Making Everything Easier!™

3rd Edition

Lean Six Sigma

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Learn to:

- Enhance business efficiency and reduce waste
- Successfully deploy Lean Six Sigma projects in your organisation
- Manage projects more tightly and fine-tune existing systems
- Apply Lean Six Sigma thinking to your day-to-day activities

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Martin Brenig-Jones
Lean Six Sigma Coaches and Directors of Catalyst Consulting

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and Martin Brenig-Jones

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Contents at a Glance

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Introduction

Lean Six Sigma provides a rigorous and structured approach to help manage and improve quality and performance, and to solve potentially complex problems. It helps you use the right tools, in the right place and in the right way, not just in improvement but also in your day-to-day management of activities. Lean Six Sigma really is about getting key principles and concepts into the DNA and lifeblood of your organisation so that it becomes a natural part of how you do things.

This book seeks to help managers and team leaders better understand their role and improve organisational efficiency and effectiveness.

If you want to change outcomes, you need to realise that outcomes are the result of systems. Not the computer systems, but the way people work together and interact. And these systems are the product of how people think and behave. So, if you want to change outcomes, you have to change your systems, and to do that, you have to change your thinking. Albert Einstein summed up the need for different thinking very well:

> *The significant problems we face cannot be solved by the same level of thinking which caused them.*

Lean Six Sigma thinking is *not* about asset stripping and 'making do'. Instead, this approach focuses on doing the right things right, so that you really do add value for the customer and make your organisation effective and efficient.

The main focus of the book relates to DMAIC (Define, Measure, Analyse, Improve and Control). This is the Lean Six Sigma method for improving existing processes that form a part of the organisation's systems, and it provides an ideal way to help you in your quest for continuous improvement.

When you need to develop a new process, the Design for Six Sigma method comes into play. Known as DMADV (Define, Measure, Analyse, Design and Verify), we provide an introduction to this method in Chapter 12.

About This Book

This book makes Lean Six Sigma easy to understand and apply. We wrote it because we feel that Lean Six Sigma can help organisations of all shapes and sizes, both private and public, improve their performance in meeting their customers' requirements.

In particular, we wanted to draw out the role of the manager and provide a collection of concepts, tools and techniques to help him or her carry out the job more effectively. We also wanted to demonstrate the genuine synergy achieved through the combination of Lean and Six Sigma. For some reason unknown to the authors, a few people feel they can use only Lean or Six Sigma, but not both. How wrong they are!

In this book you can discover how to create genuine synergy by applying the principles of Lean and Six Sigma together in your day-to-day operations and activities.

Foolish Assumptions

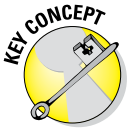
In Lean Six Sigma, avoiding the tendency to jump to conclusions and make assumptions about things is crucial. Lean Six Sigma really is about managing by fact. Despite that, we've made some assumptions about why you may have bought this book:

- You're contemplating applying Lean Six Sigma in your business or organisation, and you need to understand what you're getting yourself into.
- Your business is implementing Lean Six Sigma and you need to get up to speed. Perhaps you've been lined up to participate in the programme in some way.
- Your business has already implemented either Lean or Six Sigma and you're intrigued by what you might be missing.
- You're considering a career or job change and feel that your CV or resume will look much better if you can somehow incorporate Lean or Six Sigma into it.
- You're a student in business, operations or industrial engineering, for example, and you realise that Lean Six Sigma could help shape your future.

We also assume that you realise that Lean Six Sigma demands a rigorous and structured approach to understanding how your work gets done and how well it gets done, and how to go about the improvement of your processes.

Icons Used In This Book

Throughout the book, you'll see small symbols called *icons* in the margins; these highlight special types of information. We use these to help you better understand and apply the material. Look out for the following icons:



This icon highlights an essential component of Lean Six Sigma.

Bear these important points in mind as you get to grips with Lean Six Sigma.

Keep your eyes on the target to find tips and tricks we share to help you make the most of Lean Six Sigma.

Throughout this book we share true stories of how different companies have implemented Lean Six Sigma to improve their processes. We also share true stories of when things go wrong so you learn from others' mistakes.

This icon highlights potential pitfalls to avoid.

Beyond This Book

In addition to the material in the print or e-book you're reading right now, this book also comes with some access-anywhere goodies on the web. Check out the free Cheat Sheet at `http://www.dummies.com/cheatsheet/leansixsigma` for helpful information that you can access on a regular basis.

You can find some free articles online that expand on some of the concepts in the book. You can find links to the articles on the parts pages and on the Extras page at `http://www.dummies.com/extras/leansixsigma`.

Where to Go From Here

In theory, when you read you begin with ABC, and when you sing you begin with doh-ray-me (apologies to Julie Andrews). But with a *For Dummies* book you can begin where you like. Each part and, indeed, each chapter is self-contained, which means you can start with whichever parts or chapters interest you the most.

That said, if you're new to the topic, starting at the beginning makes sense. Either way, lots of cross-referencing throughout the book helps you to see how things fit together and put them in the right context.

Part I

Getting Started with Lean Six Sigma

Go to www.dummies.com for more information about topics that interest you – everything from using Lean Six Sigma in your organization to holding effective meetings and from building teamwork to understanding quality control.

In this part . . .

- Grasp the basics of Lean Thinking and Six Sigma so you can understand what they mean and what they don't mean.
- Get a clearer picture of what the synergy created by merging the two disciplines into Lean Six Sigma looks like and understand the key principles underpinning the approach.
- Comprehend exactly what 'sigma' means and why the term is important in Lean Six Sigma.
- Examine in depth what the commonly used process improvement method known as DMAIC – Define, Measure, Analyse, Improve and Control – means in Lean Six Sigma.

Chapter 1

Defining Lean Six Sigma

In This Chapter

- Turning up trumps for the Toyota Production System
- Finding out the fundamentals of 'Lean' and 'Six Sigma'
- Applying Lean Six Sigma in your organisation

Throughout this book we cover the tools and techniques available to help you achieve real improvement in your organisation. In this chapter we aim to move you down a path of different thinking that gets your improvement taste buds tingling. We look at the main concepts behind Lean thinking and Six Sigma and introduce some of the terminology to help you on your way.

Introducing Lean Thinking

Lean thinking focuses on enhancing value for the customer by improving and smoothing the process flow (see Chapter 11) and eliminating waste (covered in Chapter 9). Since Henry Ford's first production line, Lean thinking has evolved through a number of sources, and over many years, but much of the development has been led by Toyota through the Toyota Production System (TPS). Toyota built on Ford's production ideas, moving from high volume, low variety, to high variety, low volume.

Although Lean thinking is usually seen as being a manufacturing concept and application, many of the tools and techniques were originally developed in service organisations. These include, for example, spaghetti diagrams, part of the organisation and methods toolkit, and the visual system used by supermarkets to replenish shelves. Indeed, it was a supermarket that helped shape the thinking behind the Toyota Production System. During a tour to General Motors and Ford, Kiichiro Toyoda and Taiichi Ohno visited Piggly Wiggly, an American supermarket, and noticed Just in Time and kanban being applied. This innovation enabled Piggly Wiggly customers to 'buy what they need at

any time' and avoided the store holding excess stock. Kanban is simply a card providing the signal to order more stock. Incidentally, Piggly Wiggly was founded in 1916 in Memphis, Tennessee by the innovative Clarence Saunders, who was also the first to introduce the concept of a self-service grocery shop.

Lean is called 'Lean' not because things are stripped to the bone. Lean isn't a recipe for your organisation to slash its costs, although it will likely lead to reduced costs and better value for the customer. We trace the concept of the word 'Lean' back to 1987, when John Krafcik (who is joining Google to provide advice on the driverless car) was working as a researcher for MIT as part of the International Motor Vehicle Program. Krafcik needed a label for the TPS phenomenon that described what the system did. On a white board he wrote the performance attributes of the Toyota system compared with traditional mass production. TPS:

- Needed less human effort to design products and services.
- Required less investment for a given amount of production capacity.
- Created products with fewer delivered defects.
- Used fewer suppliers.
- Went from concept to launch, order to delivery and problem to repair in less time and with less human effort.
- Needed less inventory at every process step.
- Caused fewer employee injuries.

Krafcik commented:

It needs less of everything to create a given amount of value, so let's call it Lean.

The Lean enterprise was born.

Bringing on the basics of Lean

Figure 1-1 shows the Toyota Production System, highlighting various tools and Japanese Lean thinking terms that we use throughout this book. In this chapter we provide some brief descriptions to introduce the Lean basics and the TPS.

Toyota's Taiichi Ohno describes the TPS approach very effectively:

> *All we are doing is looking at a timeline from the moment the customer gives us an order to the point when we collect the cash. And we are reducing that timeline by removing the non-value-added wastes.*

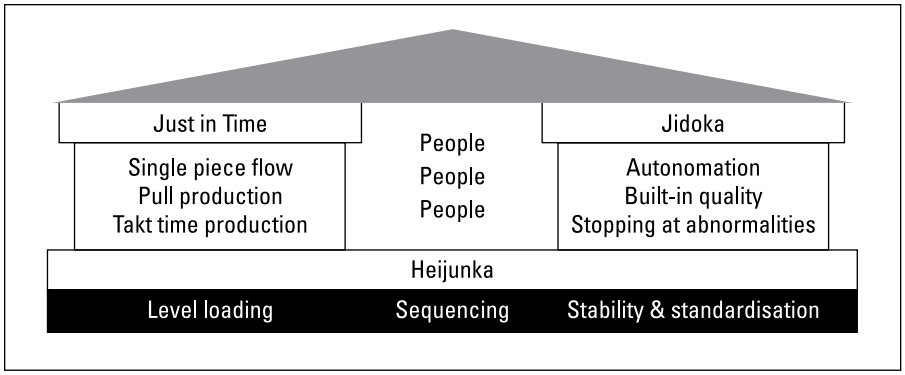


Figure 1-1: The TPS house.

The TPS approach really is about understanding how the work gets done, finding ways of doing it better, smoother and faster, and closing the time gap between the start and end points of our processes. And it applies to any process. Whether you're working in the public or private sector, in service, transactional or manufacturing processes really doesn't matter.

Think about your own processes for a moment. Do you feel that some unnecessary steps or activities seem to waste time and effort?

We must point out, however, that simply adopting the tools and techniques of the TPS isn't enough to sustain improvement and embed the principles and thinking into your organisation. Toyota chairperson Fujio Cho provides a clue as to what's also needed:

> *The key to the Toyota way is not any of the individual elements but all the elements together as a system. It must be practised every day in a very consistent manner – not in spurts. We place the highest value on taking action and implementation. By improvement based on action, one can rise to the higher level of practice and knowledge.*

Picking on people power

Figure 1-1 shows that people are at the heart of TPS. The system focuses on training to develop exceptional people and teams that follow the company's philosophy to gain exceptional results. Consider the following:

- Toyota creates a strong and stable culture wherein values and beliefs are widely shared and lived out over many years.
- Toyota works constantly to reinforce that culture.

- Toyota involves cross-functional teams to solve problems.
- Toyota keeps teaching individuals how to work together.

Being Lean means involving people in the process, equipping them to be able, and feel able, to challenge and improve their processes and the way they work. Never waste the creative potential of people!

Looking at the lingo

You can see from Figure 1-1 that Lean thinking involves a certain amount of jargon – some of it Japanese. This section defines the various terms to help you get Lean thinking as soon as possible:

- **Heijunka** provides the foundation. It encompasses the idea of smoothing processing and production by considering levelling, sequencing and standardising:
  - **Levelling** involves smoothing the volume of production in order to reduce variation, that is, the ups and downs and peaks and troughs that can make planning difficult. Amongst other things, levelling seeks to prevent 'end-of-period' peaks, where production is initially slow at the beginning of the month, but then quickens in the last days of a sale or accounting period, for example.
  - **Sequencing** may well involve mixing the types of work processed. So, for example, when setting up new loans in a bank, the type of loan being processed is mixed to better match customer demand, and help ensure applications are actioned in date order. So often, people are driven by internal efficiency targets, whereby they process the 'simple tasks' first to get them out of the way and 'hit their numbers', leaving the more difficult cases to be processed later on. This means tasks are not processed in date order, and people are reluctant to get down and tackle a pile of difficult cases at the end of the week, making things even worse for the customer and the business.
  - **Standardising** is the third strand of Heijunka. It seeks to reduce variation in the way the work is carried out, highlighting the importance of 'standard work', of following a standard process and procedure. It links well to the concept of process management, where the process owner continuously seeks to find and consistently deploy best practice. Remember, however, that you need to standardise your processes before you can improve them. Once they're standardised, you can work on stabilising them, and now that you fully understand how the processes work, you can improve them, creating a 'one best way' of doing them.

    In the spirit of continuous improvement, of course, the 'one best way' of carrying out the process will keep changing, as the people in the process identify better ways of doing the work. You need to ensure the new 'one best way' is implemented and fully deployed.

- **Jidoka** concerns prevention; it links closely with techniques such as failure mode effects analysis (FMEA), which are covered in Chapter 10. Jidoka has two main elements, and both seek to prevent work continuing when something goes wrong:
  - **Autonomation** allows machines to operate autonomously, by shutting down if something goes wrong. This concept is also known as automation with human intelligence. The 'no' in auto*no*mation is often underlined to highlight the fact that no defects are allowed to pass to a follow-on process. An early example hails from 1902, when Sakichi Toyoda, the founder of the Toyota group, invented an automated loom that stopped whenever a thread broke. A simple example today is a printer stopping processing copy when the ink runs out.

    Without this concept, automation has the potential to allow a large number of defects to be created very quickly, especially if processing is in batches (see 'Single piece flow', below).
  - **Stop at every abnormality** is the second element of Jidoka. The employee can stop an automated or manual line if he spots an error. At Toyota, every employee is empowered to 'stop the line', perhaps following the identification of a special cause on a control chart (see Chapter 7).

    Forcing everything to stop and immediately focus on a problem can seem painful at first, but doing so is an effective way to quickly get at the root cause of issues. Again, this can be especially important if you're processing in batches.
- **Just in Time (JIT)** provides the other pillar of the TPS house. JIT involves providing the customer with what's needed, at the right time, in the right location and in the right quantity. The concept applies to both internal and external customers. JIT comprises three main elements:
  - **Single piece flow** means each person performs an operation and makes a quick quality check before moving his output to the next person in the following process. Naturally this concept also applies to automated operations where inline checks can be carried out. If a defect is detected, Jidoka is enacted: the process is stopped, and immediate action is taken to correct the situation, taking countermeasures to prevent reoccurrence. This concept is a real change of thinking that moves us away from processing in batches.

    Traditionally, large batches of individual cases are processed at each step and are passed along the process only after an entire batch has been completed. The delays are increased when the batches travel around the organisation, both in terms of the transport time and the length of time they sit waiting in the internal mail system. At any given time, most of the cases in a batch are sitting idle, waiting to be processed. In manufacturing, this is seen

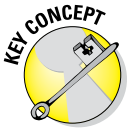
as costly excess inventory. What's more, errors can neither be picked up nor addressed quickly; if they occur, they often occur in volume. And, of course, this also delays identifying the root cause. With single piece flow, we can get to the root cause analysis faster, which helps prevent a common error recurring throughout the process.

- **Pull production** is the second element of JIT. Each process takes what it needs from the preceding process only when it needs it and in the exact quantity. The customer pulls the supply and helps avoid being swamped by items that aren't needed at a particular time.

  Pull production reduces the need for potentially costly storage space. All too often, overproduction in one process, perhaps to meet local efficiency targets, results in problems downstream. This increases work in progress, and creates bottlenecks. Overproduction is one of the 'seven wastes' identified by Ohno and covered in Chapter 9.

- **Takt time** is the third element of JIT, providing an important additional measure. It tells you how quickly to action things, given the volume of customer demand. Takt is German for a precise interval of time, such as a musical meter. It serves as the rhythm or beat of the process – the frequency at which a product or service must be completed in order to meet customer needs. Takt time is a bit like the beat of the drum on the old Roman galleys for synchronising the rowers.

Taking the strain out of constraints



Much of the focus in Lean thinking is on understanding and improving the flow of processes and eliminating non-value-added activities. The late Eliyahu Goldratt's *theory of constraints* (explained more fully in Chapter 11) provides a way to address and tackle bottlenecks that slow the process flow. Goldratt's theory proposes a five-step approach to help improve flow:

1. **Identify the constraint.**

   Data helps you identify the bottlenecks in your processes, of course, but you should be able to see them fairly easily, too. Look for backlogs and a build-up of work in progress, or take note of where people are waiting for work to come through to them. These are pretty good clues that demand is exceeding capability and you have a bottleneck.

2. **Exploit the constraint.**

   Look for ways to maximise the processing capability at this point in the process flow. For example, you may minimise downtime for machine maintenance by scheduling maintenance outside of normal hours.

3. **Subordinate the other steps to the constraint.**

   You need to understand just what the bottleneck is capable of – how much it can produce, and how quickly it can do it. Whatever the answer is, in effect, that's the pace at which the whole process is working. The downstream processes know what to expect and when, and having upstream processes working faster is pointless; their output simply builds up as a backlog at the bottleneck. So, use the bottleneck to dictate the pace at which the upstream activities operate, and to signal to the downstream activities what to expect, even if that means these various activities are not working at capacity.

4. **Elevate the constraint.**

   Introduce improvements that remove this particular bottleneck, possibly by using a DMAIC (Define, Measure, Analyse, Improve and Control) project (we delve into DMAIC in Chapter 2).

5. **Go back to Step 1 and repeat the process.**

   After you complete Steps 1–4, a new constraint will exist somewhere else in the process flow, so start the improvement process again.

Considering the customer

The customer, not the organisation, specifies value. Value is what your customer is willing to pay for. To satisfy your customer, your organisation has to provide the right products and services, at the right time, at the right price and at the right quality. To do this, and to do so consistently, you need to identify and understand how your processes work, improve and smooth the flow, eliminate unnecessary steps in the process, and reduce or prevent waste such as rework.

Imagine the processes involved in your own organisation, beginning with a customer order (market demand) and ending with cash in the bank (invoice or bill paid). Ask yourself the following questions:

- How many steps are involved?
- Do you need all the steps?
- Are you sure?
- How can you reduce the number of steps and the time involved from start to finish?

Perusing the principles of Lean thinking

Lean thinking has five key principles:

- Understand the customer and his perception of value.
- Identify and understand the value stream for each process and the waste within it.
- Enable the value to flow.
- Let the customer pull the value through the processes, according to his needs.
- Continuously pursue perfection (continuous improvement).

We've covered these briefly in the preceding pages, but look at them again in more detail in Chapter 2, when we see how they combine with the key principles of Six Sigma to form *Lean Six Sigma*.

Sussing Six Sigma

Six Sigma is a systematic and robust approach to improvement, which focuses on the customer and other key stakeholders. Six Sigma calls for a change of thinking. When Jack Welch, former General Electric CEO, introduced Six Sigma, he said:

> *We are going to shift the paradigm from fixing products to fixing and developing processes, so they produce nothing but perfection or close to it.*

In the 1980s Motorola CEO Bob Galvin struggled to compete with foreign manufacturers. Motorola set a goal of tenfold improvement in five years, with a plan focused on global competitiveness, participative management, quality improvement and training. Quality engineer Bill Smith coined the name of the improvement measurements: Six Sigma. All Motorola employees underwent training, and Six Sigma became the standard for all Motorola business processes.

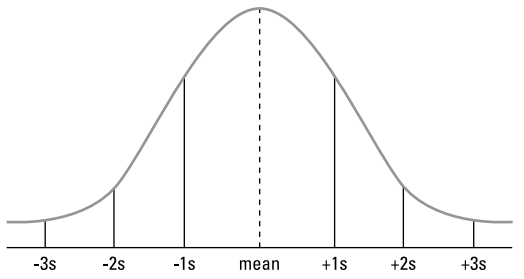
Considering the core of Six Sigma

A sigma, or standard deviation, is a measure of variation that reveals the average difference between any one item and the overall average of a larger population of items. Sigma is represented by the lower-case Greek letter σ.

Introducing a simple example

Suppose you want to estimate the height of people in your organisation. Measuring everyone isn't practical, so you take a representative sample of 30 people's heights. You work out the mean average height for the group – as an example – say this is 5 foot, 7 inches. You then calculate the difference between each person's height and the mean average height. In broad terms, one sigma, or standard deviation, is the average of those differences. The smaller the number, the less variation there is in the population of things you are measuring. Conversely, the larger the number, the more variation. In our example, imagine the standard deviation is one inch, though it might be any number in theory.

Figure 1-2 shows the likely percentage of the population within plus one and minus one standard deviation from the mean, plus two and minus two standard deviations from the mean, and so on. Assuming your sample is representative, you can see how your information provides a good picture of the heights of all the people in your organisation. You find that approximately two-thirds of them are between 5 foot 6 inches and 5 foot 8 inches tall, about 95 per cent are in the range 5 foot 5 inches to 5 foot 9 inches, and about 99.73 per cent are between 5 foot 4 inches and 5 foot 10 inches.



Sigma	Percentage
Plus and minus 1	68.26
Plus and minus 2	95.46
Plus and minus 3	99.73
Plus and minus 4	99.9937
Plus and minus 5	99.999943
Plus and minus 6	99.999998

Figure 1-2: Standard deviation.

In reality, the calculation is a little more involved and uses a rather forbidding formula – as shown in Figure 1-3.

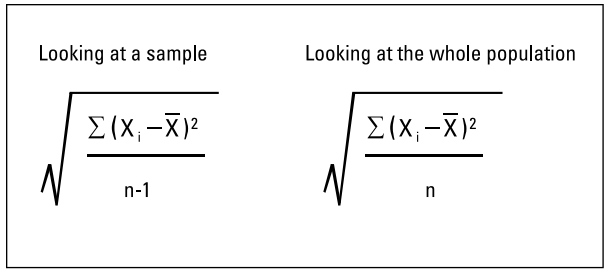


Figure 1-3: Standard deviation formula.

Using n – 1 makes an allowance for the fact that we're looking at a sample and not the whole population. In practice, though, when the sample size is over 30, there's little difference between using n or n – 1. When we refer to a 'population' this could relate to people or things that have already been processed, for example a population of completed and despatched insurance policies or hairdryers.

The process sigma values are calculated by looking at our performance against the customer requirements – see the next section.

Practising process sigma in the workplace

In the real world you probably don't measure the height of your colleagues. Imagine instead that in your organisation you issue products that have been requested by your customers. You take a representative sample of fulfilled orders and measure the *cycle time* for each order – the time taken from receiving the order to issuing the product (in some organisations this is referred to as *lead time*). Figure 1-4 shows the cycle times for your company's orders.

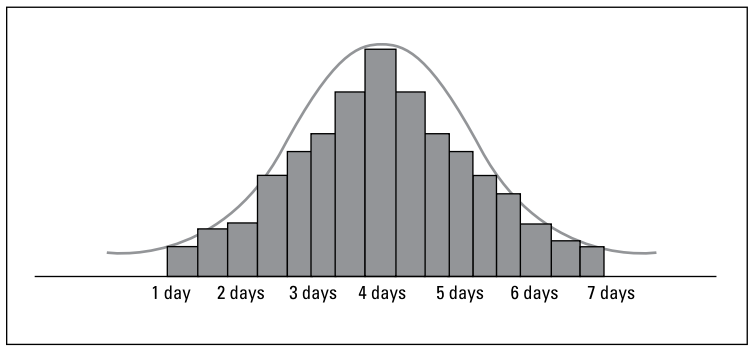


Figure 1-4: Histogram showing the time taken to process orders.

You can see the range of your company's performance. The cycle time varies from as short as one day to as long as seven days.