Lean Six Sigma and the Environment

Taking process improvement to the next level
Topics

• What is Sustainability?
• Why companies are becoming more sustainable
• Why “Green” needs to be added
• Integrating “green” into Lean Six Sigma activities
• Resources and Next Steps
• Summary
What is Sustainability?

• Meeting the needs of the present without compromising the ability of future generations (7 generations) to meet their own needs
  – Many different definitions!

• Companies cannot be successful in long term if they only focus on economic (profit)
  – Must look at environment and social issues
Triple Bottom Line (3 P’s)

- **People** (ISO 26000)
- **Planet** (ISO 14000)
- **Profit** (ISO 9000)

SUSTAINABILITY
Good for Profits

• If a company or organization goes out of business, they are not sustainable

• Other traits include:
  – Transparency and Disclosure
  – Stakeholder engagement
Good for People

• Fair working wage
• Safe work conditions
• Anti-discrimination
• Gender pay equality
• Diversity
• Volunteering
• Charitable Giving
• Community leadership
Good for the Planet

• Energy from renewable resources
• Made from materials found in nature
• Reduced or no toxins, chemicals, pollutants
• A technology, product or service that saves energy, water or natural resources, or is harvested in a sustainable way over the long term
• Designed to mimic nature
• Recyclable or biodegradable
Triple Bottom Line

• Can no longer make decisions based upon economics (cost / price) alone
  – Need to consider social and environment, but difficult to measure

• Example: Shoes
  – Economic – price of shoes
  – Social – labor practices of company
  – Environment – materials used, shipping distance, packaging, recycling options

• What else can you think of?
Triple Bottom Line

• Example: Food
  – Economic – price listed on the item or the shelf
  – Social – nutritional value, calories/fat, cruelty free, Fair Trade
  – Environment – Not quantitative, most only use words (organic, natural, GMO-free, no additives/coloring)

ECONOMIC

SOCIAL

ENVIRONMENT

Carbon Reduction Label courtesy of Carbon Trust
Bank Account Review

• If someone in the class looked at your bank account transactions, does it accurately reflect you?
  — Where do you spend your money? McDonald’s? Wal-Mart? Home Depot? BP Gas Station?

• Do these businesses align with your values?
  — If not, make different buying decisions today!

Every dollar you spend is a vote for that company or service
What will it look like in the future?

• Consumers will consider these criteria instead of comparing only by price:
  – **Airline tickets**: Aircraft fuel efficiency, total trip distance, organic food options, low VOC seat fabric
  – **House**: Walkability, proximity to public transportation, land use, annual utility costs
  – **Bread**: Local supplier, no preservatives, no bleach, minimal packaging
  – **Cell Phone**: Take back program, lead free, recycled content, compostable packaging

• Consider the long term costs over 5-10-20 years
Why companies are becoming more sustainable
This is not sustainable

How will your company be affected by these issues?

Jonas M. Helseth, Bellona Europa, 6/21/12, Energy Efficiency in Industrial Processes conference, Brussels
Why are companies “going green”?

- Financial (Revenue)
- Risk and Legal
- Employees
- Customers (Sales)
Financial reasons for “going green”

• Reduced energy, waste and materials (reduced costs)
• Decision making focused on lifecycle costs
• Drives long term strategic planning
• Incentives and rebates
Financial reasons for sustainability

• 7 areas of financial benefit for companies

1. Increased revenue
2. Reduced energy expenses
3. Reduced waste expenses
4. Reduced materials and water expenses
5. Increased employee productivity
6. Reduced employee attrition expenses
7. Avoided risk to profit

From Bob Willard [http://www.sustainabilityadvantage.com](http://www.sustainabilityadvantage.com)
Business Case Simulator

1. Enter Company Data
2. Modify Assumptions
3. Estimate Benefits

From Bob Willard [http://www.sustainabilityadvantage.com](http://www.sustainabilityadvantage.com)

Business Performance Improvement
Why Finance often overlooks “green”

• “Cost of doing business,” not viewed as opportunity
• Costs and impacts can be blanketed across many areas, hard to isolate data to biggest users
• Environmental and human health risks are often not explicitly considered in business decisions
  • Externality cost
• Side benefits of sustainability efforts not anticipated or factored in
  • Take-back, talent acquisition, employee engagement
What do manufacturers think?

• 81% of manufacturers say sustainability is essential to the success of their business
• 89% say operational sustainability is essential to the success of their business
• 60% still agree that the environment can be profitable
• 67% of manufacturers say they “strongly agree” the environment is becoming more important to consumers
• 53% say consumers are demanding more eco-friendly products that cost the same as their traditional counterparts

UL’s 2012 annual global study
http://www.environmentalleader.com/2012/12/12/over-80-of-manufacturers-call-sustainability-key/
Pressures driving sustainability

Figure 1: Top 3 Pressures Driving Sustainability Initiatives

- Desire for social and environmental stewardship: 56%
- Increase or maintain brand reputation/value: 48%
- Need for competitive advantage: 46%
- Stakeholder pressure: 29% (includes employees and customers)
- Rising energy costs: 22%
- Present or expected regulatory compliance mandates: 22%

Percentage of All Respondents

Source: Aberdeen Group, May 2009
Risk reasons for “going green”

• Regulatory compliance (proactive and reactive)
  – Fines and penalties
  – Extended producer responsibility (EPR)
    • “Cradle to Cradle,” not “Cradle to Grave”
  – Permits, Approvals, and Certifications
Risk and Legal

• Reduce future risks to revenue and expenses
  – Unknown future externality costs (i.e. carbon tax)
  – Increasing energy and utility costs
  – Fines and penalties
  – Bad publicity, protests and impact to reputation
  – Climate change impact to communities
Price of Externalities

• These environmental costs (externalities) are being tied back to the contributors (businesses)

Earth’s Free Ecosystem Services

- Nutrient dispersal and cycling
- Seed dispersal
- Food (including seafood and game), crops, wild foods, and spices
- Water
- Minerals (including diatomite)
- Pharmaceuticals, biochemicals, and industrial products
- Energy (hydropower, biomass fuels)
- Carbon sequestration and climate regulation
- Waste decomposition and detoxification
- Purification of water and air
- Crop pollination
- Pest and disease control
- Cultural, intellectual and spiritual inspiration
- Recreational experiences (including ecotourism)
- And more...

If we don’t protect these services, we will have to spend money to re-engineer them
Impact on Shareholder Value

- “Environmental issues, including climate change” is 3rd on the list of top executive concerns

Employee reasons for “going green”

- More motivated, engaged and inspired workforce
  - Higher productivity and conservation mindset
  - Want to help company save money, motivate co-workers

- Retention and acquisition of employees
  - Reduced costs for advertising, interviewing and hiring new people, productivity lost during transition, loss of knowledge

Content from Bob Willard
http://www.sustainabilityadvantage.com
Employee Mindset Change

• Recycling programs are common across companies, but vary greatly in scope and support
  – Composting food, e-waste, office supplies, etc
• Recycling is just the starting point, not the end goal
  – Need to drive towards no generation of waste!
Waste Pyramid

Zero Waste

Refuse
Reduce
Reuse
Recycle
Recover
Dispose

Business Performance Improvement
Example #1: Plastic Soda Bottle

- **Need**: Water to drink
- **Refuse** – Drink from drinking fountain
- **Reduce** – Select smaller bottle or bottle with less packaging or materials
- **Reuse** – Fill up the bottle from fountain next time
- **Recycle** – Recycle bottle in recycling bin
- **Recover** – Burn bottle to generate heat
- **Dispose** – Throw bottle into landfill
Example #2: Mailed Letter

- **Need:** Utility bill needs to be paid
- **Refuse** – Stop receiving by mail, go paperless
- **Reduce** – Reduce frequency of notification (pay twice a year, not monthly)
- **Reuse** – Reuse paper to take phone messages or leave notes for others
- **Recycle** – Put paper into recycling bin
- **Recover** – Burn paper to generate heat
- **Dispose** – Throw paper into landfill
Example #3: Light Bulbs

• **Need**: Need to complete task in low-light area

• **Refuse** – Don’t turn on light, move work closer to natural light

• **Reduce** – Put only half the number of bulbs in fixture, or use a dimmer

• **Reuse** – Use light bulbs for art

• **Recycle** – Put bulbs in recycling bin

• **Recover** – Burns bulbs to generate heat

• **Dispose** – Throw bulbs into landfill
Customer reasons for “going green”

• Opening up new markets
• More loyal customers
• Product differentiation and innovation
• Managing competitors and industry perceptions
• Customer or stakeholder request
Example: Take-back programs

EXPECTED BENEFITS
• Landfill avoidance (Legal)
• Value in selling recycled material for scrap (Revenue)
• Improved environmental perception of customers and community (Goodwill)

SIDE BENEFITS
• Interaction, feedback and idea generation with customers (Innovation)
  – Builds brand loyalty
• Evaluation of how customers use products (Innovation)
• Opportunity to sell or discount them on newer products (Sales)
Biomimicry

- The imitation of the models, systems, and elements of nature for the purpose of solving complex problems.

- Key aspect of Production Preparation Process (3P) which focuses on eliminating waste through product and process design development process.

Velcro tape mimics biological examples of multiply hooked structures such as burs.
“Greenwashing”

• Act of misleading consumers regarding the environmental practices of a company or the environmental benefits of a product or service

• Companies must avoid the 7 deadly sins:
  – Sin of Hidden Trade-off
  – Sin of No Proof
  – Sin of Vagueness
  – Sin of Worshiping False Labels
  – Sin of Irrelevance
  – Sin of Lesser of Two Evils
  – Sin of Fibbing

• Over 95% of “green” products evaluated had at least one of the sins
What is Carbon Footprint?

- A calculation of the effect human activities have on the climate in terms of the total amount of greenhouse gases produced (measured in units of carbon dioxide or CO₂)
- Greenhouse gases (GHG) trap heat in the atmosphere, leading to climate change
Carbon Footprint

• The amount of fossil carbon consumed by a group, area, business or individual, converted to metric tons of CO$_2$
  — Metric tons of carbon dioxide equivalent
  — MTCE or CO$_2$e
• Relates to amount of energy invested into products and services
• Companies calculate it to provide a summary metric of their impact on climate change
  — Can identify priority for Lean Six Sigma efforts
Why are companies reporting?

- Objective assessment for measuring progress
- Prioritize opportunities
- Increased transparency
- Risk mitigation
- Benchmarking
- Customers, investors or stakeholders asked them to report!
Why are companies “going green”?

Financial
• Reduced energy, waste and materials (reduced costs)
• Decision making focused on lifecycle costs
• Drives long term strategic planning
• Incentives and rebates

Employees
• More motivated, engaged and inspired workforce
• Retention and acquisition of employees

Risks and Legal
• Regulatory compliance (proactive and reactive)
• Reduce future risks to revenue and expenses

Customers and Sales
• Opening up new markets
• More loyal customers
• Product differentiation and innovation
• Managing competitors and industry perceptions
• Customer or stakeholder request

These were not the original intent, side benefit of green efforts
Why “Green” needs to be added to your Lean Six Sigma program
Improvement initiatives

• Most companies and organizations have an improvement initiative to help the company improve
  – Save money by eliminating waste and inefficiencies
  – Add value through better align with their customers

• Goes by many names: Lean Six Sigma, Lean, Six Sigma, Total Quality Management, Toyota Production System, Continuous Improvement, Business Excellence, etc

• Don’t have one? Put one in place first!
Lean and Six Sigma

<table>
<thead>
<tr>
<th>Characteristics of Lean and Six Sigma (Box 1.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lean</strong></td>
</tr>
<tr>
<td>✅ Focuses on maximizing product flow and velocity</td>
</tr>
<tr>
<td>✅ Provides tools for analyzing process flow and delays at each process step</td>
</tr>
<tr>
<td>✅ Centers on the separation of “value-added” from “non-value added” work with tools to eliminate root causes of non-value added activities</td>
</tr>
<tr>
<td>✅ Provides a means for quantifying and eliminating the cost of complexity</td>
</tr>
</tbody>
</table>


http://www.epa.gov/lean/environment/toolkits/professional/resources/Enviro-Prof-Guide-Six-Sigma.pdf

We’ll refer to Lean Six Sigma going forward (blended approach)
Lean naturally helps the environment!

Helping the environment should closely align with business needs, otherwise it will appear disconnected to employees.
## Environmental Impact of Waste

<table>
<thead>
<tr>
<th>Waste Type</th>
<th>Environmental Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overproduction</td>
<td>- More raw materials consumed in making the unneeded products</td>
</tr>
<tr>
<td></td>
<td>- <strong>Extra products may spoil or become obsolete requiring disposal.</strong></td>
</tr>
<tr>
<td></td>
<td>- Extra hazardous materials used result in extra emissions, waste disposal, worker exposure, etc.</td>
</tr>
<tr>
<td>Inventory</td>
<td>- More packaging to store work-in-process</td>
</tr>
<tr>
<td></td>
<td>- Waste from deterioration or damage to stored WIP</td>
</tr>
<tr>
<td></td>
<td>- More materials needed to replace damaged WIP</td>
</tr>
<tr>
<td></td>
<td>- <strong>More energy used to heat, cool, and light inventory space</strong></td>
</tr>
<tr>
<td>Transportation and Excessive Motion</td>
<td>- More energy use for transport</td>
</tr>
<tr>
<td></td>
<td>- Emissions from transport</td>
</tr>
<tr>
<td></td>
<td>- More space required for WIP movement, increasing lighting, heating, and cooling demand and energy consumption</td>
</tr>
<tr>
<td></td>
<td>- <strong>More packaging required to protect components during movement</strong></td>
</tr>
<tr>
<td></td>
<td>- Damage and spills during transport</td>
</tr>
<tr>
<td></td>
<td>- Transportation of hazardous materials requires special shipping and packaging to prevent risk during accidents</td>
</tr>
<tr>
<td>Defects</td>
<td>- Raw materials consumed in making defective products</td>
</tr>
<tr>
<td></td>
<td>- <strong>Defective components require recycling or disposal</strong></td>
</tr>
<tr>
<td></td>
<td>- More space required for rework and repair, increasing energy use for heating, cooling, and lighting</td>
</tr>
<tr>
<td>Over Processing</td>
<td>- More parts and raw materials consumed per unit of production</td>
</tr>
<tr>
<td></td>
<td>- Unnecessary processing increases wastes, energy use, and emissions</td>
</tr>
<tr>
<td>Waiting</td>
<td>- <strong>Potential material spoilage or component damage causing waste</strong></td>
</tr>
<tr>
<td></td>
<td>- Wasted energy from heating, cooling, and lighting during production downtime</td>
</tr>
</tbody>
</table>

EPA Lean and the Environment Toolkit
Why Lean Six Sigma overlooks it

• Improvement opportunities may be found outside of normal working operations or hidden from view
• Many more stakeholders involved which requires more facilitation and communication
  — Community, regulatory, non-profit organizations, activists, etc
• Not easy to capture data in events, and appears small at process level
• Full cost impact of environmental issues not calculated
• Environmental data differs than most industries, requires nonparametric and non-detect analysis skills
• Utilities and materials can be considered both value added and non-value added, which can be confusing
Go and See

• In order to truly solve problems, you must go to where the problem is, and investigate with your own eyes and talk to the people who do the actual work.

• Also called “Gemba Walk”
  – Gemba – Where the work is being done
Go and See

• Can be formal process or informal
• Requires ability to ask good questions, not leading the worker to tell you what you want to hear
• Shows respect for worker, empowers them to solve problems on their own in the future
Go and See Events

• Formal events can help align departments come together and collect data to help with an environmental issue
  – **Energy** – Look around building at different times of day for opportunities (lights on, equipment running, excess heating/cooling)
  – **Waste** – Collect and sort trash to determine what is being thrown out (recycling, compost, hazardous materials)
  – **Water** – Walk the flow of water pipes in and out of the facility to identify opportunities (leaks, condensation, and wear)
Who would be interested?

**Internal**
- Owners/investors
- Executive Board
- Management
- Employees

**External**
- Customers
- Suppliers
- Industry Groups
- Public and community
- Government agencies
- Environmental groups
- Competitors
- Media Outlets
- Friends/family of employees
- Future employees
## SIPOC – Community Recycling

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Inputs</th>
<th>Process</th>
<th>Outputs</th>
<th>Customer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grocery store</td>
<td>Food and drinks</td>
<td>Purchase Items</td>
<td>Trash</td>
<td>Landfill</td>
</tr>
<tr>
<td>Department store</td>
<td>Gifts</td>
<td>Remove from packaging</td>
<td>Recycled Materials</td>
<td>Residents</td>
</tr>
<tr>
<td>Farmer’s Market</td>
<td>Household items</td>
<td>Sort out waste into bins</td>
<td>Compost dirt</td>
<td>Community</td>
</tr>
<tr>
<td>Gas station</td>
<td>Tools</td>
<td>Bins collected</td>
<td>Greenhouse Gas Emissions</td>
<td></td>
</tr>
<tr>
<td>Department store</td>
<td>City website</td>
<td>Contents dropped off to correct location</td>
<td>Lechete</td>
<td></td>
</tr>
<tr>
<td>Restaurant</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City Officials</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*Make sure Earth is included as a Customer!*
Why costs are overlooked

Individual VSMs overlook these costs compared to much larger financial numbers (inventory, labor and material, space, etc).

Product A VSM
- Electricity = $800 per year
- Landfill Charge = $200 per year
- Hazardous Waste = $200 per year

Product B VSM
- Electricity = $1000 per year
- Landfill Charge = $150 per year
- Hazardous Waste = $50 per year

Product C VSM
- Electricity = $600 per year
- Landfill Charge = $300 per year
- Hazardous Waste = $1000 per year

Product Z VSM
- Electricity = $2000 per year
- Landfill Charge = $50 per year
- Hazardous Waste = $100 per year

Same costs totaled across all 50 products
- Electricity = $50,000
- Landfill = $15,000
- Hazardous Waste = $20,000
Finding Hidden Costs

If a product is broken in the shipping department:

True cost of waste =

Cost of wasted raw materials + cost of utilities used + lost labor time + waste treatment/handling + disposal costs

The total cost of waste is generally around 20 times the first estimate that a company makes.
Problems with Environmental Data

• Aberrant values – ozone data
• Undetected – marked as zero or max/min value
• Large amounts of data – lack of purpose
• Large measurement errors – despite efforts
• Lurking variables – not identified
• Inconsistent variance – non-linearity
• Non-normal distributions – seldom Gaussian
• Serial correlation – lack of independence

From Statistics for Environmental Engineers, P. Berthouex, L. Brown
Identifying value

- **Value added**
  - Electricity to automatically place parts on a board
  - Water usage to clean the outside of product
  - Electricity to create bid proposal
  - Heat to keep employees comfortable
  - Chemicals used that enhance the product functionality

- **Non-value added**
  - Lighting for office area on overtime to fix a document that wasn’t done right the first time
  - Air conditioner replacement due to neglect
  - Test equipment left on overnight when not being used
  - Overhead projectors left on in conference room
  - Hazardous chemicals spilled or expired due to neglect

GREENER OPTIONS? REMOVE!

The customer does not want to pay for non-value added waste!
Aligning “Green” into Lean Six Sigma

• Lean Six Sigma addresses the non-value added within the process
  – Focus on problems where the value item gets stuck, delayed or fixed
• Green addresses the non-value added outside the process, but integral to the process
  – Focus on overall impact of support functions of the process (electricity, lighting, waste disposal, heating/cooling, chemicals, water, etc)
  – Look at aggregate level, not individual process steps (may seem minor or insignificant)
Lean Six Sigma and Green

Lean Six Sigma identifies waste within the processes.

Green identifies waste outside the processes.
How to get started with Green

• Save money and reduce risk (without impacting business) by identifying these W.A.S.T.E. opportunities

Water  Air  Solids  Toxicity (Chemicals)  Energy

Graphic courtesy Purdue Technical Assistance Program
Identify Wastes and Opportunities

**Water**
- How much water is used in the process and how is it used?
- How can you reuse water and/or reduce overall water use?
- Can you reduce contaminants in wastewater discharges?

**Air Emissions**
- What types and amounts of air emissions are generated by the process?
- How can you reduce the overall amount or toxicity of air emissions?
- How far did vehicles travel to deliver parts and supplies?
- Can you reduce the vehicle miles traveled and emissions from transportation?

**Solid Waste**
- What types and quantities of solid waste are generated by the process?
- How can you reduce the overall amount of solid waste generated?
- How can you reuse or recycle solid wastes?
- Is there a local composting facility that the waste can be taken to?

* Courtesy Purdue Technical Assistance Program
Identify Wastes and Opportunities

**Toxicity (Chemicals/Hazardous)**
- What types and quantities of chemicals/materials are used in the process?
- How can you reduce the overall amount of chemicals and materials used?
- Can you switch to less harmful chemicals?
- Can you eliminate any non-value added use of chemicals or materials from the product or process (excess packaging, unneeded painting, etc.)?
- What types and quantities of hazardous waste are generated by the process?
- How can you reduce the amount or toxicity of hazardous waste generated?
- Can you better isolate and separate hazardous wastes from other wastes?

**Energy**
- How much energy is used in the process and how is it used?
- How can you reduce overall energy use?
- Is equipment running or are lights on when not being used?
- Are you using efficient light bulbs?
- Can you save energy by consolidating operations and/or storage space?
- Can you shift to a cleaner source of energy?

* Courtesy Purdue Technical Assistance Program
Does it really work?

“…savings have offset the expenses by approximately 2 to 1” - IBM

http://www.epa.gov/lean/environment/toolkits/professional/resources/Enviro-Prof-Guide-Six-Sigma.pdf
### Suboptimization case study

#### Improvement and savings

<table>
<thead>
<tr>
<th>Wastes</th>
<th>Improvement</th>
<th>Annual results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overprocessing</td>
<td>Widened online in glass bead blast cabinets, reducing cleaning time per piece by 50%, overall energy use, and material (glass bead) and nonhazardous waste.</td>
<td>Reduced labor hours</td>
</tr>
<tr>
<td>Defects</td>
<td>In-process inspection moved to the beginning of process, thereby identifying bad parts at the start of the process instead of passing defects to downstream processes, thus reducing rework. Implemented quality at the source (for example, transferred responsibility for quality from inspectors to assemblers). Required cross-training and visual standard work procedures.</td>
<td>Less detergent used: 41 gallons Less water used: 1480 gallons</td>
</tr>
<tr>
<td>Overprocessing</td>
<td>Boring, honing, and cross-hatching now performed on an automatic honing machine instead of doing one cylinder at a time manually.</td>
<td>Less nonhazardous wastewater: 259 gallons</td>
</tr>
<tr>
<td>Unnecessary motion</td>
<td>Parts repackaged in special crates to minimize handling.</td>
<td>Less glass bead: 3,631 pounds</td>
</tr>
<tr>
<td>Overprocessing</td>
<td>Eliminated one process-cleaning step, reducing electricity use (less use of high-pressure spray washer).</td>
<td>Less nonhazardous solid waste: 5,791 pounds</td>
</tr>
<tr>
<td>Waiting and scrap</td>
<td>Reused (clean and plate) formerly discarded hardware, resulting in less work stoppage due to unavailable parts.</td>
<td>$64,335 in total cost savings</td>
</tr>
</tbody>
</table>

http://asq.org/quality-progress/2010/03/lean/leaning-toward-green.html?WT.dcsvid=OTA2NDMxNDY0MgS2&WT.mc_id=EM118436
More Case Studies

- Lockheed Martin
- Baxter Healthcare
- General Motors
- DTE Energy
- Del Monte Foods
- City of Irving, TX
- Blue Cross Blue Shield
- Many more...

- JEA Utilities
- Apollo Hardwoods
- Kirkland Air Force Base
- Columbia Paint
- Idaho DEQ
- Lasco Bathware
- Univ of North Carolina

Download over 20 case studies for free at:
http://www.leansixsigmaenvironment.org/index.php/free-stuff/
Integrating “green” into Lean Six Sigma activities
Lean Six Sigma Tools

• The same tools and training applies to environmental “green” issues
• Some tools work better when modified
• Newer tools being developed to make wastes and problems easier to find

Tools provided in following slides not an exhaustive list…
**Event Checklist**

- Useful when ES&H or Facilities personnel cannot attend event

<table>
<thead>
<tr>
<th>Physical Environment</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>As a result of the Lean event, will there be:</strong></td>
<td><strong>Unk</strong></td>
<td><strong>Yes</strong></td>
</tr>
<tr>
<td>Any changes to the locations where either maintenance work or use of hazardous chemical/material will occur?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any changes to your personnel’s work zone assignments?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any new equipment or modifications to existing equipment, or movement of existing equipment that has the potential to produce air or water emissions (e.g., rinse equipment/operations, cleaning tank, heating ovens)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any changes to the facility (e.g., vents, stacks, floor drains, oil/water separators)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any changes in the location(s) of the current flammable storage locker/areas?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any new confined space entry activities or procedures (e.g., personnel entering fuel tanks for cleaning)?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Event Checklist (cont’d)

### Material/Chemical Use and Storage

<table>
<thead>
<tr>
<th>As a result of the Lean event, will there be:</th>
<th>Unk</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any changes to the type or volume of materials issued to personnel and/or used? This includes the introduction of new chemicals, elimination of chemicals, etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any changes to the chemical introduction or issuance procedure for chemicals/materials containing hazardous materials?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any changes in the volume of chemicals/materials stored?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any flammable materials that are not returned to the storage cabinets at the end of each shift?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Waste Management

<table>
<thead>
<tr>
<th>As a result of the Lean event, will there be:</th>
<th>Unk</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any change(s) to the waste profiles for wastes stored at any initial accumulation points?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any change(s) to the location or number of initial waste accumulation points?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any change(s) to the volume of waste(s) that require disposal (i.e., wastewater, hazardous or solid waste) or to the volume of material that will be recycled or reused?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5S

BEFORE

AFTER

Business Performance Improvement

BEFORE

AFTER
Overall equipment effectiveness (OEE)

- OEE = Availability x Performance x Quality
  - Availability = 86.7%
  - Performance = 93.0%
  - Quality = 95.0%
- OEE = 86.7% x 93.0% x 95.0% = 76.6%
- Infor™ suggests adding Energy Consumption to OEE metric
  - Measured against the best energy performance for that equipment
  - As the equipment experiences issues, energy usage will increase, which will impact OEE

http://www.infor.com
DO NOT SHUT OFF

CONSERVE ENERGY
Shut off when not in use.

Contact your supervisor before shutting this equipment OFF.

Shut off when not in use.

Contact your supervisor before shutting this equipment OFF.

DO NOT SHUT OFF

CONSERVE ENERGY
Shut off when not in use.

Contact your supervisor before shutting this equipment OFF.

Shut off when not in use.

Contact your supervisor before shutting this equipment OFF.

1564
ENERGY SAVING OPPORTUNITY

Use the back of the tag to explain the details of your energy saving idea.

Name:
Date:
Tag location:
## QDIP (SQDC) Board

### Safety
- No missed days
- No injuries

### Quality
- Less than 5 defects per day
- DPMO less than 50
- Test Yield greater than 95%

### Delivery
- 100% on-time to customers, schedule, next process, etc.
- Complete 10 units per day

### Inventory
- WIP less than 10 units
- No more than 3 pieces at each station
- WIP less than $10,000

### Productivity
- $/hr greater than $150
- Less than 10 minutes of downtime
- Team met daily takt time goals

### Environment
- All equipment shut off at end of shift
- No recyclables in trash
- 100% Hazardous waste adherence
Traditional VSM with Water Data

Water VSM using water not timeline

http://www.epa.gov/lean/environment/toolkits/environment/ch3.htm
Fishbone Diagram

**People**
- Denied on initial request
- Metabolism differences
- Not following procedure
- Wear incorrect clothing for time of year

**Tools / Facility**
- Not enough in stock
- Thermostat broken
- Thermostat not calibrated
- Vents blocked
- Vents outside of office
- Back wall not insulated
- Exit door has wide gap near top
- Temp controls use average of cubicle area
- Cannot find authorization form online

**Design**
- Thermostat not near office
- Vents outside of office
- Back wall not insulated
- Temp controls use average of cubicle area
- Cannot find authorization form online

**Suppliers**
- Company provided unit broke down
- Sent the wrong model

**Process**
- Authorization took too long
- Form too confusing
- Could not get status of submission
- Different forms depending on area/dept

**Unauthorized Space Heaters Being Used**
JEA’s DMAGIC roadmap

• JEA added a “Green It Up” step to the DMAIC process, creating “DMAGIC”
  – designed to ensure that every improvement project addresses environmental concern
• In the “Green” phase of each project, the team explores areas such as air quality, water quality, and ecosystem-related issues.
• The team performs the “Green it Up” phase after identifying root causes and before developing any countermeasures.
• This assures that environmental and societal concerns are “baked into” every countermeasure explored before it is evaluated.

http://www.epa.gov/sustents/environment/studies/jea.pdf
Regression Analysis

Used “Avg Outside Temp” and “Production Days per Month” as predictor, 80% of variation explained!

Also considering: Billing Days, Employee Counts, Production Volume, Power Factor, Peak Demand, etc
What happened on this weekend 2/26/11 and 2/27/11? Can we do that every weekend?

What about the baseload of 40,000 when no one is working?
Statistical Analysis
Gage R&R

• Purpose of study: to validate that the KWH results coming from either power meter or electrician (measurement process) will not add excessive variation into the data
  – 2 electricians/power meters
  – 3 repeat readings
  – 10 different items

• Perfect situation is the only thing that varies is the 10 different items
  – no variation from meters, repeats, or electricians
FMEA

- Include environmental risks into Severity rankings

<table>
<thead>
<tr>
<th>Rank</th>
<th>Severity Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Catastrophic I</td>
<td>A failure results in the major injury or death of personnel.</td>
</tr>
<tr>
<td>7-9</td>
<td>Critical II</td>
<td>A failure results in minor injury to personnel, personnel exposure to harmful chemicals or radiation, a fire or a release of chemicals into the environment.</td>
</tr>
<tr>
<td>4-6</td>
<td>Major III</td>
<td>A failure results in a low level exposure to personnel, or activates facility alarm system.</td>
</tr>
<tr>
<td>1-3</td>
<td>Minor IV</td>
<td>A failure results in minor system damage but does not cause injury to personnel, allow any kind of exposure to operational or service personnel or allow any release of chemicals into environment.</td>
</tr>
</tbody>
</table>

Next Steps
Resources

- EPA: Lean and Environment Toolkit
- EPA: The Environmental Professional’s Guide to Lean & Six Sigma
- EPA: E3 (Economy, Energy and Environment)
- Lean Manufacturing and the Environment (with Case Studies)
- Design for the Environment (DfE)
- Green Supplier Network
- Zero Waste Network - Case Studies
- Purdue/SME Green Manufacturing Workshops
- Lean Ecology: Lean and Green Video Series
- IAC Industrial Productivity Training Manual
“Lean and the Environment” Books

- Green Intentions
- Green to Gold
- Green Manufacturing
- Lean and Green
- Six Sigma for Sustainability

http://www.leansixsigmaenvironment.org/index.php/learn_aboutLean_and_green/
Checklist: What can you do?

- All process improvements naturally reduce impact on the environment, now capture them!
- Add energy, material and costs to data boxes on Value Stream Maps
- Add energy and material impacts to current waste definitions
- Focus Lean Six Sigma efforts specifically on environmental issues (W.A.S.T.E.) using traditional and modified tools
- Invite ES&H and Facility department to events and project teams
- Integrate environmental checklist into event templates
- Add Earth/Environment to SIPOC as a Customer
- Share this presentation and list of resources with others in your company
Summary

• Companies and organizations that are not aggressively pursuing sustainability goals will fall behind
  – There are strong financial reasons to “go green”
• Companies should focus sustainability on the areas that most impact their business, not to improve perception or make them feel good
• Lean Six Sigma (and other improvement initiatives) provide a good foundation for helping a company become more sustainable
Contact

• Earth Consultants (Lean and Green Resources)

• Business Performance Improvement