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Lean Kaizen

A Simplified Approach to Process Improvements

George Alukal and Anthony Manos

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To
Elizabeth (“Lizy”) Alukal
Thomas Manos, Jr.

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Preface

Lean has been receiving a lot of attention lately from quality professionals, management, and the press. What started out in manufacturing has now migrated to non–shop floor activities. Business support functions, such as sales, customer service, accounting, human resources, engineering, purchasing, within manufacturing firms, as well as purely service organizations like financial institutions, government, and hospitals are now implementing lean.

Those of us in quality became familiar with lean in different ways. Some of us started implementing kaizens in the late 1980s after getting introduced to them by Masaaki Imai's book. Continuous improvement was very important then (as now), what with the focus on statistical process control and other statistical techniques, reengineering, and the introduction of both the ISO 9000 series and the Malcolm Baldrige National Quality Award. The term "lean" came into vogue a little later, first as lean manufacturing and currently as lean enterprise. For many ASQ members, we believe, a good understanding of lean is useful both at work and also careerwise.

Lean (the term was coined by James Womack's group a few years ago), though based on the Toyota Production System (TPS), uses tried and proven, mostly commonsense tools. Toyota learned from Ford Motor Company, U.S. military practices, good old industrial engineering and operations research techniques, U.S. supermarket delivery and inventory control systems, plus German aircraft manufacturing methods, and refined these as well as added a few Toyota-grown improvements to come up with its successful TPS.

Different aspects of lean are useful everywhere. While TPS as a whole is highly beneficial for Toyota (and other automotive manufacturers), imposing all of the same techniques blindly will not be the answer for others. A manufacturing company needs to ask these questions first: Are we make-to-stock or make-to-order? Do we do mostly fabrication or

assembly? Do we create discrete widgets or continuously processed product? How about our customers' expectations (quality, cost, and delivery) and our internal lead times? Are suppliers prepared for lean and just-in-time? Are we—senior management, middle management, and shop floor employees—ready? Is the company culture ready to support the transition from traditional manufacturing to lean?

There is no turning back once you start the lean journey (unless you want to continue the flavor-of-the-month syndrome). Lean tools and techniques are simple and rely on common sense, but implementation and sustaining require discipline, motivation, incentives, good change management, and strong, long-term leadership.

From our experience working with a couple hundred companies, the successful ones have a few things in common: (1) management commitment, (2) a well-thought-out master plan, including plans for cultural change, communication, lean training, standardization at the improved level, and rewards/recognition, and (3) alignment of company goals with individual and/or team goals (including addressing the fear of downsizing due to lean improvements). We can also say categorically that the human side of the lean transformation is most critical: the various technical lean tools can easily be taught, but changing the culture, team building, sustainable motivation, alignment of goals, and potential resistance from middle management and unions are issues that need to be carefully considered before embarking on the lean journey.

These days, more and more firms are combining lean with their other improvement efforts. Even the largest corporations are implementing lean, Six Sigma (with emphasis on statistical techniques), theory of constraints, and even total quality management (Baldrige criteria, for instance) and/or ISO 9001 and its derivatives such as TS 16949, AS9100, and so on, all as a suite of useful tools and techniques. More and more, lean champions, Six Sigma Black Belts, or ISO 9001/TS 16949 management representatives are becoming one function, all using the appropriate tool the correct way, either singly or blended, for problem solving and continuous improvement. The best combination of plan–do–check–act (PDCA) and define–measure–analyze–improve–control (DMAIC) is used wherever possible. As an example, lean experts pull out the appropriate statistical or graphical techniques whenever they encounter the waste ("muda" in TPS terminology) of defects or correction. Lean addresses velocity (time or speed) while Six Sigma looks for stability in the process. Lean tools focus on waste reduction, and Six Sigma methods are used to attack variation. Lean is appropriate for cost and time reduction (directly benefiting throughput and productivity), whereas Six Sigma is good for maintaining/improving quality.

While using lean for transforming our companies, it is important that all employees have training in at least its basic concepts. For Six Sigma implementation, usually only a core group needs to be formally trained. It cannot be overemphasized that in the lean environment, it is essential to focus on *all* employees' contributions through their creativity, problem-solving skills, knowledge of the process, and team brainstorming. "Do not check your brains at the door," "It is not just management who has all the answers," and "Think! Think! Think!" are some of the sayings that have flowed down from Taiichi Ohno, the father of TPS.

Some of the core concepts of lean are: (1) creativity before capital (tapping into the experience, innovation, and knowledge of people working in the process before spending capital on improvements), (2) an improvement that is not so perfect done today is better than the perfect solution that is late (there is always room and the need for further continuous improvements), and (3) inventory is not an asset but a cost (or waste). Lean emphasizes the power of teamwork and consensus through brainstorming.

Where does one begin a lean journey? Value stream mapping is a good starting point, in most instances. The future state map will self-identify the "biggest bang for the buck" improvements, which are carried out as process kaizens.

ABOUT THIS BOOK

The history of how this book came about is as follows: ASQ had contracted the authors to develop a two-day course in lean enterprise and an additional one-day course just on kaizen. These two hands-on courses are being delivered throughout North America, usually four times a year. Based on the success of these programs, ASQ was interested in a practical book on lean kaizen, not necessarily just to complement the courses, but also as a stand-alone offering. Here it is.

All the examples of kaizens presented in the book are from our experiences with real-world lean transformations, which the reader should find useful. After introducing the concepts of lean and kaizen, various building blocks of a lean enterprise are described, so that after completing the book, any reader should gain a foundation of what we understand today as lean or TPS. Chapter 6 describes in substantial detail how to perform kaizens both on the manufacturing shop floor and in support functions or in purely service environments. Another useful feature of the book is Chapter 7, which takes one of the kaizen projects from Chapter 6 (quick changeover using single minute exchange of dies, the so-called SMED technique) and

in general terms shows how to perform a cost–benefit analysis on a typical kaizen project.

The intended audience for this book is quality or operational professionals who want to start their lean journey at work or to enhance their career opportunities. The authors recommend that you read this fairly slim volume from cover to cover and then use the various examples as and when needed. The forms, figures, and checklists included in this book and on the accompanying CD-ROM could be customized and used in the readers' own lean journeys when they perform kaizens. The authors will appreciate any comments or suggestions for improvement: authors@asq.org.

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Introduction to Lean and Kaizen

WHAT IS LEAN?

In the last ten years or so, a new term has entered our vocabulary: "lean." Executives and decision makers, especially in senior management, quality, operations, engineering, and human resources have been hearing of lean in a context other than dieting. What is it?

Lean is a manufacturing or management philosophy that shortens the lead time between a customer order and the shipment of the parts or services ordered through the elimination of all forms of waste. Lean helps firms in the reduction of costs, cycle times, and non-value-added activities, thus resulting in a more competitive, agile, and market-responsive company.

There are many definitions of lean. Here is one that is used by the Manufacturing Extension Partnership of National Institute of Standards and Technology, a part of the U.S. Department of Commerce: "A systematic approach in identifying and eliminating waste (non-value-added activities) through continuous improvement by flowing the product at the pull of the customer in pursuit of perfection." Lean focuses on value-added expenditure of resources from the customers' viewpoint. Another way of putting it would be to give the customers:

- What they want
- When they want it
- Where they want it
- At a competitive price
- In the quantities and varieties they want, but always of expected quality

A planned, systematic implementation of lean leads to improved quality, better cash flow, increased sales, greater productivity and throughput,

improved morale, and higher profits. Once started, lean is a never-ending journey of ever-improving processes, services, and products. Many of the concepts in total quality management and team-based continuous improvement are also common to the implementation of lean strategies.

BRIEF HISTORY OF LEAN

Most of the lean concepts are not new. Many of them were being practiced at Ford Motor Company during the 1920s or are familiar to most industrial engineers.

A few years after World War II, Eiji Toyoda of Japan's Toyota Motor Company visited the American car manufacturers to learn from them and to transplant U.S. automobile production practices to the Toyota plants. With the eventual assistance of Taiichi Ohno and Shigeo Shingo, the Toyota Motor Company introduced and continuously refined a system of manufacturing whose goal was the reduction or elimination of non-value-added tasks (activities for which the customer was not willing to pay). The concepts and techniques that go into this system are now known as Toyota Production System (TPS), and were recently reintroduced and popularized by James Womack's group in the United States under the umbrella of lean manufacturing.

Lean concepts are applicable beyond the shop floor. Companies have realized great benefit by implementing lean techniques in the office functions of manufacturing firms, as well as in purely service firms such as banks, hospitals, and restaurants. Lean manufacturing in this context is known as *lean enterprise*.

WHY THE EMPHASIS ON LEAN NOW?

Lean is especially important today as a winning strategy. Some key reasons are:

1. To compete effectively in today's global economy
2. Customer pressure for price reductions
3. Fast-paced technological changes
4. Continued focus by the marketplace on quality, cost, and on-time delivery
5. Quality standards such as TS 16949:2002 and ISO 9001:2000

6. Original equipment manufacturers (OEM) holding on to their core competencies and outsourcing the rest
7. Higher and higher expectations from customers
8. The need for standardized processes so as to consistently get expected results

To compete successfully in today's economy we need to be at least as good as any of our global competitors, if not better. This goes not only for quality, but also for costs and cycle times (lead time, processing time, delivery time, setup time, response time, and so on). Lean emphasizes teamwork, continuous training and learning, production to demand (pull), mass customization and batch-size reduction, cellular flow, quick changeover, total productive maintenance, and so on. Not surprisingly, lean implementation utilizes continuous improvement approaches that are both incremental and breakthrough.

THE WASTES OF LEAN

Waste of resources has direct impact on our costs, quality, and delivery. See Sidebar 1.1. Conversely, the elimination of wastes results in higher customer satisfaction, profitability, throughput, and efficiency. Excess inventory, unnecessary movement, untapped human potential, unplanned downtime, and suboptimal changeover time are all symptoms of waste.

Ohno of Toyota compiled what he called the "seven deadly wastes." In the United States, it is felt that a very important waste was omitted from this original list: the waste of not fully utilizing the precious asset of people. So in this book, the authors consider there to be eight wastes (*muda* in Japanese) associated with lean. They are:

1. *Overproduction*. Making more, earlier, or faster than is required by the next process.
2. *Inventory.* Excess materials or more information than is needed.
3. *Defective product or service.* Product requiring inspection, sorting, scrapping, downgrading, replacement, or repair. This also affects information, if it is not accurate and complete.
4. *Overprocessing.* Extra effort that adds no value to the product (or service) from the customer's point of view.
5. *Waiting.* Idle time for staff, materials, machinery, measurement, and information.

Sidebar 1.1

Waste

Eliminate waste by identifying and purging all non-value-added activities.

- Waste is any activity that does not add value to the final product or service for the customer.
- Value-adding activity is an activity that transforms or shapes raw material or information to meet customer requirements. It is generally accepted as approximately five percent of total work/time.
- Non-value-adding activity is an activity that takes time, resources, or space, but does not add to the value of the product or service itself. It is approximately 70 percent of total work/time.
- Non-value-adding but necessary activities, for example, accounting and meeting governmental regulations, take approximately 25 percent of work/time.

6. *People*. The waste of not fully using people's abilities (mental, creative, skills, experience, and so on).
7. *Motion*. Any movement of people (or tooling/equipment) that does not add value to the product or service.
8. *Transportation*. Transporting information, parts, or materials around the facility.

Eliminating these eight wastes is the major objective of lean implementation. The continuous reduction and/or elimination of them results in surprisingly high reductions in costs and cycle times. If we do a root cause analysis of each of the eight wastes, we can come up with the appropriate lean tool to tackle the causes identified. See Figure 1.1. The various lean tools and techniques, called lean building blocks, are described later in this chapter. If, for instance, long lead times and missed delivery dates are major bottlenecks, identifying the underlying reasons might lead to a focus on setup times, machine downtime, absenteeism, missed supplier shipments, quality problems, and overproduction resulting in excess inventory. The lean improvement could be implemented as a kaizen event.

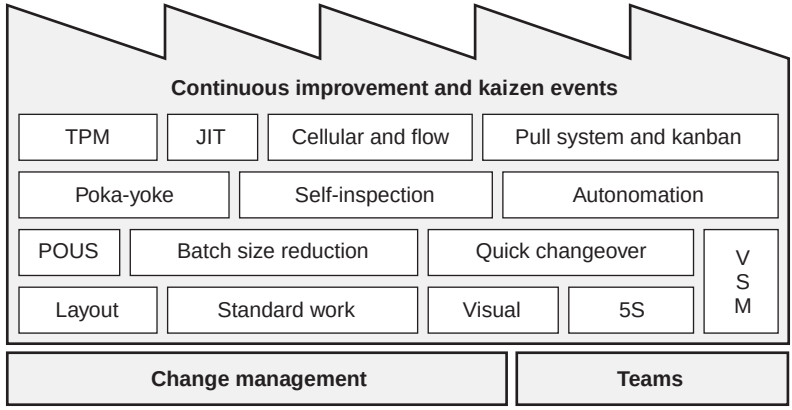

Figure 1.1 Building blocks of lean.

Let's look at one example in detail: the primary reason for overproduction and carrying excess inventory might be due to long process changeover times, in which case the correct tool (or lean building block) to use will most likely be single minute exchange of dies (SMED) or quick changeover techniques. This SMED project will be done as a kaizen.

Changeover time is defined as the time between the last good piece off the current run and the first good piece off the next run. The traditional changeover assumption is that long runs are necessary to offset the cost of lengthy changeovers. This is not valid if the changeover time can be reduced as far as possible (less than 10 minutes if the SMED technique is applicable) and standardized at that level so that we are confident that a good piece from the next run can be made in a certain time period. The changeover improvement process typically includes the following steps:

- Identify and form the changeover improvement team (operators, manufacturing/quality engineers, setup specialists, material handlers, tool/jig/fixture makers, maintenance technicians, supervisors/team leaders, and so on).
- Document the current changeover (videotape where possible).
- Through brainstorming, analyze the changeover and identify ways to reduce, eliminate, consolidate, or mistake-proof steps and convert from internal to external time/tasks. *Internal time* is when the machine is stopped, whereas *external time* is when the machine is producing the previous part.
- Implement improvements and monitor results.

Table 1.1 Variation and waste.

• Poor layout	• Not following procedures
• Long setup time	• Instructions/information not clear
• Poor workplace organization	• Poor planning
• Poor equipment maintenance	• Supplier quality problems
• Inadequate training	• Inaccurate gauges
• Use of improper methods	• Poor work environment (for example, light, heat, humidity, cleanliness, clutter, and so on)
• Statistically incapable processes	

- Streamline all aspects of setup operations.
- Standardize the improved changeover.

Besides attacking overproduction/inventory wastes, quick changeover can result in the reduction of lead time, defective product, and space requirements while improving productivity, flexibility, and producing smaller batches with more variety (mass customization).

Many of the wastes could be associated with variations in processes; statistical tools, including the Six Sigma DMAIC methodology, might be appropriate to attack such wastes. Lean and Six Sigma are not mutually exclusive—rather they are complementary. Some firms use the appropriate combination of lean, Six Sigma, theory of constraints, and elements of TQM in their constant drive for continuous improvement and competitive advantage.

Table 1.1 presents sources of waste due to variation and nonstandardization. Each of the items, if currently present in a process, can be analyzed and improved using lean tools in a kaizen mode.

THE BUILDING BLOCKS OF LEAN

The tools and techniques used to introduce, sustain, and improve the lean system are sometimes referred to as the lean building blocks. Many of these building blocks are interconnected and can be implemented in tandem. For example, 5S (workplace organization and standardization), visual controls, point-of-use storage (POUS), standard work, streamlined layout, working in teams, and autonomous maintenance (part of total productive maintenance) can all be constituents of introducing a planned implementation effort. The building blocks include:

- *5S.* A system for workplace organization and standardization. The five steps that go into this technique all start with the letter *S* in Japanese (*seiri*, *seiton*, *seison*, *seiketsu*, and *shitsuke*). These five terms are loosely translated as sort, set in order, shine, standardize, and sustain.
- *Visual controls.* The placement in plain view of all needed information, tooling, parts, production activities, and indicators so everyone involved can understand the status of the system at a glance.
- *Streamlined layout.* A layout designed according to optimum operational sequence.
- *Standard work.* Consistent performance of a task, according to prescribed methods, without waste and focused on human movement (ergonomics).
- *Batch-size reduction.* The best batch size is one-piece flow, or make one and move one! If one-piece flow is not appropriate, reduce the batch to the smallest size possible.
- *Teams.* In the lean environment, the emphasis is on working in teams, whether it be process improvement teams or daily work teams.
- *Quality at the source.* This is inspection and process control by employees so they are certain that the product or information that is passed on to the next process is of acceptable quality.
- *Point-of-use storage.* Raw materials, parts, information, tooling, work standards, supplies, procedures, and so on, are stored where needed.
- *Quick changeover.* The ability to change tooling and fixtures rapidly (usually in minutes) so multiple products in smaller batches can be run on the same equipment.
- *Pull/kanban.* A system of cascading production and delivery instructions from downstream to upstream activities in which the upstream supplier does not produce until the downstream customer signals a need (using a kanban system).
- *Cellular/flow.* Physically linking and arranging manual and machine process steps into the most efficient combination to maximize value-added content while minimizing waste. The aim is single-piece flow.

- *Total productive maintenance (TPM)*. A lean equipment maintenance strategy for maximizing overall equipment effectiveness.

Besides these building blocks, there are other concepts or techniques that are equally important in lean: value stream mapping (VSM), just-in-time (JIT) methods, error-proofing (poka-yoke), autonomation (jidoka), change management, root cause analysis and problem solving, and policy deployment (hoshin planning).

Since lean is a never-ending journey, there is always room for continuously improving.

HOW TO START THE LEAN JOURNEY

Lean will not work if it is viewed as merely a project, as single-point solutions, or as a vehicle for downsizing. It works best if deployed as a never-ending philosophy of improvement. Many firms have appointed and empowered lean champions for successfully implementing their lean transformations; these champions help others as mentors, trainers, group facilitators and communicators, and act as the drivers of continuous improvements, planners, evaluators, and cheerleaders celebrating each success. They also help in permanently capturing the gains by standardizing at the higher levels of performance as lean is implemented, so as not to slip back.

The starting point of lean initiatives could be any one or more of the following:

1. Value stream mapping. A value stream map (VSM) studies the set of specific actions required to bring a product family from raw material to finished goods per customer demand, concentrating on information management and physical transformation tasks. The outputs of a VSM are a current state map, a future state map, and an implementation plan to get from the current to the future state. Using a VSM, we can drastically reduce the lead time closer and closer to the actual value-added processing time by attacking the identified bottlenecks and constraints. The implementation plan (typically of short duration, such as 12 months) acts as the guide for doing so. Bottlenecks addressed could be long setup times, unreliable equipment, unacceptable first-pass yield, high work-in-process (WIP) inventories, and so on.
2. Lean baseline assessment. Uses interviews, informal flowcharting, process observations, and analysis of reliable data to generate an

as-is situational report from which would flow the lean improvement plan based on the identified gaps.

3. Provide training in lean to a critical mass of employees in teach–do cycles. Lean implementation should continue immediately after the training.
4. Implement the basic building blocks first, for example, 5S, visual controls, streamlined layout, POUS, and standard work. Then build on with the higher-level tools and techniques, finally achieving flow production based on customer pull.
5. Pilot project. Choose a bottleneck, constraint, or new product area to do breakthrough lean improvement (use the kaizen event approach). Then, with the lessons learned, migrate lean implementation to other areas.
6. Change management. Align the company's strategies and employees' goals, then change the culture from the traditional push production to lean pull. This should eventually result in a philosophical change in people's daily work life.
7. Analyze the internal overall equipment effectiveness (OEE) and the OEE losses. A Pareto chart of these losses will identify the biggest bang for the buck to indicate where to start the lean journey.

CORE CONCEPTS OF LEAN

Here are some important concepts that will be useful to keep in mind while preparing for the lean transformation:

- Creativity before capital. In lean, instead of spending large sums of money on capital expenditures, team brainstorming of ideas and solutions is emphasized. People working in the process are brought together to tap into their experiences, skills, and brainpower to generate the plan for reducing wastes and for process improvements.
- A not-so-perfect solution that is implemented today is better than a perfect solution that is late. Just do it *now*!
- Inventory is not an asset, but a cost/waste.
- Use the proven PDCA methodology for deploying improvements—both incremental and breakthrough.

- Once started, lean is a never-ending journey.
- Remember that, typically, 95 percent of lead time is not value-added. Collapsing the lead time closer to the actual processing time by squeezing out non-value-added time and tasks results in both cost and cycle-time reductions. Henry Ford knew this in 1926, when he said, "One of the most noteworthy accomplishments in keeping the price of Ford products low is the gradual shortening of the production cycle. The longer an article is in the process of manufacture and the more it is moved about, the greater is its ultimate cost."

LEAN ENTERPRISE

Enterprisewide lean implementation has slightly different challenges compared to deploying lean in manufacturing. On the shop floor there is a tangible product that is being transformed, so the utility of the tools and techniques described in this chapter for cost and cycle-time reduction in the processing of raw materials into usable finished goods is fairly evident. In the office functions in a manufacturing firm or in a strictly service firm, many of the same tools and techniques are applicable, be it in a slightly modified form. Instead of hardware one looks at value-adding processing and/or use of information (or software). For example, in a hospital lean can be applied to reduce wait times, improve human interactions with patients, have correct supply levels on hand, and better utilize resources. The concept of streamlining and purging of non-value-added steps in the order-to-cash cycle (or RFQ-to-cash cycle) has helped many companies. Bottlenecks are attacked using the PDCA model and the appropriate lean building blocks.

WHAT IS KAIZEN?

Kaizen, a combination of two Japanese words (*kai* + *zen*), literally means "change for the better." This is loosely translated as "continuous improvement" in English. The common use of the term in the United States means breakthrough improvement, implemented as a project or an event. Unlike incremental improvements, breakthrough improvements usually have a beginning and an end.

A few years ago, the term kaizen blitz (meaning substantial improvements in a flash, and service marked by the Association for Manufacturing Excellence) was popular. In Japanese, the term *kaikaku* is more commonly used for what we understand as a kaizen blitz or event. Nowadays people refer to such lean breakthrough improvements more and more as kaizen events or just as kaizens. Kaizens pave our lean journey.

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