

Physicist Transformed the Quality of Management

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.

tistical process control chart [Figure 1] to help him. 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 teachings. In the mid-1930s, Deming

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 his 1993 book, *The New Economics for Industry, Government, Education*. 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

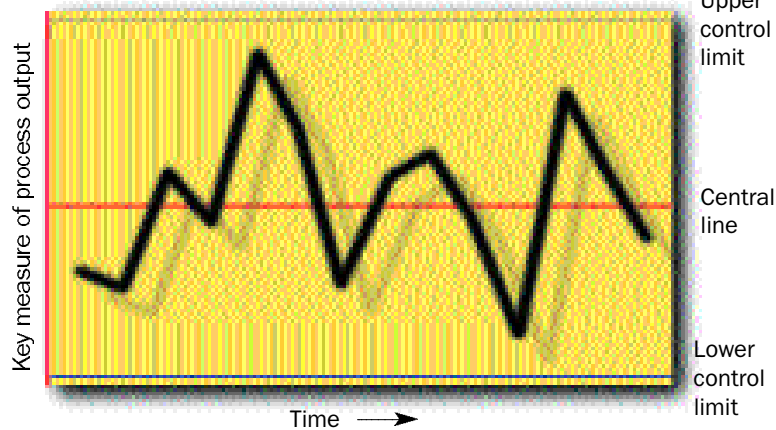
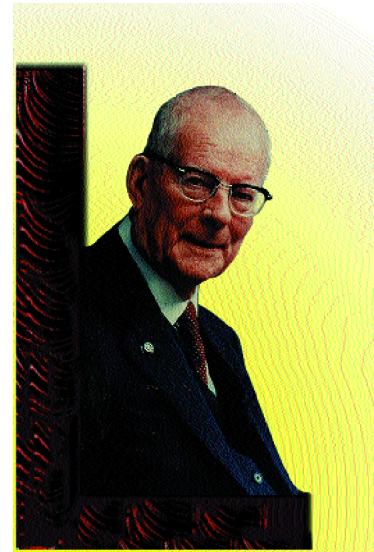


Figure 1. A Shewhart control chart showing evidence of controlled, random variation.



A friend of mine once said, "The successful industrial physicist will be more familiar with Deming than with Einstein." Unfortunately, many 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 that physics plays 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 Ph.D. 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 the sta-

arranged for Shewhart to deliver a lecture, and he wrote afterwards: "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 experience. Although only about 20% of Japanese businesses adopted his management concepts, this proved a critical mass that significantly changed the course of the Japanese economy.

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 and worldwide consulting activities.

Profound knowledge

Deming's principles for transforming management rest on what he called "the system of profound knowledge." Four components make up this system, each component interacting with the others.

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 expert in any part of the system of profound knowledge in order to understand and apply it. One need not have a Ph.D. in statistics to understand variation. Rather, he placed emphasis on understanding and differentiating between controlled, random, or common-cause variation (from within a process or system), and uncontrolled, nonrandom, or special-cause variation (from outside the process or system).

Making this distinction is critical for managers and scientists in determining an appropriate improvement strategy. For common-cause variation, the appropriate corrective strategy is to change and improve the process. For nonrandom, special-cause variation, the appropriate action is to find, remove, and prevent the recurrence of the special cause. No amount of work on a

process will address a special cause, because uncontrolled variation intervenes from outside the process.

Imagine that a manufacturer experiences a significant increase in product defects. The actual source of the defects is an unusual level of contamination in a supplier's raw material; a special cause of variation in the supplier's production process. But what if the manufacturer reacts to the situation as though the defects come from common causes within its own process, and invests capital in new machines? Failing to understand the variation and its sources, the manufacturer will have made a very costly mistake. The special cause of contamination from the supplier 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.

3. Theory of knowledge. Deming wrote that this third component helps people to understand that management in any form requires prediction—and that prediction must be based on 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 workers in an organization managed by graduates of business schools that based their curricula on case studies.

Just as daunting is Deming's contention that experience without theory teaches nothing. Videocassette recorder (VCR) technology was invented in the United States; the United States has more manufacturing experience than any other nation. But where can you buy an American-made VCR? Unfortunately, all our experience in manufacturing, absent sound management theory, failed to teach us enough to make and sell VCRs at a profit. We therefore lost the market because of bad management; as Deming had taught, experience without rational management 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 Ameri-

$$\begin{array}{l}
 \mathbf{A + B + C + D + E + F} \quad + \quad \mathbf{G} \quad = \quad \mathbf{73} \\
 \\
 \mathbf{Curriculum design, content} \\
 \mathbf{scope, and sequence; texts,} \\
 \mathbf{supplementary materials;} \\
 \mathbf{teacher, lesson plan, teaching} \quad + \quad \mathbf{Student} \\
 \mathbf{methods; learning methods;} \quad \mathbf{performance} \quad = \quad \mathbf{Test\ score} \\
 \mathbf{the\ test\ itself; physical} \\
 \mathbf{facilities, equipment, and} \\
 \mathbf{instructional\ technology;} \\
 \mathbf{and\ many\ other\ variables}
 \end{array}$$

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

can 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 grades, not learning. Workers strive for rank and merit pay, 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 performance differences managers measure have nothing to do with the workers. Rather, most of them are generated by the system, of which people are only a part. A salesperson may control whether he or she visits customer A or customer B, but does not control product design, production quality, delivery performance, billing practices, and other factors that influence whether a sale is made. The sales commission system, however, ignores that fact. It assigns to salespeople outcomes that were heavily influenced by many other variables beyond their control. Then the salespeople are rewarded or punished based on the numbers, as if they had complete control over all factors.

Systems thinking, however, assigns most performance differences to the system, not the people. Therefore, Deming urged elimination of merit ranking and reward systems, and school grading systems. One way to consider the theory behind these radical proposals is to try to solve the following math problem.

If $A+B+C+D+E+F+G=73$,

Then what is the numerical value of G?


Thinking logically, one would conclude that this problem cannot be solved without knowing the sum of A through F. But are teachers willing to give a student a grade of G and ignore a host of other factors, A through

F, that affect the student's result in a test (see Figure 2)?

Thus we hear that Molly got a 73 in her math exam, so she received a grade of C. When we look at work and learning from an appropriate systems perspective, 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 outcomes include more than 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 to optimize the system's performance. When consumers buy cars, they don't want engines that are made up of perfect, individual components. Rather they want engines whose components work well together to move them to where they want to go.

By the same token, workers and shareholders don't need corporations made up of perfect, individual divisions, and a plant manager doesn't need perfect individual departments or shifts. Rather, we need plants whose departments and shifts work well together, and corporations whose divisions work well together. This is how we remain in business, delight customers, capture markets, and provide jobs 10, 20, or 30 years from now. 

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