INTRODUCTION TO W. EDWARDS DEMING'S "SYSTEM OF PROFOUND KNOWLEDGE"

W. Edwards Deming was a physicist by training, but his passion for much of his life lay in transforming American management. Deming drew deeply from physics in formulating his ideas. Unfortunately, his early efforts garnered little acceptance in the United States. Deming's concepts won credence here only after his management philosophy was credited with turning Japan into a world economic power.

A physicist I know (a research scientist in a Fortune 100 company) once told me, "The successful industrial physicist will be more familiar with Deming than Einstein." Regrettably, most industrial and academic physicists know little of Deming, who envisioned management as a system whose components worked in elegant interdependence, or how his work emphasized the critical role played by the science of physics in any rational business strategy to compete in this new economic age.

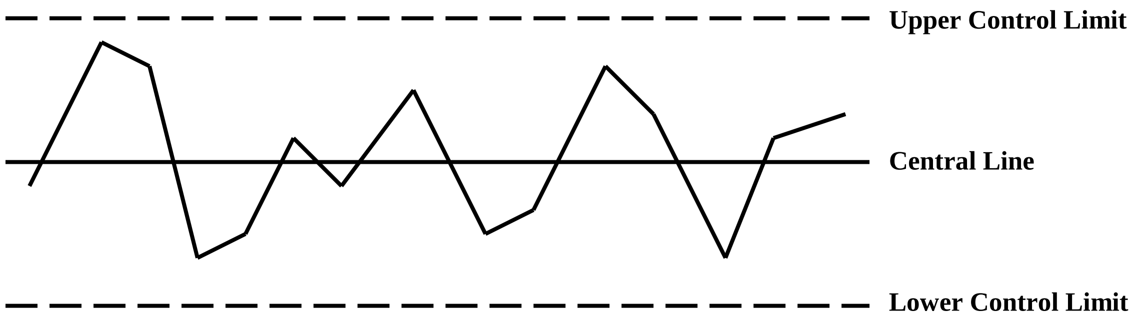
The antecedents to Deming's ideas lay in the work of physicist Walter A. Shewhart of Bell Laboratories. Deming graduated from the University of Wyoming in 1921 with a degree in Electrical Engineering and earned his PhD in mathematics and physics from Yale University in 1928. During the summers of 1925 and 1926, he worked at Western Electric Company's Hawthorne Works near Chicago, and there he first heard of Shewhart and his theory of variation.

Shewhart focused on understanding and improving systems, and he invented analytic statistics and the statistical process control chart to help him in his work [see Figure 1]. According to Donald Wheeler and David Chambers in *Understanding Statistical Process Control*, Shewhart concluded that "while every process displays variation, some processes display *controlled* variation while others display *uncontrolled* variation."

Shewhart's theory greatly impressed Deming, who incorporated parts of it into his own principles and teachings. In the mid-1930s, Deming arranged for Shewhart to deliver a series of lectures at the U.S. Department of Agriculture. He later wrote, "Even if only 10% of the listeners absorb part of Dr. Shewhart's teachings, the number may in time bring about change in the style of Western management." Those words foreshadowed his own influence and impact. Although only about 20% of Japanese businesses adopted Deming's management concepts, this proved to be a critical mass that significantly changed the course of the Japanese economy in the mid-twentieth century.

This paper was originally published as an article titled, "Physicist Transformed the Quality of Management," by James F. Leonard, *The Industrial Physicist* Magazine, American Institute of Physics, September 1997, pp. 46-48.

Figure 1. Shewhart's control chart showing evidence of controlled variation



Deming joined the faculty of the New York University Graduate Business School in 1948 and taught there until his death in 1993. His influence expanded through his seminars, worldwide consulting services, numerous papers, and his texts *Out of the Crisis* and *The New Economics for Business, Government, Education*.

Profound Knowledge

Deming's principles for transforming management rest on what he called "a system of profound knowledge." This system consists of four components, each of which interacts with the others.

1. **Appreciation for a system.** Deming defined a system as a network of interdependent components that work together to accomplish some aim. "A system must have an aim," he wrote in *The New Economics for Industry, Government, Education*. "Without an aim, there is no system." He cited a good orchestra as an example of an optimal system. "The players are not there to play solos as prima donnas, to catch the ear of the listener. They are there to support each other. They need not be the best players in the country."

2. **Some knowledge of the theory of variation**. Deming stressed that one need not be eminent in any part of profound knowledge in order to understand it as a system, and to apply it. One need not have a PhD in Statistics to understand variation. Rather, Deming placed emphasis on understanding and differentiating between controlled, random, or common cause variation and uncontrolled, non-random, special cause variation.

Common causes of variation come from within the process. They generate outcomes that are different, but not significantly different. Special causes intervene from outside the process and produce outcomes that are not different, they're significantly different.

Making this distinction is critical for managers and scientists in determining an appropriate improvement strategy. For common cause variation, the appropriate strategy is to change and improve the process. For nonrandom, special cause variation, the appropriate action is to find, remove and prevent the reoccurrence of the special cause. No amount of work on a process will address a special cause, because uncontrolled variation comes from outside the process.

Imagine that a manufacturer experiences a significant increase in product defects. The actual source of the defects was an abnormally high level of contaminants in a supplier's material; a special cause of variation from outside the manufacturer's process. What if the manufacturer, however, reacts to the defects as though they were generated by its own process, and invests capital in new processing equipment? Failing to understand the variation and its true source, the manufacturer will have made a very costly mistake. The special cause of the defects from the supplier's out-of-control inputs will come screaming in without warning – unpredictable by its very nature – and produce defects on the new machines just as it did on the old machines. The manufacturer will have flushed its capital investment right down the toilet!

3. **Theory of knowledge.** Deming wrote that this third component of profound knowledge helps people to understand that management in any form requires prediction – and that prediction must be based on some theory. He added, "The theory of knowledge teaches us that a statement, if it conveys knowledge, predicts future outcome, with risk of being wrong, and it fits without failure observations of the past." Thus, Deming insisted that examples and case studies without theory teach nothing – a daunting thought to scientists in organizations managed by graduates of business schools with curricula based on case studies!

   Just as daunting is Deming's contention that experience without theory teaches nothing. Videocassette recording (VCR) technology was invented in the United States; the United States has more experience in manufacturing than any other nation on earth. Before the dawn of DVDs, where could you buy an American-made VCR? *There weren't any left!* All of our manufacturing experience, absent sound management theory, failed to teach us enough to be able to make and sell VCRs at a profit. We lost the market due to bad management. As Deming taught, experience without knowledge of rational theory teaches nothing.

4. **Psychology.** Deming wrote, "Psychology helps us to understand people, interaction between people and circumstances, interaction between a manager and his people and any system of management." His philosophy for leadership rests on the belief that people are intrinsically motivated. They strive naturally for dignity, pride and joy in their work. Unfortunately, the current American management system destroys intrinsic motivation by substituting extrinsic motivators such as merit pay, sales commissions and grades in school. Thus, too many students strive for high grades, not knowledge. Too many workers strive for merit pay and high rankings, not quality or the intrinsic joy one experiences from a job well done.

Performance Evaluation

Based on his system of profound knowledge, Deming insisted that most of the differences observed in workers' performance levels have nothing to do with the workers. Rather, most of the performance differences are generated by the system, of which those people are but a part. Appreciation for a system would inform us that people can perform no better than the system allows.

A salesperson may control whether he or she visits Customer A or Customer B this morning; but the salesperson does not control product design, production quality, delivery performance, billing practices, after-sale technical service, and many other factors that influence whether or not a sale is made; whether or not there is a repeat sale. The sales commission system, however, ignores this reality. It assigns to the salesperson alone outcomes that were heavily influenced by many variables beyond his or her direct control. Then, salespeople are rewarded or punished based on the sales variance numbers for their territories, as if they had complete control over all the factors that generated those numbers. Sales commissions and merit pay confound the person with all the other variables that affect performance.

Systems thinking, on the other hand, assigns most performance differences to the system, not the people alone. Therefore, Deming urged the elimination of merit ranking and reward systems, as well as the abolishment of the grading system in America's schools. One way to consider the rational theory behind these radical proposals is to try to solve the following math problem.

If $A + B + C + D + E + F = 73$, what is the numerical value of "F"?

Thinking logically, one would conclude that this problem cannot be solved without knowing the values of variables A through E. The American education system, however, is willing to give a student a low grade on an exam, ignoring the host of other factors that influence test scores [see Figure 2].

Figure 2. In a school system, the student is only one of the many variables that determine his or her score on a test.

A + B + C + D + E…	**+ F**	**= 73**
Curriculum design, content, scope, and sequence; texts; supplementary materials; teacher; lesson plan; teaching methods; learning methods; assigned projects; homework; the effect of the home environment; the test itself; physical facilities; equipment; instructional technology; and many other variables…	+ Student	= Test score

Thus, we hear that Molly got a 73 on her math exam, so she received a grade of C-minus. When we look at work and learning from an appropriate systems perspective, however, it becomes clear that sources of variation in test scores include more than simply Molly and her fellow students – just as sources of variation in project schedule performance and costs include more than just scientists and project engineers.

Teamwork

Recall that appreciation for a system requires a clear understanding of an overall system, as well as managing its individual components to work well together. Doing so will optimize the system's performance. When consumers buy cars, they don't want engines in those cars that are made up of perfect individual components. Rather, they want engines with components that work well together to move them to their destinations.

By the same token, workers and shareholders don't need organizations made up of perfect individual divisions, and a plant manager doesn't need a plant that's made up of perfect individual departments or shifts. Rather, we need plants with departments that work well together, and companies with divisions that work well together. Such optimization and leadership that's guided by the system of profound knowledge will assure that we're still in business, capturing markets, providing jobs and paying dividends 10, 20 and 30 years from now.

About the author: James F. Leonard is a consultant based in Woodstock, Connecticut. He specializes in teaching the principles of W. Edwards Deming as a new system of management.