Safety & Lean

One manufacturer's lessons learned and best practices

By Matthew R. Hallowell, Anthony Veltri and Stephen Johnson

MANY SH&E SPECIALISTS are beginning to explore the lean concept. While lean production is quickly diffusing through multiple industries, many SH&E specialists are only now beginning to internalize the strategic intent of lean production (i.e., optimal production flow derived from effective and efficient use of resources) (Cua, McKane & Schroeder, 2001; Shah & Ward, 2003). This leaves them somewhat underprepared when their organizations transition from a traditional mass production strategy to a lean production strategy.

What potential SH&E issues are related to an organization's transition to lean production? Consider the lessons learned and best practices recorded by a heavy manufacturing firm that recently experienced a large-scale production transformation. This analysis focuses on the production site with strict attention to the strategies employed to ensure that the SH&E function remains concurrent with advancements in the production system.

This information contributes to SH&E knowledge in several ways. For specialists, it serves as a model for guiding decision making related to reengineering SH&E practices to be congruent with the strategic intent of lean production. This model allows SH&E specialists to make their reengineering practices more transparent to the lean production specialists, thus enhancing the efficacy of the overall transition. For lean production specialists, it offers a way to identify potential contributions of the SH&E function toward optimal production flow. The authors believe this is an underresearched linkage that deserves exploration.

Matthew R. Hallowell, Ph.D., *is an assistant professor in the Department of Civil, Environmental and Architectural Engineering at the University of Colorado. He holds a B.S. and an M.S. from Bucknell University and a Ph.D. in Civil Engineering from Oregon State University, with a major concentration in construction engineering and management, and a minor concentration in occupational safety and health. Hallowell is a professional member of ASSE's Colorado Chapter.*

Anthony Veltri, Ed.D., *is an associate professor in the College of Health and Human Sciences at Oregon State University. Veltri holds an Ed.D. from the University of West Virginia. He teaches courses in occupational safety and health management, designing for safety, emergency and disaster preparedness, and safety and health standards and laws. Veltri is a professional member of ASSE's Columbia-Willamette Chapter.*

Stephen Johnson, D.M., CSP, ARM, ALCM, *earned his D.M. from the University of Phoenix and is an adjunct professor at Eastern Washington University. He has more than 25 years' professional experience managing safety and risk in the heavy manufacturing, retail and insurance industries.*

Understanding Lean

Understanding how lean works—that is, learning to become lean—can be a challenge. Literature on the topic is saturated with lean-specific terminology, philosophy and rhetoric. Observations made by the authors and initial interviews with the case manufacturer indicate that this complex terminology often overwhelms SH&E professionals who seek to identify specific practices that characterize lean.

In other words, the strategic intent of lean is lost in the confusing terminology, philosophy and rhetoric. Although lean concepts can be complex from a systems or engineering perspective, developing congruence of the SH&E function requires that professionals possess at least a basic understanding of the essential practices which characterize lean production.

A review of the lean production literature reveals that the strategy was originally established by Toyota (Womack & Jones, 1990). Womack and Jones's landmark book characterized lean production as an innovative production strategy for improving reliability, versatility, productivity, quality, and for reducing rework and inventory.

Similarly, Dennis (2002) characterizes lean production as a system that uses minimal amounts of resources to produce a high volume of high-quality goods with maximum variety. The focus of the system is the optimization of production flow by eliminating waste throughout the entire production process. Shah and Ward (2003) explain that lean works "synergistically to create a streamlined, high-quality system that produces finished products at the pace of customer demand with little or no waste."

More recently, lean production has been characterized in industries such as construction and shipbuilding as a technique for eliminating waste by using a minimal amount of manpower, materials, machines and space while still meeting project schedule, quality and budget goals.

Many organizations, in multiple industries, have recognized improvements in business performance immediately following a transition to lean production. Results of empirical studies

show that when organizations shift from a traditional mass production strategy to lean production strategy, they achieve a reduction in inventory, rework and waste (Howell & Ballard, 1997; Womack & Jones, 1990; 1996).

The professional literature and the number of organizations shifting to lean production strategies are growing rapidly. An Internet search using the keyword phrase *lean production* indicates that lean production techniques are diffusing globally and through many industries. Industries such as aerospace, healthcare, construction, shipbuilding and textile manufacturing are implementing lean techniques and exploring additional applications (Chalice, 2007; Lean Aerospace Initiative, 2007; NSRP, 2007).

Based on the increase in industry-specific literature investigating the implementation of lean techniques, the authors hypothesize that the adoption of this innovation has transitioned from early adoption to rapid diffusion. Therefore, the authors believe that SH&E professionals have reached a critical period in which a new strategy and structure for transitioning safety into lean should be developed. This is necessary because such a transition typically involves changes in worker activities, tools, equipment and machinery, and site layout. Furthermore, senior-level executives typically desire a high level of congruency in operations to maximize efficiency and strengthen organizational culture.

The notion of understanding lean production within the context of the SH&E function is beginning to receive much needed attention in the professional safety literature (Manuele, 2007; Main, Taubitz & Wood, 2008). Manuele provides an overview of lean production, describes how safety professionals can contribute to the lean process, and presents and illustrates one company's lean design process. Main, et al. discuss the relationship between safety and lean with a focus on standards and controls. Despite recent efforts, evidence-based research providing guidance for transitioning SH&E practices with lean is absent.

Abstract: *Lean production is diffusing through multiple industries. Transition from traditional to lean production requires a redesign of production processes, worker activities and site layout, all of which can affect site safety and health. The experiences of a large manufacturing firm that recently transitioned to lean production are shared, with special attention to SH&E management opportunities and barriers associated with common lean production strategies.*

Lean Manufacturing Strategies

Lean terminology is complex, which has led to some misunderstanding. The following primer, while not a comprehensive description of lean manufacturing strategies, provides a simple introduction to the five salient strategies that characterize lean production—just-in-time inventory, transformation to a push-pull system, standardization, autonomation and production leveling. It is intended for SH&E professionals who have no background or training in lean.

Lean production has been characterized as a system that uses minimal amounts of resources to produce a high volume of high-quality goods with maximum variety. The focus of the system is the optimization of production flow by eliminating waste throughout the entire production process. From a safety standpoint, the objective is to ensure that management recognizes incidents as a component of a process's overall waste profile.

Table 1

Opportunities/Barriers to Effective Integration

Strategy	Opportunities	Potential barriers
Just-in-time (JIT) supply chain management	Delivery becomes standard and predictable allowing SH&E management efforts to be better-focused	Workers from diverse cultures are increasingly entering the workplace. SH&E professionals must regulate the behavior of these workers and interaction with the company (employees and worksite).
Standardization	Standardized procedures allow safe and healthful practices to become the expected practice (i.e., safety is the norm).	Reviewing all standard procedures may be unrealistic, especially if changes are seemingly inconsequential.
Autonomation	High-risk activities previously performed by humans can be performed by machines.	Creating machinery to replace human involvement may be extremely expensive. Therefore, it may be difficult to justify autonomation based solely on SH&E risk reduction.
Production leveling	Work becomes manageable and predictable because rushing and distraction decreases.	Production leveling does not typically require SH&E input and it is difficult to justify SH&E involvement.

Just-In-Time Supply Chain Management

Just-in-time (JIT) supply chain management involves receiving exactly the materials needed, at the time that they are needed, in the exact quantity needed. JIT requires the supplier to make more trips to a site, but it reduces inventory dramatically.

Transformation From a Push to a Pull System

Most facilities that operate in traditional mass production environments push their product through the production process. Such a system uses demand forecasts and a large amount of inventory when producing a product. Furthermore, in a push system, the product is completed before the product is needed, in hopes that a customer will purchase it in a reasonable timeline.

Alternatively, a pull system is customer driven, and the product moves through a system only when the customer has placed an order. In addition, a product is completed exactly when the customer desires, with the unique features desired.

Standardization

Standardization entails efforts to make work rules explicit, thereby minimizing and controlling variation in quality, cost and work in progress. Standardization forms the baseline for managing continuous improvement.

Specifically, standardization involves choosing a task, identifying the various methods of completing it, and selecting and repeating the best alternative. Choosing among alternatives requires one to first define the pace of customer demand (i.e., time), how the work is currently performed (i.e., current work sequence) and the inventory needed to perform the work (i.e., standard work in progress).

Autonomation

Autonomation involves separating the work of people from the work of a machine by adding human intelligence to the machine. This does not involve using artificial intelligence, rather it involves using machinery to replace high-risk, easily repeatable or inefficient work currently performed by humans. Autonomation improves a process by reducing the creation, transmission or acceptance of defects in a task by fixing abnormalities and by separating what humans do best from what machines do best. It should be noted that this technique is primarily used to reduce defects, not to eliminate the worker from the process.

Production Leveling

Production leveling starts by charting the quantity of product produced over time and determining the optimal rate. Steps are taken to standardize the process, evenly distribute the workload, and uniformly use material, labor and equipment. By leveling the rate, work becomes more predictable and inventory reduces as spikes in production rate are less likely.

SH&E specialists must understand the activities and processes associated with these lean strategies to ensure that the transition does not produce negative impacts on site safety.

Opportunities & Barriers

During an in-depth case study of a large manufacturing firm nearing the end of a 3-year transition to lean manufacturing, the researchers identified several opportunities for and barriers to effective SH&E management (Table 1). These barriers and opportunities were defined based on observations of the worksite and interviews with the manufacturer's lean transition team and SH&E professionals.

Evidence-Based Lessons Learned & Best Practices

To provide suggestions for overcoming the barriers and exploiting the opportunities for the successful transition of the SH&E function, the authors interviewed and observed work processes with SH&E professionals, lean professionals, executives, operations managers and trades workers employed by the case manufacturer.

JIT Supply Chain

When converting from traditional inventory systems with few, large shipments and significant inventory to JIT supply chain management, the case manufacturer experienced several challenges including differences in maturity of suppliers, a lack of cultural congruence and contractual constraints. Specific lessons learned and best practices are highlighted next.

Lessons Learned

SH&E issues associated with JIT supply chain management were largely associated with managing suppliers during their time on the case manufacturer's worksite. SH&E issues arose because of three factors.

1) Differences in maturity among material suppliers and subcontractors regarding their level of activity with respect to lean production, safety and health management, organizational culture, and climate-driven communication and integration issues during implementation.

2) Suppliers often had differing priorities for safety. Furthermore, assumptions, beliefs and organizational values linked to lean were not always shared or understood by subcontractors and suppliers.

3) Buyers of products, processes, technologies or services often negotiated contracts without provisions for lean and safety. When safety-related provisions were not contractual, it was difficult to ensure the desired safety state.

Best Practices

To counteract these challenges, the case manufacturer developed a set of best practices. First, firms must be willing to train, partner with, coach and counsel suppliers to improve safety performance. Second, SH&E professionals must look for more alignment and be more involved in vendor selection. Safety and health expectations must be clearly set for all suppliers and vendors, and methods must be established to ensure adherence. Effective techniques include reviewing supplier safety programs, reviewing specifications for safety provisions and conducting vendor orientations. Perhaps the most effective strategy, however, is to include SH&E provisions in contracts with suppliers.

Standardization

When creating standard processes, the manufacturer noted several unexpected SH&E issues. For example, safe work practices can become commonplace when work activities are well-structured and commonly implemented; however, once processes have been standardized, it is more difficult to implement safety interventions or alter work behaviors.

Lessons Learned

The manufacturer experienced a great deal of resistance to its standardization efforts. Some employees remained emotionally attached to local systems (the "not invented here" syndrome), which impeded consensus on the definition of best practices and their integration into standard processes. This strategy involves standardizing local processes to optimize the production system as a whole. Nevertheless, local organizations sometimes took strong stances to retain their processes.

To overcome this resistance, the company designed some flexibility into the standardization effort. It established specification-driven and performance-driven standards. Specification-driven efforts targeted hazards with catastrophic potential (e.g., electrical safety, lockout, confined spaces). Performance-driven standards were permitted for safety activities needing more local flexibility (e.g., safety meetings, select training, inspections).

Despite the resistance, standardization offered the greatest potential to improve site safety and integrate safety management techniques. By ensuring that safety policies and best practices were embedded, the need for additional safety policies became obsolete.

Best Practices

Flexibility in standards development was one best practice. In addition, to counteract resistance to change, the organization recognized the need to emphasize where current practices were not ideal from an SH&E standpoint. Two strategies led to increased acceptance of change.

1) Help employees and managers understand and accept the need for change by highlighting symptoms (e.g., uncontrolled hazards, inefficient processes) and demonstrating the degree to which current processes did not adequately safeguard employees. In other words, create a sense of dissatisfaction with the current situation to inspire employees to demand change.

In addition, these discussions promoted urgency, since it was easy to rank safety-related improvements below production, cost and schedule concerns. The company found that developing this sense of dissatisfaction and urgency created an atmosphere more receptive to implementing necessary safety measures. Solutions presented in the absence of this climate often resulted in delayed or even failed implementation.

2) Generate and present solutions through teams, workgroups and committees. This generated buy-in and ownership of the change. The more people felt they were involved in the solution, the more likely the solution was accepted and used. In fact, the firm identified several situations in which great ideas went unused simply because people affected by these ideas were not involved.

The case firm also found that involving workers in the standardization process increased buy-in and decreased resistance during implementation. When implementing this strategy, workers also helped identify and respond to hazards.

Autonomation

Autonomation involves drastic shifts in the work environment as some work activities are moved to specialized machines. This transition can produce significant SH&E issues if not managed effectively. While the need to improve productivity generally drives autonomation, SH&E professionals can serve a supporting role by reducing ergonomic and other risks associated with operating autonomated processes.

Lessons Learned

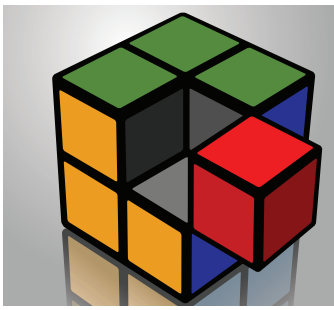
The firm stressed three lessons associated with safeguarding autonomation:

1) a need to identify and control hazardous exposures in the early phases of design;

2) difficulties and inefficiencies of teaching SH&E professionals engineering concepts;

3) the effectiveness of training engineers to recognize and control SH&E hazards.

These points were illustrated during the design of an automated stacking and retrieval system (ASRS). Engineers were taught not only to recognize major manual material handling hazards, but also to consider ergonomic factors essential to eliminating or controlling these hazards. As a result, the ASRS designed improved productivity and also reduced manual materials handling, exposure to moving machinery and powered industrial truck operations.



One effective strategy for incorporating safety and lean is to include SH&E provisions in contracts with suppliers.

Best Practices

Since the firm found it more effective to train engineers to recognize and control hazards, it was suggested that the SH&E function create programs to train engineers to recognize and control hazards associated with autonomation. In other words, SH&E should focus on educating engineering professionals about safety since engineering innovation is often ahead of the safety curve. The objective is to design safety into the process, not to design hazards out when discovered after implementation.

To accomplish this, the company recommended that the training focus on controlling exposures to hazards linked to autonomated work systems. This training should ensure that engineers:

- understand risks that workers may face (e.g., falls, manual materials handling, struck-by, exposure to harmful substances) when they enter an autonomated work space;
- recognize hazards associated with entry into autonomated work spaces;
- understand and apply appropriate control strategies to reduce risks associated with entry into autonomated work spaces;
- reduce ergonomic risks.

Production Leveling

Production leveling presents several opportunities to improve the system's safety performance. It involves the creation of a predictable, consistent work flow. According to the case manufacturer, however, it was the most difficult area to influence since these decisions are often influenced by customer demands and schedules.

Lessons Learned

Humans fatigue and deteriorate as work schedules increase. However, it is easy to expect human performance to remain constant, within narrow control limits. In essence, it becomes easy to innocently view humans as machinery. The case firm acknowledged difficulties in this arena, but suggested that managers and SH&E professionals must consciously recognize the variation in worker productivity and capability.

Production leveling can also create dilemmas encompassing prioritization, optimization and valuing of safety versus productivity. Managers and employees may feel they are acting in the company's best interest by taking shortcuts to increase production. The firm emphasized a need to shift the culture to a state where productivity is valued to the degree that shortcuts are unacceptable and that safety is always the primary value.

Best Practices

Organizational culture must value safety and make risk-taking and shortcuts unacceptable. Engineers, managers and all employees must accept the frailty and vulnerability of workers by ensuring that production demands do not exceed capabilities. This means that actions such as rests, breaks, conditioning and job rotation must be consciously designed while setting production-leveling expectations.

What It Means

These lessons and best practices are anecdotal and primarily represent the experiences of one firm. In addition, the lessons may seem obvious and the best practices may even be idealistic, especially for smaller firms wishing to integrate safety into lean manufacturing activities.

These prescriptions are not meant as a silver bullet. Rather, they represent the fruits of the tools associated with the implementation of lean manufacturing concepts. These tools are the leverage point for most SH&E professionals. These are areas where they can influence changes needed to properly address safety issues.

Integrating SH&E Into Lean Activities

A word of caution, as reflected by the case manufacturer, is appropriate at this point. This section addresses integrating safety into lean, not lean into safety. Certainly, many safety processes could be leaned, but the focus here is that safety must be integrated into the manufacturing process. This means that manufacturing demands (such as quality, cost and schedule) will drive the need to lean a process and, thereby, reduce waste. Rarely will a lean event be scheduled to address safety.

This means that SH&E professionals must be especially intuitive to the lean activities scheduled in their organizations. As a result, the first tool of integration involves relationship building—that is, building a close relationship with the organization's lean network to ensure that safety is recognized as an integral part of the waste-reduction strategy (injuries are waste). Spend time with the network to determine how safety can best be integrated into the traditional tools of lean.

Many tools and activities have evolved to help firms reduce waste and become lean. Historically, these tools were not designed to address safety, but instead were created to optimize production flow and reduce waste. Thus, from a safety standpoint, the objective is to recognize incidents as a component of a process's overall waste profile and to optimize waste reduction as a whole, not just in perspective to safety. Consequently, the tools described next are not described from a safety perspective. Rather, they are described in the framework of overall process improvement, an effort in which safety plays a large role in identifying and controlling incidents as safety-related waste.

Accelerated Improvement Workshop

An accelerated improvement workshop (AIW) is a rigorous, disciplined workshop designed to implement improvements rapidly. The workshop results in the elimination of waste for a defined process, immediate implementation of improvements, assurance that changes are sustained and improved efficiency of the work area. An AIW requires detailed planning and commitments by those who actually perform work where changes are being considered.

An AIW typically involves employees who directly perform the work, managers who directly

oversee that work, upper-level managers responsible for the operation and, when available, a consultant with experience in lean production. The workshop may last 1 day to 1 week.

During the workshop, autonomation is considered, JIT supply chain management is discussed, operations are standardized and, finally, production is leveled to match adjacent processes. Side benefits of an AIW include immediate improvements, increased communication among team members, integration of multiple disciplines and empowerment of line-level employees.

SH&E professionals should participate in the AIW, although this is rare. In fact, an AIW is the ideal venue for implementing the best practices described earlier. SH&E professionals must understand that the workshop relates to the process and predefined boundaries. Staying centered on the defined task helps generate acceptance of safety contributions in future events. Care must be taken to avoid introducing safety issues associated with peripheral arenas.

Value Stream Mapping

Like an AIW, value stream mapping (VSM) is a workshop for all affected workers, managers and support personnel. While an AIW is designed to rapidly implement a process, VSM is devoted to redesigning a process in order to add value during each step of the production process. Often, a VSM is followed by an AIW to rapidly implement the improved process.

During VSM exercises, participants diagram the material and information flows of the value stream of the products the organization provides. Then, participants examine the as-is process to identify opportunities to improve efficiency and value. During a VSM workshop, SH&E professionals can learn about the driving forces behind specific processes and identify the activities that workers must perform. This helps them better understand how safety decisions affect process efficiency and vice versa.

As with an AIW, SH&E professionals must recognize that the VSM workshop relates to the process and predefined boundaries and avoid introducing peripheral safety issues.

3P Workshop

A 3P workshop is also known as a production, preparation and process workshop. Like an AIW, all affected personnel are involved; however, unlike VSM and an AIW, its focus is the creation of an entirely new process. The objective is to develop effective and efficient processes by focusing on the transformation steps of a product to enhance production and reduce waste. Conducted correctly, such a workshop results in high-quality products, standard and reliable methods, and dramatic reductions in cost, inventory and lead time. Like a VSM workshop, a 3P workshop may be followed by an AIW for rapid implementation.

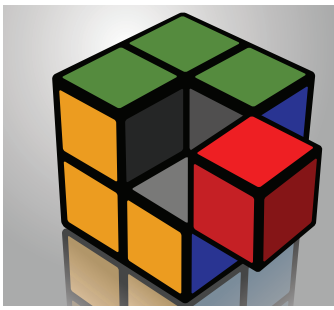
SH&E professionals must be involved in the upfront design of new processes so that hazardous conditions and unsafe work practices are considered. Otherwise, the organization will spend significant resources reacting to embedded hazards throughout the lifecycle of the process.

As noted, safety in itself is not a process; rather, it is a discipline focused on hazard recognition, evaluation and control. Therefore, these tools are rarely used solely to address a safety concern. Instead, it is more effective to allow production and process improvement to drive activities and to insert SH&E knowledge within that context. This is a critical lesson. SH&E professionals must participate as team members to target the reduction of accidents, injuries, incidents and property damage as components of waste.

Conclusion

In its purest form, lean manufacturing is simply the reduction of waste. In a production process, waste may include a measurable level of inefficiency. Incidents and other negative consequences of unsafe work environments are sources of waste and reduce the efficiency of production processes.

Therefore, SH&E professionals must strive to integrate with other organizational functions to minimize waste. This requires a close relationship with the lean manufacturing network. By implementing the best practices and tools described, the case manufacturer improved safety and health at the worksite, enhanced communication among disciplines and improved supplier relationships. ■



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