Lean and the Environment

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APICS @ ACT
January 8, 2013

Objective

- Motivate you to learn more about environmental sustainability, so you can further drive lean and sustainability concepts into your job function and company

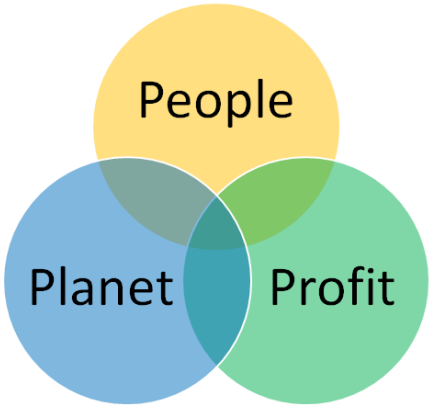
- Presentation will be made available for download

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
- Tie to Supply Chain
- 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 other people, such as employees, suppliers and the surrounding community (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?

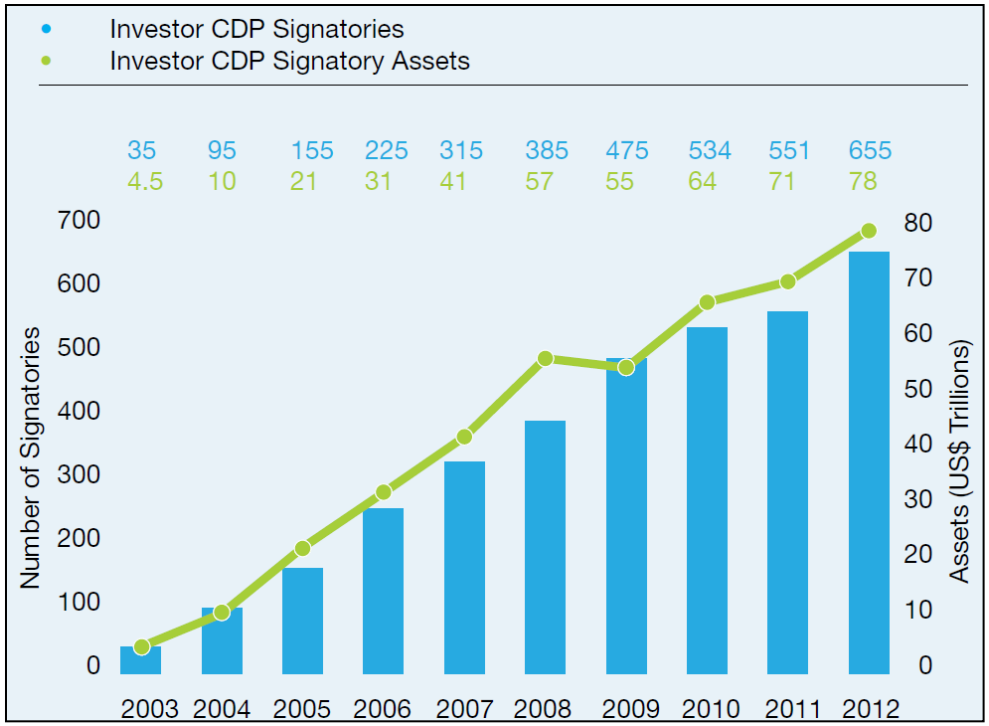
- Total amount of greenhouse gas (GHG) emissions caused by an organization, event or product
  - Each GHG is converted and expressed in terms of the amount of carbon dioxide equivalents

Gas name	Chemical formula	Lifetime (years)	Global warming potential (GWP) after 20-years
Carbon dioxide	CO2	30–95	1
Methane	CH4	12	72
Nitrous oxide	N2O	114	289
CFC-12	CCl2F2	100	11,000
HCFC-22	CHClF2	12	5,160
Tetrafluoromethane	CF4	50 000	5,210
Hexafluoroethane	C2F6	10 000	8,630
Sulfur hexafluoride	SF6	3 200	16,300
Nitrogen trifluoride	NF3	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?**

Carbon Disclosure Project (CDP)

- Not mandatory, but steady increase in companies participating (customer and investor driven)



https://www.cdproject.net/CDPResults/CDP-Global-500-Climate-Change-Report-2012.pdf

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

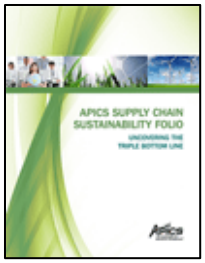
- More motivated, engaged and inspired workforce
- Retention and acquisition of employees

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

APICS Supply Chain Sustainability Folio



- **Uncovering the Triple Bottom Line**
  - Sustainability is increasingly a domain of **innovation** that is reducing cost by reducing demands on resources, while increasing the reuse of existing assets
  - Sustainability helps **integrate** and align across multiple departments, partners, or supply chains
  - Where sustainability is part of corporate philanthropy, it helps develop market awareness and **goodwill**

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 them 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

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!

Lean Tools → Green Benefits

Green Tools → Lean Benefits

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

7 Forms of Waste

Waste Type	Environmental Impacts
Overproduction	• 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	• 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	• 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	• 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	• More parts and raw materials consumed per unit of production • Unnecessary processing increases wastes, energy use, and emissions
Waiting	• Potential material spoilage or component damage causing waste • Wasted energy from heating, cooling, and lighting during production downtime

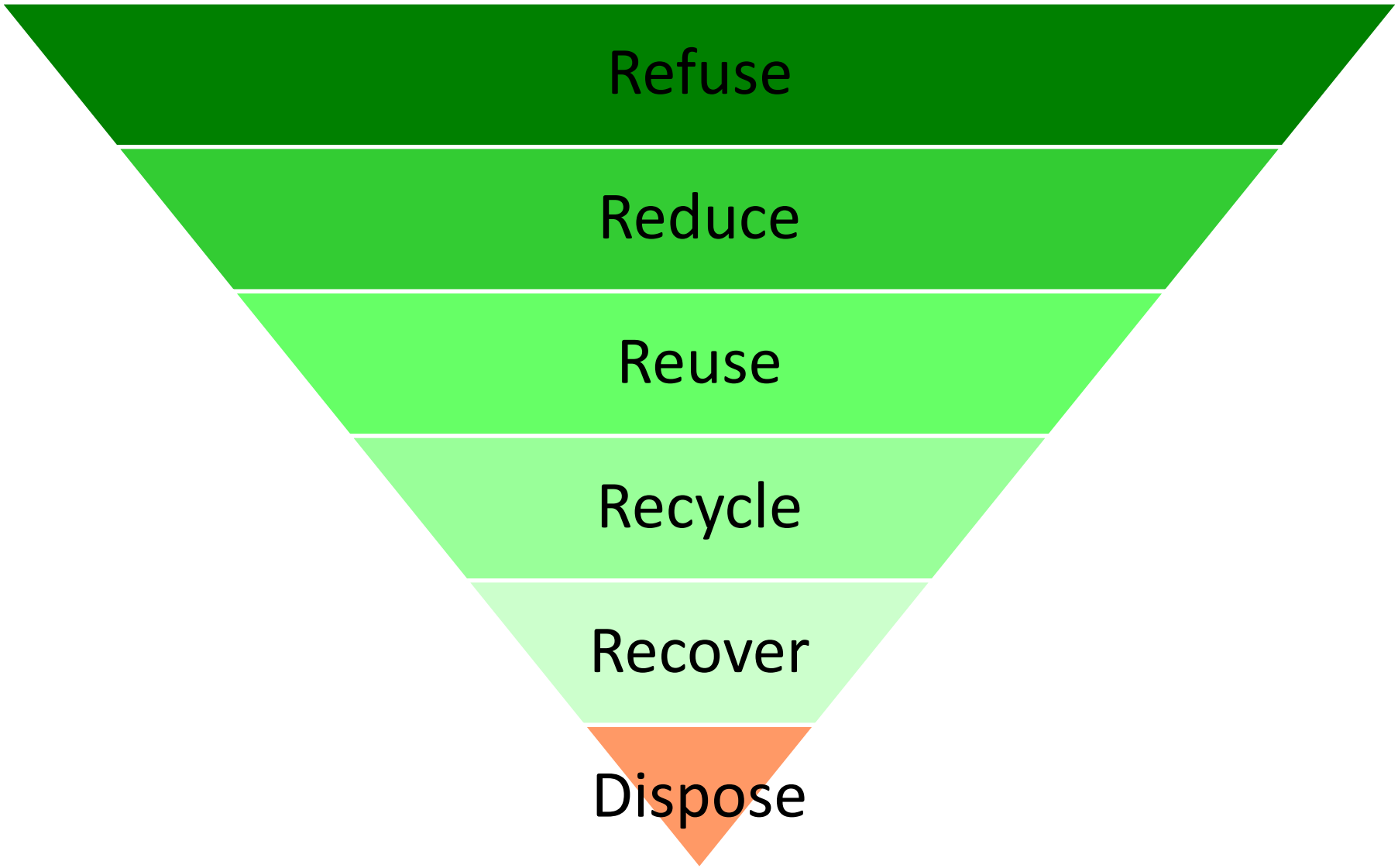
Suboptimization case study

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

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

Waste Pyramid



Traditional VSM with Water Data

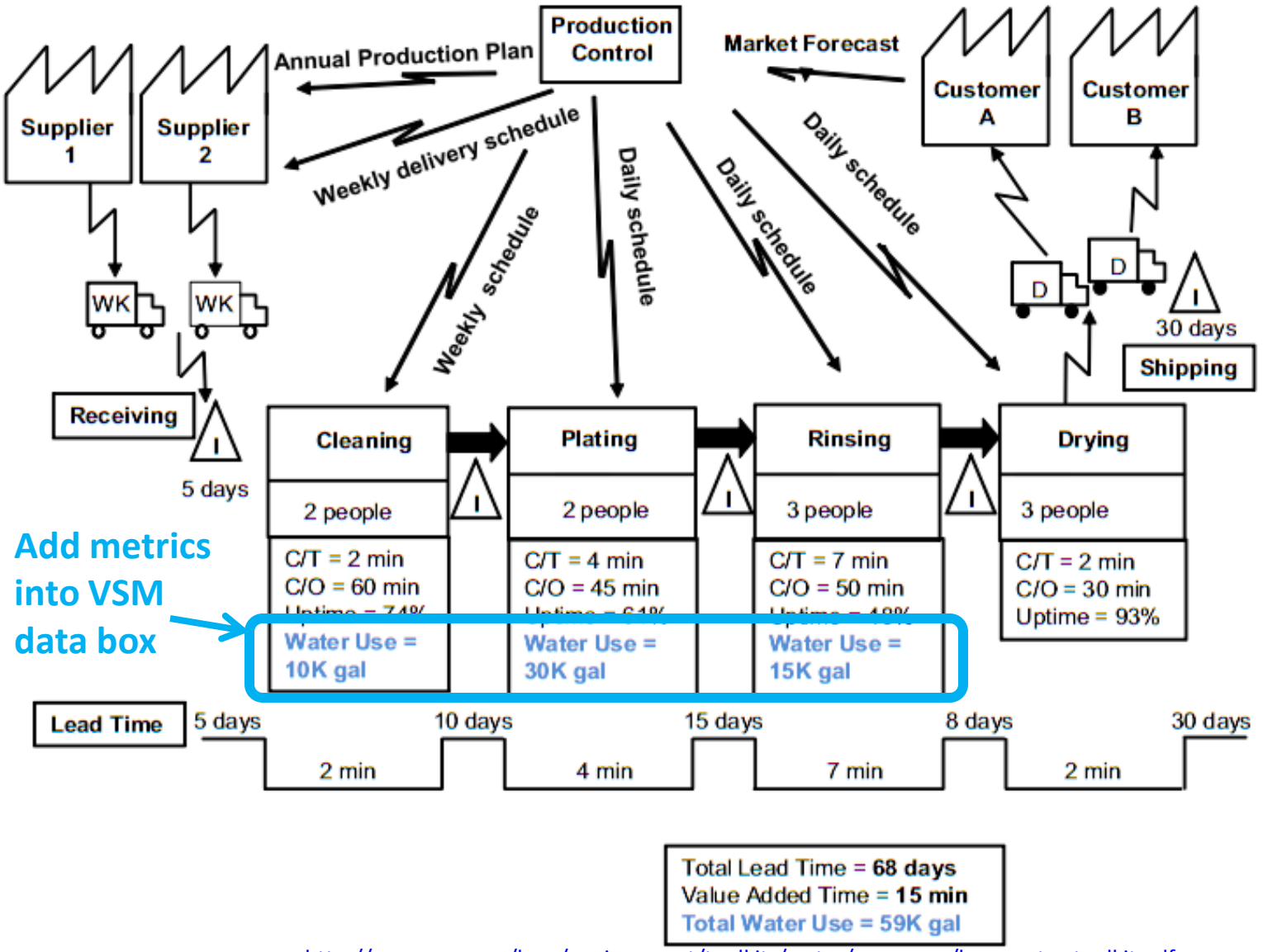
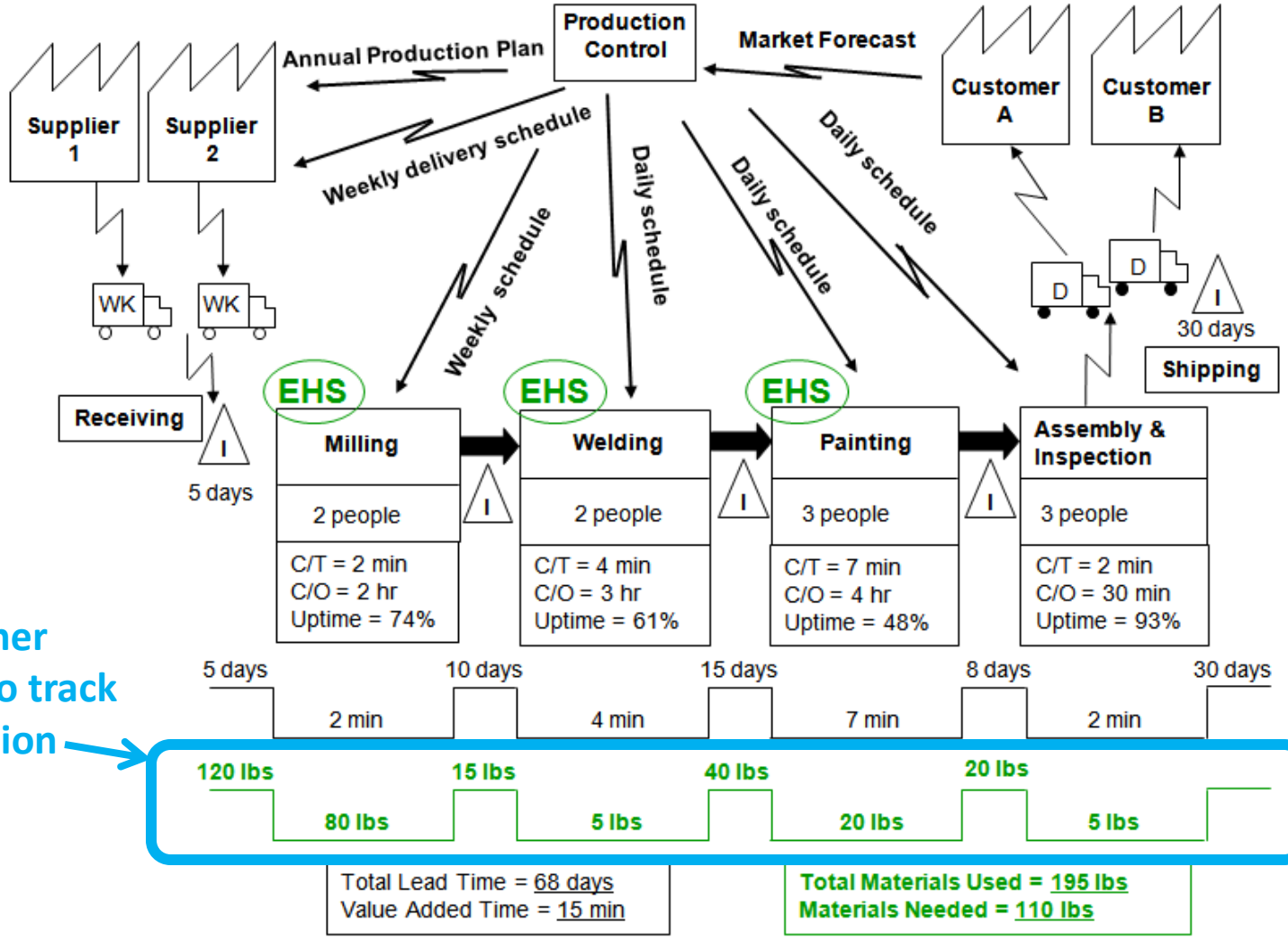


Figure 11: Value Stream Map Incorporating Water Use Metrics

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

Value Stream Maps



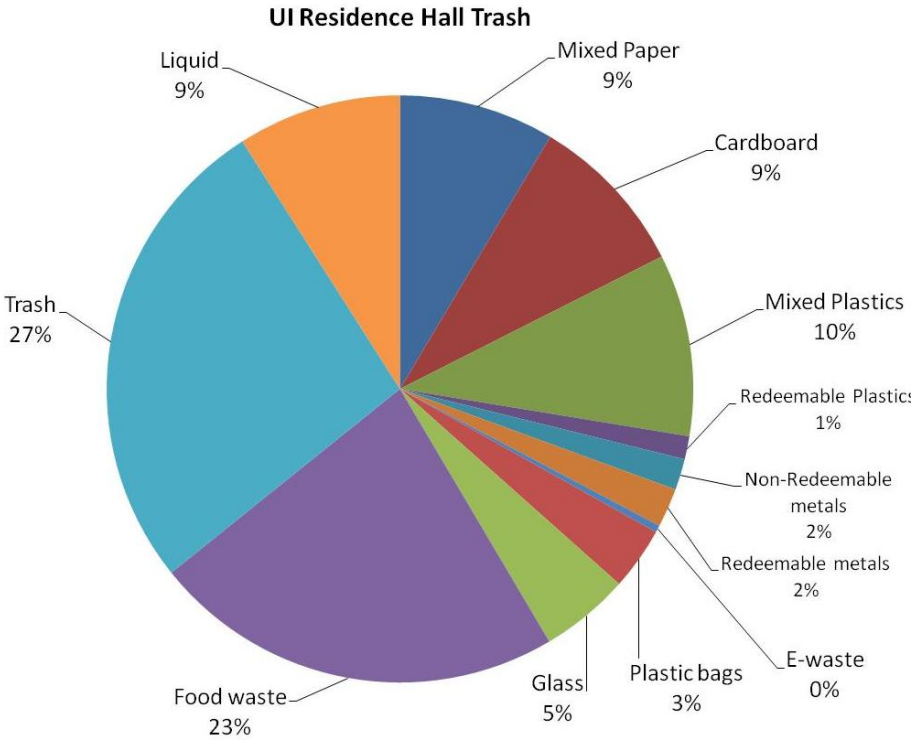
Add another timeline to track consumption

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

Energy Go and See

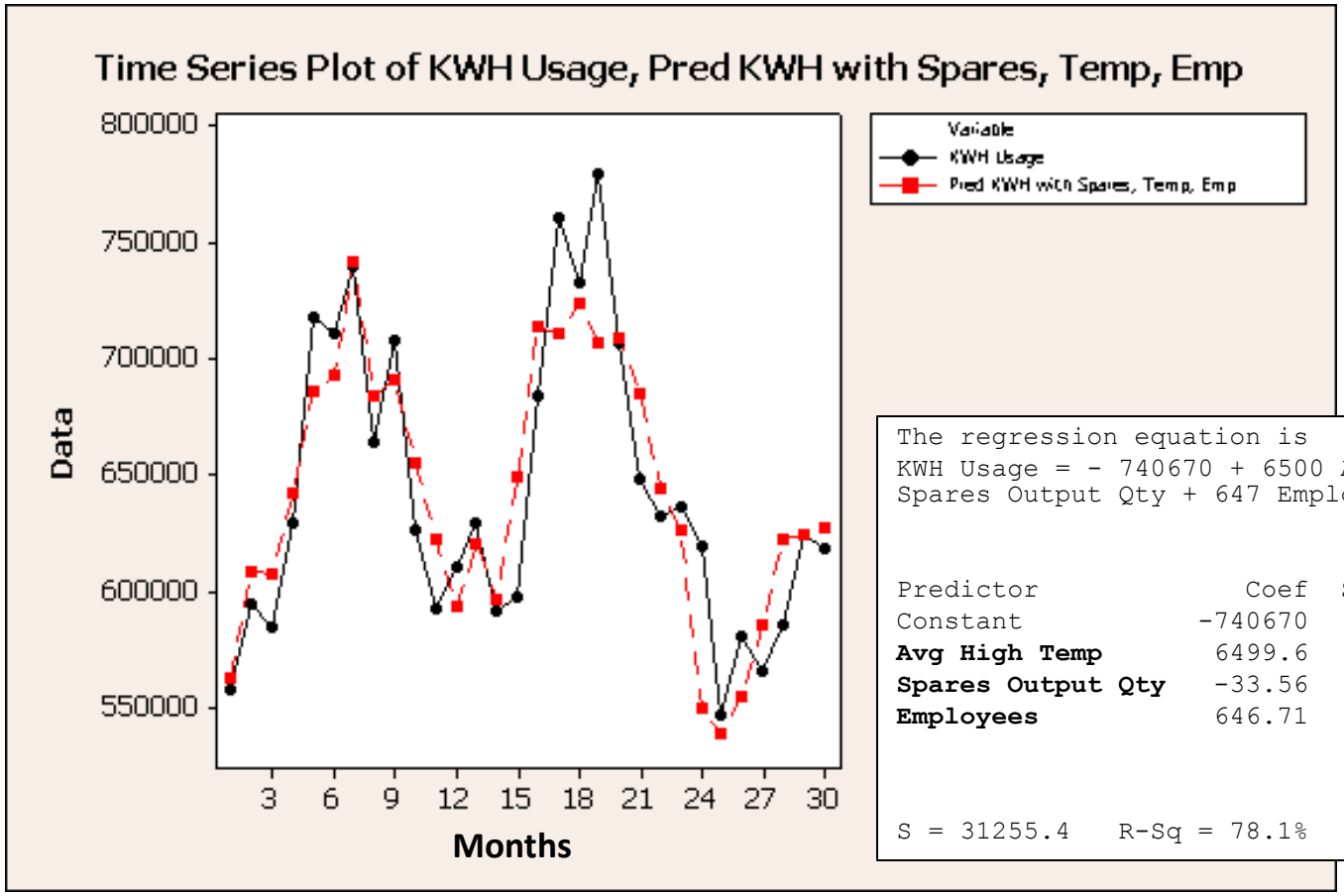
1) Off hours observations
2) Case for change
3) Define the team
4) Prepare for event
5) Kickoff training
6) Run the events
7) Organize and prioritize opportunities
8) Reviews action items
9) Establish roles and responsibilities
10) Communicate successes

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?

The regression equation is
KWH Usage = - 740670 + 6500 Avg High Temp - 33.6 Spares Output Qty + 647 Employees

Predictor	Coef	SE Coef	T	P
Constant	-740670	145555	-5.09	0.000
Avg High Temp	6499.6	944.8	6.88	0.000
Spares Output Qty	-33.56	11.17	-3.00	0.006
Employees	646.71	91.93	7.03	0.000

S = 31255.4 R-Sq = 78.1% R-Sq(adj) = **75.6%**

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			
As a result of the Lean event, will there be:	**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			
As a result of the Lean event, will there be:	**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			
As a result of the Lean event, will there be:	**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

Supply Chain Specifics

- ISO-14001
  - Is there an incentive for your suppliers in your system for certification? Other environmental criteria, like recycled content?
- LEED
  - Are these criteria and guidelines incorporated in new construction and retrofit work?
- The EPA SmartWay Program
  - program that reduces transportation-related emissions by creating incentives to improve supply chain fuel efficiency http://www.epa.gov/smartway/

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

http://www.epa.gov/dfe/

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

Environmentally Preferable Purchasing (EPP)

- Federal agencies are directed by federal laws, regulations and executive orders to comply with green purchasing requirements
- Environmentally preferable means "products or services that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose”
  - When buying products and services, make decisions with the environment in mind (based on sustainable practices)

http://www.epa.gov/epp/

Local Training Resources

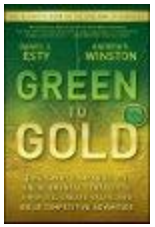
- CIRAS - extension of ISU - supports qualifying small and medium size Iowa manufacturers
  - "Green 101" workshop
    - Foundation course for the green initiative, covering topics in sustainability, solid waste management, energy management and environmental business management. Includes wind turbine 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

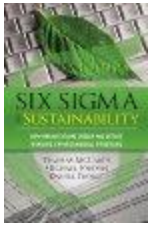
Green to Gold



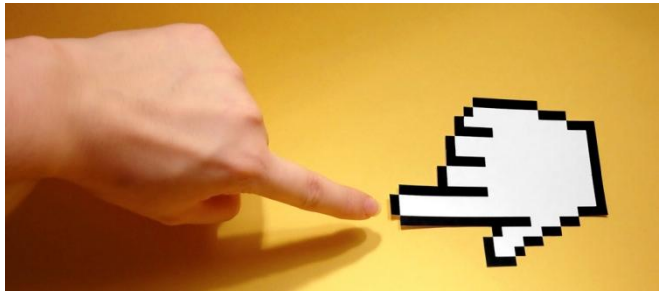
Green Manufacturing

Lean and Green

Six Sigma for Sustainability



“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

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