Foundation and History of the PDSA Cycle

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Abstract

This paper provides a history of W. Edwards Deming's PDSA Cycle for Learning and Improvement. It starts with a philosophy of science and Galileo in the 1600's and moves through Deming's last version of the PDSA Cycle of 1993. It includes the Shewhart Cycle of 1939, the Deming Wheel (circle) of 1950, The Japanese PDCA of 1951 and 1985, and the evolution of the Deming's PDSA from 1986 through 1993. It concludes with some of Deming's reactions to the PDCA.

1. Introduction

Much confusion continues today about W. Edwards Deming's PDSA Cycle. I had a unique opportunity to communicate with Dr. Deming over the 1981-1993 time frames. I managed his monthly visits to Pontiac Motor Division of General Motors from 1982 through 1986 and was a Deming helper at 70 of his famous 4-day seminars from 1982 through 1993. He also reviewed several papers and a book that I co-authored in that time period.

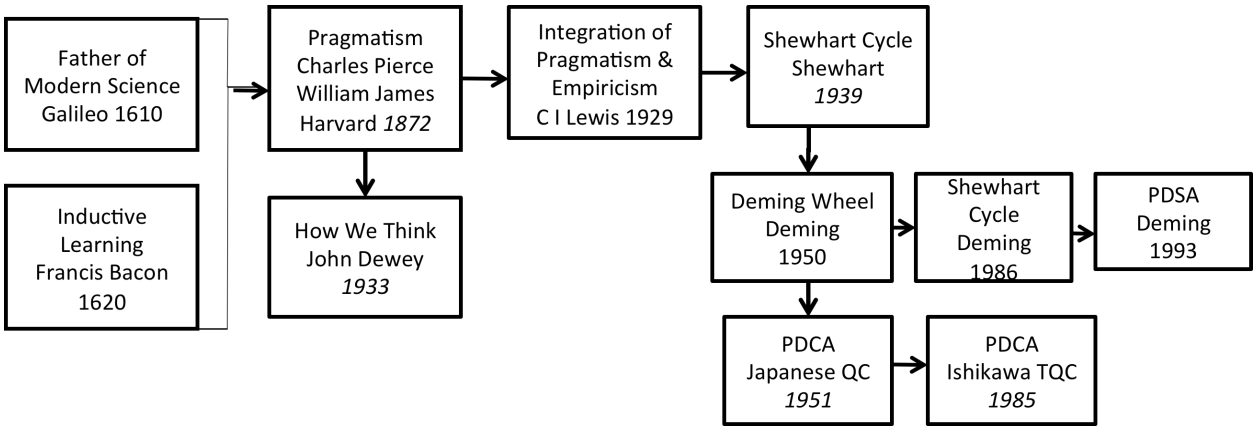
The confusion can be summarized in these three basic questions:

1. How did Deming's PDSA evolve?
2. Did Deming create the PDCA?
3. Are the PDCA and PDSA related?

2. Scientific Method: Foundation for the PDSA Cycle

Figure 1 provides a brief sketch of the history of the scientific method beginning with Galileo in 1610 through pragmatism of the early 1900's and the evolution of the PDCA Cycle and the PDSA Cycle through 1993.

Figure 1 – Evolution of the Scientific Method and the PDSA Cycle



Galileo Galilei (1564-1642) is considered by many to be the father of modern science. Galileo made original contributions to the science of motion and strengths of materials by combining designed experiments and mathematics. Conducting designed experiments are a cornerstone of science and the scientific method.

Francis Bacon (1561-1626) made his contribution as a philosopher who was very concerned about the manner in which knowledge is developed. Bacon believes that the generation of knowledge needs to follow a planned structure. Science at the time depended on deductive logic to interpret nature. Bacon insisted that the scientist should instead proceed through inductive reasoning, from observations to axiom to law. Bacon's contribution completed the interplay between deductive and inductive logic that underlies how we advance knowledge.

Charles Peirce and William James [1] met in Cambridge outside of Harvard in January of 1872 to form a discussion group called the "Metaphysical Club." This group of people would forever be linked with the uniquely American philosophy that we call "pragmatism." They stated that the function of thought is to guide action, and that truth is preeminently to be tested by the practical consequences of belief.

John Dewey (1859-1952) [2] became a leading proponent of *pragmatism* and his works would influence philosophy, education, religion, government, and democracy around the world. The pragmatism of James and Dewey could be summarized in the statement: people are the agents of their own destinies.

Clarence Irving Lewis (1883-1964) [3] an American pragmatist educated at Harvard was heavily influenced by both William James and Charles Pierce. Lewis set out three main ideas in *Mind and the World Order* to further the pragmatist's influence:

1. *a priori* truth is definitive and offers criteria by means of which experience can be discriminated;

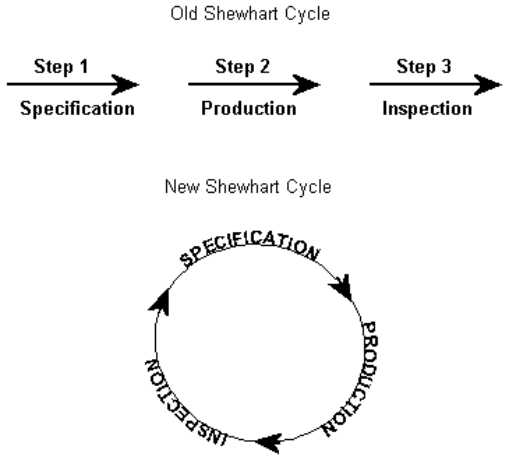
2. the application of concepts to any particular experience is hypothetical and the choice of conceptual system meets pragmatic needs; and
3. the susceptibility of experience to conceptual interpretation requires no particular metaphysical assumption about the conformity of experience to the mind or its categories.

The book of C. I. Lewis had enormous influence on Dr. Walter A. Shewhart and Dr. W. Edwards Deming in bringing the scientific method to twentieth century industry.

Shewhart [4] displayed the new version of the "Shewhart Cycle" in 1939. Figure 2 contrasts the idea of the cycle with the old view of specification, production, and inspection. Shewhart wrote,

> *These three steps must go in a circle instead of in a straight line, as shown . . . 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 making a hypothesis, carrying out an experiment, and testing the hypothesis. The three steps constitute a dynamic scientific process of acquiring knowledge.*

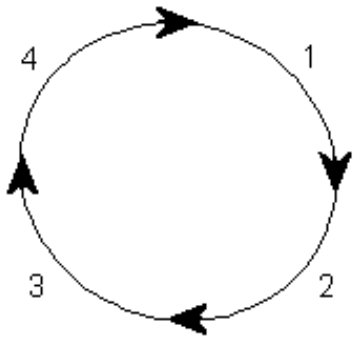
Figure 2 – Shewhart Cycle, 1939



Shewhart's 1939 book was edited by a 39-year-old W. Edwards Deming. Deming [5] modified the Shewhart cycle at a Japanese Union of Scientists and Engineers (JUSE) sponsored eight-day seminar on statistical quality control for managers and engineers in 1950. His straight line: Step 1- Design, Step 2 – Produce, Step 3 - Sell was converted to a circle with a forth step added: Step 4 - Redesign through marketing research.

Deming stressed the importance of constant interaction among design, production, sales, and research and that the four steps should be rotated constantly, with quality of product and service as the aim. Deming's Shewhart cycle was modified slightly in 1951 and is shown in Figure 3. The Japanese called this the "Deming wheel" (or Deming Circle).

Figure 3 – Deming Wheel, 1950



1. Design the product (with appropriate tests).
2. Make it; test it in the production line and in the laboratory.
3. Put it on the market.
4. Test it in service, through market research, find out what the user thinks of it, and why the non-user has not bought it.
5. *Re*-design the product, in the light of consumer reactions to quality and price.
Continue around and around the cycle.

3. The PDCA Cycle Evolves

Imai [6] stated the Japanese executives recast the Deming wheel from the 1950 JUSE seminar into the Plan-Do-Check-Act (PDCA) cycle. Imai shows the correlation between the Deming wheel and the PDCA cycle in Figure 4.

Figure 4 – Correlation between the Deming Wheel and the Japanese PDCA Cycle

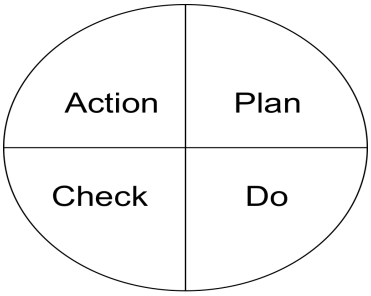
1. Design > Plan	Product design corresponds to the planning phase of management
2. Production > Do	Production corresponds to doing-making, or working on the product that was designed
3. Sales > Check	Sales figures confirm whether the customer is satisfied
4. Research>Action	In case of a complaint being filed, it has to be incorporated into the planning phase, and action taken for the next round of efforts

Imai didn't provide any details as to whom and how the executives translated the Deming Wheel into the PDCA Cycle. No one person claimed authorship and I found no evidence to dispute Imai's translation.

The resulting PDCA cycle is shown in Figure 5. The four step cycle for problem solving includes planning (definition of a problem and a hypothesis about possible causes and solutions), doing

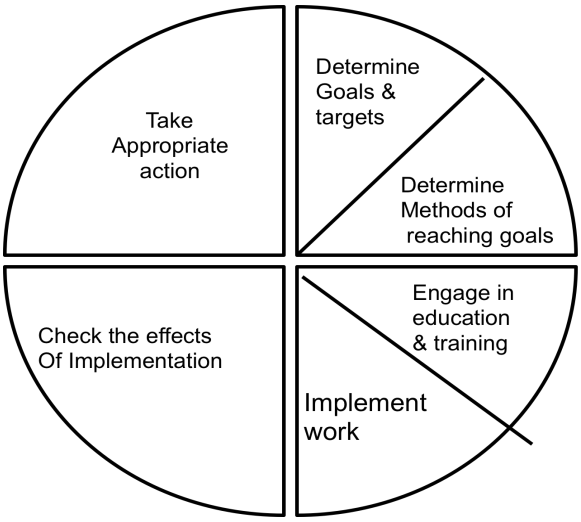
(implementing), checking (evaluating the results), and action (back to plan if the results are unsatisfactory or standardization if the results are satisfactory). The PDCA cycle emphasized the prevention of error recurrence by establishing standards and the ongoing modification of those standards.

Figure 5 – Japanese PDCA Cycle, 1951



Dr. Ishikawa [7] redefines the PDCA cycle to include determining goals and target and methods for reaching the goals in the planning step. In the do step, he includes training and education to go with the implementation. He say good control means allowing standards to be revised constantly to reflect the voices of consumers and their complaints was well as the requirements of the next process. The concept behind the term control (kanri) is deployed throughout the organization.

Figure 6 – Japanese PDCA Cycle, 1985



The PDCA cycle with goals and targets and methods described by Ishikawa can be traced back to Dr. Mizuno in 1959. Lilrank and Kano [8] state the 7 basic tools (check sheet, histograms, Pareto chart, fishbone diagram, graphs, scatter diagrams, and stratification) highlight the central principle of Japanese quality. These tools together with the PDCA cycle and the QC story format became the foundation for improvement (kaizen) in Japan and are still being used today.

The history of the PDCA was presented by Moen and Norman [9] at the Asian Network for Quality (ANQ) in Tokyo in 2009.

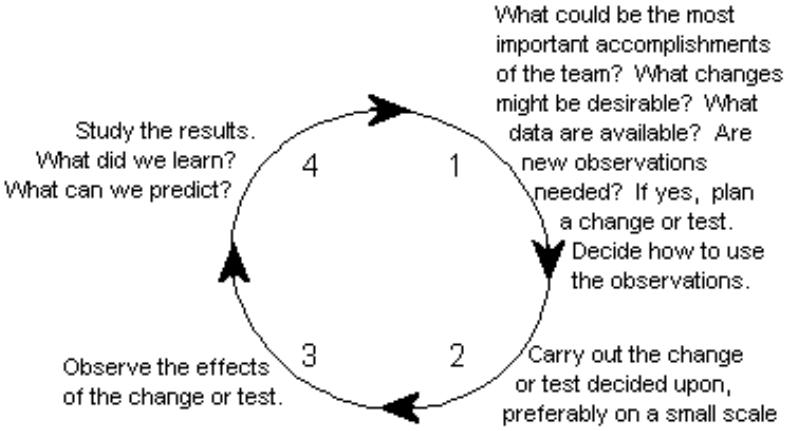
4. The PDSA Cycle Evolves

Deming [10] reintroduces the Shewhart cycle in 1986. He states that it came directly from the 1950 version. Figure 7 illustrates the procedure to follow for improvement. He states:

> *Any step may need guidance of statistical methodology for economy, speed, and protection from faulty conclusions from failure to test and measure the effects of interactions.*

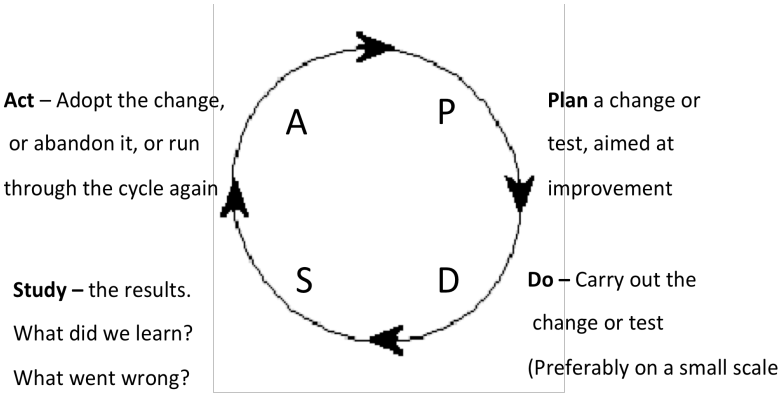
Deming presented this version in his 4-day seminars in the 1980's. Frequently, he warned audiences that the plan, do, check, and act version is inaccurate because the English word "check" means "to hold back."

Figure 7 – Shewhart Cycle: Deming, 1986



Deming [11] again modified the Shewhart cycle in 1993 and called it the Shewhart Cycle for Learning and Improvement- the PDSA Cycle. He described it as a flow diagram for learning, and for improvement of a product or of a process. It is illustrated in Figure 8.

Figure 8 – PDSA Cycle: Deming, 1993



Some of Dr. Deming's reactions to the PDCA Cycle are:

In a GAO transcript of a Roundtable discussion with Dr. Deming on August 19, 1980 [12], Deming was asked how the QC Circle: plan, do, check, and act and the Deming Circle: design it, make it, sell it, then test it in service relate? Deming's response was *"They bear no relation to each other."*

In a letter to Moen on November 17, 1990 [13], Deming commented on a Moen, Nolan, and Provost [14] manuscript*, "... be sure to call it PDSA, not the corruption PDCA."*

From a review of the Library of Congress Archives, Peter B. Petersen [15] summarizes his readings of Deming with respect to the use of the term PDCA Cycle. In responding to a letter he received in 1991, Dr. Deming had the following view about a chart labeled Plan/Do/Check/Act. *"What you propose is not the Deming Cycle. I don't know the source of the cycle that you propose. How the PDCA ever came into existence I know not."*

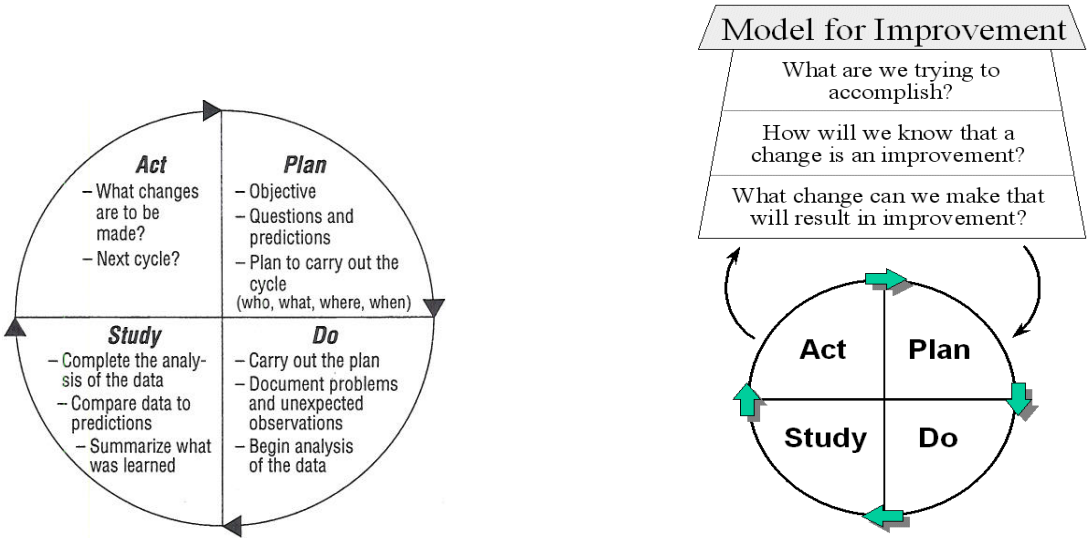
In summary:

- The Japanese developed the PDCA based on Deming's JUSE seminars in 1950 (no one person claims authorship)
- PDCA is used for implementation and compliance and has not changed in the last 40 years
- Deming evolved the PDSA from 1986 until 1993and always called it the "Shewhart Cycle for learning and improvement
- PDSA is used for testing and implementing
- Deming never embraced the PDCA
- The PDCA and PDSA are only related through the scientific method

Has the Deming PDSA Cycle evolved? In 1991, Moen, Nolan and Provost [14] added to the planning step of the improvement cycle required prediction and associated theory. The study step compared the observed data to the prediction as a basis for learning. This provides 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. 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.

Langley, Nolan, and Nolan [16] added three basic questions to supplement the PDSA cycle. Both the detailed cycle and the model are given in Figure 9.

Figure 9 – PDSA Cycle and Model for Improvement, 1991, 1994



The Improvement Guide [17, 18] expands on The Model for Improvement as a basic framework for the science of improvement. The Model for Improvement supports improvement efforts in a full range from the very informal to the most complex (e.g. introduction of a new product line or service for a major organization).

Acknowledgement

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