History of Lean Six Sigma

Although some concepts go back hundreds of years, the most notable origins of Lean can be traced to the work of early industrial engineers in the late 19th and early 20th centuries. Included in that group are:

- Frederick W. Taylor (1856-1915): An engineer who developed methods to improve industrial efficiency. Known for his 1911 book The Principles of Scientific Management which included the concept of standard work.
- Frank Gilbreth (1868-1924): Performed time and motion studies to determine the 'one best way' of performing any task (i.e., standard work). He also promoted the use of process maps, an important tool still in use today.
- Lillian Gilbreth (1878-1972): Combined concepts of scientific management with her knowledge of psychology in making improvements to business processes. Her methods delved into the motivation of workers, something which Taylor ignored.

Manufacturing productivity took a giant leap forward with the developments associated with automobile industrialist Henry Ford (1863-1947) and his chief engineer, Charles Sorenson (1881-1968). Many of their ideas are still associated with Lean and include:

- Standardized, interchangeable parts
- Standard work
- Moving conveyance (i.e., assembly line)
- Process steps in a sequential production line (process flow)
- Point of use storage of supplies
- Elimination of waste

Many of these concepts were developed for production of the Model T at the Ford manufacturing facility in Highland Park, MI. Although incredibly successful, there were several problems with Ford's system. One of the most notable was that it did not offer variety in its products. For example, while the Model T did offer a handful of body styles, the chassis on which they were installed was the same. And as Henry Ford famously said, "Any customer can have a car painted any color that he wants so long as it is black."

The Model T was produced virtually unaltered from 1908 to 1927. While other automakers could not compete with Ford on price, they began to respond to customer demands for variety by offering different colors and features. Most notable was Alfred P. Sloan who introduced the idea of model year design changes at General Motors. Sloan - who joined the company in 1916 and became President in 1923 - is also notable for integrating & offering a complete hierarchy of vehicle brands and making significant structural changes in the corporation. In 1921, GM's share of the U.S. market was 13 percent while Ford had 56 percent. In 1927, after Sloan had completed and fully introduced the multidivisional operating management structure, the numbers were reversed. By the 1930s General Motors had become the largest corporation in the world, a state it maintained until well after Sloan retired as GM in the 1950s.

Starting in the 1930s, Japanese firms began visiting the USA to study and understand American production operations. Among the firms visiting was the Toyota Motor Company. Led by Kiichiro Toyoda (1894-1952) and his chief engineer Taiichi Ohno (1912-1990), Toyota realized they would have to operate differently to compete successfully with Ford and General Motors. Toyota began international operations in the mid-1950s with a plant in Brazil where they followed a philosophy of adapting cars to the local market. They began offering not only variety but also adapting designs to the local conditions and preferences. And they began seeking ways to adapt Ford's methods of operating with minimal waste with GM's variety of product offerings. The result was the Toyota Production System.

Taiichi Ohno is considered the father of the Toyota Production System (TPS) which was later called Just-In-Time and Lean Manufacturing in the United States. He began working for Toyota in 1943 and wrote several books including Toyota Production System (published in 1978 in Japan). Some of the concepts and tools associated with the Toyota Production System include:

- Seven Wastes (Muda)
- Teamwork
- Work cells (Cellular manufacturing)
- Short setup times (SMED - Single Minute Exchange of Die)
- Small batches (with a goal of 1-piece flow)
- Kanban (pull system)
- 5S / Workplace organization
- Visual management
- Kaizen
- Poka Yoke / Mistake Proofing

Another individual associated with the Toyota Production System was Shigeo Shingo (1909-1990), an industrial engineer who worked as a consultant and teacher. He wrote a series of books on various topics associated with the Toyota Production System which were published during the 1980s-90s in the United States.

Also noteworthy were the writings and teaching of Mazaaki Imai, a Japanese organizational theorist and consultant. He wrote the book Kaizen: The key to Japan's competitive success in 1986. Imai did much to promote the concept of kaizen, or incremental change for the better. His ideas were adapted in the West in the form of kaizen events, a focused, team-based, 3-5 day effort to improve a process. Kaizen is now widely used in lean programs.

As the Toyota Production System matured, they - and other Japanese automakers - began to take away market share from domestic automakers. For example, in 1965 the Big 3 automakers (Ford, GM, and Chrysler) had 90% of all sales in the U. S. By 1975 this had dropped to ~82%, then to ~75% (1985), and 55% (2005). Similar losses occurred in other industries, most notably in consumer electronics. Though partly driven by lower labor costs overseas, the methods and ideas of the TPS played a role in this change.

Now the tables were turned and starting in the 1980s many American executives, consultants, and academicians crossed the Pacific to visit Toyota and other Japanese firms to find out what made them so successful. Several U. S. companies attempted to implement some of the tools and methods of the Toyota Production System, with varying degrees of success.

Another figure in the development of a methodology that parallels lean principles is Eliyahu M. Goldratt (1947-2011). He is best known for his business novel The Goal (1984) which tells the fictional story of a factory manager struggling to provide on-time delivery for his customers. Goldratt was a proponent of the Theory of Constraints (TOC) which emphasizes the importance of finding and exploiting the constraint operation in any business process. After introducing these concepts in The Goal Goldratt expanded on TOC in several other books and articles. Many lean practitioners make use of a combination of TOC ideas and complementary lean principles.

A 1990 book which became a best-seller on lean principles was The Machine That Changed the World: The Story of Lean Production by James Womack and Daniel Jones. The authors tracked the development of the automotive industry from its infancy to Henry Ford to Toyota. They later wrote Lean Thinking (1996), a book which explained lean principles in a broader sense. Many other books, articles, and studies on lean concepts were released during the 1990s. One article of special note was "Decoding the DNA of the Toyota Production System" by Steven Spear and H. Kent Bowen (Harvard Business Review, SEP-OCT 1999). In this article the authors provided a simple, clear explanation of the key tenets of the TPS. Today there are literally hundreds of books, articles, websites, and blogs available on Toyota, TPS, and their methods.

Starting in the 1990s, several non-manufacturing firms began utilizing lean concepts. Industries which adopted lean ideas included banking and finance, hospitality and service, healthcare, insurance, logistics, government, information systems, even homebuilding. There are numerous annual conferences, working groups, professional organizations, and certifications which are now available to lean practitioners.

The lean body of knowledge has continued to grow since the passing of Taiichi Ohno in 1990. In the 1980s the focus was on lean tools. More recent lean research and publications are focused on the application of behavioral sciences, psychology, philosophy, and management practices.

Six Sigma was developed at Motorola in the 1980s in response to quality problems the firm was experiencing in their manufacture of electronics and challenges in the market for semiconductors from Japanese manufacturers. They concluded that traditional methods - which measured quality in defects per thousand - were not adequate to achieve the level of quality needed to be competitive. The decision was made to begin measuring quality in defects per million. An engineer at Motorola - Bill Smith (1929-1993) - is credited with coining the term 'Six Sigma.' A process operating at the Six Sigma Quality Level is said to have 3.4 defects per million possible opportunities (DPMO).

Another key figure in the development of Six Sigma is Mikel Harry who worked at Motorola from the 1970s to the 90s. Harry is attributed with the naming convention of Black Belts and Green Belts (project leaders with varying skill levels) at Motorola in 1989. He was also instrumental in developing many of the other conventions now associated with Six Sigma. In 1991 Harry helped establish the Motorola Six Sigma Research Institute.

Others at Motorola associated with the development of Six Sigma include CEO Bob Galvin (1922-2011), and COO John Mitchell (1928-2006). These executives supported the growth of the Six Sigma program as it expanded into different areas of the company. In 1988 Motorola received the Malcolm Baldrige National Quality Award. And in 2005 Motorola attributed savings of $17B over the life of their Six Sigma Program. Bob Galvin is on record as saying that Motorola missed out on saving $1.5 Billion due to not realizing the impact Six Sigma would have on improving their transactional processes.

Starting in 1992 Mikel Harry promoted Six Sigma to other firms. Companies that began using the methodology included Texas Instruments, IBM, and Digital Equipment. In the early days of Six Sigma at Motorola projects had four phases: Measure, Analyze, Improve, and Control. The belief at that time was that all projects had been properly defined and scoped. But early practitioners found this was often not the case. As Six Sigma spread to other firms a fifth phase - Define - was added in which a project charter must be established that includes Problem Statement, Goal Statement, Scope, etc. The DMAIC process is now used as a standard project structure in Six Sigma.

Another firm associated with the early growth and development of Six Sigma is General Electric. Starting in 1995, Jack Welch - the CEO of GE - made Six Sigma a central part of their strategy. He is noted for growing their Six Sigma program rapidly, and across all sectors of GE. Welch is also known for incorporating Six Sigma as a method of achieving the firm's strategic goals, and for engaging the management team in their program. A GE policy at the time was that no manager was promoted until completing project work as a Green Belt or Black Belt. Welch also endorsed the idea that the best and brightest at GE should be selected to serve as Black Belts, with the vision that these individuals would be future leaders of the company. As a result of their Six Sigma program GE reported a financial impact of $12 Billion over the five year period from 1995 to 2000.

Many of the tools, concepts, and methods associated with Six Sigma are the same as those used in Total Quality Management (TQM). In the 1980s TQM was a popular continuous improvement methodology, especially in manufacturing. But there were a number of shortcomings of TQM, most notably a lack of engagement with senior management. Similarly, TQM tended to be focused on operations and was rarely used in addressing business problems in support functions such as procurement, scheduling, shipping, etc.

While Six Sigma has only been around since 1986, most of the tools and methods in the SS body of knowledge have been in use for many decades (if not longer). A partial list of contributors to the toolset and concepts used include:

- Carl Fridriech Gauss (1777-1855) - German mathematician associated with the normal distribution (Gaussian distribution)
- Ronald Fisher (1890-1962) - English statistician and geneticist who developed ANOVA (analysis of variance)
- Karl Pearson (1857-1936) - English statistician who developed correlation and regression analysis
- William S. Gossett (1876-1937) - English statistician who developed t-distribution while working at Guinness beer
- Vilfredo Pareto (1848-1923) - Italian engineer and economist known for Pareto Analysis (80-20 rule)
- Joseph Juran (1904-2008) - Romanian-American engineer known for separating the "Trivial Many from the Critical Few" and named the 80-20 rule after Pareto. Juran is also known for the "Juran Quality Trilogy."
- Simeon Denis Poisson (1781-1840) - French mathematician known for his work on probability theory associated with error rates.

- Walter A. Shewhart (1891-1967) - American physicist who developed control chart theory while at Western Electric. He also introduced the Plan-Do-Study-Act improvement cycle.
- Homer Sarasohn (1916-2001) - Raytheon engineer summoned to Japan by Gen. MacArthur to build radios so the occupying forces could communicate with the citizenry. He discovered that Japanese companies lacked fundamental knowledge about quality manufacturing and "sold" MacArthur on a program to educate Japanese management.
- Edwards Deming (1900-1993) - American statistician known for his work in developing and implementing quality methods in Japan after WW II and in the U. S. in the 1970s-80s. The Deming Prize is awarded in Japan each year in his honor.
- George E. P. Box (1919-2013) - British statistician known for his work in design of experiments, quality control, and time-series analysis

While Lean and Six Sigma were developed somewhat independently, many practitioners of continuous improvement methods used elements of both. The idea of combining the two methodologies in a formal way occurred at George Group, a Dallas-based consulting firm. Founded in 1986, George Group was led by Mike George, a physicist who had previously worked at Texas Instruments. He was concerned in the 1980s with the eroding manufacturing base in the United States and began studying best practices of Japanese firms. In response to the challenges faced by U. S. manufacturers, in 1987 Michael George co-authored America CAN Compete! George Group worked with a wide variety of firms over the next 13 years utilizing Lean tools and methods with great success.

Starting in 2000, George Group began to incorporate Six Sigma methods with their existing Lean practice. This was done in response to customer requests, most notably from ITT Industries. The CEO of ITT at that time - Lou Giuliano - approached Mike George about adding Six Sigma to the Lean methodology already in use at George Group.

Two experienced Six Sigma practitioners - Chuck Cox and Dan Campion - were brought in to assist in the effort to create a full-spectrum Lean Six Sigma offering.

Mike George subsequently wrote or co-authored Lean Six Sigma (2002), Lean Six Sigma for Service (2003), The Lean Six Sigma Pocket Toolbook (2005) and Fast Innovation (2005). These books helped to further the growth and development of Lean Six Sigma, especially the Toolbook which was translated into multiple languages. The firm grew rapidly from 2000 to 2007 and worked with a variety of Fortune 500 companies including Caterpillar, Xerox, Siemens, Capital One, United Space Alliance, and Starwood Hotels. George Group also worked with the U. S. Army and U. S. Navy in deployments of Lean Six Sigma in the Department of Defense.

In 2007, Mike George sold George Group to Accenture. Lean Six Sigma remains in use at Accenture under their Process & Innovation Performance Services practice.

Although Lean and Six Sigma have now been around independently for over 40 years - and LSS combined for over 15 years - there does not appear to be any significant drop-off in interest in these methodologies. As noted above, there are many different annual conferences, working groups, certifications, websites, blogs, videos, articles books, etc. which continue to add to the Lean Six Sigma body of knowledge.

In some industries the use of LSS is still somewhat new whereas in others it is relatively commonplace. Even in firms with somewhat mature LSS deployments there are still functional areas, divisions, or geographic locations that have yet to embrace LSS. Hence, the opportunity - and need - exists for practitioners to continue using LSS to improve their companies and make them more competitive.

There appears to be some support for changing the naming convention and methodology used in LSS. For example, some companies prefer Operational Excellence instead of Lean Six Sigma. The thought is that Operational Excellence is more accessible to a wider audience at the typical company.

Other firms have come up with alternatives to Black Belt and Green Belt. For some these names have negative connotations associated with the violent side of martial arts. At Raytheon they prefer Six Sigma Expert (instead of Black Belt). And at Mount Carmel Health they use Guides. That said, the use of Black Belt and Green Belt is pervasive in most firms using LSS.

It will be interesting to see how Lean Six Sigma grows and changes over the coming years. At TMAC we hope you will embrace the LSS methodology and add to the body of knowledge with your own success stories.