1989

ASSE membership surpasses 24,000.

**January 4**
U.S. planes shoot down two Libyan fighters over international waters in the Mediterranean.

**February 14**
Union Carbide agrees to pay $470 million to the Indian government for damages it caused in the 1984 Bhopal disaster.

**March 24**
Tanker Exxon Valdez ruptures, spilling 11 million gallons of crude oil into Alaska's Prince William Sound.

**April 19**
Chinese students begin rally for democracy in Tiananmen Square. Thousands of demonstrators would later be killed.

**May 4**
U.S. jury convicts Oliver North in Iran-Contra affair.

**June 4**
A natural gas explosion occurs near Ufa, Russia, as two trains passing each other throw sparks near a leaky pipeline. At least 645 are killed.

Comedienne Lucille Ball dies at age 87.

# Applying the DEMING PHILOSOPHY to the Safety System

**By Noe Salazar**

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IN 1950, JAPAN had a weak economy and a reputation for manufacturing cheap, low-quality goods. That year, a group of visionary scientists, engineers and businessmen sought out and brought to Japan an American management consultant by the name of W. Edwards Deming. Deming taught Japanese industry how to use a tool called statistical process control to achieve continuous improvement in quality. But more than just a tool, he brought a philosophy—which he later described with 14 points—for the total management of a company. It was a management philosophy that changed world economies.

Thirty years later, Japan had become one of the world's greatest industrial powers. It had achieved a reputation for quality that was unsurpassed. In the 1980s, the Japanese industrial and economic prowess has made almost daily headlines.

It may be argued justifiably that no one man was totally responsible for this. However, it remains without question that Deming's philosophy was the single most important influence in the Japanese turnabout. For his contribution to Japan's industrial and economic postwar recovery, the Emperor gave Deming the Second Order Medal of the Sacred Treasurer. Japan has also named its most prestigious industrial award after Deming—an award which is presented in

a televised ceremony that has become a national holiday. Deming has also been called "the father of the Third Wave of the Industrial Revolution."

However, like most great works, it is not enough to simply read Deming's 14 Obligations of Management; rather, it is necessary to study them in depth. It is not possible to explain the Deming philosophy in this short article. Those who are not already familiar with it can best gain an appreciation of this philosophy by attending one of the many seminars on the subject or by reading one of the many books on his philosophy.

The purpose of this article is to interpret how the Deming philosophy applies to safety. It is not necessary to understand this philosophy to be able to understand and use the points made here. But it is useful to know this approach is based on such a successful management philosophy. If your company has already embraced Deming, it will aid in the acceptance of this approach by management.

The basic concepts that will be presented are not new; they are simply the fusion of some sound ideas from the safety field with a sound management philosophy. The approach, however, must be new. Rather than implement new programs, the company's management philosophy in safety must be redefined.

## The Safety System

The tool of statistical process control (SPC) applies to system output. In reality, anything that changes over time can be considered a system. SPC shows us that an output is never an exact value continuously; there is always random variation. In most systems, this random variation, when plotted over time or occurrence, will yield a normal distribution or "bell" curve. Statistics provides a tool for predicting the probability that a single output value will fall within a range of output values. For example, if a system is stable or "in control," more than 99% of all output values measured will fall in a range of three standard deviations centered about a median value.

Let's define the values at three standard deviations as control limits and plot the annual defect rate in the safety system—in other words, the injury rate. In this example, one can see that the rate fluctuates from year to year but all values are within the control limits (Figure 1).

This shows that there has actually been no change in the performance of the system over these years. Undoubtedly, in years when the rate was above the median, we fretted over what was wrong; in years when it dropped down, we patted ourselves on the back. In reality, no difference existed between the two values. The effects of any programs instituted in this time period were overshadowed by the natural random variation of the system output.

To get a clear understanding of a company's safety performance, it is necessary to view injury rates in relation to the control limits of the safety system. For an accurate view, a more sophisticated graphing tool called a U-chart should be used to plot the company's monthly injury rates (see sidebar on pp. 54-55).

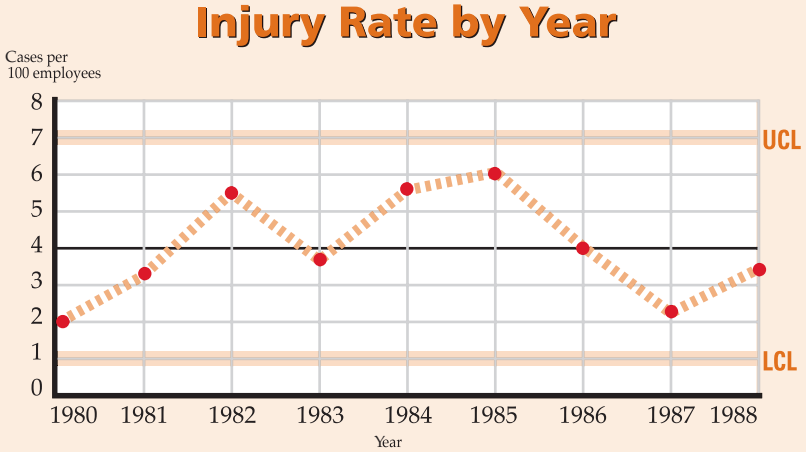
If you find that your safety system is stable or "in

*ASSE began publishing a journal in 1956.*

*To celebrate 50 years of keeping SH&E professionals current in this dynamic field, each issue of* Professional Safety *in 2006 will feature an article from a past issue of the journal.*

**FIGURE 1**

**Creating a U-chart provides an accurate view of your safety system.**



control," it is important to understand that in many respects this is the worst possible situation to be in. What this says is that you can be confident that employees in the company will continue to be injured at the present rate. The ups and downs of injury rates are simply random variation in the safety system. In this situation, the system as a whole must be changed in order to improve. To accomplish this, the company's management philosophy in safety must become the Deming philosophy of continuous improvement.

Deming's 14 points apply to companies in general. While the basic themes of these points are valid for any process or system, it would not be accurate to attempt to apply each point to a single process or system within a company. Therefore, in applying the philosophy to a company's safety system, the focus will be on the basic themes. The four points that follow are the application of those themes to safety.

1989

**SAFETY PHILOSOPHY**

- All injuries can be **prevented**.
- Management is **responsible** for preventing injuries.
- **Training** employees to work safely is essential.
- Safety requires the **involvement** of all employees.
- Accident prevention is **good business**.

### 1) Constancy of Purpose

The change process begins by establishing a constancy of purpose in safety. Are there global guiding principles for safety in your company? As in any other endeavor, there must be principles and values that guide the efforts in safety. There must be a philosophy against which everyday decisions can be compared. There must be a deliberate path toward continuous improvement. Otherwise, as an old German proverb states, "What's the use in running if you are on the wrong road?"

Before true improvement can be made in safety, top management must establish a constancy of purpose by adopting and committing to a safety philosophy. An example of such a philosophy is presented at left. Many may recognize this as being very similar to the DuPont safety philosophy. I have simply taken what is already an excellent philosophy and adjusted it slightly to relate it more clearly to the Deming philosophy.

#### *Management Is Responsible*

In quality, Deming tells us that management is 94% of the problem. What this means of course is that the system within which employees work is the cause for 94% of the problems and management establishes and controls that system.

This is also true in safety. Management controls the training resources, establishes and implements work methods, develops policies and procedures, determines expenditures for equipment and modifications, and even selects and assigns personnel. Inevitably, it is line management that establishes the performance level and the control limits for the quality of a safe workplace.

Many line managers, including some top managers, have not accepted this responsibility. Too many managers cite examples of injuries that "just happened." However, a serious in-depth analysis of any of these injuries will invariably show there were preventable causes. In any case, the facts will also show that injuries with readily identifiable causes occur much more frequently than those whose causes are more difficult to find.

As in any other line of business, a cost-versus-risk analysis should always be done—which means we are not saying "all injuries will be prevented" (that would be the same as saying we will achieve zero defects). The recognition that every injury has preventable causes, however, will allow management to take actions for continuous improvement in safety. It is essential then that the first point of the new safety philosophy, "All injuries can be prevented," becomes ingrained in the company culture.

### 2) Training Is Essential

When the potential for an injury can be predicted, actions can be taken to eliminate or minimize that potential for injury. Once we have the understanding that all injuries are preventable, training pro-

# Constructing a Control Chart (U-Chart) for Injury Rates

**In the safety field, we are interested in plotting injury rates to make comparisons and determine trends. Unfortunately, comparison between two points is usually not meaningful and it often requires a long period of time before it is possible to see whether a real trend has developed. Often, we conclude there are trends where none exist because statistically valid tools are not used.**

**To get a clear picture of actual performance, a U-chart must be used when plotting injury rates. In this example, the number of injuries is sampled on a monthly basis and the typical unit of 200,000 workhours is used as the common denominator or "standard area of opportunity" for determining *N*; *N* is, therefore, the workhours divided by 200,000.**

**•The mean or ū is arrived at by determining the arithmetic average.**

| Month | Workhours (from records) | Injuries (from records) | Units ($n$) Workhours/ 200,000 | Rates injuries/($n$) | UCL $\bar{u}+3\sqrt{(\bar{u}/n)}$ | LCL $\bar{u}-3\sqrt{(\bar{u}/n)}$ |
|---|---|---|---|---|---|---|
| 1 | 400,000 | 10 | 2 | 5.0 | 9.9 | 0.3 |
| 2 | 450,000 | 12 | 2.25 | 5.3 | 9.6 | 0.6 |
| 3 | 350,000 | 8 | 1.75 | 4.6 | 10.2 | 0.0 |
| 4 | 400,000 | 6 | 2 | 3.0 | 9.9 | 0.3 |
| 5 | 400,000 | 10 | 2 | 5.0 | 9.9 | 0.3 |
| 6 | 380,000 | 8 | 1.9 | 4.2 | 10.0 | 0.2 |
| 7 | 380,000 | 12 | 1.9 | 6.3 | 10.0 | 0.2 |
| 8 | 400,000 | 12 | 2 | 6.0 | 9.9 | 0.3 |
| 9 | 450,000 | 10 | 2.25 | 4.4 | 9.6 | 0.6 |
| 10 | 500,000 | 14 | 2.5 | 5.6 | 9.4 | 0.8 |
| 11 | 500,000 | 16 | 2.5 | 6.4 | 9.4 | 0.8 |
| 12 | 400,000 | 10 | 2 | 5.0 | 9.9 | 0.3 |
| | | | | mean (ū) | | |
| Totals | 5,010,000 | 129 | 25.05 | 5.1 | | |

vides the means for making injuries predictable. The basic difference between safe employees and those who are accident-prone is that safe employees can recognize hazards and hazardous actions and understand the consequences. These are not skills we are born with; these skills are learned. Rather than learn by making mistakes and being injured, we must ensure that employees learn through training.

Deming places great emphasis on the need for proper training of all employees. Few companies place such an emphasis on safety training. To improve the quality of safety for each employee we must institute systematic training for safety:

1) Redefine or clarify the safety professional's role to place emphasis on training at all levels.

2) Commit resources for safety training in existing training organizations/department training groups.

3) Establish comprehensive safety training for new employees.

4) Establish companywide safety training for managers and supervisors.

5) Institute a system of continual reeducation and retraining in safety.

### 3) Measure the Quality of the System

When we measure the number of injuries, we are in effect measuring the number of defectives produced by the system. This has only limited informational value. When we use these numbers to establish objectives, we are setting numerical quotas, which Deming points out are of no value.

Injury rate objectives that have been set in the past have been largely unfounded. Since most safety systems have been in control for many years, safety managers (although they might not know it) were simply praying that next year's random point would be less than this year's random point within the control limits.

There has been an additional compounding problem in that companies have always judged those whom they asked to report the numbers by the numbers they reported. In doing this, conflict was created for employees, line managers and safety managers by forcing them to choose too often between what they perceived is best for themselves and what was best for the company.

The solution according to Deming is to measure the quality of the system, not the quality of the results. Two key indicators should be selected for measurement: 1) a sample of unsafe practices, behaviors and conditions; 2) the actions taken by management to positively affect the safety system.

#### *Samples: Audits*

The Accident Triangle (Figure 2) illustrates why serious injuries should not be considered discrete events. It has been determined that for every serious injury that occurs, 600 incidences of unsafe behaviors, practices and/or conditions had occurred. As in Deming's quality examples, the question should not be, "What went wrong that caused this injury?" but rather, "What is wrong with the system that allowed the injury to happen?"

To measure the state of the system then, we should sample the level of unsafe practices, behaviors and conditions. The common term for this is safety audits. Safety audits have been attempted before and exist in various forms at many facilities. However, many of these have been ineffective because they concentrate on auditing for unsafe conditions. To get an effective and accurate sample of the system, audits must concentrate on observing for unsafe practices and behavior. An effective audit system will also require a coordinated, consistent approach with proper training for all audit participants. There must also be a commitment from management to make safety audits a permanent part of the management role.

#### *Positive Actions*

Inevitably, one number must be compared with another to determine any level of improvement. Even having a better view of system performance through safety audits does not provide a clear and complete comparative value. The variability of the measurement system is too large with safety audits alone.

**•The upper control limit UCL is drawn at $\bar{u} + 3\sqrt{(\bar{u}/n)}$**

**•The lower control limit LCL is drawn at $\bar{u} - 3\sqrt{(\bar{u}/n)}$**

**It should be evident that the control limits will change as the number of workhours change. This is how a U-chart compensates for changes in the size of the workforce or the hours worked. In tabular form, the calculations are shown at left.**

**The monthly injury rate can then be plotted against the mean and the control limits. Twelve months have been used as an example. However, in actuality, this should be a continuous running chart and not one computed only at the end of the year. The three most common methods of interest for determining whether something out of the ordinary has actually happened (versus normal random variation) are as follows: 1) Points fall outside the control limits. 2) Length of runs: 8 or more consecutive points fall on the same side of the mean (u). 3) Trends: A run of 7 consecutive points or more decreasing (or increasing). Each point must be lower (higher) than the previous point.**

**There are several other methods for determining "out of control" conditions for which you should consult a statistics book. If none of these conditions are evident, then the system is stable and all injury rate values should be considered essentially equal—that is, any difference is simply because of random variation.**

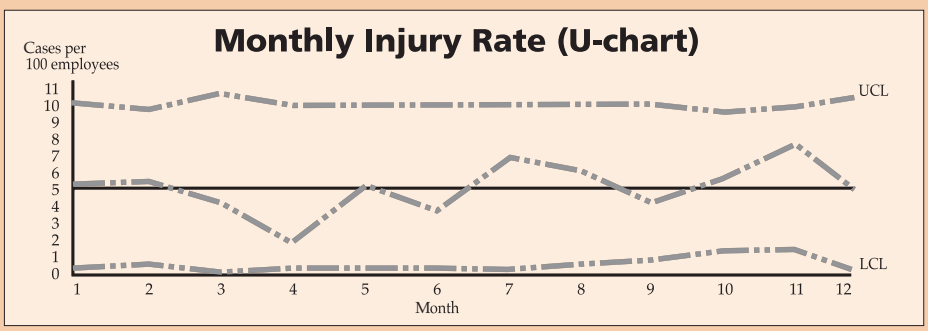


**FIGURE 2**

Serious injuries are not discrete events.

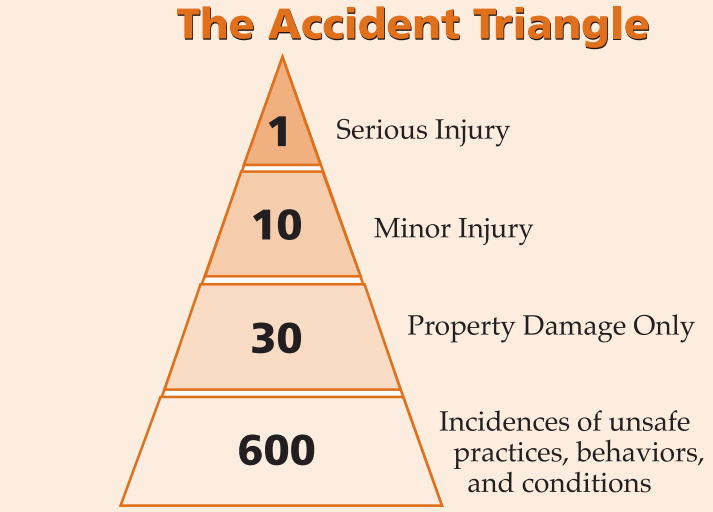
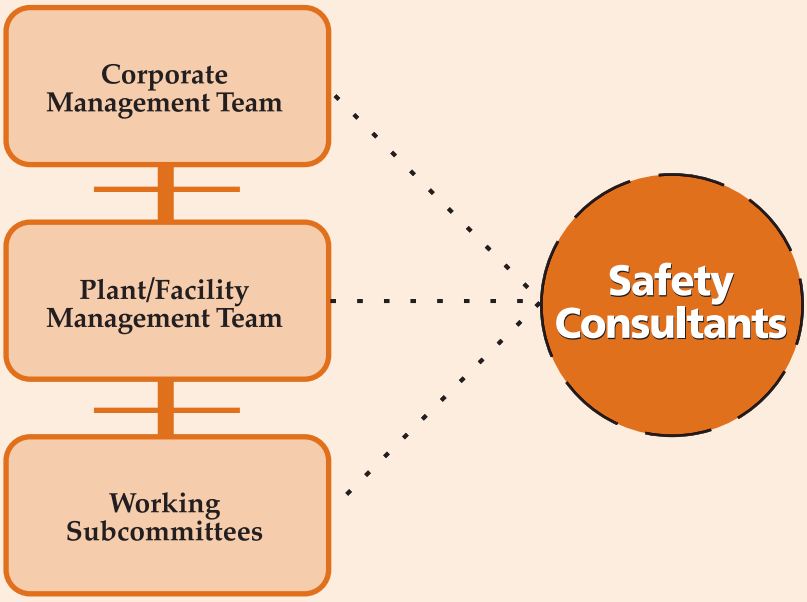



**FIGURE 3**

Integrate management and employee involvement.




There is, however, the opportunity to measure the positive activities of management toward improving the system. A measurement system based on positive actions would also provide a living blueprint for continuous improvement. To be specific, such a measurement system would look at management efforts in training, safe methods development, audits, designing for safety, employee involvement and other areas that directly impact on the safety system.

Such a system will also provide much more effective objectives and goals. Supervisors and managers cannot practically work toward an objective of achieving a 5.0 OSHA incidence rate when it is not clear how to directly affect this number. They can, however, aggressively pursue raising their safety management score by instituting job safety analysis in their shop (as an example). A practical means for establishing objectives and measuring performance is essential for management to be realistically accountable for safety.

### *A Note on Investigation of All Injuries*

The measurement of these two key indicators is not intended to diminish the effort to investigate every injury. Safety professionals have long understood that the difference between a serious injury and a minor injury is generally the degree of luck involved. For this reason, all injuries should be thoroughly investigated.

Those who advocate that investigation of every injury is equivalent to mass inspection are misinterpreting the Deming philosophy. Injuries are not the product; they are the defect in the system. So long as we understand injuries are not discrete events, there is much we can learn from injury investigations. Investigation of injuries is not the means by which we will achieve an accident-free workplace, but rather a means for gathering information on what is wrong with the system. With this knowledge, the system can be improved.

## 4) Implementing the Improvement Process: Organizing for the New Safety System

Continuous improvement in safety will not happen unless a deliberate change is made to the safety system. Three changes have already been discussed: adopting a safety philosophy, institutionalizing training, and changing the way we identify and measure safety performance. The fourth key change is that to the infrastructure of the safety system—the safety organization.

Deming integrates management responsibility and employee involvement through extensive use of steering committees and QPI teams. The practical application of this to the safety system is an organization based on safety committees. When complete, the company safety organization would be as depicted in Figure 3.

### *Corporate Management Team*

The steering committee for the company safety organization should be comprised of the top operating manager and his/her staff. As such, there is no need to establish a new committee. The direction and strategies for safety in the company will simply become part of the agenda for the corporate management team.

The first order of business for this group must be to adopt the new safety philosophy. A safety philosophy has been proposed here but should be refined as necessary to ensure that each member of top management adopts and is committed to it. Each member—and each plant/facility manager in particular—should then carry the message throughout the organization.

### *Plant/Facility Management Team*

The central guiding body for safety at a plant is

often called the central safety and health committee. To be effective, it is essential that this body be chaired by the plant/facility manager and that each member of his/her staff be a key participant. Once again, there is no need to form a new committee; in most companies the plant/facility management team already meets on a regular basis. There may be benefits to including other plant personnel in this activity as a means of getting additional input or to carry out administrative tasks. The key, however, is ensuring that as part of the regular agenda for the plant management team this group determines the plant efforts for continuous improvement in safety.

### *Working Subcommittees*

These committees may take several forms, such as standing departmental safety committees or temporary problem-oriented safety committees (much like productivity improvement teams). The basic function is to correct problems in the safety system. Experience has shown that with employee involvement and line management commitment even the most complex problems can be solved.

### *Safety Consultants*

The safety professionals have a very clear role in this organization. They provide experience and knowledge in safety. The safety professionals should be advisors at all levels. More important, they will share this knowledge and experience through development and implementation of training programs. The responsibility for plant efforts in safety, however, must rest completely with management and the safety committees.

The significance and magnitude of this change cannot be overstated. In the simplest terms: Safety departments will no longer be the company's safety organization. They must now, in practice, be consultants to the company safety organization.

## Conclusion

There has been no attempt to justify the need for continuous improvement in safety in this article. It is assumed that managers are now well aware of the significant cost of injuries. This article takes for granted that management understands accident prevention is good business and, above all, is morally right.

The plan presented in this article is necessarily brief and general in nature. Actual implementation will require a much more detailed blueprint. There is no easy road to excellence. Excellence in any endeavor requires effort and dedication. This is certainly true in safety.

The four basic changes to current safety systems described will each be difficult and trying. But they are essential for any company. It may take several years and genuine commitment to establish the new safety system, but continuous improvement and excellence in safety must be pursued. ■

## DEMING'S 14 POINTS

**1 Create constancy of purpose toward improvement of product and service, with the aim to become competitive, stay in business and provide jobs.**

**2 Adopt the new philosophy. We are in a new economic age. We can no longer live with commonly accepted levels of delays, mistakes, defective materials and defective workmanship.**

**3 Cease dependence on mass inspection. Require, instead, statistical evidence that quality is built into the product in the first place, eliminating the need for mass inspection.**

**4 End the practice of awarding business on the basis of a price tag. Depend on meaningful measures of quality, along with the price. Eliminate suppliers that cannot qualify with statistical evidence of quality.**

**5 Improve constantly and forever the system of production and service, to improve quality and productivity and, thus, constantly decrease costs.**

**6 Institute modern methods of training on the job.**

**7 Institute leadership. The aim of leadership should be to help people, machines and gadgets to do a better job. Supervision of management is in need of overhaul, as well as supervision of production workers.**

**8 Drive out fear so that everyone may work effectively for the company.**

**9 Break down barriers between departments. People in research, design, sales and production must work as a team to foresee problems of production and in use that may be encountered with the product or service.**

**10 Eliminate numerical goals, posters and slogans for the workforce, asking for new levels of productivity without providing methods. Such exhortations and targets only create adversarial relationships. The bulk of the causes of low quality and low productivity belong to the system and, thus, lie beyond the power of the workforce.**

**11 Eliminate work standards (quotas) on the factory floor. Substitute leadership. Eliminate management by objective. Eliminate management by numbers, numerical goals. Substitute leadership.**

**12 Remove barriers that stand between the hourly worker and his right to pride in workmanship. The responsibility of the supervisor must be changed from sheer numbers to that of quality. (Eliminate annual rating system.)**

**13 Institute a vigorous program of education, retraining and self-improvement.**

**14 Create a structure in top management that will push every day on the above 13 points. The transformation is everyone's job.**

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