Integrating environmental sustainability into your lean and six sigma program

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Baseline

• Does your company have a sustainability department or initiative?
• Does your Environment, Safety and Health (ES&H) and Facilities team get regularly invited to improvement efforts?
• Does ES&H and Facilities conduct their own improvement efforts?
• Have you worked on a project or event to reduce environmental impacts within your organization?
Agenda

• About Rockwell Collins
• What is Sustainability?
• Lean → Green
• Waste
• Green → Lean
• Rockwell Collins Examples
• What LSS doesn’t address
• How to address this gap
• Modified LSS Tools
• What you can do at your company
• Resources
• Summary
About Rockwell Collins

• Provides navigation, communications and heads up and heads down display products and systems for military and commercial customers

• Operating from more than 60 locations, in 27 countries, with 19,000 employees on our team
EXAMPLE: TRANSPORTATION TO CONFERENCE
<table>
<thead>
<tr>
<th></th>
<th>Sustainability Financial Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Increased revenue</td>
</tr>
<tr>
<td>2</td>
<td>Reduced energy expenses</td>
</tr>
<tr>
<td>3</td>
<td>Reduced waste expenses</td>
</tr>
<tr>
<td>4</td>
<td>Reduced materials and water expenses</td>
</tr>
<tr>
<td>5</td>
<td>Increased employee productivity</td>
</tr>
<tr>
<td>6</td>
<td>Reduced employee attrition expenses</td>
</tr>
<tr>
<td>7</td>
<td>Avoided risk to profit</td>
</tr>
</tbody>
</table>

From Bob Willard [http://www.sustainabilityadvantage.com](http://www.sustainabilityadvantage.com)
Case Study: Lean → Green

Carts

- Created clutter
- Allowed excess inventory
- Hid problems
- Took up floor space
Case Study: Lean → Green

- Reduced order from 54 carts to 30
- Floor markings
- Saved $10,000
- Preventing one pound of solid waste prevents 19 pounds of waste upstream \(^1\)


CAPTURE ENVIRONMENTAL IMPACTS OF YOUR IMPROVEMENTS
# Waste has Environmental Impact

<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 spaces</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>• More packaging required to protect components during movement</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>
Value Added vs Non-Value Added

**Value added**
- Electricity to automatically place parts on a board
- Computer used to share screen with remote employees to solve a problem
- Electricity to create bid proposal
- Heat to keep employees comfortable
- Parking lot lighting at night for safety

**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
- Cooling an area that is not being used

The customer does not want to pay for non-value added waste!
Waste Pyramid

- Zero Waste
- Refuse
- Reduce
- Reuse
- Recycle
- Recover
- Dispose
New way to think about W.A.S.T.E.

WHICH W.A.S.T.E. is more important in your organization?
Case Study: Green → Lean

Largest source of landfill was packaging from suppliers (photo).

Takes extra time to dump at transfer station.

Unpacking takes time away from value added work.

Reusable containers act as Kanban trigger to control inventory.

Visor containers (photo).
Case Study: Green → Lean

• Less unpackaging
• Easy identification
• Controls inventory (kanban)
• Breaks down for easy shipment back to supplier

FOCUSING ON GREEN IS A WIN-WIN FOR BUSINESS
Lean Energy “Go and See”

• Four “Go and See” sessions
  – Off shift
  – Start-up
  – Working time (w/breaks)
  – Shut down/Transfer

• Break into small groups

• Teams should be mix of process and technical experts, fresh set of eyes, and different levels of organization
Six Sigma Project

FY09 Metric Tons CO2 Equivalent by Facility

<table>
<thead>
<tr>
<th>Facility</th>
<th>CO2 Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>C Ave</td>
<td>80000</td>
</tr>
<tr>
<td>Main Plant</td>
<td>70000</td>
</tr>
<tr>
<td>Coralville</td>
<td>60000</td>
</tr>
<tr>
<td>Richardson</td>
<td>50000</td>
</tr>
<tr>
<td>Melbourne</td>
<td>40000</td>
</tr>
<tr>
<td>San Jose/Portland</td>
<td>30000</td>
</tr>
<tr>
<td>Mexicali</td>
<td>20000</td>
</tr>
<tr>
<td>Sterling</td>
<td>10000</td>
</tr>
<tr>
<td>Salt Lake</td>
<td>9000</td>
</tr>
<tr>
<td>Manchester</td>
<td>8000</td>
</tr>
<tr>
<td>Irvine EMS</td>
<td>7000</td>
</tr>
<tr>
<td>Binghamton</td>
<td>6000</td>
</tr>
<tr>
<td>Carlsbad</td>
<td>5000</td>
</tr>
<tr>
<td>Toulouse</td>
<td>4000</td>
</tr>
</tbody>
</table>

Time Series Plot of KWH, KWH Pred

Off-hour temperature adjustment

We're reducing our energy consumption and environmental impact with a temperature setback system that works like a programmable thermostat. During off-hours, you can override the setback via the adjustment control. It will return the temperature to its regular setting for two hours. Please dress for the setback temperature during off-hours and avoid overriding the program if you intend to work for only a brief period.

Thank you for helping Rockwell Collins become more energy conscious.
Wilsonville (Portland) Success

• Moving towards sustainability
  – Green team, 30% recycled paper, composting, “Green Bag” sessions, green cleaners
  – “Go and See” events
  – Electricity Six Sigma project
• Achieved Gold certification in Dec 2015 (getting started)
• Launched new effort at corporate level
Others having success...

Results from “Lean and Environment” Efforts (Box ES-2)

- **3M** reduced volatile air emissions by 61% and toxic inventory releases by 64% from 2000 to 2005 using Lean and Six Sigma techniques in coordination with pollution prevention.

- **Columbia Paint & Coatings** recovered 49,200 lbs per year of paint solids from wash water and reduced wastewater by 36,900 gallons per year based on a few Lean and environment events.

- **Woodfold Manufacturing** reduced volatile organic compound (VOC) emissions by nearly 1,000 lbs per year and diverted 6 tons per year of solid PVC waste from the landfill through opportunities identified in a value stream mapping event.

“The Environmental Professional’s Guide to Lean & Six Sigma

“...savings have offset the expenses by approximately 2 to 1” - IBM
Purpose-driven Excellence

• Businesses have a responsibility to balance profits with people and planet
• Companies leading the sustainability effort are seeing positive impacts to their business (not negative impact as suspected)
• Lean Six Sigma professionals have the right skills to lead this effort
  – Do you want to help with people or planet?
What gaps are missed with LSS?

Lean Six Sigma identifies waste within the value stream processes.

“Green” identifies waste outside the processes and work hours.
More gaps missed with LSS

• “Cost of doing business,” not seen as a problem
• Small impact at process or VSM level, need to view opportunities at site level
• Costs and impacts can be blanketed across many areas, hard to isolate data to biggest users
• Using recycled content, clean energy or less toxins not typically focus of improvements
• Environmental and human health risks and costs are not fully paid by businesses (externalities)
• Side benefits of efforts not known or anticipated
What approach might work?

ES&H
“Bottoms Up” with People
• Turn off equipment
• Recycling and composting
• Hazardous waste processes
• Water conservation
• Air leak prevention

Facilities
“Top Down” with Infrastructure
• Renewable Energy
• Efficiency Upgrades
• Green Cafeteria
• Electric Charging Station
• LEED buildings
• Showers for bikers
Modified LSS Tools

Figure 11: Value Stream Map Incorporating Water

<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>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety</th>
<th>Quality</th>
<th>Delivery</th>
<th>Inventory</th>
<th>Productivity</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• No missed days</td>
<td>• No injuries</td>
<td>• Less than 5 defects per day</td>
<td>• OPMO less than 50</td>
<td>• 100% on-time to customers, schedule, next process, etc</td>
<td>• Complete 10 units per day</td>
</tr>
<tr>
<td>• WIP less than 10 units</td>
<td>• No more than 3 pieces at each station</td>
<td>• WIP less than $10,000</td>
<td>• $/hr greater than $150</td>
<td>• Less than 10 minutes of downtime</td>
<td>• Team met daily takt time goals</td>
</tr>
<tr>
<td>• All equipment shut off at end of shift</td>
<td>• No recyclables in trash</td>
<td>• 100% Hazardous waste adherence</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Lead Time: 5 days, 10 days, 15 days, 19 days, 2 days

Uptime: 70%, 15%

Water Use: 30,000 gal, 15,000 gal

Total Lead Time = 68 days
Value Added Time = 15 min
Total Water Use = 59,000 gal
Modified LSS Tools

**SIPOC**
- Add Earth as a customer

**SQDC boards**
- Add “E” for environment

**DMAIC → DMAGIC**
- G is for “Green” impacts

**VSM**
- Add water, energy and chemicals to data box
- Show usage on timeline

**OEE**
- Add Energy Consumption to calculation
Strategy Enhancements

- Focus improvement efforts specifically on social and environmental metrics using Lean Six Sigma
- Relate environmental and social issues to core business needs and priorities
- All process improvements naturally reduce impact on the environment, so start capturing the benefits!
- Share this presentation with Facilities, ES&H and LSS personnel
Tactical Enhancements

- Add Earth as a customer on your SIPOC
- Add environmental usage and costs to data boxes on VSM
- Add environmental impacts to waste definitions and training materials
- Integrate environmental checklists into event templates
- Invite ES&H and Facilities personnel to lean events and Six Sigma project teams
Books
EPA Resources

- The Lean and Environment Toolkit
- The Lean, Energy & Climate Toolkit
- The Lean and Chemicals Toolkit
- The Lean & Water Toolkit
- The Environmental Professional’s Guide to Lean & Six Sigma
Useful Checklists

1. **ES&H Lean Event Checklist**
2. **10 Tips for Greening your 5S event**
3. **Tips to Green your Lean Event**

### Useful Checklists

**Physical Environment**

<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 locations where either maintenance work or use of hazardous chemical/material will occur?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any changes to your personnel’s work zone assignments?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any new equipment or modification of existing equipment to produce air or water emission? (Equipment Operations/clean)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any changes to the facility (e.g., water/sewer) system?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any changes in the locations of storage locker/areas?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any new confined space entry personnel entering fuel tanks?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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 personnel and/or use?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This includes the introduction of chemicals, etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any changes to the chemical procedure for chemicals/materials?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any changes in the volume of storage material?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any flammable materials that storage cabinets at the end of the waste management event?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any change(s) to the initial accumulation points?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any change(s) to location accumulation points?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any change(s) to volume disposal (i.e., wastewater, etc.) of material that will accumulate?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Summary

• Lean is Green
• Waste has a direct environmental impact
• Green is Lean
• Sustainability is good for business
• Leverage LSS to implement sustainability (strong alignment)
• LSS doesn’t address all the issues
• Help ES&H help with bottoms up and Facilities address from top down
• Lots of great books and websites available
Thank You!

Your opinion is important to us!
Please take a moment to complete the survey using the conference mobile app.

Session: WP/35
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