II. LEAN SIX SIGMA TOOLS

OUR PLANS MISCARRY BECAUSE THEY HAVE NO AIM. WHEN A MAN DOES NOT KNOW WHAT HARBOR HE IS MAKING FOR, NO WIND IS THE RIGHT WIND.

SENECA (4 B.C. - 65 A.D.)

II. LEAN SIX SIGMA TOOLS
VALUE OF LEAN SIX SIGMA

Lean Six Sigma Goals

The subject of Lean Six Sigma Goals is presented in the following topic areas:

- **Value of lean six sigma**
- **Origins of six sigma and lean**
- **Lean pioneers**
- **Quality and six sigma gurus**
- **Organizational leadership**
- **Metrics and goals**

Value of Lean Six Sigma

There is an ongoing debate in some organizations regarding the difference between lean and six sigma, and whether they are mutually exclusive. Toyota in particular is credited with making lean a well-known approach as embodied in the Toyota Production System (TPS). Lean is about eliminating wastes, taking time out of processes, and creating better flow.

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Value of Lean Six Sigma (Continued)

Six sigma has been defined in a variety of ways. One definition states, "Six sigma is ... a business strategy and philosophy built around the concept that companies can gain a competitive edge by reducing defects in their industrial and commercial processes."

Lean and six sigma are compared below.

Topic	Six Sigma	Lean
Improvement	Reduce Variation	Reduce Waste
Justification	Six Sigma (3.4 DPMO)	Speed (velocity)
Main Savings	Cost of Poor Quality	Operating Costs
Learning Curve	Long	Short
Project Selection	Various Approaches	Value Stream Mapping
Project Length	2 - 6 Months	1 Week - 3 Months
Driver	Data	Demand
Complexity	High	Moderate

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Value of Lean Six Sigma (Continued)

Both six sigma and lean focus heavily on satisfying customers. Six sigma makes customers the primary driver for action in a "war on variation" and identifies opportunities that promise a large, fairly immediate, financial reward. Lean considers customer inputs and conducts a "war on waste."

Both six sigma and lean empower people to create process stability and a culture of continuous improvement. The cornerstones of a lean strategy are tools such as value stream mapping (VSM), workplace organization (5S), total productive maintenance (TPM), kanban/pull systems, kaizen, setup reduction, teamwork, error proofing, problem solving, cellular manufacturing, and one-piece flow.

Many problem identification and problem solving techniques are commonly used with both lean and six sigma methodologies. These include brainstorming, cause-and-effect diagrams, 5 "whys", Pareto analysis, 8-Ds, FMEAs, and others.

II. LEAN SIX SIGMA TOOLS
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Value of Lean Six Sigma (Continued)

Both six sigma and lean methodologies have a heavy emphasis on careful problem definition. Six sigma better promotes a rigorous, systematic process to find the true root cause(s) of the problem.

Value stream mapping (VSM) is the principal lean diagnostic tool. It is credited to Toyota, who called it material and information flow mapping. VSM creates a visual representation of what is happening in a process to improve system performance. Process mapping is a tool favored by the six sigma community and is best used to identify the inputs, outputs, and other factors that can affect a process.

Ron Crabtree feels that lean approaches should precede and coexist with the application of six sigma methods because lean provides stability and repeatability in many basic processes. Once stability has taken hold, much of the variation due to human processes goes away. The data collected to support six sigma activities thereby becomes much more reliable and accurate.

II. LEAN SIX SIGMA TOOLS
VALUE OF LEAN SIX SIGMA

Value of Lean Six Sigma (Continued)

If major business problems fall into the following categories:

- **There seems to be a lot of waste**
- **Inventories and redundancies must be minimizied**
- **There is a need to improve work flows**
- **There is a need to speed up processes**
- **There are human mistakes**

If so, then lean tools should be utilized to:

- **Eliminate wastes**
- **Increase speeds**
- **Minimize inventories**
- **Simplify processes**
- **Improve flows**
- **Mistake proof processes**

II. LEAN SIX SIGMA TOOLS
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Value of Lean Six Sigma (Continued)

If organization challenges exhibit the following attributes:

- **There are quality issues**
- **There is excessive variation**
- **There are complex problems**
- **There are challenging root cause identifications**
- **There are numerous technical considerations**

In these cases, six sigma tools should be utilized to:

- **Minimize variation**
- **Apply scientific problem solving**
- **Utilize robust project chartering**
- **Focus on quality issues**
- **Employ technical methodologies**

Most executives recognize that they have both sets of issues. Lean six sigma is a relatively new paradigm providing broader selection approaches. If the only tool in a company's bag is a hammer, then all problems start to look like a nail. It is best to have a tool kit with a broader set of tools.

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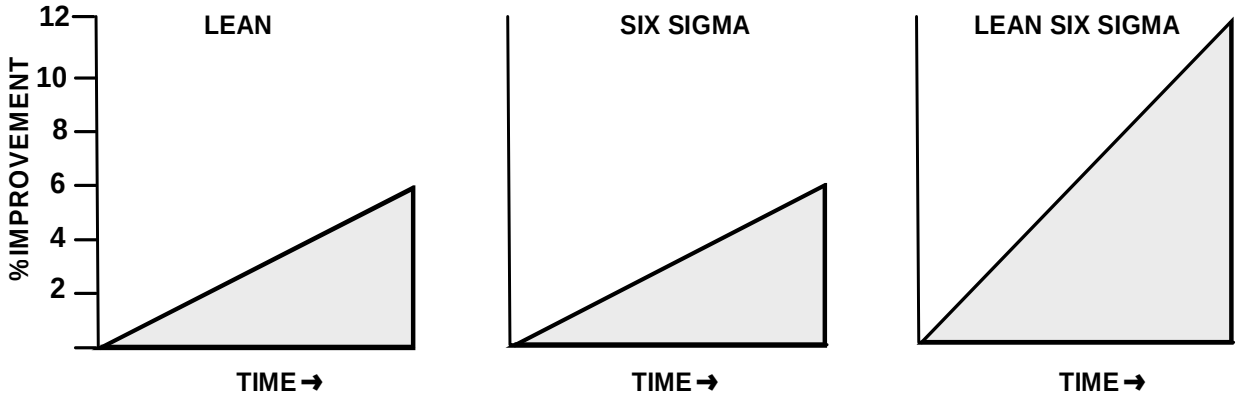
Value of Lean Six Sigma (Continued)

What has been occurring for some time (at least the past several years) is a marriage of lean and six sigma initiatives into a unified approach called lean six sigma or some variant of this nomenclature. Presented graphically, if lean specific projects represent a 6% corporate improvement over time, and six sigma initiatives represent another 6% improvement, then a combination could potentially represent an improvement of 12% (or more). Refer to the Figure below:



Various authorities tout improvements (margins, inventory reductions, waste eliminations, etc.) ranging from 2% to 20%. These percentages depend upon the industry and the initial measurement base.

II. LEAN SIX SIGMA TOOLS
VALUE OF LEAN SIX SIGMA

Value of Lean Six Sigma (Continued)

An increasing number of organizations have been unifying their efforts into a lean six sigma approach. The mechanisms of these combinations vary widely. The most effective approaches include management direction and involvement, a cadre of trained specialists, the use of teamwork, the use of project management, team member training, the humane treatment of people, an understandable problem solving methodology, and some mechanism to apply the appropriate tool(s).

On the following pages are additional descriptions of six sigma and lean enterprise. The Primer unifies the discussion of lean six sigma by use of the DMAIC problem solving approach. Obviously, other systems would work equally well.

II. LEAN SIX SIGMA TOOLS
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Value of Lean Six Sigma (Continued)

The Table below displays some applications of the various lean six sigma tools at various problem solving stages.

Define	Measure	Analyze	Improve	Control
Value Stream Mapping	Prioritization Matrices	Regression Analysis	DOE	SPC
Charter - Problem Statement	MSA Studies	5 - Whys	Kaizen Events	Visual Controls
Voice of the Customer	Capability Studies	Cause - Effect Diagrams	TOC	Control Plans
Communication Plans	Videotaping	Root Cause Analysis	Pull Systems	TPM
CTQ Issues	Time Studies	ANOVA	SMED/SUR	Standard Work
Business Results	SIPOC	Multi-Vari Analysis	5S or 6S	Procedures and Work Instructions
Benchmarking	Collecting Data	Hypothesis Testing	Work Flow Improvement	Training Requirements

Lean Six Sigma Tools in a DMAIC Matrix.

The student should note that there are a multitude of effective tools in addition to those listed above.

II. LEAN SIX SIGMA TOOLS
ORIGINS OF SIX SIGMA AND LEAN

Six Sigma Introduction

Six sigma is a highly disciplined process that focuses on developing and delivering near-perfect products and services consistently. Six sigma is also a management strategy to use statistical tools and project work to achieve breakthrough profitability and quantum gains in quality.

Snee describes six sigma as, "A business improvement approach that seeks to find and eliminate causes of mistakes or defects in business processes by focusing on outputs that are of critical importance to customers."

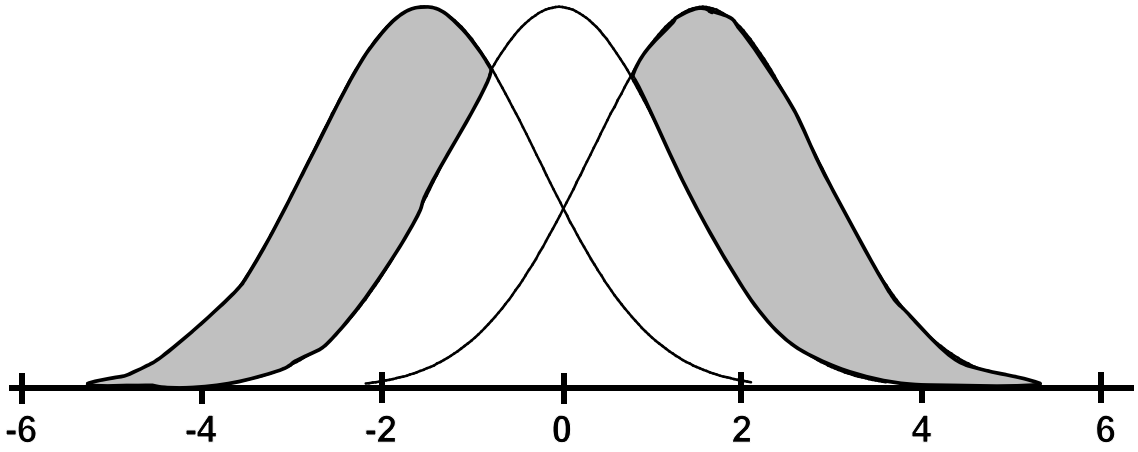
Motorola, under the direction of Chairman Bob Galvin, used statistical tools to identify and eliminate variation. From Bill Smith's yield theory in 1984, Motorola developed six sigma as a key business initiative in 1987.

Motorola noted that many operations, such as complex assemblies, tended to shift 1.5 sigma over time. So a process, with a normal distribution and normal variation of the mean, would need to have specification limits of ± 6 sigma in order to produce less than 3.4 defects per million opportunities.

II. LEAN SIX SIGMA TOOLS
ORIGINS OF SIX SIGMA AND LEAN

Six Sigma Introduction (Continued)

The following Figure illustrates the ±1.5 sigma shift. The Table below indicates possible defect levels.



Sigma Level	ppm
6 sigma	3.4 ppm
5 sigma	233 ppm
4 sigma	6,210 ppm
3 sigma	66,810 ppm
2 sigma	308,770 ppm
1 sigma	697,672 ppm

Appendix Table II provides defect levels at other sigma values.

II. LEAN SIX SIGMA TOOLS
ORIGINS OF SIX SIGMA AND LEAN

Six Sigma Introduction (Continued)

The six sigma steps for many organizations are described as DMAIC:

Define: Select the appropriate responses (the "Ys") to be improved.

Measure: Gather data to measure the response variable.

Analyze: Identify the root causes of defects, defectives, or other deviations whether in or out of specifications. These are the "Xs" (independent variables).

Improve: Reduce variability or eliminate the cause.

Control: With the desired improvements in place, monitor the process to sustain the improvements.

II. LEAN SIX SIGMA TOOLS
ORIGINS OF SIX SIGMA AND LEAN

Six Sigma Introduction (Continued)

Because of the integration of a number of tools, such as lean manufacturing, DOE (design of experiments), and DFSS (design for six sigma), six sigma has been referred to as TQM (total quality management) on steroids.

The business successes that result from a six sigma initiative include:

- **Cost reductions**
- **Market share growth**
- **Defect reductions**
- **Culture changes**
- **Productivity improvements**
- **Customer relations improvements**
- **Product and service improvements**
- **Cycle time reductions**

II. LEAN SIX SIGMA TOOLS
ORIGINS OF SIX SIGMA AND LEAN

Six Sigma Results

Harry reports that the average black belt (or green belt) project will save about $175,000. There should be about 5 to 6 projects per year, per black belt. The ratio of 1 black belt per 100 employees, can provide a 6% cost reduction per year. For larger companies, there is usually 1 master black belt for every 100 black belts.

Snee provides some reasons why six sigma works:

- **Bottom line results**
- **Senior management is involved**
- **A disciplined approach is used (DMAIC)**
- **Short project completion times (3 to 6 months)**
- **Clearly defined measures of success**
- **Infrastructure of trained individuals**
- **Customers and processes are the focus**
- **A sound statistical approach is used**

A number of companies that have embraced six sigma are listed in the Primer.

II. LEAN SIX SIGMA TOOLS
ORIGINS OF SIX SIGMA AND LEAN

Lean Enterprise

The lean enterprise encompasses the entire production system, beginning with the customer. No implementation of lean manufacturing can reach its full potential without including the entire enterprise in its planning.

Lean Manufacturing

Lean techniques are, in their most basic form, the systematic identification and elimination of wastes, the implementation of the concepts of continuous flow, and customer pull. The touted benefits of lean production systems include lower production costs, fewer personnel, quicker product development, higher quality, higher profitability, and greater system flexibility. By continually focusing on waste reduction, there is truly no end to the benefits that can be achieved.

Generally, five areas drive the lean producer: cost, quality, delivery, safety, and morale.

II. LEAN SIX SIGMA TOOLS
ORIGINS OF SIX SIGMA AND LEAN

Lean Techniques in Service

Are lean techniques applicable in a service-oriented industry or office environment? Every system contains waste. Whether one is producing a product, processing a material, or providing a service, there are elements which are considered waste. The techniques for analyzing systems, identifying and reducing waste, and focusing on the customer are applicable in any system, and in any industry.

II. LEAN SIX SIGMA TOOLS
LEAN PIONEERS

Lean Pioneers

Major contributors to lean enterprise are listed below:

Lean Pioneer	Contribution
Frederick Taylor	Wrote *Principles of Scientific Management* Divided work into component parts Was the foremost efficiency expert of his day Applied scientific methods to maximize output
Henry Ford	Known as the father of mass production Advocated waste reduction Founded Ford Motor Company Brought affordable transportation to the masses
Sakichi Toyoda	Known as a hands-on inventor Developed the jidoka concept Initiated the Toyota Motor Company (TMC)
Kiichiro Toyoda	Promoted mistake proofing concepts Became president of Toyota Motor Company
Eiji Toyoda	Developed an automotive research lab Hired outstanding people within TMC Became the Chairman of TMC
Taiichi Ohno	Created the Toyota production system (TPS) Integrated the TPS into the supply chain Had the vision and focus to eliminate waste
Shigeo Shingo	Developed the SMED system Assisted in the development of TPS elements
James Womack Daniel Jones	Well-known promoters of lean enterprise Co-authors of major lean thinking books
Anand Sharma	CEO of TBM Consulting Group Author of prominent books on lean enterprise
Michael L. George	Widely known for lean six sigma books Founder of the George Group