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**Lean, Energy, &
Environment**

Parts One and Two

Concepts and Theory

Case Study


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**Lean, Energy, and
Environment (LE2)**


Part One


Concepts and Theory

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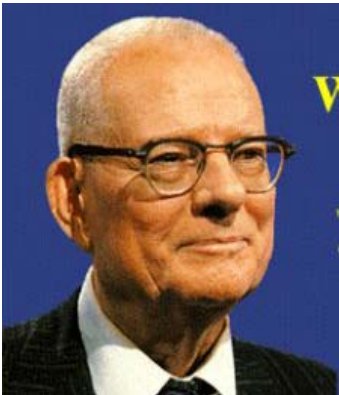
In the beginning, there was just lean



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... and it revolutionized modern manufacturing methods ...



W Edwards Deming
1900-1993


"We have learned to live in a world of mistakes and defective products as if they were necessary to life. It is time to adopt a new philosophy in America."

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Lean Enterprise


People, Materials, & Information



Start
Raw materials/
information



VALUE STREAM




Finish
Finished goods/
services

A business system for organizing and managing product/service development, operations, suppliers, and customer relations that requires less human effort, less space, less energy, less environmental impact, and less time to make products or deliver services with fewer defects to precise customer desires, compared with previous system.

WASTES

- Over-Production
- Transportation
- Inventory
- Waiting
- Over Processing
- Motion
- Defects
- Energy & Environmental wastes




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What Is 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 Toyota, President, Toyota




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The Seven (traditional) Types of Waste (TIMWOOD)


- **T**ransportation
- **I**nventory
- **M**otion
- **W**aiting
- **O**verproduction
- **O**verprocessing
- **D**efects


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The 7 Types of Waste

- **T**ransportation
 - Double and triple handling
 - Temporary storage
 - Transferring parts over a long distance

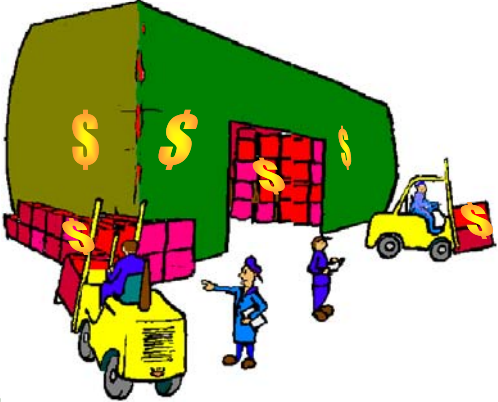



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The 7 Types of Waste

- Inventory
 - Covers up problems
 - Increases the cost of product
 - Extra handling
 - Extra space
 - Carrying cost
 - Extra people
 - Extra paperwork





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The 7 Types of Waste

- Motion
 - Walking
 - Move does not add value to work
 - Movements that are straining or unnecessary (e.g. looking for parts, tools, documents, etc.)





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The 7 Types of Waste

- **Waiting**
 - Watching machine run (no initiative to eliminate problems)
 - Equipment down
 - Needed parts or information fail to arrive

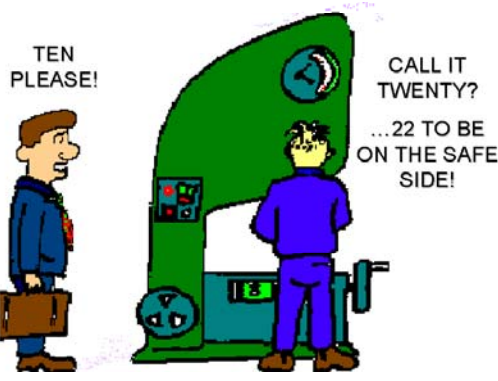



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The 7 Types of Waste

- **Over-Production**
 - Producing more, sooner or faster than required by customer
 - Extra Handling
 - Extra space
 - Extra inventory
 - Extra machinery
 - Extra defects
 - Extra overhead
 - Extra people
 - Extra paperwork





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The 7 Types of Waste

- Over Processing
 - Performing unnecessary or incorrect processing, typically from poor tool or product design
 - Defects



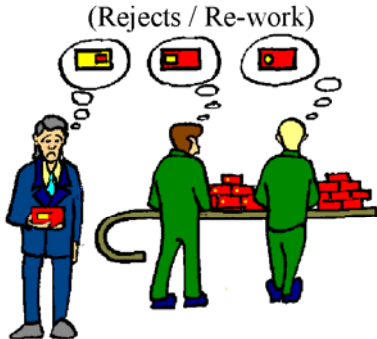
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The 7 Types of Waste

- Defects
 - Creates waiting
 - Increases lead time
 - Scrap
 - Rework

(Rejects / Re-work)



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... and now the sustainability revolution is upon us ...



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**Necessitating us to examine wastes often unaddressed by Lean:
Lean:
Environmental & Energy (E2) Wastes**




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What are E2 Wastes?


- Environmental & Energy wastes
 - 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


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E2 Wastes


- Often a sign of inefficient production
- Indicate opportunities for saving cost & time
 - Chemical & hazardous material often demand costly support activities
 - Regulatory compliance management & reporting activities
 - Use of personal protective equipment
 - Investment, operation, & maintenance of pollution control equipment
 - Create unnecessary risks to worker health & safety


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Benefits of Coordinating Lean & E2

- Reduce cost
- Accelerate Lean implementation
 - Improve process flows and reduce lead times
- Lower regulatory non-compliance risk
- Meet customer expectations
- Improve environment quality & reduce exposure to toxic substances
- Improve employee morale and commitment

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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/>







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Lean, Energy, and Environment

- 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




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Environment & Energy (E2) Impacts of Wastes

| Waste Type | E2 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 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 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 |
| 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 |



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Source: www.epa.gov/lean

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What is Value Stream Mapping?

- Value stream mapping is a process mapping method that enables your organization to:
- Current State Map: Visual representation of existing operations (information and product flows)
 - Identify the largest sources of waste (non-value added activity) in the value stream
- Future State Map: Drawing of Lean flow (vision)
 - Develop implementation plan for Lean activities

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Current State Value Stream Map (Unmodified)

The diagram illustrates the current state value stream map. It shows information flows (dashed arrows) and material flows (solid arrows) between various stages of the production process. Information flows include Annual Production Plan, Weekly delivery schedule, Daily schedule, and Market Forecast. Material flows include Receiving, Milling, Welding, Painting, Assembly & Inspection, and Shipping. Inventory buffers (I) are shown at several points in the process.

| | | | | | |
|-----------|---|---|---|---|----------|
| Receiving | Milling | Welding | Painting | Assembly & Inspection | Shipping |
| 5 days | 2 people | 2 people | 3 people | 3 people | 30 days |
| | C/T = 2 min C/O = 2 hr Uptime = 74% | C/T = 4 min C/O = 3 hr Uptime = 61% | C/T = 7 min C/O = 4 hr Uptime = 48% | C/T = 2 min C/O = 30 min Uptime = 93% | |
| 5 days | 10 days | 15 days | 8 days | 30 days | |
| | 2 min | 4 min | 7 min | 2 min | |

Total Lead Time = 68 days
Value Added Time = 15 min

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Source: www.epa.gov/lean

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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



Source: www.epa.gov/lean

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Overview of Value Stream Mapping Tools

- A variety of tools & techniques can enhance the Lean and environmental results of value stream mapping
 1. Use icons to identify processes with EHS opportunities
 2. Record environmental data for processes in VSMS
 3. Analyze materials use vs. need in a “materials line” for VSMS
 4. Expand the application of value stream mapping to natural resource flows
 5. Find Lean and environment opportunities in future state VSMS


Source: www.epa.gov/lean

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1. Use Icons to Identify Processes with EHS Opportunities

- Use icons or red dots to identify processes with key environmental, health, and safety (EHS) opportunities on value stream maps
- Icons can also highlight where EHS staff expertise will likely be needed

EHS
Milling
2 people

Process Box with EHS Icon

Source: www.epa.gov/lean



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VSM with EHS Process Icons

| Process | People | C/T | C/O | Uptime | Lead Time |
|-----------------------|----------|-------|--------|--------|-----------|
| Receiving | - | - | - | - | 5 days |
| Milling | 2 people | 2 min | 2 hr | 74% | 2 min |
| Welding | 2 people | 4 min | 3 hr | 61% | 4 min |
| Painting | 3 people | 7 min | 4 hr | 48% | 7 min |
| Assembly & Inspection | 3 people | 2 min | 30 min | 93% | 2 min |
| Shipping | - | - | - | - | 30 days |

Total Lead Time = 68 days
Value Added Time = 15 min

Source: www.epa.gov/lean



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Where to Put Environmental Icons on VSMSs?

- 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)

Source: www.epa.gov/lean




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EHS Staff Can Help

- Involve EHS staff when developing VSMSs – 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

Source: www.epa.gov/lean



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Common Processes with EHS Wastes & Opportunities

| | |
|--|---|
| <ol style="list-style-type: none"> 1. Metal casting 2. Chemical and heat treatment of materials 3. Metal fabrication and machining 4. Cleaning and surface preparation 5. Bonding and sealing | <ol style="list-style-type: none"> 6. Welding 7. Metal finishing and plating 8. Painting and coating 9. Waste management 10. Chemical and hazardous materials management |
|--|---|



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Source: www.epa.gov/lean

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2. Record Environmental 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 |



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Source: www.epa.gov/lean

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Adding Environmental Data to VSMs

- Add key environmental data to process boxes on value stream maps

EHS

| |
|--|
| Milling |
| 2 people |
| C/T = 2 min C/O = 2 hr Uptime = 74% <b style="color: green;">Haz. Waste = 5 lbs |

← Hazardous waste generated per shift

Source: www.epa.gov/lean

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VSM with Environmental Metrics & EHS Icons

The VSM diagram shows the following process flow and metrics:

- Receiving:** 5 days lead time
- Milling:** 2 people, C/T = 2 min, C/O = 2 hr, Uptime = 74%, **Haz. Waste = 5 lbs**, 5 days lead time
- Welding:** 2 people, C/T = 4 min, C/O = 3 hr, Uptime = 61%, **Haz. Waste = 20 lbs**, 10 days lead time
- Painting:** 3 people, C/T = 7 min, C/O = 4 hr, Uptime = 48%, **Haz. Waste = 60 lbs**, 15 days lead time
- Assembly & Inspection:** 3 people, C/T = 2 min, C/O = 30 min, Uptime = 93%, 8 days lead time
- Shipping:** 30 days lead time

Total Lead Time = 68 days
 Value Added Time = 15 min


Source: www.epa.gov/lean

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How Can Materials Lines Be Useful?

- 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



Source: www.epa.gov/lean


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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


Source: www.epa.gov/lean

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Example of Materials Line

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

Top line:
Materials Used by Process

Bottom line:
Materials Added to Product During the Process

Summary:
Materials Used = 135 lbs
Materials Needed = 85 lbs
Materials Wasted = 50 lbs

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4. Expand the Application of Value Stream Mapping to Natural Resource Flows

- You can also use VSMs to look in more detail at the inputs, outputs, and information flows associated with the use of energy, water, and/or materials
 - Energy/water/materials used vs. needed (as with the “materials line” VSM tool)
 - Environmental waste streams (air emissions, wastewater, hazardous waste, solid waste)
 - Information flows to environmental regulatory agencies (e.g., reporting air emissions)


New York State Pollution Prevention Institute Source: www.epa.gov/lean

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5. Find Lean & Environment 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?

Source: www.epa.gov/lean


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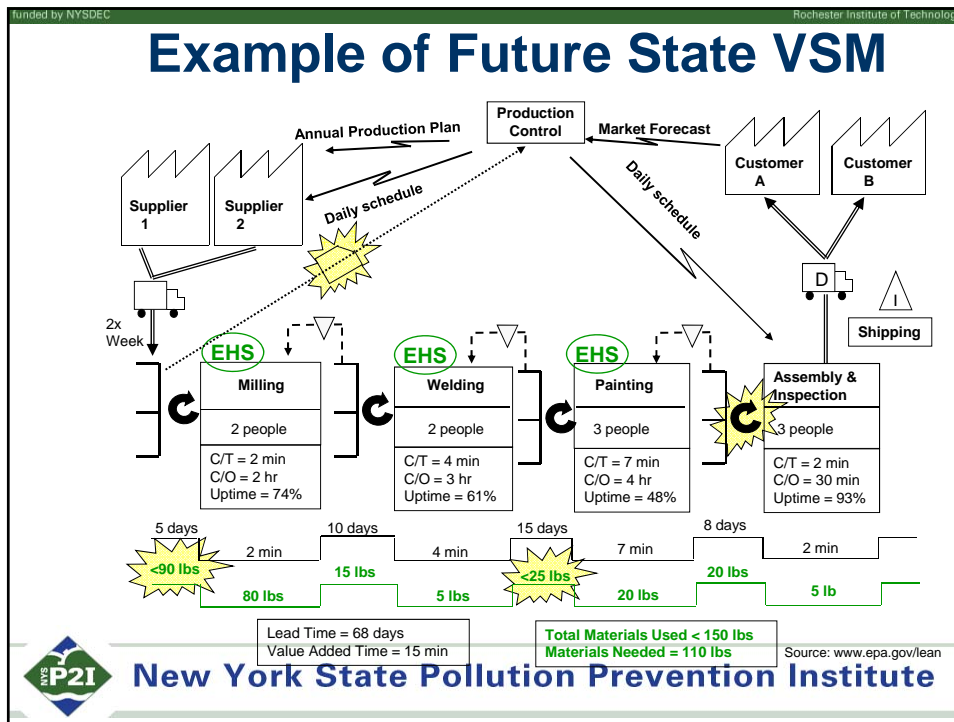
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Future State Questions

- 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?

Source: www.epa.gov/lean

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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

Source: www.epa.gov/lean

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Break Time!



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Lean, Energy, and Environment (LE2) Part Two Case Study

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LE2 Case Study – Tecmotiv (USA) Inc.

- 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

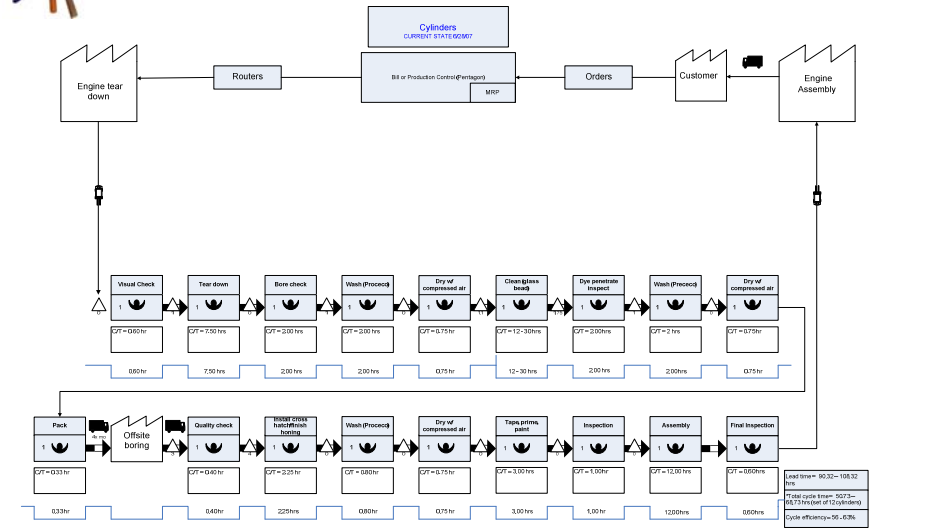






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Current State Value Stream Map – Lean Only



The Value Stream Map (VSM) illustrates the cylinder process flow. It starts with 'Engine tear down' leading to 'Routers'. The main process flow includes: Visual Check (0.60hr), Tear down (7.50hrs), Bore check (2.00 hrs), Wash (Process) (2.00 hrs), Dry of compressed air (0.75 hr), Clean glass bench (12-30hrs), Eye generate inspect (2.00hrs), Wash (Process) (2.00hrs), and Dry of compressed air (0.75hr). This is followed by 'Orders' to the 'Customer' and 'Engine Assembly'. A secondary process flow includes: Pack (0.33hr), Offsite boring (0.60hr), Quality check (0.25hr), Wash (Process) (0.60hr), Dry of compressed air (0.75 hr), Tape print part (3.00hrs), Inspection (1.00hr), Assembly (12.00hrs), and Final Inspection (0.60hrs). A box at the bottom right provides summary statistics: Lead time = 80.32 - 108.32 hrs, Total cycle time = 90.75 - 167.75 hrs (out of 12 cylinders), and Cycle efficiency = 55 - 63%.




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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)



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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 |




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Spreadsheet Calculations – 2 of 5

| | | |
|--|-------------------------------------|-----------|
| Energy | | |
| horsepower rating of pump | <input type="text" value="40"/> | hp |
| mechanical efficiency | <input type="text" value="75.00%"/> | % |
| <i>electricity for pump consumed</i> | 164.05 | KWH/day |
| other power required | <input type="text" value="0"/> | KW |
| <i>other electricity consumed</i> | 0.00 | KWH/day |
| electricity consumed per day, pump | 164.05 | KWH/day |
| cost of electricity | <input type="text" value="\$0.20"/> | \$/KWH |
| cost of electricity per day, pump | \$32.11 | \$/day |
| bath temperature | <input type="text" value="160"/> | deg F |
| temperature of bath at startup | <input type="text" value="70"/> | deg F |
| thermal efficiency of electric heater | <input type="text" value="99.00%"/> | % |
| electric heater rating (input) | <input type="text" value="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 |
| electricity consumed per day, heater | 269.75 | KWH/day |
| cost of electricity per day, pump | \$52.79 | \$/day |
| total electricity consumed per week | 2169.02 | KWH/week |
| total cost of electricity per week | \$424.50 | \$/week |
| <i>electricity chargeable to cylinders</i> | 126.20 | KWH/set |
| total cost of electricity chargeable to cylinders | \$24.70 | \$/set |




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Spreadsheet Calculations – 3 of 5

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



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Spreadsheet Calculations – 4 of 5

Materials

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

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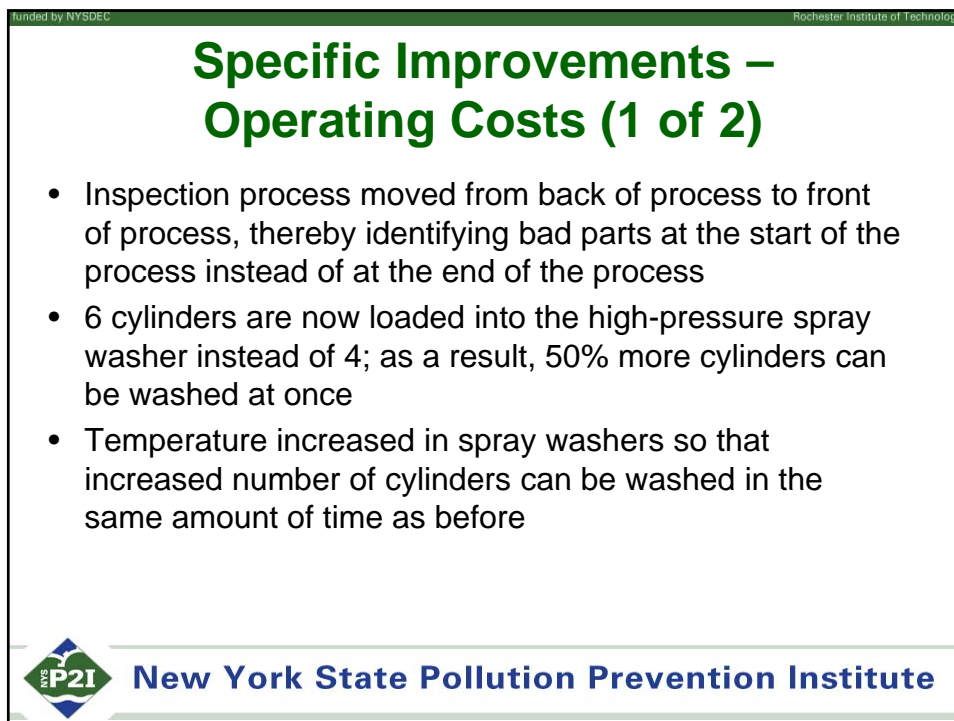
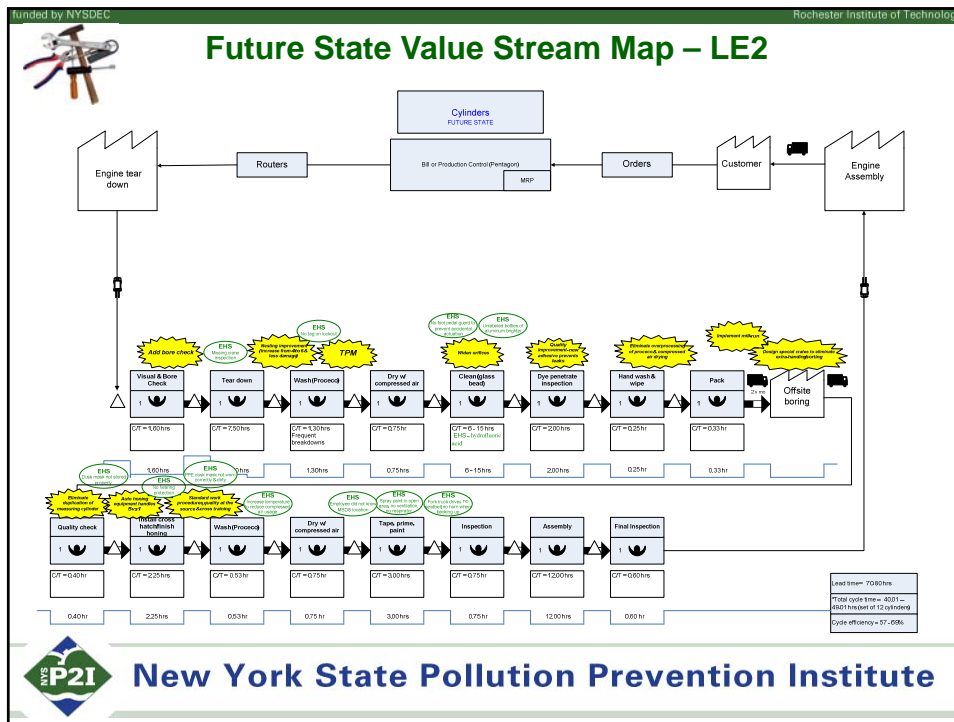


Spreadsheet Calculations – 5 of 5

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 |


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Specific Improvements – Operating Costs (2 of 2)


- 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 spreadsheets developed at NYSP2I

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Specific Improvements – Labor Hours (1 of 2)


- 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

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Specific Improvements – Labor Hours (2 of 2)


- 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 remanufacture
- Labor savings estimated by observation

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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 spreadsheets developed at NYSP2I and compressible flow equations

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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 spreadsheets developed at NYSP2I

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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 spreadsheets developed at NYSP2I and experience from observation of water use

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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 spreadsheets developed at NYSP2I and mass balance analysis

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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

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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

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Specific Improvements – Other Changes (1 of 2)


- 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

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Specific Improvements – Other Changes (2 of 2)


- 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

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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

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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



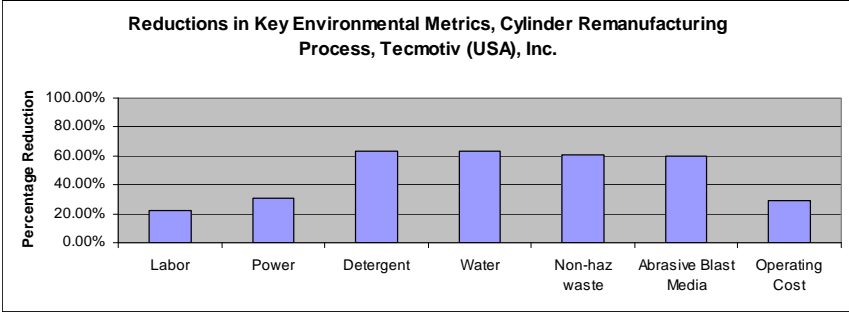


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Results from LE2 Assessment – Tecmotiv (USA), Inc.

Reductions in Key Environmental Metrics, Cylinder Remanufacturing Process, Tecmotiv (USA), Inc.




| Metric | Percentage Reduction |
|----------------------|----------------------|
| Labor | 20.00% |
| Power | 30.00% |
| Detergent | 60.00% |
| Water | 60.00% |
| Non-haz waste | 60.00% |
| Abrasive Blast Media | 60.00% |
| Operating Cost | 30.00% |




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Questions?



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