Lean and Green @
Virginia Manufacturing Summit

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October 7, 2009
Overview

1. Connection Between Lean & Clean
2. Elements of the Review Process
3. Enhancing a VSM
4. Measurement and metrics
5. L & G Project – ABB, South. Boston
Challenges

• Increasing environmental requirements around the globe
• Earth’s limited resources
• Population expected to grow by 50% over next four decades
• CO$_2$ emissions and global warming
Opportunities

• Manufacture in an efficient, cost effective way that minimizes impact on the environment

• Develop and market new products and services to address the challenges
Module 1

The Connection Between 
Lean & Clean
What is Lean?

Lean is:

A systematic approach to identifying and eliminating "waste" (non-value added activities) through continuous improvement by flowing the product at the pull of the customer in pursuit of perfection.

—The MEP Lean Network
What is Waste?

**Waste** is:

Anything other than the *minimum* amount of equipment, **materials**, parts, space, and worker’s time which are absolutely necessary to add value to the product.

- Shoichiro Toyoda, President, Toyota
What is Clean?

Clean is:

A systematic approach to eliminating waste by optimizing use and selection of resources and technologies while lessening the impact on the environment.
Combining Lean and Clean

What’s the advantage of combining lean with clean?

<table>
<thead>
<tr>
<th>Traditional “Lean” Eliminates</th>
<th>“Clean” Strives For</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defects</td>
<td>Non-toxic substitutes</td>
</tr>
<tr>
<td>Overproduction</td>
<td>Optimized raw material use</td>
</tr>
<tr>
<td>Waiting</td>
<td>Water use and wastewater reductions</td>
</tr>
<tr>
<td>Non-utilized resources</td>
<td>Air emission reductions</td>
</tr>
<tr>
<td>Transportation</td>
<td>Solid and hazardous waste reductions</td>
</tr>
<tr>
<td>Inventory</td>
<td>Transport packaging optimization</td>
</tr>
<tr>
<td>Motion</td>
<td>Energy efficiency</td>
</tr>
<tr>
<td>Extra processing</td>
<td></td>
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</tbody>
</table>
The Need for Lean & Clean

Pressures on American supply chains

• Global competition leading to loss of manufacturing jobs in US.
• Greater pressure on companies to minimize environmental impact
• Growing trends to market focusing on environmentally friendly products
• Business-to-business specifications, e.g., the Wal-Mart “scorecard”
Relationships Between Lean and Clean

• Optimize Material Use → Less Scrap = Reduced Solid Waste

• Reduce Inventory → Less Chemical Spoilage = Reduced Hazardous Waste

• Reduce Overproduction → Less Runtime = Energy Savings

• Reduce Transportation → Less Fuel Consumption = Reduce Air Emissions
Lean & Clean: Highly Complementary

- Focus on systematic and on-going efforts to identify and eliminate waste
- Seek active employee participation in improvement activities
- Emphasize the importance of using metrics to inform decisions
- Seek engagement with the supply chain to improve enterprise-wide performance
Module 2

Understanding the Review Process
What Makes Up A Review?

- Pre-assessment
- Training
- Value Stream Mapping
- Goal Setting
- Technical Assistance
- Final Report
- Follow-up
Who Participates?

• Involve the right people
• Balance a cross-functional team
  – Managers and shop personnel
  – Environmental health and safety
  – Consider engineering and purchasing departments
• Decision-makers need to be available
• Make-up of every review team varies
• Should represent the objectives and goals of project
Module 3

Value Stream Mapping
What is Value Stream Mapping?

**Value Stream Mapping** - is a traditional Lean exercise used to understand the sequence of activities that take place in order to produce a product.
How Does it Work?

Keys to Value Stream Mapping:

- Enhance a Process Map
- Capture the “current state”
- Compare use versus need - VA/NVA
- Visualize an improved “future state”
- Prioritize opportunities into action
Current State Value Stream Map

- **Supplier 1**
  - Weekly delivery schedule
  - **Milling**
    - 2 people
    - C/T = 2 min
    - C/O = 2 hr
    - Uptime = 74%
    - 5 days
  - 2 min

- **Supplier 2**
  - Weekly delivery schedule
  - **Welding**
    - 2 people
    - C/T = 4 min
    - C/O = 3 hr
    - Uptime = 61%
    - 10 days
  - 4 min

- **Receiving**
  - 5 days

- **Production Control**
  - Market Forecast
  - **Painting**
    - 3 people
    - C/T = 7 min
    - C/O = 3 hr
    - Uptime = 48%
    - 15 days
  - 7 min

- **Assembly & Inspection**
  - 3 people
  - C/T = 2 min
  - C/O = 30 min
  - Uptime = 93%
  - 8 days

- **Customer A**
  - Daily schedule
- **Customer B**
  - Daily schedule

- **Shipping**
  - 30 days

**Total Lead Time = 68 days**
**Value Added Time = 15 min**
Enhanced Value Stream Mapping

- Identify “Clean” opportunities
- Record environmental data for processes in VSMs
- Analyze materials use vs. need in a “materials line” for VSMs
- Expand the application of value stream mapping to natural resource flows
Types of Environmental Metrics

- Scrap/Non-Product Output
- Materials Use
- Hazardous Materials Use
- Energy Use
- Water Use
- Air Emissions
- Solid Waste
- Hazardous Waste
- Water Pollution/Wastewater
Common Processes with EHS Wastes and Opportunities

1. Metal casting
2. Chemical and heat treatment of materials
3. Metal fabrication and machining
4. Cleaning and surface preparation
5. Bonding and sealing
6. Welding
7. Metal finishing and plating
8. Painting and coating
9. Waste management
10. Chemical and hazardous materials management
VSM with Environmental Metrics & EHS Icons

Annual Production Plan
Weekly delivery schedule
Market Forecast
Weekly schedule
Daily schedule
Daily schedule
Weekly schedule

Supplier 1
Supplier 2

Milling
- 2 people
- C/T = 2 min
- C/O = 2 hr
- Uptime = 74%
- Haz. Waste = 5 lbs

Welding
- 2 people
- C/T = 4 min
- C/O = 3 hr
- Uptime = 61%
- Haz. Waste = 20 lbs

Painting
- 3 people
- C/T = 7 min
- C/O = 4 hr
- Uptime = 48%
- Haz. Waste = 60 lbs

Assembly & Inspection
- 3 people
- C/T = 2 min
- C/O = 30 min
- Uptime = 93%

Receiving
- 5 days

Shipping
- 30 days

Total Lead Time = 68 days
Value Added Time = 15 min
Materials lines can show you:

- Largest sources of waste for *prioritizing improvement* efforts.
- Overall difference between amounts *used* versus what's actually *needed*.
- Where *alternative materials* may be an effective option.
Analyze Materials Use Versus Need

• The “timeline” on value stream maps looks at value-added and non-value-added time in the value stream.

<table>
<thead>
<tr>
<th>5 days</th>
<th>10 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 min</td>
<td>4 min</td>
</tr>
</tbody>
</table>

Lead Time = 15 days
Value Added Time = 6 min

• Add a “materials line” to examine:
  – Amount of raw materials used by each process
  – Amount of materials that end up in the product and add value from the customer’s perspective.
Example Materials Line

Top line:
Materials Used by Process

Milling
2 people
120 lbs
80 lbs

Welding
2 people
15 lbs
5 lbs

Bottom line:
Materials Added to Product During the Process

Materials Used = 135 lbs
Materials Needed = 85 lbs
Materials Wasted = 50 lbs
VSM with Materials Line and EHS Icons

Annual Production Plan

Production Control

Market Forecast

Customer A

Customer B

Supplier 1

Supplier 2

Weekly delivery schedule

Weekly schedule

Daily schedule

Daily schedule

EHS

Milling

2 people

C/T = 2 min
C/O = 2 hr
Uptime = 74%

EHS

Welding

2 people

C/T = 4 min
C/O = 3 hr
Uptime = 61%

EHS

Painting

3 people

C/T = 7 min
C/O = 4 hr
Uptime = 48%

Assembly & Inspection

3 people

C/T = 2 min
C/O = 30 min
Uptime = 93%

Receiving

5 days

Welding

10 days

4 min

Painting

15 days

7 min

Shipping

30 days

EHS

Assembly & Inspection

120 lbs

80 lbs

5 lbs

15 lbs

40 lbs

20 lbs

5 lbs

20 days

Total Lead Time = 68 days

Value Added Time = 15 min

Total Materials Used = 195 lbs

Materials Needed = 110 lbs
The Future State

- *Future state* value stream maps are created to show what a product or process line would look like after improvements are made.
Future State VSM

Annual Production Plan

Production Control

Market Forecast

Daily schedule

Customer A

Customer B

Supplier 1

Supplier 2

Annual Production Plan

Production Control

Market Forecast

Daily schedule

Supplier 1

Supplier 2

EHS

Milling

2 people

C/T = 2 min
C/O = 1 hr
Uptime = 87%

EHS

Welding

2 people

C/T = 4 min
C/O = 3 hr
Uptime = 61%

EHS

Painting

3 people

C/T = 7 min
C/O = 1.5 hr
Uptime = 80%

Assembly & Inspection

3 people

C/T = 2 min
C/O = 30 min
Uptime = 93%

Lead Time = 27 days
Value Added Time = 15 min

Total Materials Used < 150 lbs
Materials Needed = 110 lbs
Module 4

Measurements and Metrics
Conventional Cost Allocation

- Raw Materials
  - Production Labor
    - Regulatory agency reporting time
    - Training requirements
    - Utilities
    - Permitting/regulatory costs
    - Handling & waste management costs
    - All of the traditional overhead expenses
Full Cost Accounting

*Full cost* or *environmental accounting* considers the costs of:

- solid and hazardous waste management,
- wastewater treatment
- environmental permitting
- pollution prevention technologies
- environmental fines,
- taxes or penalties,
- site remediation into the cost of producing goods and services.
Green Suppliers Network Metrics

Green suppliers track the following metrics:

- Reduction in hazardous materials used
- Reduction in non-hazardous materials used
- Energy use reduced
- Water use reduced
- Reduction in hazardous waste generated
- Reduction in solid waste generated
- Wastewater discharged
- Water pollution discharged
- Avoided purchasing costs
- Avoided disposal costs
- Total cost savings
Final Report

The final report includes:

• Value Stream Maps
• Opportunities identified
• Estimated savings
• Any supporting economic analysis
Module 5

ABB Lean & Green project
• ABB, Inc. is a producer of small power and distribution transformers located in South Boston, Virginia.

• The facility has approximately 600 employees.

• The plant is approximately 550,000 ft², in two buildings.

• Processes include, steel fabrication, core wire manufacture & winding, main assembly, painting and finish assembly.

• The ABB plant is a supplier to PG&E. PG&E has decided to participate in the EPA’s Green Suppliers Network and has offered ABB the opportunity to engage in the Lean & Green Manufacturing Assessment as part of their supply chain.
Team Make Up

The core team included:

• Thomas Minnich – Plant Manager
• Scott Bowen – Operations Director
• Matt Shepperd – Environmental Specialist
• Randy Turner – Facility Manager
• Tom Warren – Process/Quality Engineer
• Tom Zbell – VPMEP
• Jim Simons – VPMEP
• Aimee McCarthy – VPMEP
Process Steps

• Conduct a facility walk-through and pre-work including the collection of baseline metrics.

• Conduct one day LEAN AND CLEAN Value Stream Mapping (VSM) Training with integrated lean and environmental components and completion of a Process Map to include environmental measures.

• Multiple meetings with core team over a several month period to collect and analyze data and decide on a plan of action.

• Quick implementation of any and all actions that require minimum resources
  • Recycling of solid waste
  • Water use reduction in wire quench lines
  • Reuse of wire spools by vendor

• Project future state for facility and summarize actions and plans in a final report to management.
Realities

• Lean/Green data for each process step was not available
• Data collection plan would have consumed too much time and resources
• Mass Balance for the entire facility was adopted
• Additional time was needed to collect even the mass balanced data
• Plant had several initiatives scheduled that targeted Lean/Green topics
  ➢ Conversion from Solvent based to High Solids/Low VOC painting technologies
  ➢ Conversion from bake ovens to drying ovens
  ➢ Purchase of a more efficient plasma nesting program
  ➢ Conversion of waste water handling from disposal to recycle
Current State Map
ABB Company - MDT Line
Current State GSN Map

Key:
H = Haz Waste
V = VOC
S = Solid Waste
W = Water
Ng = Natural Gas
M = Metal
P = Paint
E = Electrical

Current Totals:
H = Haz Waste = 70 tons/yr
V = VOC = 73 tons/yr
S = Solid Waste = 1104 Ton/yr.
W = Water = 6,719,000 gal/yr
Ng = Natural Gas = 113,630 MM BTU/yr
M = Metal = 18,000 tons/yr
P = Paint = 13,520 gal/yr.
E = Electrical = 28,989 MWH/yr
Planned List of Changes

• Convert to high solids/low VOC paint
• Convert to more efficient plasma nesting program to reduce scrap
• Set up recycling for the following:  
  Wooden skids
  Wooden spools
  Corrugated paper
• Send epoxy paper to co-generation plant to be burned in the generation of electricity
• Set up tests for the cleaning and quench tanks to reduce the frequency of dumping this waste water.
• Purchase and install a waste water system to reduce the amount of water needing disposal.
• Partner with energy reduction consultants to reduce electric consumption and meet or exceed 5% annual reduction goal.
Future State Map
ABB Company - MDT Line
Future State GSN Map

Suppliers
- Coil Fab
  - W S Ng EM
  - Tank Fab
    - S H W
    - Buss & Bushing Fab
      - E S M

Main Assembly
- E S M

Final Assembly
- E S

Inspect & Ship
- E S

Key:
- H = Haz Waste = 18 tons/yr
- V = VOC = 19 tons/yr
- S = Solid Waste = 876 Ton/yr.
- W = Water = TBD gal/yr
- Ng = Natural Gas = 102,267 MM BTU/yr
- M = Metal = TBD
- P = Paint = 7,701 gal/yr
- E = Electrical = TBD MWH/yr

Future Totals

Key:
- H = Haz Waste
- V = VOC
- S = Solid Waste
- W = Water
- Ng = Natural Gas
- M = Metal
- P = Paint
- E = Electrical
## Results

<table>
<thead>
<tr>
<th>Waste/resource category</th>
<th>Current Annual Total</th>
<th>Future Annual Total</th>
<th>Savings</th>
<th>Percent reduction</th>
<th>Target Date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Solid - all tons</strong></td>
<td>1104</td>
<td>876</td>
<td>228</td>
<td>21%</td>
<td></td>
</tr>
<tr>
<td>Trash</td>
<td>814</td>
<td>814</td>
<td>0</td>
<td>0%</td>
<td>NA</td>
</tr>
<tr>
<td>Skids</td>
<td>150</td>
<td>0</td>
<td>150</td>
<td>100%</td>
<td>May-09</td>
</tr>
<tr>
<td>Spools</td>
<td>100</td>
<td>0</td>
<td>100</td>
<td>100%</td>
<td>May-09</td>
</tr>
<tr>
<td>Waste paper</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>100%</td>
<td>May-09</td>
</tr>
<tr>
<td>Corrugated</td>
<td>75</td>
<td>0</td>
<td>75</td>
<td>100%</td>
<td>May-09</td>
</tr>
<tr>
<td>Epoxy Paper - tons</td>
<td>54</td>
<td>54</td>
<td>0</td>
<td>0%</td>
<td>TBD</td>
</tr>
<tr>
<td><strong>Hazardous -tons</strong></td>
<td>70</td>
<td>18</td>
<td>53</td>
<td>75%</td>
<td>Dec-09</td>
</tr>
<tr>
<td><strong>VOC -tons</strong></td>
<td>73</td>
<td>19</td>
<td>54</td>
<td>74%</td>
<td>Dec-09</td>
</tr>
<tr>
<td><strong>Water - gal</strong></td>
<td>6,719,000</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>Dec-09</td>
</tr>
<tr>
<td><strong>Natural Gas MM BTU</strong></td>
<td>113,630</td>
<td>102,267</td>
<td>11,363</td>
<td>10%</td>
<td>Dec-09</td>
</tr>
<tr>
<td><strong>Electricity MWH</strong></td>
<td>28,989</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td></td>
</tr>
<tr>
<td><strong>Material</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal - tons</td>
<td>18,000</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td></td>
</tr>
<tr>
<td>Paint - gallons</td>
<td>13,520</td>
<td>7,701</td>
<td>5,819</td>
<td>43%</td>
<td>Dec-09</td>
</tr>
</tbody>
</table>
Resources

- [www.greensuppliers.gov/](http://www.greensuppliers.gov/)
- [www.epa.gov/lean/toolkit/](http://www.epa.gov/lean/toolkit/)
- [www.epa.gov/NCEI/lean/energytoolkit/](http://www.epa.gov/NCEI/lean/energytoolkit/)