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The Evolution of Process Improvement

Lean is one of the current popular approaches to improvement, efficiency, and effectiveness, in both business and higher education. The University of Minnesota, the University of Central Oklahoma, and Fuller Theological Seminary have used Lean approaches and tools in their planning and improvement. With Lean's popularity, it's worth taking a look back at the evolution of performance improvement. Each seemingly new approach builds on those approaches that have gone before.

The story of the evolution of process improvement generally focuses on the past 150 years, but some of the earliest efforts at improving the efficiency of work processes go back to the late 18th century. Observing how much work it was to remove cotton seeds by hand, Eli Whitney invented a machine to remove the seeds, thus automating the process in 1793. Five years later, in 1798, he developed equipment that would produce standard, interchangeable parts from which muskets could be assembled, making possible mass production of the guns.

For about the next 100 years, while automation and mass production were used, craftsmen tended to be involved in the work process from beginning to end. Frederic Taylor and Frank and Lillian Gilbreth changed this. In 1911 Taylor published *The Principles of Scientific Management*. The principles included studying all of the steps included in a process to find the best way of doing them, designing equipment for specific jobs or tasks, hiring and training workers for specific jobs, and setting production standards. The Gilbreths used motion pictures to determine how much time workers spent actually doing the productive parts of a job, and how much time they spent on activities such as reaching for supplies. By relocating supplies and reallocating responsibilities, they reduced motion and thus the time needed to complete tasks. While the time and motion studies of Taylor and the Gilbreths increased efficiency, they also made individual jobs more monotonous.

Henry Ford implemented many of the principles of Taylor and the Gilbreths. In 1914 he introduced the first moving assembly line, making the assembly of a car a standard sequence of steps. This process was efficient – Ford was able to produce a car that could be afforded by the public. But effectiveness was not part of his approach. In the iconic saying, customers could 'have any color they wanted, as long as it was black', and there were few design changes in Ford's cars.

In the 1920s Walter Shewhart, a statistician and engineer, added quality to the concept of efficiency in production. When Shewhart joined Western Electric in 1918, the approach was to inspect finished products and dispose of any that did not meet standards. Shewhart introduced the model of Plan – Do – Check – Act and the concept of a control chart, a graph that recorded the number of defective products. Shewhart proposed that if more than one item out of a hundred produced was defective (three standard deviations from the mean), there was a need to examine the production process, find what was causing the defects, and correct it. In the late 1930s and

1940s, W. Edwards Deming began applying Shewhart's approach to the production of materials used in World War II.

Higher education has a parallel history of reaching increasing audiences and seeking improvement. The Morrill Land-Grant Act of 1862 made possible the establishment of public universities to teach engineering and agriculture to a new segment of the population. As more colleges and universities were founded, organizations such as the Middle States Commission on Higher Education (originally founded as the College Association of Pennsylvania following a meeting of college presidents in 1887) were started to standardize admissions requirements and programs of study. This led to the concept of accreditation, and later to peer review of institutions.

Following World War II, Japan concentrated on rebuilding its industries. There was a focus on quality, to be able to sell their products in the world market. Deming and others trained Japanese leadership in using control charts. Toyota adapted Ford's standardized assembly line to production of smaller quantities, meeting specific needs, with equipment that could be quickly changed from one version of a product to another. Toyota could reduce waste while meeting different customer needs. At the same time, in the United States the emphasis was on volume, filling needs that had not been met for nearly 20 years, from the Depression through World War II.

An emphasis on efficiency, effectiveness, and quality had spread worldwide by the 1980s.

- Companies began using and adapting Quality Circles and Total Quality Management (TQM), later known as Continuous Quality Improvement (CQI). Teams or workers would map work processes, and use data to analyze them and make them more efficient.
- In 1987, the International Organization for Standardization (ISO) introduced the ISO 9000 Quality Management System, first focusing on standardization and documentation of work processes. Later versions in 1994, 2000, and 2008 added work process assessment and improvement.
- Also in 1987, the United States federal government established the Malcolm Baldrige National Quality Award to provide an approach for businesses to assess and improve their quality and position in a global marketplace.
- Motorola introduced Six Sigma™, moving beyond the criteria of three standard deviations introduced by Shewhart to six standard deviations, or only 3.4 defects per million items produced. Advances in technology such as personal computers, and trained improvement leaders ('Black Belts' and others) made this analysis possible.

In the 1990s, Six Sigma™ led to the development of Design for Six Sigma (DFSS), Define, Measure, Analyze, Improve, Control (DMAIC), and Define, Measure, Analyze, Design, Verify (DMADV). Over the last 10 years, the foundation of the Toyota process has come to be known as Lean, and there are efforts to integrate Six Sigma™ and Lean.

Over the past 30 years, in concert with the worldwide emphasis on quality, higher education and business have collaborated in sharing ways to increase quality in education. In the early 1990s, DuPont provided training on their quality approaches to a core group of Penn State faculty and staff. IBM later established grants to help numerous institutions develop quality programs. 3M is collaborating with the University of Minnesota. An education version of the Baldrige quality award was developed, and in 2001 University of Wisconsin-Stout was one of the first recipients. Troy State University in Alabama is using their state quality award as a model for improvement. Liverpool John Moores University has used the European equivalent, the European Foundation for Quality Management (EFQM) Excellence model in their assessment and strategic planning.

The journey toward efficiency, effectiveness, and quality may be never ending. The route may change with changes in technology, resources, and expectations. Past approaches have included use of data, identification of customer expectations, and involvement of those familiar with the process. Recent trends appear to include increased information sharing and collaboration across organizations. These components and trends will probably be part of the approaches that emerge in the future.