

The survey used as a foundation for this case study combines safety performance with cultural considerations to generate a holistic platform for compelling change.

CASE STUDY

A Method for Changing the System, Process, and Culture Underlying Safety Performance

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For more than 25 years we have been involved in a very specific form of change management, the improvement of safety performance. Much of the detail of this work has been published elsewhere with my colleague Patrick Ragan.^{1, 2, 3} As with most instances of change management, this involves changes in the process and changes in the culture. We began in the late 1980s with an attempt to apply Deming's principles to safety improvement. We suggested the application of the plan-do-study-act (PDSA) cycle.

To develop an effective plan, we needed information about the current state of the process and the culture. We believed a survey process would be useful to assist with our planning efforts. At the time there was one established safety survey, the Minnesota Safety Perception Survey. It was developed by the Association of American Railroads and the University of Minnesota at Duluth.⁴ The survey was designed to assess a firm's "safety system effectiveness" and provide direction for improvement efforts. It contained 74 yes/no questions

on a wide variety of safety issues. In 1994 we applied that survey to the 6,000 employees in more than 50 plant sites of a chemical manufacturing company.

Our first step was to conduct the survey at 12 sites in a pilot study. Six of the sites were chosen because they had a poor safety record and were judged to have safety programs in need of improvement. The other six sites were chosen because they had an excellent safety record and were judged to have well-functioning safety programs. We used the data from the sites to test the validity of the 74 yes/no questions that comprised the Minnesota survey. For a question to be valid, it had to receive higher scores from the excellent sites than from the weak sites, using a hypothesis test (Yates corrected chi square test with a criterion of $p < .05$). A few of the questions were not valid, and they were subsequently dropped.

The dynamics of the survey, its reliability and validity, were excellent. The reliability of a survey is typically measured in two ways. The split half reliability is



assessed by randomly dividing the survey into two parts and correlating scores on one half with scores on the other half. The split half reliability of the survey exceeded .9, which was quite high. The second method for assessing reliability is to correlate the scores on one test with scores on a second test. The test retest reliability of the survey exceeded .8. We would not want this to be much higher, as the intent of the survey was to facilitate improvement. We hoped that some sites would improve their performance, thereby reducing the correlation between the first and second tests. Validity, or more specifically predictive validity, is measured by correlating the survey score with another measure of safety system effectiveness. In this case the overall survey score was correlated with the accident rate for each of the 12 pilot plants. The correlation was highly significant (with a Pearson coefficient of $-.87$), indicating that the lower the score on the survey the higher the accident rate. Translated, this means that the lower the survey score, the lower the effectiveness of the safety system as reflected in higher accident rates.

It was interesting to note that near the time we conducted the survey the company had sent a management team to each plant to conduct an evaluation of the quality of the plant's management. These ratings were available to us, so we computed the correlation between the management ratings and the survey scores for the 12 plants. The resulting correlation (with a Pearson coefficient of $.76$) was again highly significant. Based on that relationship, we concluded that the survey has measured not only safety but also components of the overall management system.

Having established reliability and predictive validity for the survey, we proceeded with the PDSA cycle. This involved feeding the results back to the employees, setting up focus groups to understand the meaning of the survey findings, and developing proposed actions. This was done in each plant and for the corporation as a whole. The end result after the action plan was implemented was a drop of more than 50 percent in the company's recordable accident rate. This established construct validity; the survey had helped us understand the process and enabled the development of effective interventions.

Over the years the survey has evolved. We have written many new questions and dropped old ones. The current survey consists of 75 questions, all in the yes/no format. The writing of new questions has been focused on three areas—environmental protection, employee morale, and process safety, which

relates to the production, transportation, and storage of hazardous materials and, therefore, is very important to chemical manufacturers.

All questions that remain in the survey have been validated in at least one study, and most have been validated in two or more studies. Furthermore, factor analysis has been performed on the survey data, which is a statistical process that groups the questions into sets, based on intercorrelation. The idea is that the questions in a set, or factor, measure the same factor.

We have applied this survey to more than 100,000 employees in over 10 companies. The typical result of the process described above is a reduction in the company's accident rate of 30-50 percent. Employee focus groups have indicated six key factors. Some questions associated with each factor are included below:

- *Employee engagement and ownership.* Do supervisors discuss accidents and injuries with employees involved? Is the amount of safety training given supervisors adequate? Does your site actively search for near-miss incidents? Do employees participate in process safety reviews? Have your company's efforts encouraged you to work more safely? Do your co-workers support the company's safety program? Do employees participate in safety inspections? Does your supervisor ask what you need to make your job safer? Do employees participate in the development of safe work practices? Do supervisors pay adequate attention to safety matters? Are accidents and injuries thoroughly investigated? Are safety rules regularly reviewed with employees? Are you encouraged to suggest improvements to process safety at your site? Are you adequately trained to respond to an environmental incident? Do employees understand the reasons behind the rules they are asked to follow? Are employees informed about the results of their exposure monitoring? Do employees participate in the development of better environmental practices? Do supervisors discuss environmental goals and performance with employees regularly? Do supervisors discuss safety goals and performance with employees regularly? Are minutes of safety meetings kept and follow-up files maintained? Have you been trained on what to do if there is an emergency? Do employees act to correct hazards they find?
- *Living quality, health safety, and environment (QHSE).* Has your company's safety program made me a safer driver? Does your company have an effective program to make employee travel safer? Is

off-the-job safety a part of your company's safety program? Have you spoken to neighbors or friends about the company's commitment to health, safety, and environmental (HSE) excellence? Is your family more concerned about off-the-job safety as a result of the company's safety program?

- *Leadership.* Are adequate resources applied to the HSE effort? Do different departments work together to improve safety? Are you proud of the company's HSE efforts? Are you confident of the company's future success? Do employees trust the information that management provides about the company? Does the company care about the safety of you and your family? Do managers treat subordinates with respect? Does management insist upon proper medical attention for injured employees? Is safe work behavior recognized by supervisors? Do employees receive recognition for doing a good job with environmental concerns? Does your company seek prompt correction of problems found during inspections? Are safety meetings an effective part of the safety program? Do supervisors treat subordinates with respect?
- *Environmental protection.* Are environmental releases reported to management? Do you believe management is committed to environmental protection? Do employees caution other employees about practices that could lead to environmental problems? Do supervisors pay adequate attention to environmental issues? Are operations at your site well maintained to avoid leaks? Do supervisors discuss environmental spills, releases, and incidents with the employees involved? Are environmental rules followed in your area? Do employees have an adequate understanding of the environmental rules relating to the jobs they perform? Are operations at your site designed and operated to prevent environmental releases?
- *Accountability.* Are safety rules effectively enforced? Are employees checked on a routine basis to see whether they are doing their jobs safely? When employees are assigned to jobs, does the company make sure they have the physical capability to perform the duties? Does the company detect when employees are using alcohol or drugs on the job? Does the company have a fair procedure for dealing with employees who violate rules? Are checks made to ensure that required personal protective equipment is being used? Do employees caution

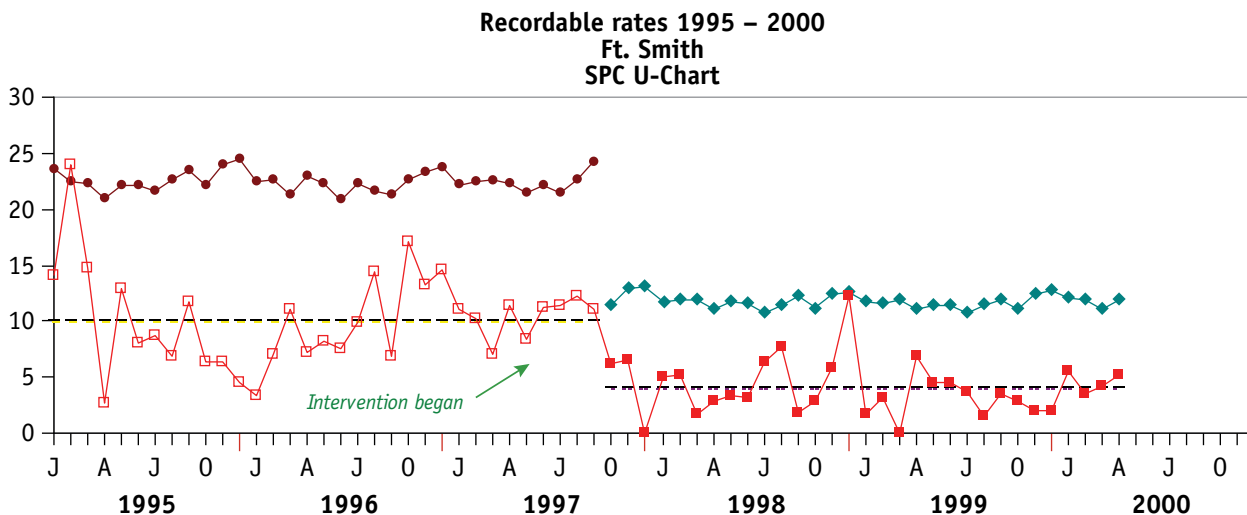
other employees about unsafe practices? Does your company deal effectively with problems caused by alcohol or drug abuse?

- *Process safety.* When you are asked to do a new job, do you receive proper training? Have you received adequate safety training related to your job? Are contractors at your site required to meet company HSE standards? Does the company provide a safety orientation for newly assigned employees? Are you well trained in the chemistry of the process units you maintain or operate? Are operating procedures reviewed and revised on a timely basis? Do you believe the equipment and facilities with which you work are maintained to ensure safe operation? Do investigations often find the fundamental causes of HSE problems? When changes are made to processes, are they properly reviewed? Do employees understand the hazards of the jobs they perform? Do you feel the processes you work with are designed properly to operate safely? Do operators and engineers communicate effectively? Are changes to procedures and processes adequately reviewed to ensure that those changes are made safely? Do you have confidence in the results of your site's process safety reviews? Is information that is needed to perform their jobs safely made available to employees? When procedures are revised or new ones developed, is proper training provided to the affected employees? Are process safety reviews comprehensive, addressing all important and relevant issues? Are the processes in the plant operated safely?

Note that many questions ask about system and process, and some are about the culture. The latter are questions such as: "Are you confident of the company's future success?", "Do employees trust the information that management provides about the company?", "Does the company care about the safety of you and your family?", and "Do managers treat subordinates with respect?" At least four questions do not mention safety or imply a relationship to safety; however, our data show that all of these questions are important to establish and maintain a safe workplace.

It often makes sense to work on broad areas of weakness, rather than attack issues associated with individual questions. When the results are fed back to employees and used by focus groups, the information they receive includes both question scores and factor scores.

Figure 1: Control Chart of Recordable Accident Incidents



Perhaps the most important thing about our experience is that lasting change in performance, the system, and the culture has been accomplished, as measured by subsequent surveys and results. This has been achieved with a relatively simple and reliable process—despite the fact that change processes generally are viewed as being very difficult.

A story that illustrates the power of this process relates to a survey we completed almost 20 years ago at a large manufacturing plant. The safety manager was a very enthusiastic promoter of the survey process. When visiting the plant after the survey was completed, it was noted that there was a gap between the enthusiastic attitude of the safety manager compared to the lack of enthusiasm from management. Approximately two years later we received a call from the safety manager telling me that his plant now had the best safety record in the company. He sent me the control chart of recordable accident rates, shown in Figure 1, documenting a dramatic improvement. Two months following the administration of the survey (indicated as “intervention began” on the control chart), there was a process shift with the accident rate dropping from approximately 10 to less than five. Subsequently, the process remained stable for more than two years.

One thing that was different in this case was that the employees and the managers were given clear data concerning the original state of affairs. The required changes were indicated by the data, as interpreted by the employee teams. There really wasn't much questioning about the need for changes to be made once the data was available. Moreover, the required changes benefited the employees because

they reduced the likelihood that employees will be injured or killed on their jobs.

Generally, the people who require persuasion to engage in this change process are not the front-line employees. Instead, senior management may be reluctant to adopt necessary changes. Without senior management's support, the safety improvement program cannot get started; however, we have found senior management to be very responsive to the data the survey produces. When we first conducted this survey, we eventually made a presentation to the company's executive committee. Our report strongly suggested some changes in their behaviors. We expected resistance—especially from the company's executive vice president. No resistance emerged, so one member of our team asked directly if the executive vice president had any concerns about the findings and recommendations. His response was, “How can you argue with data like that?” The president then said in a very friendly manner, “So you are saying we are out of touch.” We said that they had been unaware. The executive team complied with our suggestions, and the company safety record improved dramatically.

Perhaps the process we have described could serve as a model of a successful change process, based on the PDSA cycle. The first stage would be to collect data, confirming the need for change and providing some prescriptive information regarding what should be changed. The data would be used to launch the appropriate intervention to begin to redefine the process.

Of course, there is always the argument that a visionary leader sees needed changes that cannot be defined by data. We would counter that there

are plenty of changes to be made where data are very relevant. Strategic planning models, such as the approach described by Ackoff,⁵ contrast a vision with current reality, which is not dissimilar to the process we have used. Our process would seem to have two advantages. First, using a standardized survey to assess current reality may make the need for change more convincing. Second, no reasonable person would argue with a vision of fewer accidents and injuries. With these two key components setting a strong platform for change, organizational support is virtually guaranteed.

References

1. Brooks Carder and Patrick Ragan, "Benchmarking and Performance Appraisal Criteria," in Joel M. Haight, ed., *The Safety Professionals Handbook*, American Society of Safety Engineers, 2012, pp. 249-278.
2. Brooks Carder and Patrick Ragan, "A Survey-Based System for Safety Measurement and Improvement," *Journal of Safety Research*, April 2003, pp. 157-165.
3. Brooks Carder and Patrick Ragan, *Measurement Matters: How Effective Assessment Drives Business and Safety Performance*, ASQ Quality Press, 2004.
4. Charles W. Bailey and Daniel Petersen, "Using Safety Surveys to Assess Safety System Effectiveness," *Professional Safety*, February 1989, pp. 22-26.
5. Russell L. Ackoff, *Creating the Corporate Future: Plan or Be Planned For*, John Wiley & Sons, 1981.



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