State of Connecticut Commission on Enhancing Agency Outcomes

Public Hearing
Danbury, CT
April 30, 2009

Tom Nelson

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Dear Commission Members,

Thank you for permitting me to testify today on the use of Lean Six Sigma TOC to improve state government. Lean Six Sigma TOC consists of organization improvement methods that initially were used in manufacturing, then in business services and more recently in government.

Included in this package are short descriptions of Lean, Six Sigma and TOC (Theory of Constraints). Also provided are web search results related to using Lean Six Sigma TOC in government.

To assist the State of Connecticut in evaluating how Lean Six Sigma TOC may be useful to improve state government, TTTransformations will provide consulting for 5 days at no charge. The intent is a mutual discussion where the state identifies areas needing improvement and TTTransformations proposes how Lean Six Sigma TOC can be applied to make these improvements. If you have any questions, please call me at 203-992-9108 office phone or 203-733-2902 cell.

Yours truly,

Tom Nelson

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Web Searches: Lean Six Sigma TOC in Government

Lean manufacturing

From Wikipedia, the free encyclopedia (edited by Tom Nelson)

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. 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, 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.

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. 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 'The Machine That Changed the World' (1990).

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.

Origins

Also known as the flexible mass production. The TPS has two pillar concepts: Just-in-time (JIT) or "flow", and "autonomation" (smart automation). 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. 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.

Henry Ford focused 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.

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. 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. 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).

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. 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)

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. 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 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.

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.

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. 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.

Six Sigma

From Wikipedia, the free encyclopedia (edited by Tom Nelson)

Six Sigma is a business management strategy, initially implemented by Motorola, that today enjoys widespread application in many sectors of industry.

Six Sigma seeks to improve quality of process outputs by identifying and removing the causes of defects (errors) and variation in manufacturing and business processes. It uses a set of quality management methods, including statistical methods, and creates a special infrastructure of people within the organization ("Black Belts" etc.) who are experts in these methods. Each Six Sigma project carried out within an organization follows a defined sequence of steps and has quantified financial targets (cost reduction or profit increase)

Historical overview

Six Sigma was originally developed as a set of practices designed to improve manufacturing processes and eliminate defects, but its application was subsequently extended to other types of business processes as well. In Six Sigma, a defect is defined as anything that could lead to customer dissatisfaction. The particulars of the methodology were first formulated by Bill Smith at Motorola in 1986. Six Sigma was heavily inspired by six preceding decades of quality improvement methodologies such as quality control, TQM, and Zero Defects, based on the work of pioneers such as Shewhart, Deming, Juran, Ishikawa, Taguchi and others.

Like its predecessors, Six Sigma asserts that –

- Continuous efforts to achieve stable and predictable process results (i.e. reduce process variation) are of vital importance to business success.
- Manufacturing and business processes have characteristics that can be measured, analyzed, improved and controlled.
- Achieving sustained quality improvement requires commitment from the entire organization, particularly from top-level management.

Features that set Six Sigma apart from previous quality improvement initiatives include –

- A clear focus on achieving measurable and quantifiable financial returns from any Six Sigma project.
- An increased emphasis on strong and passionate management leadership and support.
- A special infrastructure of "Champions," "Master Black Belts," "Black Belts," etc. to lead and implement the Six Sigma approach.

- A clear commitment to making decisions on the basis of verifiable data, rather than assumptions and guesswork.

The term "Six Sigma" is derived from a field of statistics known as process capability studies. Originally, it referred to the ability of manufacturing processes to produce a very high proportion of output within specification. Processes that operate with "six sigma quality" over the short term are assumed to produce long-term defect levels below 3.4 defects per million opportunities (DPMO). Six Sigma's implicit goal is to improve all processes to that level of quality or better.

Six Sigma is a registered service mark and trademark of Motorola, Inc. Motorola has reported over US$17 billion in savings from Six Sigma as of 2006.

Other early adopters of Six Sigma who achieved well-publicized success include Honeywell (previously known as AlliedSignal) and General Electric, where the method was introduced by Jack Welch. By the late 1990s, about two-thirds of the Fortune 500 organizations had begun Six Sigma initiatives with the aim of reducing costs and improving quality.

DMAIC

The basic method consists of the following five steps:

- *Define* high-level project goals and the current process.
- *Measure* key aspects of the current process and collect relevant data.
- *Analyze* the data to verify cause-and-effect relationships. Determine what the relationships are, and attempt to ensure that all factors have been considered.
- *Improve* or optimize the process based upon data analysis using techniques like Design of experiments.
- *Control* to ensure that any deviations from target are corrected before they result in defects. Set up pilot runs to establish process capability, move on to production, set up control mechanisms and continuously monitor the process.

Implementation roles

One of the key innovations of Six Sigma is the professionalizing of quality management functions. Prior to Six Sigma, quality management in practice was largely relegated to the production floor and to statisticians in a separate quality department. Six Sigma borrows martial arts ranking terminology to define a hierarchy (and career path) that cuts across all business functions and a promotion path straight into the executive suite.

Six Sigma identifies several key roles for its successful implementation.

- *Executive Leadership* includes the CEO and other members of top management. They are responsible for setting up a vision for Six Sigma implementation. They also empower the other role holders with the freedom and resources to explore new ideas for breakthrough improvements.

- *Champions* are responsible for Six Sigma implementation across the organization in an integrated manner. The Executive Leadership draws them from upper management. Champions also act as mentors to Black Belts.
- *Master Black Belts*, identified by champions, act as in-house coaches on Six Sigma. They devote 100% of their time to Six Sigma. They assist champions and guide Black Belts and Green Belts. Apart from statistical tasks, their time is spent on ensuring consistent application of Six Sigma across various functions and departments.
- *Black Belts* operate under Master Black Belts to apply Six Sigma methodology to specific projects. They devote 100% of their time to Six Sigma. They primarily focus on Six Sigma project execution, whereas Champions and Master Black Belts focus on identifying projects/functions for Six Sigma.
- *Green Belts* are the employees who take up Six Sigma implementation along with their other job responsibilities. They operate under the guidance of Black Belts.

Theory of Constraints

From Wikipedia, the free encyclopedia (edited by Tom Nelson)

Theory of Constraints (TOC) is an overall management philosophy introduced by Dr. Eliyahu M. Goldratt in his 1984 book titled *The Goal*, that is geared to help organizations continually achieve their goal. The title comes from the contention that any manageable system is limited in achieving more of its goal by a very small number of constraints, and that there is always at least one constraint. The TOC process seeks to identify the constraint and restructure the rest of the organization around it, through the use of the Five Focusing Steps.

Key Assumption

The underlying assumption of Theory of Constraints is that organizations can be measured and controlled by variations on three measures: Throughput, Operating Expense, and Inventory. Throughput is money (or goal units) generated through sales. Operating Expense is money that goes into the system to ensure its operation on an ongoing basis. Inventory is money the system invests in order to sell its goods and services.

The five focusing steps

Theory of Constraints is based on the premise that the rate of goal achievement is limited by at least one constraining process. Only by increasing flow through the constraint can overall throughput be increased.

Assuming the goal of the organization has been articulated (e.g., "Make money now and in the future") the steps are:

1. IDENTIFY the constraint (the resource/policy that prevents the organization from obtaining more of the goal)

2. Decide how to EXPLOIT the constraint (make sure the constraint's time is not wasted doing things that it should not do)

3. SUBORDINATE all other processes to above decision (align the whole system/organization to support the decision made above)

4. ELEVATE the constraint (if required/possible, permanently increase capacity of the constraint; "buy more")

5. If, as a result of these steps, the constraint has moved, return to Step 1. Don't let inertia become the constraint.

The five focusing steps aim to ensure ongoing improvement efforts are centered around the organization's constraints. In the TOC literature, this is referred to as the Process of Ongoing Improvement (POOGI).

Constraints

A constraint is anything that prevents the system from achieving more of its goal. There are many ways that constraints can show up, but a core principle within TOC is that there are not tens or hundreds of constraints. There is at least one and at most a few in any given system. Constraints can be internal or external to the system. An internal constraint is in evidence when the market demands more from the system than it can deliver. If this is the case, then the focus of the organization should be on discovering that constraint and following the five focusing steps to open it up (and potentially remove it). An external constraint exists when the system can produce more than the market will bear. If this is the case, then the organization should focus on mechanisms to create more demand for its products or services.

Types of (internal) constraints

- Equipment: The way equipment is currently used limits the ability of the system to produce more salable goods / services.
- People: Lack of skilled people limits the system.
- Policy: A written or unwritten policy prevents the system from making more.

The concept of the constraint in Theory of Constraints differs from the constraint that shows up in mathematical optimization. In TOC, the constraint is used as a focusing mechanism for management of the system. In optimization, the constraint is written into the mathematical expressions to limit the scope of the solution (X can be no greater than 5).

Please note: Organizations have many problems with equipment, people, policies, etc. But the constraint is the thing that is preventing the organization from getting more Throughput (typically, sales).

Buffers

Buffers are used throughout Theory of Constraints. They appear as part of the EXPLOIT and SUBORDINATE steps of the five focusing steps. Buffers are placed before the key constraint, thus ensuring that the constraint is never starved. Buffers used in this way protect the constraint and should allow for normal variation of processing time and the occasional upset (Murphy) before the constraint.

Buffers can be a bank of physical objects, waiting to be processed by a work center sitting before a work center. Buffers can also be represented by time, as in the time before work reaches the constraint. There should always be enough work, but not excessive work, in the time queue before the constraint.

Buffers *are not* the small queue of work that sits before every work center in a Kanban system. The assumption in Theory of Constraints is that with one constraint in the system that all other parts of the system have sufficient capacity to keep up with the work at the constraint. In a balanced line, as dictated by Kanban, when one work center goes down, then entire system must wait until that work center is restored. In a TOC system, the only time work is in danger is if the constraint is unable to process (either due to malfunction, sickness or a "hole" in the buffer).

Applications

The focusing steps, or this *Process of Ongoing Improvement* has been applied to Manufacturing, Project Management, Supply Chain / Distribution generated specific solutions. Other tools (mainly the TP) also led to TOC applications in the fields of Marketing and Sales, and Finance. The solution as applied to each of these areas are listed below.

Operations

Within manufacturing operations and operations management, the solution seeks to pull materials through the system, rather than push them into the system. The primary methodology use is Drum-Buffer-Rope (DBR) and a variation called Simplified Drum-Buffer-Rope (S-DBR).

Drum-Buffer-Rope is a manufacturing execution methodology, named for its three components. The *drum* is the physical constraint of the plant: the work center or machine or operation that limits the ability of the entire system to produce more. The rest of the plant follows the beat of the drum. They make sure the drum has work and that anything the drum has processed does not get wasted.

The *buffer* protects the drum, so that it always has work flowing to it. Buffers in DBR have time as their unit of measure, rather than quantity of material. This makes the priority system operate strictly based on the time an order is expected to be at the drum. Traditional DBR usually calls for buffers at several points in the system: the constraint, synchronization points and at shipping. S-DBR has a buffer at shipping and manages the flow of work across the drum through a load planning mechanism.

The *rope* is the work release mechanism for the plant. Only a "buffer time" before an order is due does it get released into the plant. Pulling work into the system earlier than a buffer time guarantees high work-in-process and slows down the entire system.

Finance and accounting

The solution for finance and accounting is to apply holistic thinking to the finance application. This has been termed throughput accounting. Throughput accounting suggests that one examine the impact of investments and operational changes in terms of the impact on the throughput of the business. It is an alternative to cost accounting.

The primary measures for a TOC view of finance and accounting are: Throughput (T), Operating Expense (OE) and Investment (I). Throughput is calculated from Sales (S) - Totally Variable Cost (TVC). Totally Variable Cost usually considers the cost of raw materials that go into creating the item sold.

Project management

Critical Chain Project Management (CCPM) is utilized in this area. CCPM is based on the idea that all projects look like A-plants: all activities converge to a final deliverable. As such, to protect the project, there must be internal buffers to protect synchronization points and a final project buffer to protect the overall project.

Marketing and sales

While originally focused on manufacturing and logistics, TOC has expanded lately into sales management and marketing. Its role is explicitly acknowledged in the field of sales process engineering. For effective sales management one can apply Drum Buffer Rope to the sales process similar to the way it is applied to operations (see Reengineering the Sales Process book reference below). This technique is appropriate when your constraint is in the sales process itself or you just want an effective sales management technique and includes the topics of funnel management and conversion rates.

The TOC thinking processes

The Thinking Processes are a set of tools to help managers walk through the steps of initiating and implementing a project. When used in a logical flow, the Thinking Processes help walk through a buy-in process:

1. Gain agreement on the problem
2. Gain agreement on the direction for a solution
3. Gain agreement that the solution solves the problem
4. Agree to overcome any potential negative ramifications
5. Agree to overcome any obstacles to implementation

Lean and Six Sigma Process Improvement Methods

While Lean and Six Sigma process improvement approaches were developed originally for use in the private sector to target manufacturing processes, there has been steady progress towards adapting these approaches for use on service and administrative processes. Public sector interest in Lean and Six Sigma is increasing rapidly, fueled by strong improvement results. Government organizations ranging from the Connecticut Department of Labor to the City of Fort Wayne, Indiana, to the U.S. Mint, to all branches of the U.S. Armed Forces are using Lean and/or Six Sigma to improve their administrative processes. Interest among state environmental agencies in these methods is growing rapidly. One quarter of all state environmental agencies have conducted at least one lean process improvement event and have achieved impressive results across their programs and processes.

Administrative Process Wastes

- Backlog of Work
- Errors in Documents
- Rework
- Doing Work Not Requested
- Unnecessary Process Steps
- Waiting
- Unnecessary Motion
- Transport of Documents

Lean and Six Sigma efforts identify and eliminate unnecessary and non-valued added process steps and activities that have built up over time. In non-manufacturing settings, waste is most prevalent in the information flows associated with processes. Lean and Six Sigma efforts are not just about fixing broken processes. State agencies have found that these methods enable them to understand how their processes are working on the ground and to make adjustments that optimize desired outcomes. By getting routine activities and mechanisms of a process to function smoothly and consistently, staff time can be freed to focus on higher value activities that are more directly linked to environmental protection.

What is Lean?

Lean refers to a collection of principles and methods that focus on the systematic identification and elimination of non-value added activity (waste) involved in producing a product or delivering a service to customers. Two common methods used in Lean are value stream mapping and kaizen rapid process improvement events.

Value Stream Mapping (VSM). Value stream mapping refers to the activity of developing a visual representation of the flow of processes, from start to finish, involved in delivering a desired outcome, service, or product (a "value stream") that is valued by customers. In the context of environmental agencies, a value stream could be the process of permitting the air emissions of a certain type of stationary source, approving a brownfield site for redevelopment, or hiring new agency staff. VSM examines information flows and systems, as well as the flow of the product or service product (e.g., permit) through an agency's processes. VSM can increase understanding of actual decision-making processes and identify sources of non-value added time (e.g., documents waiting to be reviewed). The typical products of a 2–5 day VSM workshop are two maps—a map of the "current state" of targeted processes and a "future state" map of the desired process flow—and an associated implementation plan for future process improvement activities.

Kaizen Events. Kaizen is a combination of two Japanese words that mean "to take apart" and "to make good." Kaizen refers to an approach to continuous improvement that is founded on the belief that small, incremental changes routinely applied and sustained over a long period result in significant performance improvements. Kaizen focuses on eliminating waste in a targeted system or process of an organization, improving productivity, and achieving sustained improvement. Kaizen activity is often focused in the form of rapid improvement events (sometimes called a kaizen blitz), which bring together a cross-functional team for two to five days to study a process and begin implementation of process changes.

What is Six Sigma?

Six Sigma is a rigorous methodology that utilizes information (management by facts) and statistical analysis to measure and improve an organization's performance, practices, and systems. The fundamental objective of Six Sigma is the implementation of a measurement-based approach that focuses on process improvement and variation reduction through the application of Six Sigma improvement projects. In the context of state agency processes, unnecessary variation in how a process is implemented can result in significant delays and poor quality of decisions and outputs, such as permits. The Six Sigma DMAIC (Define, Measure, Analyze, Improve, Control) method is a system for improving existing processes that fall below specifications. Like Lean, Six Sigma focuses on identifying and implementing steps that foster continual, incremental improvement. Six Sigma can also be used to develop new processes, services, or products at Six Sigma-quality levels (often referred to as "Design for Six Sigma").

Six Sigma is typically executed by trained personnel (often referred to as "green belts" and "black belts") who have experience with multiple performance measurement and statistical analysis techniques.

For more information on Lean and Six Sigma, see the Lean and Government Primer, *Working Smart for Environmental Protection* (PDF). For a bibliography of Lean references, click here.

Last updated on Friday, February 20th, 2009.
http://www.epa.gov/lean/improvement-methods.htm

Lean Government Initiatives at State Environmental Agencies

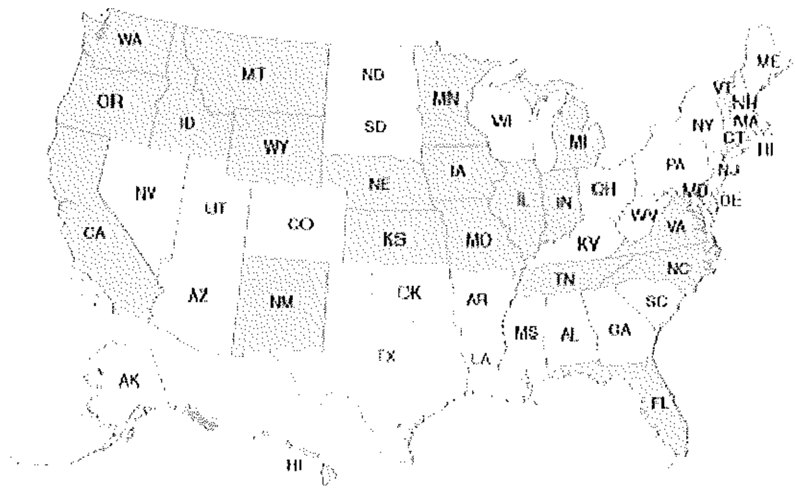
Drawing on lessons from businesses' adaptation of lean methods to eliminate waste from administrative processes, an increasing number of federal, state, and local government organizations are achieving compelling results with lean.

Interest in Lean and Six Sigma continues to grow. Since 2003, many State agencies have experienced significant efficiency gains through implementing Lean and Six Sigma methods. For example, the State of Iowa achieved significant efficiency gains through the completion of more than 65 Lean events which focused on a variety of permitting and management processes. Iowa DNR reduced the average time to issue standard air quality construction permits from 62 days to 6 days, and eliminated 70 percent of the process steps (from 23 to 7 steps). (Iowa Lean State Summary, Wastewater Case Study, Iowa Lean Article)

Other states implementing Lean include:

Lean and State Environmental Agencies

State Lean Events Completed* | State Interested in Lean



** Events EPA is aware of as of February 2009.*

- **California Department of Toxic Substances Control** held Kaizen events in August and October 2007.
- **Delaware Department of Natural Resources and Environmental Control** lowered a backlog of air construction permits from 199 to 25, while reducing the average permit processing time to less than 76 days. (State Summary)
- **Idaho Department of Environmental Quality** achieved a significant reduction in process steps and delays within their air permitting program and is planning a Kaizen event for their wastewater enforcement program in mid 2007.
- **Illinois Environmental Protection Agency** held a Kaizen event for minor source air construction permits in June 2007.
- **Indiana Department of Environmental Management** held a Kaizen event for significant source modifications to their air permitting program in early October 2007.
- **Michigan Department of Environmental Quality** decreased the time needed to process major air construction permits from 422 days to 98 days. Initial application administrative completeness rose from 82 to 95 percent. (State Summary)
- **Minnesota Pollution Control Agency** improved permitting timeliness by issuing 75 percent of NPDES permits within 180 days (from a historical baseline of 9 percent), and issued 75 percent of air construction permits within 150 days (from a historical baseline of 33 percent). MPCA has used Six Sigma methodologies to improve at least 21 agency processes. (State Summary) (Wastewater Case Study)

- **Nebraska Department of Environmental Quality** reduced the review time for ethanol plant air construction permits by 50 percent and decreased the air construction permitting backlog by 55 percent. (State Summary)
- **Tennessee Department of Environment and Conservation** conducted a Value Stream Mapping exercise in August 2007 that focused on the Aquatic Resource Alteration Permits (ARAP) program.
- **Vermont Agency of Natural Resources** completed a Kaizen event for their waste water permit program which brought about significant reductions in the number of steps and delays within the permitting process. (Wastewater Case Study)
- **Virginia Department of Environmental Quality** completed permit program reviews on their air program, hazardous waste program, solid waste program, Virginia Pollution Discharge Elimination Systems, wetland protection program, and identified numerous opportunities for process improvements.
- **Washington Department of Ecology** conducted two Lean events focusing on the financial assistance program within the water quality program and the pollution prevention planning process, both in June 2007.
- **Wyoming Department of Environmental Quality** held a Kaizen event for New Source Review oil and gas permits in June 2007. (State Summary)
- **Region 7 States (Iowa Department of Natural Resources, Kansas Department of Health and the Environment, Missouri Department of Natural Resources, and Nebraska Department of Environmental Quality)** teamed up with the EPA to hold a Lean event for water quality standards in June 2007.
- **Wyoming Department of Environmental Quality** held a kaizen event for New Source Review oil and gas permits in June 2007.

State-EPA Events

- **Region 7 States (Iowa, Kansas, Missouri, and Nebraska)** teamed up with the EPA to hold a Lean event for water quality standards in June 2007.
- **Region 7 States (Iowa, Kansas, Missouri, and Nebraska) teamed up with the EPA to hold a Lean event for the wastewater permitting review and enforcement process in August 2008.**

Additional Lean Resources and Presentations

- For more information on State Lean activities, see the Inventory of State Lean Activities (PDF) on the ECOS website.

- To learn more about how to get started with Lean and Six Sigma process improvements, see *Working Smart for Environmental Protection* (PDF)and the *Lean in Government Starter Kit*

- To view Administrative Lean presentations from the 2006 August ECOS meeting, click here (PDF).
- To view the Administrative Lean 101 presentation from the 2008 EPA-State Symposium on Innovating for Sustainable Results: Integrated Approaches for Energy, Climate and the Environment, click here. (PDF)

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http://www.epa.gov/lean/lean-initiatives.htm

Fort Wayne, IN

LEAN SIX SIGMA PROJECT SUMMARIES

Six Sigma has decreased costs, improved customer service and increased productivity throughout city government. Projects have resulted in over $10 million of savings or cost avoidance. Some specific project accomplishments include:

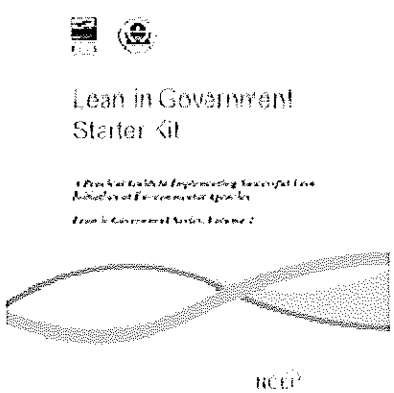
Six Sigma

1. Reducing the cost per foot of water main replacements.
2. Increased waste activated sludge processing.
3. Reducing call wait time for City Utilities customers.
4. Reducing transportation project change orders.
5. Reducing the cycle time for personal data records.
6. Increasing catch basin and inlet cleaning.
7. Increasing average chlorine dioxide generator efficiencies.
8. Decreasing the variability of slakers at water plant.
9. Reducing the number of right of way cut permit inspections.
10. Reducing the number of missed trash pickups.
11. Improving Pothole Response Time
12. Reducing the cycle time of cut restorations.
13. Reducing sprain and strain injuries at waste water and water plants.
14. Improving utility site plan routing approval process.
15. Increasing recycling participation on inner city collection routes.
16. Reducing contractor weekly payroll logging time.
17. Utilizing excess methane gas at waste water plant.
18. Increasing electrical preventative maintenance at water plant.
19. Reducing redundancy in the right of way permit process.
20. Reducing the Turnaround Time in the Site Plan Routing Review Process.
21. Reducing Water Main Design Costs.

Lean Six Sigma

1. Barrett Monthly Reporting Process Overview
2. Wage Review Project Overview
3. Encroachment License Routing Project Overview
4. Work Orders Process Overview
5. Collection and Litigation Project Overview
6. Credit and Collection Project Overview
7. Credit Off Recheck Work Order Project Overview
8. Work Order Desk Mail Merge
9. IS/TO Read Only Work Order Processes Overview
10. Site Plan Routing Review - Project Overview
11. Land Acquisition ROW Engineering Process Overview
12. Land Acquisition ROW Services Process Overview
13. Requisition Process for Construction Contracts Overview
14. Backflow Prevention Overview
15. Water Meter Work Order Process Project Overview
16. Operator Utilization Overview
17. OEE-TPM Process - Project Overview
18. Make Tapes Process Project Overview
19. Civil Accounting CIP Tracking - Project Overview
20. Hiring Process - Project Overview
21. Tort Claim Process Project Overview

Lean in Government Starter Kit



Download the Starter Kit

PDF, 70 pages, 456KB, About PDF

The *Lean in Government Starter Kit: A Practical Guide to Implementing Successful Lean Initiatives at Environment Agencies* (Lean in Government Series: Volume 2) is designed to help government agencies plan and implement successful Lean events. The Starter Kit contains practical tools, resources, and tips for:

1. how to get started with Lean;
2. how to implement and manage the phases of a Lean event; and
3. how to sustain and diffuse Lean activity within an organization.

The Starter Kit also answers questions to help agency managers determine whether Lean is right for their agency, and presents ideas for agencies interested to expand their Lean initiatives. Each section includes downloadable resources that can be tailored to meet your needs. The possibilities are exciting, whether you plan to use Lean for targeted problem-solving or to transform the culture of your agency. Whatever your path, this Starter Kit will help you get the most out of your Lean events and activities.

Contents

To download the Lean in Government Starter Kit (PDF, 70 pages, 456KB), click here.

Appendices

Last updated on Friday, February 6th, 2009.
http://www.epa.gov/lean/starterkit/index.htm

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Increase Your Organization's Performance Using Lean, Six Sigma & TOC

TTTransformations, LLC is a consulting practice established to eliminate waste, improve operational consistency, increase on time delivery, lower inventory and increase capacity. The benefits for your organization are lower costs, improved profits, higher quality and improved customer satisfaction.

Tom Nelson has worked as a Lean Six Sigma Theory of Constraints (TOC) Program Manager and Master Black Belt. He has over 30 thirty years global experience at Praxair, including Asia and Europe with a proven record of results using Lean Six Sigma TOC. From 2005 to 2008, the Praxair Electronics Division exceeded the plan for financial benefits by 24% to 48%. His expertise includes Lean Specialist, Certified Six Sigma Black Belt, and TOC Production and Distribution Expert.

Benefits for Your Organization	**Tom Nelson Lean Six Sigma TOC Skills/Experience**
Lower manufacturing and administrative costs through process improvements.	⇨ Eliminated 90% of ceramic chuck parts outsourcing costs by reducing manufacturing time which increased internal production capacity.
Improve on-time delivery by reducing cycle time.	⇨ Achieved 50% order fulfillment time reduction for gas equipment replacement parts. Performed Value Add analysis on the order process and removed non-value add steps from the work process.
Lower inventory carrying costs by reducing inventory levels for work in progress and finished goods.	⇨ Lowered finished goods inventory 25% and improved on-time delivery 30% for semiconductor cylinder gases. Performed Value Stream Mapping for key operations and distribution processes. ⇨ Reduced cylinder valve inventory 25%. Implemented Lean kanbans and make to stock and make to order methods for replenishment.
Decrease product cost and meet customer requirements	⇨ Reduced product cost by 40% for semiconductor gas systems equipment. Analyzed customer needs & satisfaction requirements, then determined product features to meet customer needs.
Increase production capacity to meet market demand while minimizing labor and capital costs	⇨ Increased capacity 30% for liquid fill products to meet higher market demand with minimal capital cost. Used TOC five step methodology to analyze production capacity. ⇨ Increased production capacity 40% for semiconductor targets. Used Value Stream Mapping and bottleneck analysis to determine options for capacity increase.
Establish a Lean Six Sigma TOC program in your organization.	⇨ Trained Black/Green Belts and Lean Practitioners on Six Sigma, Lean and Theory of Constraints methods. System administrator for savings database, led annual forecast planning and provided savings reports.

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Shown below is a partial list of the Lean, Six Sigma and TOC tools and methods that TTTransformations can provide to increase your organization's performance.

Lean	Six Sigma	TOC
5S (Sort, Straighten, Shine, Standardize & Sustain)	DMAIC (Define, Measure, Analyze, Improve & Control) Method	Five Focusing Steps (Identify, Exploit, Subordinate, Elevate, Go Back to Step 1)
Kaizen Events	Problem/Opportunity Statement	Capacity Constraints Analysis
Value Add/NonValue Add Analysis	SIPOC (Supplier Input Process Output Customer) Diagram	Constraint Identification (Internal & External)
Process Value & Cycle Time Analysis	Process & Population Sampling	DBR (Drum Buffer Rope) Production Scheduling
VSM (Value Stream Mapping)	DPMO (Defects per Million Opportunities)	Inventory Levels: [RRI (Reliable Replenishment Interval), RRT (Reliable Replenishment Time) & Customer Demand (including demand variations]
Pull Systems (Replenishment: Production, Purchase & 2 Bin)	MSA (Measurement Systems Analysis/Gage R&R)	
Kanban Signals	Hypothesis Testing	
Setup Reduction	Regression & Correlation	Buffer Sizing (Production & Inventory)
Standardized Work	ANOVA (Analysis of Variance)	
Spaghetti (workflow) Diagrams	FMEA (Failure Mode Effects Analysis)	Buffer & Inventory Zone Control
TPM (Total Preventive Maintenance)	DOE (Design of Experiments)	MTS (Make to Stock) & MTO (Make to Order) Products
Visual Process Controls	Control & Response Plans	TOC Accounting (Throughput, Inventory & Operating Expense)
Metrics & Dashboards	Control Charts	

Credentials

- Lean Six Sigma TOC Program Manager
- Master Black Belt & Lean Specialist
- Quality Systems Manager
- Customer Focus Manager
- Quality Manager
- International Business Development Manager
- Technology Program Manager
- Merchant Products Manager
- Technical Applications Market Manager
- Region Sales Engineer

Education

- MBA, Western Connecticut State University, Danbury, CT
- BS with engineering major, Illinois Institute of Technology, Chicago, IL
- BS with chemistry major, University of Nebraska, Lincoln, NE

Certificates

- ASQ (American Society for Quality) Certified Black Belt
- ASQ Certified Quality Engineer
- ASQ Certified Quality Auditor