

New York State Pollution Prevention Institute

Overview

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NYSP2I

Vision:

The vision for the NYS P2I is to foster the transformation and development of sustainable businesses and organizations in New York State in a collaborative program committed to making the State a leader in environmental stewardship.

Mission:

The mission of the NYS P2I is to provide a state-wide, comprehensive and integrated program of technology research, development and diffusion, outreach, with training and education aimed at making New York State more sustainable for workers, the public, the environment and the economy through:

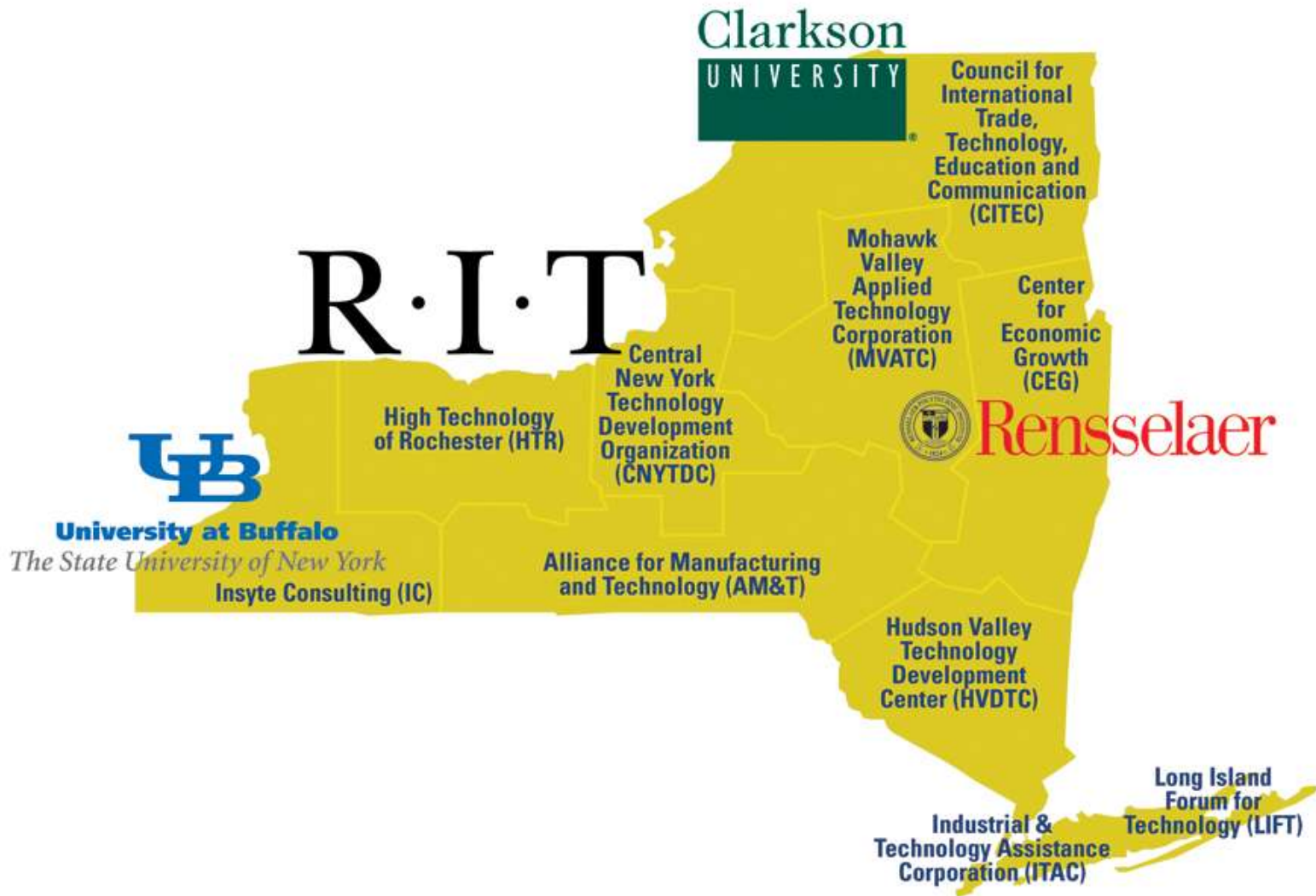
- reductions in toxic chemical use;
- reductions in emissions to the environment and waste generation; and
- the efficient use of raw materials, energy and water.

NYSP2I Goals

- To prevent the risks associated with the use and production of hazardous substances including risks to the public health and the environment.
- To reduce energy and resource consumptions as well as reduction or elimination of hazardous substances, pollution, and waste.
- To implement affordable and cost effective pollution prevention methods to sustain and safeguard the competitive advantage of New York businesses.
- To advance innovation in the reduction of energy and resource consumption and the reduction or elimination of hazardous substances, pollution, and waste.

To provide a new approach to P2 in NYS that goes beyond compliance driven activities and aims to identify opportunities to maximize ways in which to make NYS companies more resource efficient and economically vibrant (sustainable enterprises).

NYSP2I Partners



Role of the RTDCs in the NYSP2I

- Key connection to industry
- Primary delivery mechanism for P2I services
- Go-to support on environmental and energy issues
- Resource for training and building capacity

What is Available

- ***Solving Problems***: Targeted Research, Development, and Diffusion
- ***Sharing Knowledge***: Awareness, Training and Education
- ***Sharing Information***: Information Exchange and Outreach
- ***One-on-One Help***: Hands-on Direct Assistance
- ***Helping Communities***: Community Grants Program

When to call?

- Your client has an environmental issue that needs specialized effort (R&D)
- You want to add to your knowledge base
- You have a question
- You are looking for tools, examples, or case studies

Website

- www.nysp2i.rit.edu
- Hub for communication and information exchange (case studies, tools, events, links)
- Private area for RTDCs (for 10/1/08)
- Went live on August 15, but in continuous state of enhancement

Workshops

- Lean, Energy & Environment (October 27 at RIT in partnership with HTR, NYSERDA, and Energy Concepts)
- Surface Cleaning Technologies (October 28 at RIT; NYSP2I Testbed)
- P2 Assessment Techniques and Tools (early December; hosted in Albany)
- P2 Training for NYSDEC Engineers (early December; hosted in Albany; held consecutively with P2 Assessment Techniques and Tools)
- Green Building Materials or Green Products (held in NYC in March 2009 in partnership with ITAC) (TENTATIVE)
- Acid Bath Extension Technologies and P2 for Metalworking Sector (held in Central NY in early 2009 in partnership with RTDCs (CNYTDO and MVATC)) (TENTATIVE)

P2I Goals Relative to the RTDCs

- Build capacity
- Offer technical support
- Serve as source of information

Contacting the NYSP2I

- Email: nysp2i@rit.edu
- Website: www.nysp2i.rit.edu
- Telephone: 585-475-2512
- Director: Edwin Pinero
- Business Manager: Newton Green
- Senior Staff Assistant: Erica Flores

LE2

Lean, Energy and Environment

Chris Chapman

Newt Green

Kate Howard

Agenda

1. Introductions
2. LE2
3. DMAIC approach
4. Case study
5. Other success stories
6. Energy audit
7. Funding sources
8. Q&A

Lean, Energy, and Environment (LE2)

- Merging of Two Separate Programs Developed by EPA
 - Lean and Environment Program
 - Lean and Energy Program
- See EPA's website for Program Toolkits
 - <http://www.epa.gov/lean/>

Lean, Energy, and Environment (LE2)

- Lean and Environment
 - offers practical strategies and techniques to Lean implementers about how to improve Lean results while achieving environmental performance goals
- Lean and Energy
 - offers practical strategies and techniques to Lean implementers about how to improve Lean results while reducing energy use, costs, and risk

Benefits of Combining Lean & E2

“Lean” Eliminates...

- **D**efects
- **O**verproduction
- **W**aiting
- **N**on-utilized resources
- **T**ransportation
- **I**nventory
- **M**otion
- **E**xtra processing

“E2” adds...

- **F**ull use of Raw Material
- **E**nergy Efficiency
- **W**ater conservation
- **E**liminating Toxic Material
- **R**eduction of:
 - Packaging Wastes
 - Emissions to Air and Water
 - Solid & Hazardous Wastes
 - Regulatory obligations and risks



Teams

Important to have multidisciplinary teams to

- Bring different perspectives to the discussion
- Identify LE2 opportunities
- Build buy in from the start
- Understand feasibility of implementing recommendations

Integrate & involve EHS staff from the beginning

- ✓ Ensure regulatory requirements are met
- ✓ Address existing worker health & safety hazards
- ✓ Ensure additional health & safety hazards are not created
- ✓ Address opportunities to eliminate environmental waste

Case Study

American Motive Power (AMP)

- Locomotive remanufacturer
- 500,000 ft² facility with engine and locomotive reman lines
- Production rate: 8-10 locomotives/month
- Goal: double production rate and decrease environmental footprint

P2I activities

- Assessed workflow of engine and locomotive lines
- LE2 of their engine remanufacturing line
- Focus on disassembly, cleaning, reassembly, and paint processes
- Identified high priority areas for lean and E2 improvements
- Identified improvement measures
- Next step is to implement improvements

Case Study

American Motive Power (AMP)



AMP Project Team

P2I team comprised of

- Lean specialist
- Metallurgist & cleaning specialist
- EHS specialist
- Mechanical engineer
- Environmental engineer

AMP internal team comprised of

- Methods Engineer, link between management and production personnel
- 2 Production supervisors for the Engine Line
- 2 Senior Production Employees on the Engine Line
- Test Cell Specialist for the Engine Line

DMAIC

DMAIC

refers to a data-driven strategy for improving processes, and is an integral part of the company's Lean Six Sigma Initiative. DMAIC is an acronym for five interconnected phases: Define, Measure, Analyze, Improve, and Control.

DEFINE

- Define the customer and core business processes involved
- Define the boundaries, the start and stop of the process
- Define the process to be improved by mapping the process flow

MEASURE

- Measure the performance of the Core Business Process involved.
- Develop a data collection plan for the process
- Collect data from many sources to determine types of defects and metrics

ANALYZE

- Analyze the data collected and process map to determine root causes of defects and opportunities for improvement.
- Identify gaps between current performance and goal performance
- Prioritize opportunities to improve

IMPROVE

- Improve the target process by designing creative solutions to fix and prevent problems
- Create innovative solutions using technology and discipline
- Develop and deploy implementation plan

CONTROL

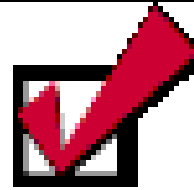
- Control the improvements to keep the process on the new course.
- Prevent reverting back to the "old way"
- Require the development, documentation and implementation of an ongoing monitoring plan
- Institutionalize the improvements through the modification of systems and structures (staffing, training, incentives)

	Process Step	Description
L E A N E2	D	<ul style="list-style-type: none"> •Define the customer and core business processes involved •Define the boundaries, the start and stop of the process •Define the process to be improved by mapping the process flow
	M	<ul style="list-style-type: none"> •Measure the performance of the Core Business Process involved. •Develop a data collection plan for the process •Collect data from many sources to determine types of defects and metrics
	A	<ul style="list-style-type: none"> •Analyze the data collected and process map to determine root causes of defects and opportunities for improvement. •Identify gaps between current performance and goal performance •Prioritize opportunities to improve
	I	<ul style="list-style-type: none"> •Improve the target process by designing creative solutions to fix and prevent problems •Create innovative solutions using technology and discipline •Develop and deploy implementation plan
	C	<ul style="list-style-type: none"> •Control the improvements to keep the process on the new course. •Prevent reverting back to the "old way" •Require the development, documentation and implementation of an ongoing monitoring plan •Institutionalize the improvements through the modification of systems and structures (staffing, training, incentives)



Drawing a Current State Map

Mapping Tips

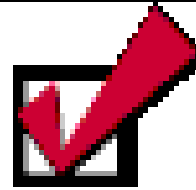


- Collect information while walking the actual paths of material and information yourself.
- Walk the path once to get a feel of the flow and sequence of processes, then go back and start collecting information.
- Begin at the end. Start closest to the customer and you will focus on things linked most closely to the customer.
- Bring a stopwatch, see it and time it for yourself. Do not trust information from the “system.”



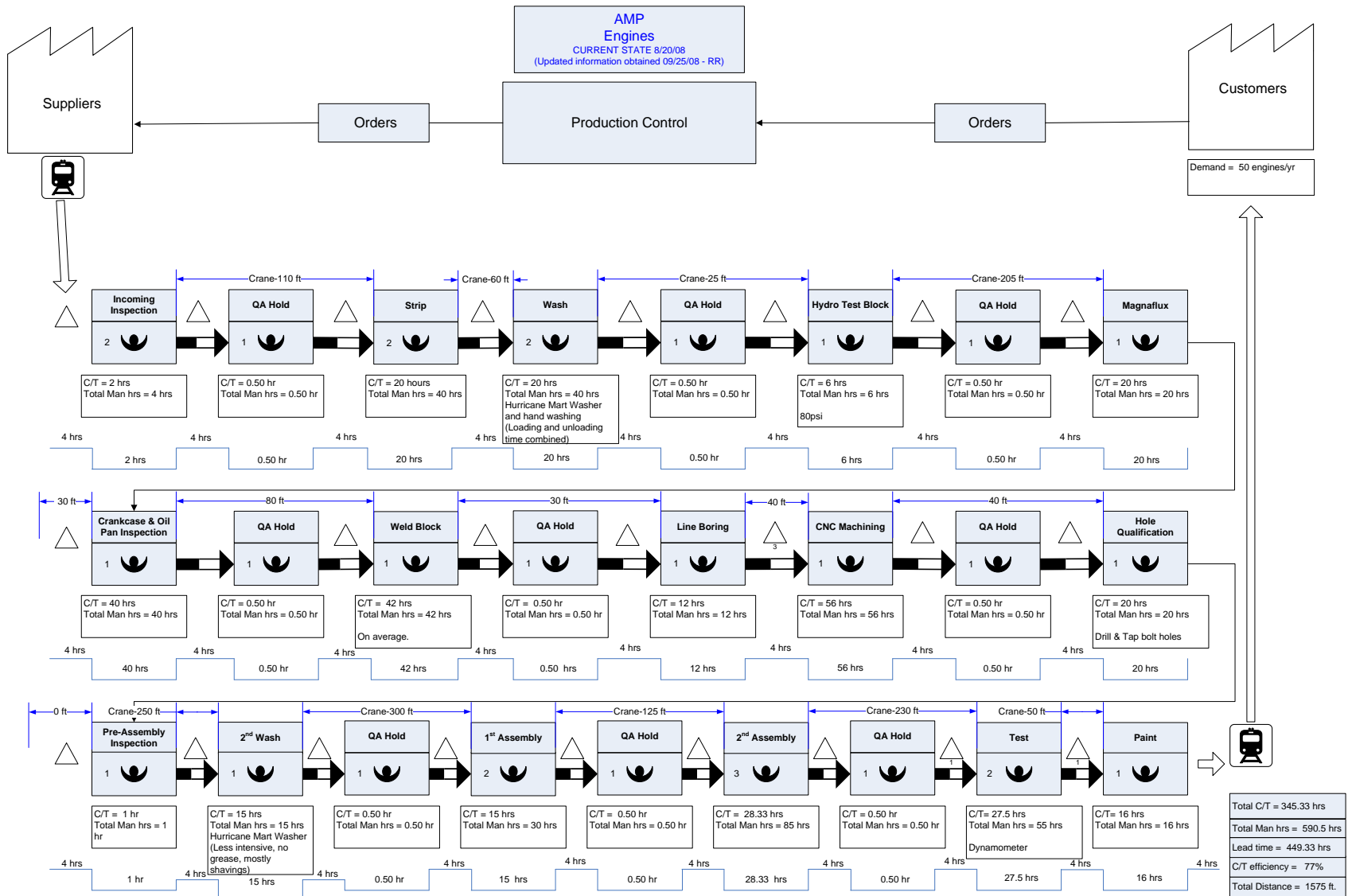
Drawing a Current State Map

Mapping Etiquette

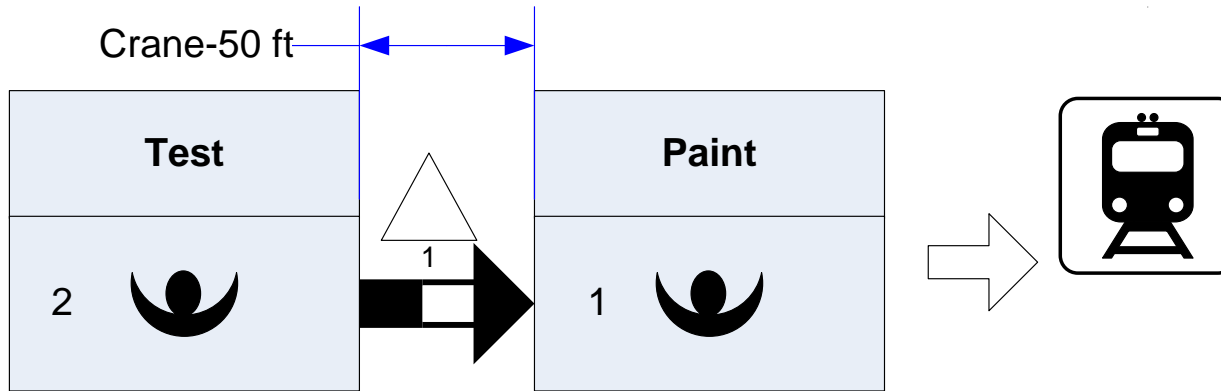
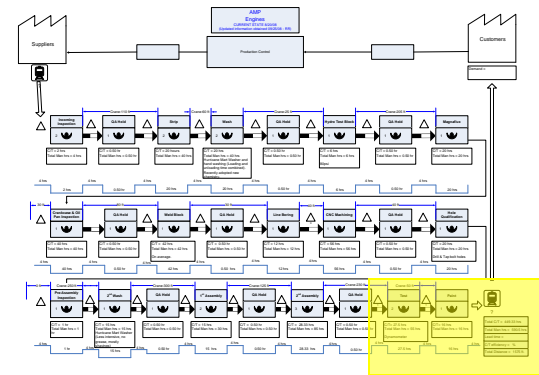


- Whenever you go to where the action is, be sure to do the following:
 - Get management approval and involvement.
 - Communicate to all areas before going there.
 - Explain your purpose.
 - Be open and honest when responding to questions.
 - Respect people's workspace.
 - Remember that the people who work there are the experts.

AMP Current State

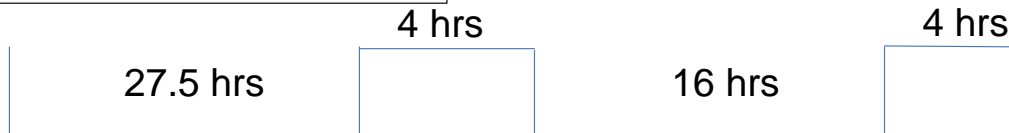


AMP Current State



C/T= 27.5 hrs
 Total Man hrs = 55 hrs
 Dynamometer

C/T= 16 hrs
 Total Man hrs = 16 hrs



Opportunities to Enhance Value Stream Mapping

- Classic Value stream mapping can overlook environmental considerations:
 - Raw materials used vs. needed in products and processes
 - Pollution & other environmental wastes in the value stream
 - Flows of information to environmental regulatory agencies
- Making some simple adjustments to your value stream map can help you explicitly address pollution and natural resource wastes:
 - Improving cost reduction opportunities
 - Saving additional time
 - Improving the health and safety of the workplace

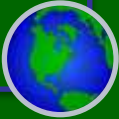
EHS Staff Can Help

- Involve EHS staff when developing VSMS – they can help identify where EHS icons are most needed
 - EHS staff involvement from start to finish is optimal
 - EHS staff involvement on a consultative basis can also be an effective option
- Build on previous environmental assessment work
 - If your organization has an Environmental Management System (EMS), EHS staff should have info on processes' environmental impacts

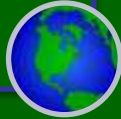
Common Processes with EHS Wastes & Opportunities



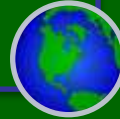
Metal casting



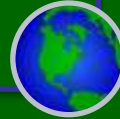
Chemical and heat treatment of materials



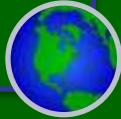
Metal fabrication and machining



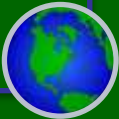
Cleaning and surface preparation



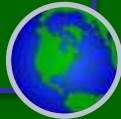
Bonding and sealing



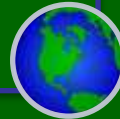
Welding



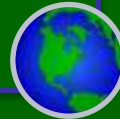
Metal finishing and plating



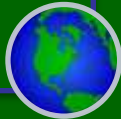
Painting and coating



Waste management



Chemical & hazardous materials mgmt.



High Energy Consuming Processes

- ✓ Motors and Machines
- ✓ Compressed Air
- ✓ Lighting
- ✓ Process Heating
- ✓ Facility Heating & Cooling

Record E2 Data for Processes in VSMS

- Start by identifying 1 or 2 environmental performance metrics to add to process boxes in VSMS, and consider adding more if appropriate

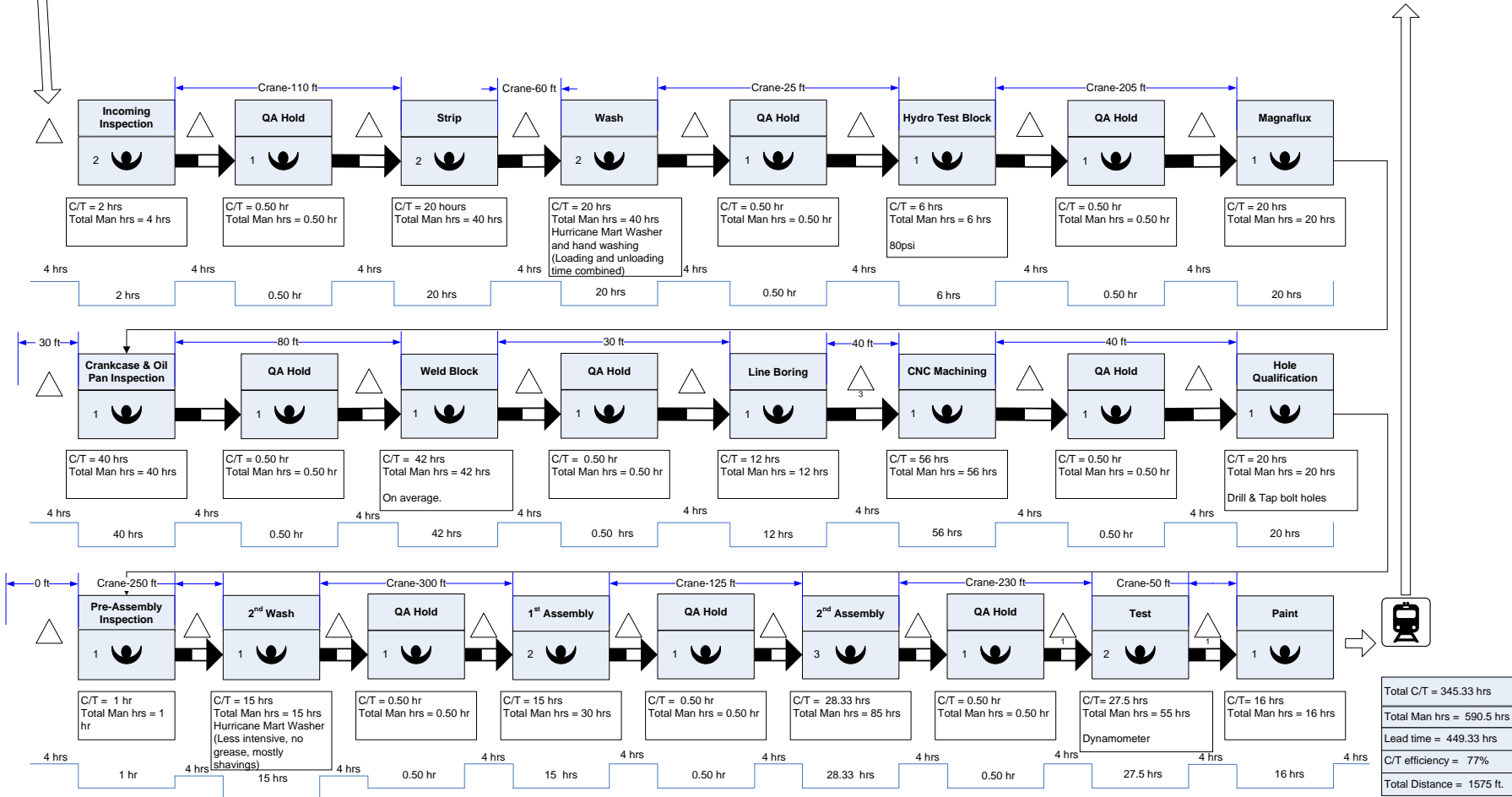
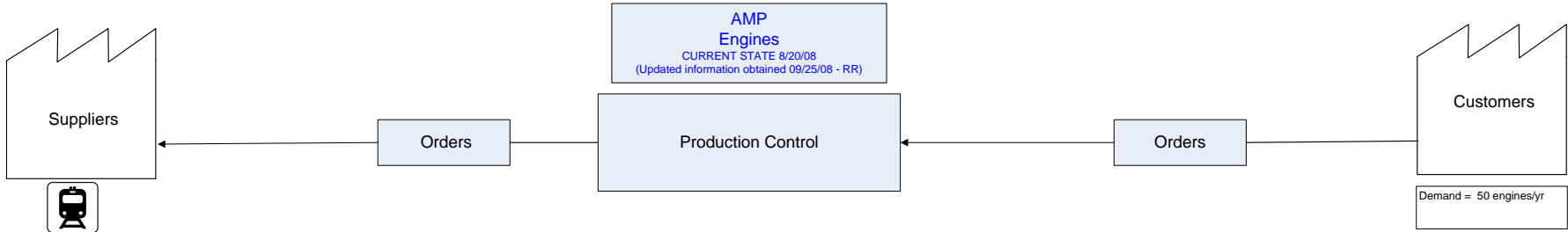
Types of Environmental Metrics	
Energy Use	Air Emissions
Materials Use	Hazardous Waste Generation
Chemical Use	Solid Waste Generation
Water Use	Wastewater Discharges

Where to Put EHS Icons on VSMSs?

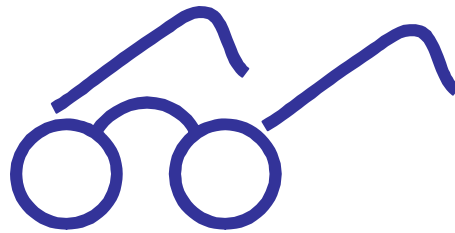
- Assess each process for E2 wastes and improvement opportunities
- Look for processes...
 - with high energy, water, and material use
 - with significant solid or hazardous waste generation
 - requiring environmental permits or reporting to environmental agencies
 - with pollution control equipment
 - using toxic chemicals that require personal protective equipment (PPE)



AMP Engines
CURRENT STATE 8/20/08
(Updated information obtained 09/25/08 - RR)

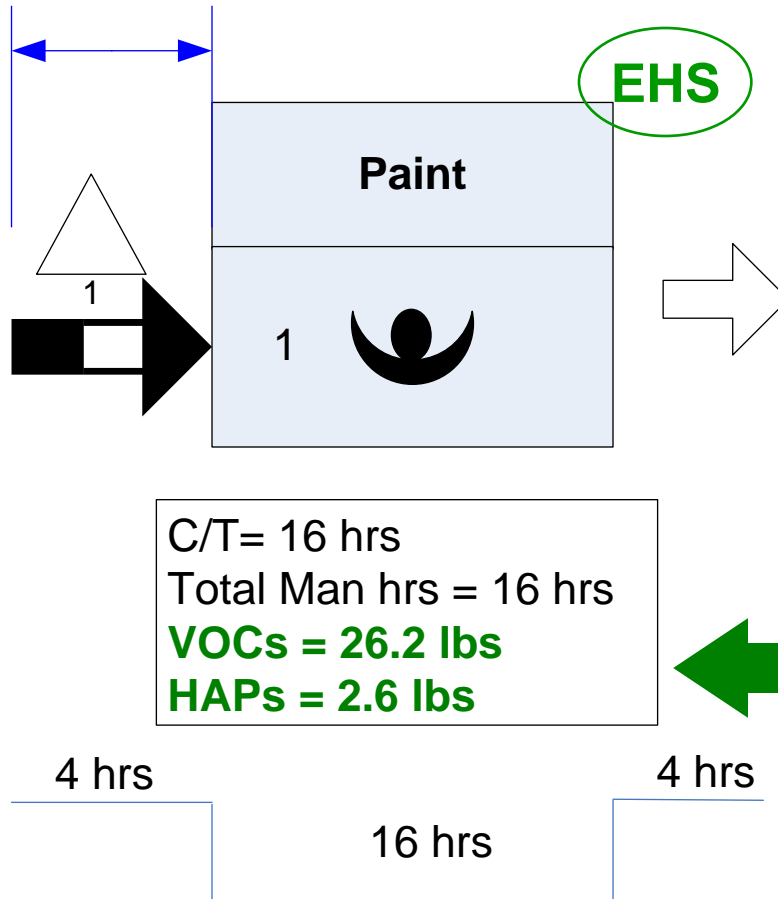
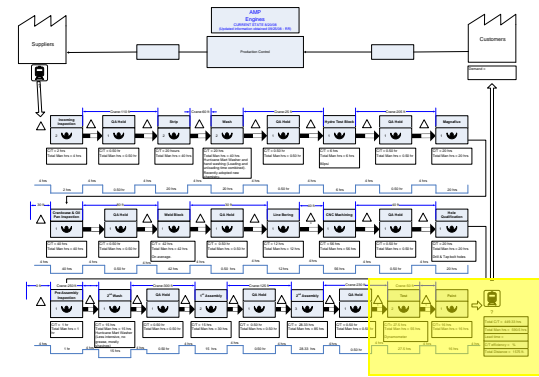


Total C/T = 345.33 hrs
Total Man hrs = 590.5 hrs
Lead time = 449.33 hrs
C/T efficiency = 77%
Total Distance = 1575 ft.



PROCESS	High energy/ water/ material use	Significant solid/hazard waste generation	Requires environmental permits or reporting to environmental agencies	Pollution control equipment	Uses toxic chemicals that require PPE
WASH	✓	✓	✓	✓	✓
HYDRO TEST BLOCK	✓				
MAGNAFLUX	✓				
WELD BLOCK	✓	✓			
DYNO	✓		✓	✓	
CNC MACHINING	✓	✓			
PAINT		✓	✓	✓	✓

AMP Paint Process Waste



**Waste
generated
per engine**

Materials Lines

- Identify and quantify the materials used and lost in a process or a facility.
- Provides concise picture of:
 - all materials used in facility
 - how each material is received, handled, stored, used, reused, and lost
- $\text{Materials in} = \text{Materials out} + \text{Materials Accumulated}$

Analyze Materials Use Versus Need in a “Materials Line”

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



- Add a “**materials line**” to examine:
 - Amount of raw materials used by each process
 - Amount of materials that end up in the product and add value from the customer’s perspective

Materials Line: Important Considerations

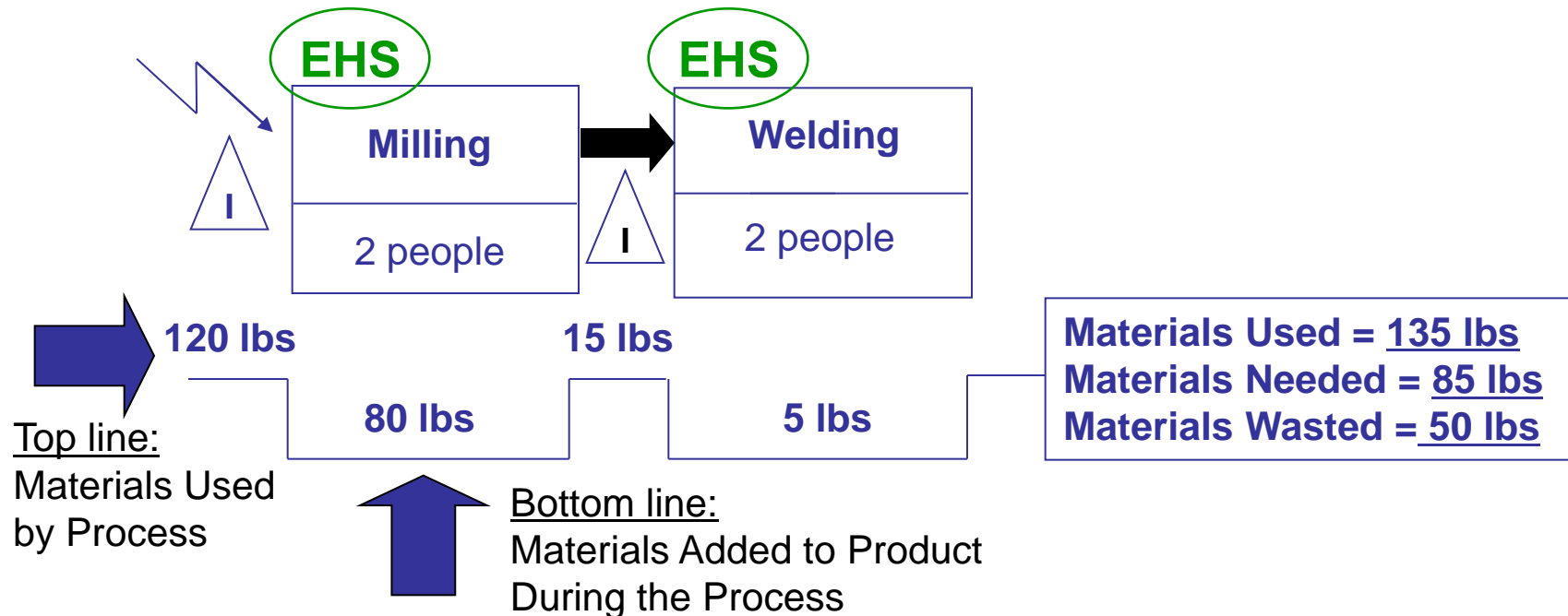
- While material use can typically be determined, it is not always easy to identify what materials are “needed” or “value added” from the customer’s perspective
 - One approach is to count all materials used in a process that are incorporated in the product as “needed”
 - However, it may be possible to meet customers’ need with even fewer materials—this raises important questions for product design

Materials Line: Important Considerations, Continued

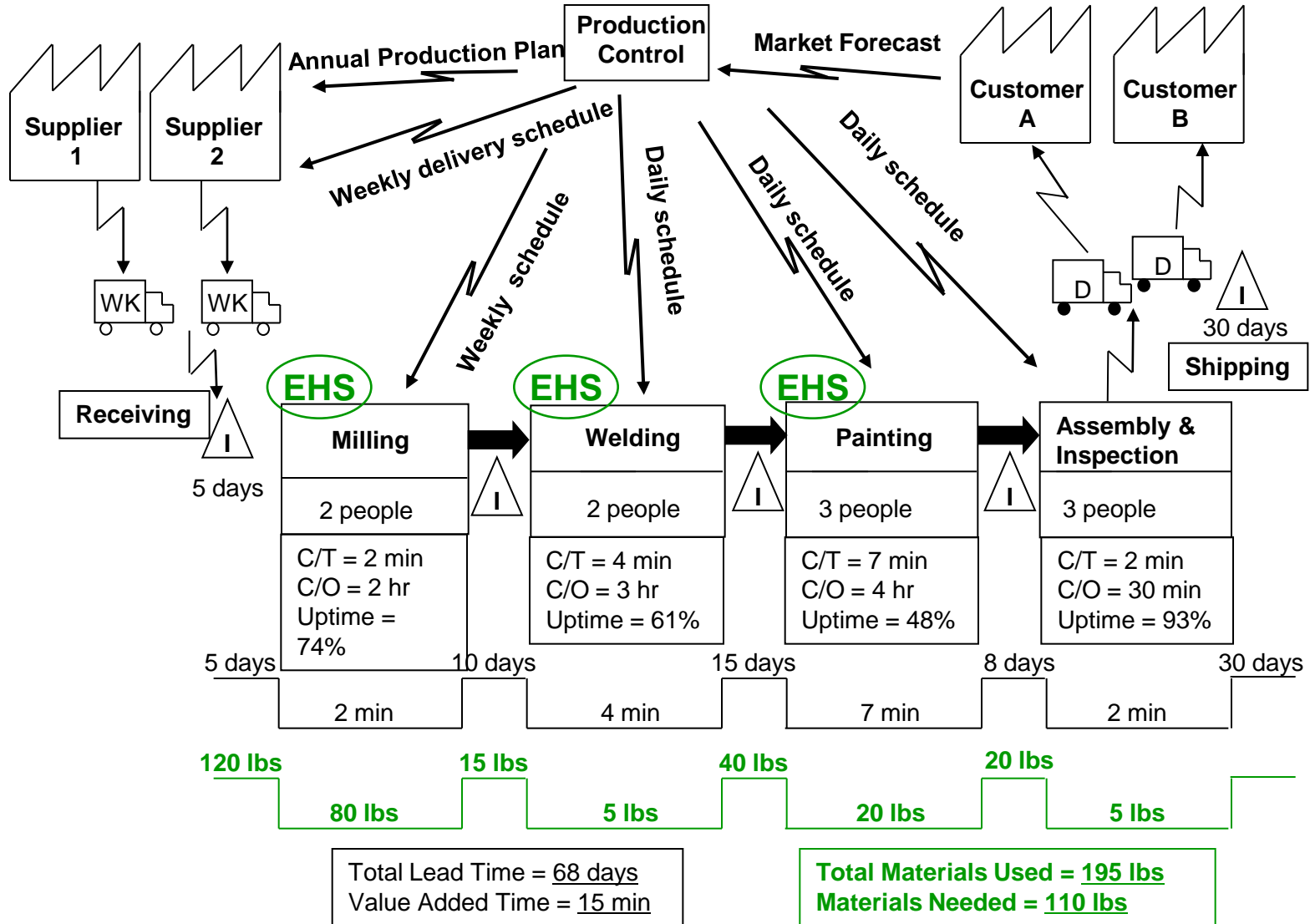
- In some cases, materials may play an important role in a process even though they do not directly add value for the customer
- The materials line raises the question: “Is this material needed in the process or is there a better way?”
- For example:
 - Solvents can be useful for cleaning processes even though they often are released to air during the process
 - In some cases, solvents could be replaced by water, compressed air, etc., or the cleaning step can be eliminated by avoiding soiling the part in the first place

Example Materials Line

- Materials lines can be developed for any major material source used in processes and products



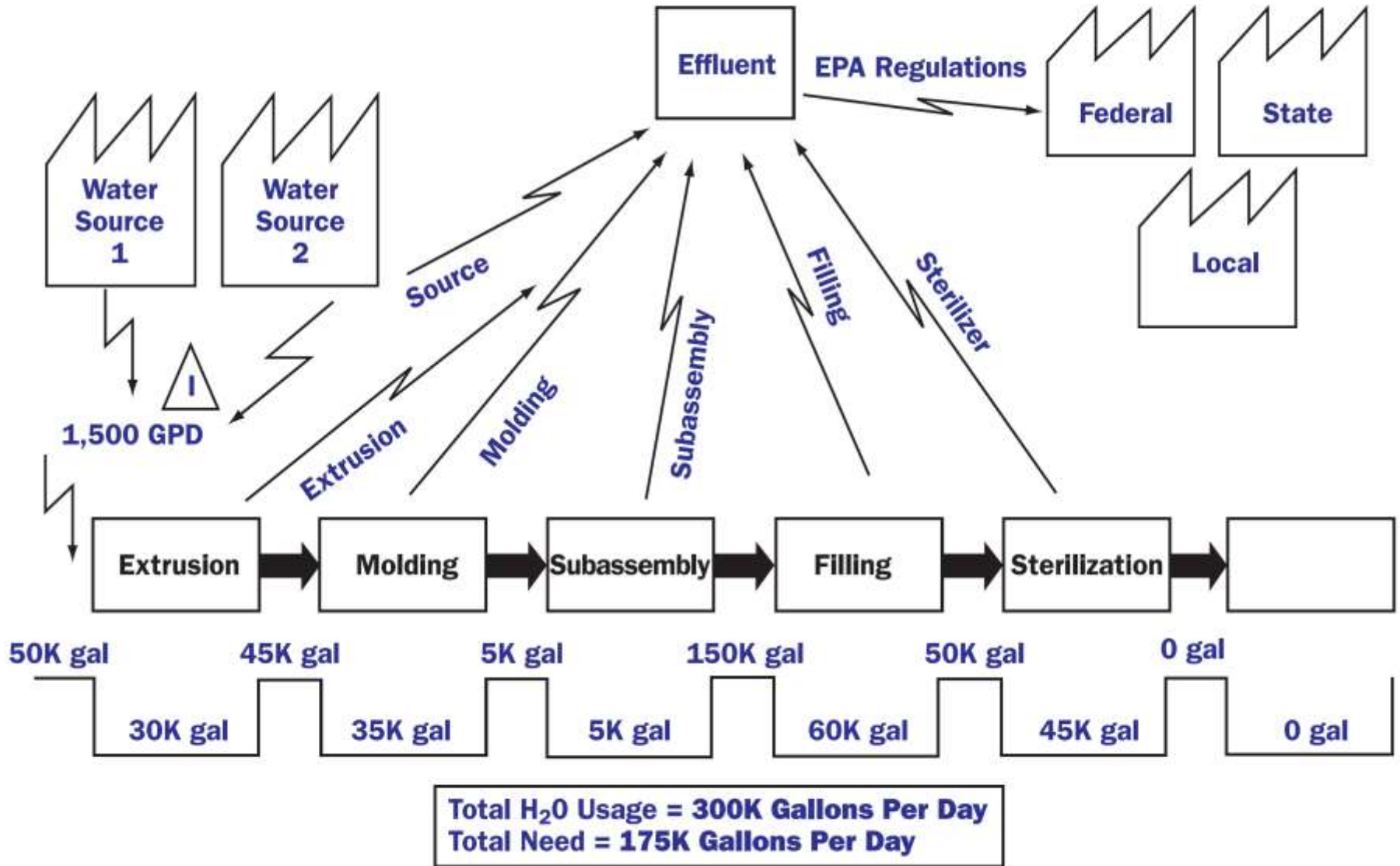
VSM with Materials Line and EHS Icons



Other Metrics to Track

- Track non product outputs similar to materials line
- Water use
- Air emissions
- Wastewater
- Hazardous waste
- Solid waste

Water Use VSM



	Process Step	Description
L	D	<ul style="list-style-type: none"> •Define the customer and core business processes involved •Define the boundaries, the start and stop of the process •Define the process to be improved by mapping the process flow
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N	I	<ul style="list-style-type: none"> •Improve the target process by designing creative solutions to fix and prevent problems •Create innovative solutions using technology and discipline •Develop and deploy implementation plan
E2	C	<ul style="list-style-type: none"> •Control the improvements to keep the process on the new course. •Prevent reverting back to the "old way" •Require the development, documentation and implementation of an ongoing monitoring plan •Institutionalize the improvements through the modification of systems and structures (staffing, training, incentives)



Lean focus: Waste

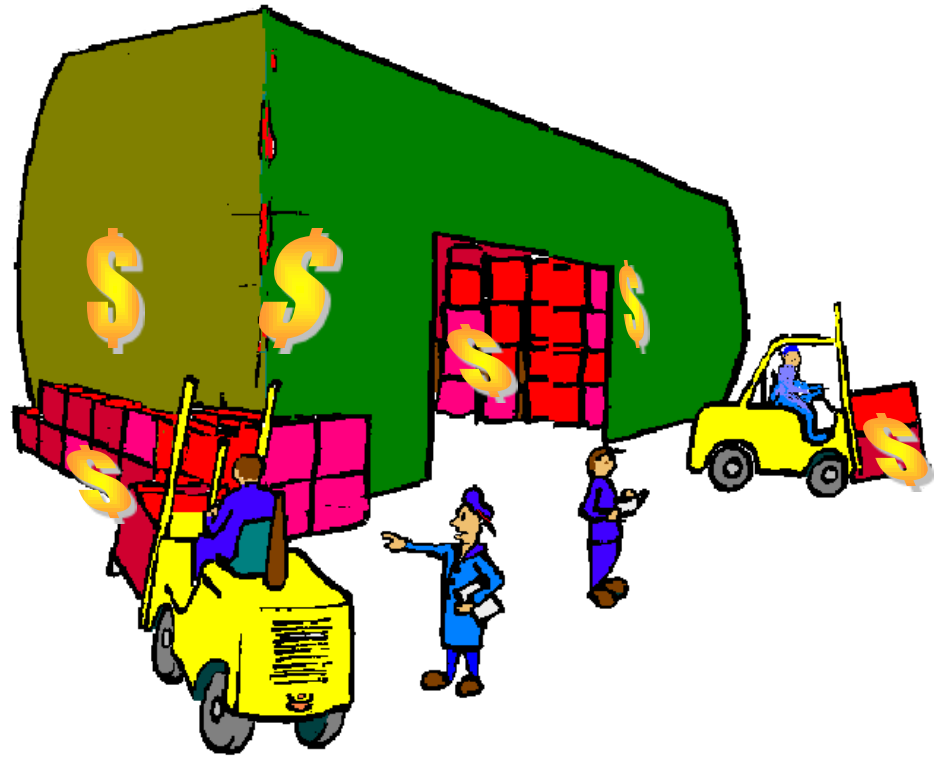
Waste is “anything other than the minimum amount of equipment, materials, parts, space, and worker’s time which are absolutely necessary to add value to the product.”

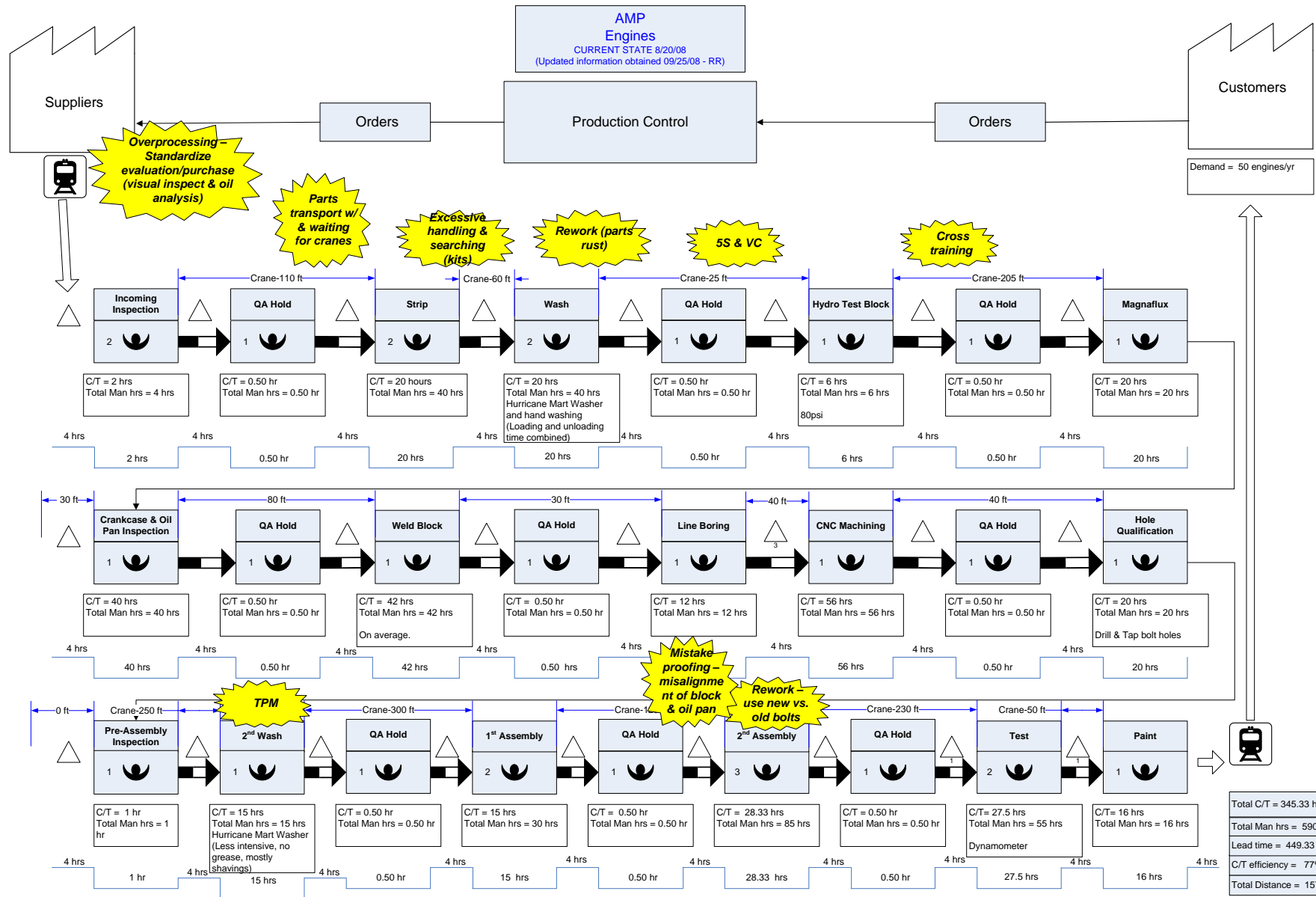
- Shoichiro Toyoda, President, Toyota

Traditional 7 Types of Waste

“Lean” Eliminates...

- **D**efects
- **O**verproduction
- **W**aiting
- **N**on-utilized resources
- **T**ransportation
- **I**nventory
- **M**otion
- **E**xtra processing



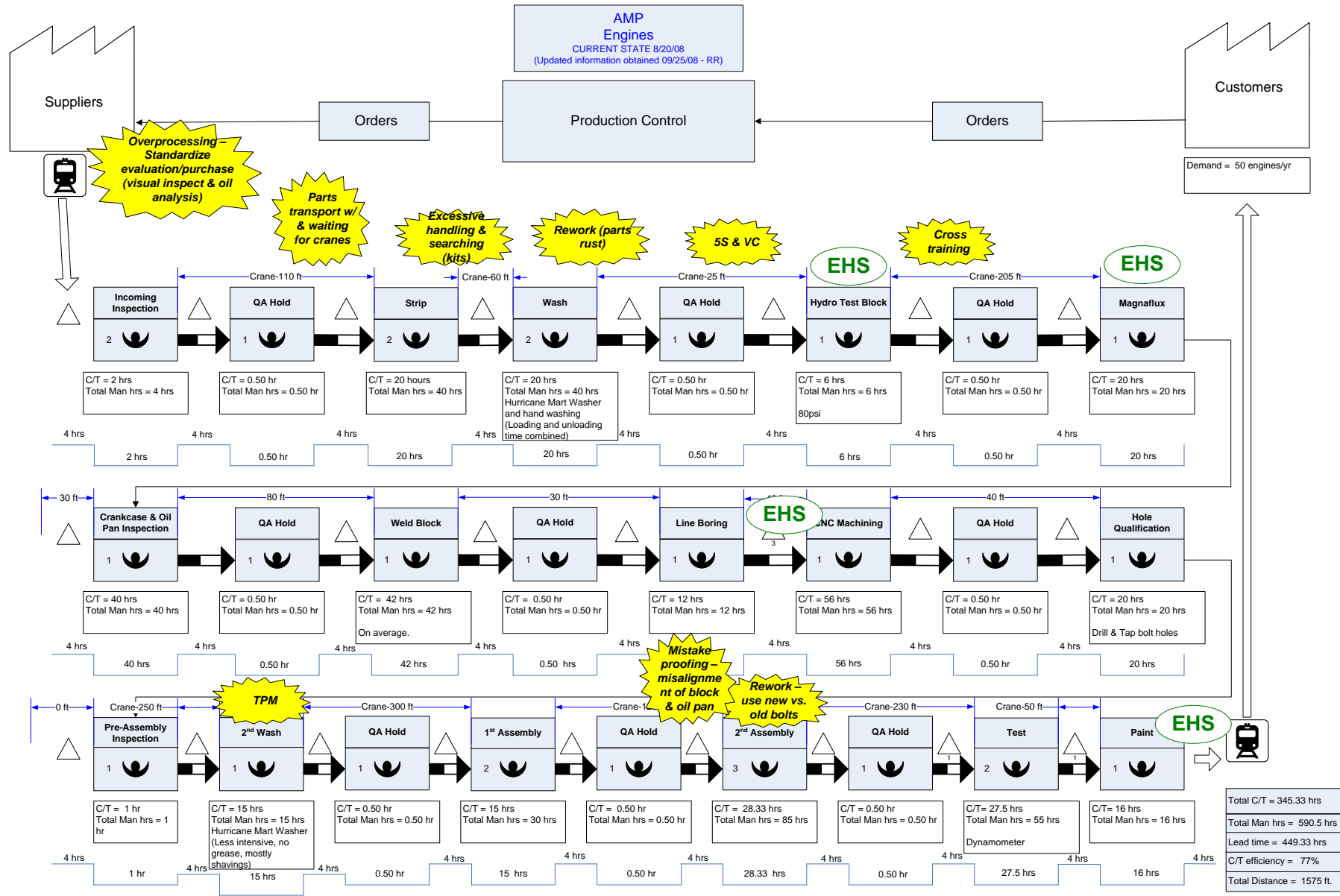


Often overlooked/unaddressed wastes...

- Environmental & Energy (E2) waste
 - **Energy, water, or raw materials** consumed in excess of what is needed to meet customer needs
 - **Pollutants and material wastes** released into the environment, such as air emissions, wastewater discharges, hazardous wastes, and solid wastes (trash or discarded scrap).
 - **Hazardous substances** that adversely affect human health or the environment during their use in production or their presence in products

Environment & Energy Impacts of Wastes

Waste Type	Environmental Impacts
Overproduction	<ul style="list-style-type: none"> • More raw materials and energy consumed in making the unnecessary 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 (WIP) • Waste from deterioration or damage to stored WIP • More energy used to heat, cool, and light inventory space
Transportation & Motion	<ul style="list-style-type: none"> • More energy used 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 and energy 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 • More energy consumed in operating equipment related to unnecessary processing
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



EPA's Lean and Environment Basic Environmental Measures

- EPA has assembled a list of environmental metrics that may be of use to organizations implementing Lean
- The metrics are derived from EPA's Green Supplier Network and Performance Track Program
 - www.epa.gov/greensuppliers
 - www.epa.gov/performancetrack
- The measures include priority chemicals that are of particular concern because of their **toxicity**, **persistence** in the environment, and/or their potential to **bioaccumulate** in organisms at higher levels in the food chain

Environmental Performance

Basic Environmental Measures			
Category	Definition	Metric	Unit of Measure
Input Measures			
Energy Use	Any source providing usable power Transportation and non-transportation sources	Energy Used	Specific to energy source such as BTUs or kilowatt hours, % reduction, energy use/unit of product
Land Use	Land covered by buildings, parking lots, and other impervious surfaces Land/habitat conservation	Land Converted, Land Restored or Protected, Area of Impervious Surfaces	Square feet, acres
Materials Use	Materials used (total or specific), including: - Ozone depleting substances (e.g., CFC-11) - Packaging materials Proportion of input materials that were recycled or recovered (vs. virgin materials)	Materials Used, Percent Utilization of Materials, Post-Consumer Recycled Content	Tons/year, pounds/unit of product, % materials utilization
Toxic/ Hazardous Chemicals Use	Use of hazardous and toxic chemicals that are regulated or otherwise of concern www.epa.gov/epaoswer/hazwasete/minimize/chemist.htm	Toxic/Hazardous Chemicals Used	Pounds/year, pounds/unit of product, % reduction
Water Use	Incoming raw water, from outside sources, e.g., from municipal water supply or wells, for operations, facility use, and grounds maintenance. NPDES	Volume of Water Used, P2 to reduce Priority Chemicals/Quality Standards/Pretreat Standards	Gallons/year, % reduction, % recycled Pounds Priority Chemicals/year, % reduced, % recycled

Environmental Performance

Basic Environmental Measures			
Category	Definition	Metric	Unit of Measure
Non-Product Output Measures			
Air Emissions	The release of any of the following: Air toxics - CAA 112b HAPs, Carbon Monoxide, Lead, Ozone and its precursors, including: VOCs (volatile organic compounds), NOx (nitrogen oxides), Ozone-depleting substances, PM10 (particulate matter), PM2.5 (fine particulate matter), Sulfur Dioxide, Greenhouse gases, including Carbon Dioxide	Air Emissions Generated	Pounds/year, Tons/year % reduction
Water Pollution	Quantity of pollutant in wastewater that is discharged to water source. Should include any substances regulated in NPDES permit. May include: Heavy Metals - Cu, Pb, Hexavalent Chromium, Cadmium, Zn, Ni, Hg; Organic Pollutants and Pesticides, Conventional pollutants, e.g., oil and grease, BOD and suspended solids, and Nutrients - N, P Pathogens, Sediment from runoff	Mass or Concentration of Regulated Pollutants Discharged	Pounds/year, mg/L or % reduction
Solid Waste	Wastes (liquid or solid) other than RCRA hazardous wastes.	Solid (Non-Hazardous) Waste Generated	Gallons or pounds/year, % reduction, % recycled

Environmental Performance

Basic Environmental Measures			
Category	Definition	Metric	Unit of Measure
Downstream/Product Measures			
Product Impacts	Expected lifetime energy and water use Wastes (to air, water, & land) from product use and disposal or recovery	Energy and water used (over product's lifecycle) Waste generated (after the product is used)	Energy - Btu, kWh, MWh Water use - gallons Wastes - pounds, tons
Other Measures			
Money Saved	Money saved in the reduction of materials or other changes in processes	Dollars saved	Dollars saved
Qualitative Measures	Other environmental improvements that cannot be directly or accurately quantified. For example: implementing an EMS or CMS	Savings/environmental benefits from leaning out of permits/DfE/Clean Production/EMS implementation/ Extended Product Responsibility	Not Applicable

Environmental Performance Metrics

- Companies and other non-governmental organizations have also developed guidance on environmental metrics
 - The Global Reporting Initiative provides guidance for company-wide environmental and sustainability metrics see www.globalreporting.org
 - The Facility Reporting Initiative provides guidance for facility-wide environmental and sustainability metrics see www.ceres.org
- While these resources do not focus explicitly on process level environmental metrics, most of the metrics in these frameworks can be considered and applied at process or sub-process levels

	Process Step	Description
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Assess LE2 Opportunities in Future State VSMs

- Asking simple questions based on the current state VSM can help to envision a less-wasteful future state
- Consider these questions:
 - Where are kaizen events needed to address the biggest areas of environmental wastes?
 - Will any changes be made to the layout of processes marked with an EHS icon, or to the chemicals used by those processes? (These may have regulatory compliance implications)
 - Can one process use the “waste” material from another process instead of using virgin materials?

Questions for the Future State, Continued

- What are appropriate targets for improving environmental performance in the future state?
- What would an *environmentally-preferred future state* look like for the value stream? What if there were:
 - Zero environmental and production wastes?
 - Products and processes that pose no risks to human health or the environment?
 - No need for environmental permits?
- What steps can be taken to get to that future state?

Future State VSMS: Planning for Lean Implementation

- When developing Lean implementation plans in future state VSMS, keep in mind that some processes may require special attention to EHS issues
 - Processes with regulatory requirements
 - Other processes with EHS icons
- Early involvement of EHS staff in planning for Lean events on these processes can help:
 - Anticipate changes needed to environmental compliance practices
 - Bring a fresh perspective and additional resources to Lean waste-reduction activities
 - Prevent harm to worker health and safety

Sample AMP LE2

Recommendations

Clean

- Use alternative chemistries that do not generate hazardous waste
- Limit hazardous waste generation with current chemistries by tuning cleaning process

Paint

- Use low VOC or water based paints to eliminate/reduce VOCs and HAPS
- Use an oven to decrease dry time
- Store paint and supplies at point of use

Dynamometer Testing

- Use waste heat in engine paint booth and decrease dry times
- Use waste energy to power an oven on the locomotive paint line and decrease dry times

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Energy Treasure Hunts at General Electric

With mentoring assistance from Toyota, General Electric (GE) launched an integrated Lean and energy initiative that has identified upwards of \$100 million in energy savings through energy treasure hunts. GE's corporate commitment to energy use and greenhouse gas reductions has helped drive this effort. From 2005 to 2007, GE:

- ✓ Conducted over 200 energy treasure hunts at GE facilities worldwide, and trained over 2,500 employees on how to conduct treasure hunts
- ✓ Used energy treasure hunts to identify 5,000 related kaizen projects, most of which are funded and in various stages of implementation
- ✓ Reduced greenhouse gas emissions by 250,000 metric tons and realized \$70 million in energy cost savings from implemented projects

Source: General Electric, Ecomagination / Energy Treasure Hunt Team, 2007.

Opportunities to Enhance Kaizen Events

- Kaizen events are a primary vehicle for change in organizations implementing Lean
- They are powerful windows of opportunity to:
 - Eliminate non-value added activity
 - Reduce environmental wastes such as scrap, pollution, and hazardous wastes
 - Save money by wasting less energy, water, and raw materials
 - Improve working conditions for employees

Kaizen Event Strategies and Tools

Change Management Strategies

1. Train Lean Team Leaders on EHS Impacts
2. Identify an EHS Contact for Kaizen Event Teams
3. Use an EHS Checklist for Lean Events
4. Proactively Involve EHS Staff in Kaizen Events

Reasons for Including EHS Expertise

- If not properly managed for EHS impacts, kaizen events can:
 - Result in regulatory compliance violations
 - Create health and safety hazards for workers
 - Overlook opportunities to reduce wastes and help organizations meet their environmental goals

Common Operational Changes That Trigger EHS Involvement (1 of 2)

- **Material/Chemical Use and Storage**
 - Include changes in the type, volume, or introduction/issuance procedure for chemicals and materials
 - These changes can *affect chemical exposure, regulatory compliance, and reporting needs*
- **Waste Management**
 - Include changes in the type or volume of waste generated by a process, including air emissions, water discharges, and liquid and solid waste.
 - These changes can *affect compliance with regulatory & permitted limits, as well as pollution control & management capacity*

Common Operational Changes That Trigger EHS Involvement (2 of 2)

- **Physical Environment**
 - Include changes to the...
 - physical layout of the process -- moving work or storage areas
 - equipment and technologies used, or
 - to the facility--moving, replacing, or installing vent hoods, stacks, floor drains, or process tanks
 - These changes can affect compliance with regulations and permits, as well as work practice requirements

Lean and Energy Use Reduction: Company Cost Savings Experience

- ✓ **Eastman Kodak Company** (New York) conducted energy kaizen events that significantly reduced energy use and resulted in overall savings of \$15 million between 1999 and 2006.
- ✓ **General Electric** (Ohio) achieved cost savings of over \$1 million at one facility due to fuel use reductions realized through Lean implementation.
- ✓ **Howard Plating** (Michigan) reduced energy use by 25 percent through a Lean implementation effort.
- ✓ **Lasco Bathware** (Washington) eliminated the need for a shrink-wrap oven when planning for a Lean event, reducing natural gas consumption by 12.6 million cubic feet and saving about \$99,000.
- ✓ **Naugatuck Glass Company** (Connecticut) used Lean to cut product lead time and improve quality, while also reducing energy use by 19 percent.
- ✓ **Steelcase Inc.** (California) used Lean to improve operations, reducing fixed utility costs (including energy) by about 90 percent.

Source: www.epa.gov/lean

Sample Lean Event EHS Checklist

(1 of 2)

Instructions: Describe the Lean event/process and answer the following questions about proposed process changes. If any of the questions are answered either “Yes” or “Unk” (unknown), there may be the potential for environmental impacts that need to be reviewed by EHS staff.

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)?			

Sample Lean Event EHS Checklist

(2 of 2)

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?			

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Strategies to help accomplish Lean & E2 efforts

1. Add environmental metrics to Lean metrics
2. Show management commitment and support
3. Include environmental waste in Lean training efforts
4. Make environmental wastes visible and simple to eliminate
5. Recognize and reward success

1. Add Environmental Metrics to Lean Metrics

- ✓ Scrap/Non-product Output
- ✓ Materials Use
- ✓ Hazardous Materials Use
- ✓ Energy Use
- ✓ Water Use
- ✓ Air Emissions
- ✓ Solid Waste
- ✓ Hazardous Waste
- ✓ Water Pollution/Wastewater

2. Show Management Commitment and Support

- Invest in Lean and environment training
- Provide resources, tools, and incentives to enable employees to succeed
- Include Lean and environment concepts in speeches, newsletters, and other communications
- Encourage Lean managers and EHS managers to collaborate
- Set performance goals and objectives related to Lean and environment
- Track Lean and environment progress and hold individuals accountable for meeting those objectives
- Recognize and reward Lean and environment accomplishments

3. Include Environmental Waste in Lean Training Efforts

- Include section on how to identify and eliminate environmental waste in introductory Lean training
- Modify Lean's seven types of waste to include an eighth waste---environmental/energy waste
- Conduct “waste walk”
- Develop checklists or pocket guide with common environmental wastes during kaizens and waste walks

4. Make Environmental Wastes Visible & Simple to Eliminate

Take advantage of Lean's focus on visual controls:

- Prominently display how individual production areas or departments are doing relative to targets for environmental metrics alongside Lean metrics
- Incorporate environmental wastes into activity and production control boards, single-point lessons, & other signs about wastes on the shop floor
- Apply 6S & mistake-proofing concepts to work areas where chemical use & management & waste collection & management activities chemical handling & waste management & environmental procedures

4. Make Environmental Wastes Visible & Simple to Eliminate

- There are many small things you can do to incorporate EHS in the 6S process. Here are just a few examples:
 - Use low-toxic paint in white or a light color - this can help save lighting and energy costs
 - Use different colored containers for hazardous waste, recycling, and other non-hazardous wastes
 - Mark aerosol cans with colored dots to indicate where to dispose them
 - Use environmentally friendly cleaning supplies



Visual Controls — Examples



Signs to
limit height

Lines to
ID
Location

Before



After



5. Recognize and Reward Success

- Highlight the environmental gains your company has already accomplished
- Encourage Lean and environment coordination efforts through recognition and awards
- Recognize Lean and environment accomplishments in simple ways (i.e., in a company newsletter)

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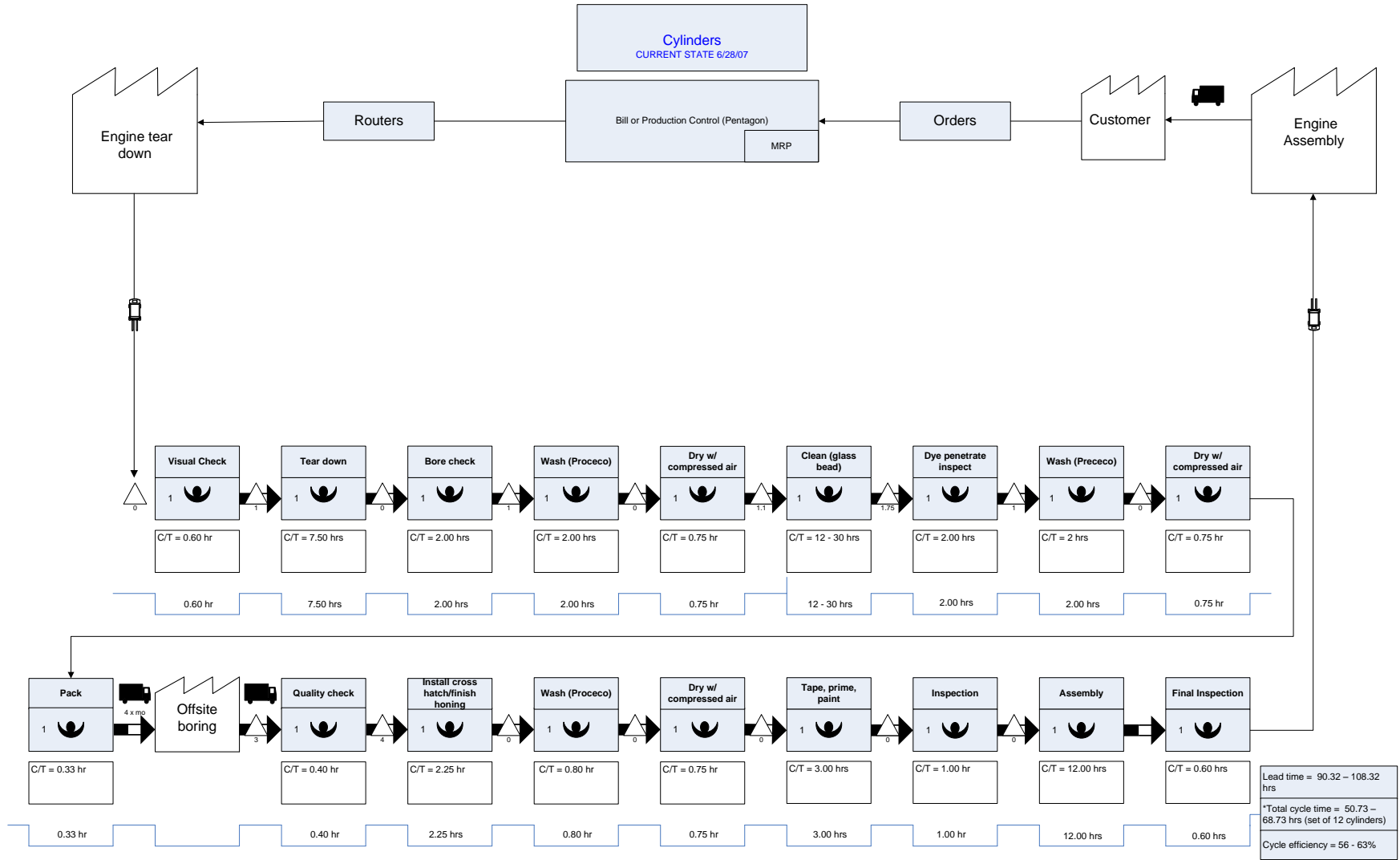


Case Study for Tecmotiv

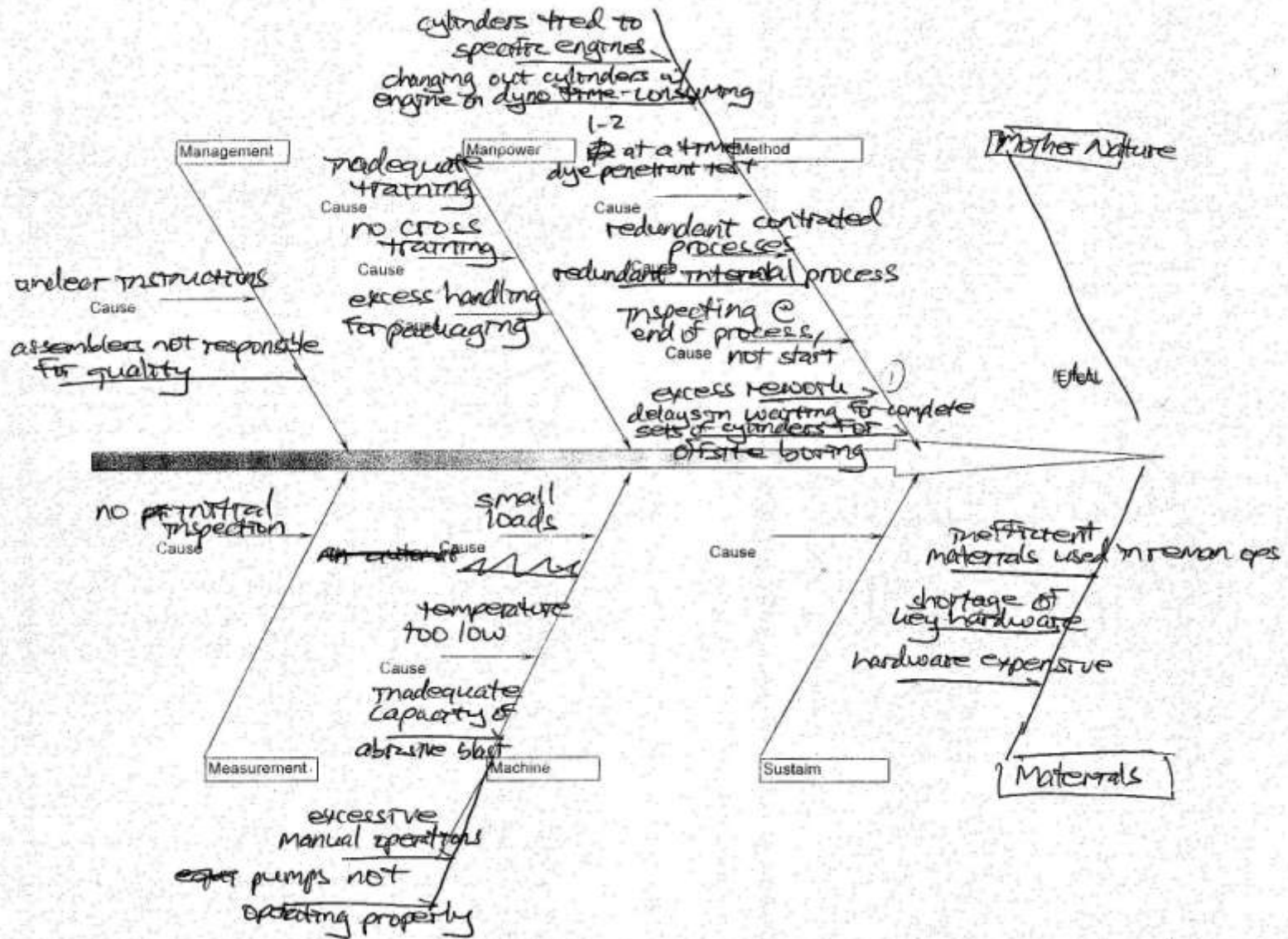
- Upstate New York Remanufacturing business
- In business more than 50 years
- Rebuild & fabricate engine parts for military tanks and armored personnel vehicles
- Focus: Cylinder process



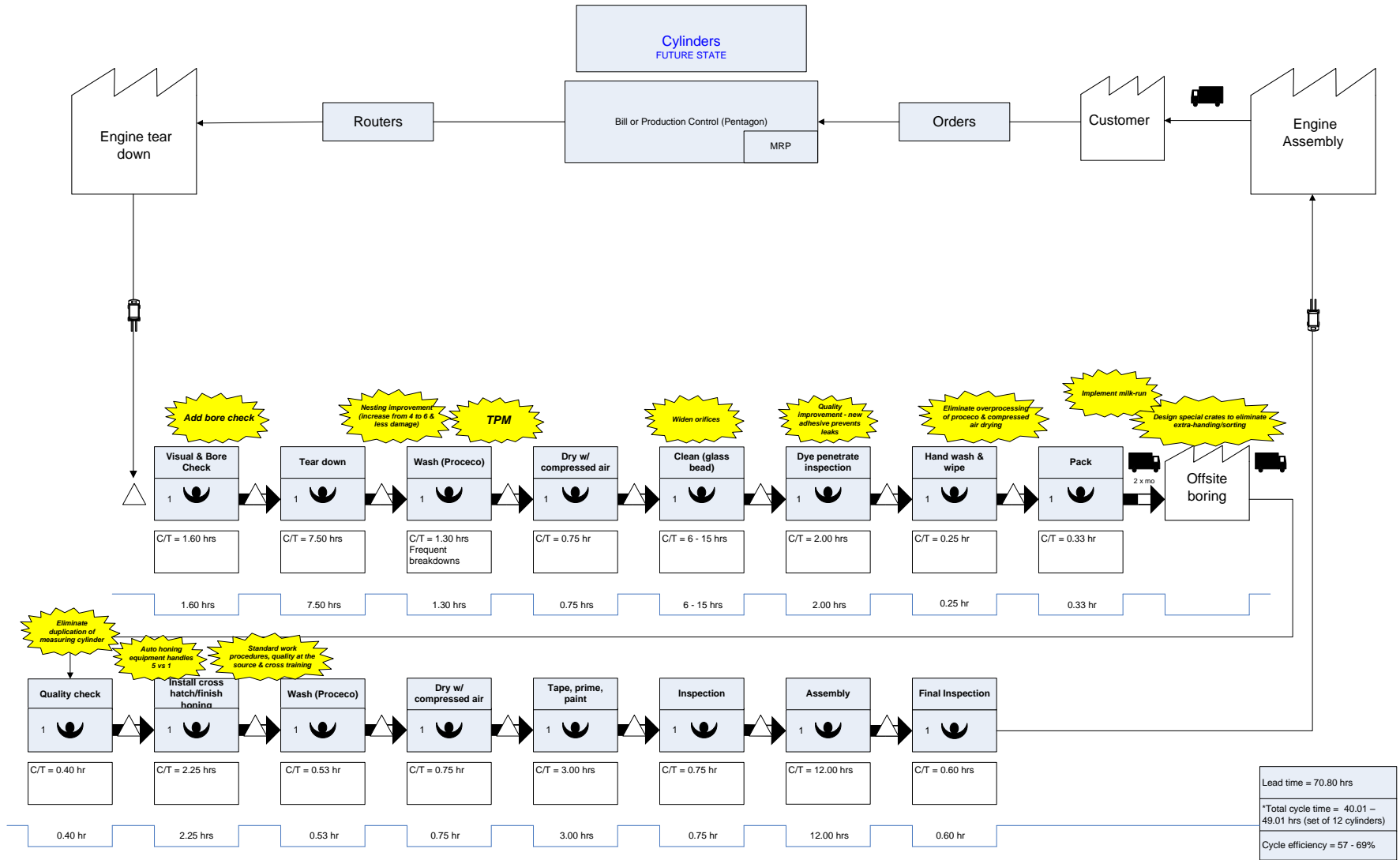
Current State Value Stream Map – Lean Only



Fishbone Diagram



Future State Value Stream Map – Lean Only



Where Do We Put Environmental Icons on VSMs?

- Assess each process for environmental wastes and EHS improvement opportunities
- Look for processes...
 - with high energy, water, and material use
 - with significant solid or hazardous waste generation
 - requiring environmental permits or reporting to environmental agencies
 - with pollution control equipment
 - using toxic chemicals that require personal protective equipment (PPE)

Spreadsheet Calculations – 1 of 5

Spray Wash Cleaning (electric heater)

Tecmotiv - 40 hp Proceco

New Process

Variable	Value	units
General		
length of pumping time per cycle	30	min/cycle
load/unload time per cycle	10	min/cycle
<i>total cycle time</i>	40	min/cycle
tank capacity	350	gallons/tank
workhours per day	8	hours/day
workdays per week	5	days/week
workweeks per year	52	weeks/year
run time per day	5.5	hours/day
<i># cycles per day, all parts</i>	8.25	cycles/day
<i># cycles per week, all parts</i>	41.25	cycles/week
<i># sets per week, cylinders</i>	1	sets/week
<i># cycles per set, cylinders</i>	2.4	cycles/set
<i># cycles per week, cylinders</i>	2.4	cycles/week
<i>% chargeable to cylinders</i>	5.82%	%
lifetime of cleaning bath (changeover period)	8	weeks
<i>lifetime of cleaning bath (# cycles)</i>	330	# cycles

Spreadsheet Calculations – 2 of 5

Energy

horsepower rating of pump	40	hp
mechanical efficiency	75.00%	%
<i>electricity for pump consumed</i>	164.05	KWH/day
other power required	0	KW
<i>other electricity consumed</i>	0.00	KWH/day
<i>electricity consumed per day, pump</i>	164.05	KWH/day
cost of electricity	\$0.20	\$/KWH
<i>cost of electricity per day, pump</i>	\$32.11	\$/day
bath temperature	160	deg F
temperature of bath at startup	70	deg F
thermal efficiency of electric heater	99.00%	%
electric heater rating (input)	24	KW
electric heater rating (input)	81,912	BTU/hour
<i>heating energy used for heatup (input)</i>	265,364	BTU/day
<i>estimated duration of heat-up period</i>	194	minutes
<i>estimated duration of heat-up period</i>	3.24	hours
<i>run time of electric heater</i>	11.24	hours/day
<i>electricity consumed per day, heater</i>	269.75	KWH/day
<i>cost of electricity per day, pump</i>	\$52.79	\$/day
<i>total electricity consumed per week</i>	2169.02	KWH/week
<i>total cost of electricity per week</i>	\$424.50	\$/week
<i>electricity chargeable to cylinders</i>	347.04	KWH/set
<i>total cost of electricity chargeable to cylinders</i>	\$67.92	\$/set

Spreadsheet Calculations – 3 of 5

Labor

direct labor hours per cycle		min/cycle
direct labor hours per changeover	<input type="text"/>	min/changeover
<i>total labor hours per cycle</i>		min/cycle
fully burdened labor rate	<input type="text"/>	\$/hour
<i>cost of labor per day</i>		\$/day
<i>cost of labor per week</i>		\$/week
<i>cost of labor chargeable to cylinders</i>	\$26.00	\$/set
<i>labor hours chargeable to cylinders</i>		hrs/set

Spreadsheet Calculations – 4 of 5

Materials

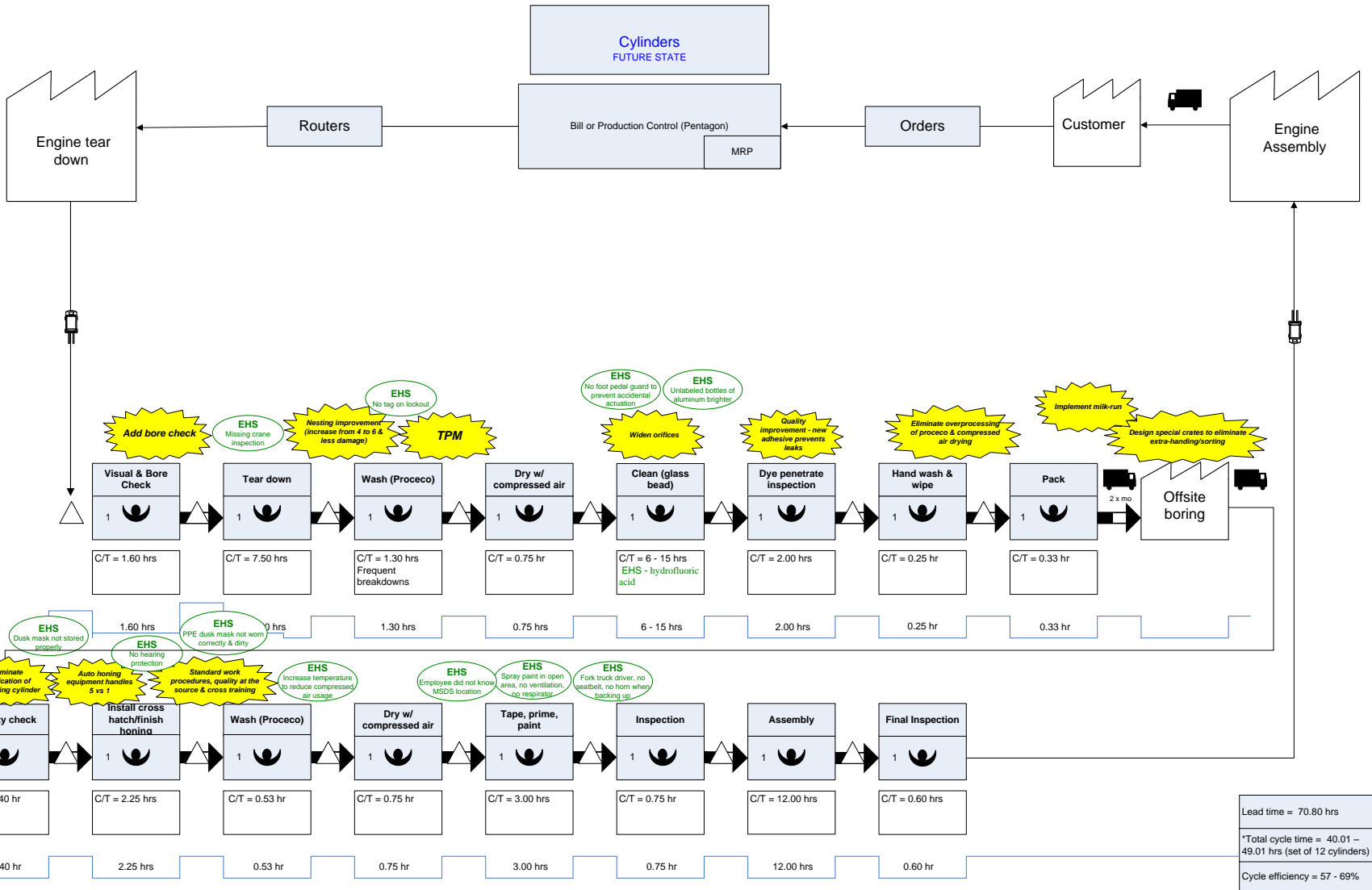
water used per day	50	gals/day
cleaning chemistry used per changeover	55	gals/change
<i>wastewater generated per changeover</i>	350	gals/change
cost of water	\$2.00	\$/Kgal
materials charges per changeover	\$1,180	\$/changeover
<i>water used per week</i>	250	gals/week
<i>water chargeable to cylinders</i>	14.55	gals/set
<i>cost of water chargeable to cylinders</i>	\$0.03	\$/set
<i>wastewater generated per set of cylinders</i>	2.55	gals/set
<i>cleaning chemistry chargeable to cylinders</i>	0.40	gals/set
<i>evaporative losses chargeable to cylinders</i>	12.40	gals/set
<i>total materials and waste chargeable to cylinders</i>	\$8.61	\$/set

Spreadsheet Calculations – 5 of 5

Summary

<i>KWH consumption per set</i>	126.20	KWH/set
<i>energy costs per set</i>	\$24.70	\$/set
<i>labor costs per set</i>	\$26.00	\$/set
<i>labor hours per set</i>		hrs/set
<i>material costs per set</i>	\$8.61	\$/set
<i>total costs per set</i>	\$59.31	\$/set

Future State Value Stream Map – LE2



Lead time = 70.80 hrs
*Total cycle time = 40.01 – 49.01 hrs (set of 12 cylinders)
Cycle efficiency = 57 - 69%

Specific Improvements – Operating Costs

- Inspection process moved from back of process to front of process, thereby identifying bad parts at the start of the process instead of at the end of the process
- 6 cylinders are now loaded into the high-pressure spray washer instead of 4; as a result, 50% more cylinders can be washed at once
- Temperature increased in spray washers so that increased number of cylinders can be washed in the same amount of time as before
- Widened orifices in glass bead blast cabinets, thereby resulting in more rapid cleaning and overall energy and material reduction
- Eliminated one process cleaning step
- Cross-training instituted
- Operating cost of high-pressure spray washer calculated using proprietary spreadsheet software

Specific Improvements – Labor Hours

- Largest reduction occurred as a result of widening orifices in glass bead blast cabinets, reducing cleaning time per cylinder from 90 minutes to 45 minutes
- Eliminated one process cleaning step
- Increased batch size in spray washer, thereby total load and unload time
- Sent multiple sets to penetrant testing instead of onesy-twosies
- Inspection process moved from back of process to front of process, thereby identifying bad parts at the start of the process instead of at the end of the process, reducing wasted labor
- Cross-training instituted
- Boring, honing, and cross-hatching now done on an automatic honing machine instead of doing one cylinder at a time manually
- Parts repackaged in special crates to minimize handling
- New materials being used to remanufacture cylinders; easier and quicker to reman
- Labor savings estimated by observation

Specific Improvements – Power

- Electricity use reduced due to less usage of Proceco high-pressure spray washer
- Electricity use reduced to less usage of abrasive blast cabinets
- Electricity use also reduced due to less rework
- Electricity savings calculated using proprietary spreadsheet software, and compressible flow equations

Specific Improvements – Detergent

- Detergent use reduced due to less usage of Proceco high-pressure spray washer
- Detergent use also reduced due to less rework
- Detergent savings calculated using proprietary spreadsheet software

Specific Improvements – Water

- Water use reduced due to less usage of Proceco high-pressure spray washer
- Water use also reduced due to less rework
- Water savings calculated using proprietary spreadsheet software and experience from observation of water use

Specific Improvements – Non-Hazardous Wastewater

- Wastewater reduced due to less usage of Proceco high-pressure spray washer
- Wastewater also reduced due to less rework
- Wastewater flow rate calculated using proprietary spreadsheet software and mass balance analysis

Specific Improvements – Glass Bead

- Glass bead use reduced to less usage of abrasive blast cabinets
- Glass bead use also reduced due to less rework
- Glass bead savings calculated using purchasing records

Specific Improvements – Non-Hazardous Solid Waste

- Non-hazardous solid waste reduced to less usage of abrasive blast cabinets
- Non-hazardous solid waste also reduced due to less rework
- Non-hazardous solid waste reduction calculated using purchasing records and mass balance analysis

Specific Improvements – Other Changes

- Posted work instructions
- Transferred responsibility for quality to assemblers from inspectors
- Received permission from client to remove the restriction that specific cylinders must remain with a specific engine; cylinders can now be “exchanged”
- Adopted ability to change out a cylinder on the dynamometer instead of having to shut down the entire engine
- Recleaning and replating formerly discarded hardware
- Reuse of hardware has resulted in less work stoppages due to unavailable parts
- Now sending partial sets of cylinders to offsite boring, rather than hold up shipments for full sets
- Outside source was duplicating work performed by Tecmotiv staff; this practice has been discontinued
- Conducted repairs on pump in high-pressure spray washer

... additional E2 improvements & savings

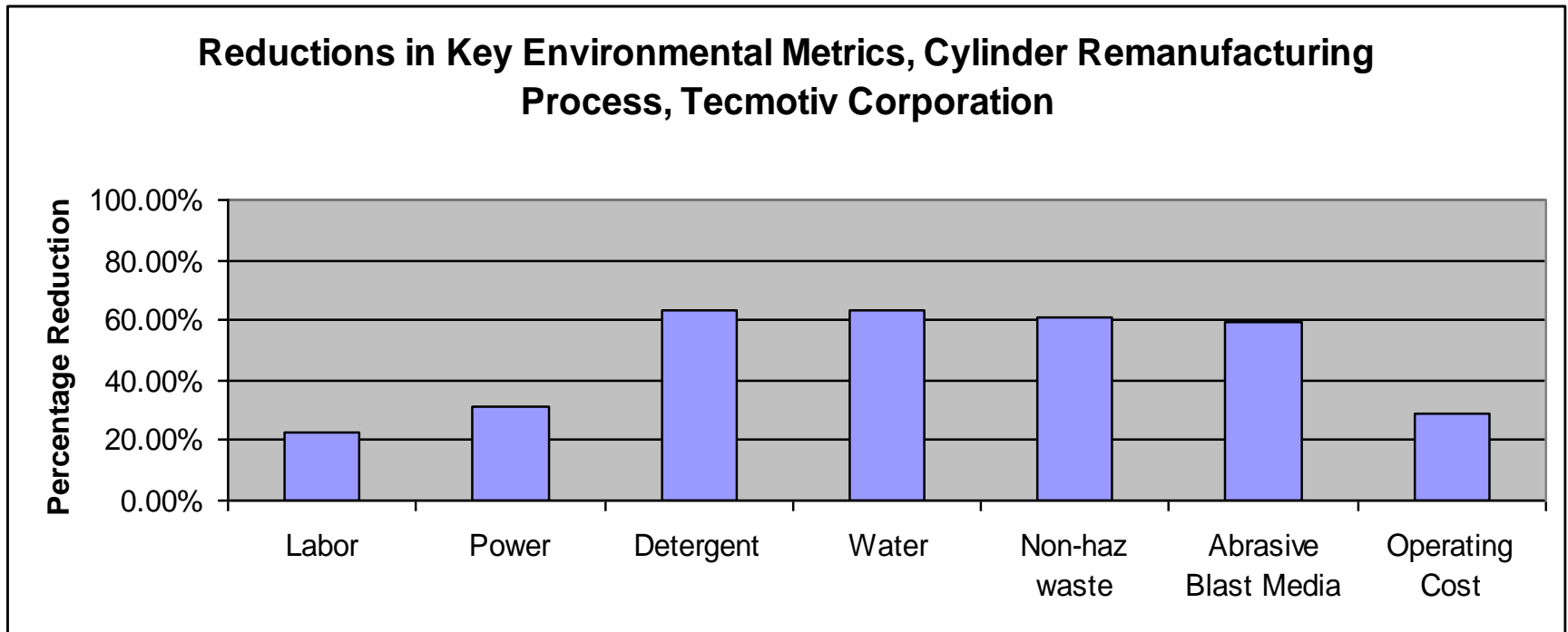
- Lower regulatory non-compliance risk
- Improve environment quality
- Reduce exposure to toxic substances
 - Still need to eliminate use of HF
- Improve employee morale and commitment
 - Cross-training
 - Assemblers now responsible for quality
 - Posted work instructions

Annual Savings from LE2 Implementation (cylinder remanufacturing operation only)

- Operating cost: \$64,335
- Power: 32,709 KWH
- Detergent: 41 gallons
- Water: 1,480 gallons
- Glass bead: 3,631 pounds
- Non-hazardous wastewater: 259 gallons
- Non-hazardous solid waste: 5,791 pounds



Results from LE2 Assessment – Tecmotiv Corporation



Questions?

