Circling Back

Clearing up myths about the **Deming cycle** and seeing how it **keeps evolving**

In 50 Words Or Less

- In the 1950s, W. Edwards Deming brought the scientific method to industry. Later, the method was called the plan-do-study-act (PDSA) cycle.
- Deming built the method from many problem-solving theories, including Shewhart's specification, production and inspection process.
- PDSA remains one of today's most popular problem-solving methods and continues to evolve.

by Ronald D. Moen and Clifford L. Norman

THERE STILL SEEMS to be much confusion surrounding W. Edwards Deming's plan-do-study-act (PDSA) cycle. The misunderstandings can be summarized by three basic questions:

1. How did Deming's PDSA cycle evolve?
2. Did Deming create the plan-do-check-act (PDCA) cycle?
3. Are PDCA and PDSA related?

Before answering these questions and clearing up the misconceptions, it's important to review the PDSA cycle's foundation, which starts with the scientific method.

Figure 1 shows the evolution of the scientific method and the PDSA cycle, starting with Galileo Galilei in 1610, pragmatism in the early 1900s and the evolution of the PDCA and PDSA cycles through 1993.

The foundation

Galileo, considered by many to be the father of modern science, made original contributions to the science of motion and strengths of materials by combining designed experiments and mathematics. Through his studies, conducting designed experiments became the cornerstone of science and the scientific method.

Sir Francis Bacon made his contribution to modern science as a philosopher who was concerned about how knowledge is developed. He believed knowledge generation must follow a planned structure. At the time, science depended on deductive logic to interpret nature.

Bacon insisted that scientists should instead proceed through inductive reasoning—from observations to axiom to law. His contribution completed the interplay between deductive and inductive logic that underlies how we advance knowledge.

Charles Peirce and William James were students at Harvard University in Cambridge, MA, in January 1872 when they formed a discussion group called the Metaphysical Club.[1] This group would forever be linked with the uniquely American philosophy called pragmatism. The group said the function of thought is to guide action and that truth is preeminently to be tested by the practical consequences of belief.

John Dewey became a leading proponent of pragmatism, and his works influenced philosophy, education, religion, government and democracy around the world.[2] James and Dewey's pragmatism could be summarized in one statement: People are the agents of their own destinies.

Clarence I. Lewis, an American pragmatist also educated at Harvard, was heavily influenced by Peirce and James. Lewis set out three ideas in *Mind and the World Order* to further the pragmatists' influence:[3]

1. A priori truth is definitive and offers criteria through which experience can be discriminated.
2. The application of concepts to any particular experience is hypothetical, and the choice of conceptual system meets pragmatic needs.
3. The susceptibility of experience to conceptual interpretation requires no particular metaphysical assumption about the conformity of experience to the mind or its categories.

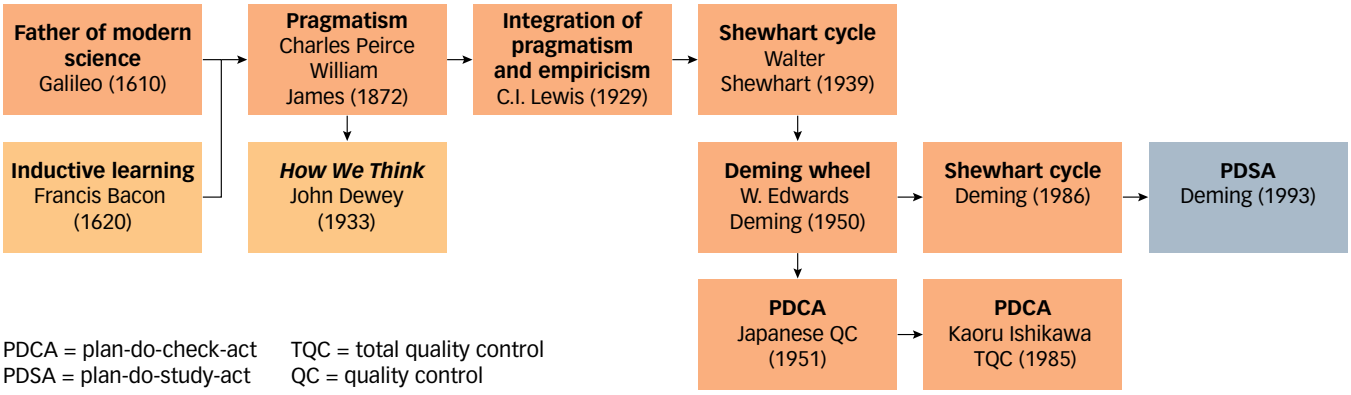
Shewhart and Deming

Lewis' book had enormous influence on Walter A. Shewhart and Deming in bringing the scientific method to 20th century industry.

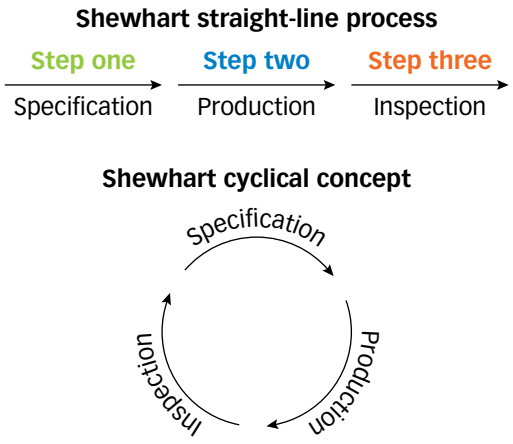
Shewhart's *Statistical Method From the Viewpoint of Quality Control*, published in 1939, first introduced the concept of a straight-line, three-step scientific process of specification, production and inspection.[4] He later revised this idea into a cyclical concept. Figure 2 contrasts the two views of Shewhart's idea of specification, production and inspection.

"These three steps must go in a circle instead of in

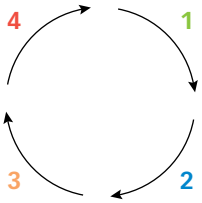
Evolution of the scientific method and PDSA cycle / FIGURE 1



Shewhart cycle—1939 / FIGURE 2



Deming wheel—1950 / FIGURE 3



1. Design the product (with appropriate tests).
2. Make the product and test in the production line and in the laboratory.
3. Sell the product.
4. Test the product in service and through market research. Find out what users think about it and why nonusers have not bought it.

a straight line, as shown," Shewhart wrote. "It may be helpful to think of the three steps in the mass production process as steps in the scientific method. In this sense, specification, production and inspection correspond respectively to hypothesizing, carrying out an experiment and testing the hypothesis. The three steps constitute a dynamic scientific process of acquiring knowledge."[5]

Shewhart's concept eventually evolved into what became known as the Shewhart cycle.

Deming had a front-row seat for Shewhart's thinking: At the age of 39, Deming edited a series of lectures Shewhart delivered to the U.S. Department of Agriculture into what eventually became the basis of Shewhart's 1939 book.

Deming built off Shewhart's cycle and modified the concept. He got the chance to present the new version of the cycle in 1950 during an eight-day seminar in Japan sponsored by the Japanese Union of Scientists and Engineers (JUSE).[6]

In his new version of the cycle, Deming stressed the importance of constant interaction among the four steps of design, production, sales and research. He emphasized that these steps should be rotated constantly, with quality of product and service as the aim, as shown in Figure 3. This new version is referred to as the Deming wheel, the Deming cycle or the Deming circle.

Deming wheel evolves

According to Masaaki Imai, Japanese executives recast the Deming wheel presented in the 1950 JUSE seminars into the PDCA cycle.[7] Table 1 shows Imai's description of the relationship between the Deming wheel and the PDCA cycle.

Imai did not provide details about which executives reworked the wheel or how they translated the Deming wheel into the PDCA cycle. No one has ever claimed ownership of this revision or disputed Imai's assertion.

The resulting PDCA cycle, shown in Figure 4 (p. 26), shows the four-step cycle for problem solving. The cycle includes:

1. **Plan:** Define a problem and hypothesize possible causes and solutions.
2. **Do:** Implement a solution.
3. **Check:** Evaluate the results.

The Deming wheel vs. the Japanese PDCA cycle / TABLE 1

1. Design = plan	Product design corresponds to the planning phase of management.
2. Production = do	Production corresponds to doing. making or working on the product that was designed.
3. Sales = check	Sales figures confirm whether the customer is satisfied.
4. Research = act	If a complaint is filed, it must be incorporated into the planning phase and action taken in the next round of efforts

PDCA = plan-do-check-act

4. **Act:** Return to the plan step if the results are unsatisfactory, or standardize the solution if the results are satisfactory.

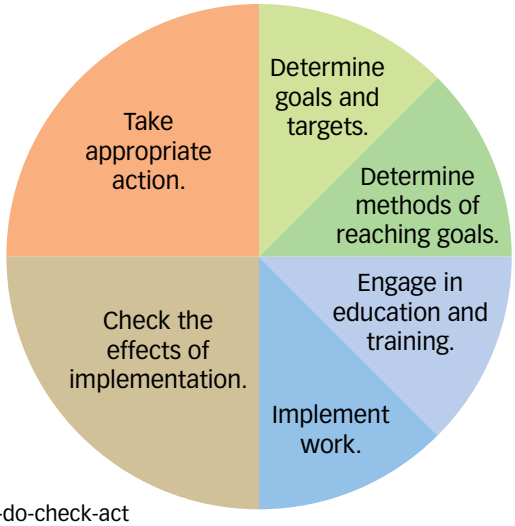
The PDCA cycle also emphasized the prevention of error recurrence by establishing standards and the ongoing modification of those standards.

Once again, others wanted to enhance and revise the cycle. This time, it was Kaoru Ishikawa. He redefined the PDCA cycle to include more in the planning step: determining goals and targets, and formulating methods to reach those goals.[8] Figure 5 shows the PDCA cycle and incorporates Ishikawa's changes.

In the do step, Ishikawa also included training and education to go along with implementation. Ishikawa said good control meant allowing standards to be revised constantly to reflect the voices of consumers and their complaints, as well as the requirements of the next process. The concept behind the term "control" (*kanri*) would be deployed throughout the organization.

The PDCA cycle, with Ishikawa's updates and improvements, can be traced back to S. Mizuno of the Tokyo Institute of Technology in 1959. The seven basic tools (check sheet, histograms, Pareto chart, fishbone diagram, graphs, scatter diagrams and stratification) highlight the central principle of Japanese quality.[9] These tools—together with the PDCA cycle and the quality control (QC) story format—became the foundation for improvement (*kaizen*) in Japan and are still being used today.

Japanese PDCA cycle—1985 / FIGURE 5



PDCA = plan-do-check-act

Japanese PDCA cycle—1951 / FIGURE 4

PDCA = plan-do-check-act

PDSA cycle evolution

More than 30 years after Deming first revised the Shewhart cycle, Deming again reintroduced it during four-day seminars he hosted in the 1980s.[10] He said the latest version had come directly from the 1950 version.

"Any step may need the guidance of statistical methodology for economy, speed and protection from faulty conclusions from failure to test and measure the effects of interactions," Deming said.[11] Figure 6 illustrates the procedure to follow for improvement.

Deming warned his audiences that the PDCA version is frequently inaccurate because the English word "check" means "to hold back."

Once again, Deming modified the Shewhart cycle in 1993 and called it the Shewhart Cycle for Learning and Improvement—the PDSA cycle, as shown in Figure 7.[12] Deming described it as a flow diagram for learning and improvement of a product or a process.

PDCA vs. PDSA

Over the years, Deming had strong beliefs about the PDCA cycle and clearly wanted to distinguish it from the PDSA cycle.

At a roundtable discussion on product quality at the U.S. Government Accounting Office, Deming was asked how the QC circle (referring to PDCA) and the Deming circle related.

"They bear no relation to each other," Deming said. "The Deming circle is a quality control program. It is a plan for management. Four steps: Design it, make it, sell it, then test it in service. Repeat the four steps, over and over, redesign it, make it, etc. Maybe you could say that the Deming circle is for management, and the QC circle is for a group of people that work on faults encountered at the local level."[13]

On Nov. 17, 1990, Deming wrote a letter to Ronald

D. Moen to comment on the manuscript for *Improving Quality Through Planned Experimentation*, coauthored by Moen, Thomas R. Nolan and Lloyd P. Provost.[14] "Be sure to call it PDSA, not the corruption PDCA," Deming wrote in the letter.[15]

In response to a letter he received in 1991, Deming commented about a chart labeled plan-do-check-act. "What you propose is not the Deming cycle," he wrote in the letter. "I don't know the source of the cycle that you propose. How the PDCA ever came into existence I know not."[16]

Has the Deming PDSA cycle evolved?

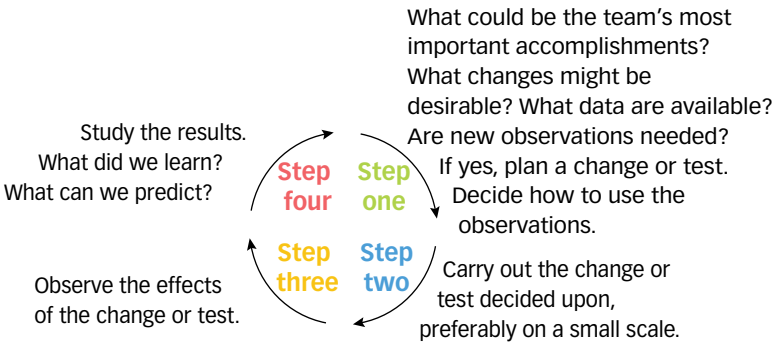
In 1991, Moen, Nolan and Provost added to Deming's PDSA planning step of the improvement cycle and required the use of prediction and associated theory.[17]

The authors said the study step compared the observed data to the prediction as a basis for learning. This provided the deductive-inductive interplay necessary for learning as required in the scientific method.

It is not enough to determine that a change resulted in improvement during a particular test, according to Moen, Nolan and Provost. As you build your knowledge, you will need to be able to predict whether a change will result in improvement under the different conditions you will face in the future.

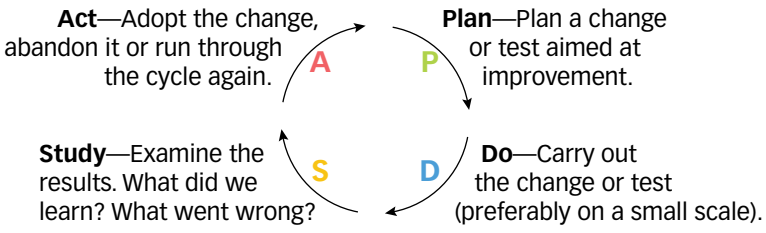
Three years later, Gerald Langley, Kevin Nolan and

Shewhart cycle: Deming—1986 / FIGURE 6

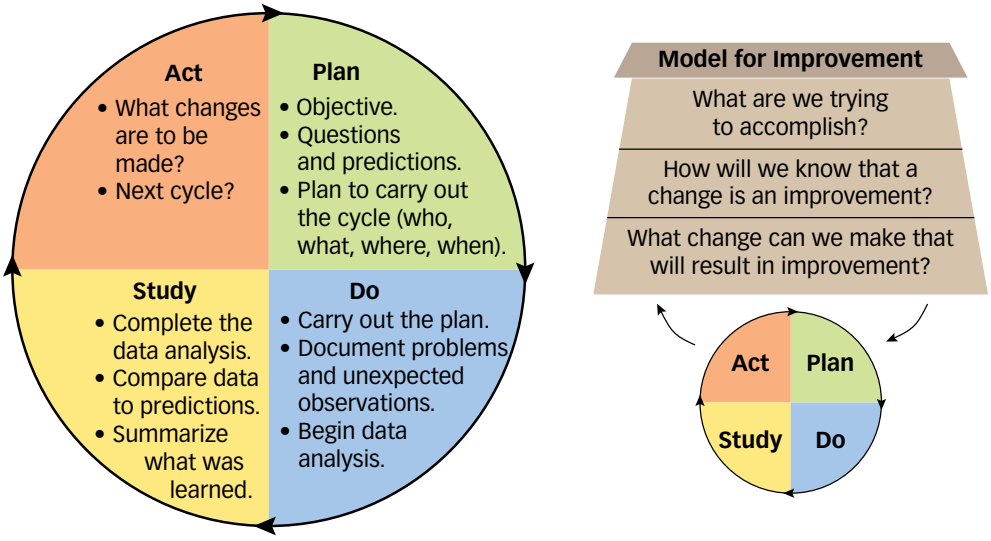


Step five. Repeat step one, with knowledge accumulated.
Step six. Repeat step two, and onward.

PDSA cycle: Deming—1993 / FIGURE 7



PDSA cycle and Model for Improvement—1991, 1994 / FIGURE 8



Deming had strong **beliefs about the PDCA cycle** and wanted to **distinguish it** from the PDSA cycle.

Thomas Nolan added three basic questions to supplement the PDSA cycle.[18] Figure 8 (p. 27) shows the detailed cycle and the Model for Improvement.

This new approach provides a basic framework for developing, testing and implementing changes to the way things are done that will lead to improvement.[19-20] The approach supports a full range of improvement efforts from the very informal to the most complex—for example, the introduction of a new product line or service for a major organization.

Continuing evolution

As Imai pointed out, Japanese executives recast the Deming wheel and developed the PDCA cycle, building from Deming's JUSE seminars of 1950. PDCA has not changed drastically in the last 40 years. It is clear, however, that Deming never fully embraced the PDCA cycle. PDCA and PDSA seem related only through the scientific method.

From 1986 to 1993, Deming was committed to evolving his PDSA cycle, and he always referred to it as the Shewhart cycle for learning and improvement. It's used for learning, testing and implementation.

Today, the PDSA cycle remains relevant and continues to evolve. QP

EDITOR'S NOTE:
One of the authors, Ronald D. Moen, had the unique opportunity to work with W. Edwards Deming. From 1982-1986, Moen managed Deming's monthly visits to General Motors' Pontiac Motor Division. At the time, Moen worked as director of statistical methods. From 1982-1993, Moen assisted Deming at 70 of his well-known four-day seminars. During that time, Deming also reviewed several papers and a book Moen co-authored. Moen and Clifford L. Norman gave a presentation on the history of PDCA at the Asian Network for Quality Conference last year in Tokyo. Some of the content of this article was adapted from that presentation.

ACKNOWLEDGEMENT
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