Lean manufacturing

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Lean manufacturing or **lean production**, which is often known simply as "**Lean**", is a production practice that considers the expenditure of resources for any goal other than the creation of value for the end customer to be wasteful, and thus a target for elimination. Working from the perspective of the customer who consumes a product or service, "value" is defined as any action or process that a customer would be willing to pay for. Basically, lean is centered around creating **more value with less work**. Lean manufacturing is a generic process management philosophy derived mostly from the Toyota Production System (TPS) (hence the term Toyotism is also prevalent) and identified as "Lean" only in the 1990s.[1] It is renowned for its focus on reduction of the original Toyota *seven wastes* in order to improve overall customer value, but there are varying perspectives on how this is best achieved. The steady growth of Toyota, from a small company to the world's largest automaker,[2] has focused attention on how it has achieved this.

Lean manufacturing is a variation on the theme of efficiency based on optimizing flow; it is a present-day instance of the recurring theme in human history toward increasing efficiency, decreasing waste, and using empirical methods to decide what matters, rather than uncritically accepting pre-existing ideas. As such, it is a chapter in the larger narrative that also includes such ideas as the folk wisdom of thrift, time and motion study, Taylorism, the Efficiency Movement, and Fordism. Lean manufacturing is often seen as a more refined version of earlier efficiency efforts, building upon the work of earlier leaders such as Taylor or Ford, and learning from their mistakes.

[edit] Overview

Lean principles come from the Japanese manufacturing industry. The term was first coined by John Krafcik in a Fall 1988 article, "Triumph of the Lean Production System," published in the Sloan Management Review and based on his master's thesis at the MIT Sloan School of Management.[3] Krafcik had been a quality engineer in the Toyota-GM NUMMI joint venture in California before coming to MIT for MBA studies. Krafcik's research was continued by the International Motor Vehicle Program at MIT, which produced the international best-seller book co-authored by James Womack, Daniel Jones, and Daniel Roos called *1The Machine That Changed the World.*[1]

For many, Lean is the set of "tools" that assist in the identification and steady elimination of waste (*muda*). As waste is eliminated quality improves while production time and cost are reduced. Examples of such "tools" are Value Stream Mapping, Five S, Kanban (pull systems), and poka-yoke (error-proofing).

There is a second approach to Lean Manufacturing, which is promoted by Toyota, in which the focus is upon improving the "flow" or smoothness of work, thereby steadily

eliminating *mura* ("unevenness") through the system and not upon 'waste reduction' per se. Techniques to improve flow include production leveling, "pull" production (by means of *kanban*) and the *Heijunka box*. This is a fundamentally different approach to most improvement methodologies which may partially account for its lack of popularity.

The difference between these two approaches is not the goal itself, but rather the prime approach to achieving it. The implementation of smooth flow exposes quality problems that already existed, and thus waste reduction naturally happens as a consequence. The advantage claimed for this approach is that it naturally takes a system-wide perspective, whereas a waste focus sometimes wrongly assumes this perspective.

Both Lean and TPS can be seen as a loosely connected set of potentially competing principles whose goal is cost reduction by the elimination of waste.[4] These principles include: Pull processing, Perfect first-time quality, Waste minimization, Continuous improvement, Flexibility, Building and maintaining a long term relationship with suppliers, Autonomation, Load leveling and Production flow and Visual control. The disconnected nature of some of these principles perhaps springs from the fact that the TPS has grown pragmatically since 1948 as it responded to the problems it saw within its own production facilities. Thus what one sees today is the result of a 'need' driven learning to improve where each step has built on previous ideas and not something based upon a theoretical framework.

Toyota's view is that the main method of Lean is not the tools, but the reduction of three types of waste: *muda* ("non-value-adding work"), *muri* ("overburden"), and *mura* ("unevenness"), to expose problems systematically and to use the tools where the ideal cannot be achieved. From this perspective, the tools are workarounds adapted to different situations, which explains any apparent incoherence of the principles above.

Origins

Also known as the flexible mass production. The TPS has two pillar concepts: Just-in-time (JIT) or "flow", and "autonomation" (smart automation).[5] Adherents of the Toyota approach would say that the smooth flowing delivery of value achieves all the other improvements as side-effects. If production flows perfectly then there is no inventory; if customer valued features are the only ones produced, then product design is simplified and effort is only expended on features the customer values. The other of the two TPS pillars is the very human aspect of autonomation, whereby automation is achieved with a human touch.[6] The "human touch" here meaning to automate so that the machines/systems are designed to aid humans in focusing on what the humans do best. This aims, for example, to give the machines enough intelligence to recognize when they are working abnormally and flag this for human attention. Thus, in this case, humans would not have to monitor normal production and only have to focus on abnormal, or fault, conditions.

Lean implementation is therefore focused on getting the right things to the right place at the right time in the right quantity to achieve perfect work flow, while minimizing waste

and being flexible and able to change. These concepts of flexibility and change are principally required to allow production leveling, using tools like SMED, but have their analogues in other processes such as research and development (R&D). The flexibility and ability to change are within bounds and not open-ended, and therefore often not expensive capability requirements. More importantly, all of these concepts have to be understood, appreciated, and embraced by the actual employees who build the products and therefore own the processes that deliver the value. The cultural and managerial aspects of Lean are possibly more important than the actual tools or methodologies of production itself. There are many examples of Lean tool implementation without sustained benefit, and these are often blamed on weak understanding of Lean throughout the whole organization.

Lean aims to make the work simple enough to understand, do and manage. To achieve these three goals at once there is a belief held by some that Toyota's mentoring process (loosely called *Senpai* and *Kohai*), is one of the best ways to foster Lean Thinking up and down the organizational structure. This is the process undertaken by Toyota as it helps its suppliers improve their own production. The closest equivalent to Toyota's mentoring process is the concept of "Lean Sensei", which encourages companies, organizations, and teams to seek outside, third-party experts, who can provide unbiased advice and coaching, (see Womack et al., Lean Thinking, 1998).

There have been recent attempts to link Lean to Service Management, perhaps one of the most recent and spectacular of which was London Heathrow Airport's Terminal 5.[7] This particular case provides a graphic example of how care should be taken in translating successful practices from one context (production) to another (services), expecting the same results. In this case the public perception is more of a spectacular failure, than a spectacular success, resulting in potentially an unfair tainting of the lean manufacturing philosophies.[8]

A brief History of waste reduction thinking

The avoidance and then latteral removal of waste has a long history, and as such this history forms much of the basis of the philosophy now known as "Lean". In fact many of the concepts now seen as key to lean have been discovered and rediscovered over the years by others in their search to reduce waste.

Pre-20th century

The printer Benjamin Franklin contributed greatly to waste reduction thinking

Most of the basic goals of lean manufacturing are common sense, and documented examples can be seen as early as Benjamin Franklin. *Poor Richard's Almanac* says of wasted time, "He that idly loses 5s. worth of time, loses 5s., and might as prudently throw 5s. into the river." He added that avoiding unnecessary costs could be more profitable than increasing sales: "A penny saved is two pence clear. A pin a-day is a groat a-year. Save and have."

Again Franklin's *The Way to Wealth* says the following about carrying unnecessary inventory. "You call them goods; but, if you do not take care, they will prove evils to some of you. You expect they will be sold cheap, and, perhaps, they may [be bought] for less than they cost; but, if you have no occasion for them, they must be dear to you. Remember what Poor Richard says, 'Buy what thou hast no need of, and ere long thou shalt sell thy necessaries.' In another place he says, 'Many have been ruined by buying good penny worths'." Henry Ford cited Franklin as a major influence on his own business practices, which included Just-in-time manufacturing.

The concept of waste being built into jobs and then taken for granted was noticed by motion efficiency expert Frank Gilbreth, who saw that masons bent over to pick up bricks from the ground. The bricklayer was therefore lowering and raising his entire upper body to pick up a 2.3 kg (5 lb.) brick, and this inefficiency had been built into the job through long practice. Introduction of a non-stooping scaffold, which delivered the bricks at waist level, allowed masons to work about three times as quickly, and with less effort.

20th century

Frederick Winslow Taylor, the father of scientific management, introduced what are now called standardization and best practice deployment. In his *Principles of Scientific Management*, (1911), Taylor said: "And whenever a workman proposes an improvement, it should be the policy of the management to make a careful analysis of the new method, and if necessary conduct a series of experiments to determine accurately the relative merit of the new suggestion and of the old standard. And whenever the new method is found to be markedly superior to the old, it should be adopted as the standard for the whole establishment."

Taylor also warned explicitly against cutting piece rates (or, by implication, cutting wages or discharging workers) when efficiency improvements reduce the need for raw labor: "…after a workman has had the price per piece of the work he is doing lowered two or three times as a result of his having worked harder and increased his output, he is likely entirely to lose sight of his employer's side of the case and become imbued with a grim determination to have no more cuts if soldiering [marking time, just doing what he is told] can prevent it."

Shigeo Shingo, the best-known exponent of single minute exchange of die (SMED) and error-proofing or poka-yoke, cites *Principles of Scientific Management* as his inspiration.[9]

American industrialists recognized the threat of cheap offshore labor to American workers during the 1910s, and explicitly stated the goal of what is now called lean manufacturing as a countermeasure. Henry Towne, past President of the American Society of Mechanical Engineers, wrote in the Foreword to Frederick Winslow Taylor's *Shop Management* (1911), "We are justly proud of the high wage rates which prevail throughout our country, and jealous of any interference with them by the products of the cheaper labor of other countries. To maintain this condition, to strengthen our control of home markets, and, above all, to broaden our opportunities in foreign markets where we must compete with the products of other industrial nations, we should welcome and encourage every influence tending to increase the efficiency of our productive processes."

Ford starts the ball rolling

Henry Ford continued this focus on waste while developing his mass assembly manufacturing system. Charles Buxton Going wrote in 1915:

> Ford's success has startled the country, almost the world, financially, industrially, mechanically. It exhibits in higher degree than most persons would have thought possible the seemingly contradictory requirements of true efficiency, which are: constant increase of quality, great increase of pay to the workers, repeated reduction in cost to the consumer. And with these appears, as at once cause and effect, an absolutely incredible enlargement of output reaching something like one hundredfold in less than ten years, and an enormous profit to the manufacturer.[10]

Ford, in *My Life and Work* (1922),[11] provided a single-paragraph description that encompasses the entire concept of waste:

> I believe that the average farmer puts to a really useful purpose only about 5%. of the energy he expends.... Not only is everything done by hand, but seldom is a thought given to a logical arrangement. A farmer doing his chores will walk up and down a rickety ladder a dozen times. He will carry water for years instead of putting in a few lengths of pipe. His whole idea, when there is extra work to do, is to hire extra men. He thinks of putting money into improvements as an expense.... It is waste motion— waste effort— that makes farm prices high and profits low.

Poor arrangement of the workplace—a major focus of the modern kaizen—and doing a job inefficiently out of habit—are major forms of waste even in modern workplaces.

Ford also pointed out how easy it was to overlook material waste. A former employee, Harry Bennett, wrote:

> One day when Mr. Ford and I were together he spotted some rust in the slag that ballasted the right of way of the D. T. & I [railroad]. This slag had been dumped there from our own furnaces. 'You know,' Mr. Ford said to me, 'there's iron in that slag. You make the crane crews who put it out there sort it over, and take it back to the plant.'[12]

In other words, Ford saw the rust and realized that the steel plant was not recovering all of the iron.

Ford's early success, however, was not sustainable. As James Womack and Daniel Jones pointed out in "Lean Thinking", what Ford accomplished represented the "special case" rather than a robust lean solution.[13] The major challenge that Ford faced was that his methods were built for a steady-state environment, rather than for the dynamic conditions firms increasingly face today.[14] Although his rigid, top-down controls made it possible to hold variation in work activities down to very low levels, his approach did not respond well to uncertain, dynamic business conditions; they responded particularly badly to the

need for new product innovation. This was made clear by Ford's precipitous decline when the company was forced to finally introduce a follow-on to the Model T (see Lean Dynamics).

Design for Manufacture (DFM) also is a Ford concept. Ford said in *My Life and Work* (the same reference describes just in time manufacturing very explicitly):

> ...entirely useless parts [may be]—a shoe, a dress, a house, a piece of machinery, a railroad, a steamship, an airplane. As we cut out useless parts and simplify necessary ones, we also cut down the cost of making. ... But also it is to be remembered that all the parts are designed so that they can be most easily made.

This standardization of parts was central to Ford's concept of mass production, and the manufacturing "tolerances", or upper and lower dimensional limits that ensured interchangeability of parts became widely applied across manufacturing. Decades later, the renowned Japanese quality guru, Genichi Taguchi, demonstrated that this "goal post" method of measuring was inadequate. He showed that "loss" in capabilities did not begin only after exceeding these tolerances, but increased as described by the Taguchi Loss Function at any condition exceeding the nominal condition. This became an important part of W. Edward Deming's quality movement of the 1980s, later helping to develop improved understanding of key areas of focus such as cycle time variation in improving manufacturing quality and efficiencies in aerospace and other industries.

While Ford is renowned for his production line it is often not recognized how much effort he put into removing the fitters' work in order to make the production line possible. Until Ford, a car's components always had to be fitted or reshaped by a skilled engineer at the point of use, so that they would connect properly. By enforcing very strict specification and quality criteria on component manufacture, he eliminated this work almost entirely, reducing manufacturing effort by between 60-90%.[15] However, Ford's mass production system failed to incorporate the notion of "pull production" and thus often suffered from over-production.

Toyota develops TPS

Toyota's development of ideas that later became Lean may have started at the turn of the 20th century with Sakichi Toyoda, in a textile factory with looms that stopped themselves when a thread broke, this became the seed of autonomation and *Jidoka*. Toyota's journey with JIT may have started back in 1934 when it moved from textiles to produce its first car. Kiichiro Toyoda, founder of Toyota, directed the engine casting work and discovered many problems in their manufacture. He decided he must stop the repairing of poor quality by intense study of each stage of the process. In 1936, when Toyota won its first truck contract with the Japanese government, his processes hit new problems and he developed the "Kaizen" improvement teams.

Levels of demand in the Post War economy of Japan were low and the focus of mass production on lowest cost per item via economies of scale therefore had little application.

Having visited and seen supermarkets in the USA, Taiichi Ohno recognised the scheduling of work should not be driven by sales or production targets but by actual sales. Given the financial situation during this period, over-production had to be avoided and thus the notion of Pull (build to order rather than target driven Push) came to underpin production scheduling.

It was with Taiichi Ohno at Toyota that these themes came together. He built on the already existing internal schools of thought and spread their breadth and use into what has now become the Toyota Production System (TPS). It is principally from the TPS, but now including many other sources, that Lean production is developing. Norman Bodek wrote the following in his foreword to a reprint of Ford's *Today and Tomorrow:*

> I was first introduced to the concepts of just-in-time (JIT) and the Toyota production system in 1980. Subsequently I had the opportunity to witness its actual application at Toyota on one of our numerous Japanese study missions. There I met Mr. Taiichi Ohno, the system's creator. When bombarded with questions from our group on what inspired his thinking, he just laughed and said he learned it all from Henry Ford's book." It is the scale, rigour and continuous learning aspects of the TPS which have made it a core of Lean.

Types of wastes

While the elimination of waste may seem like a simple and clear subject it is noticeable that waste is often very conservatively identified. This then hugely reduces the potential of such an aim. The elimination of waste is the goal of Lean, and Toyota defined three broad types of waste: *muda*, *muri* and *mura*; it should be noted that for many Lean implementations this list shrinks to the last waste type only with corresponding benefits decrease.

To illustrate the state of this thinking Shigeo Shingo observed that only the last turn of a bolt tightens it—the rest is just movement. This ever finer clarification of waste is key to establishing distinctions between value-adding activity, waste and non-value-adding work.[16] Non-value adding work is waste that must be done under the present work conditions. One key is to measure, or estimate, the size of these wastes, in order to demonstrate the effect of the changes achieved and therefore the movement towards the goal.

The "flow" (or smoothness) based approach aims to achieve JIT, by removing the variation caused by work scheduling and thereby provide a driver, rationale or target and priorities for implementation, using a variety of techniques. The effort to achieve JIT exposes many quality problems that are hidden by buffer stocks; by forcing smooth flow of only value-adding steps, these problems become visible and must be dealt with explicitly.

Muri is all the unreasonable work that management imposes on workers and machines because of poor organization, such as carrying heavy weights, moving things around,

dangerous tasks, even working significantly faster than usual. It is pushing a person or a machine beyond its natural limits. This may simply be asking a greater level of performance from a process than it can handle without taking shortcuts and informally modifying decision criteria. Unreasonable work is almost always a cause of multiple variations.

To link these three concepts is simple in TPS and thus Lean. Firstly, *muri* focuses on the preparation and planning of the process, or what work can be avoided proactively by design. Next, *mura* then focuses on how the work design is implemented and the elimination of fluctuation at the scheduling or operations level, such as quality and volume. *Muda* is then discovered after the process is in place and is dealt with reactively. It is seen through variation in output. It is the role of management to examine the *muda*, in the processes and eliminate the deeper causes by considering the connections to the *muri* and *mura* of the system. The *muda* and *mura* inconsistencies must be fed back to the *muri*, or planning, stage for the next project.

A typical example of the interplay of these wastes is the corporate behaviour of "making the numbers" as the end of a reporting period approaches. Demand is raised in order to 'make plan', increasing (*mura*), when the "numbers" are low which causes production to try to squeeze extra capacity from the process which causes routines and standards to be modified or stretched. This stretch and improvisation leads to *muri*-style waste which leads to downtime, mistakes and backflows and waiting, thus the muda of waiting, correction and movement.

The original seven *muda* are:

- Transportation (moving products that is not actually required to perform the processing)
- Inventory (all components, work-in-progress and finished product not being processed)
- Motion (people or equipment moving or walking more than is required to perform the processing)
- Waiting (waiting for the next production step)
- Overproduction (production ahead of demand)
- Over Processing (due to poor tool or product design creating activity)
- Defects (the effort involved in inspecting for and fixing defects)[17]

Later an eighth waste was defined by Womack et al. (2003); it was described as manufacturing goods or services that do not meet customer demand or specifications. This waste was not originally a part of the seven deadly wastes defined by Taiichi Ohno in TPS.

Some of these definitions may seem rather idealistic, but this tough definition is seen as important and they drove the success of TPS. The clear identification of non-value-adding work, as distinct from wasted work, is critical to identifying the assumptions behind the current work process and to challenging them in due course.[18] Breakthroughs

in SMED and other process changing techniques rely upon clear identification of where untapped opportunities may lie if the processing assumptions are challenged.

Lean implementation develops from TPS

The discipline required to implement Lean and the disciplines it seems to require are so often counter-cultural that they have made successful implementation of Lean a major challenge. Some[19] would say that it was a major challenge in its manufacturing 'heartland' as well. Implementations under the Lean label are numerous and whether they are Lean and whether any success or failure can be laid at Lean's door is often debatable. Individual examples of success and failure exist in almost all spheres of business and activity and therefore cannot be taken as indications of whether Lean is particularly applicable to a specific sector of activity. It seems clear from the "successes" that no sector is immune from beneficial possibility.[*citation needed*]

Lean is about more than just cutting costs in the factory. One crucial insight is that most costs are assigned when a product is designed, (see Genichi Taguchi). Often an engineer will specify familiar, safe materials and processes rather than inexpensive, efficient ones. This reduces project risk, that is, the cost to the engineer, while increasing financial risks, and decreasing profits. Good organizations develop and review checklists to review product designs.

Companies must often look beyond the shop-floor to find opportunities for improving overall company cost and performance. At the system engineering level, requirements are reviewed with marketing and customer representatives to eliminate those requirements which are costly. Shared modules may be developed, such as multipurpose power supplies or shared mechanical components or fasteners. Requirements are assigned to the cheapest discipline. For example, adjustments may be moved into software, and measurements away from a mechanical solution to an electronic solution. Another approach is to choose connection or power-transport methods that are cheap or that used standardized components that become available in a competitive market.

An example program

In summary, an example of a lean implementation program could be:

With a tools-based approach	With a muri or flow based approach (as used in the TPS with suppliers[20]).
• Senior management to agree and discuss their lean vision • Management brainstorm to identify project leader and set objectives • Communicate plan and vision to the workforce • Ask for volunteers to form the Lean Implementation team (5-7 works best, all from different departments) • Appoint members of the Lean Manufacturing Implementation Team • Train the Implementation Team in the various lean tools - make a point of trying to visit other non competing businesses which have implemented lean • Select a Pilot Project to implement – 5S is a good place to start • Run the pilot for 2–3 months - evaluate, review and learn from your mistakes • Roll out pilot to other factory areas • Evaluate results, encourage feedback • Stabilize the positive results by teaching supervisors how to train the new standards you've developed with TWI methodology (Training Within Industry) • Once you are satisfied that you have a habitual program, consider introducing the next lean tool. Select the one which	• Sort out as many of the visible quality problems as you can, as well as downtime and other instability problems, and get the internal scrap acknowledged and its management started. • Make the flow of parts through the system or process as continuous as possible using workcells and market locations where necessary and avoiding variations in the operators work cycle • Introduce standard work and stabilise the work pace through the system • Start pulling work through the system, look at the production scheduling and move towards daily orders with kanban cards • Even out the production flow by reducing batch sizes, increase delivery frequency internally and if possible externally, level internal demand • Improve exposed quality issues using the tools • Remove some people (or increase quotas) and go through this work again (the Oh No !! moment)

will give you the biggest return for your business.	

Lean leadership

The role of the leaders within the organization is the fundamental element of sustaining the progress of lean thinking. Experienced kaizen members at Toyota, for example, often bring up the concepts of *Senpai*, *Kohai*, and *Sensei*, because they strongly feel that transferring of Toyota culture down and across the Toyota can only happen when more experienced Toyota Sensei continuously coach and guide the less experienced lean champions. Unfortunately, most lean practitioners in North America focus on the tools and methodologies of lean, versus the philosophy and culture of lean. Some exceptions include Shingijitsu Consulting out of Japan, which is made up of ex-Toyota managers, and Lean Sensei International based in North America, which coaches lean through Toyota-style cultural experience.

One of the dislocative effects of Lean is in the area of key performance indicators (KPI). The KPIs by which a plant/facility are judged will often be driving behaviour, because the KPIs themselves assume a particular approach to the work being done. This can be an issue where, for example a truly Lean, Fixed Repeating Schedule (FRS) and JIT approach is adopted, because these KPIs will no longer reflect performance, as the assumptions on which they are based become invalid. It is a key leadership challenge to manage the impact of this KPI chaos within the organization. A set of performance metrics which is considered to fit well in a Lean environment is Overall Equipment Effectiveness, or OEE.

Similarly, commonly used accounting systems developed to support mass production are no longer appropriate for companies pursuing Lean. Lean Accounting provides truly Lean approaches to business management and financial reporting.

Key focus areas for leaders are

- PDCA thinking
- *Genchi Genbutsu* "go and see" philosophy
- Process confirmation

Differences from TPS

Whilst Lean is seen by many as a generalization of the Toyota Production System into other industries and contexts there are some acknowledged differences that seem to have developed in implementation.

1. **Seeking profit** is a relentless focus for Toyota exemplified by the profit maximization principle (Price – Cost = Profit) and the need, therefore, to practice systematic cost reduction (through TPS or otherwise) in order to realize benefit. Lean implementations can tend to de-emphasise this key measure and thus become fixated with the implementation of improvement concepts of "flow" or "pull". However, the emergence of the "value curve analysis" promises to directly tie lean improvements to bottom-line performance measuments.[20]
2. **Tool orientation** is a tendency in many programs to elevate mere tools (standardized work, value stream mapping, visual control, etc.) to an unhealthy status beyond their pragmatic intent. The tools are just different ways to work around certain types of problems but they do not solve them for you or always highlight the underlying cause of many types of problems. The tools employed at Toyota are often used to expose particular problems that are then dealt with, as each tool's limitations or blindspots are perhaps better understood. So, for example, Value Stream Mapping focuses upon material and information flow problems (a title built into the Toyota title for this activity) but is not strong on Metrics, Man or Method. Internally they well know the limits of the tool and understood that it was never intended as the best way to see and analyze every waste or every problem related to quality, downtime, personnel development, cross training related issues, capacity bottlenecks, or anything to do with profits, safety, metrics or morale, etc. No one tool can do all of that. For surfacing these issues other tools are much more widely and effectively used.
3. **Management technique rather than change agents** has been a principle in Toyota from the early 1950s when they started emphasizing the development of the production manager's and supervisors' skills set in guiding natural work teams and did not rely upon staff-level change agents to drive improvements. This can manifest itself as a "Push" implementation of Lean rather than "Pull" by the team itself. This area of skills development is not that of the change agent specialist, but that of the natural operations work team leader. Although less prestigious than the TPS specialists, development of work team supervisors in Toyota is considered an equally, if not more important, topic merely because there are tens of thousands of these individuals. Specifically, it is these manufacturing leaders that are the main focus of training efforts in Toyota since they lead the daily work areas, and they directly and dramatically affect quality, cost, productivity, safety, and morale of the team environment. In many companies implementing Lean the reverse set of priorities is true. Emphasis is put on developing the specialist, while the supervisor skill level is expected to somehow develop over time on its own.

Lean services

Lean, as a concept or brand, has captured the imagination of many in different spheres of activity. Examples of these from many sectors are listed below.

Lean principles have been successfully applied to call center services to improve live agent call handling. By combining Agent-assisted Voice solutions and Lean's waste reduction practices, a company reduced handle time, reduced between agent variability, reduced accent barriers, and attained near perfect process adherence. [21]

Lean principles have also found application in software application development and maintenance and other areas of information technology (IT).[22] More generally, the use of Lean in IT has become known as **Lean IT**.

A study conducted on behalf of the Scottish Executive, by Warwick University, in 2005/06 found that Lean methods were applicable to the public sector, but that most results had been achieved using a much more restricted range of techniques than Lean provides.[23]

The challenge in moving Lean to services is the lack of widely available reference implementations to allow people to see how directly applying lean manufacturing tools and practices can work and the impact it does have. This makes it more difficult to build the level of belief seen as necessary for strong implementation. However, some research does relate widely recognized examples of success in retail and even airlines to the underlying principles of lean.[14] Despite this, it remains the case that the direct manufacturing examples of 'techniques' or 'tools' need to be better 'translated' into a service context to support the more prominent approaches of implementation, which has not yet received the level of work or publicity that would give starting points for implementors. The upshot of this is that each implementation often 'feels its way' along as must the early industrial engineers of Toyota. This places huge importance upon sponsorship to encourage and protect these experimental developments.

See also

[edit] Closely related methodologies

- Toyota Production System
- Value Network
- Demand Flow Technology
- Theory of Constraints
- Variation Management
- Six Sigma
- Statistical process control
- Lean Dynamics

[edit] Predictive validation techniques

- Discrete event simulation

[edit] Terminology

- Just In Time or JIT
- Fixed Repeating Schedule or FRS
- Kaizen
- SMED
- Poka-Yoke
- Autonomation and Jidoka
- 5S
- Production levelling
- Cycle Time Variation
- muda, mura, muri
- workcell
- Takt time
- Andon
- Genchi Genbutsu
- Gemba
- 5 Whys

[edit] Related engineering disciplines

- Industrial engineering
- Industrial technology

[edit] Areas of implementation outside production

- Computer-Aided Lean Management
- Lean construction
- Lean Maintenance Repair and Overhaul (MRO)
- Lean laboratory
- Lean Services
- Lean Office
- Lean software development

[edit] Other

- Overall Equipment Effectiveness
- Cellular manufacturing
- Agile manufacturing
- Manufacturing
- Preorder Economy
- Process Reengineering
- Training Within Industry
- Value Stream Mapping
- 3D's Dirty, Dangerous and Difficult
- Systems thinking
- Oscillatory baffled reactor
- Lean accounting
- Value curve analysis