

ARTÍCULO 1

Customer Focus Sparks Invention

Philippine factory team reduces customer complaints and waste with a new production process

by Valerie Ellifson, manuscript coordinator

In 50 Words or Less:

- To reduce customer complaints and remain profitable, Littelfuse's facility in the Philippines designed a voice of the customer (VOC) project.
- The VOC project for fuse manufacturing resulted in the invention of a new design.
- The team won a silver award at last year's ASQ International Team Excellence Award competition for its project.

Littelfuse, a manufacturer of circuit protection products, believes satisfied customers and a quality product are the most important factors for remaining profitable. Thus, the company made listening to the voice of the customer (VOC) its very first step in selecting an improvement project.

The results led to a rise in customer satisfaction, the reduction of waste and a patent application for a new invention.

By adopting lean Six Sigma (LSS) practices and tools, the square nano quality project team at the Littelfuse facility in the Philippines earned the silver award at the International Team Excellence Award competition at ASQ's World Conference on Quality and Improvement last year.

Worldwide reach

Littelfuse is a global company that develops circuit protection products that can be found in products requiring electrical energy—from automobiles to telecom devices. Littelfuse's manufacturing company in the Philippines specializes in manufacturing automotive fuses, which are commonly used in the engine compartment of cars. The company also builds products that protect consumer electronic devices, such as flat panel TVs and computers.

Fuse construction includes the following basic elements:

- A cap that serves as the terminal.
- Solder that connects the wire and the cap.
- A body made of ceramic material that encloses and protects the fuse element.
- Wire.

A factory within a factory

Essentially, Littelfuse's Philippine facility operates as a factory within a factory. Each department and product team is composed of cross-functional teams capable of analyzing and solving a problem. Because of this organizational structure, with each project team already having ownership of the product and resolutions concerning it, formal teams for the project were never selected. Instead:

- The square nano quality project team received the problem, which went to the production team that owned it.
- External and internal customers provided feedback.
- The project charter was created by the internal stakeholder to define the problem statement, goal, members, deliverables and timeline.

Each factory is composed of three subgroups:

1. The product team is made up of Black Belts, process owners, process experts and equipment experts responsible for managing meetings, identifying problems, analyzing data and implementing the solution.
2. The support team is made up of Master Black Belts, production personnel and project managers, all providing technical support and motivation.
3. The executive team or project champion and project sponsor help the team set goals and expectations, and provide project funding.

To begin their VOC project, the square nano quality project team needed to identify the factors that would have the biggest impact on customer satisfaction. Customer needs uncovered by the team were zero customer complaints, on-time delivery and a competitive price. The LSS framework and many quality tools were used extensively throughout the project process.

A Pareto chart of customer complaints revealed "loose caps" as the highest priority for improvement. A loose cap is a critical defect that occurs when the cap exhibits slight movement on the fuse body, resulting in reliability concerns during use.

The team selected reducing the number of loose caps in square nano fuses as the project that would best improve its internal-defect parts per million (PPM) numbers and reduce the number of customer complaints.

The team also used a SIPOC (suppliers, inputs, process, outputs and customers) diagram¹ to identify key internal and external stakeholders. The square nano quality project team was then formed.

Building the case

Reducing customer complaints was not the team's only goal. Through value stream mapping, the project was further expanded to address customers' on-time delivery demand. The map showed there was a lot of rework on the production floor that delayed deliveries. The Pareto chart again identified loose caps as the main contributor to this problem, thus linking the goal back to a lean solution because the reduction of waste would lead to on-time delivery.

The team used cause and effect diagrams and failure mode effects analysis (FMEA) to identify the most significant causes of loose caps results included no solder between cap and body, handling-related concerns, misaligned caps and uncured adhesive.

Another Pareto chart revealed that the lack of solder between cap and body was the top contributor to loose caps. Cause and effect diagrams and FMEA allowed the team to identify the factors leading to this lack of solder between cap and body, reasons included solder displacement consistency, solder expansion characteristics, poor ceramic-to-cap bond, oversized clearance between cap and body, and ceramic porosity.

The team developed possible solutions to the loose cap problem caused by solder displacement consistency. Using several quality tools, such as internal benchmarking of other products without loose caps, theory of inventive problem solving and brainstorming about processes that could enhance solder formation between cap and body.

The selection of the final solution was based on two criteria: whether it would result in zero customer complaints and whether it would reduce waste. Similar to how LSS projects are conducted, the team compared the cap retention of each possible solution against the baseline or standard fuse using the analysis of variance statistical technique.

A value stream map pointed to a change in the material design and appearance of the fuse as the best solution. A slotted body design was invented when cap retention data showed that fuses with a higher solder dome had lower cap retention than fuses with small domes and solder filling the gap between cap and body.

To ensure stakeholder approval of the project, the team presented a list of tangible and intangible benefits prior to actual implementation of the solution. Stakeholders were told the expected tangible benefits would eliminate half of baseline customer complaints and half of baseline loose-cap PPM defects, and would double the baseline cap retention. Expected intangible benefits were improved work environment, less employee exposure

to chemicals (including an anaerobic adhesive that presented health risks), a better understanding of cap retention factors and process simplification.

Results

With the implementation of the slotted body design, the production process went from 18 meters with a cycle time of almost six hours to 13 meters with a cycle time of three hours. All stakeholder concerns had been heard and responded to with data-driven results and training.

Customer complaints went down to zero, as did loose cap ppm. Annual cost savings were \$700,000, with a 9% cost reduction in manufacturing and a 15% reduction in space needed to perform the process.

Post-implementation brought more changes in procedures and work instructions. To sustain results, Littelfuse's Philippine facility now:

- Trains process owners regarding new processes, such as operating and maintaining machines and gathering data for reports.
- Redefines statistical process control to ensure process stability by implementing an online data collection display and error-proofing system called DataCoDES. DataCoDES was Littelfuse's preexisting system for measuring and sustaining results.
- Documents and makes all changes from the improvement project standard operating procedures.
- Ensures machines function properly.

Littelfuse subsequently submitted an application for a U.S. patent to formalize the documentation of its invention—a new slotted body design with a higher solder dome.

References

1. Kerri Simon, "SIPOC Diagram," www.isixsigma.com/library/content/c010429a.asp.

ARTÍCULO 2

Power to the People

Survey says talent management and internal service are more important than ever

by Jerry H. Seibert and William A. Schiemann

In 50 Words or Less:

- People equity, a framework to measure and manage human capital, plays an important part in business performance.
- A recent survey explored whether that relationship was strained by the recent economic downturn.
- Results showed that companies that kept the focus on their employees outperformed those that didn't.

The recession has affected companies on every level. Many have been changed in fundamental ways, and some have not survived. The economic environment is so profoundly different from the beginning of this millennium, it begs the question of whether organizations' primary relationships have changed, including those with customers and their employees. It even calls into question the relevance of factors such as commitment to quality and internal service.

In past research conducted with QP, Metrus Group, a research and consulting firm specializing in strategic measurement and performance excellence, has documented a strong relationship between internal customer service, people equity (see sidebar, "[What is people equity?](#)") and business performance, including financial outcomes, quality and customer satisfaction.^{1,2}

But does this strong relationship continue to hold during times of economic dislocation, when corporate survival may be on the line?

What Is People Equity?

It is a framework to measure and manage human capital. People equity consists of three core elements:

- **Alignment** is the extent to which employees are connected to the business strategy. It includes employees' alignment with the strategy, customers and the

brand, as well as clarity and connection of individual, departmental and organization goals.

- **Capabilities** refer to the extent to which the organization effectively deploys talent, information and resources to meet customer requirements and execute the strategy.
- **Engagement** goes beyond employee satisfaction and includes commitment, advocacy on behalf of the organization and discretionary effort. —*J.H., W.S.*

This is the central question we addressed in a recent survey. We also explored the impact of various anti-recession strategies companies adopt involving the people-equity factors of alignment, capabilities and engagement (ACE). Finally, we examined the effect of those strategies on internal customer service and identified techniques that have been effective at closing internal service gaps.

About the survey

ASQ members, customers and a sample provided by Metrus Group were surveyed in October 2009. A total of 2,147 people responded. Almost half (48%) of the participants were managers or executives representing companies from a wide range of industries. A summary of the most frequently represented industries and a breakdown by organizational size is provided in Table 1.

Executive summary / TABLE 1

Most frequently represented industries	Number of respondents
Manufacturing and industrial products	583
Professional services	247
Pharmaceutical, biotech and medical devices	148
Aerospace	105
High tech	92
Healthcare services	90
Government	60
Transportation and automotive	54
Defense	50
Others	718
Total	2,147

Number of employees	Number of respondents
100 or fewer	377
101-500	375
501-5,000	437
More than 5,000	385
Not reported	573
Total	2,147

[Table 1](#)

We asked participating companies:

- How organizational performance changed during the past two years.
- What tactics the company used in response to the recession.
- The level of workforce alignment, capabilities and engagement, as well as the focus on business results and quality.
- Internal customer service levels for key functions.
- Techniques used to close internal service gaps.

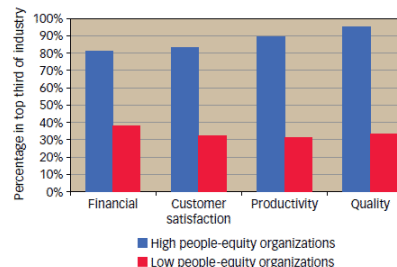
We also asked how the companies were currently performing in the areas of financial results, productivity, customer satisfaction and quality relative to their industry.

Our first goal was to test whether the strong positive relationships previously observed between people equity (as measured by ACE) and business performance, people equity and internal customer service, and internal customer service and business performance held in a downturn.

In our previous research, we found that companies with more engaged employees outperformed those with lower engagement levels.³ This is in keeping with other studies on the subject. But we also found that engagement alone is not enough.⁴ Even if employees feel highly connected and committed to the organization, optimal performance is not achieved unless there is also alignment with company strategy and values, as well as sufficient capabilities to meet customer requirements.

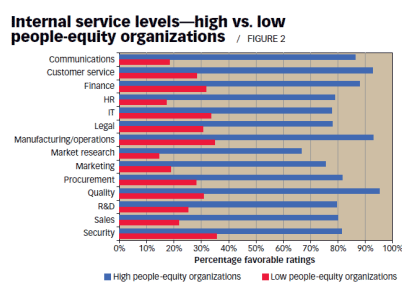
The current survey results demonstrate that even in challenging economic times, high levels of people equity are associated with better performance, as illustrated in Figure 1. Organizations in the top quartile of people equity are much more likely to be industry leaders (defined as being in the top third of the industry) on key metrics, such as financial outcomes, customer satisfaction, productivity and quality. While most companies with high people-equity are industry leaders, only about a third of companies with low people equity achieve that status.

People equity/business performance relationship / FIGURE 1



[Figure 1](#)

In a 2006 study, we reported that internal customer service levels were also strongly influenced by ACE.⁵ At that time, we found an average difference of almost 40 percentage points between internal customer service levels in high versus low people-equity companies. As dramatic as that difference was, it appears that during this stressful economic period, the differences are even more extreme. In Figure 2, we compare the internal customer service ratings of various departments for high and low people-equity businesses. The average difference in 2009 is a significant 56 percentage points.



[Figure 2](#)

The third relationship we wanted to test was the pattern of better business performance among companies with outstanding levels of internal service. Because people equity showed a strong correlation to business performance and is an extremely strong predictor of internal customer service levels (see Figure 2), it seems a given that internal customer service and business performance are also linked.

Indeed, that was the case: Top quartile internal customer service companies are about twice as likely as low internal customer service companies to be industry leaders on the key metrics of financial results, productivity, customer satisfaction and quality.

With strong support for the robustness of the relationship between people equity and business performance, we examined the effect of the recession on people equity. Or, to be more precise, we examined the effect of tactical responses to the recession on people equity.

Smaller vs. smarter

Belt tightening is the recession tactic of choice for most companies. Smaller is better, the current mantra goes, which leads to reductions in staff, budgets and services. An alternative to cutting back is to invest more in improving and streamlining processes. We wondered if choosing this approach—getting smarter, not just smaller—made a difference in ACE levels within companies. To put it another way, is there a people equity benefit from using the tools of process improvement and cost reduction as part of a recession survival strategy?

Common wisdom says the steps companies typically take to manage an economic downturn have an across-the-board negative impact on ACE levels. But we found there is a difference between the various recession tactics companies use and the impact of those actions on people equity factors. Figure 3 summarizes the results of regression models examining the impact of 10 different tactics on each people equity factor, including the following:

Recession-fighting actions' effect on people equity / FIGURE 3

Action	Alignment	Capabilities	Engagement
Laid off staff	↓	↓	↓
Mandatory budget cuts	↓	↓	↓
Hiring freeze	↓	↓	↓
Reduced pay	X	X	↓
Frozen pay (no increases)	X	X	↓
Reduced benefits	X	X	↓
Mandatory furlough	X	X	X
Identified process changes to reduce costs	↑	↑	↑
Reduced services to customers	↓	↓	↓
Reduced services internally, between departments	↓	↓	↓
X No impact ↓ Moderate impact ↑ Strong impact			

Figure 3

1. Reducing resources: Tactics such as layoffs, budget cuts and hiring freezes uniformly had a negative impact on ACE levels. These actions, which include the most severe responses to the recession, can leave employees feeling like they need to carry a heavier load with no additional recognition. With fewer resources, capabilities decline. The perceived inequity of these tactics weakens engagement.

Cutting back also can lead to a value disconnect between employees and their company, thereby undermining alignment. Employees find it difficult to be in sync with the strategic direction of the company when those around them are losing their jobs.

2. Compensation cuts: In an interesting contrast, the effects of compensation-oriented tactics were very different. Pay cuts, pay freezes and benefit reductions had a negative impact on employee engagement, which should come as no surprise. But compensation cuts did not have a significant impact on alignment or capabilities. It is possible these actions, while not welcomed, are more likely to be viewed as rational and acceptable—sharing the pain through lower profits for the company and lower rewards for staff. Thus, alignment may be maintained, and with resources preserved in the organization, capabilities remain largely intact.

We examined one other tactic for reducing labor costs: mandatory furloughs, which are typically used to cut pay by reducing total work hours. Like the other techniques, use of furloughs had no impact on alignment and capabilities. But they also had no impact on engagement. Perhaps that is because, unlike the other actions, a furlough may be viewed as somewhat more equitable—you don't get paid, but you're also not required to work during the furlough.

3. Service suffers: The greatest negative impact did not come from eliminating resources or reducing compensation. Surprisingly, the most powerful negative effects occurred when companies chose to reduce service levels to customers and when they made changes that reduced services internally between departments.

Reducing services to customers had a strong negative impact on alignment and engagement. It would seem employees see a disconnect between oft-repeated strategies and mission statements that emphasize customer service, and actions that may damage customer relationships, if not harm the customers themselves.

It's no shock that aspects of engagement, such as advocacy and discretionary effort, might also decline in that situation. A lesser effect was observed for capabilities, which may mean employees realize the capabilities for good service remain in place; they are just being underused.

When companies reduced services between departments, there was a strong impact on all three people-equity factors. Logically, changes that imperil a department's ability to service other internal groups would lead to lower perceptions of capabilities. After all, points of failure within the organization can reasonably be expected to ultimately lead to failures with customers. Employees may feel less certain they are on the same strategic page as senior leadership, thus lessening alignment.

The strong impact on engagement is a little more puzzling. Perhaps it is a reaction to being placed in a situation where you're prevented from doing the best work possible, resulting in a certain degree of cognitive dissonance. Or perhaps it flows from frustration with a lack of support from other parts of the organization.

Each of the previously mentioned tactics for managing through an economic downturn can be considered reductive, if not destructive, in their fundamental nature. Leaders may choose to think of them as pruning now for future growth, but that does not change the fact that pruning has serious repercussions for employees and the customers they serve.

One tactic had a positive impact on people equity: identifying process changes to reduce costs. Companies that used this tactic reported a strong positive impact on alignment and engagement, and a moderate positive impact on capabilities. This tactic likely maintains consistency with prerecession goals. Therefore, looking within the organization to collaboratively make improvements and reduce costs actually increases alignment.

For employees, it represents the company choosing surgery over amputation. Not surprisingly, this path can actually lead to higher levels of engagement. Employees are highly attuned to organizational behavior that values people and recognizes their ability to help a company prevail in challenging times. There is a lesson here for every organization facing a difficult future.

The recession-service connection

In a study of internal customer service conducted in 2007, we reported that average service levels improved compared to a similar study in 1993.⁶ In a recession, however, we expected lower levels of internal customer service. Surely, the effects of cutting back on people equity outlined in Figure 3 hold equally true for internal customer service.

In fact, the 10 recession-fighting tactics had similar effects on internal service. Service reductions between departments had the greatest negative impact, as you may expect. Cost-oriented process improvement had a moderate positive effect, while other tactics had modest negative effects. Yet, on average, internal customer service levels have continued to improve, even through the recession. The typical department had a seven percentage point increase in favorable ratings compared to the 2007 results.

But this unexpected finding is somewhat misleading. Companies that are doing well despite the recession—their performance on key metrics has improved during the last two years—account for all of the increase in internal customer service ratings. In companies where financial performance, productivity, customer satisfaction or quality have deteriorated over the last two years, internal customer service scores are down by approximately 15 percentage points. There is a gap of as much as 25% between the firms that are struggling and those that are successfully navigating the recession.

Closing the gaps

The finding that, for many companies, internal customer service (as well as business performance) is trending downward means there will be an increasing number of internal service gaps. The needs and requirements of internal customers are diverging from the capabilities of internal service providers, but there are a range of techniques that can be used for addressing such gaps. The final part of this study asked respondents which techniques they have used and how effective each has been.

Table 2 reveals that among 12 well-known techniques, most are used for closing internal service gaps by about one-third of companies. Two techniques stand out as more widely applied: plan-do-check-act and process management were used by at least half of the companies. They were also more likely to be effective compared to other techniques.

Techniques for closing internal service gaps / TABLE 2

Technique	Percentage using	Percentage rating effective or very effective
Plan-do-check-act	50%	67%
Process management	57%	66%
Customer value mapping	32%	62%
Lean/lean office	36%	60%
Lean Six Sigma	34%	58%
Benchmarking	40%	58%
Six Sigma	33%	57%
Process value analysis	27%	56%
Business process reengineering	30%	54%
Balanced scorecard	28%	49%
Work out	29%	48%
Theory of constraints	22%	44%

[Table 2](#)

Customer value mapping, while one of the less frequently used techniques, was also among the most effective. Some—such as balanced scorecard, work out and theory of constraints—were rated as effective by less than half of those who applied them.

This data may help guide companies that are beginning to experience problems related to internal service gaps. An awareness of which techniques have been effective in other companies could accelerate service improvement efforts and help companies avoid wasting effort on approaches that are less likely to succeed.

The criticality of people

Our survey results demonstrate the importance of workforce alignment, capabilities and engagement on organizational performance and business results, independent of the vagaries of economic fluctuation. The relationship between people-equity factors and business outcomes remains strong, as does the connection to internal service levels.

These relationships take on more importance when you consider the impact of various tactics used in response to an economic downturn. Staff, budget and salary reductions all have detrimental effects, although not always in the same way. The riskiest strategies involve reducing service levels to customers or making changes that reduce internal service levels. Those tactics had the greatest negative impact on ACE levels.

Companies that take this route risk double jeopardy: Lower ACE scores lead to lower internal and external customer service, both of which are drivers of business results. Companies will be better served by focusing on process improvement and closing

internal service gaps. The only recession tactic that had a positive impact on ACE was a strategy of process improvement, with a focus on reducing costs.

Internal service includes many processes amenable to this approach, and our data highlight several techniques that have been reported as effective at a wide range of companies. To maintain the highest levels of performance, leaders must manage more than the bottom line; there must be a focus on the organization's people equity and a commitment to internal customer service.

© 2010 Metrus Group Inc.

References

1. J.T. Kostman and William A. Schiemann, "[People Equity: The Hidden Driver of Quality](#)," *Quality Progress*, May 2005, pp. 37-42.
 2. Jerry H. Seibert and J. Lingle, "[Internal Customer Service: Has It Improved?](#)" *Quality Progress*, March 2007, pp. 35-40.
 3. Kostman and Schiemann, "People Equity: The Hidden Driver of Quality," see reference 1.
 4. William A. Schiemann, *Reinventing Talent Management*, John Wiley & Sons and Society for Human Resource Management, 2009.
 5. Seibert and Lingle, "Internal Service: Has It Improved?" see reference 2.
 6. Ibid.
-

Jerry H. Seibert is global director of diagnostic services for Metrus Group, a research and consulting firm based in Somerville, NJ. He earned a master's degree in industrial/organizational psychology from Western Kentucky University in Bowling Green.

William A. Schiemann is the CEO and founder of Metrus Group. He earned a doctorate in organizational psychology from the University of Illinois at Urbana-Champaign. He is the co-author of *Bullseye! Hitting Your Strategic Targets Through High Impact Measurement* and author of *Reinventing Talent Management*.

ARTÍCULO 3

Under Scrutiny

New approach to root cause analysis can help clear up misconceptions

by Mark Paradies

In 50 Words or Less:

- Cause and effect analysis has inherent limitations that may result in root cause analysis misconceptions and hinder problem-solving efforts.
- Problem solvers need help analyzing human performance issues.
- A new definition of root cause could help people realize a systematic process beyond cause and effect is needed for root cause analysis.

For many years, quality improvement practitioners have been taught to find root causes of problems by using a set of tools based on the theory of cause and effect. These tools include the five whys and fishbone diagrams. Many users of these techniques, however, find that some problems, especially those caused by human error, keep happening.

Because of the failure of these techniques to stop problems, some problem solvers might start wondering:

- Am I using the tools correctly?
- Is there a misconception in using cause and effect to find the root causes of problems that produces unacceptable results?
- Is there another technique to help me go beyond basic cause and effect analysis and get better results when investigating quality issues?

If you use cause and effect to find root causes, you might want to rethink your beliefs on this concept and look at what some consider to be misconceptions in applying commonly taught root cause analysis techniques.

"Only tool" misconception

Many quality professionals believe cause and effect (the infinite chain-of-causation philosophical model¹) is the only (or perhaps preferred) method to find root causes, maybe because cause and effect is taught in most Six Sigma courses.

Many quality professionals don't realize, however, that cause and effect analysis has major shortcomings that could lead them astray. Perhaps their confidence in cause and effect is based on the fact that cause and effect has been around for so long. After all, Socrates first demonstrated the concept to the Western world prior to 399 B.C. through his Socratic method.

Similar to many philosophical concepts, it may surprise you that cause and effect is not a rule or law. It's a model—with benefits and limitations debated by philosophers since Socrates. For example, David Hume, author of *An Enquiry Concerning Human Understanding*, questions the very basis for our human understanding of cause and effect: "When we ... consider the operation of causes, we are never able, in a single instance, to discover any power or necessary connection; any quality, which binds the effect to the cause, and renders the one an infallible consequence of the other."²

Rehashing philosophical arguments of a bygone era is not my purpose. Rather, as an engineer, I prefer to search for practical answers to everyday problems faced by people trying to improve performance, and to focus on the practical limitations of cause and effect.

Confirmation bias

Philosophical arguments may not convince current users of cause and effect to look beyond their current tools. An understanding of the scientific limitations of the approach, however, may convince people to explore other concepts.

For example, one practical limitation for people applying cause and effect is confirmation bias, a problem-solving heuristic that simplifies the analysis of contradictory information collected on a complex problem.

Researchers who have examined confirmation bias say people tend to jump to conclusions before all the data are gathered and analyzed. From the point that people see or hypothesize a familiar pattern (answer), they tend to look for information to confirm their conclusions (the bias).

People may subconsciously disregard evidence that counters their conclusion. This concept was first explored to explain the biases observed in scientific research. Extensive research shows this is a common human error made by all types of problem solvers, not just experienced scientific researchers or inexperienced problem solvers.³⁻⁵

Why are cause and effect analysis and the five whys susceptible to the trap of confirmation bias? Because the unguided, deductive reasoning inherent in cause and effect analysis requires problem solvers to use their understanding of the problem to develop a chain of causation. Problem solvers tend to collect evidence about problems they understand. Therefore, the evidence they search for confirms their existing bias. They disregard, or perhaps don't even see, evidence that doesn't fit their mental model (that is, a model based on their experience).

Can't go beyond current knowledge

Another misconception related to the reasoning behind the confirmation bias problem is that problem solvers using cause and effect seldom go beyond their current knowledge. This problem was demonstrated in a QP article, "Flip the Switch," which included an example of the Jefferson Monument dirtied by birds.⁶ Park service rangers asked "why" five times (or more) to form this chain of causation:

- Why does the memorial deteriorate faster? Because it gets washed more frequently.
- Why is it washed more frequently? Because it receives more bird droppings.
- Why are there more bird droppings? Because more birds are attracted to the monument.
- Why are more birds attracted to the monument? Because there are more fat spiders in and around the monument.
- Why are there more spiders in and around the monument? Because there are more tiny insects flying in and around the monument during evening hours.
- Why are there more insects? Because the monument's illumination attracts more insects.

But this causal chain assumes the rangers know washing the monument is the causal chain to investigate. The rangers seem to come up with the idea that reducing the washing frequency could occur if the lights were turned on one hour later (thus, attracting less bugs).

You might ask, "Where did they get this idea?"

The first answer is already jumping to conclusions. You could assume that someone involved with solving this problem had the idea that bugs, birds and washing caused this problem. The problem solver then built a causal chain to validate the answer.

Could other ideas be developed if the rangers had started looking at the sequence of events of the monument's deterioration? Could they discover other important factors? For example:

- Selection of materials for the monument.
- Selection and installation of lighting. Was it always lit?
- Selection or purchasing of cleaning materials.
- Application of cleaners and cleaning methods.
- Changes in bird habitats and feeding or roosting patterns.

This isn't an exhaustive list, but it presents a few possibilities to demonstrate what could be missed without fully understanding the sequence of events before drawing conclusions. Missing potential alternatives can waste efforts when fixing phantom problems or pushing problems from one area to another.

But how can you argue with success? The rangers' solution of turning on the lighting one hour later in the evening reduced monument deterioration by 90%. But remember that correlation does not prove causation.

Do we know the lighting change was the only change? Did the measurement of the problem cause the monument cleaners to be more careful and do less damage? Did a weather change (dry or cold spell, or global warming) contribute to a temporary shift in insect breeding and density? Are measurements of deterioration accurate? Did the change in lighting simply shift the bird-dropping problem to another monument where the bugs and birds now congregate?

This example shows it can sometimes be difficult for people to analyze problems beyond their current knowledge because they try to make the problem fit inside their understanding of the issue. Therefore, when using cause and effect, you must know the cause of an effect, and you must have knowledge of all possible causes to be able to reach an accurate conclusion.

The human factor

This may be OK in a narrow field being analyzed by one of the world's leading experts. But most quality problems are not caused by wildlife interacting with monuments. Most quality problems aren't within a narrow area of expertise. Most people on the factory floor aren't the world's leading experts in human performance, equipment reliability, or bug and bird habits.

Human performance issues (human errors) cause most quality problems. But most problem solvers have no formal training in human engineering or ergonomics (the science of human error and human performance).

In nonscientific polls of those who attended my root cause courses, few (less than 4%) said they had training in human factors, but almost everyone said investigations they perform look into causes related to mistakes made by people (operators, mechanics, engineers, doctors, nurses and managers, for example).

How can someone without training in the science of human error use a misguided process (cause and effect) to find the root causes of human performance problems when they don't know what causes human error? W. Edwards Deming said: "Lack of knowledge ... that is the problem. You should not ask questions without knowledge. If you do not know how to ask the right question, you discover nothing."⁷

One common misconception is that anyone can use cause and effect to analyze any problem. Because of the limitation of cause and effect, however, you can only use it to analyze problems that are already understood.

Single-cause misconception

Another common misconception in analyses performed by people trained in cause and effect is the error of identifying a single cause. This was demonstrated in the two cause-and-effect examples presented in "Flip the Switch."⁸

Although neither example is a typical quality related problem, they were presented as successful examples of the technique and provide interesting insight into the limitations of cause and effect.

Both examples focused on a single chain of causation. This is common when people apply the five whys method. They ask why five times around a single cause and then correct the cause at the root of their five whys chain.

Why is this single causal-chain focus a problem? Major accidents or quality issues are seldom the result of a single causal chain. Trevor Kletz, an expert in accidents in the chemical industry and author of many books on process safety, wrote in *Lessons From Disaster*: "Every accident has many causes. Bill Doyle, one of the pioneers of loss prevention, used to say that for every complex problem there was at least one simple, plausible, wrong solution."⁹

Just like accidents, major quality problems are usually the result of a sequence of events containing multiple causal factors. Each causal factor has one or more root causes that, when corrected, will improve performance and eliminate future quality problems.

The single causal chain misconception leads to missed opportunities to improve performance by eliminating multiple root causes that may not be present in the causal chain picked by the five whys problem solver.

Some may argue the five whys technique isn't intended to be used to solve complex issues, but only simple ones. For this concept to work, a problem solver must know when a problem has a single causal chain (simple problem) and when a problem is more complex (multiple causal chains).

Unfortunately, in reviewing thousands of problem analyses, many simple problems (for example, injuries, human errors, equipment failures and management missteps) are either:

- Part of a much more complex sequence of events.
- Seen as a simple problem because they are not thoroughly investigated. After further analysis, the problems turn out to be more complex.

Thus, the five whys examples presented in "Flip the Switch" demonstrate the misconception that major problems (cholera epidemics and monument deterioration)

may be caused by a single root cause, even though the article states before the examples that "There could be multiple root causes."¹⁰

More misconceptions

More misconceptions or problems are not the only practical limitations inherent in the cause and effect approach to root cause analysis. Other practical limitations include:

- Improper use of deductive reasoning.¹¹
- Lack of practical training.¹²
- Difficulty in trending results.
- Tunnel vision.¹³
- Fuzzy haze (when the brain automatically fills in missing information when it perceives something, sometimes leading to misperceptions).¹⁴⁻¹⁵
- Results not repeatable (varied based on the analysts).¹⁶

Redefine and change your approach

A common definition of root cause that springs from the cause-and-effect tradition of root cause analysis is that a root cause is "an initiating cause of a causal chain which leads to an outcome or effect of interest."¹⁷ This definition, the theory of cause and effect and the practice of "ask why five times" all lead to the problems outlined earlier.

With so many people trained in this method, is there hope? What can you do to move beyond cause and effect? Perhaps it's time to challenge some common beliefs, accept a new definition for root cause and adopt a new, systematic method for root cause analysis.

New definition: Let's begin with a completely new definition of root cause not based on the cause and effect philosophy: A root cause is the absence of a best practice and the failure to apply knowledge that would have prevented the problem.¹⁸

Once you accept that root cause analysis is the search for the missing best practices and knowledge that will prevent a problem, it is easier to see how a root cause analysis system should help guide a problem solver to the missing knowledge. Root cause analysis can be a structured, repeatable process that helps the problem solvers go beyond their current knowledge and find the real, fixable causes of the human errors and equipment failures that lead to most quality issues.

New method: For a root cause analysis process to help problem solvers go beyond their current knowledge, it must be much more robust than simply asking why five times (or more) or looking for an infinite chain of causation. It must:

1. Use evidence of the failure (problem) to completely understand what happened before trying to decide why it happened.
2. Identify multiple opportunities to stop the problem (multiple causal factors).

3. Have built-in expert systems that can be used intuitively by problem solvers to find the root causes of each of the causal factors.
4. Help problem solvers look beyond the immediate causes to find correctable systemic issues (generic causes).
5. Help problem solvers find effective actions to prevent the problem's recurrence when all the root and generic causes have been identified.

Anything less than the thorough understanding of the causes and corrective actions based on an advanced analysis of the problem's root causes is simply a misconception. To avoid being accused of bias, there are alternative root cause analysis techniques that can be used to find a system that avoids the drawbacks mentioned, and meets their needs and the criteria my research and experience has shown as necessary to produce reliable root cause analysis results.

Getting beyond the pitfalls common with cause and effect analysis is critical for those interested in systematic elimination of quality issues.

References and notes

1. Gary G. Jing, "Flip the Switch," *Quality Progress*, October 2008, pp. 50-55.
2. David Hume, *An Enquiry Concerning Human Understanding*, 1910.
3. Jonathan J. Koehler, "The Influence of Prior Beliefs on Scientific Judgments of Evidence Quality," *Organizational Behavior and Human Decision Processes*, Vol. 56, 1993, pp. 28-55.
4. Peter Watson, "On the Failure to Eliminate Hypotheses in a Conceptual Task," *Quarterly Journal of Experimental Psychology*, Vol. 12, 1960, pp. 129-140.
5. Mark Paradies, "Defending Categorization," Root Cause Analysis Blog, Nov. 7, 2008, www.taproot.com/wordpress.
6. Jing, "Flip the Switch," see reference 1.
7. Ron McCoy, *The Best of Deming*, SPC Press, 1994.
8. Jing, "Flip the Switch," see reference 1. The error of identifying a single cause in cause and effect analysis was illustrated in the two cause and effect examples presented in this article.
9. Trevor Kletz, *Lessons From Disaster*, Gulf Publishing Co., 1993.
10. Jing, "Flip the Switch," see reference 1.
11. Mark Paradies, "Teruyuki Minoura (Toyota Exec) Talks About Problems With 5 Whys," Root Cause Analysis Blog, March 14, 2007, www.taproot.com/wordpress. This blog entry, along with references 13, 15 and 16 are resources to explore how the application of cause and effect can hinder rather than help find the true root causes of quality problems.
12. Ibid.
13. Chris Vallee, "Why Ask Why When You Should Be Asking What?" *Automotive Excellence*, ASQ Automotive Division, Spring 2008.
14. Ibid.

15. Christopher D. Wickens and Justin G. Hollands, *Engineering Psychology and Human Performance*, Prentice-Hall Inc., 2000.
 16. Anthony Mark Doggett, "A Statistical Comparison of Three Root Cause Analysis Tools," *Journal of Industrial Technology*, Vol. 20, No. 2, 2004, pp. 1-9.
 17. "Root cause," Wikipedia, http://en.wikipedia.org/wiki/root_cause.
 18. Mark Paradies and Linda Unger, *TapRoot—Changing the Way the World Solves Problems*, System Improvements Inc., 2008.
-

Mark Paradies is president of System Improvements in Knoxville, TN. He is co-author of TapRoot— Changing the Way the World Solves Problems, a contributor to the Root Cause Analysis Blog and the editor of the Root Cause Network newsletter. Paradies earned a master's degree in nuclear engineering with an emphasis on human factors at the University of Illinois. He was certified by Navsea 08 as an engineer in the Nuclear Navy and is a certified professional ergonomist, a certified hazard control manager and a senior member of ASQ.

© Mark Paradies and System Improvements Inc., 201