



# EPA Lean and Environment Toolkit Overview

**National Shipbuilding Research Program  
Environmental Technologies Panel Meeting**  
Wednesday, June 21, 2006



# Presentation Objectives

- » Briefly review Lean principles and how Lean relates to environmental performance
  
- » Learn practical strategies and tools for integrating environmental considerations into Lean methods
  - Value Stream Mapping
  - Kaizen Events
  - 6S (5S + Safety)



# Lean and Environment Toolkit Overview Presentation Outline

- » **Lean and Environmental Performance**
- » Introduction to the Lean and Environment Toolkit
- » Value Stream Mapping Tools
- » Kaizen Event Tools
- » 6S (5S + Safety) Tools



# What is Lean?

- » A production approach (philosophy and methods) developed by Toyota, adapted by others
  
- » Lean thinking aims to produce:
  - high quality products and services
  - at the lowest cost
  - with maximum customer responsiveness
  
- » Seeks to eliminate “waste” (non-value added activity)

# Lean = Eliminating Wastes

## Lean's "Deadly Wastes"

1. Defects
2. Overproduction
3. Waiting
4. Non-value added processing
5. Transportation
6. Inventory
7. Motion
8. Employees underutilized

## ***Where are the environmental wastes?***

- Excess materials use
- Pollution/emissions
- Scrap & non-product output
- Hazardous wastes

***Many environmental wastes are embedded in, or related to, Lean's deadly wastes***



# Lean Production's Environmental "Coattails"

- » Less scrap, fewer defects, less spoilage = **reduced environmental waste**
- » Fewer defects, less overproduction, simpler products, right-sized equipment = **reduced use of raw materials**
- » Less storage, inventory space needed = **reduced materials, land and energy consumed**
- » Less overproduction, lighting/heating/cooling unneeded space, oversized equipment = **less energy use**
- » Less overprocessing, more efficient transport and movement = **lower emissions**



## Lean's “Blind Spots”

- » Lean can be leveraged to produce even more environmental improvement, by addressing environmental “blind spots” in Lean
  - **Hidden environmental waste** is often buried in overhead and facility support costs
  - **Environmental and human health risks** are often not explicitly considered in lean initiatives
  - **Environmental impacts** throughout the **product lifecycle** can affect customers and stakeholders



# How We Talk About Lean and Environment Matters...

- » Lean and pollution prevention (P2) are not the same thing, although they use similar tools and are highly complementary
  
- » Lean is the “moving train” in many organizations –there are opportunities to bring environmental considerations into Lean initiatives
  - Lean and environmental management systems (EMS) are synergistic and can add value to each other
  
- » The key is to harness Lean’s power for identifying and eliminating “waste” to improve environmental performance without distracting Lean



# Learn More About How Lean Manufacturing Relates to the Environment...

- » EPA Lean & Environment Website

[www.epa.gov/lean](http://www.epa.gov/lean)

- » Lean Manufacturing and Environment Report (2004 Shingo Research Prize Winner)

[www.epa.gov/lean/leanreport.pdf](http://www.epa.gov/lean/leanreport.pdf)

- » Shipbuilding Sector Lean and EMS Report

[www.epa.gov/sectors/shipbuilding/leanEMS\\_report.pdf](http://www.epa.gov/sectors/shipbuilding/leanEMS_report.pdf)



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# The Lean and Environment Toolkit: How To Enhance Lean's Environmental Outcomes

- » EPA's **Lean and Environment Toolkit** (Version 1.0)  
[www.epa.gov/lean/toolkit](http://www.epa.gov/lean/toolkit)
  - Assembles experience from multiple organizations with Lean and environment experience
  - Provides strategies and tools for integrating environmental considerations into Lean methods
  - Primary audience is Lean practitioners
  
- » An associated series of **Lean and Environment Training Modules** is also available



# The Business Case: Why Connect Lean and Environment?

1. Learn to see hidden environmental waste (blind spots)
  - Reduce costs
  - Reduce risk
2. Enhance the effectiveness of Lean implementation
  - Anticipate and ease constraints to applying Lean to “monument” processes
  - Improve process flow and reduce lead times
3. Deliver what customers and employees want
  - Satisfy customer preferences for environmental attributes
  - Safeguard company and brand reputation
  - Improve employee morale and commitment
  - Improve environmental quality

# Connecting Lean and Environment at Different Levels in an Organization





## A Word About The Tools in The Toolkit...

- » Many focus on minor enhancements to conventional Lean methods
- » The intent is to strengthen the results and effectiveness of Lean methods at identifying waste...
  - ...without altering the focus or usefulness of the methods in the context of Lean



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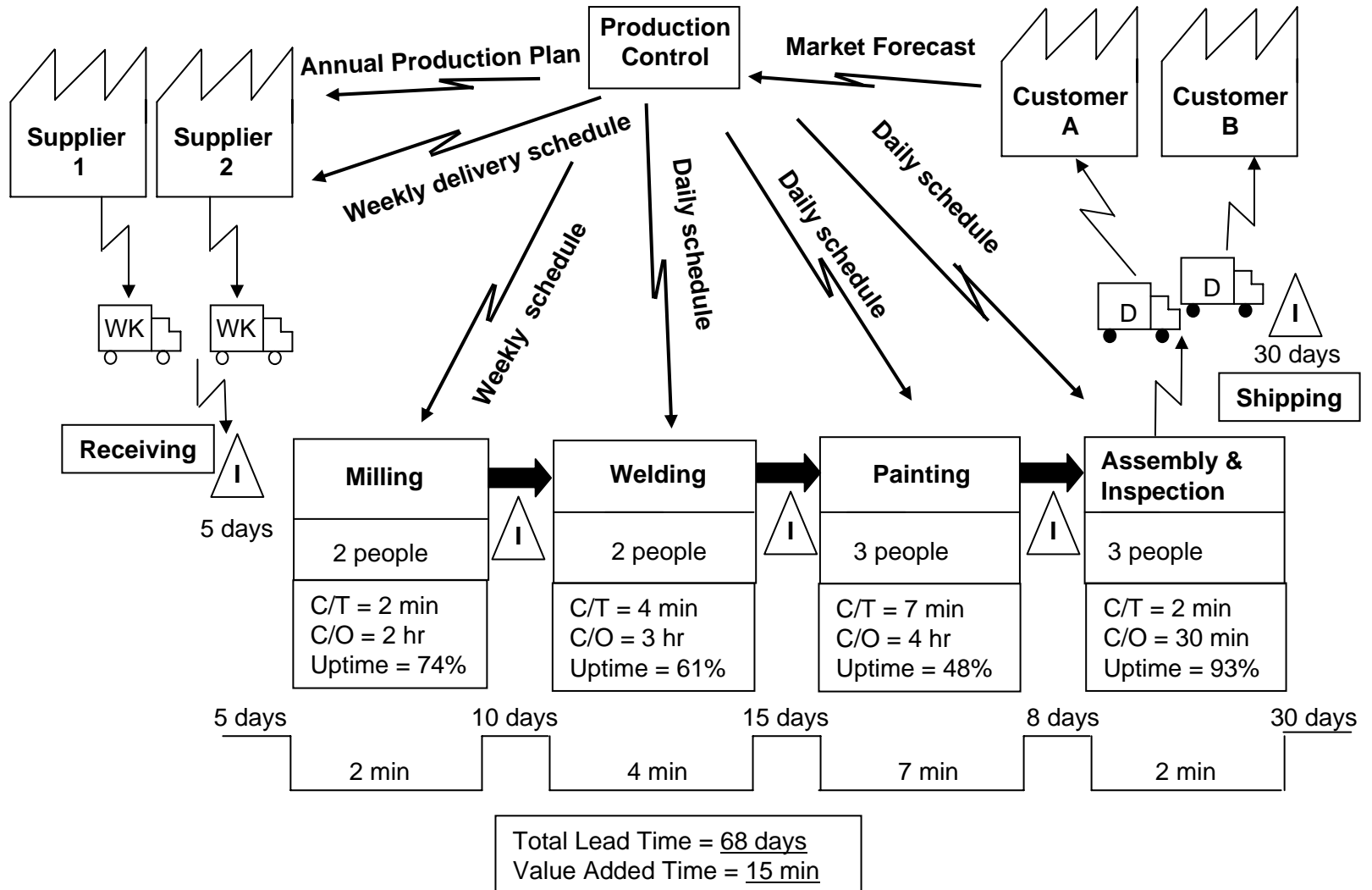
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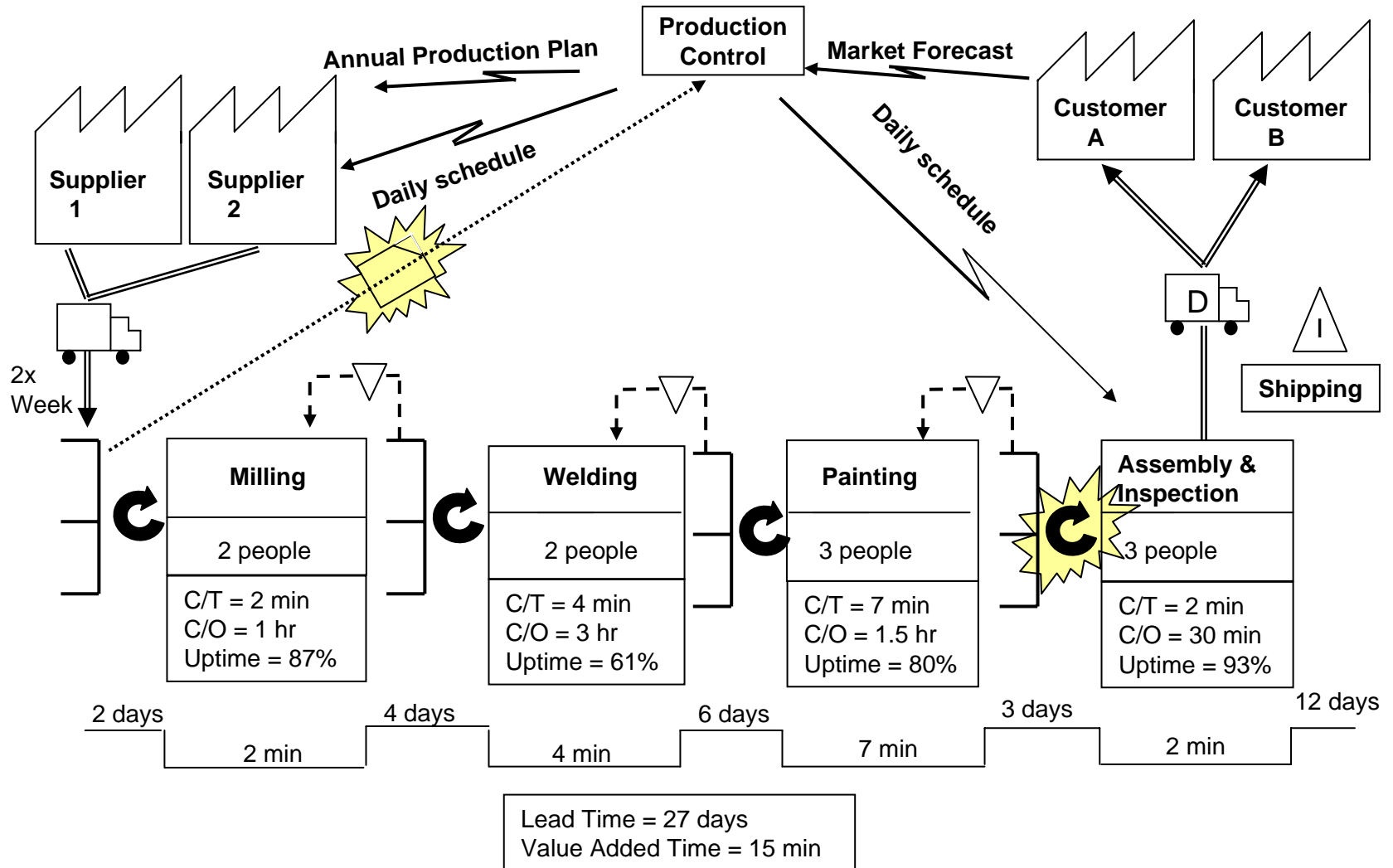
# What Is Value Stream Mapping?

- » **Value stream mapping** is a process-mapping method that enables an organization to “see” all the actions involved in producing a product or service
- » 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

# Current State Value Stream Map (Unmodified)



# Future State Value Stream Map (Unmodified)

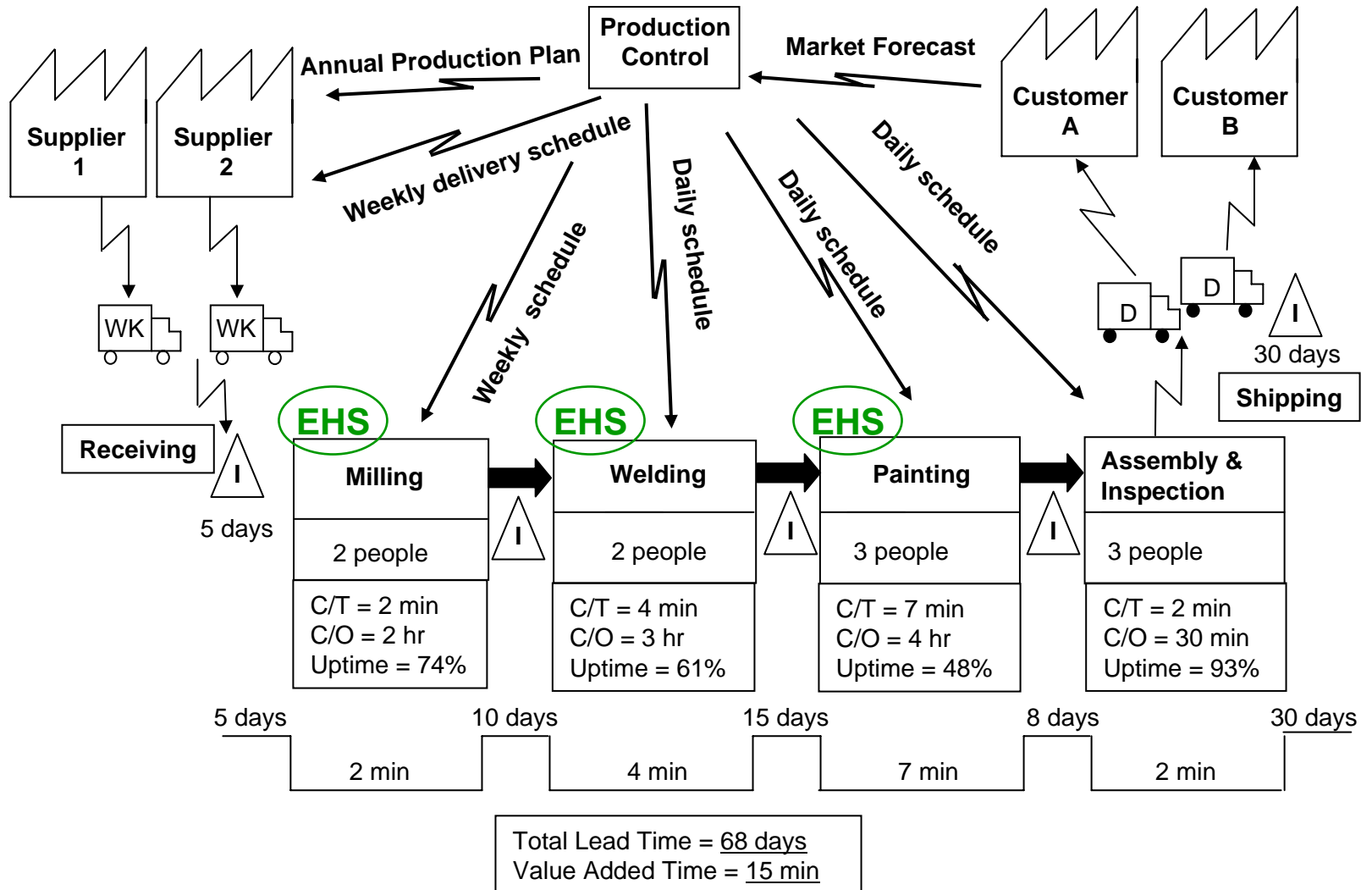


# Value Stream Mapping Tools

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



# 1. Adding EHS Icons to Value Stream Maps

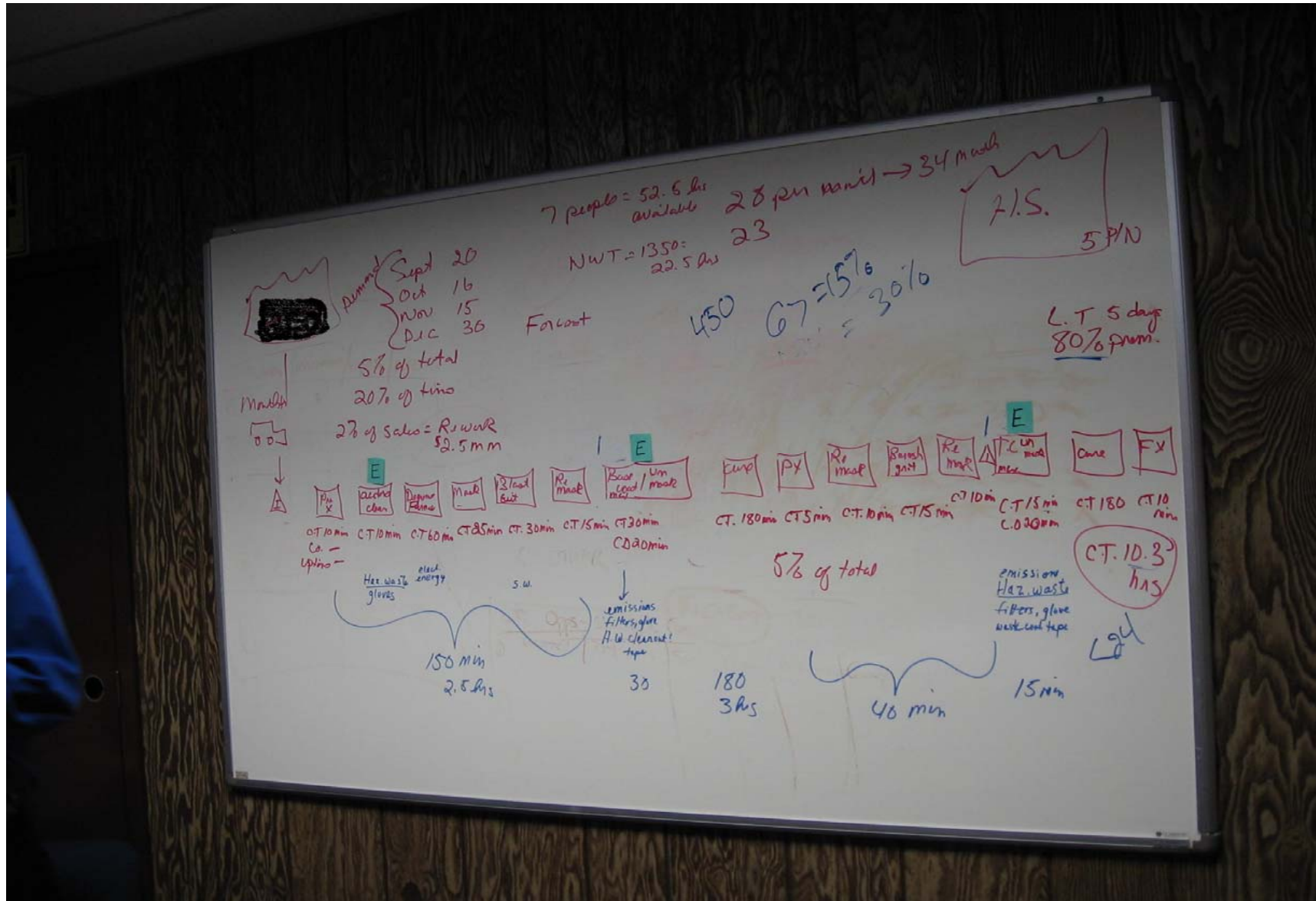




# Common Processes with EHS Wastes and Opportunities

1. Metal casting
2. Chemical and heat treatment of materials
3. Metal fabrication and machining
4. Blasting, cleaning, and surface preparation
5. Bonding and sealing
6. Welding
7. Metal finishing and plating
8. Painting and coating
9. Waste management
10. Chemical and hazardous materials management

# Current State Value Stream Map Example

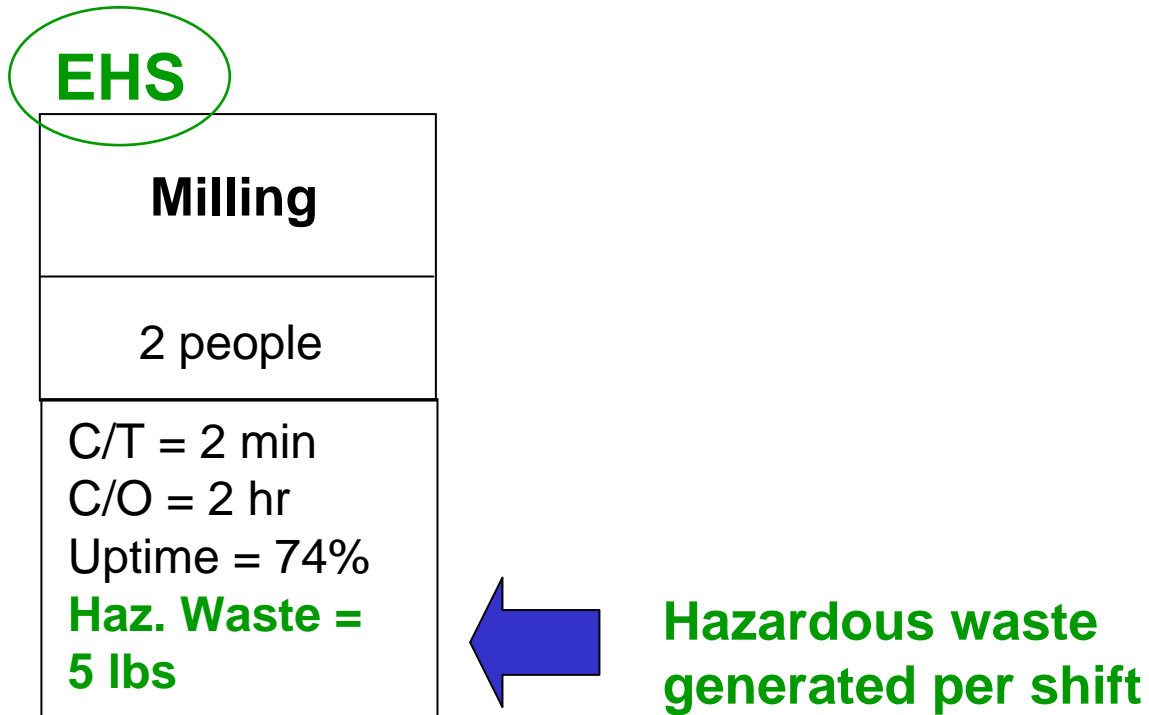




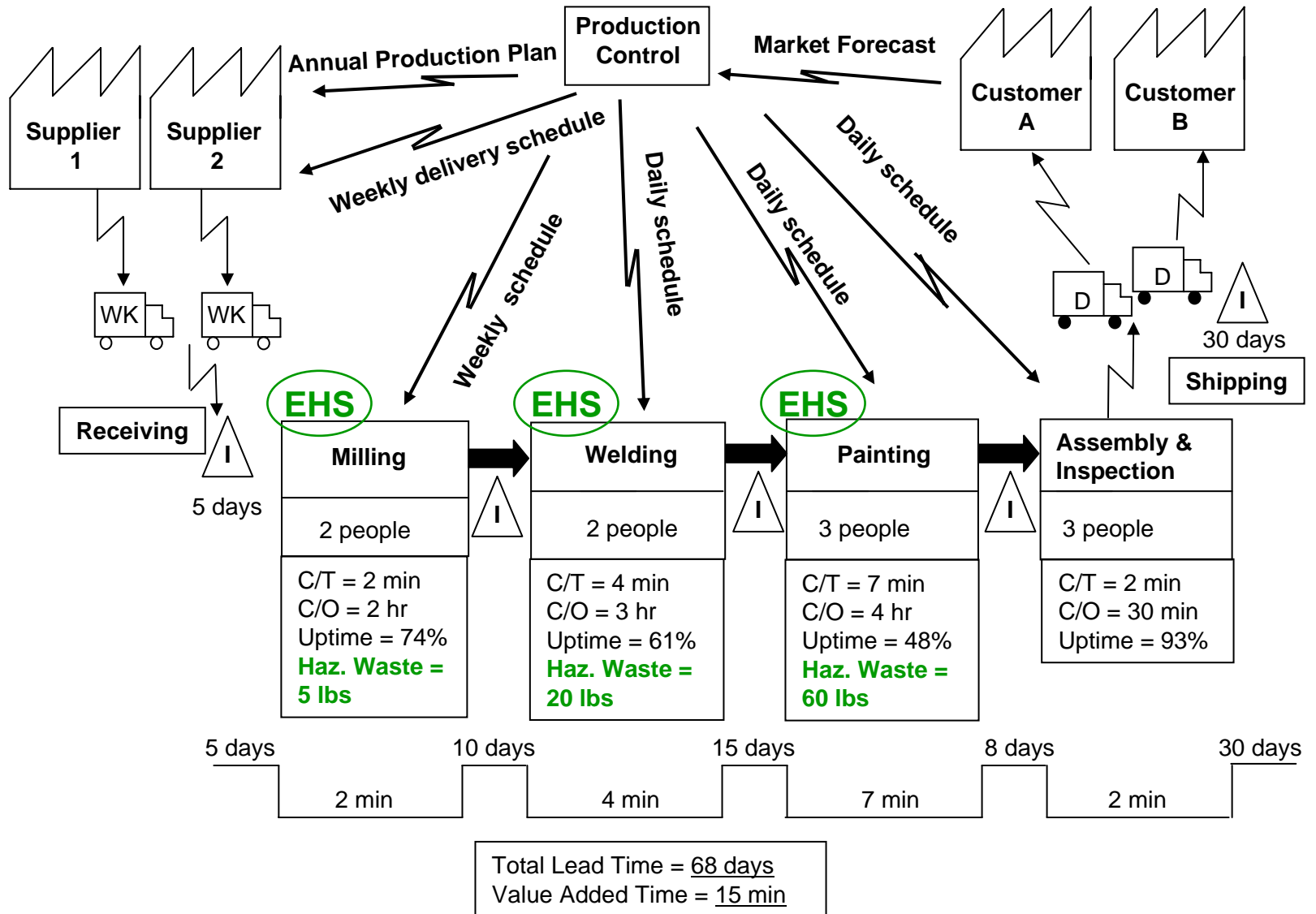
# Value Stream Mapping Strategies and Tools

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- 2. Record environmental data for processes in VSMs**
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## 2. Record Environmental Data for Processes in VSMs



# VSM with Environmental Metrics & EHS Icons





# Value Stream Mapping Strategies and Tools

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
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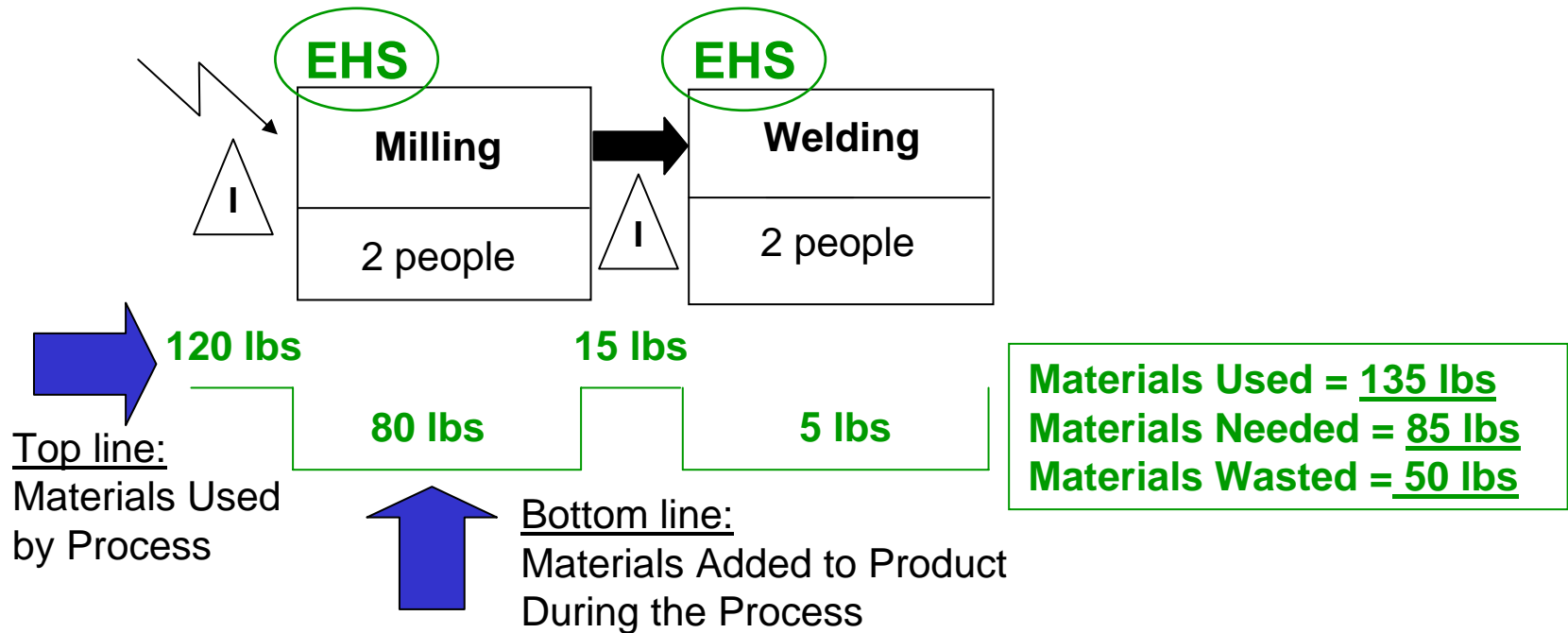
### 3. Analyze Materials Use Versus Need in a “Materials Line” for VSMs

- » The “**lead time ladder**” or “**timeline**” on VSMs looks at value-added and non-value-added time



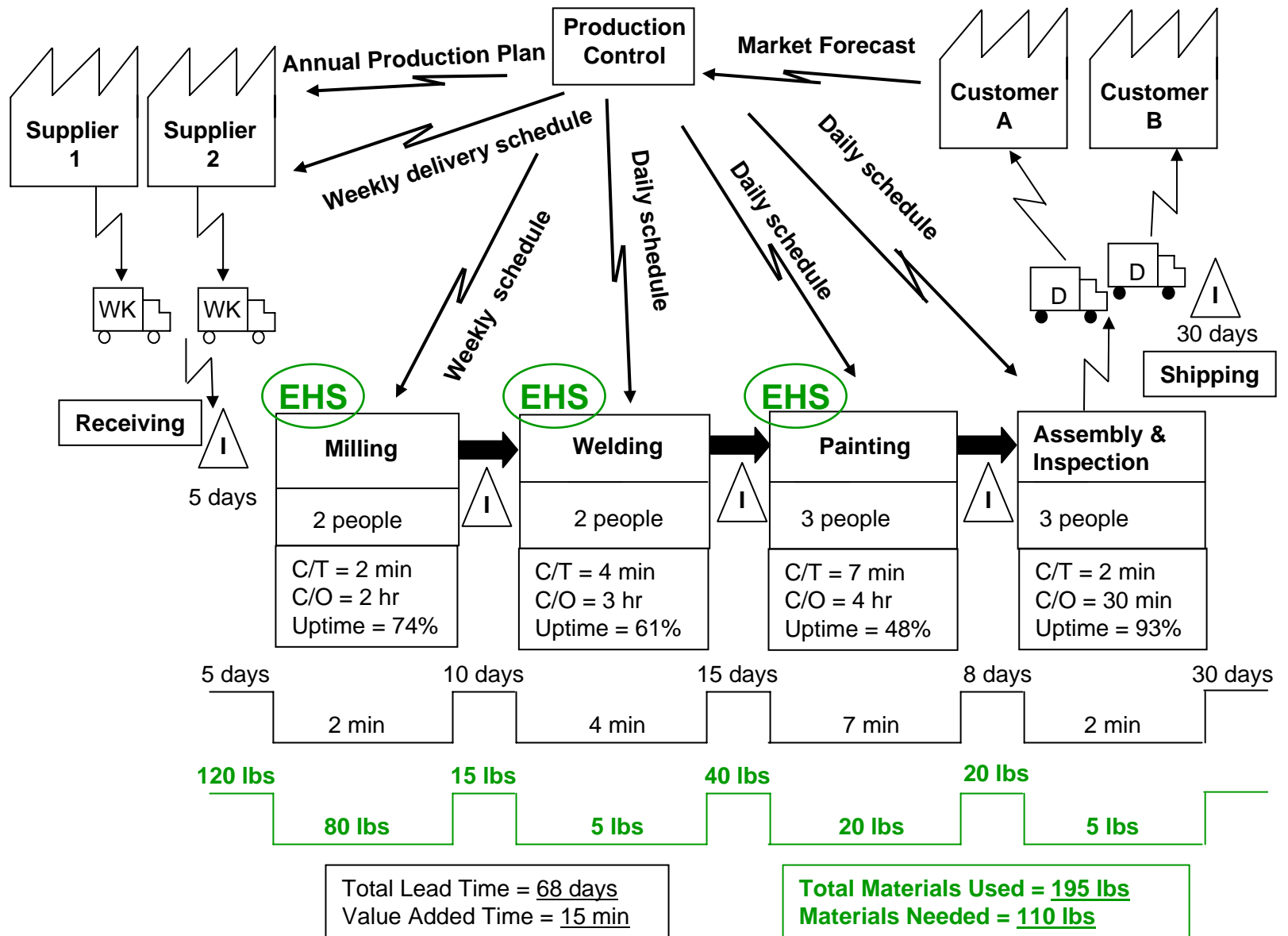
- » Add a “**materials line**” to examine:
  - Amount of raw materials (e.g., paint) used by each process
  - Amount of materials that end up in the product and add value from the customer’s perspective

# 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





# Value Stream Mapping Strategies and Tools

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



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

- » You can also use VSMS to look in more detail at the use of energy, water, and/or materials
  - Energy/water/materials used vs. needed
  - Environmental waste streams
  - Information flows to regulatory agencies
  - Laboratory samples and R&D information flows



# Value Stream Mapping Strategies and Tools

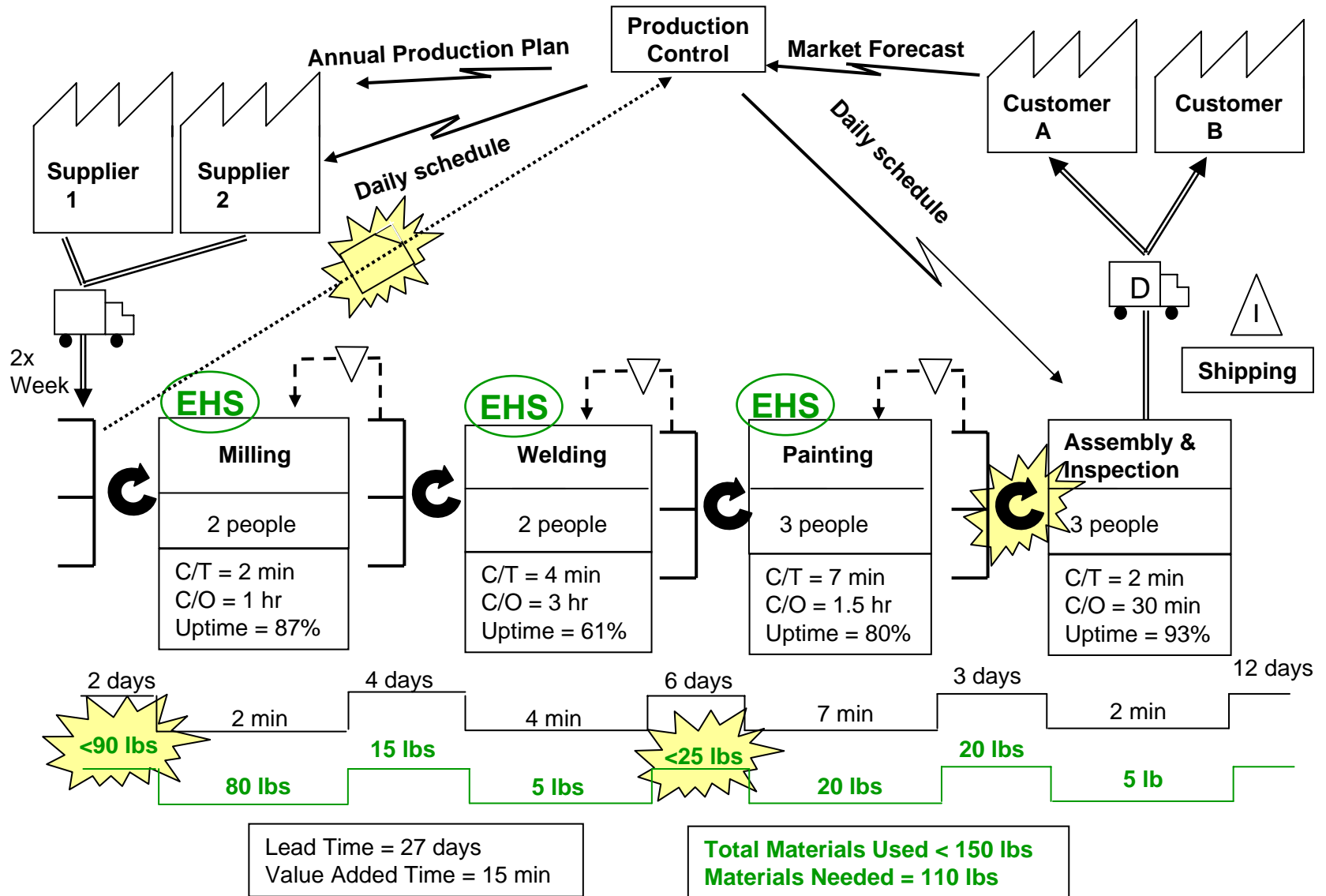
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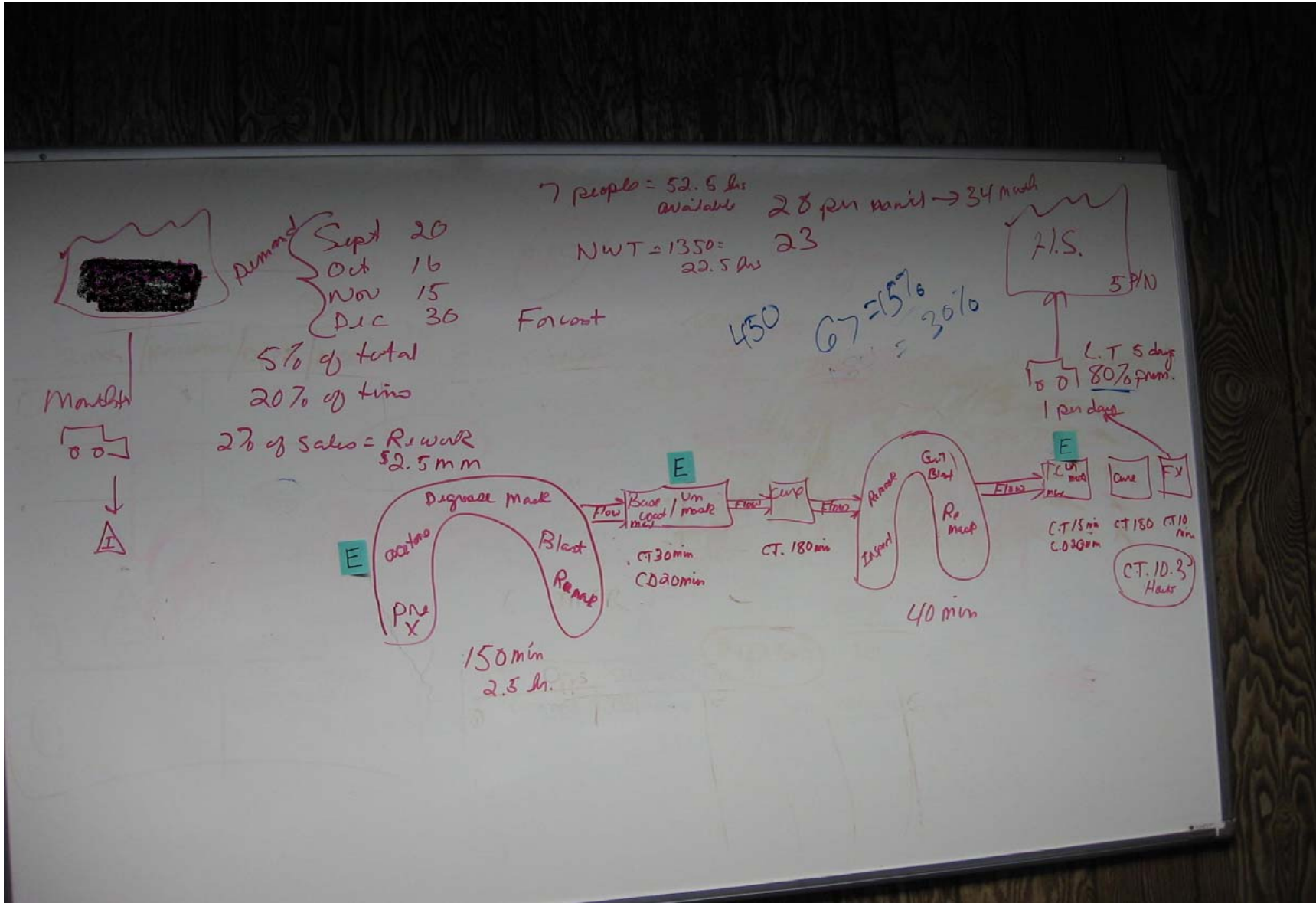
## 5. Find Lean and Environment Opportunities in Future State VSMs

- » 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?
- » Can one process use the “waste” material from another process instead of using virgin materials?

# Example Future State VSM



# Future State Value Stream Map Example





# Reflections on Value Stream Mapping Tools

- » What questions do you have about value stream mapping strategies and tools?
- » What experiences have you or your organization had with integrating EHS and value stream mapping?
- » What other ideas do you have for improving environmental outcomes with value stream mapping?



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- » **Kaizen Event Tools**
- » 6S (5S + Safety) Tools



# What Are Kaizen Events?

- » **Kaizen events** are team-based activities that:
  - Eliminate waste
  - Make rapid changes in the workplace
  
- » Events last 2-7 days, but planning takes much longer
  
- » Steps in kaizen events include:
  - Gathering baseline data
  - Brainstorming improvement ideas
  - Testing ideas
  - Presenting the results

# Example Lean Event Meeting Room...





# Reasons to Include EHS Expertise in Kaizen Events

- » 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



# Kaizen Event EHS Change Management Strategies

- » Proactively Involve EHS Staff in Kaizen Events
- » Use an EHS Checklist for Lean Events
  - Determine which events may have EHS impacts
- » Train Lean Team Leaders on EHS Issues
- » Identify an EHS Contact for Kaizen Event Teams

# Kaizen Event Implementation Tools



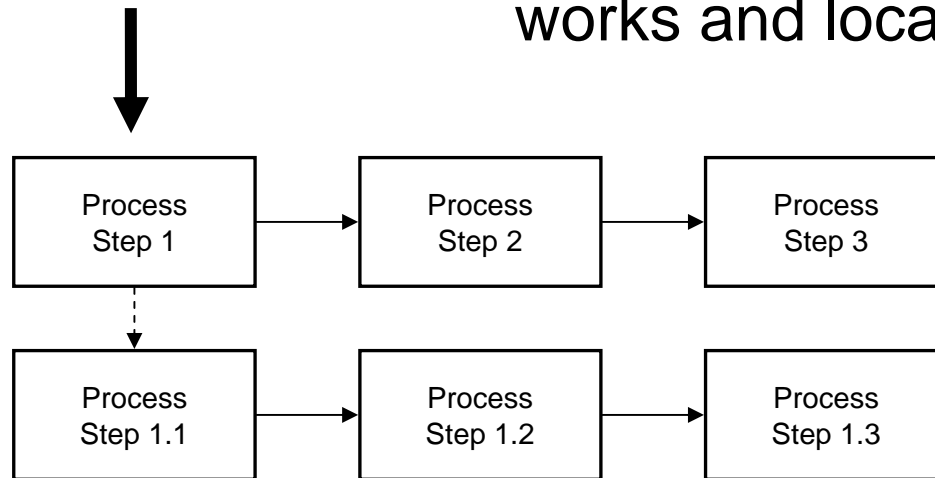
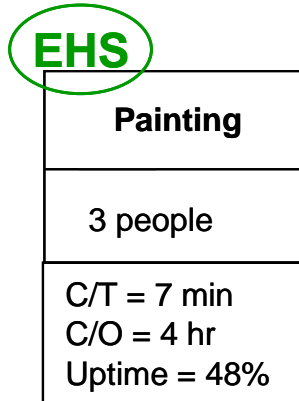
1. Hierarchical Process Mapping
2. Questions to Identify Lean and Environment Opportunities



# 1. Hierarchical Process Mapping

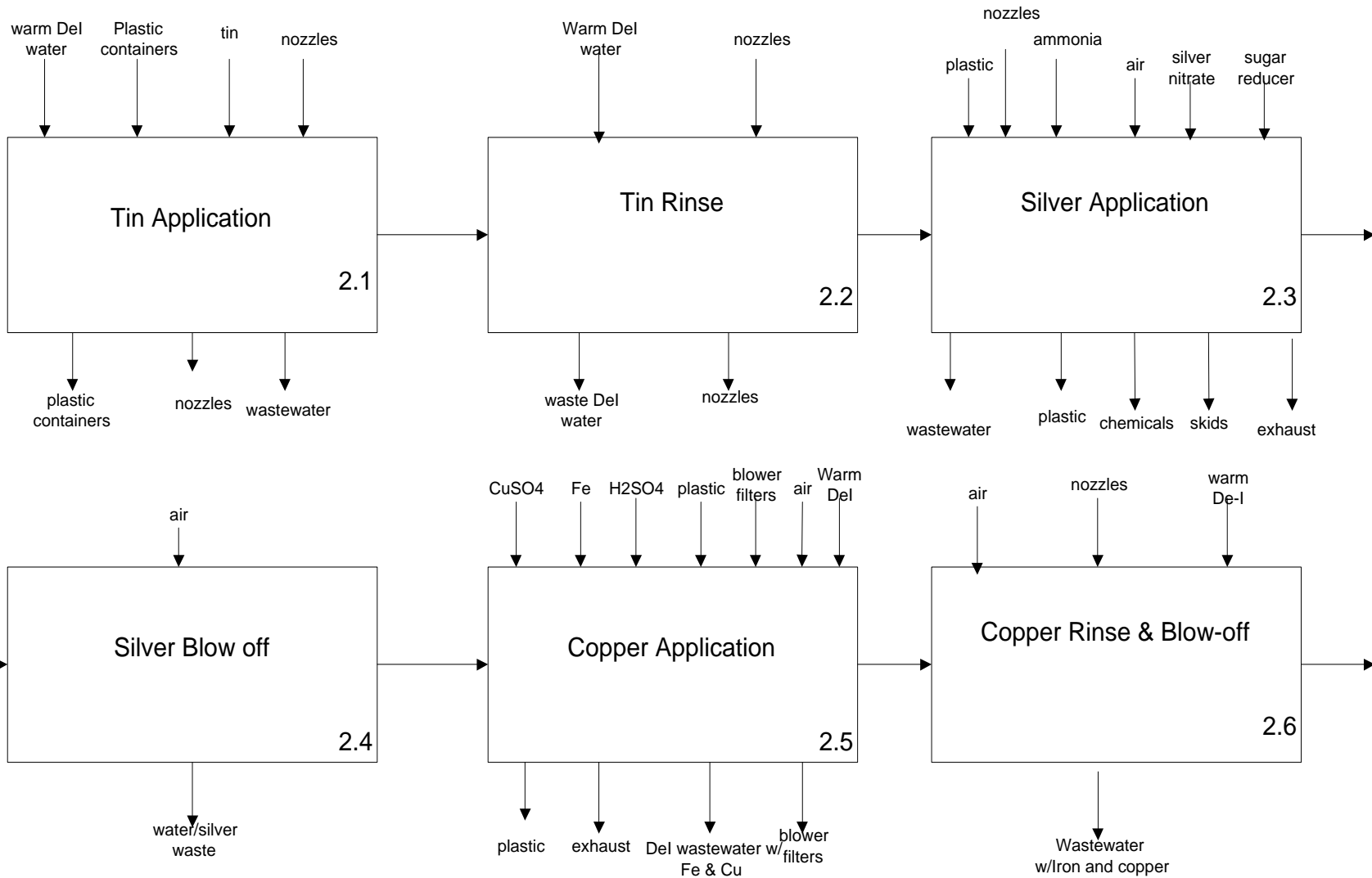
- » **Hierarchical process mapping** is a tool used to create a workflow diagram to “drill down” steps within a single process in a value stream
  
- » Uses a tiered approach that can:
  - Identify sources and root causes of waste
  - Uncover new waste-reduction opportunities
  - Identify and prioritize among potential Lean improvement projects

# Hierarchical Process Mapping: Drilling Down from VSM



- » Breaks VSM process boxes into specific process steps
- » Helps Lean teams see how the current process works and locate waste

# Plating Line Process Map



## 2. Questions to Identify Lean & Environment Opportunities

- » Asking the right questions in Lean events can uncover hidden waste-reduction opportunities and costs
  - Chemicals that could harm human health and/or the environment
  - Water and energy utilities
  - Compliance support infrastructure that may be hidden in facility overhead





# Sample Questions to Identify Lean and Environment Opportunities

## » **Energy**

- How much energy is used in the process?
- How can you reduce overall energy use?

## » **Chemicals and Materials**

- Can you switch to less harmful chemicals?

## » **Hazardous Waste**

- What types of hazardous wastes are generated?
- How can you reduce hazardous wastes?

## » **Air Emissions**

- How can you reduce air emissions?



# Reflections on Kaizen Event Tools

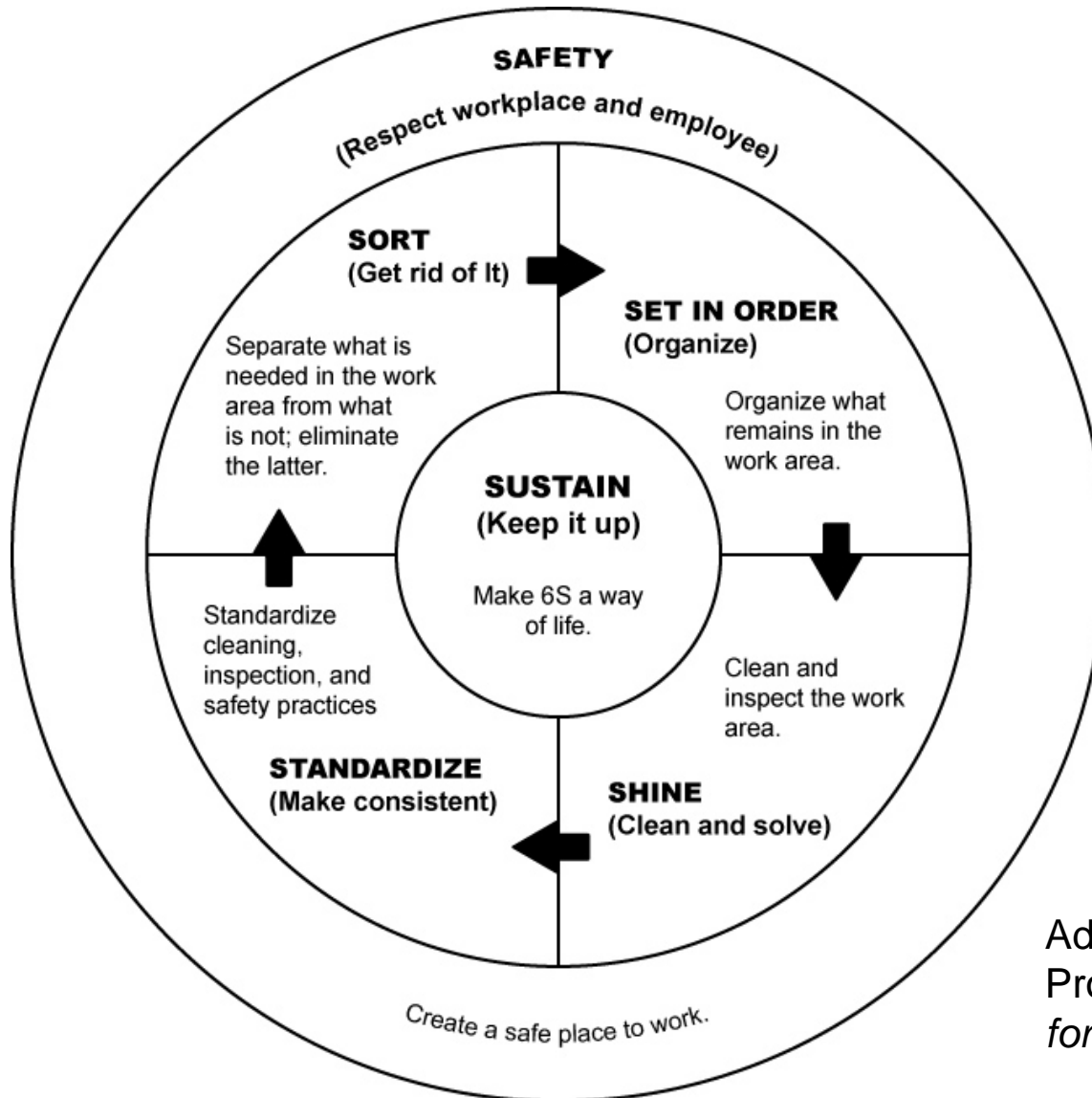
- » What questions do you have about strategies and tools for integrating EHS issues into kaizen events?
- » What experiences have you had with combining or integrating Lean and P2/EMS process mapping?
- » What other ideas do you have for improving environmental performance using kaizen events?



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# The Six Pillars of 6S (5S + Safety)



Adapted from  
Productivity Press, *5S  
for Operators*, 1996.



# Why Should EHS Be an Integral Part of 6S?

- » Avoid productivity losses from injuries and health hazards by providing clean, accident-free work areas
- » Meet or exceed your company's environmental performance and waste reduction goals



# Tools for Incorporating EHS into 6S

1. “Yellow-Tagging Items” with EHS Issues
2. 6S Inspection and Audit Checklists
3. Visual Controls to Reinforce EHS Procedures

# The First Step in 6S: Red Tagging (Sort Pillar)

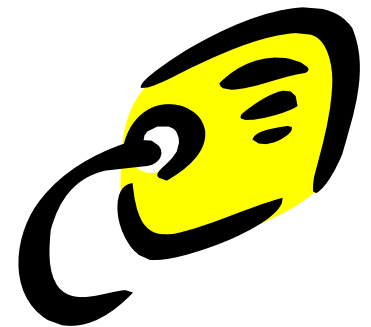


An Example  
Red-Tag  
Holding Area

# 1. Use Yellow Tagging to Identify EHS Issues During the Sort Process

## » *Supplement Red Tagging with Yellow Tagging*

- Identify environmental wastes and hazards
- Evaluate the need for these items
- Evaluate potential alternatives for these items
- Address them appropriately



# Example Yellow Tag

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

## 2. 6S Inspection and Audit Checklists

- » Expand 6S inspections of the Shine pillar to include EHS issues
- » Expand 6S audits performed as part of the Sustain pillar to include EHS issues





## Example 6S Inspection and Audit Questions for Eliminating Environmental Waste and Risk

- » **Sort:** Are red-tag items being disposed of properly?
- » **Set in Order:** Are containers with chemicals or wastes covered or sealed when not in use?
- » **Shine:** Are there any leaks from equipment, piping, tanks, exhaust lines, or other areas?
- » **Safety:** Are lockout and emergency procedures posted and easily accessible?
- » **Standardize:** Are relevant EHS procedures for the work area integrated into standard work?
- » **Sustain:** Are workers in the area aware of chemical hazards associated with standard work tasks?

# Detailed 6S Audit Checklist

Document Title:  6S AUDIT RECORD (SAFETY)	Document No.
Revision No.	Page: 1 of: 4
Required by:	

Audit Type:  Initial Certification  
 Sustaining

Auditors: \_\_\_\_\_ Date: \_\_\_\_\_  
 Name: \_\_\_\_\_ Name: \_\_\_\_\_  
 Name: \_\_\_\_\_  
 Workplace Representatives: \_\_\_\_\_  
 Name: \_\_\_\_\_ Name: \_\_\_\_\_

Subject	Questions	Yes	No
<b>1. Aisles</b>	<b>A.</b> Are aisles marked? 29 CFR 1910.22(b)(2)		
	<b>B.</b> Are aisle widths maintained? 29 CFR 1910.22(b)(1)		
	<b>C.</b> Are aisles in good condition? 29 CFR 1910.22(b)(1)		
	<b>D.</b> Are aisles and passageways properly illuminated?		
	<b>E.</b> Are aisles kept clean and free of obstruction? 29 CFR 1910.22(b)(1)		
	<b>F.</b> Are fire aisles, access stairways, and fire equipment kept clear? 29 CFR 1910.178(m)(14)		
	<b>G.</b> Is there a safe clearance for equipment through aisles and doorways? 29 CFR 1910.176(a)		

See the full example checklist: <http://www.epa.gov/lean/toolkit/app-e.htm>

### 3. 6S in the Work Area – Using Visual Controls to Reinforce EHS Procedures





# Reflections on Integrating EHS and 6S

- » What questions do you have about strategies and tools for incorporating EHS concerns into 6S?
- » What experiences have you or your organization had with integrating EHS and 6S?
- » What other ideas do you have for improving environmental performance using 6S?

# Connecting Lean and Environment at Different Levels in an Organization





# Getting Started with Lean and Environment

1. Understand the “business case” for connecting Lean and environment
2. Begin dialogue between Lean and EHS managers
3. Cross-train Lean and EHS leaders
4. Pilot test Lean and environment integration techniques
5. Expand and fully integrate Lean and environment improvement efforts

# Thank you...

- » EPA Sector Strategies Program

[www.epa.gov/sectors](http://www.epa.gov/sectors)



- » EPA Lean & Environment Initiative

[www.epa.gov/lean](http://www.epa.gov/lean)



- » Jennifer Tice, Ross & Associates  
Environmental Consulting, Ltd.

[www.ross-assoc.com](http://www.ross-assoc.com)





# Lean and Environment Tools Reference Slides

# Key to Symbols on Current State VSM

<b>Milling</b>
2 people
C/T = 2 min C/O = 2 hr Uptime = 74%

Production process (with data box)

C/T

Cycle time

C/O

Changeover time



Inventory



Truck shipment



External sources (suppliers, customers, etc.)

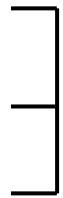


Electronic Information flow



Movement of production material

# Future State VSM Symbols



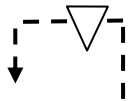
Supermarket (a controlled inventory of parts)



Withdrawal (pull of materials, usually from a supermarket)



Production Kanban (card or device that signals to a process how many of what to produce)



Signal Kanban (shows when a batch of parts is needed)



Kaizen Starburst (identifies improvement needs)

# 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)

<b>Material/Chemical Use and Storage</b>			
<i>As a result of the Lean event, will there be:</i>	<b>Unk</b>	<b>Yes</b>	<b>No</b>
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?			
<b>Waste Management</b>			
<i>As a result of the Lean event, will there be:</i>	<b>Unk</b>	<b>Yes</b>	<b>No</b>
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?			