

Lean and the Environment

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Rockwell Collins

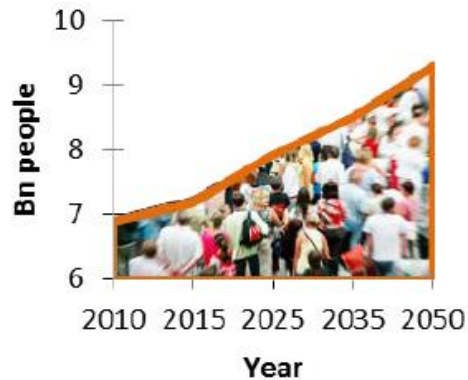
Lean Six Sigma Network

April 11, 2013

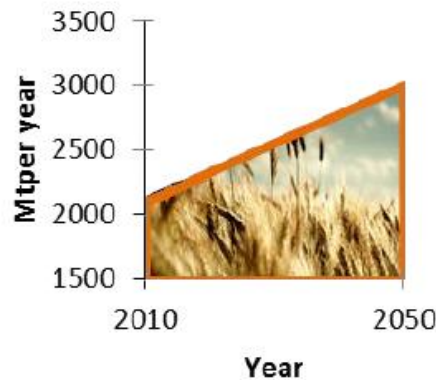


Current State

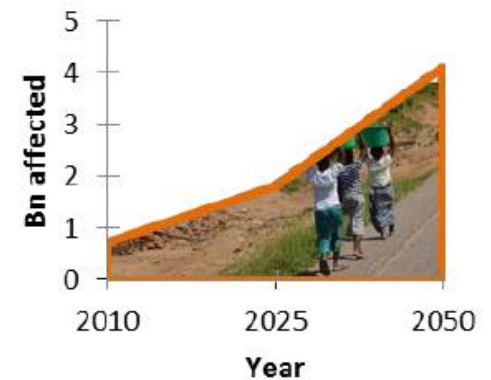
Population



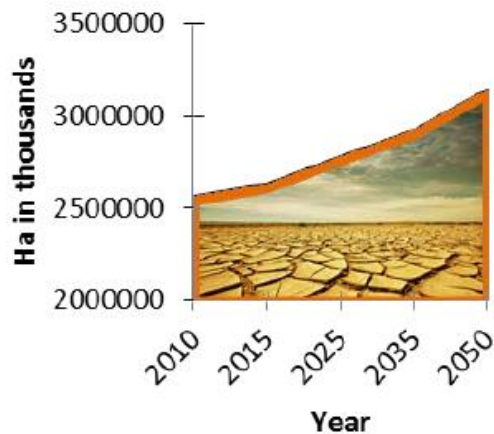
Demand for cereal



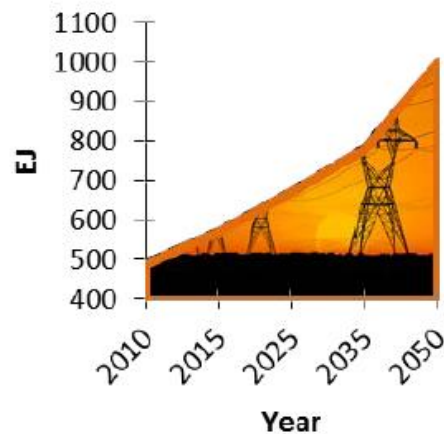
Water scarcity



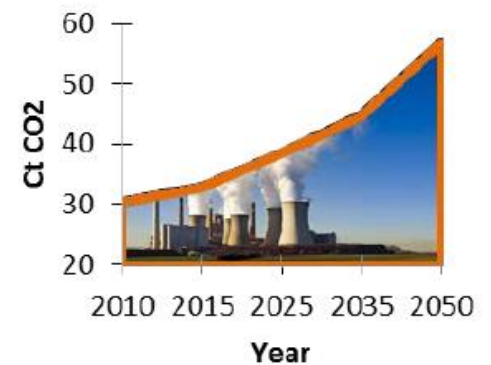
Arid areas



Energy consumption



Energy-related CO2 emissions



Objective

- Motivate you to learn more about environmental sustainability, so you can further drive lean and sustainability concepts into your job function and company
- Presentation will be made available for download



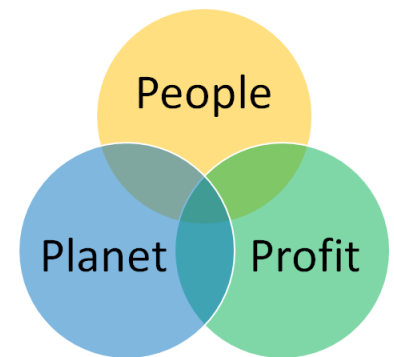
Agenda

- What is sustainability?
- What is carbon footprint?
- Why are companies going green?
- Example of side benefits
- Why issues are not addressed with lean
- Tie to existing Lean and Six Sigma tools and concepts
- Resources



What is sustainability?

- Meeting the needs of the present without compromising the ability of future generations to meet their own needs
- What does it mean for business?
 - Satisfying customers' demands, while managing the expectations of stakeholders
 - Balanced integration of social and environmental considerations in business strategy and operations
 - Keep business thriving for generations
 - **Triple Bottom Line**
 - People, Profit, Planet
 - Economic, Social, Environmental



Triple Bottom Line

- Example: Food

- Economic – price listed on the item or the shelf, very clear
- Social – nutritional value, calories/fat, cruelty-free, Fair Trade
- Environment – Local sources (low food miles), most only use words (organic, GMO-free, no additives/coloring)

ECONOMIC



SOCIAL



ENVIRONMENT



Carbon Reduction Label
courtesy of [Carbon Trust](#)

What is Carbon Footprint?

- Total amount of greenhouse gas (GHG) emissions caused by an organization, event or product
 - Each GHG is converted and expressed in terms of the amount of carbon dioxide equivalents

Gas name	Chemical formula	Lifetime (years)	Global warming potential (GWP) after 20-years
Carbon dioxide	CO ₂	30–95	1
Methane	CH ₄	12	72
Nitrous oxide	N ₂ O	114	289
CFC-12	CCl ₂ F ₂	100	11,000
HCFC-22	CHClF ₂	12	5,160
Tetrafluoromethane	CF ₄	50 000	5,210
Hexafluoroethane	C ₂ F ₆	10 000	8,630
Sulfur hexafluoride	SF ₆	3 200	16,300
Nitrogen trifluoride	NF ₃	740	12,300

- General agreement that global carbon emissions need to be cut by 80% by 2050 to be sustainable (G8 Summit 2009)
- **Does your company report carbon footprint?**



Why are companies going “green”?

Financial

- Increased revenue
- Reduced energy, waste and materials (reduced costs)
- Decision making focused on lifecycle costs
- Drives long term strategic planning

Risks and Legal

- Regulatory compliance (proactive and reactive)
- Reduce future risks to revenue and expenses

Employees

- More motivated, engaged and inspired workforce
- Retention and acquisition of employees

Customers and Sales

- Opening up new markets
- More loyal customers
- Product differentiation and innovation
- Managing competitors
- Customer or employee request

These were not the original intent, side benefit of green efforts

Example: Take-back programs

EXPECTED BENEFITS

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



SIDE BENEFITS

- Interaction, feedback and idea generation with customers (Innovation)
- Evaluation of how customers use products (Innovation)
- Opportunity to sell or discount customers on newer products (Sales)
- Customer loyalty due to interaction and idea sharing



How to “go green”

- Save money and reduce risk without impacting business by identifying these opportunities

Water



Air



Solids



Toxicity
(Chemicals)



Energy



Graphic courtesy Purdue Technical Assistance Program

...but shouldn't our
existing Lean program
cover these already?

Why isn't Lean enough?

- “Cost of doing business” - not viewed as opportunity
- Costs and impacts can be blanketed across many areas, hard to isolate data to biggest users
- Improvement opportunities may be found outside of normal working operations
- Environmental and human health risks are often not explicitly considered in business decisions
- Side benefits of efforts not anticipated or factored in
 - Take-back, talent acquisition, employee engagement



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.



Does Lean work on these issues?

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

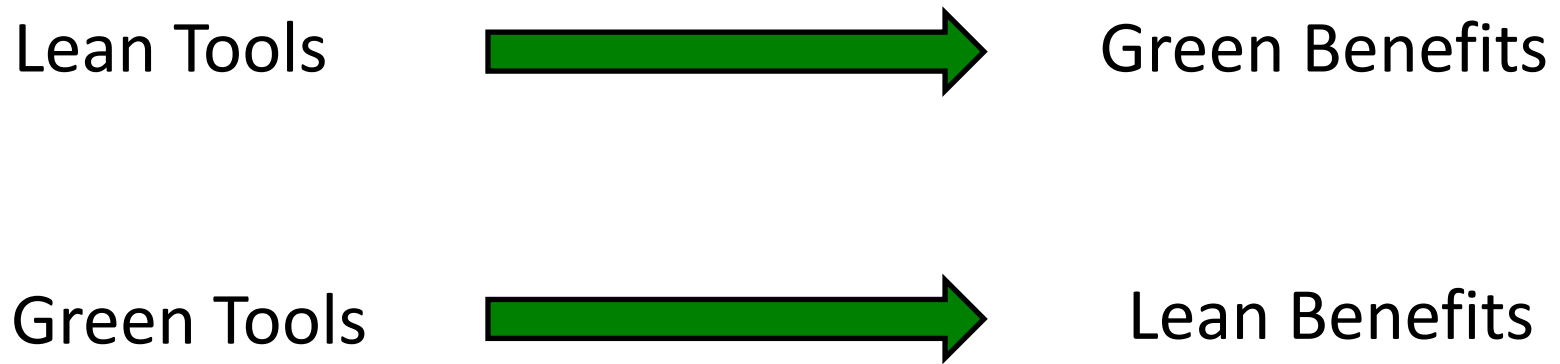
- ✓ **3M** reduced volatile air emissions by 61% and toxic inventory releases by 64% from 2000 to 2005 using Lean and Six Sigma techniques in coordination with pollution prevention.
- ✓ **Columbia Paint & Coatings** recovered 49,200 lbs per year of paint solids from wash water and reduced wastewater 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.

“...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>



Lean naturally helps the environment!



Helping the environment should closely align with business needs, otherwise it will appear disconnected to employees and stakeholders



Value applied to the environment

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

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

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

7 Forms of Waste

Waste Type	Environmental Impacts
Overproduction	<ul style="list-style-type: none"> • More raw materials consumed in making the unneeded products • Extra products may spoil or become obsolete requiring disposal • Extra hazardous materials used result in extra emissions, waste disposal, worker exposure, etc.
Inventory	<ul style="list-style-type: none"> • More packaging to store work-in-process • Waste from deterioration or damage to stored WIP • More materials needed to replace damaged WIP • More energy used to heat, cool, and light inventory space
Transportation and Excessive Motion	<ul style="list-style-type: none"> • More energy use for transport • Emissions from transport • More space required for WIP movement, increasing lighting, heating, and cooling demand and energy consumption • More packaging required to protect components during movement • Damage and spills during transport • Transportation of hazardous materials requires special shipping and packaging to prevent risk during accidents
Defects	<ul style="list-style-type: none"> • Raw materials consumed in making defective products • Defective components require recycling or disposal • More space required for rework and repair, increasing energy use for heating, cooling, and lighting
Over Processing	<ul style="list-style-type: none"> • More parts and raw materials consumed per unit of production • Unnecessary processing increases wastes, energy use, and emissions
Waiting	<ul style="list-style-type: none"> • Potential material spoilage or component damage causing waste • Wasted energy from heating, cooling, and lighting during production downtime

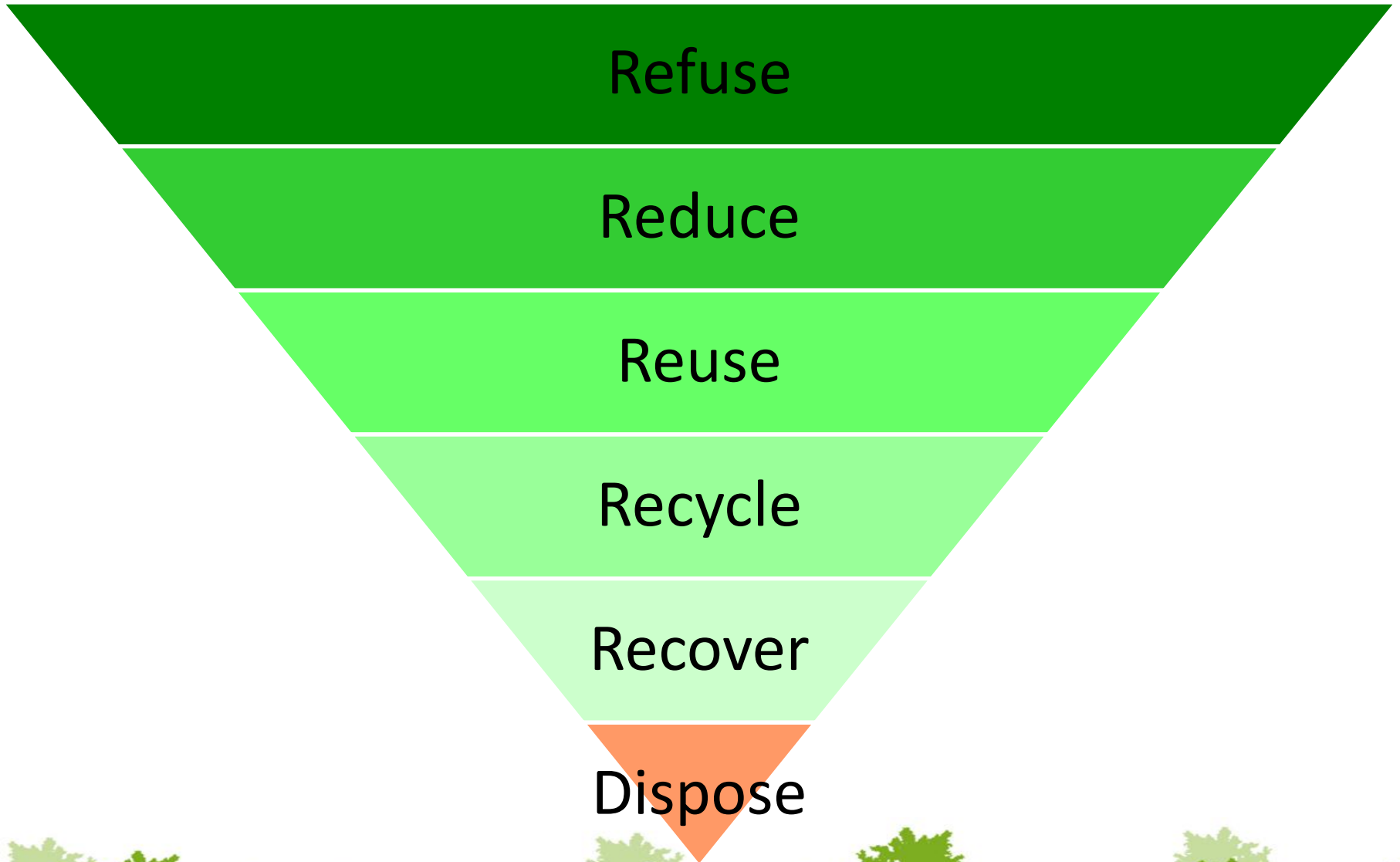
“Sub-optimization” case study

Improvement and savings / TABLE 1



Wastes	Improvements	Annual results
Overprocessing	Widened orifices in glass bead blast cabinets, reducing cleaning time per cylinder by 50%, overall energy use and material (glass bead) and nonhazardous waste.	Reduced labor hours
Defects	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). This required cross-training and visual standard work procedures.	Less detergent used: 41 gallons Less water used: 1,480 gallons
Overprocessing	Boring, honing and cross-hatching now performed on an automatic honing machine instead of doing one cylinder at a time manually.	Less nonhazardous wastewater: 259 gallons
Unnecessary motion	Parts repackaged in special crates to minimize handling.	Less glass bead: 3,631 pounds
Overprocessing	Eliminated one process-cleaning step, reducing electricity use (less use of high-pressure spray washer).	Less nonhazardous solid waste: 5,791 pounds
Waiting and scrap	Reused (clean and plate) formerly discarded hardware, resulting in less work stoppage due to unavailable parts.	\$64,335 in total cost savings

Waste Pyramid



Traditional VSM with Water Data

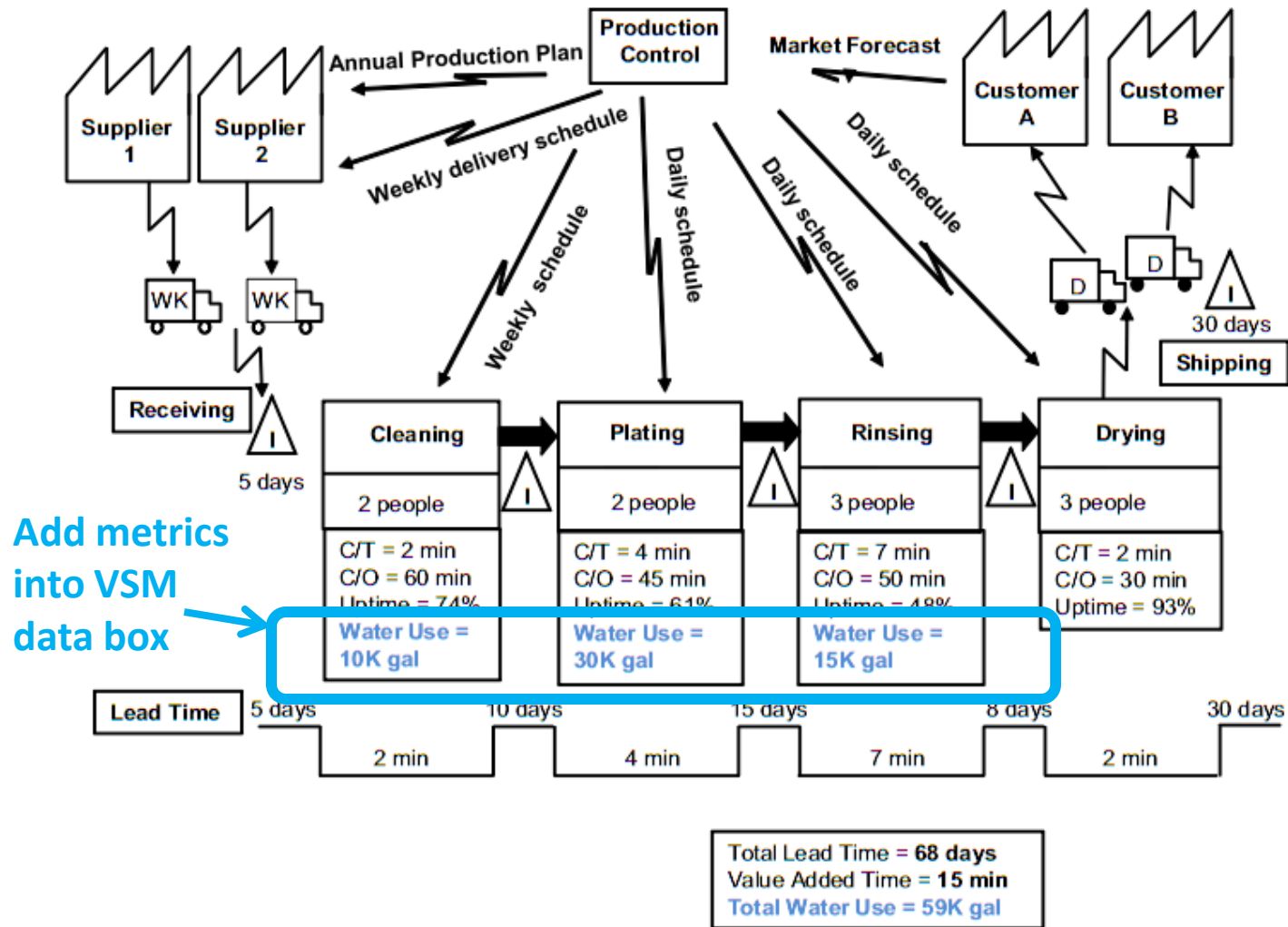
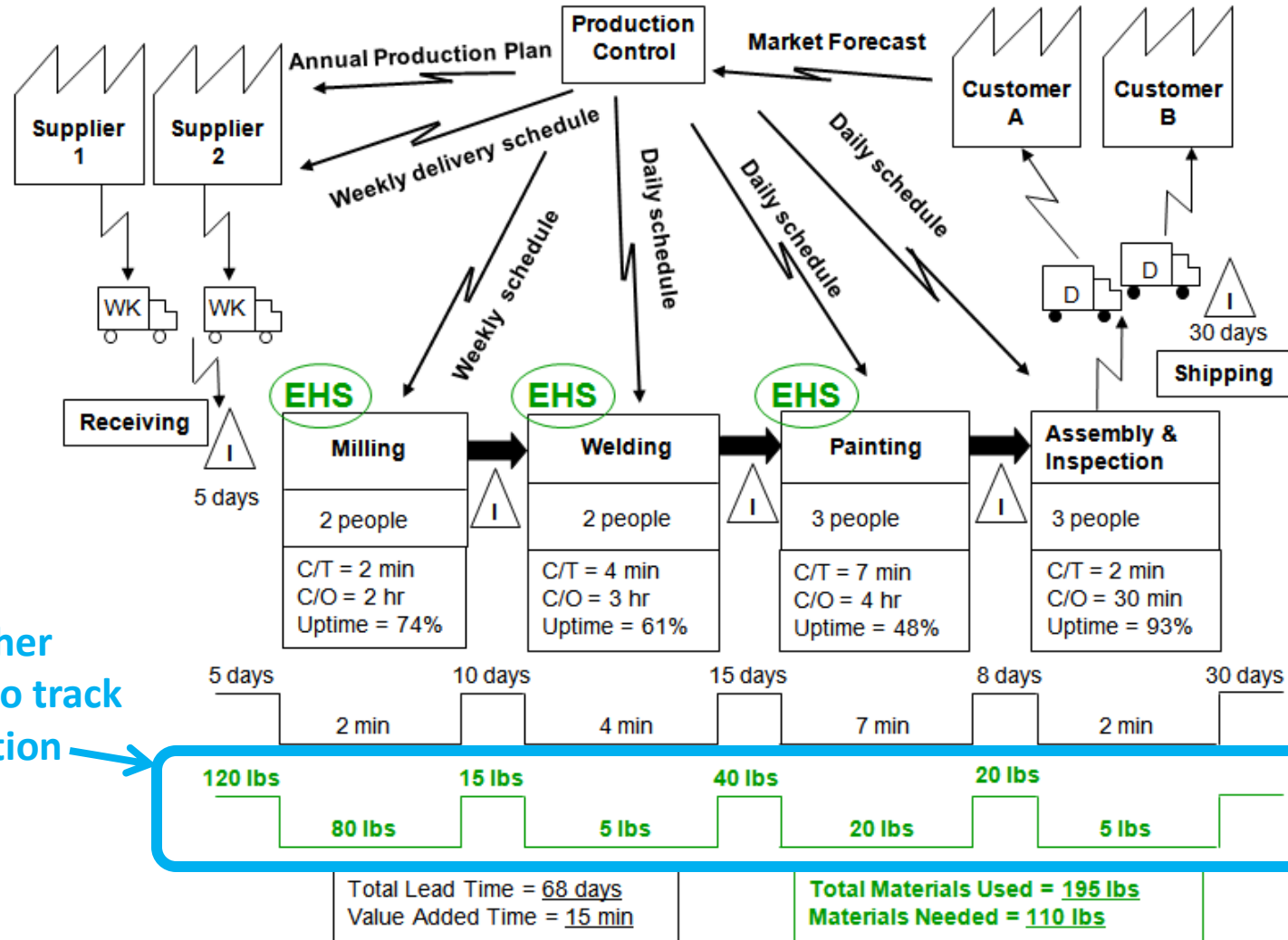


Figure 11: Value Stream Map Incorporating Water Use Metrics

<http://www.epa.gov/lean/environment/toolkits/water/resources/lean-water-toolkit.pdf>

Value Stream Maps



Add another timeline to track consumption

http://www.greensuppliers.gov/tech/tools.html?id=lean_clean

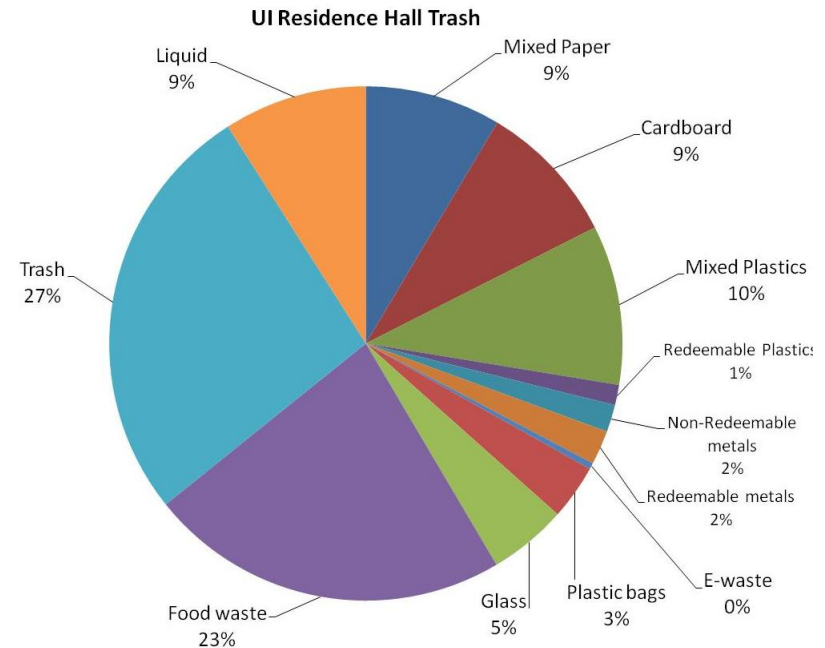
- 1) Off hours observations
- 2) Case for change
- 3) Define the team
- 4) Prepare for event
- 5) Kickoff training
- 6) Run the events
- 7) Organize and prioritize opportunities
- 8) Review action items
- 9) Establish roles and responsibilities
- 10) Communicate successes



Dumpster Dive / Waste Audit



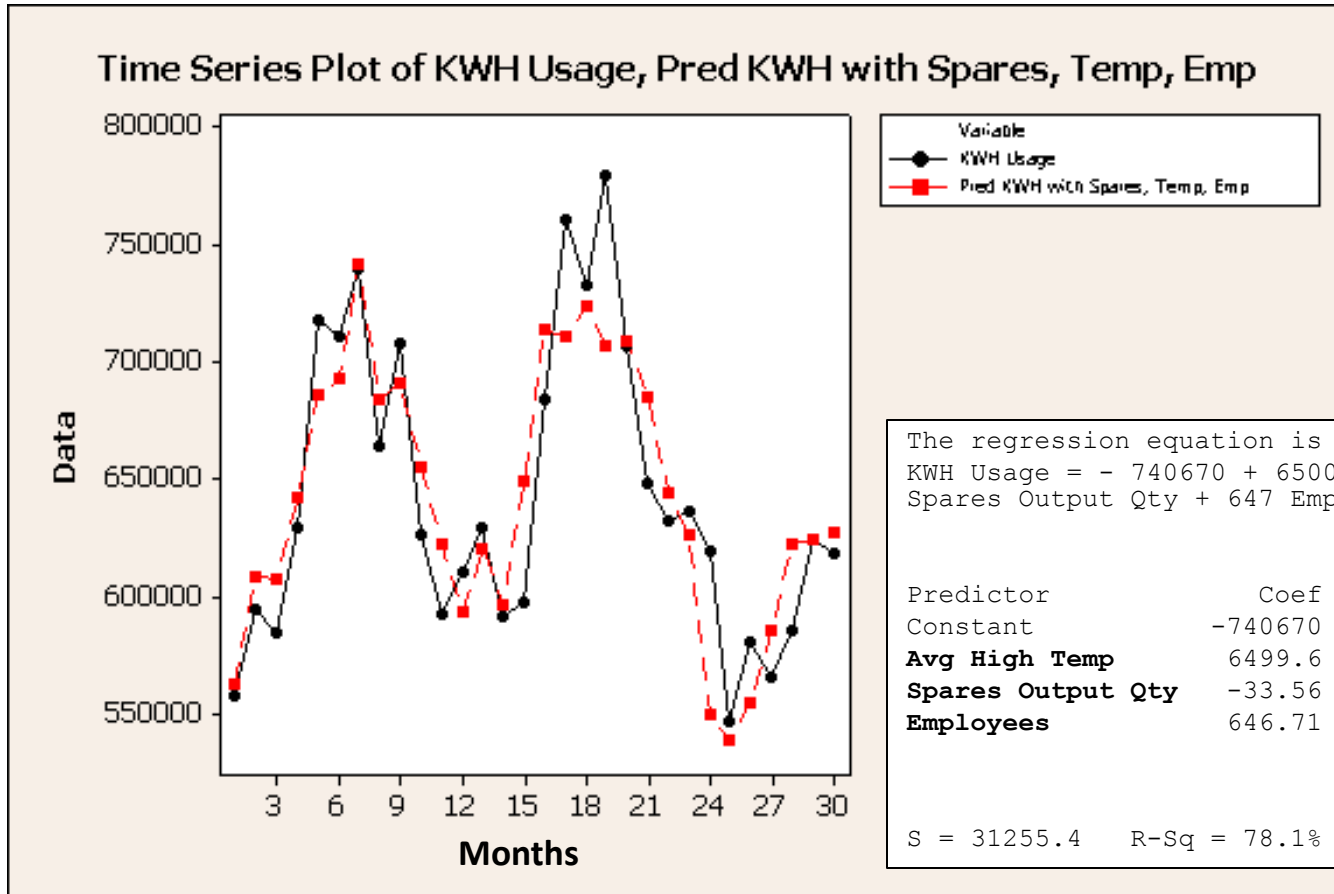
Courtesy of Univ of Iowa Office of Sustainability and ECO Hawk



Regression Analysis

Determine
largest drivers of
electricity usage

**What does this
tell you?**



FMEA

- Include environmental risks into Severity rankings

Table 2 ES&H Severity Level Definitions

Rank	Severity Level	Description
10	Catastrophic I	A failure results in the major injury or death of personnel.
7–9	Critical II	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.
4–6	Major III	A failure results in a low level exposure to personnel, or activates facility alarm system.
1–3	Minor IV	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.

<http://www.semtech.org/docubase/document/0963beng.pdf>

Event Checklist

- You can't be in every event, so provide this checklist to the teams, so they know what things to consider, and when to call for help

Physical Environment			
<i>As a result of the Lean event, will there be:</i>	Unk	Yes	No
Any changes to the locations where either maintenance work or use of hazardous chemical/material will occur?			
Any changes to your personnel's work zone assignments?			
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)?			
Any changes to the facility (e.g., vents, stacks, floor drains, oil/water separators)?			
Any changes in the location(s) of the current flammable storage locker/areas?			
Any new confined space entry activities or procedures (e.g., personnel entering fuel tanks for cleaning)?			

Event Checklist (cont'd)

Material/Chemical Use and Storage			
<i>As a result of the Lean event, will there be:</i>	Unk	Yes	No
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.			
Any changes to the chemical introduction or issuance procedure for chemicals/materials containing hazardous materials?			
Any changes in the volume of chemicals/materials stored?			
Any flammable materials that are not returned to the storage cabinets at the end of each shift?			
Waste Management			
<i>As a result of the Lean event, will there be:</i>	Unk	Yes	No
Any change(s) to the waste profiles for wastes stored at any initial accumulation points?			
Any change(s) to the location or number of initial waste accumulation points?			
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?			

http://www.greensuppliers.gov/pubs/module4_kzn.pdf

Integrating Green into Lean

- ❑ Add Earth/Environment to SIPOC as a Customer
- ❑ All process improvements naturally reduce impact on the environment, now capture the environmental benefits!
 - Eliminate non-value added tasks, reduce space allocation, reduce time between processes, reduce raw materials needed
- ❑ Add environmental usage and costs to data boxes on Value Stream Maps
- ❑ Add environmental impacts to existing “7 Forms of Waste” table
- ❑ Relate environmental issues to core business needs and priorities (money, risk, reputation, etc)
- ❑ Focus improvement efforts specifically on environmental metrics
- ❑ Integrate environmental event checklists into templates
- ❑ Communicate Resources slide to Lean and ES&H personnel in your company



Local Training Resources

- **CIRAS** - extension of ISU - supports qualifying small and medium size Iowa manufacturers
 - “Green 101” workshop
 - Foundation course for the green initiative, covering topics in sustainability, solid waste management, energy management and environmental business management. Includes wind turbine assembly simulation
 - "Dumpster Dive" workshop
 - Fundamentals of solid waste streams
 - Methods to evaluate materials used in products and processes
 - Concepts relating to life cycle analysis
 - How to reduce or eliminate the solid waste stream
 - How to apply the 4Rs - Refuse, Reduce, Reuse, Recycle
- Purdue Technical Assistance Program (TAP) offers additional workshops
 - Energy Management, Green Chemistry, H2O Conserve, Pollution Solutions, Waste Stream Mapping and Sustainability into Practice (plus Green 101 and Dumpster Dive)



“Lean and the Environment” Books



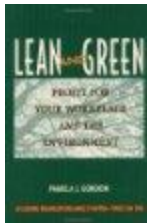
[Green Intentions](#)



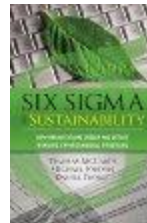
[Green to Gold](#)



[Green Manufacturing](#)



[Lean and Green](#)



[Six Sigma for Sustainability](#)



[Creating a Lean and Green Business System](#)



[Green Manufacturing:
Fundamentals and
Applications](#)

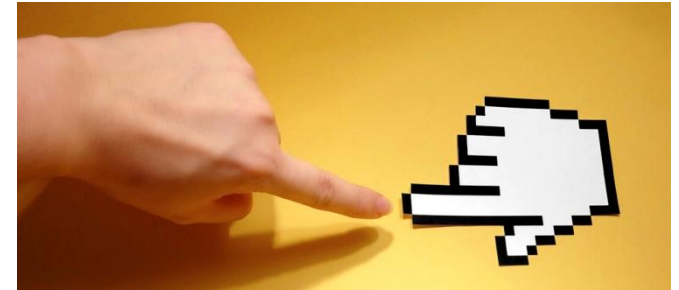


[Green Your Work](#)



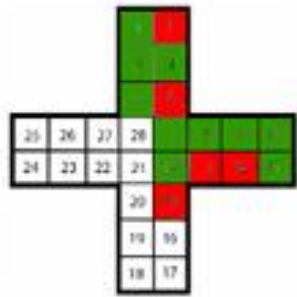
“Lean and the Environment” Resources Online

- Iowa State University
 - Center for Industrial Research and Service (CIRAS)
 - <http://www.ciras.iastate.edu>
 - Industrial Assessment Center (IAC)
 - <http://www.me.iastate.edu/iac/>
- Purdue/SME Green Manufacturing
 - <http://www.greenmanufacturing.purdue.edu>
- US Environmental Protection Agency (EPA)
 - “Lean and Energy Toolkit”
 - <http://www.epa.gov/lean/environment/toolkits/energy/index.htm>
 - “Lean and Environment Toolkit”
 - <http://www.epa.gov/lean/environment/toolkits/index.htm>
 - “The Environmental Professional’s Guide to Lean & Six Sigma”
 - <http://www.epa.gov/lean/environment/toolkits/professional/resources/Enviro-Prof-Guide-Six-Sigma.pdf>
 - Green Supplier Network
 - http://www.greensuppliers.gov/tech/tools.html?id=lean_clean
- IBM “Green Sigma”
 - <http://www.ibm.com/green>
- Zero Waste Network – Case Studies
 - <http://zerowastenetwork.org/success/index.cfm?regionalcenter=>
- GE “Ecomagination”
 - <http://www.ecomagination.com>
- UTC Energy Management Guidebook
 - http://www.utc.com/StaticFiles/UTC/StaticFiles/utc_energy_management_guidebook.pdf

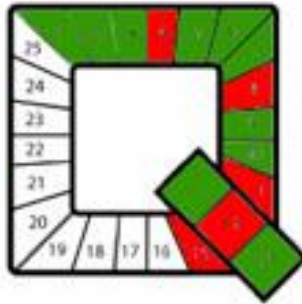


Other Environmental Tools

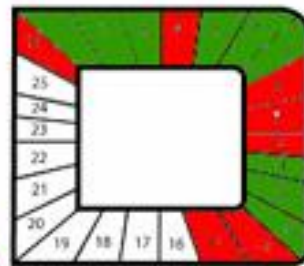
QDIP (SQDC) Visual Controls



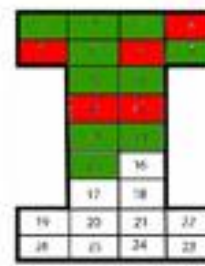
SAFETY



QUALITY



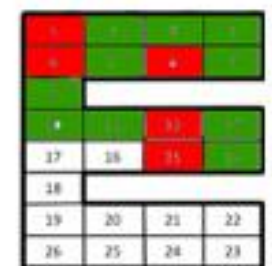
DELIVERY



INVENTORY



PRODUCTIVITY



ENVIRONMENT

Safety	Quality	Delivery	Inventory	Productivity	Environment
<ul style="list-style-type: none"> •No missed days •No injuries 	<ul style="list-style-type: none"> •Less than 5 defects per day •DPMO less than 50 •Test Yield greater than 95% 	<ul style="list-style-type: none"> •100% on-time to customers, schedule, next process, etc •Complete 10 units per day 	<ul style="list-style-type: none"> •WIP less than 10 units •No more than 3 pieces at each station •WIP less than \$10,000 	<ul style="list-style-type: none"> •\$/hr greater than \$150 •Less than 10 minutes of downtime •Team met daily takt time goals 	<ul style="list-style-type: none"> •All equipment shut off at end of shift •No recyclables in trash •100% Hazardous waste adherence

What is 5S Yellow-Tagging?

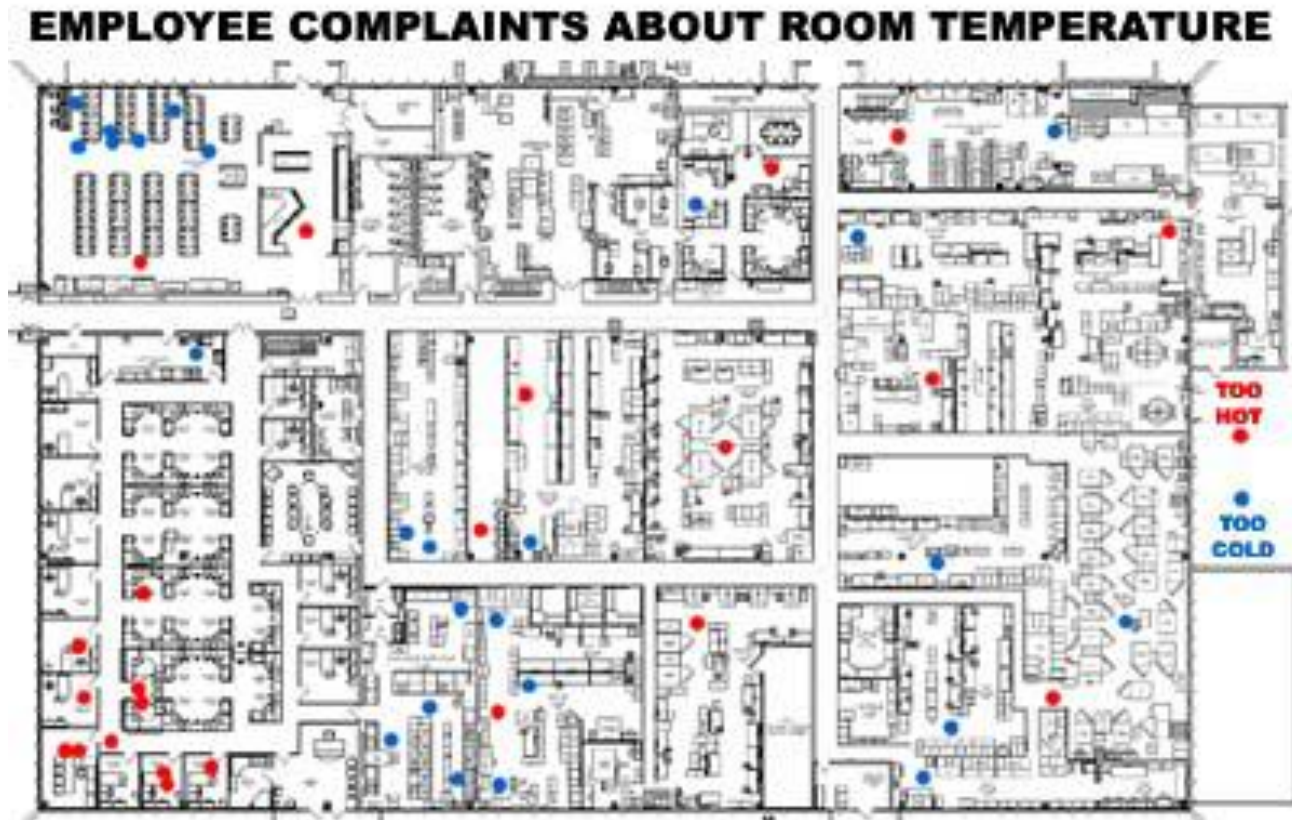
- **Yellow-tagging is a simple strategy used to:**
 - Identify environmental wastes and items that may be harmful to human health or the environment in the work area
 - Evaluate the need for these items
 - Evaluate potential alternatives for these items
 - Address them appropriately
- This is a supplement to red-tagging-- key differences include the scope of projects, criteria used, and options for disposal or reuse

Category (circle one)	1. Health or safety concern 2. Environmental concern		
Item Name and Number			
Description of Issue or Question			
Division Responsible:		Date:	

http://www.greensuppliers.gov/tech/tools.html?id=lean_clean

Defect Concentration Chart (Pictogram)

- HVAC Issues



Overall Equipment Effectiveness (OEE)

- Metric for overall utilization of facilities, time and material for manufacturing operations
 - **OEE = Availability x Performance x Quality**
- 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



Design for Environment (DfE)

- Considerations to reduce W.A.S.T.E. must be made throughout entire life cycle
 - Pre-Manufacture
 - Manufacturing and Assembly
 - Packaging and Transportation
 - Product Use
 - End of Life
- Key concepts
 - Abundant, non-toxic, non-regulated materials
 - Natural materials instead of synthetic materials
 - Minimize material and energy use in products, processes and services throughout all life cycles
 - Do not deplete the ozone or increase global warming
 - Maximize recycling streams before raw material extraction



Life Cycle Assessments (LCA)

- Technique to assess the environmental aspects and potential impacts associated with a product, process, or service, by:
 - Compiling an inventory of relevant energy and material inputs and environmental releases
 - Evaluating the potential environmental impacts associated with identified inputs and releases
 - Interpreting the results to help you make a more informed decision
- Provides data and analysis needed for DfE decisions
- Ties closely with Lean concept of value streams

<http://www.epa.gov/nrmrl/std/lca/lca.html>



Contact



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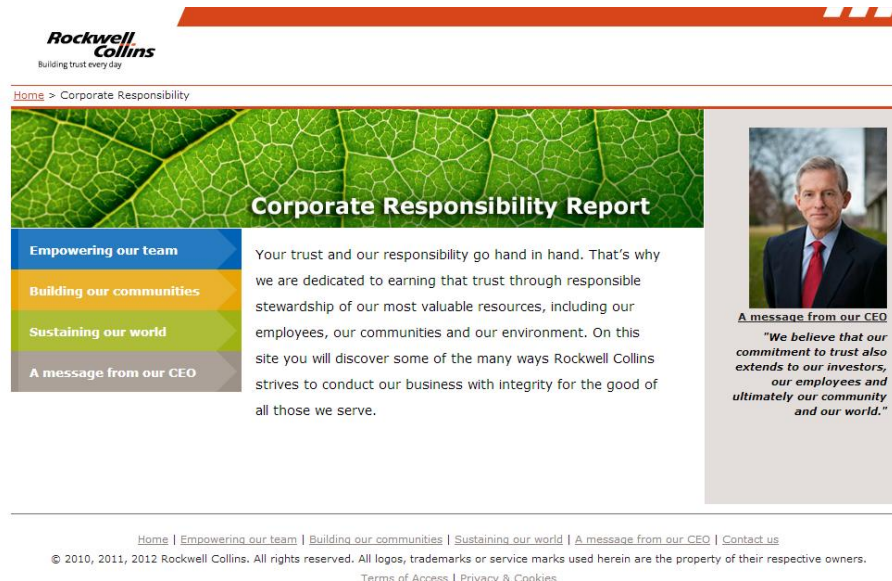
What will it look like in the future?

- Consumers will consider these criteria instead of comparing only by price:
 - **Airline tickets:** Aircraft fuel efficiency, total trip distance, organic food options, low VOC seats
 - **House:** Walkability, proximity to public transportation, 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





- Reported to CDP last six years
- Named to the Dow Jones Sustainability Index North America (DJSI) last four years
- Annual Corporate Responsibility Report (CRR)



<http://www3.rockwellcollins.com/csr/>