Six Sigma Safety

Applying quality management principles to foster a zero-injury safety culture

By Michael M. Williamsen

IS SAFETY GIVEN THE SAME COMMITMENT as product quality? Are employees accountable for their own safety? Is safety excellence embedded into the company psyche? These fundamental questions are driving today's safety revolution.

In much the same way quality management made significant strides during the 1980s, industrial safety is poised for its own transformation. This article provides an actionable approach to how a zero-injury culture can be driven by adopting the same tools and tactics of product quality's Six Sigma methodology. It includes a previously unpublished case study that documents the teamwork, methodology and results of a corporate continuous improvement team at Frito-Lay Inc.; it involved 40 plants and 10,000 employees.

Six Sigma tools are nonproprietary, with a growing number of documented references to their statistical origin (ReVelle). This article documents their practical application to safety and their resulting injury breakthroughs (as illustrated in the case study and accompanying figures).

Safety Performance Culture

Like all innovations, Six Sigma encompasses the perspectives of leading thinkers in manufacturing and production. Although the concept originated with a group of Motorola engineers during the mid-1980s, Six Sigma encompasses the theory and logic of quality pioneers such as W.E. Deming, Joseph Juran and Philip Crosby to address the question, "Is the effort to achieve quality dependent on detecting and fixing defects? Or can quality be achieved by preventing defects through manufacturing controls and product design?"

At its core, this approach is about improving effectiveness and efficiency. Its primary pursuit is perfection—a never-ending dissatisfaction with current performance. What separates Six Sigma from conventional quality concepts is its focus on communicating measurable error ratios. By incorporating customer-focused objectives and metrics to drive continuous improvement—and by establishing processes which are so robust that defects rarely occur—Six Sigma quality objectives aspire to reach a three-parts-per-million error ratio at a 99.9996 percent incidence. Statistically, Six Sigma variations are the standard deviation around the mean, represented by the Greek letter sigma (σ).

Today's Six Sigma quality community includes certification that incorporates formal instruction, performance standards, and applying a wide range of analytical problem-solving tools such as Pareto charts, process maps and fishbone diagrams. Its mastery borrows martial arts vernacular (e.g., black belt, sensei) to define levels of understanding and performance.

Six Sigma Control Levels

In the author's opinion, what Six Sigma did for quality is about to occur in industrial safety. The same desire to eliminate product mistakes is at work to reduce injury rates. This parallel journey has six levels. Each sigma control builds on the previous level until the sixth sigma—a zero-injury culture—is attained.

One Sigma Control

One sigma is set in the era of the three Es of safety: engineer, educate and enforce. The tools for these rudimentary safety mechanics include work orders, safety rules, injury investigations and compliance programs. While barely touching the surface of why injuries occur, one sigma tools establish the foundation for creating a safe workplace. As with one sigma in quality, the performance (conceptually at least) is 68.5-percent error-free. This level represents the ability to sustain the essentials in worker safety.

Michael M. Williamsen, Ph.D., *is a consultant with CoreMedia Training Solutions, a Portland, OR-based safety products and services company. Williamsen has more than 30 years of business change management experience with companies such as Frito-Lay Inc., General Dynamics and Standard Oil. He earned his Ph.D. in business from Columbia Southern University.*

The Safety Perception Survey: 20 Categories

1) **Accident investigation.** Does your safety system deal positively with the investigation of accidents? Are the real causes ever covered up for political reasons or to meet production quotas? Do employees feel free to discuss the underlying causes and circumstances?

2) **Quality of supervision.** Are supervisors perceived to be competent in accident prevention? Do they hold meaningful safety discussions with employees on a regular basis? Do they reward safe behavior?

3) **Substance abuse.** Are employees with substance abuse problems allowed in the workplace? Is there an effective program for prevention and rehabilitation?

4) **Attitudes toward safety.** Is there a positive attitude toward safety at all levels of the organization? Do employees feel that management is fair and effective in its approach to safety?

5) **Communication.** Do managers and employees communicate freely on safety issues? Are there informal systems of communication in addition to the more traditional channels?

6) **New employees.** Are new employees thoroughly trained in safety? Does training continue on the job with reinforcement from experienced workers?

7) **Safety performance goals.** Do workers and management formulate behavior-oriented safety goals? Are goals effectively communicated to all employees?

8) **Hazard correction.** Is there an effective system for dealing with reported hazards? Is this system understood and supported at all levels of the organization?

9) **Inspections.** Are there regular inspections of all operations? Do employees have an opportunity to participate in these inspections?

10) **Employee involvement.** Are there opportunities for employees to become involved in safety through such means as quality improvement teams, ad hoc committees or effective supervision?

Two Sigma Control

The tools for two sigma control include observation programs, job safety analyses and near-hit reporting. At this level, awareness and analysis tools are applied to reach a two sigma level—or an injury-free rate of about 98.5 percent. Research indicates that a 10-percent error level requires about 3,000 observations to detect and act on mistakes [e.g., Harry(a),(b); Jackson; Walmsley]. As errors decrease, more observations are needed to detect the incorrect activities, which means a one-percent error level requires about 10,000 observations to be statistically valid [Petersen(b) 114-118]. It is a benchmark that underscores how challenging it is to move beyond two sigma control without adding to the traditional safety repertoire of observation programs and "rearview mirror" reporting. Two sigma safety control is focused on "what is seen" in the workplace.

Three Sigma Control

Three sigma product quality requires well-defined responsibilities and accountabilities to provide predictable results on a regular basis. The same is true for three sigma safety [Petersen(a)]. Without safety accountability at all levels, it is essentially impossible for a company to attain this level of control. Organizations that have been able to move from two sigma to three sigma generally attribute their success to the introduction of individual accountabilities into their safety programs. Embracing the conventions of accountability and personal responsibility is a critical factor in achieving a 99.7-percent injury-free workplace. While three sigma is commendable, companies at this level still incur lost-time injuries at a rate of three per 1,000 employees. Three sigma safety addresses "what is done" in the workplace.

Four Sigma Control

Beginning in 1979, Dan Petersen teamed with Charles Bailey to develop a comprehensive and statistically validated safety perception survey on behalf of the U.S. rail industry [Bailey(a),(b); Bailey and Petersen]. Today, the survey is used to audit an organization's safety culture and identify perception gaps across 20 categories (above), cross-tabulated by management, supervisors and frontline employees. The self-administered questionnaire includes 73 questions and provides firms with a statistically reliable method to answer the questions, "Where do our people believe we are weak?" and "Where do they agree and disagree?" Today's safety perception survey results can be compared with a database that contains more than two million respondents. It is a tool that provides statistically valid data for industrywide comparative analyses.

This development added an important dimension to pinpointing improvement opportunities. Not only does it identify safety shortcomings, its implementation is recognized as a valuable "buy-in" mechanism to set the stage for continuous improvement work teams—a necessary component to reach four sigma control—99.97-percent injury-free. Four-sigma control concentrates on the nonobservable "what is believed" in workplace safety.

Figure 1

Action Item Matrix: Accountability Team

Date: 6-27-04
Members: Wolf, Lowery, Jennings, Williamsen, Brown, Morrison, Gilbert

Item	Action Item	Who	Target Date	Comments
1	List all job titles/functions	Morrison	7-2	In database
2	Hand out accountabilities from company "xyz" for examples	Jennings	7-2	Will be e-mailed
3	Each team member to list their own safety accountabilities	Team	8-27	Judy to put in database
4	Critique accountabilities	Team	Until completed	Final copy review by safety council and other potential parties

11) **Program awareness.** Do awareness programs stress safety both on and off the job? Do employees look favorably on these efforts?

12) **Performance recognition.** Is good safety performance recognized at all levels of the organization? Are workers routinely reinforced on the job for safe behavior or is recognition merely relegated to occasional safety awards?

13) **Discipline.** Is the company perceived as taking a fair approach to handling rules infractions? Is the emphasis on discipline in proportion to the emphasis on positive reinforcement?

14) **Safety contacts.** Are there regular safety contacts with all employees? Are one-on-one discussions used in addition to safety meetings?

15) **Operating procedures.** Are safe procedures seen as both necessary and adequate by all levels of the organization? Are employees actually aware of the company's safety-related procedures?

16) **Supervisor training.** Are supervisors perceived to be well-trained and able to handle problems related to safety? Is their performance measured and rewarded appropriately?

17) **Support for safety.** Is the whole organization seen as working together to create a safe work environment? Is each level of the organization perceived as contributing effectively to the safety effort?

18) **Employee training.** Do employees feel that they receive adequate training in how to work safely? Do employees understand how to work safely?

19) **Safety climate.** Is the climate conducive to adopting safe attitudes and work habits? Is safety perceived as important to the organization?

20) **Management credibility.** Is management seen as wanting safe performance? Are they willing to provide necessary resources to achieve this performance?

Source: Bailey(b).

Five Sigma & Six Sigma Control

The next challenge is to use the data from the previous four levels of safety:

- injury and work order data;
- observable processes;
- accountabilities;
- information based on a safety perception survey.

The material from these four areas needs to be applied in a rapid, accurate and functional way. Once a company is nearing four sigma, the major barriers to effective cross-functional continuous improvement are eliminated. A roadmap can be developed to an unprecedented five sigma (99.997 percent) and Six Sigma (three injuries per million employees) safety performance. At this point, an organization can approach a zero-injury workplace.

As in a Six Sigma quality program, all foundational mechanics—engineer, educate, enforce, observe, investigate, accountability principles and thought patterns—are required to establish an authentic Six Sigma safety culture. The challenge is to create a sustainable safety culture where heightened safety decisions occur without thought. It is a process that begins by addressing the milestones to continuously improve.

Good data are necessary. However, to achieve four sigma performance and beyond, SH&E professionals need to implement a similar approach to what zero-error quality cultures use in manufacturing. To do this, an organization's continuous improvement teams must "own" and implement the following:

- A regular, sanctioned meeting system with actionable rules and mechanisms and trained leaders to manage the CI process in safety.
- Six Sigma analytical techniques/tools with safety issues and projectible data.

Once these critical factors are in place, a zero-error safety culture can be a recognized strength alongside the traditional business necessities of customer service, quality assurance and manufacturing efficiencies. As the case study will illustrate, the resulting savings in both cost and hardship can be dramatic.

Applying Six Sigma Tools in the Workplace

Five and Six Sigma injury control requires statistical process control tools, a dedicated continuous improvement (CI) team and active participation from all levels of employees. This latter component emphasizes the importance of effective meetings. Organizing effective "subteams" to execute tasks is essential. Furthermore, because many of the subteams combine cross-functional employees from disparate groups, it is critical to delineate proven principles to create a meeting structure that ensures efficiency, participation, action and high performance.

Effective Meetings for Continuous Improvement

To achieve results from safety meetings, the person who calls the meeting must focus on its purpose and desired outcomes. By deploying the POP model—purpose, outcomes, process—the group can remain focused and on task.

Purpose

The purpose is a mini-mission statement. Why is the group meeting? If the purpose is unclear, start

Task: Define Machine Operator Role

Definition

The key safety accountabilities of the operator are to use safe work practices, use all safety equipment when required and promote safety with coworkers.

Responsibilities

1) Before each shift, inspect/check the work area to identify any unsafe issues and correct or initiate corrective action as needed.

2) Perform daily housekeeping duties to keep/maintain work area in a safe and clutter-free condition.

3) Attend and participate in all shift supervisor safety meetings.

4) Team with the supervisor to present/discuss topics in the supervisor safety meeting (two to four per year).

5) Initiate and follow up on safety work orders.

6) Provide appropriate safety and health training to new/transferred personnel.

7) Review and improve job hazard analyses regularly.

8) Be familiar with all documents in work area.

9) Pay attention to coworkers and outside personnel working in the area. If they are not following proper practices or procedures, talk with them immediately about correcting their activities.

10) Inspect containers to ensure that they are labeled correctly. If not, relabel them immediately.

Measures of Performance

1) Appraisal by supervisor of individual task achievement.

2) Observations by supervisor.

A Case Study: Six

This previously unpublished case study illustrates how Six Sigma measurements were applied to a Fortune 500 food product company that was experiencing hundreds of injuries across multiple facilities. The initiative resulted in a rapid improvement in workplace injuries and the start of a zero-injury safety culture.

Pareto Charts

The Pareto chart is one of the most helpful visual tools in the safety Six Sigma tool box. These charts help to pinpoint unacceptable occurrences that warrant high priority. The charts (Figures 2-8) show the frequency and severity of problems and where they occurred geographically.

Process Maps

Process maps or process flow diagrams graphically illustrate how a task or process can be accomplished effectively within the constraints of time and resources (Figures 9-12, pp. 47-48). This tool allows a continuous improvement team to break down a complicated sequence of events into simple metered steps, which result in a "spaghetti diagram." The team then analyzes each step in the process being studied and optimizes each individual task to a point where inefficiencies, errors, complicated "spaghetti" and safety hazards are eliminated.

Cause-&-Effect Diagram

As the CI team continued its efforts to eliminate back and soft-tissue injuries, the safety team used another Six Sigma tool, the cause-and-effect diagram (Figure 13, which is also referred to as a fishbone or Ishigawa diagram). Team members were able to refer to the chart to identify multiple potential causes for the problem at hand. The "bones" of the normal potential "cause" categories include people, methods, machinery and materials. As problem situations vary, this Six Sigma tool has the added benefit of being able to creatively identify different elements to better fit the individual situation. For the food products company,

Figure 3

Injuries by Gender

"Are males or females more apt to have costly injuries?" The pie chart is an effective tool whenever the variables are limited and the sum is 100 percent. This example reveals a need to find out why so many women were getting injured.

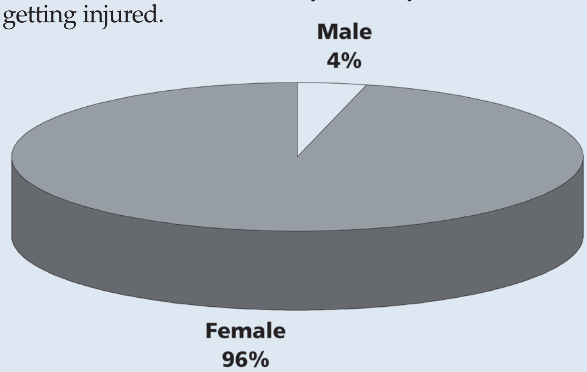


Figure 2

Lost-Time Injuries for 10 Periods

A baseline must be determined to indicate where the investigation should begin. This figure illustrates lost-time injuries over the last 10 months by various departments, and breaks out which departments warrant the most attention (e.g., packaging with 52 injuries, then shipping and processing). Once identified, plants with high numbers of injuries in these departments determined where to begin the continuous improvement in safety initiative.

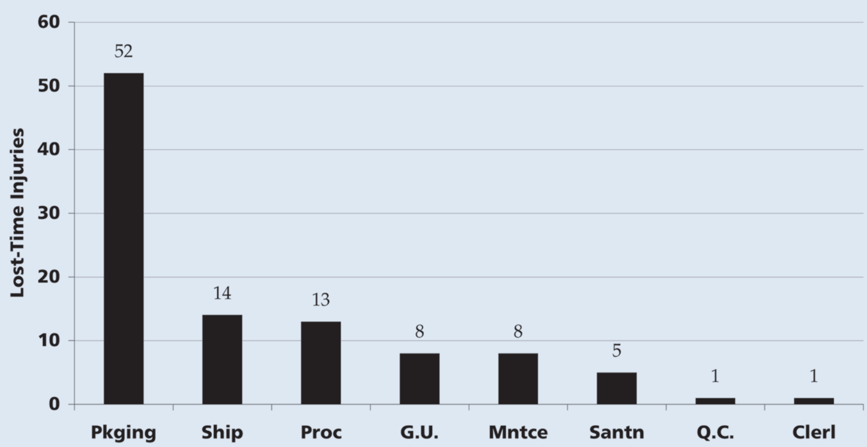
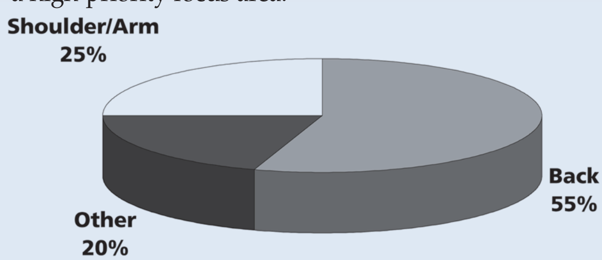


Figure 4

Lost-Time Injuries

By sorting injury data, the company drilled down on back and shoulder/arm injuries for individual facilities. Ultimately, it was found that all the sites were experiencing similar injury patterns, which presented a high-priority focus area.



with an open-ended question, "What is our purpose for this meeting?" If necessary, record responses on a flipchart until agreement is reached. Subsequent meetings of this same group need to restate the purpose and make sure it remains on target. If the meeting starts to wander or branch into a tangent, ask whether the current topic is "on purpose." A typical safety purpose may resemble a statement such as, "Develop safety accountabilities for all levels of the organization that will help eliminate injuries."

Outcomes

What will be accomplished when the stated purpose is achieved? This is a brainstormed list of the issues that the meeting is designed to address. It is also the metric for whether those tasks have been accomplished. The whole team or group participates in setting these outcomes and, therefore, seeks complete agreement as to definitions of success. Not only will this eliminate future differences, it also helps eliminate environment and technology were added as potential causes. After listing all potential causes, each team member voted for two or three of the individual fishbone diagram causes deemed most important. This individual voting process is referred to as "Pareto voting" in Six Sigma organizations; other trainers use the term "multivoting" (ReVelle). It is not a rigorous statistical evaluation; rather, it is a method that uses the personal experiences and judgment of the engaged subject-matter experts. It is an efficient way to quickly determine the top "vote-getting" issues believed to warrant more research and detail. These "focus causes" were then placed in an AIM for deeper team analysis and problem resolution.

In the next step, the team began a systematic search for low-cost, highly effective solutions. The cause-and-effect diagram (in group mode) allowed each team member to record what s/he thought was important. In turn, the team began to work on areas of interest believed necessary to be resolved in order to eliminate back and soft-tissue injuries (Figure 14, pg. 49).

From start to finish, the CI team approach to safety-issue resolution worked well for the manufacturing environment. The efforts to apply Six Sigma and other CI tools led to improvements in both total recordable and lost-time injury rates (Figures 15-17, pg. 49).

Although the impact cannot be entirely attributed to the team initiatives, the number of serious injuries dropped by more than 80 percent over the course of two years.

Figure 5

Back Injuries by Location

Examination of back injuries and where they occurred provided a lens through which to categorize injuries. To begin the investigation and issue-resolution process, volunteers were asked from relevant departments. By sharing this visual with the continuous improvement team, hands-on data and perspective were gathered and troubleshooting began.

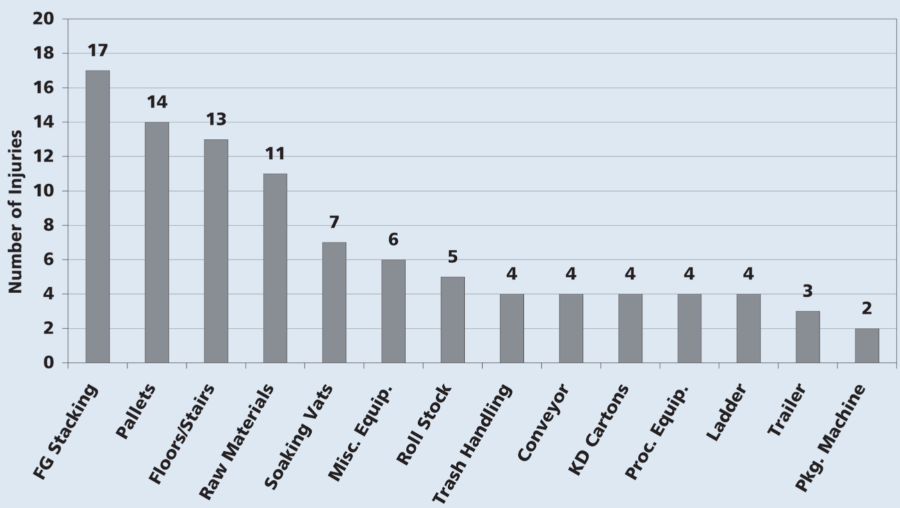
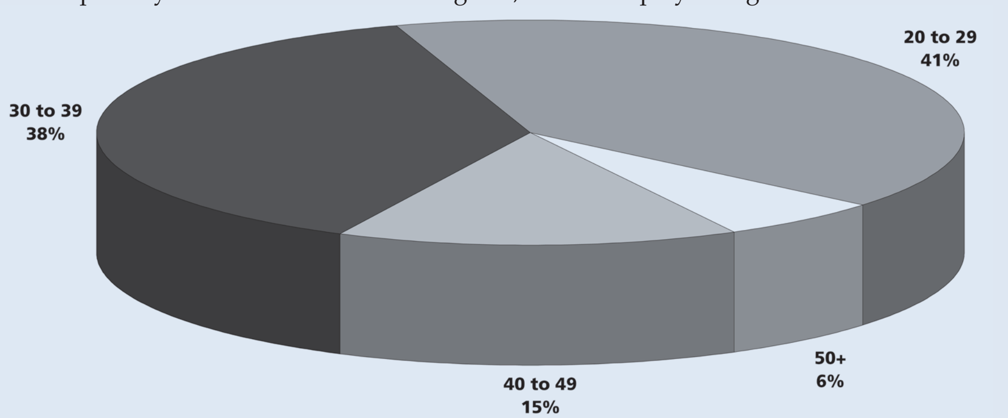


Figure 6

Back Injuries by Age

"Are the back injuries age-related?" While the initial expectation hypothesized that an older workforce were a high probability segment, this was not the case. Most back injuries were reported by workers over age 20 and under age 40. This Pareto chart represents scores of back injuries in some 40 manufacturing facilities. The chart was not meant to determine the cause of back injuries, but to illustrate whether advanced age was a significant factor as had been presumed for many years. The CI team's conclusion was that the type of injury should be the primary consideration to be investigated, not the employee's age.



discussions that stray from the desired outcome. A typical set of outcomes for a safety team might be: Accountabilities that make a difference in safety for every job in the facility; a tracking system to follow accomplishment of these accountabilities; a reward system that reinforces these activities; reduced injury frequency as a result of doing this work well.

Process

How will the purpose and outcomes be accomplished? What typically follows is a description of how the team will work. Often, it is divided into small problem-solving groups that include volunteers to accomplish small tasks. Why volunteers? When people get to place

Figure 7

Injuries vs. Month

Were more injuries occurring during certain times of the year? Could shipping schedules be a factor? The Six Sigma team was still seeking some "silver bullet" that would provide a simple, quick action plan. The Pareto chart in this figure revealed that neither was a predominant factor and, as a result, eliminated any false hypotheses and red herrings that could waste time and effort.

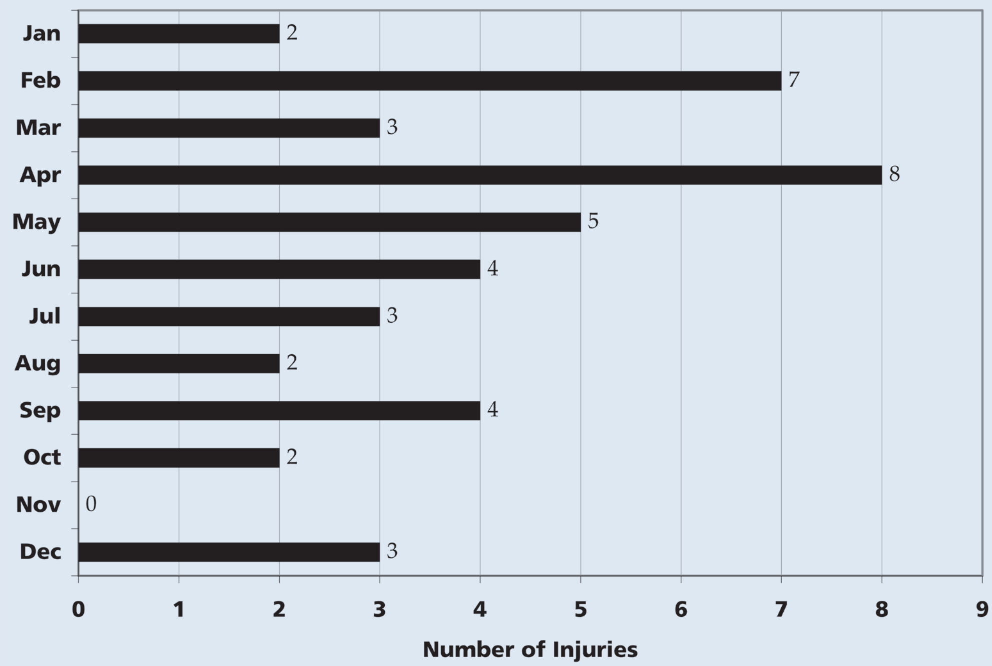


Figure 8

Injuries per Shift

The CI team also assessed where injuries were occurring within an individual plant by shift. While employee figures revealed a high injury incidence rate during the second shift, they also directed attention to a substance abuse issue. The swing shift employees had manifested a mini-subculture, which led to a quick resolution to address the issue. Pareto charts allow continuous safety improvement teams to focus on what is different, then question why. All that remained was for the internal safety teams to address the issues highlighted by the Six Sigma continuous improvement process.

themselves in performance zones where they are comfortable, they are more likely to succeed. Conversely, quick delegation can lead to having the wrong people assigned to the wrong task. If there are not enough volunteers to perform all the work in the time allotted, time or resources (or both) may need to be increased. One distinction must be remembered throughout: This is not a crisis team; it is an improvement team that fosters the continuous improvement process.

Action Item Matrix

In many cases, a significant number of tasks need to be completed by various people in varying time frames. To effectively manage this wide spectrum, it is best to use an action item matrix (AIM), which is a simple five-column spreadsheet (Figure 1, pg. 42). The columns (from left to right) are:

- **Item number.** Each item on the list is numbered. As items are completed, they are moved to the bottom of the list. This provides a record of what the team has completed as well as what still needs to be accomplished.
- **Task to be accomplished.** This is a simple, succinct statement of the issue. Each task or action item is a small, manageable portion of the larger project scope.
- **The team.** The list of volunteers who have agreed to accomplish this action item. Each item may have one or more volunteers—or in some cases none, if the assignment is not ready to be worked on.
- **The date.** This indicates the next report date for the task team on this action item. It may be a completion date, a progress report date or other target date.
- **Comments.** This field holds information pertinent to the action item, e.g., "awaiting vendor quote."

At this point, the team has its assignments, the POP statement and its progress-tracking mechanism, and the AIM. How often

Figure 9

Case Erection Process

This figure is a flowchart for erecting a cardboard case for packaging the food product. After a thorough discussion, the safety team can identify key areas for concern: reaching for a new case, twisting the body, inspecting the case, possibly throwing out rejects, unfolding the case, etc. Based on this process-flow diagram, the team started to understand the numerous reasons for the prevalence of ergonomics-related injuries.

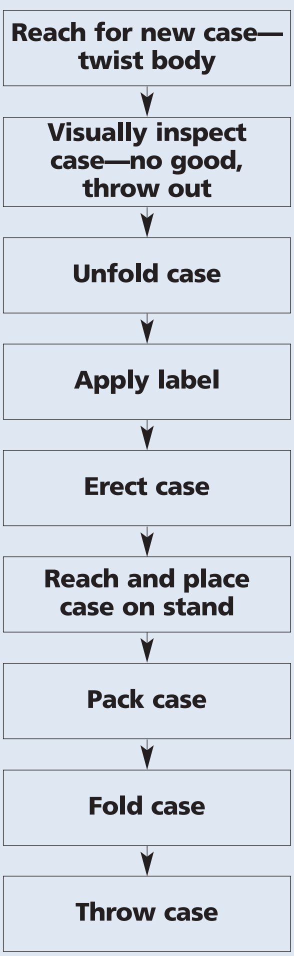


Figure 10

One-Pound Package Movements Per Hour

By analyzing operators' work tasks, packaging maneuvers are assessed for a one-hour period. In this example, the total weight was equal to 1,950 pounds per hour. The calculations would ultimately include the weight of handling and moving full cases, which brought the total weight to almost two tons per hour. Examples such as these demonstrate the greater impact of ergonomics issues.

Example: One-pound package movements every hour

1,800 grasp
300 case reach
150 twist
450 fold/unfold, erect
167 throw
1,800 package reach
1,800 package place

Pounds per hour:

1,800 packages
150 cases
1,950 pounds

This figure puts the preceding statistics into a Pareto bar format. In this instance, the process map was a better presentation of the data than a Pareto chart.

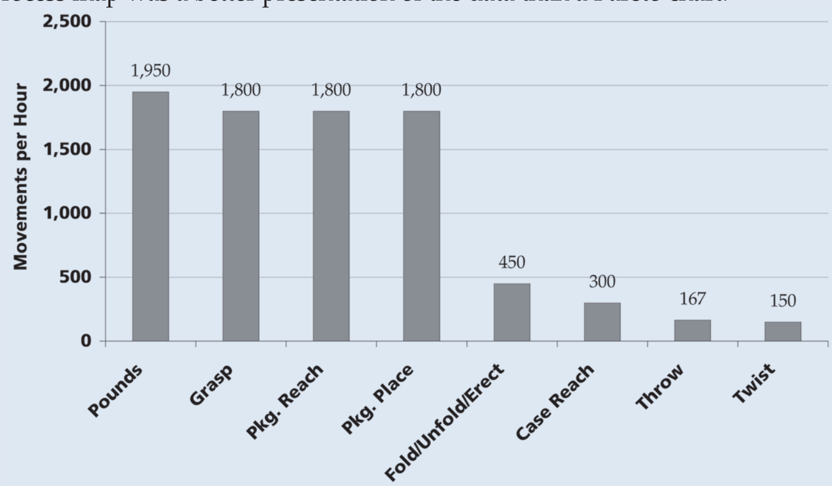


Figure 11

Packer Process Flow Diagram

This figure provides another look at process flow by including both sequential tasks and their timing as they relate to employee functions. By breaking down the packaging process into micro steps, the safety team started recognizing areas to reduce the amount of muscle-strain-related injuries. The safety team then had a micro and macro perspective on the data for a more complete picture.

6:00 AM	7:00 AM	7:45 AM	*Start Shift* 8:00 AM	9:00 AM	*Break* 10:00 AM
Get up					
Eat breakfast Talk with spouse					
Read the paper Feed the dog					
Two cups of coffee	Drive 30 minutes thru heavy traffic	Arrive at plant			
	One cup of coffee	One cup of coffee			
		Clock in			
			Arrive at machine		One cup of coffee
			Pack one-pound bags at 30/min		Rest, take break
			0 pounds	1,950 pounds packed	3,900 pounds packed

should the teams meet? The whole team meets every two weeks, with the task or subteams meeting more frequently as they are problem-solving units. More-frequent whole team meetings do not allow the subteams enough time to com-

Figure 12

Injury Sequence

This figure was developed as a result of a continuous improvement team's effort to achieve consistent injury reporting and analysis throughout the corporation. The team found that each of the plants handled its injured employees in its own way. Employees from the plants were assembled to analyze the injury action process (below). The resulting process map was what worked best and most consistently in the manufacturing environment.

It was found that when plants sent the supervisor to the clinics with injured employees, every step in the process functioned better. Part of the reason supervisors took more personal responsibility for employee safety was because of the cost and inconvenience of leaving the plant every time an injury occurred.

When questioned, plant personnel believed there was a more consistent and clear discussion of the injury (and description of work tasks) with healthcare professionals when the supervisor was present. These same plant personnel felt that the employees needed an additional perspective to describe or reconstruct the incident. Ultimately, it was decided that a revised approach should include personal employee care as opposed to simply sending injured employees alone, by cab, to a clinic. This was viewed as a significant improvement by the employees. However, the real effort to eliminate all injuries—not simply handle them correctly—remained at large.

Injury → First Aid → Foreman Takes Employee to Clinic → Treatment → Foreman Returns to Work With or Without Employee → First Report of Injury → Investigate Injury → Staff Review of Injury → Injury Review Board → Corrective Actions → Communication of Actions

plete their tasks and are an inefficient use of time. Less-frequent meetings do not create the needed sense of urgency.

An entire safety program was developed in less than nine months using this meeting process [Petersen(c)]. Hourly and salaried employees applied these guidelines for all 20 safety perception survey categories. Although the impact cannot be entirely attributed to the team initiatives, the number of serious injuries dropped by more than 80 percent over the course of two years (see Figures 15-17, pg. 49).

Effective Safety Task Forces

How are safety taskforces created? How are tasks priority ranked? The answers are summarized in this process:

•Start with an AIM.

•At Frito-Lay, supervisors trained in CI techniques could generally lead up to two CI teams of three to 10 people while still performing their normal work tasks.

•Attempt to enlist only volunteers so people assign them-

Figure 13

Cause-&-Effect for Packers

Environment
Air conditioned (cold)
Standing
No footrest/cushions
Only assigned breaks
Work "hurt" philosophy exists
High turnover of EEs
High turnover of supervisors

Methods
Poor training
No preconditioning
No return to work physical
Little rotation of workstation
No assimilation program
Inconsistent supervision
Training support by management lacking
Supervisers don't reinforce proper procedures
EEs clean up spillage/area
EEs responsible for quality control

People
Untrained
Unconditioned
No hiring profile
Returned injured EEs to same job
No work hardening
No EE input to improve situation
Supervisors at low training level
Entry-level job
20-percent long-term EEs

Soft-tissue injuries
$1,500,000/year direct cost

60 people injured

Technology
Not state of art
Auto case packers coming?

Machinery
Doesn't stack for ease of pickup
Isn't ergonomically designed
Throw cases
Stack cases
All manual tasks
For cases
Speeds seemingly set high
Incorrect heights for EEs
Little to no automation
No diagnostics

Materials
Slippery bags
Various sizes
Different stacking configurations
Different placement configurations
Seals fail regularly
Cases often bad

selves to tasks they want to pursue and are willing to make the time to complete.

•Implement only short-term, 90-day teams that have effective facilitation, leadership and closure. If those three characteristics are not achievable, then the teams should not be initiated. The short-sighted approach of trying to "do everything for everybody right now" will only lead to frustration.

•Have teams meet every two weeks to reconnect on a regular basis. The time between meetings can be increased to three weeks, but the groups should not meet more often than every two weeks. Subteams should meet as necessary to test, discuss and resolve problems. The "Task" sidebar on pg. 43 provides an example of hourly employee safety accountabilities developed through this process. This process can can be used in each of the 20 safety perception survey categories.

Conclusion

The case study and figures demonstrate how a CI approach helped to improve safety performance in a manufacturing setting. Injury data were combined with perception survey data to obtain a full spectrum of workplace realities—both observable and hidden. Hourly and salaried employees then team—using Six Sigma tools and effective safety meeting techniques—to develop and implement a zero-injury safety culture, a workplace that neither tolerates, nor experiences, injuries. ■

Figure 14

Action Items

This figure lists agreed-upon action items from all the cause-and-effect diagrams, process maps and Pareto charts. Team members then began focused efforts to eliminate the disabling back and soft-tissue injuries experienced each year.

Team: Packer Safety Improvement **Date:** 11/30
Members: John, Sam, Steve, Dimitri, Sharon, Bob

Item	Action Item	Who	Date	Comments
1	Hire ergonomist to study and make recommendations	John	12/10	M. Ayub, J.L. Sangre, K. State, UT
2	Get EEs to develop training program	Sam	3/3	
3	Retain doctor to develop physical requirements of job	Steve	3/3	
4	Improve case sorting prior to use	John & packers	12/2	
5	Change supervision rotation program from six months to one year	Sharon	2/6	
6	Improve mechanical reliability of packaging machines	Bob	12/8	
7	Work with EEs to develop warm-up program	Dimitri	1/15	

Figure 15

Total Injury Frequency

The CI team was formed in 1985 at a time when the 40-plant aggregate injury-reduction rates stalled. Based on total injury rates alone, there appears to be a direct correlation between team efforts and their use of Six Sigma tools.

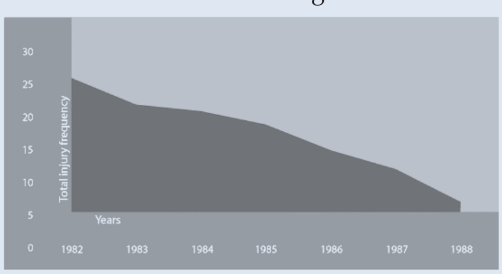


Figure 16

Lost-Time Injuries History

Lost-time data also improved during the same time period.

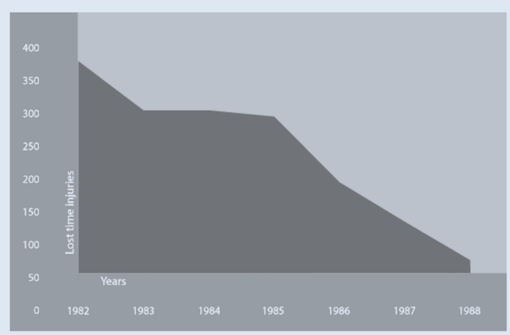
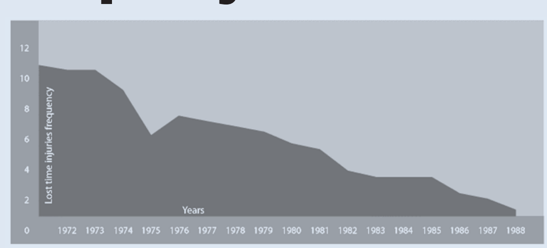


Figure 17

Lost-Time Injuries Frequency



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