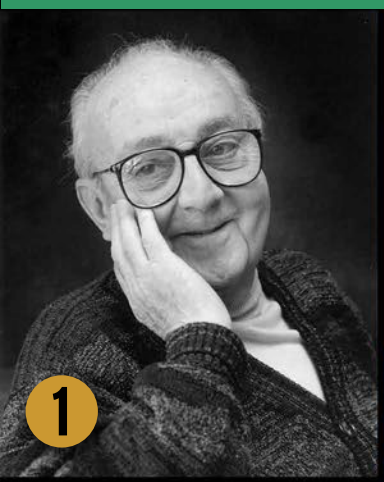
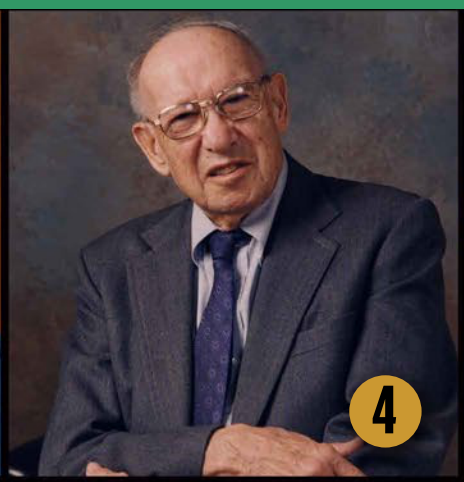
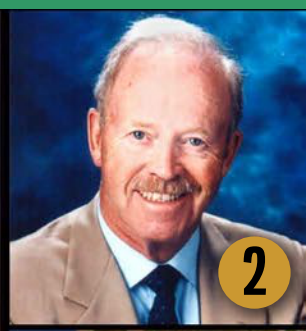
JUNE 2020

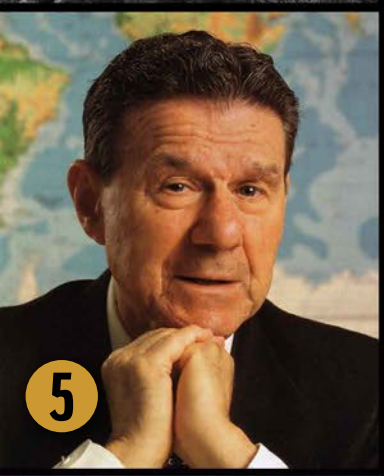
PCB007 MAGAZINE

I-Connect007









Can you name these fathers of quality?

[click to learn more]

This issue is jam-packed with columnists. Dr. John Mitchell tackles "Problem Solving While Innovating," and George Milad covers "Minimizing Signal Transmission Loss in High-Frequency Circuits." Steve Williams continues with Part 3 of his "Guerilla Tactics to Pass Any QMS Audit" series, and Mike Carano launches a new column series titled "A Process Engineer's Guide to Advanced Troubleshooting."

My personal takeaway from this issue is that embracing change is a given in the world of innovation, and maintaining an emotional appetite for change is a requirement. This leads to the necessity that change be encouraged from all levels of the organization and managed to maximize its benefits. TQM is most certainly worth a revisit during these dynamic and chaotic times.

And remember that the Canadian rock band Rush gave wise advice regarding how to respond to change in their song "Free Will," when Geddy Lee sang, "If you choose not to decide, you still have made a choice." **PCB007**

Reference

1. S. Madsen, "Why Is Organizational Change So Hard?" LiquidPlanner, January 11, 2018.

Nolan Johnson is managing editor of *PCB007 Magazine*. Nolan brings 30 years of career experience focused almost entirely on electronics design and manufacturing.
To contact Johnson, click here.

From the Cover: Meet the Fathers of Quality

1. George E. P. Box (1919-2013): A British statistician, who worked in the areas of quality control, time-series analysis, DOE, and Bayesian inference.

2. Philip B. Crosby (1926-2004): A businessman and author who contributed to management theory and quality management practices.

3. W. Edwards Deming (1900-1993): An American engineer, statistician, professor, author, lecturer, and management consultant.

4. Peter Drucker (1909-2005): An Austrian-born American management consultant, educator, and author, whose writings contributed to the philosophical and practical foundations of the modern business corporation.

5. Armand V. Feigenbaum (1920-2014): An American quality control expert and businessman who devised the concept of TQC, which inspired TQM.

6. Bob Galvin (1922-2011): A U.S. executive. He was the son of the founder of Motorola, Paul Galvin, and served as the CEO of Motorola from 1959-1986.

7. Mikel J. Harry (1951-2017): A statistician, quality expert, and author who was sometimes referred to as "the father of Six Sigma."

8. Kaoru Ishikawa (1915-1989): A Japanese organizational theorist and professor of engineering at The University of Tokyo who was noted for his quality management innovations.

9. Joseph M. Juran (1904-2008): A Romanian-born American engineer and management consultant. He was an evangelist for quality and quality management, having written several books on those subjects. He and his wife, Sadie, both passed away in December 2008 at 103 years of age. They were married for nearly 82 years.

10. Dorian Shainin (1914-2000): An American quality consultant, aeronautics engineer, author, and college professor most notable for his contributions in the fields of industrial problem solving, product reliability, and quality engineering–particularly the creation and development of the "Red X" concept.

11. Walter A. Shewhart (1891-1967): An American physicist, engineer, and statistician. He was sometimes known as "the father of statistical quality control" and also related to the Shewhart cycle (plan-do-check-act.)

12. Genichi Taguchi (1924-2012): An engineer and statistician. From the 1950s onward, he developed a methodology for applying statistics to improve the quality of manufactured goods. (Source: Wikipedia)

Dr. W. Edwards Deming

Photo courtesy of The W. Edwards Deming Institute®

W. Edwards Deming's Lost Chapters Recovered

Feature by Happy Holden
I-CONNECT007

Hewlett-Packard (HP) had a reputation for excellence long before I joined the company in 1970. The owners and creators of the company had a passion for excellence in their DNA. But when HP's Japanese Division Manager Yoji Akao won the Deming Prize in 1978, HP realized that as good as it was, it could be better (Figure 1).

Early benchmarking of our product designs with the Boothroyd Dewhurst Method (DFMA) provided data showing that we weren't as good as we thought we were, and improvement was needed. The book the Japanese Division of HP wrote about the process of winning the Deming Prize created a whole new sense of urgency for top management. Foremost in their process was the advice of Dr. W. Edwards Deming.

Even in the 1980s, Dr. Deming was world-famous. He was known as the person responsible for the "Japanese quality revolution" of the 1950s. Dr. Deming was so successful at training the Japanese that he was in constant demand to help American corporations learn to compete against their Japanese competitors. However, his first requirement for working with a company was that the program had to be driven and championed by the company head.

I was cleaning up my bookcase recently and came across a tired, dog-eared set of papers that was Dr. Deming's initial draft of his book *On The Management of Statistical Techniques for Quality and Productivity,* which I received when he came to HP to lecture about quality and productivity on March 11, 1981. Dr. Deming's presentation took place in the company's largest auditorium in Cupertino, California. The front row was populated with the company's president at the time, John Young, as well as the VPs and directors. I received an invitation, but alas, I was in the rear row of the auditorium.

Figure 1: The Deming Medal.

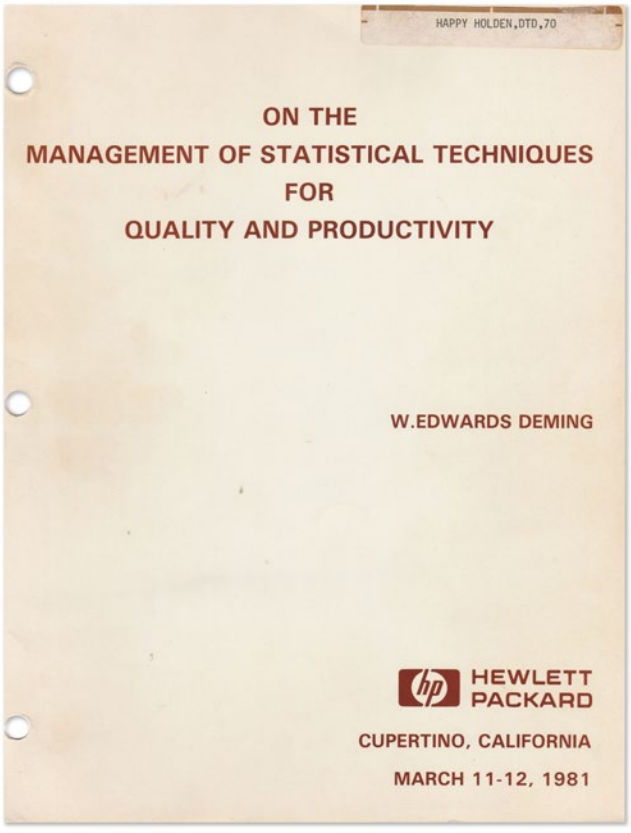


Figure 2: The front cover of the 1981 manuscript Dr. Deming provided HP.

Dr. Deming's lecture was inspirational but very much directed to all the managers in the auditorium and focused on leadership. His 14 points for management took shape during his lectures and were covered in various locations in the early draft he supplied to HP (Figure 2). When his book was finally published in 1982 by the Massachusetts Institute of Technology Center for Advanced Engineering Study under the name *Quality, Productivity, and Competitive Position*, the 14 points had their own chapter (Figure 3) [1].

14 Points for Management

Dr. Deming's 14 points describe responsibilities for top management. He asserted that shareholders were best served by profitability—not by quarterly manipulation but by quality—and quality was everyone's job, but it had to be led by management. His 14 points include the following [2]:

1. Create constancy of purpose toward improvement of product and services with a plan to become competitive and to stay in business. Decide to whom top management is responsible.
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 in to eliminate the need for inspection on a mass basis. Purchasing managers have a new job and must learn it.
4. End the practice of awarding business on the basis of the price tag. Instead, it depends on meaningful measures of quality, along with the price. Eliminate suppliers that cannot qualify with statistical evidence of quality.
5. Find problems. It is management's job to work continually on the system (design, incoming materials, composition of material, maintenance, improvement of machines, training, supervision, health and safety, and retraining).
6. Institute modern methods of training on the job.
7. Institute modern methods of supervision of production workers. The responsibility of foremen must be changed from sheer numbers to quality. Improvement of quality will automatically improve productivity. Management must prepare to take immediate action on reports from foremen concerning barriers, such as inherited defects, machines not maintained, poor tools, and fuzzy operational definitions.
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 that may be encountered with various materials and specifications.
10. Eliminate numerical goals, posters, and slogans for the workforce, asking for new levels of productivity without providing methods.

11. Eliminate work standards that prescribe numerical quotas.
12. Remove barriers that stand between the hourly worker and his right to pride of workmanship.
13. Institute a vigorous program of education and retraining.
14. Create a structure in top management that will push every day on the above 13 points.

Lessons Learned Throughout My Career

In the years following, I've put together my comments and observations on Dr. Deming's 14 points based on lessons I learned throughout my career [3].

1. Long-term perspective and constancy of purpose are necessary ingredients for continuous improvement of the extended process or products. Concern for improvement and innovation of products, processes, or services for today and tomorrow gives management foresight to allocate resources to become competitive, increase productivity, stay in business, satisfy return for stockholders, and provide jobs.

2. Top management must be committed to nurturing an "I win, you win" mentality rather than an "I win, you lose" mentality. The organizational vision needs to include all members of the extended process: customers, suppliers, employees, investors, and the community. This vision must consider and balance the needs of all members of the extended process.

3. Mass inspection is essentially checking goods with no consideration for how to make them better, improve the process, or achieve higher quality. Quality is not improved by after-the-fact inspection; the defective items have already been produced. One way we practiced this point was to start to statistically analyze the rejects of our electrical test data, rather than just using it to sort the good from the bad. We found that random defects that kept reoccurring were not random but based on specific PCB design practices rather than manufacturing processes.

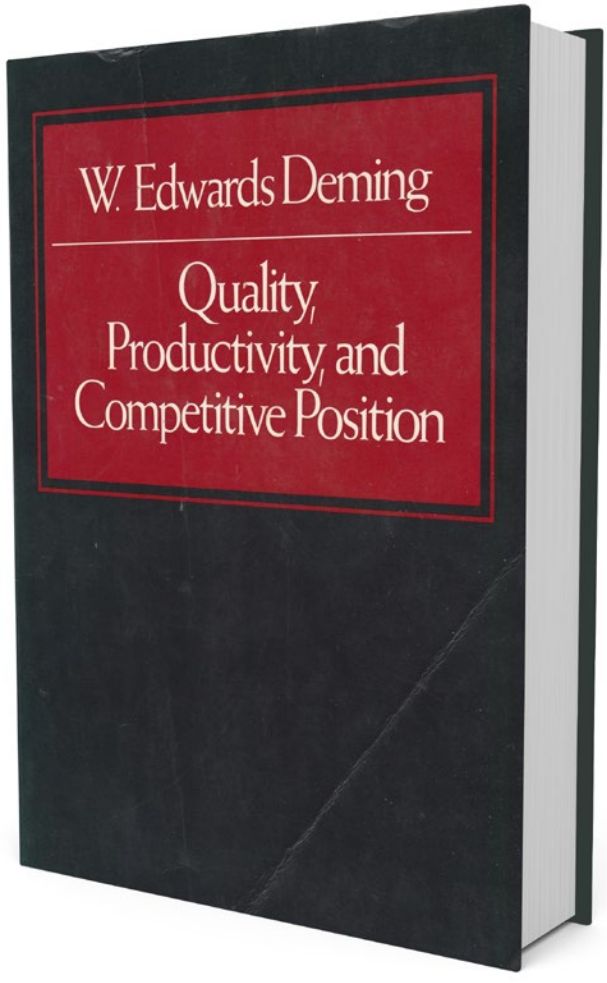


Figure 3: The final published book in 1982.

4. We started to create a working system for the cost of quality with purchasing. By brainstorming and looking at all aspects of production—not just the price of an object—a consensus was obtained that created a new linear model for the figure of merit for a purchase rather than just its price.

5. Management is responsible for the entire system and all its various processes. Process and product improvement and innovation are accomplished by planning projects that require statistical and behavioral methods. We found that training the process engineers in DOE and other topics in engineering statistics—and making it fun—was the best way to give them new tools to improve process yields and eliminate waste (rejects). We used the successful training program developed by DuPont and Dorian Shannon.

6. Proper training—which gives workers an understanding of their jobs, specific procedures to do their jobs correctly, and a method of evaluation when training is complete—will result in quality improvement. Everyone knows his or her job and is in statistical control, pursuing never-ending improvement. Further, everyone in an organization should be trained in basic statistical methods, and organizations should foster everyone's ability to understand variation.

My engineers and workers interpreted this to request "confidence tests" for each major process in printed circuit manufacturing—not the tests that the chemical lab does but simple tests for them to understand that the process was behaving correctly; otherwise, how could they be responsible for the quality of the PCBs? This was an interesting request, so engineering developed simple, short tests that each worker could perform in less than two minutes that provided that confidence.

7. Institute leadership at every level. The aim of leadership should be to help people and machines to do a better job, not to assign blame. Attributes of a leader at any level are to be a coach, counselor, and facilitator—not judge and jury.

8. Fear is a malady that may not be apparent to top management, but it affects quality. Many managers and supervisors use their power to create fear because they believe the way to motivate employees is through coercive power, but it is not. During the COVID-19 pandemic, workers may be reluctant to voice a concern about how their job is performed while still ensuring that they will be safe for themselves and their families. Management has control over these work elements and is responsible for changing the organizational climate.

9. Barriers impede the smooth flow of the extended process and its information, and everyone suffers—especially the customer. The most notable effect is that it can cause multiple interpretations of a given message. In his book [4], Alfie Kohn said, "Operationally defining the ultimate customer's needs and expectations so that everyone understands how he contributes to the success of the organization is a solid step to breaking down barriers between departments." I always felt that HP's practice of having quarterly "beer and hamburgers busts," where top management would tell us about business and then do the cooking and service while everyone else talked shop, solved more problems between departments than formal systems.

10. This is a tough one for management because many expect that leadership includes being a cheerleader with slogans, which will motivate the individual to achieve and clarify what is expected of that person. Unfortunately, it usually has the opposite effect. Targets and slogans that are set arbitrarily without an understanding of the process, as well as new methods to achieve such goals, are meaningless and do not help anyone do a better job. Management owns the system.

Examples of slogans, posters, and targets that do not help anyone do a better job are:

- Do it right the first time
- Safety is job number one
- Increase return on net assets 3% next year
- Decrease costs 10 percent next year

These targets do not represent action statements for employees, but rather management's wishes for the desired result. Management is simply lazy or incompetent if it thinks its only responsibility is to create slogans rather than improving the system.

11. Similar to point #10, this is a tough point for management to swallow. Old-style management believes they own the quota, production rates, and shipments, but these targets do not represent action statements for employees. Rather, they represent management's wishes for the desired result and ignore quality, so they are at odds with the new philosophy Dr. Deming is talking about. Output—quantity and quality—is based on the process's capability as determined by statistical methods.

Management owns the budgets, machines/processes, and systems. To change the output, change the system (point #7).

12. Many organizations in the United States do not use workers to their fullest potential, robbing them of their pride of workmanship and treating them as commodities. This loss of pride is an obstacle to achieving a competitive advantage. There is a lot of wisdom that accumulates by workers doing a job repeatedly. One of the insights that General Electric found while investigating the high quality and productivity of Japanese corporations in the early 1980s was that they had nearly three times the number of engineers on the factory floor working with employees to eliminate waste and losses than GE employed. The Japanese were not working harder than Americans; they were working smarter, and the engineers were there to implement what the workers had discovered and to make their work go smoother—to change the system!

13. In Dr. Deming's theory of management, education is the first step for an organization that wants to improve quality. Everyone in the organization should receive this education, beginning with top management. Statistical education at all levels is also necessary to prepare employees to implement these methods.

I was impressed that John Young started the "Stand in Quality" training program personally. Self-development is an attitude and characteristic that is essential in electronics, as we have the fastest-changing technology in the world. One of my jobs was to make sure each of my engineers had a self-improvement plan for themselves. Together, we helped every production supervisor create a plan for each worker. Installing a love of learning for production workers was one of the toughest activities I ever undertook.

14. Top management in an organization must make a commitment to transform the organization. Setting the change process in motion involves the recognition that problems exist and a desire to create a new organizational environment—one in which the never-ending improvement of quality is the primary goal. Dr. Deming's message to managers is to stop focusing on the judgment of results from a process and to start focusing on the improvement of the process that created the results.

This Time, TQM Stuck

HP had tried to introduce statistical quality/process control twice before, but both times, it did not really stick. Dr. Deming was right; this time, the program was pushed from the top management. In fact, John Young appointed a corporate facilitator to work with Dr. Deming and put together HP's plan of implementation. One of the first tactics was the plan for TQM training called "stand in quality."

It involved taking advice from past Malcolm-Baldridge winners. They all emphasized Dr. Deming's 14 points but also introduced us to the LUTI (learn, use, teach, implement) training strategy—a training process from the top, moving down. Starting with the corporation president, he would instruct his staff (the learn step) and then give each member an individual project (use). After completion, each of his staff would train (teach) their respective staff and assign a project (implement) to each person. The four-step process is repeated all the way down until everyone has been trained.

I learned the "stand in quality" concept from my boss, and after my project, I taught it to my engineering staff, who taught it to supervisors and technicians, and so forth. This time, it stuck! It was not merely being exposed four times, but having it come from the top down that made it real. And the enthusiasm created by this process never dissipated.

Quality circles were created that gave production workers an active role in improving board quality. A willing young engineer was selected to champion the DOE course we licensed from DuPont. This course and workbook went out to all engineering groups in the company. When my engineering group had the opportunity to take the 5.5-day course, the response was immediate. Yields went up, problems were solved—and didn't come back—and my engineers wondered why this important tool was left out of their education.

Conclusion

There is a lot of overlap between HP's pursuit of excellence in the 1980s and the situation in which companies find themselves during the COVID-19 pandemic. Process and procedures will have to change. Now is the ideal time to start to (re)implement Dr. Deming's 14 points. Documenting your process, looking for obvious areas for improvements, guaranteeing the safety of all employees, eliminating all forms of "waste," deciding what functions can be permanently left "at home," and (re)focusing on retraining/skills were all part of Dr. Deming's teaching. I consider TQM and DOE the two most important skills for any engineer in printed circuit design and manufacturing.

If you want further reading on TQM and DFM, from someone that comes from PCB/A, check out Dr. Sammy Shina's books. Sammy Shina, Ph.D., was an HP engineer in PCB and PCBA who went back to school for a Ph.D. and is now a professor at the University of Massachusetts-Lowell. **PCB007**

References

1. Deming, W. Edwards, *Quality, Productivity, and Competitive Position,* Massachusetts Institute of Technology Center for Advanced Engineering Study, 1982, p. 373.
2. Deming, W. Edwards, *On the Management of Statistical Techniques for Quality and Productivity,* early draft of a planned book, duplicated with permission by HP Corporate printing services, March 1981, p. 349.
3. Gitlow, Howard S., *Planning For Quality, Productivity, and Competitive Position,* Dow Jones-Irwin Press, 1990, p. 164.
4. Kohn, Alfie, *No Contest: The Case Against Competition,* Houghton Miffin Harcourt, 1986, p. 82.

Further Reading

- Shina, Sammy G., *Concurrent Engineering and Design for Manufacture of Electronics Products,* Van Nostrand Reinhold, 1991.
- Shina, Sammy G., *Six Sigma for Electronics Design and Manufacturing,* McGraw-Hill, 2002.

Happy Holden has worked in printed circuit technology since 1970 with Hewlett-Packard, NanYa/Westwood, Merix, Foxconn and Gentex. He is currently a contributing technical editor with I-Connect007. To read past columns or to contact Holden, click here.

Making Nuclear Energy Cost-Effective

Nuclear energy is a low-carbon energy source that is vital to decreasing carbon emissions. A critical factor in its continued viability as a future energy source is finding novel and innovative ways to improve operations and maintenance (O&M) costs in the next generation of advanced reactors. The U.S. Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E) established the Generating Electricity Managed by Intelligent Nuclear Assets (GEMINA) program to do exactly this. Through $27 million in funding, GEMINA is accelerating research, discovery, and development of new digital technologies that would produce effective and sustainable reductions in O&M costs.

Three MIT research teams have received APRA-E GEMINA awards to generate critical data and strategies to reduce O&M costs for the next generation of nuclear power plants to make them more economical, flexible, and efficient. The MIT-led teams will collaborate with leading industry partners with practical O&M experience and automation to support the development of digital twins. Digital twins are virtual replicas of physical systems that are programmed to have the same properties, specifications, and behavioral characteristics as actual systems. The goal is to apply AI, advanced control systems, predictive maintenance, and model-based fault detection within the digital twins to inform the design of O&M frameworks for advanced nuclear power plants. (Source: MIT News)