

LEAN SIX SIGMA

YELLOW & ORANGE BELT

MINDSET, SKILL SET AND TOOL SET

CLIMBING THE MOUNTAIN

ir. H.C. Theisens

SECOND EDITION

Lean Six Sigma Academy®

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Climbing the Mountain preface

Would you consider to buy a new smart phone from a certain phone provider if your friends keep complaining about connection problems or bad service? You probably would not. You also would probably not want to go to a school with a reputation for poor teaching, a hospital with a high rate of infections due to bad hygiene or to eat in a restaurant that had served you bad food before. It does not matter what type of product or service we keep in mind; good service, good quality and a short response time are important for all products and services that we buy. For all types of products and services there is only one direction for response time, quality and price. We expect a product that meets our expectations and without any defect. Expected delivery time and response time should be shorter and quicker. The price we are willing to pay should be in line with the quality.

Because of the internet, consumers can obtain a huge amount of information about the performance of products and organizations. It is very easy to compare prices of different suppliers and ordering a product or service can be done at any time. If we want to buy a book, a jacket or even a car, we want to receive the product as soon as possible. On top of that we expect companies to develop new models every year. Of course we expect the price of a new model to be the same as the old model or even less.

Do you, as a consumer, have any idea what this means for companies that have to develop and deliver these products? In the past decades the increasing quality expectations and shorter Lead Times has had a huge impact on innovation, production, quality management and supply chain management. If a company is not able to keep up with this it will not survive. Each year many companies, both small and large, have to close their doors because they cannot meet the increasing expectations of customers. Companies and organizations must constantly improve their knowledge of processes and quality control in response to increase customer requirements for higher quality and shorter Lead Times.

Since process improvement has been going on for decades, process improvement techniques have been applied for decades. Different methods have been developed over the years like Lean Manufacturing, Kaizen, 'Theory of Constraints' (TOC), 'Total Quality Management' (TQM), 'Total Productive Maintenance' (TPM) and Six Sigma. Many books have been published about process improvement and quality management by people like Deming, Imai, Taiichi Ohno and Eliyahu Goldratt.

Different methods have helped different companies to make significant improvements. The approach that is most suitable for your organization depends very much on where it stands right now and what it needs to do in order to reach a higher level of performance. It is important to determine the level of operational excellence, before an improvement program is started. Over the past years an integration has taken place based on best practices from improvement methods like Kaizen, Lean, Six Sigma and others. This book will explain these different methods and an all-inclusive approach of the most commonly applied tools and techniques.

The road to the top of the mountain can be tough, as the path is full of technical and organizational obstacles. You will discover that the journey is also a very interesting, instructive and satisfactory one. The roadmap and techniques described in this book will give insight and understanding of a number of powerful tools and techniques to improve processes and quality.

How to use this book

Thousands of books have been published over the years about process improvement and quality management. You can find many different books on the topics Lean Management and Six Sigma. This book is different because it reviews an approach across all improvement methods that have been proven to be successful over the past decades, such as TQM, Kaizen, TPM, Lean and Six Sigma. These methods, tools and techniques have been united in the 'Continuous Improvement Maturity Model' (CIMM™). This is a framework describes the process of continuous improvement from a very early stage through delivering World Class products and services. The CIMM framework connects Lean, Six Sigma and other improvement methods. The framework incorporates the best practices methods and techniques of process improvement, quality management and new product development. CIMM is an open standard and is maintained by the 'Lean Six Sigma Academy' (LSSA).

The structure of this book is based on the Lean Six Sigma Academy Syllabi for Yellow Belt [6.] and Orange Belt [7.]. All of the techniques described in these Syllabi will be reviewed in this book. We also advise you to use the accompanying 'Lean Six Sigma Yellow Belt & Orange Belt Exercise book' (ISBN 978-94-92240-05-7). Information about the Lean Six Sigma certification process is reviewed in Appendix A. We advise you to register this book at www.lssa.eu. After registering you will be able to download additional examples and templates.

Those who would like to apply Lean Six Sigma at the Green or Black Belt level are advised to read the 'Lean Six Sigma Green Belt' book or 'Lean Six Sigma Black Belt' book and the accompanying exercise book from the series 'Climbing the Mountain'.

As the entire journey of becoming World Class cannot be taken overnight, you do not have to read this book entirely at once. We recommend to start reading the first three chapters. It will give insight into the five CIMM levels and at what level your organization is currently acting. This will clarify which chapters will be interesting for you to read and which techniques useful to apply. The CIMM framework will guide you to define the most appropriate approach for the situation your organization is currently in. Guidelines are given that will help you and your organization from the very beginning till World Class performance. I wish you the best of luck on your journey of 'Climbing the Mountain'.

To aid readability this book has been written with male gender pronouns, but in every case a female gender pronoun could equally be substituted.

About the author

Having graduated from the University of Twente (Enschede, the Netherlands) in 1994, Theisens (1969) developed his experience of process improvement as a consultant in the automotive and high-tech industry at Texas Instruments, Sensata Technologies, Thales and several other companies. During a period of 20 years he was given the opportunity to help a broad range of organizations deploying Continuous Improvement initiatives in a wide range of industries.

In a production plant in Mexico he led several 5S programs, Kaizen initiatives and a Lean transformation. In several plants in Europe and Malaysia he executed and coached around 50 Six Sigma breakthrough projects. At an automotive engineering department he supported the introduction of Design for Six Sigma.

Currently Theisens is Managing Director and Master Black Belt of a Consultancy and Training company in the Netherlands that is specialized in 'Business Improvement', and he is a guest lecturer at the University of Twente. Theisens is also founder of the LSSA – Lean Six Sigma Academy©, which is Scheme owner of the world wide Lean Six Sigma certification program of the APMG (APM Group Limited), iSQI (International Software Quality Institute) and ECQA (European Certification and Qualification Association).

“In the beginning of my career I endured tough quality audits from several Japanese, German and American companies, which I think is the best way to understand the importance of quality and to learn what works to improve quality and what does not. In these years, I experienced that there are many different methods and tools for process improvement and also encountered discussions on which method is more effective; Kaizen, Lean, TOC, Six Sigma.... Some say that any problem can be solved with Six Sigma, while others says that Lean is the most effective methodology. I have always been looking to combine best practices.”

“Currently many use Lean Six Sigma as a holistic approach, but are still struggling with the integration and selection of tools. Others have problems to implement Lean Six Sigma effectively because they underestimate the impact of change. I hope this book will be a guidance for many companies and organizations to define a process improvement strategy, to choose the proper tools and to enthuse others in their journey of becoming World Class.”

“I would like to thank my colleagues for giving me the opportunity to share best practices, for reviewing this book and for supporting the development process of the ‘Continuous Improvement Maturity Model’ that has been the basis for this book. I would also like to thank my family for supporting me to find the time to write this book.”

H.C. Theisens

“It always seems impossible,
until its done.”

- *Nelson Mandela* -

1

World Class Performance

World Class Performance is the highest level that a company can reach within its own sector by developing new products and services that exceed customer expectation in a very short time-to-market. In order to achieve World Class Performance, organizations need to develop and produce products and services that are the best in the world. Its production and delivery process should perform at the level of Operational Excellence and the organization should continuously improve its processes. The organization needs to be innovative, agile and should have a high ability for renewal.

World Class Performance is not something that you can realize in a few months. There is no golden roadmap to success. Working to become World Class is a long and bumpy journey with successes and setbacks. There will be roadblocks on the winding way to the top of the mountain. It is very unlikely that all people involved will reach the summit. Some will fall behind. Others will drop off completely. Although this is not a joyful perspective, it is a path that must be followed if you want to stay competitive in the future as most of your competitors work on Continuous Improvement.

1.1 Competitive strategies

Each company has the same challenge: ‘How can we provide products or services with maximum value for our clients at the lowest possible costs and with the shortest delivery time?’ Michael Treacy and Fred Wiersema described in their book ‘The Discipline of Market Leaders’ (1997), three generic competitive strategies: Operational Excellence, Customer Intimacy and Product Leadership. According to the authors a company should embrace and become successful in at least one of these three strategies, and perform to an acceptable level in the other two.

1.1.1 Operational Excellence

Continuous improvement methods like Lean and Six Sigma support organization to become successful in ‘Operational Excellence’. Operational Excellence focuses on delivering to customer expectation, without failures, on time and in a cost-efficient manner. It is a philosophy where problem solving, teamwork and leadership result in the on-going improvement of the organization. Operational Excellence involves focusing on the customer’s needs, keeping the employees positive and empowered and continually improving the current activities in the workplace. This strategy is often followed by high-volume and transaction-oriented companies that operate in a mature and commoditized market.

1.1.2 Physical versus Transactional processes

In general, processes can be divided into two groups. The first group is physical processes. The second group is transactional processes. Most companies tend to have both types of processes, but have a focus on one of these groups. In Table 1.1 a number of examples are listed for both groups.

Although Lean Six Sigma finds its origin in manufacturing, it is often applied within service organizations as well. It is good to realize some of the similarities and differences between physical processes and transactional processes:

- Transactional environments tend to have a stronger need for fast adaptability as customers’ requirements change more frequently.
- Inventory is less visible in transactional environments, as most work in process has the form of electronic data and correspondence rather than physical items.
- Transactions within one process take place on computer systems that are connected across multiple locations, sometimes around the world, while manufacturing processes are more centralized in one location.
- The connection of different manufacturing processes is much more complicated as parts are produced around the world by different companies, making it a logistical challenge to get all parts together at the right moment without huge piles of inventories.
- Maintenance has a different meaning within transactional environments, as computer software and algorithms do not wear out like equipment and tooling.
- Transactional processes tend to have more waiting time than manufacturing. In most cases this is the consequence of several approval steps in the process.
- Transactional processes are less data-driven. Even if data is recorded, it is hidden in systems. People are unaware or do not have access to data or do not look for data to support decisions. As a consequence decisions are often based on opinions rather than facts.
- People in service organizations tend to have less affinity with statistical analysis, whereas this is an important element within Six Sigma.

If you read all the above, you might think that Lean Six Sigma is difficult to apply in service organizations. This is not the case, although it requires a different approach. On the other hand, transactional processes have great opportunities for improvement, as there is more low-hanging fruit and more waiting time.

Table 1.1. Overview of processes

Sector	Process type
Physical processes (Manufacturing)	Assembling, connecting
	Forming, machining
	Chemical processing
	Joining, finishing
	Testing (e.g. inspection, electrical, laboratories)
	Groceries, shops, restaurants, etc.
	Distribution, transportation & logistics
	Construction
Transactional processes (Service)	Strategic planning process
	New product development & IT development
	Financial transactions (e.g. billing, invoicing, banking, insurance)
	Request for quotation
	Customer service
	Complaint management
	Planning process & order entry process
	Human resource management

1.2 History of Continuous Improvement

In the last few years, the Lean and the Six Sigma philosophies have merged to Lean Six Sigma as a complete approach for process improvement. It is a combination of Lean Manufacturing and Six Sigma and uses a combined set of tools that can be applied to reduce Lead Time, reduce operational cost and improve quality. This will provides organizations with greater speed, less variation and more bottom-line impact.

1.2.1 History of Total Quality Management, Lean and Six Sigma

In this section we will review the history of quality management in general and Lean Manufacturing and Six Sigma in particular.

History of Quality Management

The origin of managing quality goes back thousands of years. Building the great pyramids of Cheops in 2560 BC could not have been done without proper quality management. Even today we are astonished by the way the 5.5 million tons of limestone, 8,000 tons of granite and 500,000 tons of mortar were used in the construction of the Great Pyramid. The largest granite stones in the pyramid weigh 25 to 80 tons. The accuracy of the pyramids workmanship is such that the four sides of the base have an average error of only 58 millimeters in length. The base is horizontal and flat to within ± 15 mm. These numbers prove that the level of quality was very high.

The concept of quality as we think of it now first emerged during the industrial revolution. Previously, goods had been made from start to finish by the same person or team of people, with handcrafting and tweaking the product to meet quality criteria. Mass production brought huge teams of people together to work on specific stages of production where one person would not necessarily complete a product from start to finish. In the late 19th century pioneers such as Taylor and Henry Ford recognized the limitations of the methods being used in mass production at the time and the varying quality of output. Henry Ford (1863 - 1947) was the founder of Ford Motor Company and sponsor of the development of the assembly line technique of mass production. Many would say that Lean started with Henry Ford. Initially this was more a Lean initiative than a quality management initiative. Each T-Ford was supplied in any desired color, as long as it was black, and it was supplied with a tool box in the trunk. Later Ford emphasized standardization of design and component standards to ensure a standard product was produced. Management of quality was the responsibility of the Quality department and was implemented by inspection of product output to catch defects.

Shewhart (1891 - 1967) was an American physicist, and known as the father of statistical quality control. He has set the basis for the Control chart and bringing the production process into a state of Statistical Process Control (SPC). He is also the creator of the PDCA circle. The application of statistical control evolved during World War II where quality became a critical component of the war effort.

After World War II the Japanese welcomed the input of Americans Juran (1904 - 2008) and Deming (1900 - 1993). Juran was a management consultant and engineer. He wrote several influential books on quality management. He was one of the first to write about the 'Cost of Poor Quality' (COPQ). He is also known for the Pareto tool or '80/20 rule'. Deming was a statistician after whom the Deming Prize for quality is named (1951). Deming proclaimed the PDCA circle for solving problems from Shewhart. Deming is regarded as having had more impact upon Japanese manufacturing and business than any other individual of Japanese heritage. He was only just beginning to win widespread recognition in the U.S. at the time of his death in 1993.

Masaaki Imai (born 1930) is a Japanese organizational theorist and management consultant, known for his work on quality management, specifically on Kaizen. In 1986 he founded the Kaizen Institute to help Western companies introducing the concepts, systems and tools of Kaizen.

‘Total Quality Management’ (TQM) in the United States came much later as a direct response to the quality revolution in Japan. By the 1970s, U.S. industrial sectors such as automobiles and electronics had been broadsided by Japan’s high-quality competition. The U.S. response became known as ‘Total Quality Management’ and consists of continuously improving the ability to deliver high-quality products and services to customers. TQM typically relies heavily on the previously developed tools and techniques of quality control. TQM enjoyed widespread attention during the late 1980s and early 1990s before being overshadowed by ISO 9001, Lean Manufacturing and Six Sigma. Many of its principles and tools however are still present in today’s quality management programs.

History of Lean Manufacturing

Lean Manufacturing focuses on stability and elimination of waste. Lean Manufacturing began with Henry Ford who was the first person to truly integrate an entire production process. He did this by lining up fabrication steps in process sequence using Standardized Work and interchangeable parts. Ford called this ‘Flow’ production (1913). The problem with Ford’s system was its inability to provide variety. As mentioned the Model-T was limited to one color and to one specification. As a result, all Model-T chassis were essentially identical until the end of production in 1926.

In the 1930s, and more intensely just after World War II (1950), Kiichiro Toyoda, Taiichi Ohno, and others at Toyota started looking at Ford’s situation. While Ford was producing 8,000 vehicles per day, Toyota had produced only 2,500 vehicles in 13 years. Toyota wanted to scale up production but lacked the financial resources required for the huge quantity of inventory and subassemblies as seen at the Ford’s plant. It occurred to them that a series of simple innovations might make it possible to provide both continuity in process flow as well as a wide variety of product offerings. Soon after, Toyota developed the ‘Toyota Production System’ (TPS). TPS borrowed ideas from Ford but developed the ‘Just In Time’ philosophy (JIT), the ‘Pull Concept’ and ‘Jidoka’ to address the issues of high cost associated with Ford’s large inventories. The Lean thought process is thoroughly described in the book ‘The machine that changed the World’ (Womack and Jones, 1990) and in a subsequent volume, ‘Lean Thinking’ (1996), which specifically describes the five Lean principles [see section 6].

In 2008 Toyota became the world’s largest auto manufacturer in terms of overall sales. Over the past two decades, Toyota’s continued success has created an enormous demand for further knowledge concerning Lean Thinking. There are literally hundreds of books, papers and other resources currently available to this growing Lean Management audience.

Lean Thinking or Lean Management has been widely distributed around the world. Lean principles and tools are being used in production, logistics and distribution, services, trade, health, construction, maintenance and even in government with the common goal of reducing turnaround time and operational costs while at the same time improving quality. One of the most important activities within Lean programs is the identification and elimination of Waste or Muda.

History of Six Sigma

It was 1979 when Motorola was engaged in a painful process of self-discovery and began to realize the extent to which it had lost market share in many key segments, including televisions, car radios and semiconductors. That same year, during a company officers' meeting, Motorola's President and CEO Bob Galvin asked the question, 'What is wrong with our company?' Many officers and corporate chiefs began voicing the standard, politically correct excuses. Blame it on the Japanese, blame it on the economy in general, blame it on weak research and development.

While all this was going on, a lone voice in the back of the room spoke up loudly and clearly saying 'I will tell you what is wrong with this company... our quality stinks!' That voice was Art Sundry, a sales manager for Motorola's most profitable business at the time. Everyone thought he would be fired for this ballsy assertion. How could someone make such a statement in such horrible and turbulent times? Surely Motorola had always been and still was among the world's best manufacturers, regardless of the hard times it was facing. (Mikel J. Harry, www.mikeljarry.com).

Motorola was at a major turning point in its history. It could continue on a downward trend relative to competitors, or it could break that trend with an ambitious culture change and quality improvement initiative. This was the moment Motorola began its search for ways to eliminate waste and improve its quality. Two Motorola engineers, Bill Smith and Mikel Harry, were credited for their pioneering work aimed at improving processes and for finding and resolving defects. Their work on process capability, tolerance, critical-to-quality characteristics, and design margins laid much of the foundation for what today is called Six Sigma.

Six Sigma focuses on capability and reducing variation. Recognizing a link between fewer defects and lower costs, Motorola set out to incorporate this connection into their manufacturing processes, which they called 'Six Sigma'. Motorola's Six Sigma quality program was so radical that managers were forced to think about the business differently. Applying these concepts to Motorola's electronics manufacturing delivered more than \$2.2 billion in benefits within four years and \$16 billion within 15 years. Motorola's CEO Bob Galvin cited the work of Bill Smith and Mikel Harry in achieving these benefits.

One of the companies that embraced the Six Sigma philosophy was General Electric (GE). GE Chairman, Jack Welch was told that Six Sigma could have a profound effect on GE's quality. Although skeptical at first, Welch initiated a huge campaign called 'the GE Way'. He made an official announcement and launched the quality initiative at GE's annual gathering of 500 top managers in January 1996. Welch described the program as 'The biggest opportunity for growth, increased profitability, and individual employee satisfaction in the history of the company'. His goal was to take quality to a whole new level and to become a Six Sigma quality company, producing nearly defect-free products and providing nearly defect-free services and transactions. Welch's intention was to infuse quality into every corner of the company. He later called Six Sigma 'the most difficult stretch goal', but also suggested that it was 'The most important initiative GE had ever undertaken'. General Electric saved more than \$12 billion with Six Sigma in the five years after implementation.