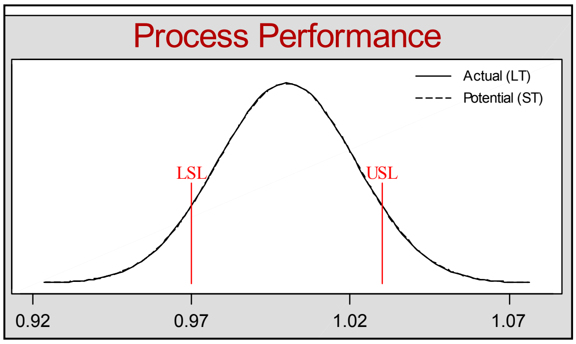
This looks like a pretty good process! The operator can be 95% sure that he is filling the bags with somewhere between 0.996 and 1.003 pounds of products, which is well within the customer's demand of 0.97 to 1.03 pounds. Also, his process is right on target with an average bag weight of 1.00 pound. Life is good…or so he thinks!

The operator's boss attends Six Sigma training and comes back to audit the packaging process (Define). The first thing he does is plot the data from the 100 batches (Measure), as shown in this histogram:

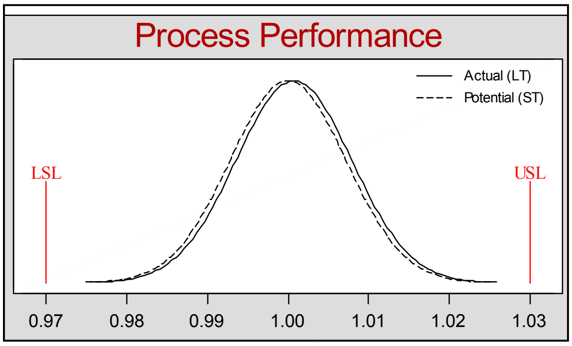


The histogram shows that there are batches as light as 0.95 pounds and has heavy as 1.05 pounds. It looks like there are several batches at 0.97 pounds, and several more at or above the 1.03 pound limit.

The boss applies some of the statistical analysis tools that he learned in training and determines that this is only a 0.96 Sigma process, with 168,000 defects per million opportunities! This means that the customer will be "unhappy" almost 17% of the time! Although the mean is right on target, the variation in the process is killing it! Plotting the process distribution against the upper and lower specification limits looks like this:



The boss assembles his team and together they apply several other Six Sigma tools to improve the packaging process. They discover several steps in the dispensing process that contribute significantly to the variation in final product weight (Analyze). They run some experiments and arrive at a solution that their data says should improve the process (Improve). Several weeks later, they collect data on 100 batches and discover that the standard deviation has been reduced from 0.02 to 0.008 pounds! They run the data through the Six Sigma process capability calculations and plot the following results:



The process is now a 3.98 Sigma process with only 34 defects per million opportunities! This dramatic improvement results in greater customer satisfaction and less product waste. Finally, before moving on to the next process improvement project, the team creates a control plan using a few other Six Sigma tools. The control plan will help them sustain these favorable process improvements well into the future (Control).

Key Six Sigma Philosophy Summarized

Six Sigma forces a business to focus on the customer's needs first and foremost. It strives to eliminate defects by examining all aspects of a process and narrowing the list of potential contributors to variability down to those that have the most impact. Finally, Six Sigma provides a way to pilot solutions and control them so that gains are sustained.

Recognizing that variation is the true enemy of most processes, General Electric, one of the leaders in the Six Sigma revolution, sums up the value of Six Sigma as follows:

> Customers don't judge us on averages, they feel the *variance* in each transaction, each product we ship. Six Sigma focuses first on reducing process variation and then on improving the process capability.

Customers value consistent, predictable business processes that deliver world-class levels of quality. This is what Six Sigma strives to produce.[2]

Applying Six Sigma to Energy Projects

During 1999 and 2000, as more and more DuPont employees became trained in Six Sigma, the methodology began to take hold across all of the corporation's functions. People quickly learned that this was not simply a "program of the month" but rather represented a fundamental shift in the corporate culture. It also became evident that Six Sigma could be used on more than just traditional manufacturing processes. Here was a methodology and collection of tools that could be used to eliminate waste and variability from any value chain, often without spending capital funds. It did not take long before Six Sigma was being applied to the company's energy procurement, conversion and utilization processes.

Energy-related Six Sigma projects have covered all aspects of the energy value chain, as illustrated by this list of successful project titles:

- Increase Condensate Return to Powerhouse by 40%
- Boiler and Chiller Optimization
- Increase Steam Capacity
- Lower the Dewpoint of Plant Air
- Boiler Efficiency Improvement
- Reduce Purchased Electricity Price
- Ethylene Heater Burner Maintenance and Firing Efficiency
- Improved Boiler Sootblowing
- Reduce Cooling Water Header Pressure
- Improve 110 psig Compressed Air System
- Reduce Makeup Water to Lower Chemical Treatment Cost
- Reduce Electricity Demand Charges

The projects listed above have a combined savings run rate of $4.9 million per year and an average savings of $440,000 per year. Even more remarkable is the total capital investment to secure these savings: $0! While many energy-related Six Sigma projects save much less than this list of all-stars, it is not uncommon for a project to realize $250,000 in validated savings.

Six Sigma provides a common language and problem solution platform that puts all aspects of the business on an equal playing field. Energy management opportunities can be discussed and evaluated in the same light as manufacturing improvement or revenue growth efforts. While some might correctly argue that the projects listed above should have been possible without Six Sigma, historical experience and management behavior suggests that energy savings, once realized, would not have been successfully sustained without Six Sigma's follow-through and auditing discipline.

[2] *What is Six Sigma? The Roadmap to Customer Impact*, February 17, 2003, <http://www.ge.com/sixsigma/>.

Case Studies: Typical Energy Projects

Four case studies are presented here to further illustrate the types of energy Six Sigma projects that DuPont has successfully executed. Each case study lists the project statement, objective, and metric as given on the project's charter. Where available, the initial and final Sigma scores are shown to illustrate the degree of improvement achieved by the project team. The validated financial benefits and project team members are also listed. Finally, a brief summary of the project team's work follows each project's table.

Project 1. Improved Boiler Sootblowing

Problem Statement:	The boiler operating procedure calls for sootblowing once per day to remove deposits formed on the boiler heat transfer surfaces as a result of burning #6 fuel oil. The operator log indicated that soot was only being blown 39% of the time. Sootblowing frequency is set arbitrarily by procedure, with no attention to pre- and post-blow boiler efficiency or the cost of operating the sootblowers. Boiler stack temperature was averaging 81 F above standard, eroding boiler efficiency 2% and costing $40,000/year in additional fuel costs.
Objective:	Improve boiler efficiency 1.2% by reducing average stack temperature 50 F.
Metric:	Average stack temperature, correlated to steam flow, as measured on Powerhouse distributed control system.
Initial / Final Sigma Score:	-0.86 / 0.58 (1.44 Sigma improvement)
Benefit:	$26,000 / year fuel savings
Team Members:	Horace Bunnells, Lewis Goodwin, Alb Inman, John Kane, Art Tolentino

Project summary: Average stack temperature (correlated to boiler steam load) was reduced 45 F by enforcing existing sootblowing procedures and modifying the way operators actuate the sootblower elements. The cost to operate the sootblowers was compared to the average resulting efficiency gain to demonstrate that blowing soot is economically justified anytime stack temperature can be lowered by more than 10 F. Six Sigma helped the project team narrow a list of a dozen suspected variables down to the two variables that contribute most to sootblower effectiveness: frequency of sootblowing and duration of steam blow.

Project 2. Improve 110 psig Compressed Air System

Problem Statement:	The site's compressed air demand varies widely depending on the type of product being run. Over time, as system demand grew unchecked and unquestioned, it became common to run all six compressors regardless of the product type. Production was often curtailed so that the compressors could maintain plant air header pressure. Without a spare compressor available, the plant was eventually forced to rent compressor capacity as needed while restricting production until a rental could be delivered and installed.
Objective:	Reduce plant compressed air demand by 10%.
Metric:	Total compressed air produced as measured at each of the plant's six air compressors.
Initial / Final Sigma Score:	1.54 / 1.98 (0.44 Sigma improvement)
Benefit:	$140,000 / year increase in recurring revenue
Team Members:	Winston Fan, George Griffith, A.M. Kelly, Jennifer Slivka, Elton Stevison, Scott Marshall

Project summary: The project team initiated an aggressive survey program to check the plant's instrument and tool airlines. Power operators were encouraged to not only find leaks, but to identify wasteful uses of instrument or tool air as well. Leaks were tagged as they were identified, and work orders were subsequently written to repair the leaks. The power operators followed up with the area to ensure that the work orders were completed. They also worked with the areas to correct wasteful practices. The survey program resulted in a reduction in the average plant air demand of 654 scfm, about 7% of the original demand. The control plan for the project established an ongoing survey program that has the operators auditing a portion of the air system every quarter. Survey activities are set up in the plant's preventive maintenance (PM) system and a history of all compressed air work orders is maintained.

Project 3. Improved Micronizer Steam Condensate Heat Recovery

Problem Statement:	190 million pounds of steam per year at a variable cost of $663,000 are required to heat filtration area wash water. Hot steam condensate from the micronizing process is recycled to a head tank and reduces the required steam for heating. The condensate that is not recycled overflows the seal tanks as waste. Waste heat is rejected at a rate of 184 million Btu/hour.
Objective:	Reduce the steam required to heat the wash water through increased condensate recovery by 116 million pounds per year resulting in $405,000 savings.
Metric:	Steam flow to wash water system.
Initial / Final Sigma Score:	-3.2 / 0.25 (3.5 Sigma improvement)
Benefit:	$577,000 / year energy savings
Team Members:	Bob Creasy, Alan Eaton, James May, Scott Owen, Dwayne Ross

Project summary: The project began with a thorough examination of all of the system components in an effort to completely recover all of the condensate. After all known mechanical and control problems were remedied, the steam requirement for the process was reduced by 30.5 million pounds per year, which represented 25% of the project's goal. The team next looked at the heat losses in the process and discovered that enough energy to meet the wash water heating load was being rejected in the recovery process heat exchangers. A new pump and piping system was installed to maximize recovery of the waste flow to the head tank, and the cold water makeup to the system was relocated to the front of the process to further enhance heat transfer between the two systems. Total steam savings of 152 million pounds per year (31% more than the original goal) were realized.

Project 4. Reduce Cooling Tower Water Header Pressure

Problem Statement:	Average monthly Cooling Tower Water (CTW) header pressure was 10% higher than required, increasing pump electricity consumption.
Objective:	Reduce CTW header pressure from 68 psig (average) to 62 psig (average).
Metric:	Average monthly CTW header pressure
Initial / Final Sigma Score:	Not available
Benefit:	$133,000 / year electrical energy savings
Team Members:	Bill Bailey, Larry Peebles

Project summary: Plots of cooling tower water system pressure over time showed that the system rarely operated near the minimum required pressure of 62 psig. The team discovered that operators did not normally shut down unneeded pumps at night when the demand for cooling water decreased, meaning that on average there was always at least one more pump operating than the system needed to satisfy the users. The team also challenged the 62 psig requirement and, through controlled system testing, determined that the actual minimum pressure required by the users was 6 psi lower, or 56 psig. Low pressure alarms to remind operators to start and stop pumps at the appropriate times were added.

Simple Solutions – Significant Results

The four projects highlighted above are not unusual in their simplicity. In each case, the solution to the perceived problem is a simple or subtle change in the way that the system is operated, configured, or maintained. Whether it is simply enforcing an existing procedure (as in the sootblowing project) or changing operating conditions (as accomplished by the cooling water pumping project team), energy savings are often so easy to attain that in retrospect it is almost embarrassing that it took a Six Sigma project to realize the savings!

The discipline of Six Sigma forces project teams to look at all aspects of a process, not just the complicated inner workings but also the simple "givens" that are often overlooked or discounted. We assume that soot is being blown daily, for example, because the procedure says so. We fail to challenge a 62 psig header pressure requirement because "it's always been 62 psig." Six Sigma provides a framework within which fundamental questions can be asked and their answers challenged in a way that gives the project team ample ammunition for making changes that can truly improve the process.

Sharing Energy Project Successes

As stated earlier in this paper, large companies like DuPont face a daunting challenge when it comes to leveraging energy efficiency successes globally across the corporation. DuPont's Energy Technology Network (ETN) recognized the need for sharing across the energy community and began a series of "virtual workshops" to showcase energy-related Six Sigma projects.

What Is a "Virtual Workshop?"

A "virtual workshop" is simply a discussion among a geographically dispersed group of people having a common interest conducted virtually, that is, without anyone having to leave their work location. As in real group discussions, content in virtual workshops is both auditory and visual: an audio bridge telephone conference call is used to transmit voices while Microsoft NetMeeting™ conferencing software is used to transmit visual information to remote participants in real time. In effect, NetMeeting™ becomes a "virtual overhead projector," beaming visual aids to all connected participants while the presenter explains the material on-screen.[3]

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[3] Bailey, W., and J. Kane. 2000. "Virtual Workshops: Using Today's Networking tools to Train Tomorrow's Experts." In *Proceedings of the 22nd National Industrial Energy Technology Conference*, 153-157. Houston, TX: Texas A&M Energy Systems Laboratory.

Because participants do not have to travel, virtual workshops create knowledge transfer opportunities for a large and very important segment of DuPont's population: plant operators and mechanics. Thus, knowledge can be transferred and applied right on the shop floor, bypassing time-consuming intermediate steps caused by traditional plant hierarchies. The bottom line is that virtual workshops have the ability to reach a much broader group of people, with much greater speed and efficiency and at far lower costs than conventional meetings or workshops.[4]

Virtual Workshop Structure

A typical "Energy-related Six Sigma Projects" workshop will highlight four or five recent projects and will last two hours. Presentations are structured to highlight how Six Sigma enabled improvements to be identified, implemented, and sustained. Each project presentation is followed by a brief question and answer period during which the audience can interact with the presenter.

In addition to the energy project presentations, the virtual workshop agenda also includes a brief tutorial on a Six Sigma concept or some other useful tool. Recent workshops have featured topics such as "Estimating the Stake for Energy Reduction Projects," "How to Identify Energy Conservation Opportunities," and "Easing the Pain of Data Gathering for Six Sigma Projects."

Success of the Virtual Workshop Approach

The DuPont ETN presents two or three energy-related Six Sigma project virtual workshops each year. Connected attendance to the workshops averages 77 people and 36 sites globally. Participants frequently contact the presenters after the workshop seeking more information for potential similar applications at their sites. Workshop organizers also routinely receive unsolicited ideas for future presentations, and there is no shortage of volunteers willing to present their projects at future workshops. These successes have enabled the virtual workshop series to be self-sustaining.

Conclusion

Over the past four years, DuPont has transformed the way in which it solves problems. Six Sigma is a proven methodology that provides all employees with a common approach to improving operations. By focusing on the customer and eliminating defects using a structured, data-driven process, DuPont has been able to achieve remarkable savings.

The extension of Six Sigma into the energy arena has armed DuPont's energy professionals with valuable new tools. Together with traditional energy management best practices, Six Sigma is being used to improve energy system efficiency, reduce total energy costs, and assist in the challenging goal of holding total global energy use flat from 1990 to 2010.

As DuPont begins its third century, the application of Six Sigma across the energy value chain will remain a critical contributor to its ability to remain competitive in the face of volatile energy prices and global economic pressures.

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[4] Ibid.