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Lean Six Sigma for Environment, Health and Safety (EHS) Managers

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ABSTRACT

Lean Six Sigma is a powerful business improvement system that is rapidly being deployed across several manufacturing and service sectors. This paper introduces environmental professionals—including environmental health and safety (EHS) managers, environmental agency personnel, and non-governmental environmental technical assistance providers—to these methods. This paper also evaluates how Lean Six Sigma can be related to the environment and provides guidance on how environmental professionals can leverage Lean Six Sigma activities to generate better environmental and operational results. The challenge, and opportunity, for environmental professionals is to figure out how to leverage Lean Six Sigma improvement efforts in a seamless way that embeds environmental considerations and sustainability concepts into the normal way of doing business. This paper is designed to assist environmental professionals in meeting Lean Six Sigma practitioners where they are; help them translate environmental concepts into the Lean Six Sigma lexicon; and make environmental improvement efforts a seamless, integrated aspect of delivering waste-free value to meet customers' needs.

Introduction

For environmental professionals, the fundamental value of integrating Lean and environment efforts is to get more environmental results faster. Four compelling reasons support the business case for Lean Six Sigma and environment.

I. **Fast and Dramatic Results:** Lean Six Sigma produces change and results fast. Kaizen rapid improvement events identify waste and implement solutions in less than a week. When environmental issues are integrated into Lean Six Sigma activities, companies have seen quick and compelling environmental results. Without proper attention, however, Lean Six Sigma's focus on immediate implementation can sometimes conflict with permitting requirements for environmentally sensitive processes. This is an important reason for environmental professionals to be involved.

II. **Continual Improvement Culture:** Lean Six Sigma tools—such as value stream mapping (VSM), kaizen events, 5S, standard work, visual controls, and total productive maintenance—engage personnel throughout an organization in identifying and eliminating Lean wastes. Leveraging these tools can make environmental professionals' jobs easier, reinforcing roles and responsibilities and breathing life into EMS implementation. The more eyes and ears there are seeing environmental wastes and improvement opportunities, the more progress can be made.

III. **Avoided Lean Six Sigma Pitfalls:** While Lean Six Sigma (without intervention by environmental professionals) can produce powerful environmental improvement results on its coattails, the rapid changes can also create environmental and regulatory compliance headaches. Lean Six Sigma and environment integration can help ensure adverse environmental impacts are avoided and navigate regulatory and permitting issues that may arise during Lean Six Sigma driven changes.

IV. **New Market for Environmental Improvement Ideas:** Lean Six Sigma practitioners are an important new audience for environmental improvement ideas and tools. By connecting with Lean Six Sigma practitioners, environmental professionals can connect the wealth of environmental improvement ideas and tools with those who are driving strategic and operational change within many organizations.

Why EHS managers need to coordinate Lean Six Sigma & Environment management activities?

EHS managers need to co-ordinate Lean Six Sigma and environmental activities mainly for the following key reasons

1. EHS Team's involvement in lean implementation can proactively identify and eliminate environmental wastes. Environmental wastes can be defined as raw materials, energy or water consumed in excess of what is needed to meet customer requirement. Pollutants and material wastes released into the environment, such as air emissions, wastewater discharges, hazardous wastes and solid wastes. Hazardous substances also affect human health and pollute environment during their use in production or their mere presence in products. Like other Lean wastes, environmental wastes do not add customer value. They also incur costs to the company.
2. Proactive identification and elimination of environmental wastes might subsequently reduce the need for non-value added activities such as regulatory compliance management and reduce the investment in pollution control devices, waste/effluent treatment plants etc., EHS team can significantly reduce scrap, air Emissions, materials usage, solid waste generated, hazardous materials usage, hazardous waste generation, energy usage and wastewater discharge
3. EHS managers should assist Lean Six Sigma implementation by anticipating and addressing environmental constraints such as the need to obtain and renew permits, consents like consent to

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establish (CTE) [7], consent to operate (CTO) [7] under Air Act (1981) [7], Water Act (1974) [7]and Environment Protection Act (1986) [7] and by identifying environmentally friendly process alternatives.

4. Organization can achieve competitive advantage by providing customers with "Environment-Friendly" products or services with less environmental impacts.

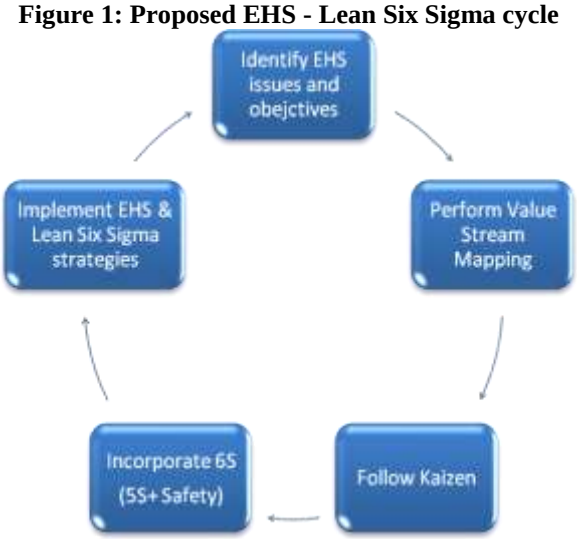
5. Occupational Safety can be guaranteed by improving the work environment for employees.

EHS - Lean Six Sigma Cycle

Major steps in EHS - Lean Six Sigma Cycle are

1) Identifying EHS issues and Objectives
2) Performing Value Stream Mapping
3) Following Kaizen
4) Incorporating 6S (5S+ Safety)
5) Implementing EHS and Lean Six Sigma strategies

Figure 1: Proposed EHS - Lean Six Sigma cycle



Identifying EHS issues and Objectives

Identification of EHS issues and objectives is the first step in EHS Lean Six Sigma cycle.

EHS interpretation of 7 lean wastes are discussed below

Performing Value Stream Mapping

Value stream mapping is a Lean Six Sigma process-mapping tool for understanding the sequence of activities and information flows used to produce a product or deliver a service. Conventional value stream mapping can overlook three types of environmental considerations:

1) Raw materials used in products and processes;
2) Pollution and other environmental wastes in the value stream; and
3) Flows of information to environmental regulatory agencies.

There are at least five ways to explicitly address pollution and natural resource wastes using value stream mapping:

1. Use icons to identify processes with EHS opportunities in value stream maps, and involve EHS staff in planning Lean events on those processes.
2. Record environmental performance data for processes in value stream maps, and consider these data in developing a vision for the future state. (Figure 2)
3. Analyze materials used by each process versus materials actually needed for the product, and summarize this information in a "materials line" below the timeline on value stream maps. (Figure 3 & Figure 4)
4. Expand the application of value stream mapping to natural resource flows such as energy and water use, by including additional information on materials use, waste streams, and regulatory information flows in the maps. (Figure 5)
5. Consider Lean and environment questions, as well as environmental data included in the current state map, when developing the future state map. (Figure 6)

EHS professionals can help to:

✓ Collect environmental performance data for processes in the value stream;

✓ Identify processes with environmental opportunities in value stream maps;

✓ Make sure that changes to those processes are managed safely and effectively through Lean implementation.

Figure 2: Current Value stream map with environmental data for EHS improvement[5]

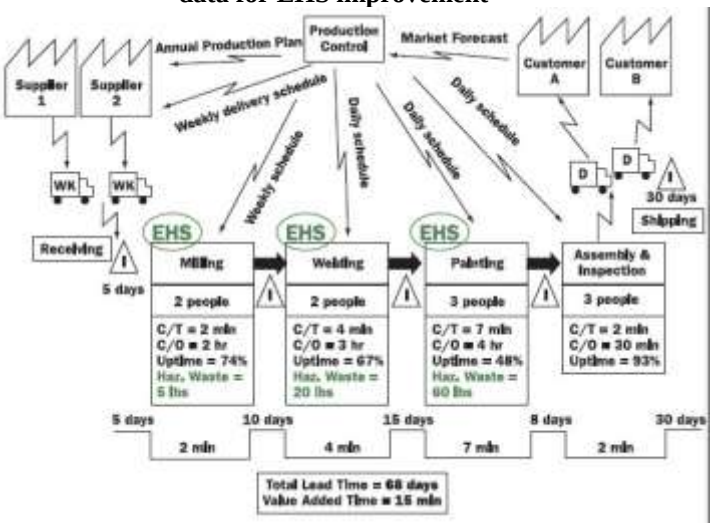


Figure 3: Example "Materials Line" Showing Materials Use versus Need[5]

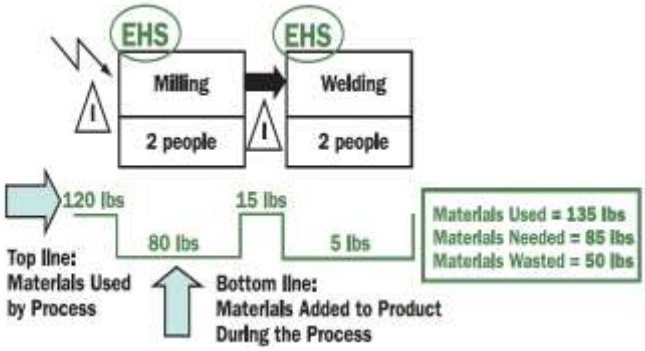


Figure 4: Current Value stream map with Materials Line[5]

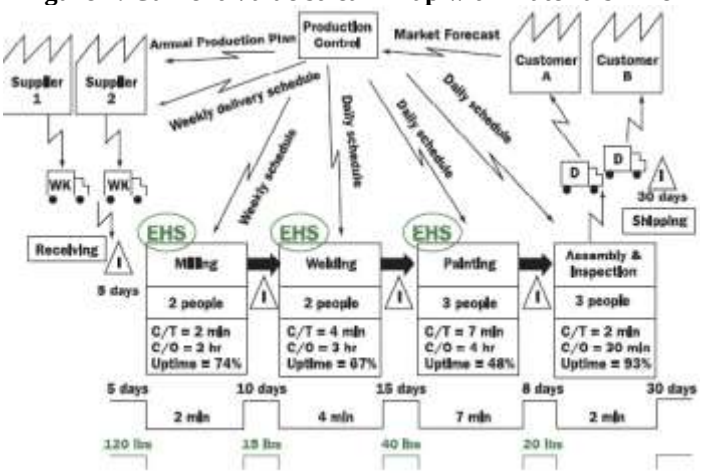


Figure 5: Value stream map with water usage for EHS improvement (Current State) [5]

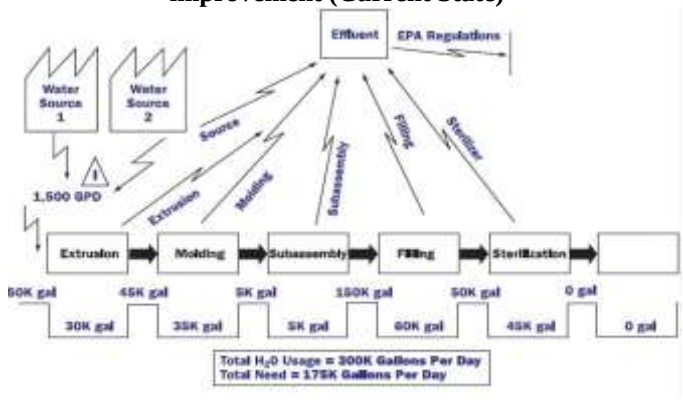
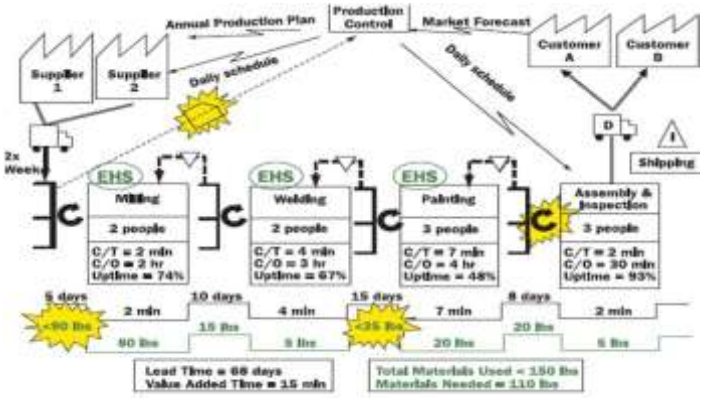


Figure 6: Future State Value Stream Map with EHS Icons and a Materials Line[5]



Following Kaizen

Kaizen events are team-based activities designed to eliminate waste and make rapid changes in the workplace through the targeted use of Lean methods. If not properly managed, the operational changes made through kaizen events could harm the health and safety of workers or result in violations of regulatory compliance requirements.

To prevent these problems, it is important to establish an effective EHS change management system for Lean events. This can involve four steps:

1)Train kaizen event team leaders to identify operational changes that may trigger EHS involvement. These include changes that affect chemical exposure, compliance with regulations and permits, pollution control management capacity, and work practice requirements.

2)Identify a responsive EHS contact that Lean managers and kaizen team leaders can contact with EHS questions and needs.

3) Fill out a Lean Event EHS Checklist for each Lean event. This simple tool identifies operational changes planned during a kaizen event that may warrant the involvement of EHS expertise.

4)Involve EHS representatives in Lean events early on to anticipate and address potential EHS compliance issues and avoid risks to workers.

Tools to support the planning and implementation of kaizen events include:

• Questions to identify Lean-environment opportunities in kaizen events;

• Hierarchical process mapping, which can drill down from value stream maps to uncover specific sources of waste within a single process; and

• Process-specific pollution prevention resources to improve business results and cause less harm to human health and the environment.

Incorporating 6S (5S + Safety)

6S is modeled after the 5S system designed to reduce waste and optimize productivity through maintaining a clean, orderly workplace and using visual cues to achieve more consistent operational results. 6S uses the 5S pillars with an additional pillar for safety. The six pillars of 6S are:

1. Sort (Arrange);
2. Straighten (Organize);
3. Sweep (Clean and solve);
4. Safety (Respect workplace and employee);
5. Standardize (Make it consistent); and
6. Sustain (Keep it up).

The pillars work together to increase productivity, reduce defects, make accidents less likely, save time, and reduce costs. When expanded to include EHS issues, they can also help reduce hazards and improve environmental performance.

The following four steps provide an example of how EHS issues can be identified and addressed through 6S using yellow tags along with red tags in the Sort process. The objective of this strategy is to identify environmental wastes in the work area with a yellow tag, evaluate their need and potential alternatives, and address them accordingly.

1. Identify yellow-tag targets such as EHS hazards, chemicals and other hazardous materials, and environmental wastes. Also, agree on criteria for evaluating yellow-tagged items.
2. Make and attach yellow tags to identified items and include data to allow for evaluation of performance improvements.
3. Evaluate and address yellow-tagged items.
4. Document results.

By explicitly incorporating EHS issues into all six pillars during 6S inspections, we can eliminate more waste and risk. Inspection checklists and audit questions are powerful tools to sustain 6S improvements and to prompt identification of new improvement opportunities.

Implementing EHS and Lean Six Sigma Strategies

Implementation of the above Lean Six Sigma techniques for enhancing EHS performance can be done in below 4 steps

1. Begin the Dialogue
2. Cross-Train Lean and EHS Leaders
3. Test and Pilot Lean and EHS Integration Techniques
4. Scale-Up Lean and Environment Integration

Begin the Dialogue

If an organization has dedicated personnel who are responsible for Lean Six Sigma implementation and for environmental, health and safety management, it is suggested to organize a meeting. Even a brief discussion can open the door for identifying shared interests and opportunities for collaboration. Discuss a plan for building a relationship between Lean Six Sigma and EHS improvement efforts over time. Set a tone for collaboration—having Lean Six Sigma and EHS managers working together typically enhances the results of both Lean Six Sigma and Environmental initiatives.

Cross-Train Lean and EHS Leaders

Taking a few steps to understand each other's language can go a long way. Invite EHS personnel to participate in Lean Six Sigma trainings and organize events to introduce them to Lean Six Sigma principles and techniques. Periodic meetings between EHS managers and Lean champions or value stream managers can help those involved in Lean efforts better understand when and where to seek EHS technical assistance and how to identify

environmental wastes. Mentioning environmental wastes in Lean training presentations is another good initial step.

Test and Pilot Lean and EHS Integration Techniques

Experiment with one or more of Lean and EHS integration strategies & tools and test one or two tools in a single event or area of the plant. Evaluate how well they worked. Adapt them to fit into the organizational systems and culture. Move on to experiment with other tools.

Scale-Up Lean and Environment Integration

After testing and piloting various techniques for improving Lean Six Sigma and environmental results, adapt and use the techniques throughout the organization. Consider applying Lean Six Sigma methods to improve the performance of EHS functions, ranging from regulatory compliance management and reporting systems to chemical and waste management processes. Explore opportunities to incorporate environmental considerations into Lean Six Sigma process and product design activities. Convene Lean and EHS leaders to discuss other potential areas of collaboration for improving organization results and competitive advantage.-

Cases of EHS- Lean Six Sigma Integration

Below are the cases of environmental benefits that had resulted from EHS-Lean Six Sigma integration.

Apollo Hardwoods Company[3]

• Uses fewer trees and less energy to produce the same amount of product

• Designed equipment that can use smaller pieces of wood, which reduces wood scrap and alleviates the need to harvest large-diameter, mature black cherry tree

Baxter Healthcare Corporation[3]

• Over a three-day event, an interdepartmental team developed value stream maps (VSM) that detailed the plant's use of water and identified processes with potential for improvement

• Using the VSMs, the team developed an implementation plan that will save 170,000 gallons of water *per day* and over $17,000 over three months, with little or no capital investment

The Boeing Company[3]

Boeing Everett

• Realized resource productivity improvements of 30-70 percent from lean initiatives

• Eliminated the use of 350 cubic feet of cardboard and bubble wrap packing material per 747 wing panel set

• Reduced chemical usage per airplane by 11.6 percent

Boeing Auburn

• Defects have been reduced from 1,200/10,000 in 1996 to fewer than 300/10,000 presently

• Reduced floor space by 200,000 square feet

Canyon Creek Cabinet Company[3]

• Expect savings of almost $1.5million annually from process changes

• Process improvements included reduction in lead time, work-in-progress, defects, overproduction, downtime, operator travel time, and material loss and damage

• Decreased VOCs which will reduce permitting requirements

Columbia Paint & Coatings[3]

Environmental savings included:

• Reduction of 15,000 lbs of paint solids from wash water

• Saved 18,000 lbs of shrink wrap

• Removed 2,820 lbs of hazardous materials from the waste stream

DuBois-Johnson Diversey and Steelcase[3]

Lean practices resulted in:

• Energy savings of a 60 percent reduction in the BTUs required

• Reduction in water usage by 80 percent

• Waste stream was cut by 85 to 95 percent

General Electric[3]

Peebles, Ohio Facility

General Electric's jet engine facility in Peebles, Ohio has found ways to reduce its greenhouse gas emissions by implementing Lean methods, while also producing significant cost savings. Lean events contributed to the following successes at the facility:

• Reduced fuel consumption for GE90 engine testing from 20,000 gallons to 10,000 gallons.

• Produced 5,000 metric tons less of GHG emissions from the GE90 in 2007 compared to 2006.

• Achieved cost savings of $1,000,000 due to fuel use reduction.

• Reduced GHG emissions from the CFM testing cycle by 1,600 metric tons annually.

• Streamlined engine balancing process and troubleshooting techniques.

NBC & Universal Studios – The Treasure Hunt Model

NBC Universal, which is 80% owned by GE, is one of the world's leading entertainment companies and is involved in the development, production and marketing of various entertainment ventures throughout the world. Through the Treasure Hunt model, many savings were realized at Universal Studios Hollywood.

• Conducted well over 200 treasure hunts globally with a combined emissions reduction of over 250,000 metric tons of GHGs.

• Seen over $14 billion dollars in revenue from ecomagination products and services.

General Motors[3]

Saturn Kanban Implementation

• Saved 17 tons per year in air emissions

• Eliminated 258 tons per year of solid waste

• Reduced hazardous waste generation from 9.0 pounds per car in 1992 to 3.2 pounds per car in 1996

Fairfax Assembly Paint Booth Cleaning

• Reduced purge solvent used by 369 tons in the first year

Lean Supply Chain Development

• Eliminated 7 tons per year of volatile organic compound (VOC) emissions, hazardous wastes, and transportation-related impacts by working with suppliers to eliminate a painting process step

Goodrich Aerostructures[3]

Lean Chemical Management at California Facilities

• Eliminated four 5,000 gallon tanks containing methyl ethyl ketone, sulfuric acid, nitric acid, and trichloroethane

• Eliminated the potential for large scale spills and the need to address risk management planning requirements for these tanks.

JEA[3]

Process improvement efforts at JEA have produced the following overall results:

• Achieved a utility-wide cumulative cost savings of $579 million from Lean and Six Sigma initiatives.

• Avoided an impact of $95 million on the utility's 2010 budget from projects specifically focused on cost reduction.

• Saved an average of $950 per customer and avoided rate increases of $20 per month directly related to process improvement efforts.

• Completed over 580 projects since 2000.

Lasco Bathware[3]

Process improvements include:

Seven Lean Wastes	Environment Health Safety(EHS) Interpretation
1. Overproduction Manufacturing in excess quantities to current customer requirements	• Excess raw materials and energy consumed in making the unnecessary products • Excess products may spoil or become obsolete requiring disposal • Hazardous materials used results in extra emissions, waste disposal, worker exposure, etc
2. Inventory Excess raw material, work-in-process, or finished goods	• Need of more packaging to store work-in-progress (WIP) inventory • Waste from deterioration or damage to stored WIP • Additional raw materials needed to replace damaged WIP • Consumption of energy to heat, cool, and light inventory space
3. Defects Flaws in the WIP, final products, or services that do not meet customer's requirements	• Raw materials and energy consumed in making defective products • Defective components require recycling or disposal • Additional space required for rework and repair which increasing energy use for heating, cooling, and lighting
4. Transport Excess transport of raw materials, WIP or finished products	• Energy requirement for excess transport • Emissions from excess transport • More space required for WIP movement, increasing lighting, heating, and cooling demand and energy use • Excess packaging required to protect components during movement
5. Motion Human movements that are unnecessary	• Damage and spills during transport can be hazardous to workers • Transportation of hazardous materials requires special packaging to prevent risk during accidents. • Health and Safety of workers had to be guaranteed inside the workplace.
6. Over processing Process steps that are not required to produce the product	• Excess raw materials consumed per unit of production • Unnecessary processing increases waste discharge, energy usage and emissions
7. Waiting Time Delays associated with stock-outs, equipment downtime, and capacity bottlenecks. The time that is not directly related to a customer requirement	• Potential material spoilage or component damage producing waste • Wasted energy from heating, cooling, and lighting during production downtime

Reduced production bottlenecks and established cleaner and more organized work areas

• Decreased variability in spray operations

• Reduced energy use and FRP wastes

• Reassigned over 1,900 annual labor hours to other value-added activities

Lockheed Martin[3]

• Reduced hazardous waste resulting in cost savings due to the elimination of RCRA permit requirements

• Reduced facility size by 1/3 (a reduction 550,000 square feet)

• Reduced chemical storage capacity to 2% of it's original size

Plymouth Tube[3]

• At a facility in West Monroe, LA, Environmental, Health and Safety (EHS) and Production personnel were able to identify environmental wastes that presented opportunities for working with lean techniques to improve their processes.

• Their lean efforts reduced lubrication used at this facility by 1400 gallons, saving almost $4000 annually in lube costs and $1800 is recycling fees

• The team was able to completely eliminate a costly hazardous waste stream of ink by changing their printing process

Robins U.S. Air Force Base[3]

Waste Collection Process

• Used methods such as Value-Stream Mapping (VSM), standard work, and 6S to reduce the lead time to collect and haul away hazardous waste on schedule

"Point-of-Use" Distribution of Hazardous Materials

Through a series of rapid process improvement events, the environmental, safety, and occupational health (ESOH) staff at Robins AFB instituted point-ofuse (POU) cabinet systems for distributing "right-sized" quantities of hazardous materials/chemicals for use on the shop floor

3M[3]

• Lean Six Sigma has helped 3M reinvigorate its highly successful pollution prevention program by training more than 55,000 salaried employees since 2001 and involving them in improvement projects that often have environmental benefits

• Lean Six Sigma is a valuable tool that contributed to 3M exceeding its corporate Environmental Goals from 2000-2005, reducing volatile organic compound (VOC) emissions by 61 percent, Toxic Release Inventory releases by 64 percent, waste generation by 30 percent and energy use by 27 percent (when indexed to net sales)

Conclusion:

Lean Six Sigma is a powerful improvement method that is growing in significance to businesses. It improves environmental results by eliminating production "wastes" and variation. However, on its own, Lean Six Sigma can create environmental health and safety problems or overlook opportunities to address environmental wastes. Furthermore, Lean Six Sigma and environmental professionals often operate in "parallel universes," using different languages and involving different people, despite having synergistic goals and using some similar tools.

There are compelling benefits from linking Lean Six Sigma and EHS improvement efforts. Environmental health and safety professionals can leverage the continuous improvement culture fostered by Lean to improve environmental results and deliver greater business value. There are multiple successful models for integrating Lean Six Sigma and EHS improvement efforts. These include ways that organizations have linked Lean to environmental efforts at facilities, as well as partnerships between Lean and environmental technical assistance providers.

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