Understanding the Difference Between Six Sigma and Lean in the Supply Chain

Gary Jing, PhD, MBB

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The Tie Between the Speaker & the Topic

- MS in Reliability & Applied Statistics
- PhD in IE
- Editorial Review Board of Six Sigma Forum Magazine
- Founding MBB at Seagate TCO, the world largest disc drive design center (1998 - 2005)
- 2 patents in disc drive modeling generated from his Sigma work
- Personally trained dozens of BB/GB’s.
- Sr. Mgr., Global Lean Sigma / MBB, Entegris (2005 - present)
  - The group resides in Global Supply Chain, which manages the manufacturing section of the corporation.
Personal Philosophy – Striving for Balance

Topics to be Covered

- The Tie Between the Speaker & the Topic
- Define “Lean” & “Six Sigma”
- The Linkage Between Different Problem Solving Approaches
- A Comparison Between Lean and Six Sigma
- Various Lean - Sigma Integration Models Adopted by Companies
  - Entegris Model: Real examples showing that Lean & Sigma are embedded in each other
  - Seagate Model
- Typical Challenges When Bringing Sigma into a Lean Environment.
- Your Takes vs. Our Takes
Define “Lean” & “Sigma”

**Lean Program**
- An improvement approach aimed to primarily improve efficiency through removing wastes. Positively correlated

**Six Sigma Program**
- An improvement approach aimed to primarily improve process capability through reducing variation.

**Lean (Six) Sigma Program**
- An improvement program/approach aimed to combine both and improve efficiency & capability through primarily removing wastes & variation.

How Does “Lean” See the World – Waste/ Loss

**Eight Major Wastes**
1. Excess Inventory
2. Waiting
3. Overproduction
4. Rework
5. Over processing
6. Excess motion
7. Transportation
8. Underutilized people

**Six Major Losses**
1. Breakdown Losses
2. Set-up and Adjustment Losses
3. Idling and Minor Stoppages
4. Reduced Speed Losses
5. Quality Defects and Rework
6. Start-up and Yield Losses
**Supply Chain Excellency**

**Lean Production System**

**Just in Time**
- One-piece Flow
- Cellular Manufacturing
- Pull System
- Standardization
- Setup Reduction
- Inventory Control
- Cross-functional Assoc

**Jidoka**
- Visual Control
- 5S / Andon
- Response to Abnormality
- Mistake-proofing (Poke-Yoke)
- Ergonomics
- Autonomation
- TPM

**Production Smoothing**

- Kaizen event is the most popular venue.

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**How Does “Six Sigma” See the World**

**Defects**

“Six Sigma” means:

1. A statistical term & business metric.
2. A business strategy & initiative.
3. A problem solving / preventing system & methodology - DMAIC.
**DMAIC Process (Roadmap)**

- **Define**
  - Define the problem;
  - Establish project charter (goals, scope, team & timeline)

- **Measure**
  - Identify customer requirements / Critical To Quality (CTQ’s)
  - Translate into measurable Key Process Output Variables (KPOV’s)
  - Verify measurement system
  - Establish present capability

  - **Identify any factors / Key Process Input Variables (KPIV’s) that may potentially affect the outputs (KPOV’s) through process mapping**

  - **Establish high potential suspects (hypotheses) through cause-effect analysis** (subjective analysis using experiences & expertise)

- **Analyze**
  - Validate the suspects / hypotheses using existing data through statistical testing (objective analysis)

  - Reduce list of high potential KPIV’s to vital few

- **Improve**
  - Generate improvement ideas using soft tools (subjective)
  - Use DOE to generate new data when no existing data available and to optimize & validate outputs (objective)

- **Control**
  - Put in place permanent controls

**DMAIC Mind Set**

<table>
<thead>
<tr>
<th>Process Map</th>
<th>30 - 50</th>
<th>Inputs Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>C&amp;E and FMEA</td>
<td>10 - 15</td>
<td>Key Process Input Variables (KPIVs)</td>
</tr>
<tr>
<td>Gage R&amp;R, Capability</td>
<td>8 - 10</td>
<td>KPIVs</td>
</tr>
<tr>
<td>Multi-Vari Studies, Correlations</td>
<td>Improve</td>
<td>4-8</td>
</tr>
<tr>
<td>T-Test, ANOM, ANOVA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Screening DOE’s</td>
<td>Improve</td>
<td>4-8</td>
</tr>
<tr>
<td>DOE’s, RSM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality Systems</td>
<td>Control</td>
<td>3-6</td>
</tr>
<tr>
<td>SPC, Control Plans</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The Linkage Between Different Problem Solving Approaches

- Although they look different, they are alike in nature

MAIC vs. Alternative Models

![Diagram showing the seven steps of DMAIC and other models]

- Seven-Step
- DMAIC
- PDSA/PDCA
### Sample Agenda for Six Sigma Training*

<table>
<thead>
<tr>
<th>Topic</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intro to Course</td>
<td>1.0 hr</td>
</tr>
<tr>
<td>Intro to Six Sigma</td>
<td>3.0</td>
</tr>
<tr>
<td>Defining Projects</td>
<td>3.0 - 7.0</td>
</tr>
<tr>
<td>Intro to <strong>Measure</strong></td>
<td>0.5</td>
</tr>
<tr>
<td>Define the <strong>Process</strong></td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Cause - Effect Analysis</strong></td>
<td>2.5</td>
</tr>
<tr>
<td><strong>FMEA / PPA</strong></td>
<td>1.5</td>
</tr>
<tr>
<td>Data and Graphical Analysis</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Measurement Sys Analysis</strong></td>
<td>1.5</td>
</tr>
<tr>
<td>Process Capability</td>
<td>2.0</td>
</tr>
<tr>
<td>Wrap Up</td>
<td>0.5 - 14.0</td>
</tr>
<tr>
<td>Intro to Analyze</td>
<td>0.5</td>
</tr>
<tr>
<td>Basic Statistics - Testing</td>
<td>2.0</td>
</tr>
<tr>
<td>Contingency Tables</td>
<td>1.0</td>
</tr>
<tr>
<td>Sample Size Selection</td>
<td>1.0</td>
</tr>
<tr>
<td>Regression Analysis</td>
<td>2.0</td>
</tr>
<tr>
<td>Wrap-Up</td>
<td>0.5 - 7.0</td>
</tr>
<tr>
<td>Intro to Improve</td>
<td>0.5</td>
</tr>
<tr>
<td>Introduction to Experimentation</td>
<td>1.0</td>
</tr>
<tr>
<td>2 x 2 Experiments</td>
<td>2.0</td>
</tr>
<tr>
<td>DOE Exercise</td>
<td>2.0</td>
</tr>
<tr>
<td>Improving a <strong>Business Process</strong></td>
<td>1.5 - 7.0</td>
</tr>
<tr>
<td>Intro to Control</td>
<td>0.5</td>
</tr>
<tr>
<td>Surveys</td>
<td>1.5</td>
</tr>
<tr>
<td>Control Plan</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Statistical Process Control</strong></td>
<td>2.0</td>
</tr>
<tr>
<td>Agent of Change</td>
<td>1.0</td>
</tr>
<tr>
<td>Wrap-Up, Evaluation</td>
<td>0.5 - 7.0</td>
</tr>
</tbody>
</table>

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*GB Transactional. A BB training is like a mini MS program in IE.*

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### Six Sigma Tools

#### Soft Tools
- 5 S’s
- Structured Brainstorming
  - Mind mapping
  - Affinity diagram
- Cause Effect
  - “5 Whys”
  - Fish Bone Diagram
  - Root Cause Analysis
- Process Mapping
  - Non value added
  - Hidden factory
- Preventive Control Plan
  - PPA
  - FMEA
- Error Proofing

#### Hard Tools
- Gage R&R
- Capability Analysis
- Multi-Variant Studies
- T-Test
- Correlation
- Regression
- ANOM
- ANOVA
- DOE
- SPC

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DMAIC Embedded in Kaizen

Kaizen Breakthrough Methodology from TBM

Day 1
- Conceptual training on:
  - Business Process Kaizen
  - Standard Operations
  - 5S
  - Kaizen Methodology
  - Tools & Techniques

Day 2
- Project-Specific Training
- Measure & Analyze Current Work Process
- Formulate Process Improvements

Day 3
- Simulate & Refine Improvements

Day 4
- Evaluate Improvements
- Establish New Standard Process
- Operate Using New Standard Process
- Finalize New Standard Process

Day 5
- Present Results and Celebrate!

A Comparison Between Lean & Six Sigma

- Everyone develops a perspective upon exposure to both
  - Much Literature available
  - What's my take?
## A Comparison Between Lean and Six Sigma

<table>
<thead>
<tr>
<th>Differentiation</th>
<th>Lean</th>
<th>Six Sigma</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Interest</strong></td>
<td>Remove waste</td>
<td>Reduce variation</td>
</tr>
<tr>
<td><strong>The Way They Look at the World</strong></td>
<td>Flow / waste</td>
<td>Problem / defect</td>
</tr>
<tr>
<td><strong>Primary Effect</strong></td>
<td>Reduce waste and smooth flow</td>
<td>Reduce defects through reducing variation</td>
</tr>
<tr>
<td><strong>Secondary Effects</strong></td>
<td>Less inventory, fast throughput, better performance, more uniform output, less variation, improved quality.</td>
<td>Improved quality, better performance, less waste, less inventory, fast throughput, uniform process output.</td>
</tr>
<tr>
<td><strong>Format</strong></td>
<td>Typically Kaizen event format; concentrated resources in short timeframe; best for quick &amp; initial gain.</td>
<td>Project format; resources spread over months; suitable for long-term, in-depth study.</td>
</tr>
</tbody>
</table>

## A Comparison Between Lean and Six Sigma (cont.)

<table>
<thead>
<tr>
<th>Differentiation</th>
<th>Lean</th>
<th>Six Sigma</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Approach</strong></td>
<td>Has selected sets of approaches for selected sets of situations: e.g., 5S, visual control, setup reduction, etc.</td>
<td>Generic approach DMAIC; one size fits all.</td>
</tr>
<tr>
<td><strong>Efficiency</strong></td>
<td>More efficient in selected sets of situations: e.g., 5S, visual control, setup reduction, leadtime reduction, etc.</td>
<td>Allows more thorough study, more &quot;science&quot;, but not as efficient in selected applications.</td>
</tr>
<tr>
<td><strong>Limitation</strong></td>
<td>Statistical data analysis not emphasized; relies more on intuition &amp; common sense.</td>
<td>System view limited; may &quot;over spend&quot; when problem and solutions are simple and apparent.</td>
</tr>
<tr>
<td><strong>Tools</strong></td>
<td>Six Sigma tools ~ Lean tools + Statistics</td>
<td></td>
</tr>
</tbody>
</table>

*The materials integrity management company*
Problem Types to be Solved

<table>
<thead>
<tr>
<th>Problem Type</th>
<th>Lean</th>
<th>Supply Chain</th>
<th>Six Sigma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle Time Reduction</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Inventory Reduction</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Defect Reduction</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost Reduction</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Low Efficiency Improvement</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Process Design &amp; Improvement</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

They each have their own emphasis, but can ultimately achieve similar results with different efficiency.

Conclusion

- Lean & Sigma each emphasizes and is more efficient than the other in certain areas.
- Going deeper, each alone can achieve the very similar results; yet combined they can leverage each other and be more efficient & effective.
- Practitioners should learn both Lean & Sigma.
Various Lean - Sigma Integration Models Adopted by Various Companies

Possible Integration Model: Tier-Based Integration

<table>
<thead>
<tr>
<th>Differentiate the problem</th>
<th>Lean (Kaizen)</th>
<th>Six Sigma</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>By size</strong></td>
<td>Small or tactical projects ( &lt; 1 Mon ). The first step in improvement. The 1st punch.</td>
<td>Large or strategic projects ( &gt; 1 Mon ). The second step in improvement. The 2nd punch.</td>
</tr>
<tr>
<td><strong>By timeframe</strong> (to solve)</td>
<td>Weeks</td>
<td>Months</td>
</tr>
<tr>
<td><strong>By format</strong></td>
<td>Fulltime dedicated team - event</td>
<td>Part time dedicated team - project</td>
</tr>
<tr>
<td><strong>By nature</strong></td>
<td>Time reduction / waste</td>
<td>Process variation</td>
</tr>
<tr>
<td><strong>By the doer</strong></td>
<td>Lean practitioner</td>
<td>Sigma practitioner</td>
</tr>
</tbody>
</table>

Most people differentiate by one or a combination of them.
Various Integration Models In Practice

**Entegris Model:**
- Tier based application +
- Embed Sigma in Kaizen: Example - [Kaizen event involving DOE](#)
- Embed Kaizen in Sigma: Example - [Scrap reclaim project](#)

**Seagate Model:**
- GB projects cover traditional Kaizen level improvements
- Lean focuses more on higher-level, supply chain activities.

Seagate Model: Improvement Methodologies

```
Lean

Define

Measure

Analyze

Improve

Control

Six Sigma

Identify

Design

Optimize

Validate
```
Challenges in Integration

When Bringing Sigma into a Heavily Lean-Oriented Environment

1. Lack of understanding of the differences between Lean & Sigma.
2. Deeply-rooted mindset to use Lean way to see & solve problems.
3. “We don’t need Sigma if we really do Lean well”.
   - From a Shingo award winner.

Tips / experience:
- I was forced to develop a module (like this one) to address the relationship.
- Quick success of a couple of Sigma projects with good impact will be very helpful in turning the tide.

Challenges in Integration (cont.)

When Bring Sigma into a Poorly Managed Environment (e.g., some of our sites) - Reality is Far From Ideal
- Unstable organization.
  - Frequent management changes / Candidates move around
  - Trainees over-committed: adding up various commitments from management requires 150~200% of nominal work hours
  - “Remodeling while the house is on fire.”

Tips / experiences
- More improvements are achieved through Lean activities in nature.
- Leverage can be acquired by tying projects to daily work.
- Need strong centralized leadership, personal level incentives/metrics.
Our Takes – The Summary

- Lean & Sigma each emphasizes and is more efficient than the other in certain areas.
- Lean & Sigma are embedded within each other and can provide a “one – two punch”.
- *Differentiate* Lean & Sigma activities by size, time, nature, format or simply the practitioner.
- Practitioners should learn both to be more efficient & effective.
- There are challenges when adding Sigma to Lean. Some tips / experiences are shared.

Your Takes – Q&A


• Contact: [gary_jing@entegris.com](mailto:gary_jing@entegris.com), [gary_jing@yahoo.com](mailto:gary_jing@yahoo.com)