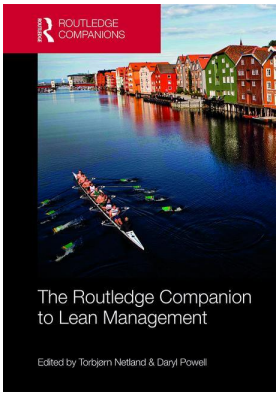

The Routledge Companion to Lean Management

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Lean Production

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PART I

The Lean Enterprise

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3
LEAN PRODUCTION

Pauline Found and John Bicheno

Introduction

At the time of writing, it is more than one quarter-century since the term "*lean production*" was first introduced to the management lexicon by John Krafcik, a researcher from the Massachusetts Institute of Technology (MIT), who was working on the International Motor Vehicle Program (IMVP) (Krafcik, 1988). Womack, Jones, and Roos later popularized lean in the bestselling book *The Machine that Changed the World*. However, it was Richard Schonberger and Robert Hall who wrote the two books, in 1982 and 1983 respectively, that effectively launched (or relaunched) the concept that became known as lean production in the West. Schonberger (2007) noted that while *The Machine that Changed the World* is commonly perceived to mark the beginning of the lean movement, in reality lean manufacturing was actually already well established in the US in the early 1980s, albeit under different names.

In *The Machine*, the authors contend that the findings of the IMVP large-scale study revealed that there was a dramatic performance gap between Japanese and Western car producers and asserted that lean production should be universally adopted: "Our conclusion is simple: Lean production is a superior way for humans to make things . . . It follows that the whole world should adopt lean production, and as quickly as possible" (Womack et al., 1990, p. 225). The impact of *The Machine* has been far-reaching and the book led to the commissioning of two follow-up studies that provided further support for the existence of a substantial performance gap (Anderson, 1992; Oliver et al., 1994). These studies were publicized extensively to the manufacturing community at the time.

In the period since the introduction of lean, huge changes have taken place, yet it is also true that, for the majority of operations organizations, the lean potential has hardly been tapped. This chapter looks at the evolution and spread of lean and opens the discussion on lean as the dominant operations paradigm of the 21st century.

Evolution of Lean Production

Lean emerged in the West as a result of great interest in Japanese production and management methods stimulated by the second oil crisis when automotive production in the US fell by almost 22 percent as consumers turned to the more fuel-efficient small Japanese cars. The golden days of mass manufacturing in the US were over in 1976 as Chrysler declared bankruptcy and both GM

and Ford were losing money. The interest in Japanese manufacturing techniques and, in particular, Toyota's production system, led to the publication of two English language articles in 1977, one by Sugimori et al. in the *Journal of Production Research* and the other by Ashburn in the *American Machinist* (cited in Schonberger, 2007) which raised concerns in US and European automotive companies, but it was an NBC-TV broadcast by producer Claire Crawford-Mason in 1980 entitled "If Japan Can, Why Can't We?" that prompted a quality revolution, which led to the five-year, five million dollar IMVP research program.

The ideas behind what is now termed "lean" originate from several sources, including great industrialists like Henry Ford in the US, Frank Woollard in the UK who developed the concepts behind flow manufacturing and moving assembly lines and management thinkers such as W. Edwards Deming and Peter Drucker who criticized mass manufacturing and won support in Japan to think differently. In Japan, one of the main sources is considered to be Sakichi Toyoda in the Toyoda loom factory, who originally developed the philosophy and methods associated with lean production at the turn of the 20th century; these influenced his son Kiichiro Toyoda to develop what is known as the just-in-time (JIT) method at the Toyota Motor Company in the late 1930s which became one of the pillars of the company.

The Second World War reconstruction of Japanese manufacturing and the lack of available capital resources and severe economic slump saw these ideas extended and combined with a discipline of daily improvements (*kaizen*) at Toyota that was supported by Eiji Toyoda, the new chairman, and enforced by chief engineer Taiichi Ohno, who had transferred from Toyoda Loom Works to Toyota Motor Company in 1943. The new approach, created by Taiichi Ohno, became known as the Toyota Production System (TPS). The philosophy and methods of TPS evolved over time, extending to Toyota's supply base in the 1970s, its distribution and sales operations in the 1980s, and became a competitive weapon as Toyota competed openly with US and European automakers. Toyota's business success and world-leading product quality is an established fact. Rother (2010) recently summarized Toyota's success into four key statistics: Toyota has shown sales growth for over 40 years (at the same time other car makers' sales have reached a plateau or declined); Toyota's profit exceeds that of other car makers; Toyota's market capitalization has for many years exceeded that of other car makers; and in sales rank Toyota has become the world leading car maker. This success is often attributed to the production system Toyota developed during 1950s and 1960s as a result of intense post-war competition.

TPS is characterized by a systematic approach to the organization of production that emphasizes the elimination of all forms of waste (Ohno, 1988). However, over time TPS has been discovered to be a complex, multifaceted element of Toyota's broader management system and culture, something that has been reflected in the prolific lean literature. In his book *The Evolution of a Manufacturing System at Toyota*, Takahiro Fujimoto (1999) describes how Toyota developed three layers of manufacturing capabilities: a routinized manufacturing layer, a routinized learning layer, and a non-routine and dynamic evolutionary learning capability which gives Toyota the capacity and strength to adapt and change over time. Spear and Bowen (1999, p. 99) attempted to codify TPS and describe four key rules that describe the tacit knowledge and guide the design, operation, and improvement of every activity, connection, and pathway of products and services and it is these rules that are the essence, or DNA, of TPS. These rules are as follows:

1 All work shall be specified as to content, sequence, timing and outcome.
2 Every customer–supplier connection must be direct.
3 The pathway for every product or service must be simple and direct.
4 Any improvement must be made in accordance with the scientific method, under the guidance of a teacher, at the lowest level in the organization.

In spite of a plethora of academic and practitioner books and articles on lean, however, there is still not a precise and agreed-upon definition (Shah and Ward, 2007). Referring to the old fable of the blind men touching an elephant and imagining very different animals, Shah and Ward suggest that over time commentators on lean have focused on single, visible aspects of the process while missing the invisible highly inter-dependent links of lean systems as a whole. As well as being a poorly defined construct, interpretations of lean have continued to evolve over time. Originally presented by Womack et al. (1990) as a counter intuitive alternative to traditional manufacturing, it is now presented, by some at least, as a new paradigm for operations management (Bartezzaghi, 1999; Holweg, 2007). In addition, lean has expanded beyond its original applications on the shop floor of vehicle manufacturers to other functional areas within organizations, to other manufacturers and to non-manufacturing organizations. Consequently, lean means different things to different people (see Table 3.1).

Lean is described as a philosophy (Bhasin and Burcher, 2006), a management system (Hines et al., 2004), and an operating system of production planning and control (Standard and Davis, 1999).

Lean Production as a Philosophy, Management and Operating system

Lean as an Operating System for Production Planning and Control

A shop floor-based view of lean still emerges as the prominent means of implementation. The essence of this view is smoothing and improving operational processes through the application of lean tools. Often, these are not even a set of tools but completely independently introduced by companies trying to emulate the TPS. For example, managers employ a variety of mapping tools

Table 3.1 Lean viewed as a philosophy, a management system, and an operating system for lean production planning and control

Lean philosophy
Systems thinking
Value for the customer
Waste elimination
Lead time reduction
Humility and respect for humans
Continuous improvement
Lean management
Hoshin kanri (policy deployment)
Value stream (cross functional and "gemba" management)
Visual management and visual controls
Kata
Leader standard work
TWI (Training Within Industry)
Lean operations
Value stream management
5S
Standard work
TPM (total productive management)/SMED (single-minute exchange of dies)
Pull systems/Kanban
Demand and capacity management

Source: Adapted from Slack et al. (2004).

to identify the value-added and non-value-added activities of each process. From this they can reduce the operating costs by eliminating non-value-added activities, waste, and reorganizing value-added activities. In these cases, the primary goal of the shop floor tool-based method is to efficiently improve the organization's performance at an operational level, by enhancing quality and reducing waste, inventories, and lead times (Manos and Vincent, 2012).

Womack and Jones began their book *Lean Thinking* with the words "Muda. It's the one Japanese word you really must know" (Womack and Jones, 2003, p. 15). Today there is widespread awareness of waste. Fujio Cho, former President of Toyota, defined waste as "anything other than the minimum amount of equipment, materials, parts, space and worker's time, which are absolutely essential to add value to the product" (Suzaki, 1987, p. 8). The concept of *muda* primarily originated from Taiichi Ohno's production philosophy in the early 1950s (Dahlgaard-Park, 2000) although Toyota also talks about three Ms—*muda* (waste), *muri* (overburden), and *mura* (unevenness). Knowing about all three gives a more complete understanding of lean; the three are interlinked and lean is about mobilizing people to reduce all three. While total quality management (TQM) was not mentioned in *The Machine that Changed the World*, possibly because TQM was not a well-known management philosophy in the West at that time (Dahlgaard and Dahlgaard-Park, 2006), the mention of muda in lean thinking is very significant as it links the two management philosophies and confirms that the aim of lean production is to eliminate waste.

Lean is often described as a pull system, compared with a materials requirements planning (MRP), or push, system. Toyota implemented a JIT pull system in post-World War II Japan as the capital resources to support the high levels of inventory that were often the consequence of push and MRP systems were not available. The concept behind JIT is described by Monden (1983, p. 2). JIT means "to produce the necessary units at the necessary quantities at the necessary time" and core to implementing a JIT and pull system is managing demand and capacity to reduce the lead time between customer order and cash received. Therefore, pull systems are based on responding to actual customer demand, not in response to orders *pushed* on to the shop floor from schedules based on forecasts. Pull is based on a sell-one (or use-one), make-one concept of small batches. To run a successful pull system, demand needs to be leveled as much as possible to eliminate spikes and to allow the products to flow without disruption and diversion, thus reducing the need for excess inventory. This is managed by understanding the "load" and the "capacity" of the system. Load is the amount of work imposed on the system and capacity is the resources available to do the work. Ohno used a simple formula to show that present effective capacity is the sum of work and waste:

Present capacity = work + waste.

While this is a simple way to demonstrate that you can get more work out of the current system by reducing the waste, this can be misunderstood and may suggest that you can increase capacity if you increase waste. There are actually three factors that influence queues or lead time. These are arrival variation, process variation, and utilization, as in the equations: *Utilization = load/capacity* and *load = real demand + mistake demand* (mistake demand could be rework, work done due to errors, failure demand). Therefore, *present capacity = base capacity – waste*. Hence, there are four things that should be tackled: arrival variation, process variation, mistake demand, and waste.

The key to realizing JIT is not relying on a central planning approach to production control which "pushes" a product through production by simultaneously scheduling the individual processes but, rather, that work (or value) should flow through the system at the pace of the demand without deviation, detour, or delay. Where flow is not possible, pull systems might use a *kanban*

system as the way to manage JIT production. Kanban is a signal from a process to the preceding process to indicate that product has been consumed and that it is necessary to produce more to replenish the quantity withdrawn. The signal can be in the form of a card system, a square or, indeed, any suitable signaling system that is visual and recognizable by the operators (Harmon and Peterson, 1990). Kanban is not the only control system used in a lean environment. *Drum buffer rope* (DBR) and *constant work-in-process* (CONWIP) are often the most effective pull-oriented hybrid production control systems in other situations, such as process plants (Hopp and Spearman, 2000).

To be implemented successfully, JIT/pull systems need to be aligned to strategy, supported by senior management and operated by skilled people. Pull may not be the best strategy for all products; some products that are made infrequently may be better "made to stock" and replenished when needed. There are several lean tools that support small batches and pull systems, such as *single-minute exchange of dies* (SMED) to reduce changeover times, *total productive management* (TPM) to increase availability and 5S to organize the workplace. JIT is supported by *jidoka*, or autonomation, which may be interpreted as "automation with a human touch" that prevents defects from disrupting the flow from process to process. JIT and jidoka are the two pillars of the Toyota Production System (TPS) and, consequentially, in lean production systems (Bicheno and Holweg, 2008).

While, for many, lean production starts with "tools," Toyota did not start with this way. It started with the unremitting focus on how to use its resources to produce a product that is defined to be as close as possible to what the customer wants to buy and how to align the flow of production as close as possible to the flow of cash. The five lean principles (Figure 3.1) presented in the book *Lean Thinking*, by Womack and Jones (1996), represent a "roadmap" for those organizations attempting to implement lean or emulate TPS.

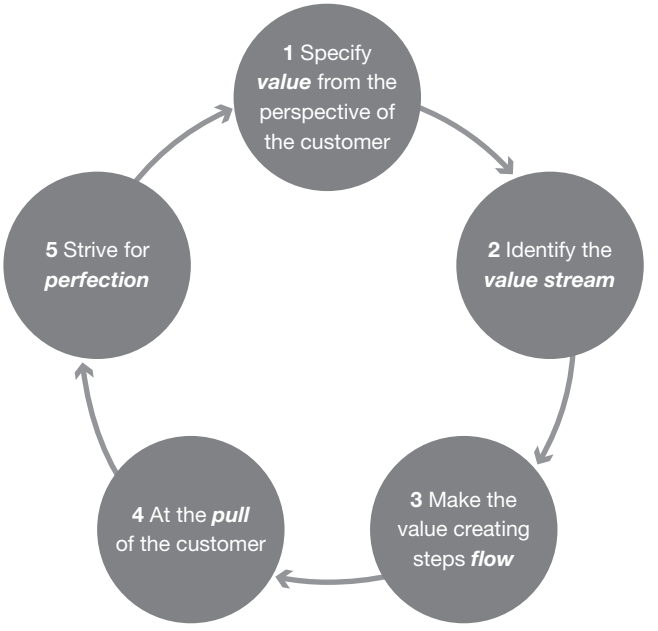

Figure 3.1 The five lean principles

Source: Based on Womack and Jones (1996).

The empirical data in *Lean Thinking* is based on case studies of companies that have successfully adopted the lean imperative to become lean organizations. The five lean principles defined introduced a structure, or framework, to better describe the approach at Toyota and the focus moved from the "tools" approach towards the principles of self-help, and respect and responsibility towards staff, customers, and society. At this point some lean commentators began to realize that "real" lean (Emiliani, 2007) is behavior-driven and linked to a mindset of creating thinking people who can solve real production problems and the focus shifted in the literature from tools to problem solving (Spear and Bowen, 1999; Hines et al., 2004, 2011; Liker, 2004; Spear, 2009) and becoming a learning organization (Senge, 1990).

Lean as a Management System for Process Improvement

The Japanese word *kaizen* quite literally means change, or changing (kai), for the better, or good (zen), and the term entered popular Western management terminology in the 1980s (Imai, 1986) to refer to problem solving and continuous improvement. Continuous improvement is the essence of the fifth lean principle: Strive for Perfection. This principle recognizes that lean is not a single project that has an endpoint, but rather a journey of daily improvements as identified by Eiji Toyoda and Taiichi Ohno in TPS. Problem solving, experimentation, and continuous improvement are part of the culture of the whole organization and built in to the day-to-day management system. Deming's improvement cycle, *plan, do, check* (or *study*), *act* (PDCA or PDSA) is often used by organizations as a vehicle by which to maintain and sustain improvement activities.

Not all of the quality influences on Toyota came from the West; one of the most influential Japanese authors on quality and problem solving is undoubtedly Kaoru Ishikawa who gave his name to the "*Ishikawa diagram*," more popularly known as the "fishbone" cause-and-effect diagram. The diagram is so-called because it resembles the skeleton of a fish when it is drawn. The method is used to determine problems within a workplace and then to identify the root cause of the problem before assigning it to a theme, or category. The head of the fish is the visual problem (symptom) and the skeleton forms the possible underlying causes, sorted into themes that resemble the spines of the fish skeleton. Along each spine the issues (causes) are highlighted. The original main themes used in such kaizen and problem solving were the methods used, the machinery used, the materials used, the measurements used, the management of the process (often known as manpower), and the working environment or mother nature (six themes that can all begin with the letter M), but these can be adapted to be specific to a particular setting and are used in many organizations as part of their kaizen and problem-solving events (Bicheno, 2006).

Kaizen is well established as an improvement methodology in manufacturing and is increasingly being used in the service sector. Three types of kaizen improvements are often employed within organizations to tackle different levels of problems (Figure 3.2):

1 Daily problem solving, which focuses continuously on small problems that can be tackled immediately, or over a few days.
2 Kaizen events (blitz) actions which usually last for one week and focus on medium-sized problems such as reducing changeover times. Kaizen events are not typically used in Japan. They are actually a US innovation, suited to using outside experts and consultants (cited in Stoller, 2015).
3 System kaizen for the few strategic, large problems that are longer in duration, possibly up to three to four months. The scope of the problem would be a process redesign at a departmental level.

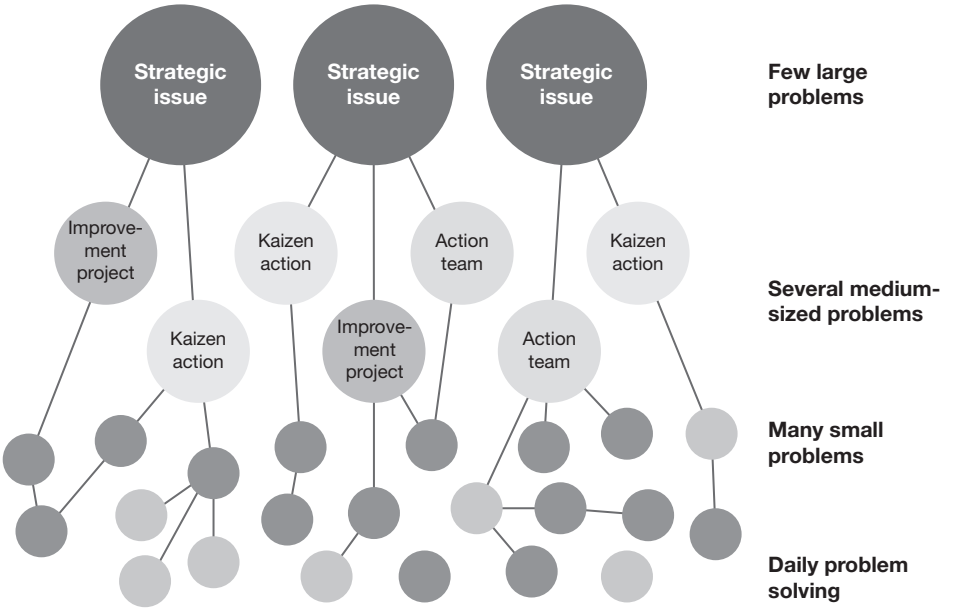

Figure 3.2 Cascade of problems and solutions

Source: Adapted from Dennis (2006).

Kaizen teams utilize a full range of problem-solving tools, such as fishbone diagrams, to determine the root cause of the problem. A very effective tool used in kaizen is the "5 Whys" technique to ask "why does this happen?" repeatedly until the root cause appears. Typically, a kaizen event includes a *value stream mapping activity* to describe the current state and identify problems or improvement opportunities. Central to kaizen is *genchi genbutsu* (go and see for yourself), and the concept of personal involvement. George Koenigsaecker, former CEO of the Danaher Corporation, who has led several successful lean transformations, expected executives from all the companies he managed to participate personally in at least ten kaizen events. His philosophy was that only by participating personally could an executive really know and understand the business and its internal and external issues (Koenigsaecker, 2009).

In recent years, *kata* has often replaced kaizen. Kata is described by Rother (2010) as a structured routine of continual improvements that are practiced every day under the guidance of skilled coaches to build new habits and ways of thinking. By practicing improvement kata daily obstacles are removed to enable an organization to move from its current condition toward a new target condition that is aligned to a long-term vision.

As a management system, lean focuses on supporting the lean principles and aligning the goals of the organization to the operational business improvement plans through a structured deployment of the strategic policies, known in the West as *policy* (or *strategy*) *deployment*. In Japan the term is *hoshin kanri*, meaning "shining needle," and refers to directional management. The methodology of hoshin kanri is to align visibly the key performance indicators (KPIs) of the business goals through a cascading system, where the top-level strategy is a function of all of the sub-strategies of the business hierarchy. Hoshin kanri is a strategic management system that shares the commercial vision and goals for the business with everyone providing clarity of purpose and communicating business priorities to all employees so that they can contribute to, and understand their role in, organizational improvement.

Lean management is also built on *visual management*, where performance is transparent so managers and team leaders can see easily how the business is performing and the improvement targets. Critical to this are standard work operations, visual controls, and mistake-proof devices (known as *poka yoke*). Performance boards are located in the workplace, or *gemba*, and managers are encouraged to spend time at the workplace practicing *genchi genbutsu,* going to the source to get the facts and then making informed decisions based on consensus of the solutions.

Leaders are encouraged to practice *leader standard work* (LSW) by creating standard routines for most leadership tasks, such as morning meetings, audit checks, and problem escalation procedures to reduce problems and ensure permanent fixes are introduced by those closest to the process.

Initially, lean production was seen to be incompatible with enterprise resource planning (ERP) and there were major debates in the literature about whether lean and MRP conflicted or complemented each other. However, new insights have shown that they can co-exist and most ERP vendors have now developed lean programs within their ERP systems that complement the shop floor and visual management systems (Powell, 2013).

Lean as a Philosophy

TPS was founded on two pillars, just-in-time, making only what is needed, when it is needed, and in the amount needed, and *jidoka*, automation with a human touch. Jidoka is putting people in charge of the process to identify problems and to stop the line if defective parts are detected. Combining the concept that quality must be built into products and operations systems with respecting people's judgment in recognizing poor quality/variation is key to improving productivity. To support this, a collaborative approach to team-based problem solving is required within a leadership culture that promotes transparency and open reporting of problems. A blame culture prohibits kaizen, and the use of specialists only to solve problems distances operator teams from suggesting and owning improvement solutions. The lean philosophy involves everyone: it is neither a top-down nor bottom-up approach but all-inclusive. Leaders at all levels are encouraged to coach and mentor less experienced people daily to transfer knowledge throughout the organization. The daily opportunity to learn, experiment, and improve engrains these activities in the organizational culture—one that accepts change rather than resists it.

A good example of a lean enterprise that views lean as a philosophy is GKN, a major British multinational corporation with operations in more than 30 countries and over 140 manufacturing businesses, which employs more than 50,000 people around the world. Founded in 1759, in South Wales, UK, GKN was one of the first companies of the modern industrial age. After more than 250 years, this global British engineering company operates in four divisions: GKN Aerospace, GKN Driveline, GKN Powder Metallurgy, and GKN Land Systems—and is a major first tier supplier to the automotive and aerospace industries with established solid foundations and policies in both lean and environmental fields.

Lean was introduced in 2004 in the GKN automotive sector to improve competiveness in that market and one of the early significant milestones was the support by senior leadership for the Site Continuous Improvement Leader (SCIL) training program. This series of training workshops takes promising manufacturing leaders and trains them to expert level over a period of a year. These leaders return to their home site and become the local lean change agents for their factory, focusing on the deployment of lean to manufacturing processes. This structure has become the backbone of lean deployment at GKN where all sites are required to develop an annual continuous improvement plan, aligned to their business objectives, which engages every employee in driving value through the business. In addition to the SCIL program, GKN also introduced a Mastering Continuous Improvement Leadership (MCIL) program that saw 350 leaders graduating in 2011.

Employee involvement is at the heart of GKN's lean enterprise model. Employees are able to submit improvement ideas and implement many of these ideas in the workplace. Leaders are encouraged to coach their teams at every opportunity, allowing team members to grow and thrive. Together these form a culture in which improvement is encouraged.

Although there are different views of lean production, these could also reflect the position of the organization on the lean implementation journey. Most organizations will start with an operations focus by implementing tools; this would progress to a management system and, ultimately, to an organizational culture where the philosophy of lean is embedded, if the organization completes the journey. Netland and Ferdows (2014) describe the pattern of performance improvement in Volvo and other major organizations and explain how the journey goes through four stages that represent an "S" curve in performance improvement, where the rapid gains appear to occur in Stage II. In this "S" curve stages I and II might reflect an operations approach to performance improvement, whereas Stage III is more reflective of a management system. For an organization to transition to the final stage and become a "cutting edge" plant, managers have to manage their own, and the organization's, expectations to ensure that the organization does not become complacent and slip back due to tool and change fatigue. Therefore, in "cutting edge" plants managers need to think strategically to leverage the gains and embed the changes into the culture and philosophy of the organization.

The Future of Lean Production

While lean production started as a description of TPS, the evidence in the literature demonstrates that it has evolved over time well beyond the traditional Japanese automotive manufacturing roots to an enterprise system focused on best practice and process improvement methodologies that has been adopted, and adapted, by public and private sector organizations around the world. In a study on the diffusion of lean, Samuel (2011) found that the period 1987–1995 was dominated by automobile and automotive supply chain publications. From 1995, publications on aerospace and electronic industries emerged, followed by retail, construction, financial services, and health. Since 2000, the body of lean literature in all sectors has increased substantially and spread from private sector manufacturing and service organizations to the public sector and public services in almost all departments. In addition, more recent publications on innovation, new product/service development, leadership, culture, and IT have taken lean beyond the traditional fields of operations and process improvement into more enterprise-wide areas as well as into start-ups and small to medium-sized (SME) businesses. Lean has extended into areas such as "lean and green" and combined with concepts such as *systems thinking* to push the boundaries of lean to solve 21st-century environmental concerns and compete on innovation.

So, 25 years on, lean has touched many aspects of our everyday lives beyond how companies structure, operate, and organize themselves. It is clear that lean has come a long way from its shop floor origins in the very best car-making companies. It continues to evolve today and to infiltrate our strategic and operational management thinking into the 21st century, yet so much potential remains untapped.

References

Anderson (1992). *The Lean Enterprise Report*, London, Anderson Consulting.

Bartezzaghi, E. (1999). The evolution of production models: Is a new paradigm emerging? *International Journal of Operations and Production Management*, *19*(2), 229–250.

Bhasin, S. and Burcher, P. (2006). Lean viewed as a philosophy. *Journal of Manufacturing Technology Management*, *17*(1), 56–72.

Bicheno, J. (2006). *Fishbone Flow: Integrating Lean, Six Sigma, TPM and TRIZ*, Johannesburg, South Africa, PICSIE Books.

Bicheno, J. and Holweg, M. (2008). *The Lean Toolbox: The Essential Guide to Lean Transformation*, Johannesburg, South Africa, PICSIE Books.

Dahlgaard, J. J. and Dahlgaard-Park, S-M. (2006). Lean production, six sigma quality, TQM and company culture. *The TQM Magazine*, *18*(3), 263–281.

Dahlgaard-Park, S-M. (2000). From Ancient Asian Philosophies to TQM and Modern Management Theories. Licentiate Thesis, Linköping University, Linköping.

Dennis, P. (2006). *Getting the Right Things Done: A Leader's Guide to Planning and Execution*, Cambridge, MA, Lean Enterprise Institute.

Emiliani, B. (2007). *Real Lean*, Kensington, CT, Center for Lean Business Management.

Fujimoto, T. (1999). *The Evolution of a Manufacturing System at Toyota*, Oxford, Oxford University Press.

Hall, R. W. (1983). *Zero Inventories*, Homewood, IL, Dow Jones-Irwin/APICS.

Harmon, R. L. and Peterson, L. D. (1990). *Reinventing the Factory: Productivity Breakthroughs in Manufacturing Today*, New York, Free Press.

Hines, P., Holweg, M., Piercy, N. and Rich, N. (2004). From production toolkit to strategic value creation—a review of the evolution of contemporary lean thinking. *International Journal of Operations and Production Management*, *24*(10), 994–1011.

Hines, P., Found, P., Griffiths, G. and Harrison, R. (2011). *Staying Lean: Thriving, Not Just Surviving*, Boca Raton, FL, CRC Press.

Holweg, M. (2007). The genealogy of lean production. *Journal of Operations Management*, *25*(2), 420–437.

Hopp, W. J. and Spearman, M. L. (2000). *Factory Physics*, 2nd edition, New York, McGraw-Hill/Irwin.

Imai, M. (1986). *The Key to Japan's Competitive Success*, New York, McGraw-Hill/Irwin.

Koenigsaecker, G. (2009). *Leading the Lean Enterprise Transformation*, Boca Raton, FL, CRC Press.

Krafcik, J. F. (1988). Triumph of the lean production system. *MIT Sloan Management Review*, *30*(1), 41–51.

Liker, J. K. (2004). *The Toyota Way: 14 Management Principles from the World's Greatest Automaker*, New York, McGraw-Hill.

Manos, A. and Vincent, C. (eds) (2012). *The Lean Certification Handbook: A Guide to the Bronze Certification Body of Knowledge*, Milwaukee, WI, ASQ Quality Press.

Monden, Y. (1983). *Toyota Production System: Practical Approach to Production Management*, Norcross, Engineering & Management Press.

Netland, T. and Ferdows, K. (2014). What to expect from corporate lean programs. *MIT Sloan Management Review*, *55*(4), 83–89.

Ohno, T. (1988). *Toyota Production System: Beyond Large-scale Production*, New York, Productivity Press.

Oliver, N., Jones, D. T., Lowe, J., Roberts, P. and Thayer, B. (1994). *Worldwide Manufacturing Competitiveness Study: The Second Lean Enterprise Report*, London, Anderson Consulting.

Powell, D. (2013). ERP systems in lean production: new insights from a review of lean and ERP literature. *International Journal of Operations and Production Management*, *33*(11/12), 1490–1510.

Rother, M. (2010). *Toyota Kata: Managing People for Continuous Improvement and Superior Results*, New York, McGraw-Hill.

Samuel, D. E. (2011). *Exploring UK Lean Diffusion in the Period 1988 to 2010*, Cardiff University.

Senge, P. M. (1990). *The Fifth Discipline: The Art & Practice of the Learning Organization*, New York, Doubleday/Currency.

Shah, R. and Ward, P. T. (2007). Defining and developing measures of lean production. *Journal of Operations Management*, *25*(4), 785–805.

Schonberger, R. (1982). *Japanese Manufacturing Techniques: Nine Hidden Lessons in Simplicity*, New York, Simon & Schuster.

Schonberger, R. J. (2007). Japanese production management: An evolution—with mixed success. *Journal of Operations Management*, *25*(2), 403–419.

Slack, N., Chambers, S. and Johnston, R. (2004). *Operations Management*, 4th edition, Harlow, UK, Financial Times/Prentice Hall.

Spear, S. (2009). *Chasing the Rabbit*, New York, McGraw-Hill.

Spear, S. and Bowen, H. K. (1999). Decoding the DNA of the Toyota Production System. *Harvard Business Review*, 77, 96–108.

Standard, C. and Davis, D. (1999). *Running Today's Factory: A Proven Strategy for Lean Manufacturing*, Dearborn, MI, Society for Manufacturing Engineers.

Stoller, J. (2015). *The Lean CEO: Leading the Way to World-Class Excellence*, New York, McGraw-Hill Professional.

Sugimori, Y., Kusunoki, K., Cho, F. and Uchikawa, S. (1977). Toyota Production System and Kanban system: Materialization of just-in-time and respect-for-human system. *International Journal of Production Research*, *15*(6), 553–564.

Suzaki, K. (1987). *New Manufacturing Challenge: Techniques for Continuous Improvement*, New York, Simon & Schuster.

Womack, J. P. and Jones, D. T. (1996). *Lean Thinking: Banish Waste and Create Wealth in your Corporation*, New York, Simon & Schuster.

Womack, J. P. and Jones, D. T. (2003). *Lean Thinking: Banish Waste and Create Wealth in your Corporation*, new edition, London, Simon & Schuster.

Womack, J. P., Jones, D. T. and Roos, D. (1990). *The Machine that Changed the World*, New York, Simon & Schuster.