

APPLYING



METHODS FOR BREAKTHROUGH SAFETY PERFORMANCE

By **TOM RANCOUR** and **MIKE McCracken**

From board rooms to manufacturing floors, organizations around the world are using quality improvement tools such as six sigma to bring about dramatic changes in their operations. The ultimate goal is to gain competitive advantage by meeting or exceeding customer requirements while controlling costs.

Today's safety professionals need to delight customers—employees—by tapping into these same quality tools and using them to continuously improve safety processes. This article reviews Honeywell's Six Sigma Safety Approach for detecting and eliminating safety defects and re-engineering processes for enhanced employee protection and business results.

SIX SIGMA: A HISTORICAL PERSPECTIVE

In the mid-1980s, Motorola was being consistently beaten in the competitive marketplace by foreign firms that were able to produce higher-quality products

at a lower cost. Bob Galvin, Motorola's then-CEO, started the company on a quality path now known as six sigma (6σ). It provided an intense management focus on preventing defects in products, processes and services, reducing cycle times and controlling costs in order to generate value to the customer.

Results were dramatic. Motorola became the market leader and won the Malcolm Baldrige National Quality Award in 1988 (Pande 7). Six sigma has since been embraced by many other companies, most notably General Electric (GE) and Honeywell (Conlin; Harry and Schroeder 40). This process has led to significant cost reductions, increased market share and superior financial performance. For example, at GE, in less than three years, the company's operating margin soared to a record 16.7 percent. In dollar amounts, six sigma delivered more than \$300 million to GE's 1997 productivity gains and profits (Pyzdek). At Honeywell's former AlliedSignal opera-

tions, application of six sigma methods saved \$600 million in 1999 (Honeywell International Inc.).

SIX SIGMA DEFINED

Sigma (σ) is the Greek letter used in statistics to designate the estimated standard deviation or variation in a process. The lower the "sigma level," the more variation or defects in the process; the higher the sigma level, the fewer the defects.

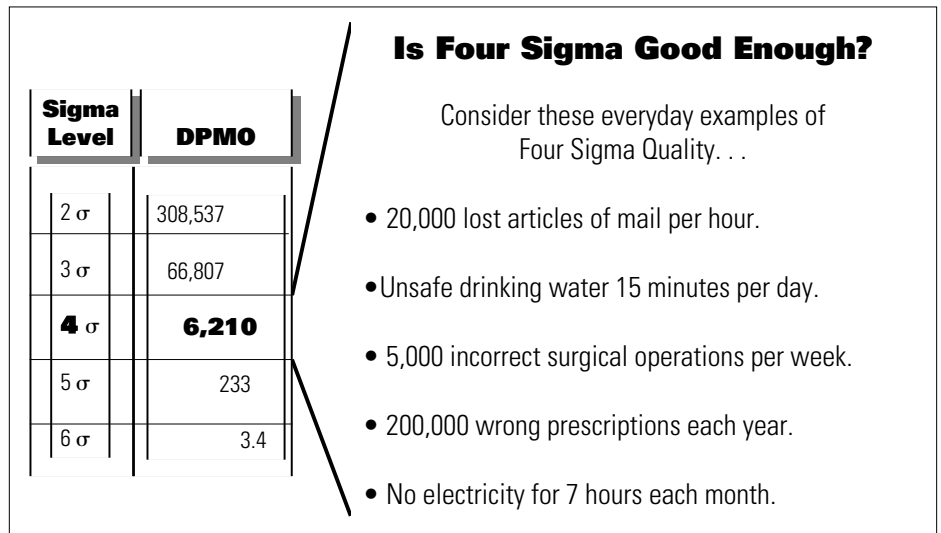
"Sigma level" is often used as a shorthand notation for indicating the number of defects per million opportunities (DPMO) involved with a process. For example, a "two sigma level" process has 308,537 DPMN (not a very controlled process). If a process has a "three sigma level," it has 66,807 DPMO.

So, what is six sigma? Six sigma means operating at less than 3.4 DPMO. That's essentially being defect-free 99.99966 percent of the time.

Consider this example involving the simple "process" of driving a car within

FIGURE 1

Relationship Between Sigma Level and Defects Per Million Opportunities



the speed limit. Each mile is an “opportunity” and each excursion over the speed limit a “defect.” A six sigma level of performance means the driver would exceed posted speed limits only 3.4 times every 1 million miles. At 20,000 miles per year, that would represent a 50-year period with less than four speeding incidents.

Figure 1 depicts how sigma levels relate to DPMO. As noted, a two sigma process is equivalent to 308,537 DPMO. On the other end of the spectrum, six sigma is only 3.4 DPMO.

Now, consider four sigma performance. This level is equivalent to only 6,210 DPMO—about 99.4 percent error-free. Not bad, but is it good enough? Consider these everyday examples of four sigma: 20,000 lost articles of mail per hour; unsafe drinking water for 15 minutes each day; 5,000 incorrect surgical operations per week; 200,000 wrong prescriptions per year; no electricity for almost seven hours each month.

Clearly, six sigma is a demanding standard. As a philosophy, six sigma is an extension of management’s total quality commitment to reducing both defects and process variations in products, processes and services. As a metric, six sigma allows a company to use the same

measurement language across all businesses globally. It is a uniform standard of performance.

When it comes to safety, safety professionals must strive to prevent all incidents that lead to injuries and illnesses. Using six sigma continuous-improvement tools is an effective way to move more rapidly toward that goal.

THE BUSINESS CASE FOR APPLYING SIX SIGMA TO SAFETY

Manufacturing staffs routinely apply six sigma methods to eliminate defects and reduce process variation (Figure 2). Each aspect of a process is first carefully defined or “mapped” using flowcharts

that detail key process inputs and outputs. All process defects are identified and their frequencies measured as defects per million units (DPUs).

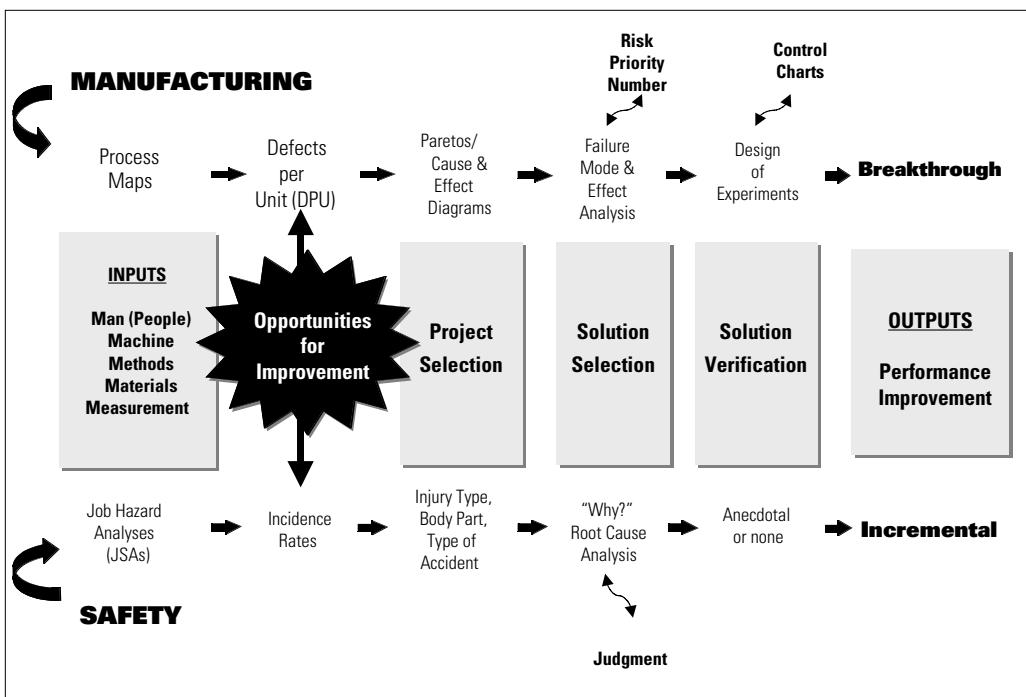
Manufacturing then uses tools such as Pareto analyses and cause-and-effect diagrams to isolate and target the most-prevalent and critical defects for specific process improvement projects. Potential improvements are selected based on their predicted effectiveness, through another six sigma tool, failure mode and effects analysis (FMEA). Prior to full implementation, solutions are validated through pilot studies. Once solutions are implemented, statistical control charts are used to monitor process improvements and sustain gains.

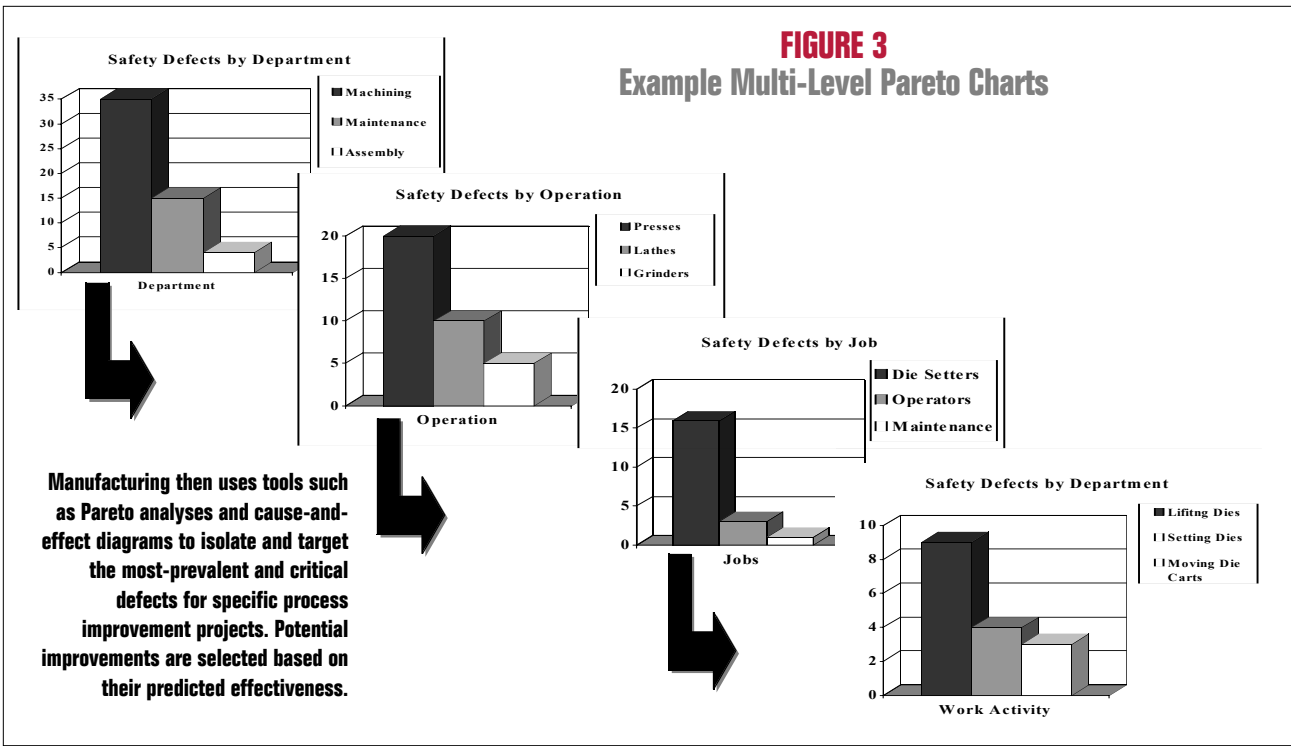
In contrast, safety staffs often take a less-rigorous approach to controlling defects and process variation (Figure 2). Typically, safety personnel complete some process mapping in the form of job safety analyses (JSAs), which identify major job steps, hazards and precautions. Often, the improvement opportunities are narrowly defined as employee injuries and illnesses.

However, these “trailing” metrics tell only a limited story; underlying safety defects that result in first aid, “near hits” and other incidents are often missed. These more-subtle defects may be responsible for the next serious injury or illness.

Traditionally, safety staffs analyze only injury and illness data, focusing on broad trends such as “type of injury,” “part or body” and “type of accident.” Root causes are deduced by asking the question “Why?” several times. Corrective actions are then de-

FIGURE 2
Comparison of Process Variation Control Approaches





signed and implemented, often without testing. Performance is again monitored using trailing indicators such as incidence rates.

In summary, this approach falls short. It does not detect and evaluate all process defects nor does it use advanced assessment tools to identify and follow-up on critical defects. By acting on fact, six sigma tools fill the gaps and deliver breakthrough performance gains where only incremental improvements were possible. At the same time, these tools improve communication, better integrate safety into business and increase credibility with management through use of common

business languages—quality, continuous improvement and cost reduction.

HONEYWELL SIX SIGMA SAFETY

Honeywell's approach involves a disciplined, multi-step process that helps answer these important questions:

- How effective are current safety processes?
- How can they be improved?
- What are barriers to improvement?
- Which improvements will have the greatest impact?
- How will gains be achieved and maintained?

The first step is to clearly define the

customers, their safety needs, and associated work processes through brainstorming and process mapping techniques. From a safety perspective, key internal customers include employees, supervisors, department managers and the plant manager. Customers are interviewed to determine their safety requirements and needs. What are their safety concerns? Which is most critical and why? What are their expectations? Customer feedback allows key requirements and expectations—known as key process output variables (KPOVs)—to be developed (Table 1, pg. 32). KPOVs identify candidate work processes for improvement.

Once a specific work process is targeted, a process map is constructed. Process mapping captures the sequence of individual work steps, including inputs and outputs. The best way to determine process steps is to interview the people who actually perform the work—they know what really happens. One can never assume that the process flows the way it is described in a procedure.

Safety defects are carefully measured across the targeted work process to obtain an accurate assessment of performance. These defects are broadly defined. Valuable process insights are gained by including all defects that could result in injury or illness.

The focus is then sharpened to identify the most prevalent defects using Pareto charts. These charts display the relative frequency of safety defects and help identify the best starting point for problem solving. Figure 3 shows sample multi-level Pareto charts. The most-prevalent defects detected are then further analyzed using a cause-and-effect diagram (Figure

FIGURE 4
Example Cause-And-Effect Diagram (leading cause circled)

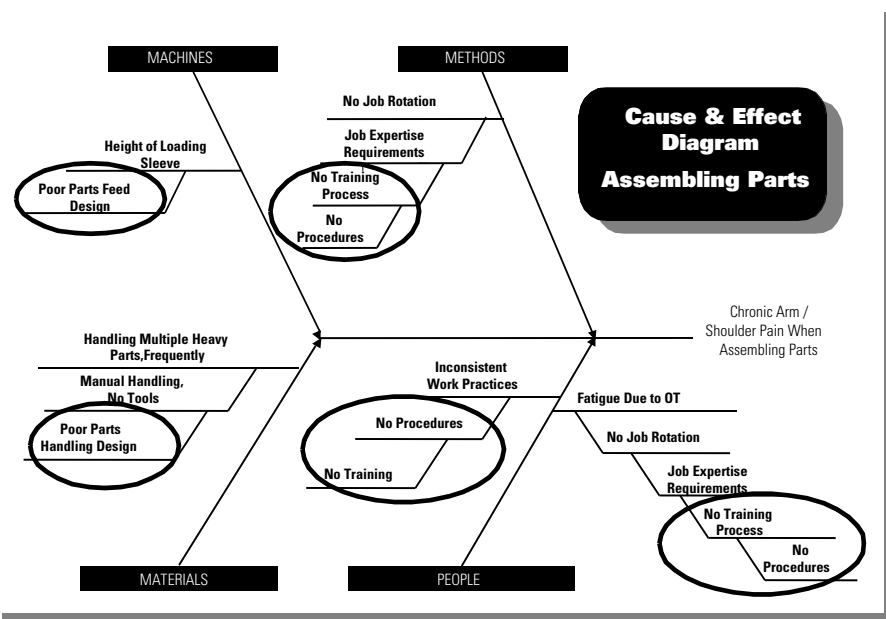
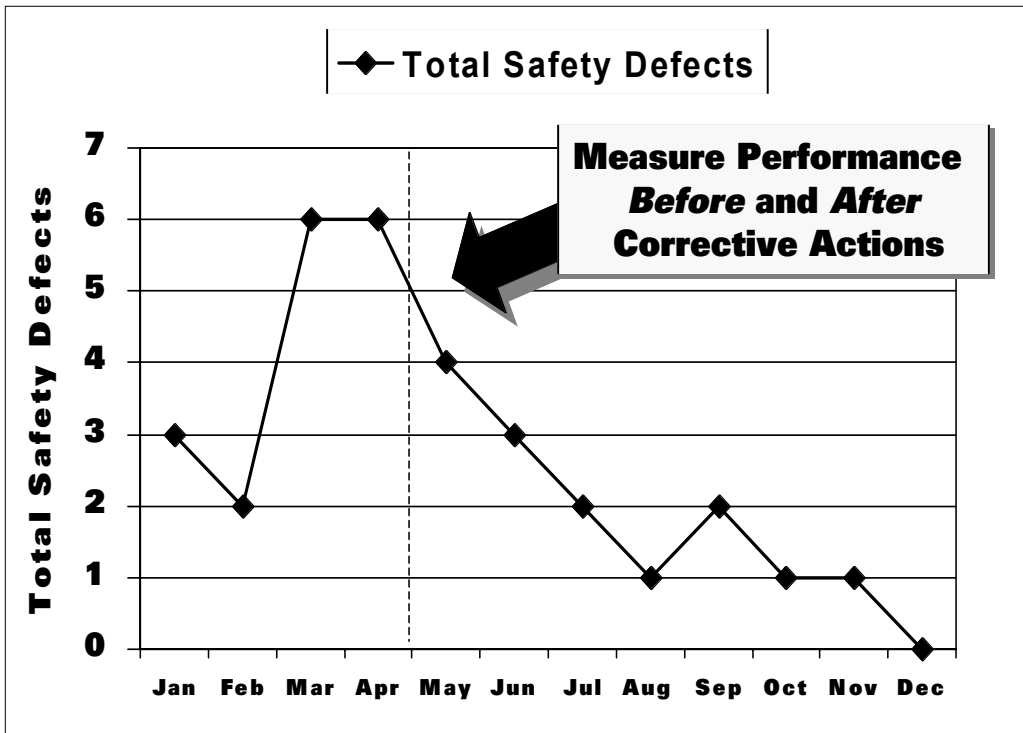


FIGURE 5
Example Control Chart



4). This diagram helps identify possible causes related to a problem or condition in order to discover its root cause. It is normally constructed by cross-functional teams to ensure accuracy.

Possible root causes identified should then be ranked by importance using FMEA. This tool ranks causes by severity, frequency of occurrence and effectiveness of current controls. Those causes or "failure modes" with the highest risk are given the highest priority for intervention.

When evaluating intervention options, it is best to first select those options that completely eliminate the failure mode or defect. For example, redesigning a specific process step may mistake-proof the entire process; mistake-proofing eliminates root causes of defects.

Prior to selecting a final solution, its effectiveness must be tested through a validation study. The safety and health professional should check with workers, engineers and other process owners to evaluate effectiveness of proposed solutions. These studies ultimately answer the question, "What is the net effect on defect reduction of installing the proposed control?"

Once proposed actions are validated, a written countermeasure plan—with clear assignment of responsibilities and accountabilities—must be deployed. This plan need not follow a set format; however, at minimum, it should indicate what actions need to be taken, who is responsible and when corrective actions will be completed.

Sustaining gains is a key step in six sigma safety. One way to monitor gains is to construct control charts that graphically display how the process has "shifted" following countermeasure implementation. Control charts measure overall performance and quantitatively assess gains. Figure 5 depicts an example control chart. Statistical tools such as t-tests are used to prove whether defect reductions are real and not due to random chance.

Control charts also serve to establish both a new performance baseline and starting point for additional improvements. Using six sigma tools has no real finish line. Following implementation of countermeasures and control charting, safety professionals must continuously re-analyze the process for new improvement opportunities.

CONCLUSION

Applying six sigma tools to safety offers a new, important opportunity for safety professionals. By taking the same approach used by manufacturing, operations and quality functions, safety professionals can identify, prioritize and eliminate safety process defects in order to achieve breakthrough safety performance. ■

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Tom Rancour, CSP, CIH, is director of safety and industrial hygiene with Honeywell International, Farmington Hills, MI. He has 20 years' experience and holds an M.P.H. in Environmental and Industrial Health from the University of Michigan, an M.S. in Biochemistry from Michigan State University and a B.S. in Biochemistry from the University of Michigan. Rancour is a professional member of ASSE's Detroit Chapter.

Mike McCracken is director of safety and loss prevention with Honeywell International. He has more than 20 years' experience in the safety, health and environmental fields. McCracken holds an M.S. in Safety and Health Management from the University of Arizona and a B.S. in Safety Engineering from Indiana State University. He is a professional member of ASSE's Maumee Chapter.

TABLE 1
Key Customer Requirements and KPOVs (Safety Examples)

- Clear Safety Procedures
- Job-Specific Safety Training
- Prompt Corrective Actions for Identified Deficiencies
- Minimize Heavy Lifting in Maintenance Dept.
- Minimize Hand Lacerations in Machining Dept.
- Meet Regulatory Requirements
- Minimize Injuries and Illnesses in Oven Dept.

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