

## Lean Principles

by  
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### Introduction

“Lean” operating principles began in manufacturing environments and are known by a variety of synonyms; Lean Manufacturing, Lean Production, Toyota Production System, etc. It is commonly believed that Lean started in Japan (Toyota, specifically), but Henry Ford had been using parts of Lean as early as the 1920’s, as evidenced by the following quote:

*“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.”* Henry Ford 1926

In order to set the groundwork for this paper, let’s begin with the definition of Lean, as developed by the National Institute of Standards and Technology Manufacturing Extension Partnership’s Lean Network:

**“A systematic approach to identifying and eliminating waste through continuous improvement, flowing the product at the pull of the customer in pursuit of perfection.”**

Keep in mind that Lean applies to the entire organization. Although individual components or building blocks of Lean may be tactical and narrowly focused, we can only achieve maximum effectiveness by using them together and applying them cross-functionally through the system.

### Overview of the Toyota Production System

The *wastes* noted above are commonly referred to as non-valued-added activities, and are known to Lean practitioners as the Eight Wastes. Taiichi Ohno (co-developer of the Toyota Production System) suggests that these account for up to 95% of all costs in *non-Lean* manufacturing environments. These wastes are:

- **Overproduction** – Producing more than the customer demands. The corresponding Lean principle is to manufacture based upon a pull system, or producing products just as customers order them. Anything produced beyond this (buffer or safety stocks, work-in-process inventories, etc.) ties up valuable labor and material resources that might otherwise be used to respond to customer demand.
- **Waiting** – This includes waiting for material, information, equipment, tools, etc. Lean demands that all resources are provided on a *just-in-time* (JIT) basis – not too soon, not too late.
- **Transportation** – Material should be delivered to its point of use. Instead of raw materials being shipped from the vendor to a receiving location, processed, moved into a warehouse, and then transported to the assembly line, Lean demands that the material be shipped directly from the vendor to the location in the assembly line where it will be used. The Lean term for this technique is called *point-of-use-storage* (POUS).
- **Non-Value-Added-Processing** – Some of the more common examples of this are *reworking* (the product or service should have been done correctly the first time), *deburring* (parts should have been produced without burrs, with properly designed and maintained tooling), and *inspecting* (parts should have been produced using statistical process control techniques to eliminate or minimize the amount of inspection required). A technique called *Value Stream Mapping* is frequently used to help identify non-valued-added steps in the process (for both manufacturers and service organizations).
- **Excess Inventory** – Related to Overproduction, inventory beyond that needed to meet customer demands negatively impacts cash flow and uses valuable floor space. One of the most important benefits for

implementing Lean Principles in manufacturing organizations is the elimination or postponement of plans for expansion of warehouse space.

- **Defects** – Production defects and service errors waste resources in four ways. First, materials are consumed. Second, the labor used to produce the part (or provide the service) the first time cannot be recovered. Third, labor is required to rework the product (or redo the service). Fourth, labor is required to address any forthcoming customer complaints.
- **Excess Motion** – Unnecessary motion is caused by poor workflow, poor layout, housekeeping, and inconsistent or undocumented work methods. *Value Stream Mapping* (see above) is also used to identify this type of waste.
- **Underutilized People** – This includes underutilization of mental, creative, *and* physical skills and abilities, where *non-Lean* environments only recognize underutilization of physical attributes. Some of the more common causes for this waste include – poor workflow, organizational culture, inadequate hiring practices, poor or non-existent training, and high employee turnover.

### ***Lean Building Blocks***

In order to reduce or eliminate the above wastes, Lean practitioners utilize many tools or Lean Building Blocks. Successful practitioners recognize that, although most of these may be implemented as stand-alone programs, few have significant impact when used alone. Additionally, the sequence of implementation affects the overall impact, and implementing some out of order may actually produce negative results (for example, you should address quick changeover and quality before reducing batch sizes). The more common building blocks are listed below. Note that some are used only in manufacturing organizations, but most apply equally to service industries.

- **Pull System** – The technique for producing parts at customer demand. Service organizations operate this way by their very nature. Manufacturers, on the other hand, have historically operated by a Push System, building products to stock (per sales forecast), without firm customer orders.
- **Kanban** – A method for maintaining an orderly flow of material. Kanban cards are used to indicate material order points, how much material is needed, from where the material is ordered, and to where it should be delivered.
- **Work Cells** – The technique of arranging operations and/or people in a cell (U-shaped, etc.) rather than in a traditional straight assembly line. Among other things, the cellular concept allows for better utilization of people and improves communication.
- **Total Productive Maintenance** – TPM capitalizes on proactive and progressive maintenance methodologies and calls upon the knowledge and cooperation of operators, equipment vendors, engineering, and support personnel to optimize machine performance. Results of this optimized performance include; elimination of breakdowns, reduction of unscheduled and scheduled downtime, improved utilization, higher throughput, and better product quality. Bottom-line results include; lower operating costs, longer equipment life, and lower overall maintenance costs.
- **Total Quality Management** – Total Quality Management is a management system used to continuously improve all areas of a company's operation. TQM is applicable to every operation in the company and recognizes the strength of employee involvement.
- **Point-Of-Use-Storage** – See above for more information on POUS.
- **Quick Changeover (a.k.a., Set Up Reduction and Single Minute Exchange of Dies)** – The technique of reducing the amount of time to change a process from running one specific type of product to another. The purpose for reducing changeover time is not for increasing production capacity, but to allow for more frequent changeovers in order to increase production flexibility. Quicker changeovers allow for smaller batch sizes. See Batch Size Reduction below for more details.
- **Batch Size Reduction** – Historically, manufacturing companies have operated with large batch sizes in order to maximize machine utilization, assuming that changeover times were “fixed” and could not be reduced. Because Lean calls for the production of parts to customer demand, the ideal batch size is ONE. However, a batch size of one is not always practical, so the goal is to practice continuous improvement to

reduce the batch size as low as possible. Reducing batch sizes reduces the amount of work-in-process inventory (WIP). Not only does this reduce inventory-carrying costs, but also production lead-time or cycle time is approximately directly proportional to the amount of WIP. Therefore, smaller batch sizes shorten the overall production cycle, enabling companies to deliver more quickly and to invoice sooner (for improved cash flow). Shorter production cycles increases inventory turns and allows the company to operate profitably at lower margins, which enables price reductions, which increases sales and market share.

- **5S or Workplace Organization** – This tool is a systematic method for organizing and standardizing the workplace. It's one of the simplest Lean tools to implement, provides immediate return on investment, crosses all industry boundaries, and is applicable to every function within an organization. Because of these attributes, it's usually our first recommendation for a company implementing Lean.
- **Visual Controls** – These are simple signals that provide an immediate and readily apparent understanding of a condition or situation. Visual controls enable someone to walk into the workplace and know within a short period of time (usually thirty seconds) what's happening with regards to production schedule, backlog, workflow, inventory levels, resource utilization, and quality. These controls should be efficient, self-regulating, and worker managed, and include kanban cards, lights, color-coded tools, lines delineating work areas and product flow, etc.
- **Concurrent Engineering** – This is a technique of using cross-functional teams (rather than sequential departmental assignments) to develop and bring new products to market. In many instances, implementing concurrent engineering has reduced time-to-market by 50%; the automotive and computer industries are good examples. Time-to-market is one of the most important tools for capturing and maintaining market share.

### ***Benefits of Implementing Lean***

The benefits of implementing Lean can be broken down into three broad categories; Operational, Administrative, and Strategic Improvements. Even to this day, most organizations that implement Lean do so for the operational improvements, primarily because of the perception that Lean only applies to the operations side of the business. However, from our experiences, Lean's administrative and strategic benefits are equally impressive. Some of Lean's benefits are summarized below.

#### ***Operational Improvements***

The NIST Manufacturing Extension Partnership recently surveyed forty of their clients who had implemented Lean Manufacturing. Typical improvements were reported as follows:

- Lead Time (Cycle Time) reduced by 90%
- Productivity increased by 50%
- Work-In-Process Inventory reduced by 80%
- Quality improved by 80%
- Space Utilization reduced by 75%

#### ***Administrative Improvements***

A small sample of specific improvements in administrative functions is (based upon personal experiences):

- Reduction in order processing errors
- Streamlining of customer service functions so that customers are no longer placed *on hold*
- Reduction of paperwork in office areas
- Reduced staffing demands, allowing the same number of office staff to handle larger numbers of orders

- Documentation and streamlining of processing steps enables the out-sourcing of non-critical functions, allowing the company to focus their efforts on customers' needs
- Reduction of turnover and the resulting attrition costs
- The implementation of job standards and pre-employment profiling ensures the hiring of only "above average" performers – *envision the benefit to the organization if everyone performs as well as the top 20%!*

### **Strategic Improvements**

Many companies who implement Lean do not adequately take advantage of the improvements. Highly successful companies will learn how to market these new benefits and turn them into increased market share. One specific example involves a midwestern manufacturer of a common health care product. Of approximately forty U.S. competitors, the third largest company in the industry decided to implement Lean manufacturing principles. The industry average lead-time was fifteen days, and this company was no different. At the end of the project, Company #3's average lead-time was four days, with no products shipped in less than seven days. In order to capitalize upon these improvements, the company began a marketing campaign, advertising that customers would receive the product in ten days, or the order would be FREE. Sales volume increased by 20% almost immediately. After making the appropriate improvements to handle the new demand, they company initiated another marketing campaign; for only a 10% premium, they would ship within seven days. Again, sales volume increased (by only 5%) because new customers wanted the product within seven days, *but more than 30% of existing customers also paid the premium, even they were already receiving the product in less than seven days.* The end result was that the company increased revenues by almost 40% with no increase in labor or overhead costs. Another key benefit was that the company was able to invoice customers eleven days sooner than before, greatly improving cash flow.

### ***Barriers to Successful Implementation***

Many of the companies that attempt to implement Lean experience difficulties and/or are not able to achieve the anticipated benefits. Some of our own observations in this area include:

- The company fails to tie the improvement metrics to financial statements. In other words, the company only reports the *percent improvement* and doesn't convert this to a monetary measure. By not communicating in the same language as management, the department or function implementing Lean doesn't get the support needed to continue the efforts.
- The company implements the building blocks in the wrong sequence. For example, if batch sizes are reduced prior to reducing changeover time, and changeover times are lengthy, equipment utilization will drop, and the ability to serve customers will be reduced. A typical reaction to this might be, "We tried to implement Lean, and things got worse." Of course, they did.
- Choosing a difficult or low-impact project as the first one. Lean isn't difficult, but can be complicated because of all the variables and communication involved. If the first Lean project isn't successful or generates little return on investment, cooperation and support for future projects will fade.
- Overlooking administrative areas. Some manufacturing environments, especially continuous processes (e.g., high-volume chemical manufacturers) have only small or insignificant opportunities in the production or operations areas. Implementing Lean there will provide little impact.
- The company spends too much time on training and not "doing," or they start at the wrong place.
- Failing to expand lean implementation to the supply chain. Because of the need for just-in-time delivery of materials, minimization of inventories and Lean's dependence upon high quality products and services, companies need to bring suppliers into the improvement efforts. If critical suppliers cannot deliver on time, and in smaller quantities, the benefits of Lean will be greatly diminished or even non-existent. The development of a lean supply chain is probably one of the most difficult, but more financially rewarding, aspects of implementing Lean.

- Lean radically impacts every person in every function of an organization, and literally changes the organizational culture. The change causes discomfort, and many companies are not able to cope with this magnitude of change.
- It takes years to fully understand and implement lean throughout a large organization; frequently longer than the life expectancy (i.e., turnover cycle) of U.S. managers and decision makers. One manager might decide to implement lean, just to have his/her successor scrap the program.
- Finally, many of the concepts we learn in Lean are different than managers, accountants, and other decision makers were taught. Some of the more interesting ones that we've encountered (and, address in our own lean implementations) include:

<b>Concept</b>	<b>Traditional Organization</b>	<b>Lean Organization</b>
<b>Inventory</b>	An asset, as defined by accounting terminology	A waste – ties up capital and increases processing lead-time
<b>Ideal Economic Order Quantity &amp; Batch Size</b>	Very large – run large batch sizes to make up for process downtime	ONE – continuous efforts are made to reduce downtime to zero
<b>People Utilization</b>	All people must be busy at all times	Because work is performed based directly upon customer demand, people might not be busy
<b>Process Utilization</b>	Use high-speed processes and run them all the time	Processes need to only be designed to keep up with demand
<b>Work Scheduling</b>	Build products to forecast	Build products to demand
<b>Labor Costs</b>	Variable	Fixed
<b>Work Groups</b>	Traditional (functional) departments	Cross-functional teams
<b>Accounting</b>	By traditional FASB* guidelines	“Through-put” Accounting
<b>Quality</b>	Inspect/sort work at end of process to make sure we find all errors	Processes, products, and services are designed to eliminate errors

\*Financial Accounting Standards Board

### Concluding Remarks

Lean is becoming the next "quality" or "eBusiness" practice area. In the 1980s, companies with superior quality were able to more easily enter new markets and command higher prices for their products and services than companies with inferior quality. Now, "quality" is the price of admission for entering the business environment. eBusiness was the 1990s equivalent; an eBusiness strategy and presence is required in many markets. Today, many large manufacturers are demanding that suppliers adopt lean practices. Lean organizations are able to be more responsive to market trends, deliver products and services faster, and provide products and services less expensively than their non-lean counterparts. Lean crosses all industry boundaries, addresses all organizational functions, and impacts the entire system – supply chain to customer base.

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