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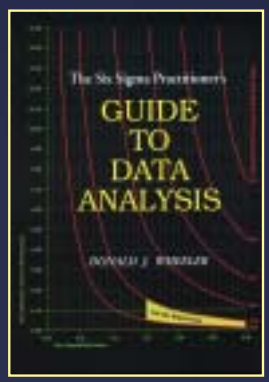

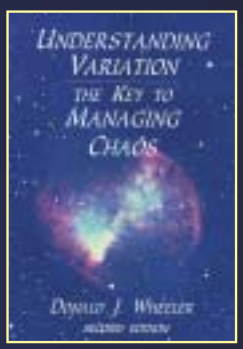

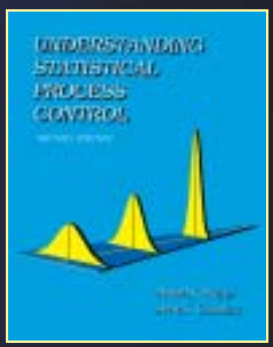

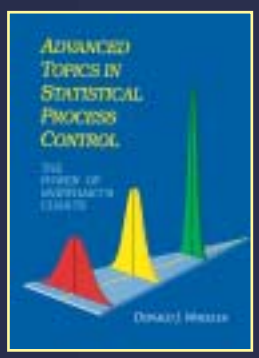

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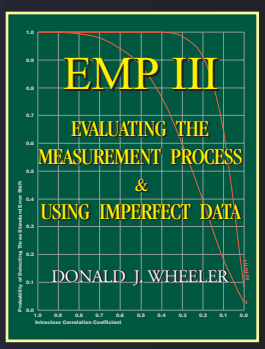

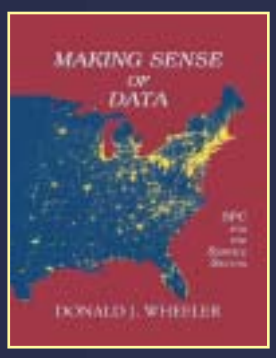

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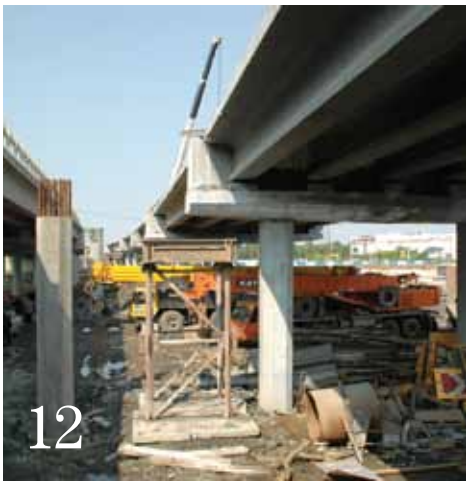

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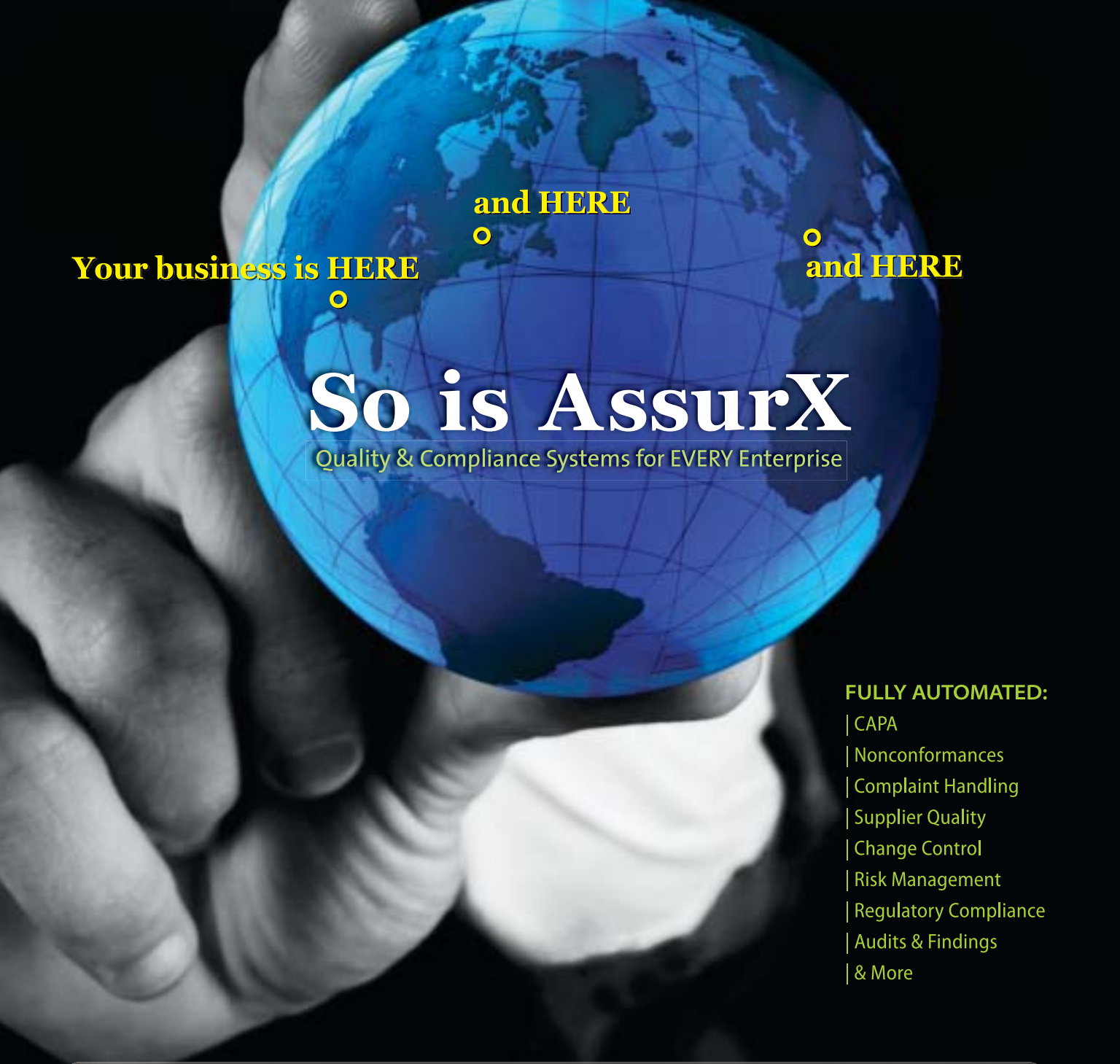

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The Road Back

Will Obama's stimulus plan pave the way?

UNTIL THIS MONTH, my friends and family had remained relatively unscathed by the economic melee. That's not to say incomes didn't shrink due to slumping sales, or that companies didn't scale back benefits or pay—that all happened. But nobody close to me had lost his or her job or home.

In recent weeks, that changed. I've had friends and family in the automotive, financial and construction industries lose their jobs, and I've heard about dozens more "friends of friends" who got laid off and are looking for work while struggling to make mortgage payments. It's a very different feeling when hard times befall those you love.

I suppose it was bound to strike closer to home at some point. In January, 598,000 people lost their jobs—the most in a single month since 1974. That nudged the unemployment rate from 7.2% to 7.6%. In the past year, U.S. unemployment has risen by about 4.1 million (www.washingtonpost.com/wp-dyn/content/article/2009/02/06/AR2009020601156.html). Based on calls and e-mails I've received, I know many of you have been affected, too.

As we near press time, President Obama is seeking approval for an economic stimulus package that will—it is hoped—help get the nation's economy back on track. It appears a good chunk of the nearly $800 billion will go to schools, roads and healthcare. Quality is at the heart of some of the proposed initiatives: further funding for No Child Left Behind and renovations to schools, the digitization of healthcare records, and infrastructure improvements to repair our nation's roads and bridges.

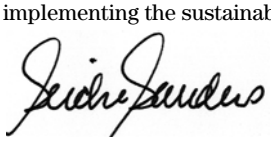
But the road back will be a long one, and there are no guarantees. What do you think about the stimulus plan? How do you think it will affect your industry or the quality field? Write to me at editor@asq.org.

When you're feeling insecure about your job or career path, there's no better time to explore alternatives. Some people choose to take classes or go back to school full-time. Others pursue a new certification—something that will further solidify their worth to employers.

New industries are also emerging—areas in which new jobs are springing up rather than drying up. Social responsibility is one such area.

This month, QP features two articles on this subject: In "Back in Circulation," p. 16, the author asserts that lean principles help businesses conserve resources, which in turn can be invested in socially responsible practices, benefiting everyone.

"Practice What You Teach," p. 24, tells of the journey of one college that did just that, implementing the sustainability-based principles espoused in its classrooms. QP



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Editor

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Seiche Sanders

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INBOX

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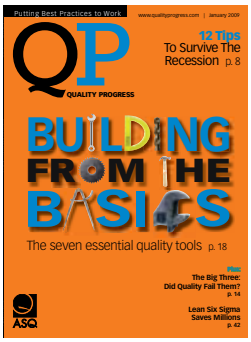

I am a retired engineering manager and a former ASQ senior member. I want to say the January issue of QP impressed me with its presentation of quality tools. For me, this issue emphasized the application of tried and true methods for producing consistent quality products that are essential in today's marketplace.

I think you have achieved excellence in providing meaningful and useful information to quality engineers everywhere.

G.H. Lufkin

Steering off course

Although I don't disagree with Mark Edmund's comparisons of Japanese and domestic automakers' defect rates ("The Big Three: Will a Bailout Be Enough?" Keeping Current, January 2009, p. 14), I was very disappointed to see quality so narrowly defined. If you use a broader definition of companywide quality, as the Japanese do, it is pretty clear quality is, in fact, the problem for U.S. automakers.

General Motors (GM) and Ford began embracing this broader definition in the early 1980s. Ford, under the direction of Donald Peterson, came back from the brink of bankruptcy, with fewer defects per 100 vehicles than Honda and passing GM in profitability. GM, with the help of W. Edwards Deming and Bill Scherkenbach, had similar results, and Cadillac even won the Baldrige award in 1990. In both cases, the efforts were not sustained, and they have fallen back into their old ways.

A true comparison of quality should include leadership, strategic planning, customer focus, measurement, analysis, knowledge management, workforce focus, process management and business results. If you look at specifics in any of these areas, it is clear the domestic automakers have little chance for survival, no matter how big the bailout package.

They must look at how they lead, how they plan and how they deploy plans to every level of the organization (a Japanese CEO would never go to his government to ask for help without a long-term plan). They need to create a customer hierarchy that puts the end user above stockholders and above Mr. Goodwrench. They need to work with employees and unions rather than giving in when times are good and battling in difficult times. They must learn to partner with their suppliers rather than make demands that discourage investment and innovation.

Finally, yes, they must get costs under control—not just the costs mentioned in Edmund's article, but many other tangible and intangible costs that have gotten out of control since they abandoned their total quality focus.

I am from Detroit, I grew up in the auto industry, and many of my friends and immediate family are dependent on the survival of the domestic automakers. I truly hope they survive.

Bill Osburn
Battelle
Columbus, OH

MORE TO SAY, MORE TO READ

Log on to www.qualityprogress.com for further discussion of the auto bailout and the items that should be in every quality professional's toolbox.

EXPERTANSWE

Mapping returns

Q: I am new to the quality profession and have been asked to determine the cost of product returns by customers. I am wondering what items roll into that. I've included transportation costs, the average labor wage per hour and how much average time is involved in processing a return. Is there anything else? Is there a formula I should use?

Steve Becker
Resource Optimization and Innovation
St. Louis

A: The question you ask is interesting and, of course, depends on how a return is processed.

When trying to determine the cost of any process, I do not guess at the costs involved. Instead, I always return to a map of the process. If you don't have one, I strongly encourage you to build one.

In this case, I suggest a value stream map. This tool provides a systematic means of determining probabilities of process paths, time delays, cycle times and transportation times, as well as a host of other highly useful information. In addition, it will allow you to define the boundaries of the return process and minimize the possibility of overlooking anything.

Once the details of the process become visible, you can examine each element and identify the various costs, times or rates you will need to determine the overall cost of the product return. At this point, you will probably have sufficient information to develop a formula of your own for computing the cost of a return.

This is where I usually turn to the finance department, which will be able to help plug in any missing information. Finance departments are generally the final authority on costs in most organizations. They're an important component if the final number for the cost of a product return is to have any credibility.

Remember: Use the process as the basis for developing the metric you are seeking. If you do, it will be accurate and defensible.

T.M. Kubiak
Author and consultant
Weddington, NC

FOR MORE INFORMATION

Kubiak, T. M., "Data Dependability: Improve data accuracy for managing, improving processes," *Quality Progress*, June 2008, pp. 61-64.

Kubiak, T. M. and Donald W. Benbow, *The Certified Six Sigma Black Belt Handbook*, second edition, Quality Press, 2009.

Manos, Tony, "Value Stream Mapping—An Introduction," *Quality Progress*, June 2006, pp. 64-69.

Faulty structure

Q: I work for a telecom company. I am the head of the department of business excellence and cost leadership. The responsibilities are scattered in the following departments:

1. *Quality and business processes support: covers ISO 9001 quality audits, process improvement and enhanced Telecom Operations Map (eTOM) standards. Also does Six Sigma projects.*
2. *Performance measurements: responsible for Six Sigma measures, quality of service measures and Six Sigma projects.*
3. *Sustainable business improvement: performs Six Sigma projects and is responsible for program continuity.*
4. *Cost leadership: Looks at initiatives to reduce operating costs.*

I need to restructure these activities in a better way.

Souad Alkabie
Batelco
Hamala, Bahrain

A: I work with a number of clients who claim they're implementing Six Sigma, but when I ask what they mean by Six Sigma, I get a lot of different answers. For some, Six Sigma is little more than a lean initiative. For others, it's the define, measure, analyze, improve and control approach or Six Sigma projects under the leadership of a Black Belt (BB). Elsewhere, Six Sigma appears to be a lot of number crunching and charting with various software tools.

Seldom, if ever, do I see any evidence that Six Sigma is understood as a method, not a goal, and even more seldom do I see any evidence it has been accepted and applied by top management as a strategic initiative. Six Sigma remains something that is delegated to the BB and attached to the organization's body. It hasn't been integrated to become a part of the body.

This question seems to reflect this phenomenon. You refer to the business excellence and cost leadership department's responsibilities as "scattered" among four apparently different areas. One will note, however, the term "Six Sigma projects" showed up in three of the four scattered responsibilities. You conclude, "I need to restructure these activities in a better way."

To your credit, you seem to have made real progress in all four areas of responsibility and seem to be addressing most of the elements of a solid quality initiative. Rather than restructuring, however, I would recommend integrating all of these activities into one strategic initiative for the organization.

I don't care what you call this effort. You can call it a quality system, continuous improvement process, Six Sigma or whatever. I'd prefer to see it viewed as the company's management system. Regardless, time

RS

Seldom, if ever, do I see **any evidence** that Six Sigma is **understood as a method,** not a goal.

should not be spent on restructuring, but on combining current strengths and past progress into one strategic initiative.

This can be accomplished by drafting a plan to be executed over the next year, preferably in Gantt chart format, for taking action in six strategic areas (a worksheet that I provide my clients for their initial implementation plans can be found at www.qualityprogress.com):

1. Customer relations.
2. Training.
3. Projects and teams.
4. Supplier relations.
5. Measurement systems.
6. Communication.

This approach can be used to integrate the department's current responsibilities into one cogent initiative. Business processes support and sustainable business improvement responsibilities will be addressed in the customer relations and supplier relations portions of the worksheet. Six Sigma projects and cost leadership (reduction) projects will be slotted into projects and teams. Quality audits, eTOM standards and similar items can be incorporated into the measurement and communication portions of the plan.

Training will be essential for any and all future business leadership progress—in particular, training for top management. Too often, senior managers see that a few BBs and Green Belts are trained, but the same managers do not learn the leadership theory, concepts and methods that are critical for survival in this new economic age.

Finally, I must add the caveat that all of my recommendations are based on something I learned from the late W. Edwards Deming. For the past 22 years, I have specialized in teaching a new system of management based on the principles of Deming, who taught the need for a transformation of the Western style of management.

We do not need any more improvement in American industry, nor do we need restructuring. What's needed is transformation, which implies a complete change of state. To accomplish the transformation, we need more leadership, less use of software tools and fewer ISO audits.

Jim Leonard
Consultant
Woodstock, CT

FOR MORE INFORMATION

Imler, Ken, "Core Roles in a Strategic Quality System," *Quality Progress*, June 2006, pp. 57-63.

A sample plan

Q: I am in the process of completing performance evaluations. A portion of the rating is determined by an employee's error rate in documentation.

Performance cutoffs are 96% or greater for exceptional performance, and fully successful performance is 95% or less. One employee has generated 3,600 records over the rating period. How many of these records should be audited to prevent bias?

Cliff Morrell

A: This question appears to relate to auditing samples, because we know the population size (3,600) and are interested in identifying the sample size needed to ensure that if the error rate is less than or equal to 4%, the sample size is large enough to detect that error rate.

There are a number of tables that could be employed in this situation. The most widely used tables that give these sample sizes with 95% or 99% confidence are by Herbert Arkin in his book, *Handbook of Sampling for Auditing and Accounting*.[1] So, in your example, to detect an error rate of not over 2% + 2% (which would give a lower bound of 96%) with 95% confidence, you would need a random sample of 179 records.

If you need further assistance, there are online calculators that can help determine the appropriate sample size.[2]

I. Elaine Allen
Associate professor of statistics
Babson College
Wellesley, MA

ASKED AND ANSWERED

Sooner or later, everyone runs into a problem they can't solve alone. Let us help. Submit your question at www.qualityprogress.com, or send it to editor@asq.org, and our subject matter experts will help you find a solution.

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1. Herbert Arkin, *Handbook of Sampling for Auditing and Accounting*, McGraw Hill Higher Education, 1983.
2. iSixSigma, "Sample Size Calculator," www.isixsigma.com/offsite.asp?A=Fr&Url=http://www.surveysystem.com/sscalc.htm.

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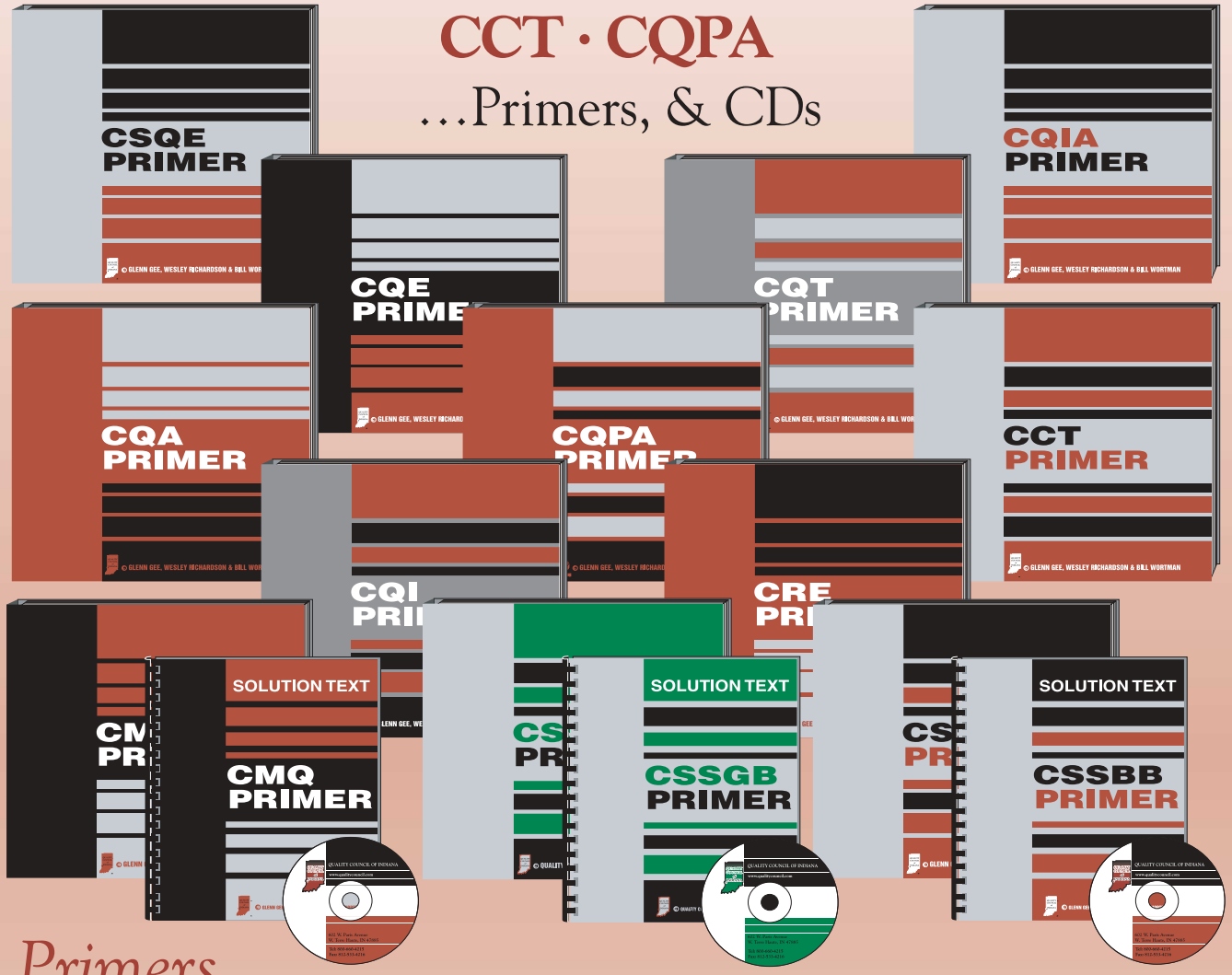

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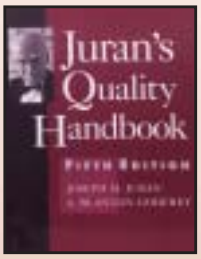

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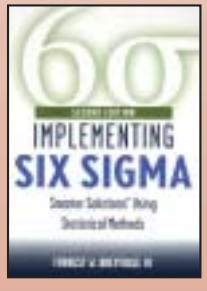

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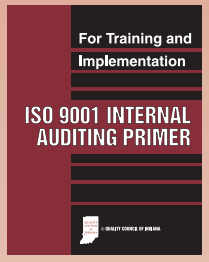

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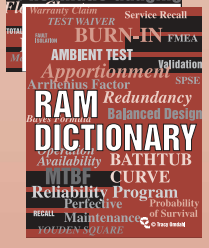

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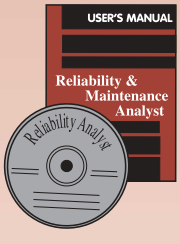

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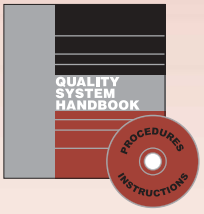

DESIGN AND CONSTRUCTION

Degrading Infrastructure

Latest engineers group report card again gives public works low marks

In the few months since President Obama took office, discussions in Washington, D.C., about reviving the troubled economy centered on a $789 billion stimulus package that will address, among other things, the country's infrastructure needs.

Hoping to influence the debate on Capitol Hill, the American Society of Civil Engineers (ASCE) last month reported the nation's infrastructure remains in poor condition and will require $2.2 trillion in fixes over the next five years. The society had planned to release its report later but moved the report up amid the stimulus talk.

"Our leaders are looking for solutions to the nation's current economic crisis," said Wayne Koltz, ASCE president. "Not only could investment in these critical foundations have a positive impact, but if done responsibly, it would also provide tangible benefits to the American people, such as reduced traffic congestion, improved air quality, clean and abundant water supplies and protection against natural hazards."

In the 2009 version of *Report Card for America's Infrastructure*, engineers assessed 15 infrastructure categories and compiled 15 grades. The grades ranged from a high of C+ in the solid waste category to a low of D- in the categories of drinking water, inland waterways, levees, roads and wastewater. A cumulative grade of D was given to the nation's infrastructure.

Preliminary estimates of the $789 billion stimulus package had $47 billion going to transportation projects, including $27 billion earmarked for highway and bridge construction and repair, and $12 billion for mass transit and rail projects. The package also included $4.6 billion for the Army Corps of Engineers and $31 billion to build and repair federal buildings and other public infrastructure.[1]

Little has changed since ASCE's last report card, released in 2005, The overall grade then was also a D then, although ASCE said there have been improvements in the energy category.

In addition to increased funding and federal leadership on the matter, ASCE's report card recommended:

- Developing federal, state and regional infrastructure plans.
- Addressing lifecycle costs and ongoing maintenance.
- Increasing and improving infrastructure investments from all stakeholders.

"The nation's infrastructure faces some very real problems, problems that pose a real threat to our way of life if they are not address appropriately," said Andrew Herrmann, the chair of ASCE's advisory council for the report card. "However, while it may not happen overnight, these problems are solvable if we have the right kind of vision and leadership."

REFERENCE

1. Foon Rhee, "Stimulus Pitch Stresses Infrastructure," *Boston Globe*, Feb. 11, 2009, www.boston.com/news/politics/politicalintelligence/2009/02/stimulus_pitch.html.

ECONOMY

BANKS URGED TO IMPROVE RISK MANAGEMENT

Despite the continued fallout from the financial crisis across the banking industry, KPMG International says it appears that not enough institutions are planning to make fundamental changes to their risk frameworks.

The claim is based on a new survey into apparent risk management failures. The results show that 90% of the 400 banking execs surveyed have carried out or plan to carry out reviews of the way they manage risk. Yet only 42% of respondents have made or plan to make fundamental changes to their risk processes.

The KPMG research highlights several areas in which changes will need to be made, including the lack of risk expertise at board level, communication between the risk function and the rest of the business, and the relative lack of influence exerted by the risk function.

The full report can be found at www.kpmg.com/global/pressroom/pressreleases/pages/banks-urged-to-grasp-nettle.aspx.

ASQ

SURVEY: ENGINEERING HAS IMAGE PROBLEM WITH YOUTH

Eighty-five percent of young students say they're not interested in pursuing an engineering career, maybe because they don't know what engineering is about or they aren't confident in their math or science skills, a recent ASQ survey revealed.

About one-third of the students said they would prefer "a more exciting career."

The survey among youths (ages 8 to 17) and their parents also showed that 97% of parents said they believe math and science knowledge will help their children be successful. But only 20% of parents said they have encouraged or will encourage their children to consider engineering.

"It's clear that there is a low level of interest and knowledge about engineering careers for both parents and children," said Maurice Ghysels, chair of ASQ's K-12 Education Advisory Committee. "Educators and engineers need to work more closely together to get students excited about the profession and spotlight interesting role models."

ASQ hosted a webinar for young students, parents and educators during National Engineers Week last month to raise awareness of engineering as a career choice.

For more information about the survey, visit www.asq.org/media-room/press-releases/2009/20090122-engineering-image.html.

Who's Who in Q

NAME: Carl E. Floren.

RESIDENCE: Decatur, IL.

EDUCATION: Bachelor's degree in mechanical engineering from the University of Southern California (USC) in June 1951.

QUALITY-RELATED JOBS: Floren began working for Mueller Co. in Decatur, IL, one month after he graduated from USC. He held many positions in research and development at Mueller, which makes infrastructure and flow control products for potable water distribution networks and treatment facilities. He retired in 1989 but stayed on as a consultant and was named corporate director of quality improvement. Floren coordinated ISO 9001 certification at several plants and also reviewed patent, trademark and liability issues. In December, he retired again.

ASQ ACTIVITIES: Floren has been an active member of ASQ since 1962, and he has held numerous positions in Central Illinois Section 1200, including chairman of the section since 2004. Floren proctored exams for several years. He is a certified quality technician and certified quality engineer.

FLOREN SETS UP a test to gauge the stress and strain of a pipe put under hydrostatic pressure in this photo from 1955.

OTHER ACTIVITIES/ACHIEVEMENTS: Prior to his career in quality, Carl served in the U.S. Army's 94th Infantry Division. He was wounded in Germany in 1945 and was awarded the Bronze Star. When he worked as an engineer at Mueller, Floren was involved with securing 72 patents, 27 of which were domestic. He was a member of the American Society of Mechanical Engineers (ASME)—specifically, a member of ASME B16 standards committee—standardization on valves, flanges and gaskets and chairman of ASME B16's subcommittee L on gas shutoffs and valves. Floren also served as president of the local chapter of the Society of Manufacturing Engineers.

FAMILY: Floren and his wife, Kathryn, have three sons, Carl, John and Andrew.

ASQNEWS

SOCIAL RESPONSIBILITY EVENT Chris Jordan, a Seattle-based photographic artist and activist, will speak at an ASQ event April 22 in Milwaukee. Jordan is known for social commentary through the images and art he creates, and he has become a spokesperson for social change in many circles. His art will be on display at the event, which is part of ASQ's initiative to promote and support social responsibility.

GREEN IN MILWAUKEE ASQ headquarters has teamed up with local governments and a business group to form an initiative to advance social responsibility and sustainability. Through the Metro-Milwaukee Green initiative, ASQ and the other organizations hope to challenge businesses to reduce their waste and impact on the environment, while at the same time cutting costs and enhancing customer satisfaction. To learn more about the initiative, visit www.thesro.org, click on "Join the SRO movement," and look under "Groups."

FREUND SCHOLARSHIP April 1 is the application deadline for the Richard A. Freund International Scholarship. The $5,000 scholarship is intended for graduate study of the theory and application of quality control, quality assurance, quality improvement and total quality management. Visit www.asq.org/about-asq/awards/freundscholar.html to find out more or download an application.

NEW CERTIFICATION ASQ has unveiled a new certification for professionals in the pharmaceutical industry. Certification for the Pharmaceutical Good Manufacturing Practices (GMP) will test the individual's knowledge of GMP principles as regulated and guided by national and international agencies for the pharmaceutical industry. The first exams are scheduled for May 17 during the ASQ World Conference on Quality and Improvement, June 6 and Dec. 5. To learn more about application deadlines and other details about the certification, visit www.asq.org/certification/pharmaceutical-gmp/index.html.

PACT WITH FOOD INSTITUTE ASQ has signed a collaboration agreement with the National Food Institute of Thailand. The scope includes exchange of information and joint programs.

HEALTHCARE CONFERENCE

QIHC SPEAKERS ANNOUNCED

ASQ has announced the keynote speakers for the Quality Institute for Healthcare (QIHC) Conference, May 18-20, in Minneapolis:

- Rosalie Vlahutin of Allina Hospitals and Clinics in St. Paul and Minneapolis will speak on "Infrastructure for Improving Care."
- Richard C. Karl, the founder and CEO of Surgical Safety Institute in Tampa, FL, will discuss using aviation's crew resource management to reduce errors in a healthcare setting.
- Glenn W. Bodinson of BaldrigeCoach in Richardson, TX, will talk about Baldrige best practices.
- Heather Vass of SSGB Premier Inc. in Charlotte, NC, will discuss never events.
- Robert E. Matthews of PriMed Physicians and Health First Physicians in Dayton, OH, will speak about clinical Six Sigma in outpatient medicine.

QIHC will be held concurrently with ASQ's World Conference on Quality and Improvement.

For more information on QIHC, visit http://qihc.asq.org.

DATEINQUALITYHISTORY

QP looks back on an event or person that made a difference in the history of quality.

March 7, 1964

Samuel Stanley Wilks, known in many circles as the "statesman of statistics," died at his home in Princeton, NJ. He was 57.

Wilks was born in Little Elm, TX. He earned a degree in architecture, but because of his poor eyesight, Wilks feared his career in that profession might stall. He later pursued a career in mathematics. He studied at the University of Texas and became an instructor before he was awarded a fellowship at the University of Iowa.

In 1933, he was appointed instructor of mathematics at Princeton University. There, his research revolved around multivariate analysis. One of his most influential papers was *Certain Generalizations in the Analysis of Variance.*

Over the years, he also worked with the U.S. government in the Department of Agriculture and was a member of the National Defense Committee.

In 1947, Wilks was awarded the Presidential Certificate of Merit for his contributing to antisubmarine warfare and for offering solutions to convoy problems.

Source: Turnbill World Wide Web Server, School of Mathematical and Computational Sciences, University of St. Andrews, Scotland, www-groups.dcs.st-and.ac.uk/~history/Biographies/Wilks.html (case sensitive).

Mr. Pareto Head

BY MIKE CROSSEN

STANDARDS

IAQG RELEASES REVISION TO AEROSPACE STANDARD

The International Aerospace Quality Group (IAQG) has released a revision to the quality management system standard for the aviation, space and defense industries.

The standard is known as AS9100 in the United States, EN9100 in Europe and JISQ9100 in Asia-Pacific. Nearly 700 comments and change recommendations were reviewed and dispositioned by the IAQG 9100 team. Changes include:

- Expansion of scope to include land and sea-based systems for defense applications.
- Risk management.
- Project management.
- Configuration management.
- Critical items and special requirements.

The IAQG has posted deployment support material at www.iaqg.org to accompany the release of the 9100C version. This includes frequently asked questions and a revision overview presentation.

The standard can be purchased from national and regional standards publication bodies, including SAE International in the United States. Visit www.sae.org/technical/standards/AS9100C.

ASQ

MOST ASQ MEMBERSHIP DUES STAY PUT THIS YEAR

There will be no increases in individual ASQ membership dues this year, the ASQ Board of Directors has announced.

Individual full, senior and fellow annual dues remain at $129. Associate dues remain at $74, while forum or division-only membership dues stay at $31, and student dues continue at $25.

Dues for K-12 school and K-12 district members will not increase, either.

The board did approve increases for organization members: site members that renew will see a $50 increase to $850. New site members can join at $1,000. Changes take effect July 1.

Direct any questions about ASQ membership or these changes to mgdteam@asq.org.

ONLINEONPAPER

QUICK POLL RESULTS

Each month at www.qualityprogress.com, visitors can take a short, informal survey, and we post the results.

Here are the numbers from a recent Quick Poll:

"In light of the economy's downturn, is your organization outsourcing:"

- The same? 42.8%
- Less? 39.2%
- More? 17.8%

Answer the most recent Quick Poll question posted:

"How extensive are your company's social responsibility efforts?"

- We've made a few changes to become more socially responsible.
- We've made major changes to become more socially responsible.
- We haven't done anything differently.

Back in Circ

Free up assets and **reinvest them in the community** to achieve true SR

In 50 Words Or Less

- As lean has evolved, its potential impact has broadened.
- The philosophy, which once was limited to the shop floor, has found its way into all facets of organizations.
- Resources freed by lean can be reallocated to improve society at large and, in turn, the sustainability of an organization.

ulation

by Chad Vincent

IN THIS TIME of fading barriers between organizations and society at large, ASQ looked at the future of quality and how the quality profession fits into this new world. It found the quality profession is becoming increasingly important to bridge the gap between organizations and society.[1]

The most recent quality movement—lean—is at the forefront of changes organizations are implementing to become more competitive in the global economy. Once used exclusively with business processes, lean is being employed by organizations to solve environmental concerns and to become more socially responsible.[2]

As the applications for lean continue to expand, organizations must realize lean's usefulness goes beyond environmental efforts. But first, we must look at the history of lean and its evolution to understand how the future of lean fully complements social responsibility (SR).

From production to enterprise

The phrase "lean production" was coined in the late 1980s by John Krafcik, of the international motor vehicle program of the Massachusetts Institute of Technology (MIT)[3] and popularized in the book *The Machine that Changed the World*.[4] This was the generally accepted name of the system derived from the Toyota Production System.

Lean production, or lean manufacturing, began as a means of organizing and managing various operations of production—from suppliers to product delivery—so they require fewer personnel and less time, money and material to make products with higher quality when the customer demands them.

As manufacturers realized the benefits of lean on the shop floor, the philosophy was incorporated into business processes, indirectly impacting the manufacturing of products, including purchasing, accounting, sales, customer service, distribution and logistics.

This expanded use of lean incorporates closer relationships with suppliers and end-use customers. It requires partnering with all stakeholders outside the organization and sharing not only ownership of those processes, but also the results of continuous improvement efforts to those processes. The effort to eliminate all waste across the supply chain with the collaboration of all stakeholders became known as lean enterprise.[5]

Lean to green

This expansion of the lean philosophy, or lean thinking, to other business processes began to have benefits beyond the traditional lean practitioner's viewpoint. The rewards were being recognized by individuals in the environmental, health and safety (EH&S) functions of organizations. While lean reduced operational waste, it also reduced environmental waste.[6] It is called different things by different organizations, but for the purpose of this article, we will call it green manufacturing.

Conceptually, lean enterprise and green manufacturing are similar, because both pursue the elimination of waste.[7] Lean enterprise becomes green manufacturing when an organization adds the environment as a key stakeholder in the supply chain.

Green manufacturing expands the supply chain to consider what happens to the material and product after use. In a sense, it closes the loop from raw materials to environmental waste, whether that waste is caused by the organization's operations or by what the end customer does with the product after use. Green manufacturing creates a focus on the preservation of life-sustaining resources (soil, air and water) and a reduction in toxic-material release.[8]

While lean enterprise strives for the elimination of the eight traditional wastes, green manufacturing strives for the elimination of environmental waste and reuse of resources. As a result, green manufacturing has created the eight green wastes, which are outlined, along with the eight traditional lean wastes, in Table 1.

The ideal state of green manufacturing is to use 100% renewable resources, with complete use of all materials and no byproducts—zero waste. In today's world, much like most value streams, the ideal state is a far cry from reality. In reality, organizations must use a combination of renewable and nonrenewable resources, and reusable and nonreusable materials.

Green manufacturing focuses on the following to reduce waste:

- Minimizing the use of nonrenewable resources.
- Maximizing the value use of nonrenewable resources when they must be used.
- Maximizing the value use of renewable resources.
- Maximizing the value use of materials.
- Maximizing the reuse of scrap raw materials.
- Minimizing total byproducts.
- Maximizing byproducts that can be reused.
- Minimizing toxic byproducts or byproducts that cannot be used.
- Minimizing the use of product materials and packaging (including shipping materials).
- Maximizing the reuse of product materials and packaging after use.

Some organizations easily make the connection between being environmentally friendly and the lean philosophy and its associated tools. This green frame of mind is ingrained in the culture of the organization that is given the most credit for lean: Toyota.

Driving the lean effort

Reviving itself from the ashes of World War II, Toyota had to maximize the use of natural resources that were not readily available in Japan. A culture of waste reduction was created as a foundation for Toyota to reduce the impact of material shortages and keep in-

Lean wastes vs. green wastes / TABLE 1

The eight lean wastes	The eight green wastes
1. Overprocessing: Tighter tolerances or higher grade materials than are necessary.	1. Water: use for production, use by employees and wastewater.
2. Motion: Bending, turning, reaching and lifting.	2. Electricity: created by nonrenewable resources (gas, coal, nuclear, petroleum-based fuels) and renewable resources (wind, hydroelectric, geothermal, solar, biofuels).
3. Inventory: Storing parts, pieces and documentation ahead of requirements.	3. Gas: natural, propane, methane.
4. Transportation: Moving people, products and information.	4. Earth material: soil and earth, plants and unprocessed raw materials (salt, coal, crude oil, bauxite, lead).
5. Waiting: For parts, information, instructions and equipment.	5. Emissions: smoke, water vapor, heated air, gaseous toxins, residual gases from processes.
6. Skills: Underusing capabilities and delegating tasks to those with inadequate training.	6. Product use: waste from product discarded after use, product packaging and containers for product shipping.
7. Defects: Rework, scrap and incorrect documentation.	7. Raw material: traditional waste from production scrap that is excess material discarded for no further use by the organization.
8. Overproduction: Making more than is immediately required.	8. Byproducts: solid waste toxins, processed materials not usable by the organization and biohazard waste.

SOURCE
Bellamy, Stewart, "8 Wastes of Lean," www.isixsigma.com/dictionary/8_Wastes_of_Lean-915.htm.

Note: At this time, there is no known source for the classification of green manufacturing wastes. This is a classification created by the author of this article. For benchmarking purposes, metrics can be based on volume of each waste category and normalized by total production metrics of an organization.

dustrial Japan alive during the rebuilding period of the late 1940s and early 1950s.

Toyota had no obligation to preserve Japan's resources while building automobiles. But, by limiting the company's impact on Japan's resources, it maximized the use of organizational resources to sustain the organization in the long term. By doing so, Toyota became a leader in corporate citizenship by providing jobs and supporting the local community.

Looking at the situation from the viewpoints of Toyota, its employees and the community, staying in business was socially responsible during the rebuilding of Japan. To do so, Toyota had to overcome the challenges of material shortages and workforce knowledge and skill limitations.

At that time, many types of industries that were needed for rebuilding Japan required the same resources. For survival, organizations from different industries were forced to rely on each other to accomplish a single goal and put the country first. By sharing knowledge and providing a means for the people of the local communities to be productive rather than waste valuable materials, Toyota was being socially responsible. It found ways to survive the rebuilding period and, in 2008, became the world's largest automaker.[9]

While learning from the Toyota benchmark, some organizations adopted lean enterprise and green manufacturing as an environmentally conscientious and, hence, more socially responsible business strategy. Can organizations that adopt green manufacturing stop there and state they are socially responsible organizations? The answer is no. There is much more to SR than a focus on the reduction of environmental waste.

The evolution of SR

The upcoming ISO 26000 standard and the Malcolm Baldrige National Quality Award (MBNQA) criteria define SR as more than environmental friendliness. The MBNQA criteria explain that practicing good citizenship involves leadership and the support of resources for publicly important purposes (see sidebar, "The MBNQA and SR," p. 20).[10] It is further understood that when organizations lend this leadership and support, it should be done within the limits of an organization's resources.

The latest working draft of ISO 26000 defines SR as: "responsibility of an organization for the impacts of its decisions and activities on society and the environment, through transparent and ethical behavior that contributes to sustainable development, health and the welfare of society; takes into account the expectations of stakeholders; is in compliance with applicable law and consistent with international norms of behavior; and is integrated throughout the organization and practiced in its relationships."[11]

Despite the fact that lean enterprise is widely associated with the environmental movement, the connection to SR is much stronger. This is best demonstrated using the first of the 14 management principles described in Jeffrey Liker's book, *The Toyota Way*: "Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals."[12]

Liker interprets this principle as Toyota's focus to "generate value for the customer, society and the economy … evaluate every function in the company in terms of its ability to achieve this."

Organizations should create a culture with an understanding that making money is not the sole purpose of an organization. Many companies that made being profitable their sole purpose—and initially succeeded, by the way—have either ceased to exist or have come dangerously close to collapsing.

Companies such as Enron, WorldCom and those associated with the current economic crisis are prime examples of profitability trumping SR and long-term sustainability. Without a balanced approach for all stakeholders (customers, society, employees and the overall economy) and not just shareholders, it is difficult for an organization to generate value for all parties who have a vested interest in the organization's sustainability.

Liker further suggests that this first principle implies an organization should act with self-reliance and determine its own destiny. I would broaden Liker's interpretation to mean that organizations should strive to be self-sustaining while providing for the local community in such a way that future generations will look back and view the organization as existing for the greater good.

Who's being served?

A basic lean principle is to define the value of a product or service in terms of the customer.[13] The true principle of lean, however, should be to focus on all stakeholders via an expanded definition of "customer."

THE MBNQA AND SR

An organization's leaders should emphasize responsibility to the public, ethical behavior and good citizenship. Leaders should be role models for the organization, focusing on ethics and the protection of public health, safety and the environment. This includes an organization's operations, as well as the life cycles of its products and services. Organizations also should emphasize resource conservation and waste reduction at the source. Planning should anticipate adverse impacts from production, distribution, transportation, use and disposal of products. Effective planning should prevent problems, provide for a forthright response if problems occur, and make available the information and support needed to maintain public awareness, safety and confidence.

For many organizations, the design stage is critical from the perspective of public responsibility. Design decisions impact production processes and, often, the content of municipal and industrial waste. Effective design strategies should anticipate growing environmental concerns and responsibilities.

Organizations should meet all local, state and federal laws, as well as regulatory requirements, and should treat these and related requirements as opportunities for improvement beyond mere compliance. Organizations should stress ethical behavior in all stakeholder transactions and interactions. Highly ethical conduct should be a requirement of and be monitored by the organization's governance body.

Practicing good citizenship involves leadership support—within the limits of an organization's resources—of publicly important purposes. Such purposes might include improving education and healthcare in the community, pursuing environmental excellence, practicing resource conservation, performing community service, improving industry and business practices, and sharing nonproprietary information. Leadership as a role-model organizational citizen also entails influencing other organizations, private and public, to partner for these purposes.

Managing SR requires the organization to use appropriate measures and to have effective leaders who will assume responsibility for those measures. *—C.V.*

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National Institute of Standards and Technology, *Criteria for Performance Excellence*, Baldrige National Quality Program, www.baldrige.nist.gov/Criteria.htm (case sensitive).

Organizations **should create a culture** with an understanding that making money **is not the sole purpose.**

Organizations must create a balanced focus on everyone invested in the sustainability of the organization. Principles 9, 10 and 11 in *The Toyota Way* focus on adding value to the organization by developing your people and partners.[14] These principles deal with the development of people, teaching others, following a common philosophy, and challenging partners and suppliers to improve (for the complete list, see sidebar, "The 14 Principles of *The Toyota Way*," p. 22).

Ask yourself who the aforementioned people, partners and suppliers of your organization are. Why should the definitions of these entities be limited to your workforce, customers and suppliers? Broaden the scope of these entities to define all stakeholders, including society and local communities.

Each of these entities, in one way or another, is connected to the success and failure of the organization. Through the expansion of the term "customer," organizations can begin to define value in terms of local communities, society and the workforce. With this new frame of reference, organizations can establish more ways to become socially responsible beyond the current state of green manufacturing.

Ethical behavior

Behaving ethically is part of being a socially responsible organization.[15] Internally, responses to ethical infractions are critical to a workforce's morale, because employees have a basic need to know their voice is heard. Another way to achieve ethical behavior is through transparency of internal and external operations. Visual management (also known as visual control) plays a key role in this transparency.

Employees, suppliers, partners, customers and other stakeholders have a basic need to know the state of the business in which they are vested. The philosophy behind visual management is to make information visual, or transparent, to stimulate continuous improvement.[16]

Those individuals who have a vested interest in an organization will support the improvement of that business if information is shared freely. Suppliers will be more willing to work with businesses that do not hide information from them. Employees will speak up if they know their ideas will have an impact on the business. If local communities know that a company in its early stages is in trouble, they will come to the aid of that company.

Local support

Lean can be useful as a two-step process to support local communities. The first step is through the application of lean enterprise within the organization, resulting in the creation of additional capacity by reducing the burden on existing resources. With less-burdened resources, organizations will be able to contribute more to local communities. Those contributions may include improving education and healthcare, performing community service, improving industry and business practices, and sharing nonproprietary information.

SR emphasizes that organizations should act as role models to influence other organizations—public and private—to partner in the continuous improvement of the local community. Organizations should find ways to move beyond the walls of the company to improve the community, thus improving the quality of life of the employee.

Toyota has an open-door policy. It welcomes any and all organizations to benchmark its operations. It does so with the understanding that what makes other organizations stronger will make the local, state, national and global communities stronger, resulting in Toyota becoming more sustainable.

The second way an organization can use lean enterprise to contribute to its local community is by teaching the lean philosophy to benefit everyone. Teaching local organizations the benefits of lean enterprise and how to apply it at their own organizations will allow them to create more value through their operations and resources.

If local organizations are operating more efficiently, this makes the local community stronger and more productive. As a result, the burden of the local community on an organization is reduced, because the quality of life of the organization's employees has improved.

That policy has its roots in the Ford Motor Co.'s Service School, which was created to educate foreign students for Ford's business branches overseas and also to spread the idea of mass production methods. Henry Ford believed his company had no trade secrets, saying, "If we are doing anything which another manufacturer may find use for, then we want that manufacturer to have the benefit of what knowledge we possess. That we take as our duty."[17]

THE 14 PRINCIPLES OF THE TOYOTA WAY

1. Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals.
2. Create a continuous process flow to bring problems to the surface.
3. Use pull systems to avoid overproduction.
4. Level out the workload (*heijunka*). Work like the tortoise, not the hare.
5. Build a culture of stopping to fix problems, to get quality right the first time.
6. Establish standardized tasks and processes as the foundation for continuous improvement and employee empowerment.
7. Use visual control so no problems are hidden.
8. Use only reliable, thoroughly tested technology that serves your people and processes.
9. Grow leaders who thoroughly understand the work, live the philosophy and teach it to others.
10. Develop exceptional people and teams who follow your company's philosophy.
11. Respect your extended network of partners and suppliers by challenging them and helping them improve.
12. Go and see for yourself to thoroughly understand the situation (*genchi genbutsu*).
13. Make decisions slowly by consensus, thoroughly considering all options; implement decisions rapidly (*nemawashi*).
14. Become a learning organization through relentless reflection (*hansei*) and continuous improvement (*kaizen*).

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In the 1950s, Eiji Toyoda, managing director of manufacturing at Toyota and cousin of founder Kiichiro Toyoda, was sent to study the U.S. auto industry and its production methods. After reading the report, Kiichiro said, "We shall learn production techniques from the American method of mass production. But we will not copy it as it is. We shall use our own research and creativity to develop a production method that suits our own country's situation."[18]

Although he may not have realized it, Kiichiro Toyoda was creating the foundation of lean philosophy. Toyota's success can be credited to Ford's sense of duty to SR and sharing what he learned with others—even competitors.

The broad side of lean

In general terms, lean as it relates to SR says an organization should strive for continuous improvement to fit the needs of society and then spread that knowledge to help others improve, regardless of the industry.

In the healthcare realm, nonhealthcare organizations must become role models and provide expertise in best-demonstrated business practices, such as lean, to improve hospitals, doctors' practices and clinics. This may include sharing improvement ideas and teaching healthcare professionals the tools and methods needed to continue the improvement journey. The partnering business can bring in healthcare professionals to participate in *kaizen* events, so they can get hands-on experience before they try to implement lean in their organizations.

In the end, this benefits the workforce by keeping it healthier through an improved local healthcare system, thereby creating long-term, loyal employees. The healthcare providers benefit beyond the improvement of operations by hearing the voice of their customers firsthand. A partnership like that takes time and commitment before knowledge can be shared openly. Organizations in this type of partnership must believe they have a larger sense of purpose beyond the product or service they provide.

The same opportunities exist in education. Business organizations can open their doors and involve the younger generation in real-life experiences, thereby creating an environment in which academic training and professional experience go hand in hand. This makes a textbook out of the working environment, where students can apply what they have learned in

theory to working situations and produce tangible results.

The EAST Initiative in Arkansas is a prime example. This program takes students at the primary school level and assigns them projects that deal with real problems in their communities. Students are given the training and tools to understand technology—including global positioning systems, 3-D design and animation tools, and information systems—and to apply them to solve problems related to education, health, government, agricultural or environmental issues.[19]

While having a substantial benefit to the organization, there is benefit to the students, who get a sense of pride when a project is completed and receive the education needed to be more productive when entering the workforce of tomorrow.

From a lean perspective, we are removing the waste of complete theoretical education in which graduates are not fully prepared to enter the workforce immediately without extensive training by the organization. Why should organizations need to train individuals who should be ready for real life once they graduate? Isn't that waste, too? By combining education with real experiences and tangible benefits, the future workforce will be more productive when entering the workplace, needing no additional training.

The choice is yours

It is through the ideology of long-term sustainability that local communities embrace an organization. When a local community can depend on an organization to provide jobs, the local community becomes a partner with the organization and will be more willing to work with that business.

In contrast, some organizations use lean to reduce overhead costs by reducing their workforces. Those organizations do not fully embrace the lean philosophy from the perspective of SR that was taught by Toyota, which demands a respect for people and partners.[20]

While layoffs may be inevitable at times, there is a difference between organizations who plan for them and those that just do them. The socially responsible approach is to prepare the workforce for layoffs and make plans to reduce the impact. This can include job placement programs, additional education to fill other positions that are open within the community and attrition planning to reduce the amount of layoffs, with a focus on metered replacement of retirees.

SR, like lean, is a choice. Companies that embrace the lean enterprise philosophy create additional capacity for their resources, not only to produce better results with those resources, but also to use that additional capacity and give back to society. That is the true nature of the lean enterprise organization: all stakeholders working together to continuously improve the world and make it a better place. Isn't that what being socially responsible is all about? If Toyota can change a nation, why can't we change the world? QP

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CHAD VINCENT is principal engineer at Baxter Healthcare Corp. in Mountain Home, AR. He earned a bachelor's degree in engineering management, specializing in quality engineering, from Missouri University of Science and Technology in Rolla, MO. Vincent is a senior member of ASQ and is an ASQ-certified quality manager, quality engineer, reliability engineer and Six Sigma Black Belt.

BE SOCIAL

Does this broader definition of social responsibilty have a place in today's global marketplace? Use the comment feature at www.qualityprogress.com to share your opinion. And for more on the SR movement, visit www.thesro.org.

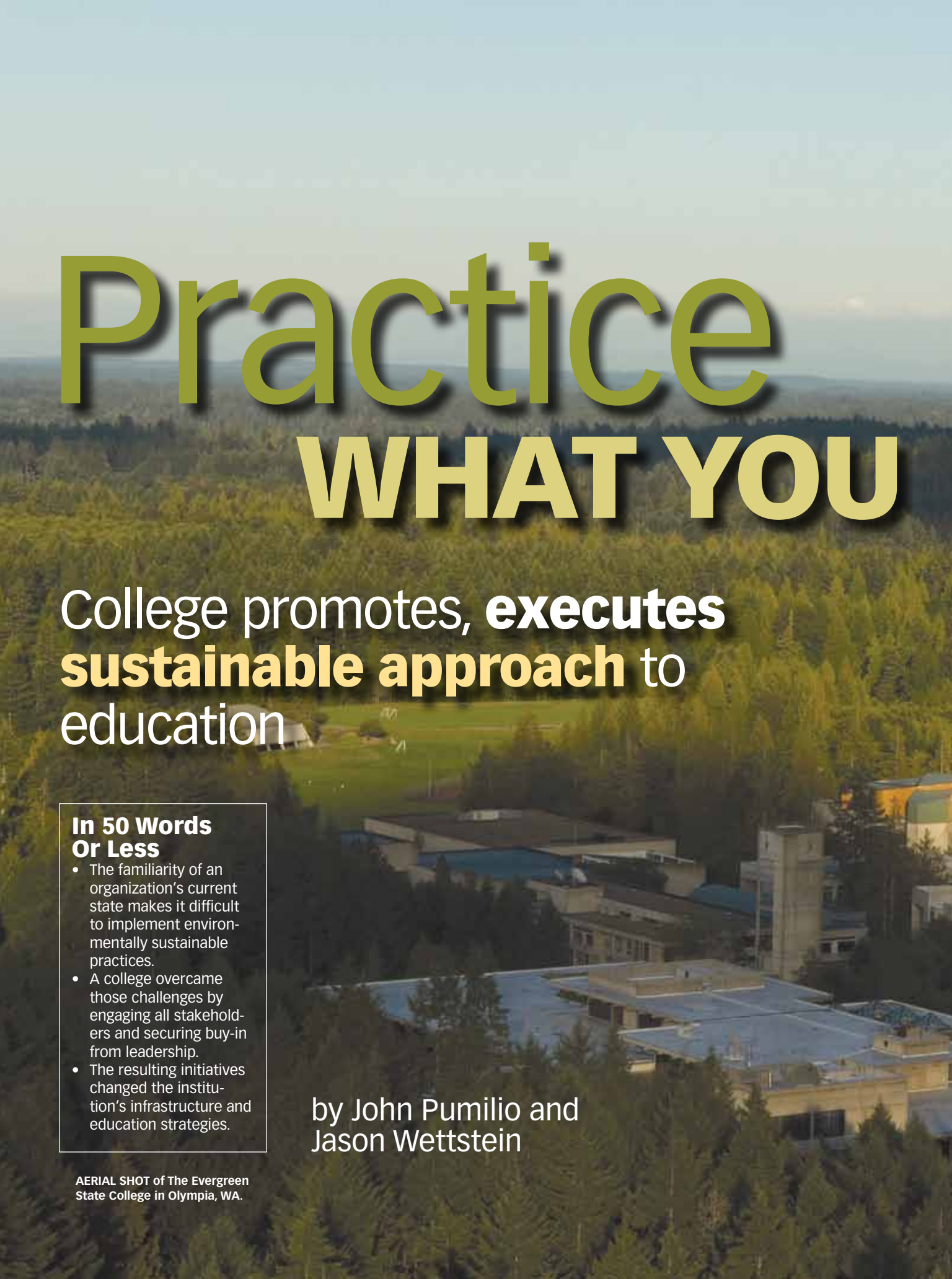
Practice WHAT YOU

College promotes, **executes sustainable approach** to education

In 50 Words Or Less

- The familiarity of an organization's current state makes it difficult to implement environmentally sustainable practices.
- A college overcame those challenges by engaging all stakeholders and securing buy-in from leadership.
- The resulting initiatives changed the institution's infrastructure and education strategies.

by John Pumilio and Jason Wettstein



AERIAL SHOT of The Evergreen State College in Olympia, WA.

Teach

ALL TOO OFTEN, efforts to make a business or institution more environmentally sustainable begin and end with talk. Despite good intentions, formidable barriers can waylay the best-laid plans. Society's day-to-day practices, institutional value sets and consumption patterns are built on the assumptions that resources are cheap and everlasting, and our natural environment is resilient enough to cope with perpetual mistreatment.

Sustainability is an awakening to the fact that our institutional foundations have been built on faulty ground and false premises. For many institutions, the challenge of advancing sustainability by building a new foundation is twofold:

1. How to do it without grinding the entire organization to a halt.
2. How to do it when the current system is entrenched and creates additional barriers.

The Evergreen State College in Olympia, WA, was founded in 1971 on principles of social responsibility and environmental stewardship. Student success is not measured by GPAs or letter grades. Rather, we reward collaborative learning, interdisciplinary teaching, critical thinking and, above all, problem solving. We convey progress toward these goals via narrative evaluations. Because of its approach and philosophy, Evergreen has been a pioneer in sustainable teaching and learning, which has created pathways to leadership in sustainability.

Many institutions do not have a foundation conducive to sustainability efforts. For many, change will be cumbersome. Opportunities exist, however, and persistence will be an ally. The Evergreen experience is distinctive, but in combination with the study of other institutions, its efforts may provide lessons that can help shape approaches to sustainability at other organizations.

Support for sustainability

Evergreen's approach is self-analytical. The focus and institutional direction of the college is constantly re-evaluated. In 2005, following three summers of faculty-initiated institutes that focused on campus sustainability, it was recommended that Evergreen incorporate sustainability into the college's mission and strategic plan in a much more salient way.

We began to realize that our institutional practices were often out of sync with social and environmental values expressed in our classrooms. It was time to look inward and further integrate sustainability throughout our curriculum and implement sustainability into our day-to-day practices.

The college appointed a sustainability task force, which included high-level staff, faculty and students. The team had the support of our vice presidents and thus had access to information from the decision-makers with purview over academics, admissions, student affairs, communications and operations. The task force was charged to write a new section for the college's five-year strategic plan, which is closely linked to budget allocations.

We began with the premise that, for sustainability to be meaningful and enduring at Evergreen, the vision for sustainability and its accompanying action plan had to be built from the ground up. But the task force could not create an enduring definition and plan without broad participation.

The team saw itself as a facilitator of a community-wide conversation that would result in a consensus of what sustainability is at Evergreen and how to achieve it. Without that consensus and common definition, we knew we would never galvanize the needed institutional support for our initiatives to go forward. We set out to engage a broad cross-section of our community members, including staff, faculty, administrators and students. These community members occupy the same space, but they live in different day-to-day worlds.

We realized it would be difficult to engage a diverse and busy population in our deliberations. Instead, we chose several methods to bring a large number of people into the conversation. These included one-on-one interviews with faculty members and students, interviews with student groups, student workshops that were facilitated within academic programs, visits to sector staff meetings culminating in a cross-campus staff institute, interviews with administrators and decision-makers at the college, and an online survey.

Because of the varied forms of engagement with our many diverse stakeholders, we needed some measure of consistency, which would be especially critical when it came time to analyze the feedback from our engagements. To achieve that consistency, we chose three central themes for our questions:

1. What is your current perception of sustainability at Evergreen?
2. What should a sustainable Evergreen look like in the future?
3. How do we get there?

These questions, conversations, forums and other engagements helped us define sustainability at Evergreen and determine the initial major steps for getting closer to our goal.

Vision quest

Once we completed our outreach, the task force assumed a leadership role. Members of the team were responsible for assimilating the information from these engagements and distilling the common vision and tasks to produce our sustainability strategy. We began this process by sequestering task-force members in a room, where they remained until they had put together a coherent vision that incorporated many of the community's diverse voices and suggestions.

As a result of these engagements, the following vision statement emerged:

"The Evergreen State College will be a laboratory for sustainability as demonstrated in its operations, curriculum and quality of life for employees and students. We will nurture values and practical skills that motivate a lifetime commitment to a sustainable, intergenerationally just way of living on a healthy planet."[1]

This larger vision is what ultimately propelled us to reach agreement on internally controversial steps toward sustainability, some of which require meaningful financial resources. These were our initial strategies for a sustainable future:

- Establish a curricular pathway in sustainability.
- Increase opportunities for a practical education in sustainability.
- Initiate a robust plan for reduced and efficient use of resources.
- Examine and implement best sustainable practices and purchasing policies.
- Increase communication and assemble the history behind Evergreen's sustainability goals, achievements and indicators.
- Manage Evergreen's land endowment for increased biodiversity and maximum educational opportunities related to sustainable practices.
- Become a carbon-neutral college.
- Strengthen bonds and relationships among all of Evergreen's programs.
- Strengthen bonds and relationships with Evergreen's neighbors and greater community region.
- Improve campus spirit and internal wellness, and foster healthy relationships.

We also realized that to help monitor our progress and coordinate this long-term effort, we needed permanent institutional support structures. In March 2008, we hired a full-time director of sustainability. As the newest member of the president's staff, the director helps to bridge academic programs, operations and the student experience in sustainability in a broad cooperative effort.

In August 2008, Evergreen's vice presidents formally created a permanent sustainability council, which includes about 25 faculty, staff and student community members. The council focuses on projects to enact clean energy systems, sustainable food practices, alternative transportation, waste reduction and green purchasing. Together, the sustainability council and the director of sustainability form the backbone of Evergreen's office of sustainability, which also includes graduate fellows and student interns.

BY REPLACING gasoline-powered vehicles with electric-powered ones, The Evergreen State College will save almost 6,000 gallons of gas and prevent the release of 60 tons of carbon-dioxide emissions over a seven-year period.

The road ahead

Early this year, an Evergreen graduate student working with the office of sustainability will complete a comprehensive sustainability-indicators report that will be the most thorough evaluation of our progress thus far.

Advancing sustainability often requires a two-pronged approach:

1. Individual behavior change.
2. Systemic and operational change.

In the coming months, the office of sustainability will further develop our Greener Living Program that incorporates community-based social marketing techniques into many of our sustainability initiatives. Shifting social norms can result in more sustainable behavior that promises to prevent the wasteful use of resources, which in turn has a positive impact on the college budget, and instills values and habits that will carry on long after students graduate from Evergreen.

Additionally, the director of sustainability will work with graduate students in the environmental studies program to produce Evergreen's first climate action plan. This plan will serve as a long-term institutional roadmap to carbon neutrality.

Although our strategies are well reasoned and discussed at length, the focus is increasingly on measurable outcomes and actions. We embrace theory but thrive on practice.

Practice 1: Evergreen integrates campus operations and teaching with its curriculum and planning. Everything starts with people. For several years, our dedication to environmental sustainability

STUDENTS ROAMING the campus at The Evergreen State College see the results of the institution's sustainability efforts in the classroom and have the opportunity to aid similar efforts by local companies.

has been a factor in recruitment and hiring, particularly among senior officials, such as the vice president for administration and the director of facilities.

All segments of the Evergreen community—students, faculty and staff—actively participate in advancing sustainable practices through governance structures. By integrating operations and curriculum, Evergreen community members learn transferable skills that allow them to make lifelong contributions to achieving a more environmentally sustainable world.

Governance efforts bridge academics and operations through the management of the campus land, building space, green building design and purchasing policies. This has led to a number of management innovations.

The new, groundbreaking campus master plan features a series of education centers on our 1,000-acre campus that will engage students in studying campus environment and facilities impacts. This includes a storm-water monitoring center, sustainable design resource center, organic farm education center, Terrascope interdisciplinary center to study the evolving tree canopy of second-growth forest, alternative energy education center, and a solid waste stream and renewable fuels education center.

2

Practice 2: Evergreen welcomes student initiative. Students drive Evergreen's green efforts. A self-imposed student tax offsets 100% of Evergreen's electricity use through green tag purchases. Building on our achievement of the first publicly funded Leadership in Energy and Environmental Design (LEED)-certified gold building in the state of Washington, students voted to renovate our campus activities building to achieve LEED gold status.

This year, Evergreen's clean energy committee funded 14 projects, including a biodiesel production facility for our organic farm, a nine-kilowatt photovoltaic array for our library building, solar-powered lighting for our covered bus shelters and a new solar-powered weather station that will collect data and reduce campus water use by 6.5 acre-feet per year.

3

Practice 3: Evergreen enables sustainable living on campus. Sustainable living is Evergreen's guiding principle and is woven into its identity, values and building environment. We enable a lifestyle in which human communities can coexist in harmony with ecological communities. A walk around campus quickly reveals this. Our campus is located on nearly 1,000 acres of Pacific Northwest forest. Our campus core consists of teaching gardens that provide exceptional educational value and landscaping that is herbicide and pesticide free.

Among an increasingly wide stream of awards for sustainable practice, green building, education and conservation, we were recently recognized by the U.S. Environmental Protection Agency as one of the best workplaces for commuters. We provide transit passes to faculty, staff and students, offer a guaranteed ride home program, provide commuter and bicyclist lockers, and employ staff and students to encourage greener commuting options.

Evergreen's food-service purchases from local and organic sources is up 28% from 20% in 2006. Students recently opened the Flaming Eggplant Café, with a focus on sustainable food service. We offer a vigorous ecological agriculture program that works in conjunction with our organic farm and local farms.

This commitment also extends to purchasing. The energy savings plan will reduce carbon output by 500

tons and save $73,000 per year. We recently retired five gasoline-powered vehicles and replaced them with electric-powered ones. Over the seven-year lifespan of each electric vehicle, we will save 5,950 gallons of gasoline and 60 tons of carbon dioxide pollutants.

Practice 4: Evergreen embodies environmental ethics in its academic offerings. The Evergreen community—students and employees—are dedicated to a sustainable future. We recognize that civilization is at a crossroads: Global population is increasing, natural resources and our planet's ecological life support systems are in decline, rates of consumption and resource extraction are increasing, and half of the world's population lives in poverty. These trends cannot continue.

At Evergreen, we embrace this challenge and work and teach every day to help overcome challenges and realize opportunities. We believe every Evergreen student requires a basic education in sustainable thinking and living. Without it, students will be ill-prepared for life and work in the 21st century.

Moreover, our community thinks critically about our institutional practices and about the theoretical underpinnings of what a sustainable society would look and feel like. Our community strives to be a model for sustainability and social justice.

Our curriculum is cross-generational in focus, with emphasis on social justice and environmental responsibility. A sampling of sustainability-related programs for 2008-2009 include the following course titles: Climate Change; Conceptualizing Native Place; Environmental Health: Science, Policy and Social Justice; Food, Place and Culture; Green Studio; Mediaworks in Context: Sustainability and Justice; Practice of Sustainable Agriculture; The Pacific Northwest: History, Culture and Environment; Toward a Sustainable Puget Sound: Place, People and Policy; and Why Businesses Succeed: Designing a Sustainable Company.

Another example of Evergreen's commitment to sustainability in academics is the "Curriculum for the Bioregion" initiative of the Washington Center, which was established in 1985 to improve the quality of undergraduate education in the state of Washington.

The initiative is viewed as an opportunity for a collaborative teaching approach that can be applied to existing courses, while presenting students with the environmental issues facing the community. The intent is to connect faculty and students with the organizations working on solutions to those issues. As a result, students will be better prepared to live in a world in which the complex issues of environmental quality, environmental justice and sustainability are paramount. This curriculum is shared with institutions across the state.[2]

Practice 5: Evergreen's academic model encourages students to embrace complexity and meet complex challenges. Visitors to Evergreen from around the country want to know how a small college tucked in the Puget Sound region of Washington has been able to inspire such a deep level of commitment to a sustainable future.

The answer, like Evergreen, is multifaceted. The subject matter of ecology and society, the challenges of sustainably living within nature and the solutions to challenges such as climate change are cross-disciplinary. Evergreen develops a student's aptitude to deal with complexity, and the college's educational philosophy encourages creativity, critical thinking and cooperation.

Evergreen students are required to think laterally, develop broad perspectives and specialties, and define what inspires them, be it art, science or politics—or all at the same time. As an alternative to grades, professors provide written reviews of student work that more closely approximate the feedback they will receive in their professional lives.

At Evergreen, our philosophy—extending back almost four decades—has been to encourage students to struggle collaboratively with issues from a variety of disciplines and perspectives, and embrace creative solutions to real-world challenges. We see our job as offering a practical liberal-arts education that will provide students with theory and skills to live better, more environmentally friendly lifestyles. QP

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JOHN PUMILIO is the director of sustainability at The Evergreen State College in Olympia, WA. He received a bachelor's degree in environmental and forest biology from the State University of New York at Syracuse and a master's degree in environmental studies from The Evergreen State College.

JASON WETTSTEIN is the media and community relations manager at The Evergreen State College. He earned a master's degree at Georgetown University, studying international politics, communications, science policy and public administration.

Human

In 50 Words Or Less

- Safety concerns in the workplace involve more than just individual safety.
- The safety of employees and customers, concern for the environment and concern about employee satisfaction can be considered critical to humans (CTH).
- CTH should be another branch on the critical to quality tree.

by John Nelson and
Jean-Paul Lemarquis

Touch

Making the human element a necessary part of the **critical to quality** tree

"NO JOB IS SO IMPORTANT, nor service so urgent, that we cannot take the time to perform our work safely."[1]

Those familiar with the old Bell System will remember this long-established safety creed. It helped guide many an employee's decision in potentially dangerous situations.

Today, we can widen our interpretation of these words to embrace not only immediate, personal safety concerns, but also the effects of actions on the environment and the health and safety of any person impacted by a process.

Health and safety and environmental responsibilities are basic precepts of the practice of quality. For example, when assessing the impact of a particular potential mode of failure in a failure mode effects analysis (FMEA), the highest severity ranking is often described as "hazardous without warning," "very high severity ranking when a potential failure mode affects safe vehicle operation and/or involves noncompliance with government regulation without warning," or "may endanger operator (machine or assembly) without warning."[2]

Many companies want to acquire ISO 14000 environmental management systems certification. They want to attract and retain customers who place an

Current flat tire change process / TABLE 1

Supplier	Input	Process	Output	Customer
Owner of the car	• Flat tire • Spare tire • Tools	1. Notice that a tire may be flat. 2. Pull over to side of the road. 3. Confirm there is a flat tire. 4. Get tools and spare tire from trunk. 5. Remove the hubcap. 6. Loosen the wheel nuts. 7. Jack up the wheel. 8. Remove the wheel nuts. 9. Remove the flat tire. 10. Mount the spare tire on the car. 11. Install the wheel nuts semitight. 12. Lower the car and remove jack. 13. Tighten the wheel nuts. 14. Replace hubcap if appropriate. 15. Place tools and flat tire in trunk. 16. Re-enter traffic and resume journey.	Functioning tire on the car	People in the car

	Examples of critical to process (CTP) — may have attributes of quality (Q), cost (C), delivery (D) or human (H) impact.*		Critical to quality (CTQ), cost, delivery and humans		Critical to satisfaction (CTS)
	CTP (H)	Adherence to speed limits.	CTQ	Ability to drive vehicle at desired speeds	To get to their destination as planned
	CTP (H)	Proximity to traffic of roadside location.			
	CTP (D) (Q) (C)	Existence and condition of spare tire.	CTD	Minimize time the vehicle is undriveable	
	CTP (D) (Q) (C)	Existence and condition of jack.			
	CTP (D) (Q) (C)	Existence and condition of lug wrench.	CTC	No immediate cost	
	CTP (D) (H)	Degree of corrosion of wheel nuts.			
	CTP (H) (Q)	Torque of reinstalled wheel nuts.	CTH	No injuries sustained	
	CTP (H)	Cleanliness of tires, jack and tools.			
	CTP (H)	Smoothness of traffic re-entry.	CTH	Clean people and clothing	

(*) Not an exhaustive list
SIPOC = supplier-input-process-output-customer
CTD = critical to delivery
CTC = critical to cost
CTH = critical to humans

increasing importance on the environmental impact their product choices may have. For instance, sales of hybrid vehicles in the United States rose 82% year-on-year in November 2007 to 33,233 units, or 2.8% of the total November light-duty vehicle sales, according to AutomotiveWorld.com,[3] suggesting more car buyers are choosing green-friendly options.

More companies have developed programs that reduce waste and energy to benefit the company's operations and address stakeholder concerns.[4] Environmental soundness has evolved from simply being an option that's virtually invisible to an expectation or requirement that, if fulfilled, induces excitement or delight.

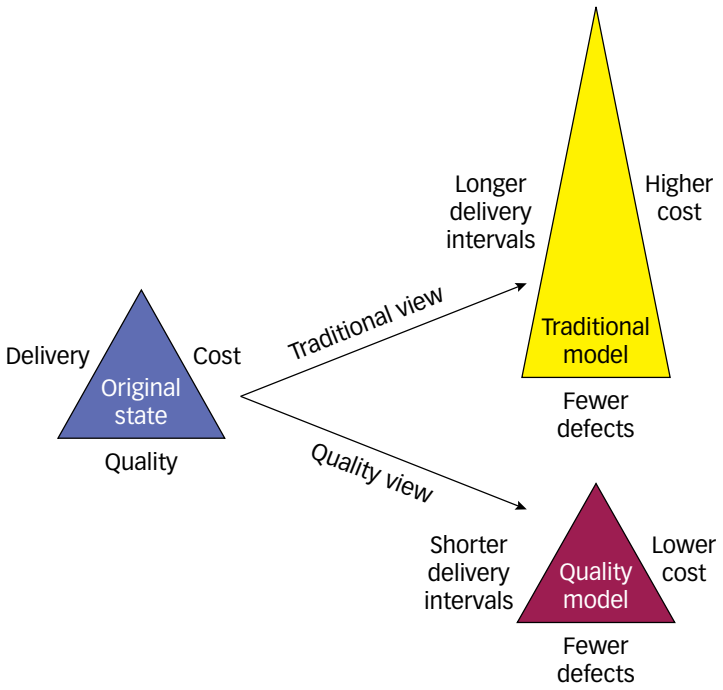
Companies are also keenly aware of the impact of employee satisfaction on productivity. Employee-value indexes, developed from comprehensive internal surveys, are used to gauge the collective state of mind of a workforce so action can be taken to bolster successful communication strategies.

These three issues—safety of employees and customers, concern for the environment and concern about employee satisfaction—may be considered critical to humans (CTH).

A decade ago, quality practitioners often used the quality-cost-delivery triangle to illustrate the challenge to the axiom that an increase in quality would result in higher costs and poor delivery. Figure 1 illustrates the now-accepted reality that by decreasing defects, delivery intervals and costs are reduced.

Today, the shape of quality should be the quality-cost-delivery-human square, as shown in Figure 2, to incorporate the belief that improving CTH factors will result in higher quality, lower costs and improved delivery.

The changing shape of quality / FIGURE 1



CTH and Six Sigma

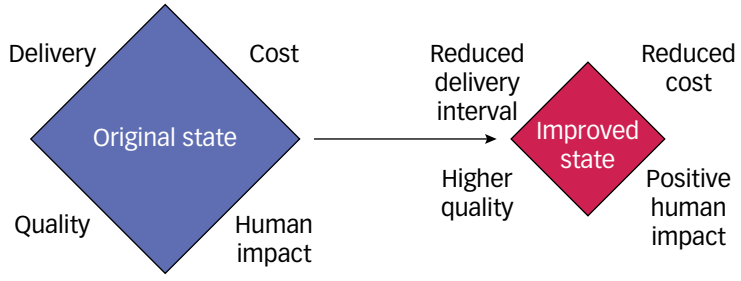
In the earliest phase of Six Sigma projects, a critical to (CT) quality tree is often used to break down general statements of customer needs—for instance, translating critical to satisfaction (CTS) into specific, measurable attributes.

Historically, three aspects of process output reflecting what is critical are considered: critical to quality (CTQ), critical to cost (CTC) and critical to delivery (CTD). Unlike the FMEA severity ranking, none of these attributes explicitly embraces factors that impact people—the CTH factors.

All the different CT components are related to the process we are considering. CTS is a general expression of why the customer needs the process output. CTQ, CTC, CTD and CTH are quantifiable attributes of process output. These output metrics describe the effects that are caused by the upstream process and its inputs.

We identify the causes (for example, the inputs and the process steps) and nominate those that have the most significant impact on the effects as critical to process (CTP). CTPs may also have the characteristics of

The quality-cost-delivery-human square / FIGURE 2



quality, cost, service or human impact.

We characterize the output metrics as *Y*s and the input and process metrics as *X*s, leading to the equation $Y = fx$, or to put it simply, the effects are a function of the causes. Figure 3 describes the familiar supplier-input-process-output-customer (SIPOC) concept that summarizes these relationships.

Fixing a flat

Consider this simple example. Many people have changed a flat tire. As part of a "changing a flat tire process improvement" initiative, one of the first things we need to do is to identify the customer. Almost everyone can agree the customers are the people in the car. What do they need from this process? They need to get to their destination as planned. This is their CTS.

Then, we need to discover and document the existing process and its output CTs using SIPOC. To achieve the process output—a functioning tire on the car—the following critical characteristics may be measured:

- CTQ: The ability to drive the vehicle at desired speeds.
- CTD: The time the vehicle is not driveable.
- CTC: The cost not to exceed a given figure.
- CTH: Any injuries sustained and the cleanliness maintained.

The SIPOC concept is illustrated in Figure 3. The CTs and examples of CTPs that have attributes that are CTHs in the flat tire process are included in Table 1 (p. 32.

Consider CTHs early

You could argue that safety and environmental concerns will be addressed eventually, in the fullness of time. This could occur in the project or initiative when the project team conducts an FMEA, when the user's manual is reviewed by the company lawyers, when the first lawsuit is filed, or when the first person is injured or killed.

You could argue that CTH aspects may be merely a subset of those CTQ or CTD.

By explicitly bringing CTH factors to the forefront of a Six Sigma improvement or design project, you give the project team a head start. By treating CTH factors at the outset of a project with the same rigor as quality, cost, or delivery, project teams may be able to pinpoint root causes and, perhaps, aspects of solutions they might otherwise miss. These may include health, safety, environmental and employee concerns. Considering these aspects at the beginning of a project could pay big dividends later when there may be limited time to implement the solutions.

In trying to provide a solution and prevent flat tires that leave travelers stranded, the automotive industry has expanded the flat tire changing process to include avoidance of flat tires altogether. The industry has generalized the CTS as the ability to travel safely with a certain liberty—anytime, anywhere. In a literal sense, an automobile ("auto" meaning self and "mobile" meaning capable of movement) actually becomes an "auto-stationary" when it suffers a flat tire. It fails the quality test of fitness for use.

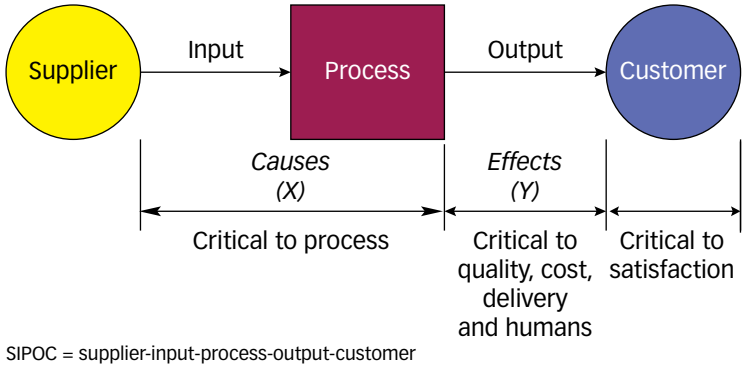
The outputs of the process of avoiding flat tires have a number of significant CTH attributes—for example, personal safety in adverse weather or unsafe areas. But who has ever asked a car dealer for a guarantee that a new car will never suffer a flat tire?

Fortunately, the automotive industry has recognized this CTH, and some provide roadside assistance as part of warranty packages. But the industry has gone further and developed solutions such as tires that can be driven on for 30 miles while they are flat and tire pressure monitoring systems that warn the driver of tire problems.

Curing a compensation process

One of the authors of this article worked on a Six Sigma project to improve an organization's disability compensation process. Injured or sick employees typically experienced delays of up to three weeks before receiving payments. This caused financial and emotional stress for employees and their families.

The SIPOC concept / FIGURE 3



SIPOC = supplier-input-process-output-customer

CTHs can help **Six Sigma teams** address the **process life cycle.**

Beyond that, the administrative clerk in the HR department who handled these matters described how miserable her life had become as she tried to explain the delays. One outraged worker actually threatened the clerk's life because he held the clerk personally responsible for the unjustified financial crisis he and his family were suffering.

A Six Sigma project was initiated to address the compensation delay. The project team identified several process outputs (CTQ, CTD, CTC and CTH). Among the CTHs was the poor relationship between upset employees and the HR clerk.

Several solutions were found that addressed the vital few CTPs, which affected that CTH. Solutions included communicating immediately with the insurance company through a fax, rather than mailing an original form, to minimize the claim process cycle time. As a result of the project, employees received their checks on time, which eliminated the financial stress affecting their family life and the need to complain.

The HR clerk immediately experienced a real change in her life, and her job was more rewarding as she became known as a very helpful employee. The project eliminated the disturbing effect on her and on the entire department when an angry employee raised a fuss just to get what he or she rightfully deserved.

The project team had identified the factors of the upset employees and the stressed clerk as CTHs, along with CTD, CTQ and CTC issues. Both of these CTH attributes are real and measureable. By recognizing two process output attributes (*Y*s) that were CTHs, the team's understanding of the impact of delivery issues was enhanced, and they were able to recognize some CTPs (*X*s) as vital to problem resolution.

A riveting example

Riveting aircraft wings is a process that has been applied for many years and is perceived by many as mature and perhaps beyond improvement. Rivet flushness (CTQ) is a key contributing attribute to wing aerodynamics. Flushness nonconformity requires repair and rework, and the most frequent cause identified was human error. This generated significant employee frustration, and other workers in the plant labelled that workstation as the worst area to work in (CTH).

Several Six Sigma projects were performed to improve and control this manufacturing process. One of the causes identified was the measuring system used to control the countersink drilling. With new instruments (CTP) available, the process was brought under control and the rivet flushness problem was eliminated. As a result, not only was rework reduced and quality improved, but the CTH was improved. This work cell shed its bad reputation, and employees regained pride in their work.

Internal and external customers are aware of and sensitive to process output attributes that are CTH. Awareness and formulation of CTHs can help Six Sigma project teams better address direct and indirect needs of the organization and help teams understand and address the entire process life cycle. QP

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JOHN NELSON is a Six Sigma professional specializing in training and coaching. He has more than 25 years of experience in telecommunications operations, much of that in quality and process improvement. Nelson has a degree in civil engineering technology from Mohawk College of Applied Arts and Technology in Hamilton, Ontario. He is a certified Six Sigma Black Belt and a senior member of ASQ. He belongs to ASQ Chapter 400 in Hamilton.

JEAN-PAUL LEMARQUIS is a design for Six Sigma specialist at Bombardier Aerospace and a Six Sigma consultant. He teaches at École Polytechnique of Montreal. Lemarquis is a mechanical engineer with more than 30 years of experience in R&D, project management, consulting and training. He has also taught at the École Nationale d'Aéronautique in Saint-Hubert, Quebec.

FMEA Minus the

Splitting the assessment into **two phases** **eliminates some challenges**

In 50 Words Or Less

- Team activities, such as brainstorming, can be taxing during failure mode effects analysis (FMEA).
- Split the assessment into cause and effect analysis and ranking to make human interaction more effective.
- What results is more effective FMEA sessions free of traditional obstacles.

by Govind Ramu

HEADACHE

FAILURE MODE EFFECTS analysis (FMEA) has stood the test of time as a powerful risk assessment tool for products, processes and systems. This has been true since its beginnings in the U.S. military in 1949 through its early uses in aerospace to its extension to automotive manufacturing,[1] healthcare[2] and other industries.

As with any team tool, however, FMEA comes with its own challenges. In particular, the sustained brainstorming and consensus-building required to rank risks and prioritize failure modes can be physically and mentally exhausting.

Partial FMEA table / TABLE 1

Subassembly description / process step	Function	Failure mode	Local effects	End effects	Severity	Causes	Occurrence	Current controls	Detection	RPN

An innovative approach to completing a thorough FMEA without exhausting your team is to split the assessment into two phases:

1. Cause and effect analysis.
2. Ranking.

Separating causal analysis from ranking allows your team to focus on one type of activity at a time and offers you a chance to avoid some of the challenges and obstacles related to the traditional FMEA approach.

Traditional approach

Typically, a cross-functional team will complete an FMEA through the following steps:

- Review design and process using a functional block diagram, system design, architecture and process flow chart.
- Use a brainstorming approach to gather potential failure modes.
- Use historical data from customer returns, complaints and internal issues from comparable products or processes.
- List potential effects, both internal and external, of failure.
- Assign severity, occurrence and detection (SOD) rankings based on the effect, probability of occurrence of the root cause and ability to detect the root cause before the failure mode happens.
- Calculate the risk priority number (RPN) by multiplying severity, occurrence and detection rankings. Also, calculate criticality by multiplying severity and occurrence.
- Prioritize the failure modes (risks) based on RPN score and/or criticality.
- Take actions to eliminate or reduce the risks.

At first glance, this list looks simple and straightforward. The practical reality, however, is that com-

TRADITIONAL APPROACH PITFALLS

In developing the innovative approach to FMEA facilitation presented in this article, I had to examine what can go wrong with the traditional approach.

During development:

- Not understanding the fundamentals of failure mode effects analysis (FMEA) development.
- Inadequate representation in the team from subject matter experts.
- Failing to identify the right inputs for the FMEA.
- Poor planning before assembling for brainstorming and failure ranking.

During implementation:

- Breaking the sessions into weekly meetings (thus losing continuity).
- Using severity, occurrence and detection (SOD) scales that are not representative of the industry, product family or process group.
- Failing to learn from the risks exposed at the component and module-level FMEA while drafting at the system level FMEA.
- Allowing the rigor of the tool to drive the intensity of initial interactions, causing fatigue for participants.
- Wasting time on risk-rating debates.
- Failing to follow through on recommended actions.
- Failing to drive actions across the board in a systemic way.
- Failing to integrate the learning from design and process FMEAs or to link to control plans, critical to quality characteristics and critical to process parameters.

During sustainability:

- Not incorporating the identified, mitigated risks into manufacturing guidelines to be used for future product development.
- Failing to keep the FMEA alive by including feedback by subsequent stages of product life. —*G.R.*

pleting these steps can be more challenging than it appears. Moreover, when a team must repeat the same series of steps for multiple failure modes, fatigue is likely to take a toll on results.

Challenges

There are three major challenges to FMEA:

1. Quality of the FMEA: Due to their intensity, FMEA discussions should last no longer than an hour and a half per session. Otherwise, the process can easily tire participants and deteriorate the quality of the content.

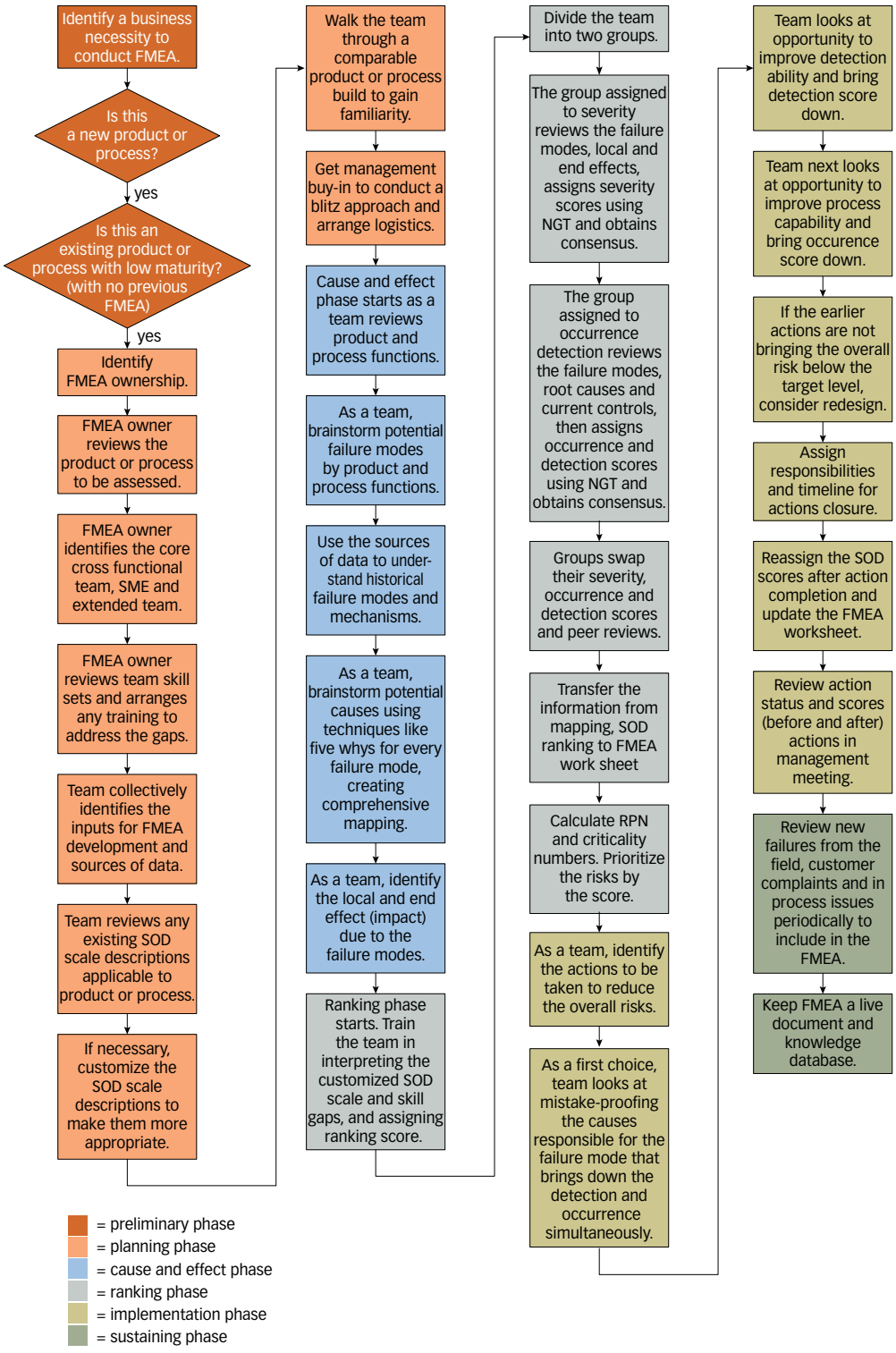
Most FMEAs are developed by conducting weekly meetings. Allowing too much time to pass between discussions is wasteful because in every meeting a significant amount of time is spent getting the team back on track.

This waste of time is due to interruption in continuity of the discussion because of team members' business travel, paid time off or simple forgetfulness regarding previous discussions. Even worse, team attendance will gradually diminish in subsequent sessions.

If all necessary data and information are collected up front, performing a one to two-day FMEA using a blitz approach with adequate intermittent breaks has a higher chance of success.

2. Quantity of completion: While plowing their way through the long list of FMEA steps, teams tend to try to brainstorm the failure mode, its causes, effects, severity, occurrence, current controls, detection and

New FMEA approach flowchart / FIGURE 1



everything else in one stretch, continuing this way until all failure modes are completed. The arrows in Table 1 (p. 38) illustrate the order of activity in this traditional approach.

These teams, by brainstorming causes, identifying the impact and relating to current controls for every line item, also spend a lot of time obtaining consensus on severity, occurrence and detection ratings one by one. Too many differences of opinion will jeopardize timely submission of the FMEA deliverable to the customer or the new product development team.

3. Bundling the causes: A common error FMEA teams make during the traditional process is bundling the causes in one cell of the table, as Table 1 illustrates, and assigning common occurrence and detection ratings. If a given failure mode has multiple causes, an occurrence rating must be assigned independently for each one of those causes.

For example, a failure mode of "incorrect dimension" could have multiple causes, such as improper loading, tool wear, incorrect machine setting, incorrect measurement method and incorrect material.

In the example in Table 1, improper loading and incorrect measurement happen more frequently than the other causes. Loading and measurement occur for every single part, whereas changes in materials, tools and settings happen at different frequencies.

Skills needed for FMEA completion / TABLE 2

Phase	Hard skills	Soft skills
Cause and effect analysis phase	• Flow charting. • Compartmentalizing products into subassemblies; system to components. • Brainstorming. • Mind mapping. • Five whys. • Seven basic tools of quality.	• Creativity. • Ability to see the big picture and small details. • Interpersonal skills.
Ranking phase	• Measurement scales. • Nominal group technique. • Multivoting. • Prioritization matrix. • Pareto analysis.	• Tact. • Interpersonal skills. • Communication skills. • Negotiation skills. • Logic and realism. • Conflict resolution skills. • Good sense of humor.

Similarly, based on the ability of the current control to prevent or reduce the occurrence of each cause, detection ratings are assigned. Following the example of "incorrect dimension," current controls associated with the cause of "improper loading" may be "visual," whereas for "incorrect measurement," the controls may be "automatic gauging."

The detection rating could be a very high number (lack of control) for "visual" and a low number (detection type error proofing) for "automatic gauging."

Therefore, there is more than one RPN for the same failure mode, depending on the number of causes. Bundling causes into one cell of the FMEA table means the individual risks are not assessed. See the sidebar, "Traditional Approach Pitfalls," (p. 38) for the list of things that can go wrong in FMEA development, implementation and sustainability.

Innovative approach

The innovative approach of dividing FMEA development into a cause and effect phase and a ranking phase makes the human interaction more effective and FMEA sessions more productive. I have implemented this technique and received positive feedback from users in terms of quality of content and productivity. The flowchart in Figure 1 (p. 39) shows detailed step-by-step instruction for implementation.

As discussed earlier, every step of an FMEA requires intense human interaction and active participants who have a variety of hard and soft skills. Table 2 summarizes the hard and soft skills that are essential for successful FMEA completion.

The first task is to ensure team participants have adequate exposure to and experience with the related hard skills that are required for FMEA development. If they do not, you can train team members as requirements surface.

Specifying too many prerequisite training requirements before facilitating an FMEA session can turn off participants. Training as the team moves along enforces the application of hard skills.

Soft skills are equally important. These skills or lack thereof can make or break a team. A quality engineer who acts as a facilitator can be an effective coach and mentor to the team for both hard and soft skills.

Cause and effect analysis phase

First, write down the function of the subassembly or

the process step. Then brainstorm the failure modes of the subassembly via design FMEA (DFMEA) or process step FMEA (PFMEA) and list them on a white board, as shown in Table 3. Use information such as customer return data and internal process failure data from a comparable product or process or supplier data, as appropriate.

To use the cross-functional team time effectively, the FMEA owner should take responsibility for the significant planning and preparation work represented in Table 3.

The next step is to ask five whys and get to the root cause. Red flagging the most likely root cause, demonstrated in the mind map in Figure 2, will help with assigning occurrence and detection ratings later.

This approach also ensures the causes are rated independently for the occurrence and detection ratings, as Figure 3 (p. 42) illustrates, and not bundled into one cell of the FMEA table. Having completed the mapping of the failure modes and causal chain, the team can start to identify local and end effects. This is required for assigning severity.

The figure's expanded mind map, with identification of local and end effects, feeds into the FMEA table, as shown by the lines linking the subtopics to corresponding table columns.

Brainstorm potential failure modes / TABLE 3

Subassembly function . . . potential failure modes:	Process-step function . . . potential failure modes:	Planning and preparation:
• Low power. • No power. • Fiber damage. • Delamination. • Moisture. • Electrical shock	• Contamination. • Oversize. • Undersize. • Low bond strength. • Surface scratches. • Over-etch. • Under-etch.	• Computer model of the product. • Functional block diagram. • Product system design. • Process flow diagram. • Historical Pareto of failures from various sources of data. • Customer returns and complaints. • List of current controls from similar or comparable products or processes.

Ranking phase

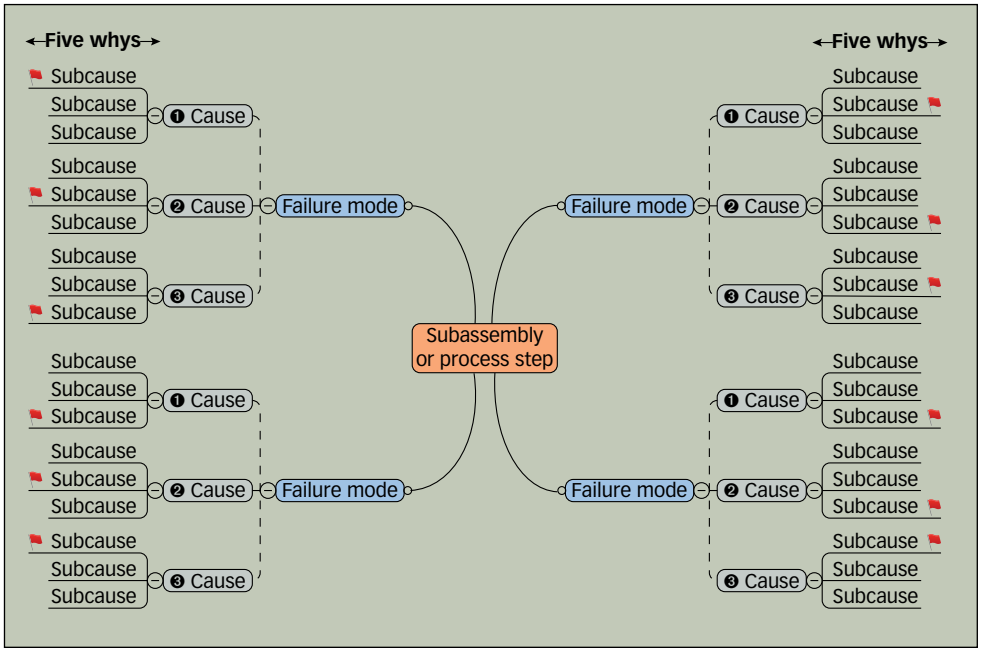
The scale descriptions and scales you use should adequately reflect your industry and product category. Having customized scales and descriptions is required to ensure appropriate ranking.[3]

Also, the scale descriptions should be detailed enough so team members easily understand the differences between ranks. Team members should be aware of the current controls in place to be able to assign detection rankings.

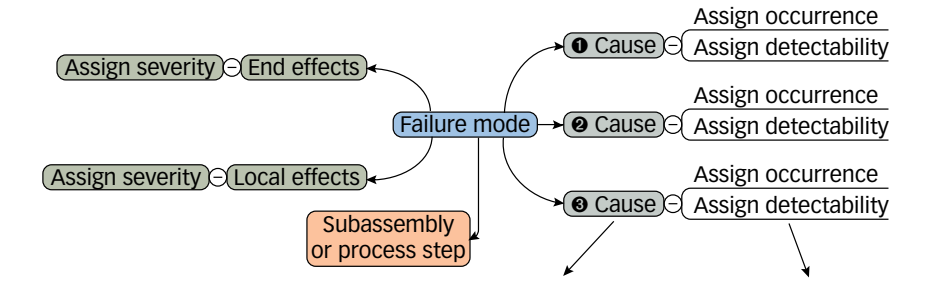
Print the scale description on chart-sized paper and place it in a visible location the team can always see. Consider dividing larger teams into two subteams that will work independently: one focusing on severity and another on occurrence and detection.

Now you are ready to start assigning severity, occurrence and detection rankings, which usually involve the most intense human interaction of the entire process. Because your FMEA team may be composed of anyone from high-profile scientists to shop-floor

Mind map of failure modes and corresponding five whys analysis / FIGURE 2



Expanded mind map / FIGURE 3



Subassembly description / process step	Function	Failure mode	Local effects	End effects	Severity	Causes	Occurrence	Current controls	Detection	RPN

operators, using nominal group technique (NGT)[4] to rank the SOD scales can ensure participation and build consensus much more quickly.

The team should revisit a given scale score only when the range is more than one point. In other words, if the scored data for severity of occurrence or detection by a team of eight people turn out to be 4, 5, 5, 5, 6, 6, 6 and 7, review why the two team members assigned the 4 and the 7 and resolve their disagreement.

Remember that the purpose of ranking is for prioritization, so higher risks can be addressed first. Risks with lower RPN are addressed later, not ignored. For this reason, a precision within one point is adequate for most occasions and does not merit further debate, which will only waste cross-functional team members' time. Adhering to this approach will help accelerate the traditionally time-consuming ranking phase.

If you have created a severity subteam, along with ones for occurrence and detection, then allow each subteam to switch gears and review the output of the other. A wide range of scoring within a scale by the team members will indicate issues with scale interpretation or appropriateness, a lack of necessary breaks between sessions or other opportunities for improvement.

Having completed the most human-interactive portion of FMEA development, your remaining activities are to update the other columns of the FMEA table, complete the RPN calculations and prioritize the risks by RPN score.

Knowledge management

Although this two-phase approach to FMEA is designed to speed the process, by no means does it represent a shortcut. In fact, your team should recognize it is making a long-term contribution to your organization.

Even if the team decides to transfer only the high-RPN, high-criticality[5] items to the FMEA table, the comprehensive mind-mapped diagram created in the cause and effect analysis phase will serve as a knowledge base for future reference.

Every FMEA should be treated as a living document. The team should remember to review the document periodically, updating it with newly learned failure modes, root causes and effects. This way, the team will be able to save significant FMEA development time for new products or processes by building on previous FMEA mind maps and reserving valuable discussion time for addressing any new areas. QP

MORE ON FMEA

For more articles on failure mode effects analysis, including the traditional approach, go to www.qualityprogress.com.

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Govindarajan "Govind" Ramu is a quality manager and Six Sigma Master Black Belt at JDS Uniphase Corp. in Milpitas, CA. He has also performed quality-related functions in different manufacturing organizations in India, Malaysia, Thailand and Canada. Ramu is an ASQ fellow and holds six ASQ certifications. He is a co-author of The Certified Six Sigma Green Belt Handbook *(ASQ Quality Press, 2008).*

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Off the

by Mark Edmund, associate editor

In 50 Words Or Less

- A team at Boeing used quality tools and data-measuring methods to examine the C-17 manufacturing process.
- The work resulted in the development of a machine that automates drilling fasteners into the aircraft's fuselage.
- The team demonstrated the project and won a gold award at ASQ's team competition last year.

Boeing project team takes C-17 manufacturing process to new heights

Ground

NONE OF THE 4,000 FASTENERS that were hand drilled into the fuselage of any C-17 cargo plane was misaligned or had gone missing. For years, Boeing has been building these top-notch planes out of its Long Beach, CA, facility. It just wanted to build them better.

So finding ways to improve the production of these large aircraft became the mission of one team, and the fasteners became the focus of one project for Boeing's C-17 program.

In doing so, the team used a host of quality tools and data-measuring methods that aided in developing a machine that automated the fastener-into-fuselage function. The team discovered new ways for the C-17 program to save time and money, and it made the production process more efficient while preventing injuries and ailments suffered among mechanics.

At ASQ's World Conference on Quality and Improvement last year, the team showcased what it did to complete the project, and it took home top honors—a gold award at the International Team Excellence competition.

Choices, choices

The quality-minded professionals that are part of Boeing's C-17 program always gravitate to areas that may help their mission. Maybe the robotic drilling function needs overhauling. What about updating existing automated machinery?

Members of the C-17 program manage data and processes using an over-arching seven-step continuous improvement model called the process-based management system, shown in Figure 1. Improvements are incorporated in step seven, revalidated in step three and then repeated through the model.

To determine what improvement project would be worth tackling this time, the team—Mark Adams, Pat Wishall, Ron Gill, Mike Caldarera, Sal Gutierrez, Jeff Stagner and Daniel Munoz—used lean value-stream mapping, trend analysis of performance metrics and brainstorming sessions.

Performance metrics, too, revealed to the team that a strong opportunity to improve the process existed. Early estimates through benchmarking and computer simulation showed the potential to increase efficiency by as much as 300%. Other benefits would include reductions in:

- The number of personnel by three.
- Rework and repair by 50%.
- Direct labor hours by 72%, saving 220 direct hours.
- Span time from six to two days.

To further identify specific improvement opportunities in the build process, the team incorporated several quality methods and tools: 5S + 1 (sweeping, sorting, simplifying, self-discipline, safety and standardizing); benchmarking users of automated drilling technology; observing the current process; and face-to-face interviews of manufacturing end users to obtain task-level information.

Improvement opportunities all came back to drilling, countersinking, deburring (removing sharp edges, burs or fins) and fastener installation. These activities were slow and inefficient because of the mechanics' repetitive motions and poor ergonomics. The team concluded that these deficiencies eventually led to:

- A poor build process.
- Stalled team performance.
- Poor tooling.
- Inefficient planning.
- Assembly rework and repair.
- Poor ergonomics and injury.

The team applied the Five Whys to examine the potential results of improving the situation of hand-drilling 4,000 fasteners. Then the team inserted answers into a cause and effect diagram, and hand-drilling again proved to be a common source of variation.

If the team could negate the negative influence hand-drilling was having on process and performance, significant improvements would be there for the taking.

The right solution

Now that the team was certain it had identified the crux of the problem, it could come up with specific answers. To develop them into workable and realistic solutions, the team conducted brainstorming sessions and used lessons learned from best practices. Specifically, the team got feedback from users of other automated systems that had been benchmarked, including flex rails used in Boeing's 787 program.

The Boeing C-17 project team leaned heavily on value-stream mapping to assess the impact of any of the possible solutions. For example, the team examined how using a stationary system for drilling and burring would differ from using a portable riveting system.

The team members weren't afraid to ask questions during these brainstorming and knowledge sharing sessions: "Can we automate the fastener installation?"

Process-based management / FIGURE 1

"What about that electromagnetic clamping stuff?" "Does the assembly need that many fasteners?"

After further analysis, the ideas were narrowed down to a high-level list of potential solutions, which included:

1. Automate drilling and countersinking.
2. Automate fastener installation.
3. Incorporate electromagnetic clamping.
4. Revise the required manpower used in the process.
5. Reduce the number of fasteners.
6. Move a portion of work upstream in the value-stream map.

Trying to predict success

Each potential solution was noted in the cause and effect diagram, and then the solution was inserted into the current value stream to identify any roadblocks.

For example, the possible solution of decreasing the number of fasteners required a 6 to 8% reduction in repetitive motion, man hours, and span and cycle time. Implementing the solution wouldn't cost much, which made it a viable solution to consider.

The final solution, however, was a combination of several on this list: electromagnetic clamping, automated drilling and countersinking, and automated fastening. As shown in Figure 2, combining these elements would maximize speed and accuracy while achieving first-time quality, burrless holes and fastener installation in a portable unit.

Another value-stream map was created, which contained a new process with the combination of solutions. The team ran computer simulations to verify process flow, cycle time and cost reduction data. The simulation also confirmed the reduction of ergonomic and repetitive motion issues, and it verified that manpower needs would drop. Combined, this all would enhance efficiency and cost of the build cycle.

Other data from a cost and benefits analysis were developed to justify the implementation of the solution so money would be allocated to pay for the project. In other words, the team translated the project into dollars and cents to convince management to fund the project.

This analysis included safety, regulatory, contractual, cost savings, assumptions and risk analysis data. From this, the team presented the following potential benefits of the project to management:

- A savings of 480 labor hours.

MEMBERS OF THE Boeing Co.'s univeral splice machine project team show off the gold award they received at ASQ's team competition last year.

- A return on investment (ROI) of about three to one.
- An internal rate of return of nearly 29%.

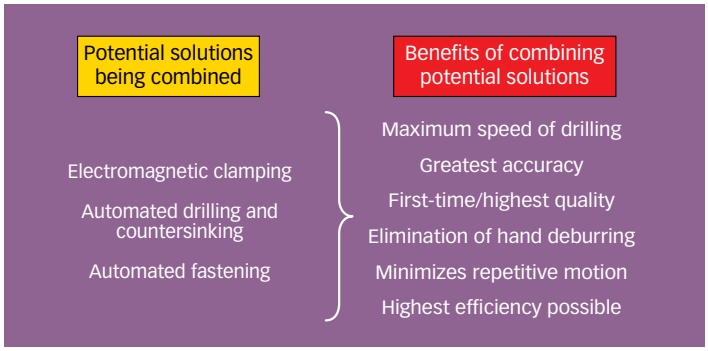
Risks were also noted, including:

- Low to medium risk for the electromagnetic clamping techniques to enable burrless drilling.
- Low risk for the multifunctional end effectors.
- Low to medium risk for the vacuum technology to attach and stabilize tooling and machinery on fuselage structures.

Developing the machine

From the discussions and activities—the analysis, examination, measuring and benchmarking—the universal splice machine (USM) was born. The automated machine—a joint project between Boeing and Broetje

Potential solutions / FIGURE 2



Automation—can hold parts on the fuselage as the machine drills holes and inserts fasteners. It drills holes without having to deburr and insert fasteners.

The first of its kind, the USM operates on a rail system mounted directly onto the fuselage using a vacuum cup system. The system is clamped onto the fuselage through the use of an advanced electromagnet. A control chart follows along next to the fuselage and includes an automated fastener feeding system.[1]

Some resistance

Once the USM project was approved, the machine built, and implementation begun, the team encountered some resistance during meetings with production mechanics and support personnel stakeholders.

Some mechanics feared job loss. Others worried about possible health risks associated with the technology. One mechanic asked about electromagnetic interference with pacemakers and hearing aids.

Production managers were concerned about the lower-than-normal performance levels during the time it took to train workers and implement the machine into the process.

To alleviate these worries and get buy-in from stakeholders, the team did two things:

Got everyone involved: Each stakeholder was included in the various phases of implementing the project: conception, goal setting, improvement identification, solution selection and development, and implementation requirements.

Stayed within requirements: The team adhered to funding requirements through earlier cost and benefits analysis, which documented anticipated benefits, risk assessments, ROI and internal rate of return.

The team answered all questions to quell any fears and worries about safety and job loss. Data on the anticipated benefits of the solution were shared, which helped everyone buy into the project. Eventually, resistance to the project disappeared.

Actual implementation

The plan started with a list that itemized high-level requirements, and each was detailed to the lowest level to ensure all items and tasks would be tracked.

Off-the-shelf project management software was used to aid in this tracking. Each task was entered into the software, and a start and end date for each individual task's completion was included. Examples of specific tasks included: training production and programming personnel on USM technology and use, and a stakeholder process walk-through to choreograph the first day of production.

With this new USM thrown into the C-17 mix, new process standards were now needed. For example, production personnel now work to a set of process standards detailing fabrication, assembly, rework and repair of aircraft parts. After implementing the USM, an entirely new standard was created incorporating the use of the new USM into the build process.

Goals and results

There was little doubt that the team made the right decision in selecting this project. After all, the goals of the USM improvement project aligned with Boeing's C-17 program's organizational goals so well.

For instance, in terms of the program goal to use company assets efficiently, the USM project aligned well because by building an automated system (the USM), repetitive tasks were reduced and the program became more efficient. Other program goals and project goals synchronized together as follows:

- **Providing the highest quality:** The USM project provided greater quality and reduced repair and rework.
- **Lowering the cost of doing business:** The USM project reduced the number of hours necessary to build airplanes.
- **Reducing overall time to build:** The USM project optimized the workload of days required to build the airplanes.

After implementing the USM, manpower requirements were reduced from four mechanics to one mechanic, defects were reduced by 50%, hours worked were lowered from 311 to 97, and the overall time span went from six days to two days. The risk of suffering any injuries or ailments because of the repetitive motion of hand-drilling 4,000 fasters plummeted, and the mechanics' workmanship and efficiency reached new heights. QP

REFERENCE AND NOTE

1. Joerg Heithus and Patrick L. Wishall, "Universal Splice Machine," presented at AeroTech Congress and Exhibition in Los Angeles, September 2007.

This article is based on the presentation delivered by the Boeing C-17 project team at ASQ's World Conference on Quality and Improvement on May 16, 2008. The 70-slide presentation is available at http://wcqi.asq.org/2008/team-competition/pdf/2008-gold-presentation.pdf.

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 BY TIM O'CONNOR

Beyond Appearances

Modify Alzheimer's patients' behavior by thinking outside the box

THROUGHOUT MY 40 years in the healthcare industry, I have always believed quality must be intentional. The only true responsibility of a leader is to create an environment in which staff can choose to be successful. Unfortunately, in healthcare, the center of attention in determining quality is measuring how staff members comply to a rule, regulation, policy or protocol. The emphasis should instead be on an ongoing commitment to provide total quality.

A farmer once told me, "It ain't just the horse—it's the oats." Borrowing from that logic, it isn't just the process; it very well may be the people. If the box we focus on is always the process, there is a very good chance we may be thinking outside the wrong box.

I frequently ask the question "Who is the most important individual in our facility?" The answer I most often hear is the resident. Staff was usually surprised when I suggest it is, rather, the responsible, hands-on staff member. The reasoning is simple and straightforward: If your best quality improvement efforts are directed at establishing commitment of staff, they will, in turn, render superior care. This fact has proven to be true during my entire career in numerous settings.

For the last 35 years, I have created multiple seminars and educational workshops for healthcare staff directed at enhancing the quality of care. In every instance, we first established a shared vision of quality of care. We would ask the question, "Is what we are doing getting us what we want?" If not, then we can either change what we are doing or change what we want.

We can continue to improve and apply the same protocols and care processes over and over again with the expectation of attaining the results we want, but what happens when we fall short of the expectations and results we intended?

Meeting true needs

All behavior is purposeful. This fact holds true for every individual in all circumstances without exception, even for those who suffer from severe Alzheimer's disease.

In one particular long-term care workshop, I focused on meeting the true needs of the Alzheimer's resident and understanding his or her behavior. Once the workshop attendees understood and accepted the fact that all behavior is purposeful, they could observe, evaluate and respond appropriately, and manage Alzheimer's-related behavior quite effectively.

For example, an 82-year-old Alzheimer's resident lived in one of our facilities, and in the morning, he would wake up and urinate on the radiator under the window in his room. Policies and protocols were immediately put in place to monitor his fluid intake the night before, wake him earlier in the morning and assist him to the bathroom. More often than not, however, he continued his behavior.

All the traditional interventions were deployed to no avail. Policies and protocols were reviewed and new interventions were established. The care process was studied fervently to address the issue, and the resident was constantly approached and verbally encouraged by the staff to change his behavior.

You can imagine the nursing and housekeeping staff's ongoing frustration.

THE PERSONAL SIDE OF QUALITY

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It isn't **just the process;** it very well **may be the people.**

Not only was the odor repulsive and the sanitation situation unacceptable, the time spent cleaning the inside and outside of the radiator was substantial.

As a result of attending the Alzheimer's behavior workshop, however, a committed resident care aide took her newly acquired Alzheimer's-behavior knowledge base and decided to step back and think outside the box—not the protocol box, but the resident behavior box. She reflected on the fact that "if it is indeed true that all behavior is purposeful, then why is he doing what he's doing?" She spent time observing him and investigated his background and history.

A farmer for life

She learned he grew up on a farm and was a farmer his entire life. She thought about what this had to do with his behavior. One morning, she observed his behavior through a new mental lens and noticed the radiator was under the window. Outside the window was a tree the resident gazed at while urinating.

Then it occurred to her: Perhaps he was recalling his times on the farm and seeing himself out in the fields away from the house when a sense of urgency arose. Could it be that simple? That he had to urinate, and in his mind, there was an opportune tree?

Her solution was to purchase a three-foot plastic ornamental tree and place it in the resident's bathtub. She left the bathroom door open where the resident could see the tree immediately when he got up in the morning. It worked. He saw the tree in the bathroom and urinated in the bathtub, which was a lot easier to clean than the radiator.

It worked phenomenally. The resident retained his dignity, and the staff was amazed at how such a simple solution was so effective. Resident-care protocols and interventions were still in place and improved upon for more appropriate outcomes. In time, the resident was weaned from the tree and eventually used the toilet.

As for the aide, she was so proud and elated that her solution was effective, she could not wait to get to work and address other challenges. There was no need for her to focus on a level of compliance; to her, it was all a matter of commitment.

Understanding the past

There was another elderly gentleman, also afflicted with Alzheimer's, who would never bathe or shower. The staff initiated every conceivable intervention, but the man still refused to shower.

An aide stepped back, reflected on his behavior and investigated his background. She discovered he was a handyman for 50 years. A light went off, and she purchased a $3 wrench.

She approached the resident and told him the shower head in the bathtub didn't work. She asked him if he thought he could he fix it. The resident jumped into the bathtub and began, in his mind, to "fix" the broken shower. After a few minutes—and a few scratches on the chrome shower head—the resident proudly exclaimed the shower was fixed. The aide then asked if he would mind testing it out. The aide helped him take off his clothes, and he took a shower to test his work.

The shower was "broken, fixed and tested" every Wednesday morning at 9 a.m. from that day forward.

To say the least, all staff members changed their perspective on human behavior. For them, quality was not an option—it became their mantra.

"It ain't just the horse—it's the oats." Smart farmer. QP

Tim O'Connor is a management consultant in Big Flats, NY. He earned his MBA in healthcare from the State University of New York at Buffalo. He is a member of ASQ.

BY DILIP SHAH

Standard Definition

Getting to the bottom of measurement uncertainty

IN THE LAST edition of this column (January 2009, p. 52), I emphasized the importance of documenting measurement uncertainty to establish metrological traceability as it is defined in *ISO/IEC Guide 99:2007*. In this column, other *ISO/IEC Guide 99:2007* definitions pertaining to measurement uncertainty are discussed.

Measurement uncertainty is documented in an uncertainty budget, which is defined as a statement of measurement uncertainty, of the components of that measurement uncertainty, and of their calculation and combination.

Note: An uncertainty budget should include the measurement model, estimates and measurement uncertainties associated with the quantities in the measurement model, co-variances, type of applied probability density functions, degrees of freedom, type of evaluation of measurement uncertainty and any coverage factor.

On Sept. 30, 2008, the International Organization for Standardization (ISO) published *ISO/IEC Guide 98-3:2008—Guide to expression of uncertainty in measurement*, which replaced *ISO/IEC Guide 98:1995* (the U.S. equivalent guide is *ANSI/NCSL Z540-2-1997*).

To develop a measurement uncertainty budget, all known error sources contributing to the measurement process should be evaluated and estimated as either Type A or Type B evaluations of measurement uncertainty.

Type A evaluation is defined as the evaluation of a component of measurement uncertainty by a statistical analysis of measured quantity values obtained under defined measurement conditions.

Note 1: For various types of measurement conditions, see repeatability condition of measurement, intermediate precision condition of measurement and reproducibility condition of measurement.

Note 2: For information about statistical analysis, see *ISO/IEC Guide 98-3*.

Note 3: See also *ISO/IEC Guide 98-3:2008*, 2.3.2, ISO 5725, ISO 13528, ISO/TS 21748, ISO 21749.

Type B evaluation is defined as the evaluation of a component of measurement uncertainty determined by means other than a Type A evaluation of measurement uncertainty.

This includes evaluation based on information associated with authoritative published quantity values, associated with the quantity value of a certified reference material, obtained from a calibration certificate, about drift, obtained from the accuracy class of a verified measuring instrument or obtained from limits deduced through personal experience.

Note: See also *ISO/IEC Guide 98-3:2008*, 2.3.3.

The Type A uncertainty that is obtained by statistical analysis is expressed as a standard deviation and is called standard measurement uncertainty, standard uncertainty of measurement, standard uncertainty or measurement uncertainty expressed as a standard deviation.

The uncertainty budget **needs to be evaluated** whenever a **change in the process** occurs.

Type B uncertainty estimates are also converted to standard uncertainty estimates by correction factors based on their estimated probability distributions.

Combined standard measurement uncertainty (or combined standard uncertainty) is defined as standard measurement uncertainty that is obtained using the individual standard measurement uncertainties associated with the input quantities in a measurement model.

Note: In case of correlations of input quantities in a measurement model, covariances also must be taken into account when calculating the combined standard measurement uncertainty; see also *ISO/IEC Guide 98-3:2008*, 2.3.4.

When Type A and B uncertainty estimates are quantified and expressed as standard uncertainty, they are normally combined via the root sum square (RSS)

Coverage factors for reporting expanded measurement uncertainty / TABLE 1

Confidence interval	*k* coverage factor
68.26%	1.000
90%	1.645
95%	1.960
95.45%	2.000
99%	2.576
99.73%	3.000

method to derive the combined uncertainty. The combined uncertainty is denoted by u_c.

$$u_{c_a} = \sqrt{u_{c_{a^1}}^2 + u_{c_{a^2}}^2 + \ldots..}$$

$$u_{c_b} = \sqrt{u_{c_{b^1}}^2 + u_{c_{b^2}}^2 + \ldots..}$$

$$u_c = \sqrt{u_{c_a}^2 + u_{c_b}^2}$$

Expanded measurement uncertainty (or expanded uncertainty) is defined as the product of a combined standard measurement uncertainty and a factor larger than one.

Note 1: The factor depends on the type of probability distribution of the output quantity in a measurement model and on the selected coverage probability.

Note 2: The term factor in this definition refers to a coverage factor.

Note 3: Expanded measurement uncertainty is referred to as "overall uncertainty" in paragraph 5 of Recommendation INC-1 (1980) and as "uncertainty" in IEC documents.

The combined uncertainty is normally multiplied by a coverage factor (k) to report the expanded measurement uncertainty at approximately 95% confidence interval level ($k = 2$). The expanded uncertainty is denoted by:

$$U = k \cdot u_c$$

Table 1 shows the values for the coverage factors for reporting expanded measurement uncertainty at different confidence interval levels.

Therefore, when a traceable measurement x is made, it is reported with its associated expanded measurement uncertainty as:

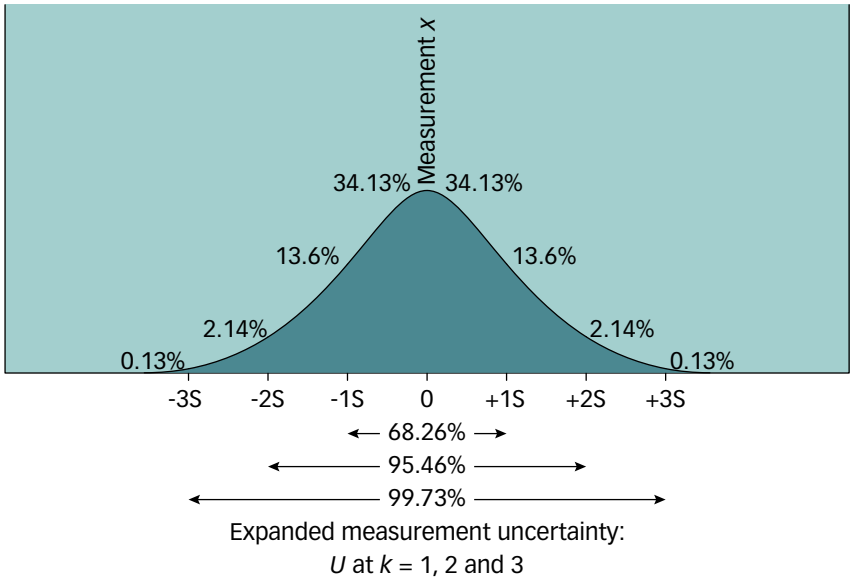
$$x \pm U_{k=2}$$

This means that the measurement x can be anywhere within the interval of:

$$x + U_{k=2} \text{ and } x - U_{k=2}$$

at 95.45% confidence interval.

Expanded measurement uncertainty of measurement *x* / FIGURE 1



Expanded measurement uncertainty:
U at k = 1, 2 and 3

The error associated with this measurement is the uncertainty, $U_{k=2}$, stated at 95.45% confidence interval. This is shown graphically in Figure 1.

The documented uncertainty budget is maintained for future reference when making measurements using the same measurement process (equipment, environment, operator and any other associated components). The uncertainty budget is a live document and needs to be evaluated whenever a change in the process occurs. Typical triggers for evaluation are:

- When equipment is calibrated.
- When equipment is replaced by another instrument.
- When the operating environment is changed.
- When operator interaction is changed.
- When any significant change in the process is made.

The general process of documenting measurement uncertainty with its associated definitions was outlined in this column. In a future column, the process of quantifying Type A and B uncertainties and developing an uncertainty budget will be discussed in detail using a measurement example. QP

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DILIP SHAH is president of E = mc3 Solutions in Wadsworth, OH. He has more than 30 years of experience in metrology and applications of quality and statistics in metrology. He is a past chair of ASQ's Measurement Quality Division and Akron-Canton Section 0810, and is co-author of The Metrology Handbook *(ASQ Quality Press, 2004). Shah is an ASQ-certified quality engineer and calibration technician, and a senior member of ASQ.*

STILL UNCERTAIN?

If you have questions to ask or answers to offer regarding measurement or metrology, log on to www.qualityprogress.com and post a comment on this article's page, or e-mail editor@asq.org.

Make Your Own Luck

Transform a basic quality model using sacred geometry

A COLLEAGUE mentioned that he thought of me as the most successful person he knew and asked for advice.

Ironically, I don't ever actually feel successful and am always trying to improve some aspect of how I do things, but I told my friend I was probably just lucky.

"Come on!" he said. "Surely you don't believe in luck." I explained that I just like to stack the odds in my favor. To improve my odds, I keep trying lots of new things until one works.

He looked at me a bit strangely and asked, "How do you do that without failing?" I smiled and said, "I fail a lot. I also know that if I keep trying, I will eventually succeed. People who don't try don't fail, but they also never succeed.

So, the bottom line is that the more often I fail, the more likely it is I'll succeed. I also need to be right only just slightly better than half the time to beat the odds. I can certainly do much better than that."

Seneca, a first century Roman philosopher, is quoted as having said, "Luck is what happens when preparation meets opportunity."[1] There are ways though to dramatically improve our luck. In fact, those of us in the quality assurance profession base our livelihoods on it.

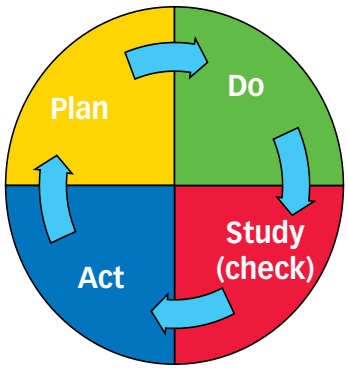
The most important elements of luck, from my perspective, are courage and wisdom, not necessarily in that order. To apply these elements to better assure success, I have slightly modified a basic quality improvement model.

The model is usually represented as a circle (see Figure 1) and is known as the plan-do-check-act (PDCA) or plan-do-study-act (PDSA) cycle.[2] But, by changing it from a circle to a spiral (see Figure 2), it makes a great model for the process by which we create luck.

The spiral I have chosen to use is based on what is sometimes referred to as sacred geometry, used in the design of sacred architecture and art.[3] This same spiral, the Fibonacci Spiral,[4] recurs throughout all forms of nature on earth and, on a galactic scale, throughout the universe. The chambered nautilus is a beautiful, naturally occurring example of the Fibonacci Spiral.

Notice that to be used as a model for luck creation, the spiral must swirl inward toward a goal instead of outward toward infinity. You might also look at this as a way to explain bringing order to chaos, reducing variation or continually improving.

PDSA or PDCA cycle / FIGURE 1



Eight steps

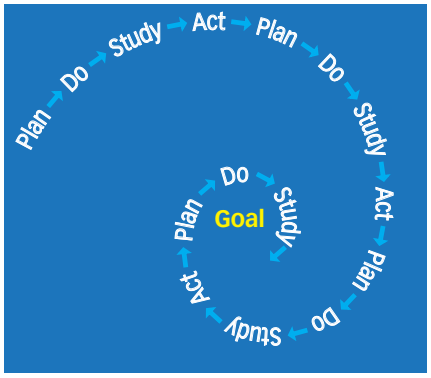
Here is a step-by-step explanation of how this model works:

1. **Plan:** Plan to be lucky. Plan to succeed. Plan to be ready when opportunity knocks. Figure out what you want.

> People who **don't try** don't fail, but they also **never succeed.**

   Establish a goal. Visualize success. Pick something, somewhere, someone, somehow to be.
2. **Do:** Try. Do something. Try something. Be bold. Overcome inertia. Create experience. You can experience success or failure, but the most valuable experience is often the result of failure. Experience is what you get when you don't get what you wanted. Great experience is the result of great failures.
3. **Study:** Learn. Understand. Collect information. Turn it into knowledge. Check your actual results against your expected results. Learn what worked and what did not so you can either repeat it or avoid repeating it. The most fundamental weapon against waste is knowledge.
4. **Act:** Take action. Try again. Do something else. Overcome inertia again. Never give up. Never quit. Never surrender. Continue. Persist. Resolve to keep trying, despite the likelihood of new failures. Continue after making

PDSA spiral / FIGURE 2



adjustments based on what you have learned. If you fail, consider this Rocky Balboa quote: "It ain't about how hard you hit. It's about how hard you can get hit and keep moving forward."[5]

5. Combine knowledge from step three with experience from step two to get wisdom, which can take you to the next level of effort with a better chance for success.
6. Combine experience from step two with the resolve required for action in step four to get courage, which can also take you to the next level of effort with a better chance for success.
7. Combine the wisdom from step five with the courage from step six and you have the two most fundamental elements for improved chances of success; in fact a significantly higher likelihood of success. The odds are now stacked much better in your favor.
8. Repeat steps one through seven as often as necessary to achieve success.

Especially for those of you who might think of yourselves as unlucky, I would like to leave you with one of my favorite quotes about luck from former Red Sox pitcher, the late Earl Wilson: "Success is simply a matter of luck. Ask any failure."[6] QP

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DIANE G. KULISEK of Simi Valley, CA, is director of quality for Moore Industries International Inc., president of CAPAtrak LLC, a writer and motivational speaker. She holds a master's degree in engineering management from California State University, Northridge. Kulisek is a senior member of ASQ and is active with the ASQ Food, Drug and Cosmetic Division and ASQ San Fernando Valley Section 706. She holds ASQ certifications as a manager of quality/organizational excellence and quality engineer.

BY SANDFORD LIEBESMAN

Dynamic Duo

Lean and Six Sigma improve profits and customer satisfaction

LEAN AND SIX SIGMA are two methods aimed at improving the quality of an organization's operations and its financial results. Both concentrate on customer satisfaction and improved business performance.

Lean's focus is on time and waste reduction and improved throughput, while Six Sigma concentrates on reducing cost and increasing profits by eliminating variability, defects and waste. It was natural to combine these programs because of the large amount of synergy among their goals and activities.

Lean Six Sigma (LSS) has links to financial management, ISO 9001, ISO 14001 and IT. The projects implemented as part of an LSS program generate value to the customer and to the organization, but they cannot operate in a vacuum. They require effective financial, quality, environmental and other management systems.

Conversely, these management systems can be greatly improved by using LSS to provide valuable changes that result in positive effects to the organization's bottom line.

Financial management

The major goal of LSS is to reduce the cost of operations and thus add value to the organization's bottom line.

A financial management system is defined as consisting of six elements:

1. Investment management.
2. A statement of cash flow.
3. A profit and loss (P&L) statement.
4. A balance sheet.
5. A general ledger.
6. A system of internal control.

Although LSS can contribute to each of the six, its major contributions are to the P&L statement and the balance sheet.

LSS contributes to the P&L statement by improving net profits. Profits are improved by increasing revenues through improved customer satisfaction, reducing waste and increasing product throughput by creating a more efficient manufacturing or service program. Thus, the organization can better satisfy its customers and earn increased revenue.

LSS also can improve the expense line in the P&L by reducing the cost of goods sold (COGS). It does this by improving the quality of supplied products and services and by reducing the cost of not only purchased materials, but also of operations and production. Again, reducing wastes can have a major impact on the expense line.

> The **major link** between LSS and IT is **project management.**

LSS's goal of reducing defect levels results in lower costs and better customer satisfaction. LSS can also be used to eliminate nonvalue-added activities, improve the efficiency of the organization's processes, decrease transaction costs and optimize organizational efficiency.

LSS can contribute to improving the balance sheet by reducing the cash tied up in inventory or decreasing the spending of capital. Also, reduction in nonvalue-added activities can eliminate the need for staff expansion. LSS can also improve intangibles such as customer satisfaction, employee satisfaction and workplace safety.

LSS is quite explicit about the desired financial benefits of each project, and many organizations define yearly dollar improvement levels expected for Champions, Black Belts and Green Belts.

LSS success stories

Many LSS success stories have been written. For example, the Naval Surface Warfare Center, Indian Head Division, initiated an LSS program in 2004 after other improvement programs failed. Naval personnel at the center manufacture war materials for fighters, including propellant mixtures, rockets, mines, undersea weapons and ship-mounted guns.

From 2005 to 2007, the center saved $8.9 million as a result of its LSS efforts.[1] Two of the improved processes were vendor certification, in which labor hours were reduced by 1,000, and the time needed to process travel orders, for which labor hours were reduced by 183.

The center also created a utilities algorithm that saved $584,000. In manufacturing, the center staff created real-time X-rays and digital X-raying of the Zuni Rocket. This reduced labor by 5,000 hours and saved about $300,000 in material requirements.

In another example, Honeywell International has had a great deal of success with LSS. From 1994 to 2002, Honeywell exceeded $3 billion in financial benefits from its program.[2]

At one of its chemical plants in Europe, the LSS team turned a $900,000 loss into a $3.4 million gain. The key tools used were

variance reduction based on design of experiments and process flow simplification.

ISO 9001 and 14001

For LSS to be effective long term, an organization must have efficient quality and environmental management systems, such as ISO 9001 and ISO 14000. Let's look at how Six Sigma's define, measure, analyze, improve and control (DMAIC) process works with these standards.

Define: The define phase is used to create project purpose, scope and scale. A team is created during this stage and may contain a sponsor, Black Belt leader, Green Belt support and other members. During this phase, the organization must hear the voice of the customer (VOC) to determine customer requirements.

Planning clauses of ISO 9001 relate to the define phase. Clause 7.1, planning of product realization, requires defining quality objectives and requirements; developing verification, validation, monitoring, inspection and test activities, acceptance criteria and records needed.

The organization is required to determine the requirements of the customer in clause 7.2.1, review the requirements related to the product in clause 7.2.2 and provide a means of communicating with the customer in clause 7.2.3.

The last clause related to the define phase is 7.5.1, control of production and service provision, which describes methods for planning and carrying out production. This includes requirements for product information; work instructions; availability of suitable equipment, including monitoring and measuring devices; and defining release, delivery and postdelivery activities.

The relevant ISO 14001 clause is 4.4.6, operational control, which requires creating procedures to identify significant environmental aspects and communicating applicable procedures and requirements to suppliers.

Measure: The measure phase is used to create a baseline for determining current performance of the product or service. ISO 9001 has three clauses relating to data gathering: 8.2.3, monitoring and measurement of processes; 8.2.4, monitoring and measurement of product; and 8.2.1, customer satisfaction measurements.

The relevant ISO 14001 clause is 4.5.1, which requires procedures to monitor and measure operations that can have significant environmental impacts.

Analyze: Sources of variation are investigated during the analyze phase. This phase starts with historical data but then focuses on gathering new data and looking for root causes of variability.

The relevant ISO 9001 clause is 8.4, analysis of data, which requires analyses to assure conformity to product requirements, understanding characteristics and trends of processes and products, and opportunities for preventive action. The relevant ISO 14001 clause is 4.5.2.1, which requires evaluation of compliance to legal and other requirements.

Improve: The next DMAIC phase is improve. This phase is supposed to create lasting process improvements. The team needs to decide which potential root causes to address and how to counter the effects of these causes. This phase also includes a small-scale implementation.

The relevant ISO 9001 clauses are 8.5.1, continual improvement; 8.5.2, corrective action; and 8.5.3, preventive action. The relevant ISO 14001 clause is 4.5.3, which requires identification of nonconformities and corrective and preventive actions.

Control: The final DMAIC phase, control, is where solutions are evaluated and the gains are maintained. The organization maintains control of the inputs and monitors outputs with the goal of reducing variation. A methodology is developed to

Relationships between ISO 9001 and 14001 and DMADV / TABLE 1

DFSS phase	ISO 9001 clause	ISO 14001 clause
Define: Listen to the customer.	7.2.1: Determine product related requirements. 7.2.2: Review the requirements. 7.2.3: Communicate with the customer. 7.3.1: Design and development planning. 7.3.2: Design and development inputs.	4.3.1: Identify environmental aspects. 4.3.2: Identify legal and other requirements. 4.4.6: Operation control: Plan operations associated with significant aspects. 4.4.3: Communication.
Measure: Determine critical to quality measures.	7.3.3: Design and development outputs.	4.4.6c: Operational control: identify significant environmental aspects.
Analyze: Determine and evaluate the high level design.	7.3.4: Design and development review. Identify problems and corrective actions.	4.4.6a: Operational control: control situations that could lead to environmental deviations.
Design: Create, evaluate, verify and optimize the design.	7.3.5: Design and development verification.	4.4.6: Operational control: ensure significant environmental aspects are carried out under specified conditions.
Verify: Create, run and analyze a pilot; start production; test in service; provide field service.	7.3.6: Design and development validation. 7.3.7: Control design and development changes.	4.4.6b: Control situations that could lead to deviations from environmental policy, objectives and targets.

provide early warning of problems.

The organization documents new procedures, sets up data collection and develops ongoing monitoring processes. During this phase, the implementers determine what they learned and pass the information on to the rest of the organization.

The ISO 9001 clause that supports control is 5.6, management review. This clause requires determination of the status of the quality management system. Subclause 5.6.2 requires a review of the audit results, customer feedback, process performance and product conformity, status of preventive and corrective actions, and follow-up of actions from previous management reviews. Subclause 5.6.3 requires decisions and actions to improve processes and products and provide needed new resources.

The corresponding ISO 14001 clause is 4.6, management review, which contains input and output requirements similar to ISO 9001.

There is a great deal of similarity between the way ISO 9001 and 14001 work with DMAIC and how they work with design for Six Sigma (DFSS). Table 1 (p. 57) shows the relationships to the DFSS process called define, measure, analyze, design and verify (DMADV).

The major link between LSS and IT is project management. Software used by organizations may have been developed for general projects, but LSS requires special software because of the vast array of LSS tools and the need to keep track of success stories, especially those showing financial gains.

Software is also needed to show the connections to the customers and suppliers of the organization. An effective LSS project must show an understanding of VOC and the communications with the design team and suppliers. There is a strong need to capture events, including periodic reviews of progress, as part of the project's history.

Database and program availability need to be straightforward so the LSS team can effectively pursue the project goals. This is especially important for those who work at remote locations or from home.

The automation of these tools and the management systems that use them require software professionals with a strong background in statistical analysis and program management. They must understand the fundamentals of LSS.

The basic goals of LSS are a simplification of processes by removing nonvalue-added activities and a reduction in variability and defectives during operations. Software developers need to keep these in mind when developing the LSS software. Of equal importance is the need to simplify the organization's processes before handing them over to the developers.

The LSS philosophy can have a positive effect on the development of software. In fact, DMADV or DMAIC philosophies are often applied to develop new software or reengineer old software.

LSS development will go through the same stages as any other software development. At the start of the project, the error rate will be high, and new problem conditions will be identified. Then, as fixes are applied, new sets of problems will arise. This is when application of DMADV or DMAIC can result in superior software being developed.

A good example is the basic cash flow process in a company. Good transaction management requires accurate purchase orders, a fast flow of information and low cost of management. IT is used to manage the transactions, and the system can generate a useful amount of data. This data can then be used as inputs to a host of automated LSS tools.

There are two types of software used to support LSS: analytical tools that perform statistical or process analysis and program management tools that track the LSS program and individual projects.

The **basic goals** of LSS are a **simplification of processes.**

Bottom line

Lean engineering seeks out VOC and then focuses on customer satisfaction while improving the speed of operations and reducing waste. Six Sigma determines the causes of defects and focuses on eliminating process variability.

Combining the two gives you a powerful program with a successful track record in improving the bottom line of a company and providing value to its customers. QP

A POWERFUL COMBINATION

For more articles on how combining lean and Six Sigma can increase profits and customer satisfaction, go to www.qualityprogress.com.

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1. Terry Widner and Mitch Gallant, "A Launch to Quality," *Quality Progress*, February 2008, pp. 38-43.
2. William J. Hill and Willie Kearney, "The Honeywell Experience," *Six Sigma Forum Magazine*, February 2003, pp. 34-37.

SANDFORD LIEBESMAN is president of Sandford Quality Consulting LLC, Morristown, NJ, following more than 30 years of experience in quality at Bell Laboratories, Lucent Technologies and Bellcore (Telcordia). He is an author of TL 9000, Release 3.0: A Guide to Measuring Excellence in Telecommunications*, second edition, and* Using ISO 9000 to Improve Business Processes. *Liebesman, a fellow of ASQ and chairman of the Electronics and Communications Division, is a member of ISO technical committee 176 and the ANSI Z-1 committee on quality assurance and a RABQSA International certified ISO 9000 and TL 9000 lead auditor.*

In a Certain Way

Quantifying uncertainty for meaningful and objective results

WHENEVER WE estimate a population parameter from a sample, in addition to providing a point estimate, we should also include an interval to characterize the associated uncertainty.

Let's explore what the confidence level means (the "95" in a 95% confidence interval), how statistical intervals differ from subjective ones and where it is common to have problems with the quantification of level if we are dealing with subjective intervals. Our ability to understand and explain uncertainty is instrumental to the good use of statistical methods.

Consider collecting a representative sample of parts from a stable manufacturing process, with the goal of estimating the mean population length of the parts by looking at the average sample length. Suppose you observe the average sample length to be 14.18 inches. It is unlikely our sample estimate will exactly match the true population value, but we are counting on it to be relatively close.

Without a range to quantify our uncertainty, it is difficult to interpret your results meaningfully. Could the mean population length be as large as 14.21 inches? 14.63 inches? 16.81 inches? What does relatively close really mean?

Suppose the 95% confidence interval based on our sample is 14.18 +/- 0.73 = [13.45, 14.91]. We can describe this as the range of sensible values for the population mean length based on the information gained from the observed sample. The 95% confidence level implies that if we repeated the procedure of collecting a sample many times, the resulting intervals will include the true population mean length 95% of the time.

This is not the same as saying there is a 95% chance the population length is contained in [13.45, 14.91]. For our particular interval based on a single sample, the true but unknown population value is either in the interval or not. But how should you think about the confidence level associated with this range?

General knowledge quiz / TABLE 1

Answer the following giving an upper and lower bound that you feel 95% confident will contain the true value.		
For example: Average age of U.S. men when they first marry (2006). Answer = 27.5 years	L: 20	U: 30
1. Number of square miles in the United States.	L: _____	U: _____
2. Population of the United States (2007).	L: _____	U: _____
3. Population growth rate per year (as a percentage) in the United States (2007).	L: _____	U: _____
4. Population of the United States (1900).	L: _____	U: _____
5. Gross national product of the United States (2007).	L: _____	U: _____
6. Population of the world (2007).	L: _____	U: _____
7. Average rainfall per year (in inches) in New York City.	L: _____	U: _____
8. Average temperature (in degrees F) in New York City.	L: _____	U: _____
9. Life expectancy of a typical American (in years, male and female combined).	L: _____	U: _____
10. Median age of Americans (2007).	L: _____	U: _____
11. Percentage of Americans (age >25) who graduated from high school (2007).	L: _____	U: _____
12. Percentage of Americans (age >25) who graduated from college (2007).	L: _____	U: _____
13. Median annual household income in the United States (2007).	L: _____	U: _____
14. Percentage of U.S. households with income more than $100,000 per year (2007).	L: _____	U: _____
15. Percentage of the U.S. population over 65 years old (2007).	L: _____	U: _____
16. Proportion of U.S. pregnancies resulting in twins (give as 1 in _____).	L: _____	U: _____
17. Percentage of world population living in Asia.	L: _____	U: _____
18. Height (in feet) of tallest mountain in the United States.	L: _____	U: _____
19. Height (in feet) of tallest mountain in the world.	L: _____	U: _____
20. Depth (in feet) of deepest point in the ocean.	L: _____	U: _____
L = Lower bound U = Upper bound		

Quiz time

On the surface, it appears to be relatively simple. Yet many of us are weak at appropriately describing and quantifying our

uncertainty. We are chronically overoptimistic about what we know.

For example, consider the 20-question quiz shown in Table 1 (p. 59). The questions all have known answers (if only you could get to a computer to do a few Google searches, right?). Take a moment to answer the questions using only your current knowledge.

Really—stop reading and fill in the blanks, but don't use the web or anything else to find answers. This will give us a basis for discussion for how well you can quantify your uncertainty.

The goal is to provide intervals for each question that correctly capture your knowledge by making them wide enough that you are confident 95% of the intervals will correctly contain the true value.

Before interpreting the quiz results, let's compare what the 95% confidence intervals and the exercise you have just done have in common and where they differ. One similarity is that the goal of the intervals is the same: to bound sensible values for a fixed but unknown value, calibrated by the long-run average of the true values being contained in their respective intervals 95% of the time.

Note that for a particular question, we are not sure whether the answer will be correct. We only know that over a large range of questions, we should maintain a specified standard.

One important difference is that a confidence interval is based on information obtained from a specific set of data. The quiz intervals were not based on data, but rather on less precise expert knowledge (OK, some of us may not want to claim to be experts on the topics of these questions). Hence, the confidence interval is objective; namely, for a given sample, we would all obtain the same answer, as long as we applied the appropriate method correctly.

Subconciously, **we are reluctant** to reveal **how little we know.**

The quiz intervals are clearly subjective. They are dependent on what information and background we have available. Even from one day to the next, we might answer a particular question differently. This leads to another difference between the two sets of intervals: Every time we use the confidence interval procedure, the chance of obtaining a sample that leads to a confidence interval that correctly includes the true value is the same.

Because we are each using a different collection of information for the answers to the subjective quiz, however, we are more likely to get some questions correct than others.

Calibrating uncertainty

Next, we explore our own calibration of uncertainty for the quiz. Take a moment to match your intervals with the answers listed in Table 2. Mark your answer correct if the true value lies between your lower and upper bound. Give yourself a score out of 20. Remember from the instructions, your goal was to make the bounds wide enough to get 95% (19 of 20 answers) correct.

How did you do? If you're average, you probably were not too close to the target value of 19 of 20. Table 3 shows a stem-and-leaf plot of the results of a nonscientifically obtained sample of my friends and colleagues (all of whom are trained in mathematics, statistics or engineering).

Recall that a stem-and-leaf plot is similar to a histogram, but it gives the detailed values of the quiz scores. The stems (left of line) give the first digit of the score out of 20, and the leaf (right of line) gives the second digit. For example, the top line of the plot with "0 | 0 1" means the two lowest scores were "00" (or 0) and "01" (or 1) out of 20. The highest score, denoted by "1 | 8", was 18.

Why are so many of us so consistently miscalibrated? Examine your own thought processes for selecting an answer. Often, the incorrect answers are the ones for which we would have said that we were more confident about the answer, and thus we did not build in enough margin of error to capture our true uncertainty.

There is also a sense that to be a good expert, we need to be precise about our answer for it to be useful, and so we are reluctant to build appropriate width into the intervals.

Subconsciously, we are reluctant to reveal how little we know. The majority of my participants answered only 40 to 70% of the questions correctly. The expert elicitation literature suggests this is quite typical. The only person in my sample

Stem and leaf plot of quiz results / TABLE 3

```
0 | 0 1
0 |
0 | 4 4
0 | 6
0 | 8 8 9 9 9
1 | 0 0 0 1 1
1 | 2 2 2 2 3 3
1 | 4 5
1 |
1 | 8
2 |
```

ARE YOU CERTAIN?

Do you think any of your investigations have been slowed because of missteps in quantifying uncertainty? Share your story or ask questions on the QP Discussion Board at www.qualityprogress.com or e-mail them to editor@asq.org.

who came close to achieving the target of 95% correct (with 18/20) admitted he first came up with a set of ranges, and then he intentionally doubled the widths of the intervals. Research has shown while there are many things that experts can estimate well, incorporating appropriate uncertainty is done poorly on a consistent basis, regardless of quantitative training.[1]

So what?

Why does it matter that we do not quantify uncertainty well? First, when presenting results, it is important to define what an interval means. We may see results published in the form "14.18 +/- 0.73" with no explanation given to whether this is a confidence interval or a mean plus or minus some number of standard deviations.

Without this additional information, the associated confidence level is left a mystery. Understanding how the interval should be interpreted and precisely specifying the definition of an interval in our own presentations will make the quantitative result much more meaningful.

Second, an awareness of this systematic miscalibration should lead to improvements in our own ability to think about uncertainty and to interpret other subjective intervals that we encounter in our lives.

Finally, given these problems with subjective intervals, it should make us appreciate available statistical tools, and provide for consistently meaningful and objective results to our scientific investigations. QP

REFERENCE

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CHRISTINE M. ANDERSON-COOK is a research scientist at Los Alamos National Laboratory in Los Alamos, NM. She earned a doctorate in statistics from the University of Waterloo in Ontario, Canada. Anderson-Cook is a fellow of the American Statistical Association and a senior member of ASQ.

General knowledge quiz answers / TABLE 2

1. 3.79 million square miles	11. 84.4%
2. 301 million people	12. 27%
3. 0.89% per year	13. $48,201
4. 76.2 million people	14. 19.3%
5. $14.2 trillion	15. 13%
6. 6.6 billion	16. 1 in 32
7. 40.3 inches per year	17. 61%
8. 54.7° F	18. 20,320 feet
9. 77.8 years	19. 29,029 feet
10. 35.3 years	20. 35,840 feet

QP TOOLBOX

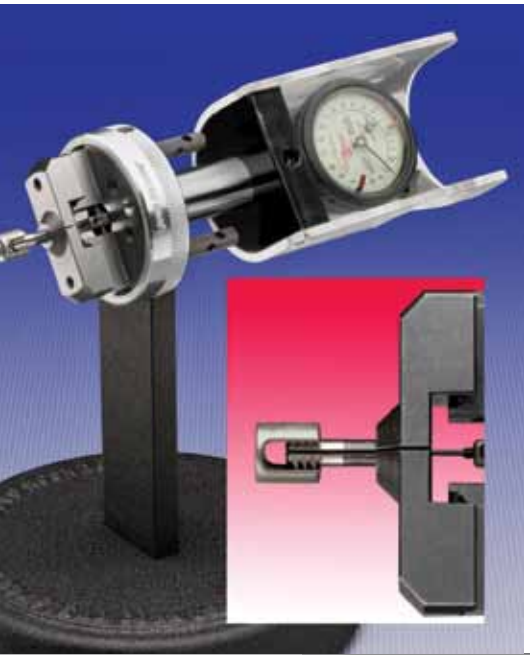
Noncontact blade measurement system ▸

NVision's Maxos XR expands the measurement capabilities for multiple vane applications in the aerospace and industrial power generation industries. Nozzle or vane segments of a turbine stator are difficult to inspect using optical measurement and time-consuming to inspect using conventional coordinate measuring machine technology.

The problem is the limited space between individual blades and the resulting angles of approach.

The Maxos XR addresses these problems. The sensor's concentrated light spot can measure at a standoff of 8 in. with an angle of incidence to the surface of as little as 15 degrees. The Maxos XR can scan between individual vanes and measure complete cross-sections of each blade segment at all required section heights.

Another feature for the measurement of nozzle segments is the ability of the Maxos XR to measure the position and depth of slot seals.



Call: 248-468-2525; visit: www.nvision3d.com.

Gage thread inspection system ◂

Johnson Gage has developed a thread inspection system for the verification and in-process control of reverse-angle buttress threads commonly used in anti-splaying medical devices such as orthopedic implants.

It's available for external or internal thread forms. The system, which is based on advances in grinding and manufacturing technologies, can be used for medical applications such as bone screws and dental implants. The system is suitable for inspection and manufacturing environments.

Common applications include design validation, dimensional inspection and conformance, initial manufacturing and tool verification, and in-process determination of capability degradation.

Call: 800-245-4243; visit: www.johnsongage.com.

Information lifecycle management software

ReportLine 3.0 information lifecycle management software from The Network can help organizations better manage their ethics and compliance programs with technology-assisted intake and dissemination, on-demand reporting analytics tools and secure case management.

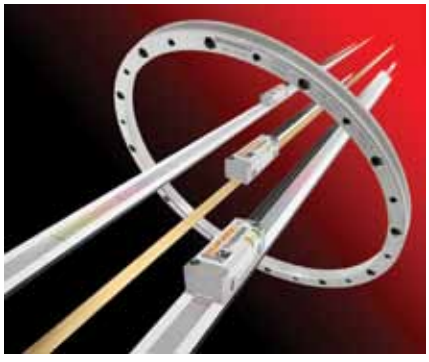
ReportLine 3.0 features dynamic graphics for viewing program information, additional standard reports, and Report Wizard, which allows users with no report writing experience to create, save and publish reports. ReportLine 3.0 also offers integrity checks, access to a library of benchmarking and case management data, and the ability to identify trends. Automatic date and time stamp of any change to a case results in a comprehensive audit trail, and a centralized database provides access to all issues and complaints.

Call: 404-929-0091 x209; e-mail: afilliat@arketi.com.

Optical encoder ▼

The Tonic from Renishaw provides a solution to problems found in a range of motion-control applications, such as manufacturing systems for the semiconductor, lab and medical fields. The optical encoder is available in linear and rotary versions, which support standard motion control to ultra high-precision stages.

The Tonic features Renishaw's autophase In-Trac optical reference mark.



In-Trac provides a bi-directionally repeatable index and temperature range without increasing overall system width. Integral dual limits are also available for users to select end-of-travel position.

Call: 847-286-9953; visit: www.renishaw.com.

Defect and rework tracking software

ASI DataMyte's Inspect 5.0 defect and rework tracking software offers visual inspection and dynamic data collection, event service and real-time reporting capabilities. The software features defect isolation, root cause tracking, custom defect lists for each inspector, checklist pop-up mode and direct entry, and warnings for duplicate defects.

Inspect 5.0 also includes additional filtering, searching and charting functions. The software is for aerospace, automobile, medical device, electronics and food industries.

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High-strength epoxy resin ▼

Impco's high-strength epoxy resin Imseal-800 makes permanent repairs in industrial maintenance, repair, production and tooling applications. It cures at room temperature or can be accelerated by heat. It provides resistance to pressure, impact and a range of chemicals and temperatures.

Imseal-800 goes deep inside cavities, inclusions and porosity in metal. It hardens to a permanent seal that can be drilled, tapped or machined. It's resistant to most fuels, oils, alcohols, glycols, solvents, salts, mild acids and Freon. Imseal-800 is packaged in a premeasured system that is activated by mixing the two parts inside the sealed packet.

Call: 401-521-2490; e-mail: mail@impco-inc.com.

Large ring gear ▲ measuring system

Wenzel GmbH has designed a coordinate measuring machine (CMM) for inspecting large ring gears and bearings used by manufacturers of large construction cranes. The inspection machine is capable of inspecting bearings and ring gears up to 6,000 mm in diameter. Each CMM measuring arm is mounted to a table that is, in turn mounted to a large granite base.

Both arms measure the large rings concurrently, and the metrology of each measuring arm is coordinated through the use of a specially designed calibration tool. The ring gears and bearings are located and clamped on a 2,200 mm diameter hydrostatic rotary table that can handle loads up to 100,000 lbs.

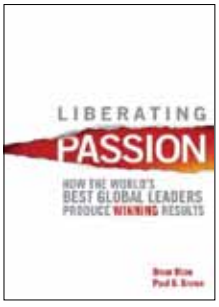
Wenzel expects this machine will have additional applications in the aircraft engine, wind energy and construction equipment markets.

Call: 248-705-8272; e-mail: kmills@xspectsolutions.com.

QP REVIEWS

Liberating Passion

Omar Khan and Paul B. Brown, John Wiley & Sons, 2008, 200 pp., $19.95 (book).



What would happen if employees were passionate about the work they performed, or if managers actively sought to create an atmosphere where that passion could be unleashed? It could have a tremendous effect on productivity, innovation, customer satisfaction, employee satisfaction and other measures of business success.

Unfortunately, this sentiment does not appear to be the norm in the workplace. The authors of *Liberating Passion* note a Gallup survey that indicated seven out of 10 workers feel disengaged. Why do so many people lack passion for the work they do?

The book begins by outlining several examples of passion killers: corporate strategy, customer focus and human resources. In each of these examples, the potential exists for energizing employees. But, by focusing on the technical aspects of execution, the joy and passion can be beaten out of the tasks until they become drudgery.

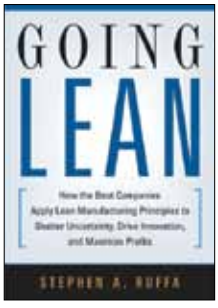
The authors provide a strategy for unleashing the passion that exists within the workforce. The nine points of this strategy provide a better understanding of how passion can be undermined and outline proactive approaches for addressing these passion killers. Some of the approaches focus on what readers can do to influence their own situation, while others can be applied by managers to change the culture within their organizations.

This book provides useful insights for anyone who feels the energy has been drained from their organization. If organizations become truly passionate about how their efforts and products contribute to the success of their stakeholders, change can be transformational. If the reader finds only a few useful pieces of information in this book and becomes only slightly more passionate and fulfilled about his or her own work, then it is worth the time invested.

Reviewed by Rich Anderson
Tucson, AZ

Going Lean

Stephen A. Ruffa, Amacom, 2008, 263 pp., $27.95 (book).



Because the future can't be predicted, drawing up a lean roadmap is a sensible strategy for most companies. In this book, Ruffa describes a lean roadmap for change that could prove to be very useful.

Ruffa graphically portrays company performance using a value curve, a tool used to study lean dynamics that accounts for a firm's capabilities based on its creation of value—a key focus of lean. It is an effective tool, because it shows how well corporations sustain positive results in response to dynamic change conditions. In this cyclical system, the value curve helps management understand the impact of process variations on the way value flows, which can lead to more favorable value curves.

Ruffa notes that operational flow interacts with three elements that make up the end-to-end flow of value: organization, information and innovation. Southwest Airlines, Wal-Mart and Toyota are used as examples of companies that have demonstrated the principles of lean dynamics and have transformed their flow to achieve superior results.

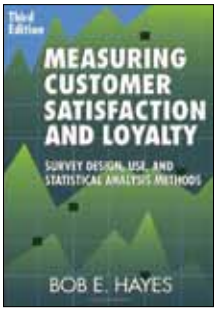
Organizations are encouraged to move beyond managing an operating system that was built to rely on consistency and limitless markets that no longer exist in the global economy. The system Ruffa presents challenges organizations to move from supply chains to value streams. In this approach, organizations in the supply chain must be value-stream partners and overcome their individualism to optimize the whole system.

Going Lean should be read by manufacturing executives and their staffs, and is recommended for corporate executives and leaders in quality or materials functions. It also has value for investors, who can learn how to apply the value curve to their portfolios. The book shows how to introduce innovation during downturns, strive for perfection and deliver excellent performance.

Reviewed by John J. Lanczycki Jr.
West Springfield, MA

Measuring Customer Satisfaction and Loyalty

Bob E. Hayes, ASQ Quality Press, 2008, 312 pp., $50 list, $30 member (book).



This book provides a set of guidelines for developing customer satisfaction questionnaires. It is totally self-contained, encompassing all aspects of the

process: determining the purpose of the survey, shaping the questions, selecting types of sampling, interpreting the data and following up after the survey is completed and analyzed.

Web-based and traditional hard copy surveys are discussed, and different scenarios showing how surveys can be used to further business processes are presented with specific commercial examples. Hayes also points out many of the subtleties and contradictions found in surveys, as well as the implications of results.

Nearly one-third of the book is presented in the form of appendixes, which are devoted to explaining the more complicated parts of the survey process—such as statistics, measurement, variance and analysis—in a simple, easily comprehendible manner. There is also an extensive bibliography for those looking for more information.

Notable for their clarity are Hayes' explanations of statistical sampling, measurement and the meaning of customer loyalty. Whenever possible, he also uses examples and figures to speed and enhance understanding. Helping that cause is an attached index, which proves to be a big help, because it's sometimes necessary to find specific items for reference.

In today's world, everyone is seraching for answers. This book can aid that search, helping the reader shape the questions needed to gain the information on which meaningful decisions are based. Reading this gave me a deeper understanding and more appreciation for the surveys that come my way—or less, when they're not done right.

Reviewed by Marc A. Feldman
Solvay Chemicals Inc.
Houston

Community: The Structure of Belonging

Peter Block, Berrett-Koehler Publishers, 240 pp., $26.95 (book).

This book is not an exploration of or a manual for technical aspects of quality-as-process or quality-as-result. It is not a measurement guide, and it is not a reference on implementing quality within the complexities of communities. The book is a guide that influences thinking about building, maintaining and strengthening communities of people.

Block makes this clear from the beginning, stating, "The essential challenge is to transform the isolation and self-interest within our communities into a connectedness and caring for the whole." He continues, "We begin by shifting our attention from the problems of community to the possibility of community."

Block explores neighborhoods, organizations, governmental units and the people who make things happen in each. An interesting project with this book would be to tie concepts presented and insights that result to quality philosophy—more specifically, how a quality philosophy can deliver results in a community.

The book is recommended for a limited audience—leaders working to develop communities beyond the traditional thinking about governance, measurement, statistics, authority, process control, budgets and the limitations of trying to lead by implementation of policies.

Reviewed by Gerald Brong
Ellensburg, WA

RECENT RELEASES

100% Leadership

Gabriel Hevesi, Enna, 2008, 130 pp. $21.99 (book).

The New Art of Managing People

Phil Hunsaker and Tony Alessandra, Free Press, 2008, 357 pp., $18 (book).

Enterprise Excellence

Normand L. Frigon and Harry K. Jackson, Wiley and Sons, 2009, 484 pp., $95 (book).

QP CALENDAR

To receive information or to register for ASQ Education Courses, contact Learning Offerings, ASQ, 600 N. Plankinton Ave., Milwaukee, WI 53203, call 800-248-1946 or 414-272-8575, fax 414-272-1734 or visit www.asq.org.

APRIL

1 ASQ Education Course. **Process-Based Auditing.** Orlando, FL.

1-3 ASQ Education Course. **Internal Auditor Training for AS9100.** Orlando, FL.

1-3 ASQ Education Course. **Rapid Results with Lean Methods for Healthcare Organizations.** Orlando, FL.

1-3 ASQ Education Course. **Implementing Statistical Process Control.** Orlando, FL.

2 ASQ Education Course. **Lean *Kaizen*—Virtual Course.**

2-3 ASQ Education Course. **16-Hour ISO 9001:2008 Lead Auditor Training.** Orlando, FL.

2-3 ASQ Education Course. **Cost of Quality: Finance for Continuous Improvement.** Orlando, FL.

7-8 **HACCP VI: Effective Procedure Writing and Document Control for HACCP.** Guelph, Ontario. Call the Guelph Food Technology Center at 519-821-1246 or visit www.gftc.ca.

13-17 ASQ Education Course. **Certified Quality Engineer Exam Preparation Course.** Toronto.

14-17 **Robust Product and Process Designs.** Detroit. Call Nutek Inc. at 248-540-4827 or e-mail support@nutek-us.com.

15 ASQ Conference. **Rochester Section 65th Annual Conference—Quality Convergence.** Rochester, NY. Call David Gilfoy at 585-330-7567 or visit www.asqrs.org/conference.htm.

17-22 **The Performance Improvement Conference.** Orlando. Call the International Society for Performance Improvement at 301-587-8570 or e-mail info@ispi.org.

20-23 **SAE 2009 World Conference: Racing to Green Mobility.** Detroit. Call the Society of Automotive Engineers at 877-606-7323 or e-mail customerservice@sae.org.

21-23 **Leadership Through Quality: Strategy and Execution, module 1.** Minneapolis. Call the Carlson School of Management at 800-388-3863 or visit www.carlsonschool.umn.edu.

27-29 ASQ Education Course. **Design of Experiments.** Toronto.

MAY

4-5 ASQ Education Course. **Lean for Service.** Oakland, CA.

4-5 ASQ Education Course. **Internal Auditor Training for ISO 13485:2003.** Oakland, CA.

4-8 ASQ Education Course. **Black Belt Quality Engineering Statistics.** Oakland, CA.

4-8 ASQ Education Course. **Introduction to Quality Engineering.** Oakland, CA.

4-8 ASQ Education Course. **Reliability Engineering.** Oakland, CA.

4-8 ASQ Education Course. **Certified Quality Engineer Certification Exam Refresher.** Oakland, CA.

7-8 ASQ Education Course. **Failure Mode and Effects Analysis—Design and Process.** Oakland, CA.

11-15 **14th Annual Knowledge Management Conference and Training.** Houston. Call the American Productivity and Quality Center at 800-776-9676 or visit www.apqc.org.

12-14 **Green Six Sigma Conference.** Chicago. Call Worldwide Conventions and Business Forums at 312-466-5774 or visit www.wcbf.com.

17-22 **STLE Annual Meeting and Exhibition.** Orlando, FL. Call the Society of Tribologists and Lubrication Engineers at 847-825-5536 or visit www.stle.org.

18-20 ASQ Conference. **Quality Institute for Healthcare.** Minneapolis.

18-21 ASQ Conference. **World Conference on Quality and Improvement.** Minneapolis.

SAVE THE DATE

If you'd like your event included in QP Calendar, submit information at least three months in advance to bkrzykowski@asq.org. Non-ASQ organizations may list one event per issue.

Are you in the business of **recognizing others?**

QP is updating its guide to quality-related awards given out by national, automotive, government, international and state programs. If you are involved in one of the programs, visit www.asq.org/pub/qualityprogress/past/0803/awards/38stateAwards.html (case sensitive) and check out the information.

If you notice anything missing or know of an award you would like included, please contact QP staff at manuscripts@asq.org by April 1.

To be included, awards have to meet specific criteria. They must be quality related, eligibility cannot be limited to members of a sponsoring organization, and they have to be based on past achievements. Awards in the forms of grants and scholarships for future works are not included.

Training Day

A WWII program is used to instruct project staff

EFFECTIVELY TRAINING project staff and capturing and diffusing the training is difficult within any industry. At my company, Cadforce Inc., we used a forgotten program from the World War II era to help train construction field staff.

Training Within Industry (TWI) was used successfully to train thousands of inexperienced American workers between 1940 and 1945. After the war, TWI became the training program that helped revive the economic infrastructures of many war-torn countries. TWI enabled these economies to reinvent their industrial and manufacturing training programs.

Our project team discovered TWI and its foundational principle, the five needs, while exploring lean tools. We worked with the Lean Construction Institute to develop lean systems for construction services, as well as create standardized work and processes. We found we needed a training program to help diffuse our lean program.

TWI and the five needs

We discovered the original TWI trainers built the program on a knowledge model of the five needs:

1. **Knowledge of work:** Information that makes one business different from other businesses.
2. **Knowledge of responsibilities:** A company's policies, rules and organizational requirements.
3. **Skill in instructing:** Helping supervisors develop a well-trained workforce.
4. **Skill in improving methods:** By requiring trainers or supervisors to identify and list each task breakdown, the trainer and learner identify areas for improvement.
5. **Skill in leading:** Helping the trainers improve their ability to work with staff.

TWI supported the five needs with a three-part program of job instruction, methods and relations. The philosophy and rollout of the program was based on training within industry—that is, to coach supervisors within the organization so the newly trained staff can teach other members of the industry.

An example of promoting TWI is the industry estimate that skilled optical glass grinders required three years of apprenticeship before they could successfully turn out an acceptable product. Training sounded similar enough to the architectural and construction industry's requirements, so we investigated further. We needed to slightly modify the training to make it more adaptable to our professional staff by changing the three-part jobs program to task instruction, task methods and systems, and task improvement.

Tracking tasks

Task instruction stressed understanding the task requirements and created task breakdown requirements, including important steps, key points and reasons for key points (see Online Figure 1 at www.qualityprogress.com).

In developing breakdown sheets for each task, the trainer, our project manager, had to think through each task's step and action, and identify the purpose for each before training a staff member in the task. Our training matched the TWI curriculum and consisted of four steps:

1. **Preparation:** Help the learner think to help comprehend the new idea.
2. **Presentation:** Add the new idea to those already in the learner's mind.
3. **Application:** Train the learner to apply what was presented and check results.
4. **Testing:** Test the ability of the learner to apply the new idea alone.

The second part, task methods and systems, identified the relationship of individual tasks to others and systems within the organization. Individual tasks, which had been delineated through task instruction, were measured against the project's system requirements (see Online Figure 2).

The third part, task improvement, became the *kaizen*, or continuous improvement, activity.

By implementing our version of TWI, which we called project staff training, we were able to instruct our site-based staff team more quickly and effectively, as well as help staff assume a productive role in creating and improving systems while developing learned and transferable skillsets.

True to the original TWI philosophy, the team went on to become mentors in the transfer and improvement of those processes to other internal teams and projects, as well as client, contractor and code review agency teams. We have implemented it as a basic part of our skills training program for onshore and offshore staff. QP

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Imai, Masaaki, Kaizen: *The Key to Japan's Competitive Success*, McGraw-Hill/Irwin, 1986.

Lean Construction Institute, www.leanconstruction.org.

TWI Institute, www.trainingwithinindustry.net.

CLIFF MOSER is vice president of project experience for Cadforce Inc., a global architectural services outsourcing firm in Marina del Rey, CA. He earned a master's degree in quality assurance from California State University in Dominguez Hills. Moser is a senior member of ASQ and is chair of ASQ's Design and Construction Division.

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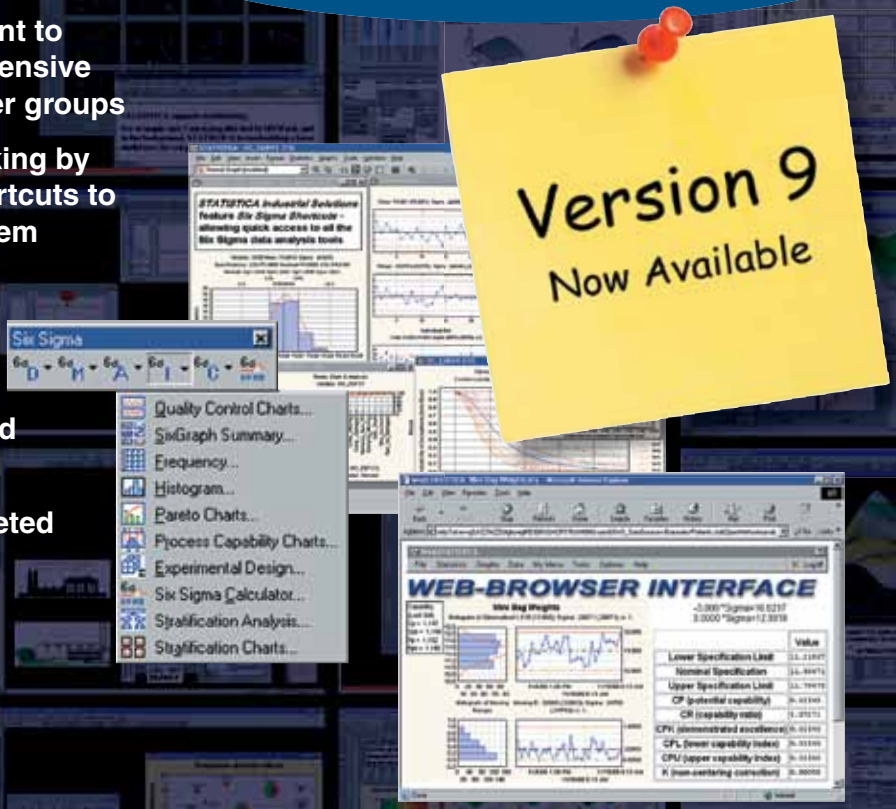

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