

You Cannot Get Lean Without Safety

Submitted to Professional Safety 30 June 2007

Bruce Main
design safety engineering, inc.

Michael Taubitz
The General Motors Corporation
Automotive Industry Action Group

Willard Wood
The Boeing Company

Introduction

In the ultra competitive business environment today, the concepts of lean manufacturing offer an opportunity to gain a competitive edge in production, services and other applications. In one company, a lean team set about changing its work area to cut out the sources of waste and improve productivity. Machines were moved, the 5S process was worked (a lean tool to be discussed shortly) and the resulting work cell demonstrated a significant improvement in cycle time and reduced waste. However, in their zeal to “lean out” the system, the team also “leaned out” safety. Guarding for the point of operation was removed to speed cycle times. When the safety director viewed the result, a culture clash ensued. Although the guarding was reinstalled, the safety director was forced into the role of the bad guy. Several weeks after the clash, the guards were found to be removed again. Worse, safety was “leaned out” of the lean process – safety personnel were perceived as inhibiting process improvements and the safety personnel began to be excluded from lean projects. Unfortunately this is not an isolated scenario.

Research of the technical literature reveals ample information on lean manufacturing concepts. Similarly, the literature on safety is rich in depth and breadth, much of it appearing in the proceedings and journal of ASSE. Yet a search that addresses both safety and lean concepts yields very little information. Lean and safety occupy different spaces in the technical literature.

Persons formally trained in the concepts of lean will respond that safety is an integral part of the 5S process and that to exclude safety concerns is inconsistent with lean concepts. The same can be said about persons formally trained in safety – their solutions to minimizing risk will appropriately address productivity concerns. But as lean gains momentum, people less well trained in lean and/or safety will attempt projects and the results can be less than ideal.

ANSI B11 TR7

To address this problem, a Task Group was formed in the machine tool community with the support of the B11 Accredited Standards Committee. The Task Group studied this problem and developed a technical report based on materials provided by the Boeing Company, Deere & Company, General Motors Corporation, the Liberty Mutual Group, and design safety engineering, inc. *ANSI B11 Technical Report 7: Designing for Safety and Lean Manufacturing (TR7)* is soon to be released by the B11 secretariat, the Association for Manufacturing

Technology (AMT). Although written by and primarily for the machine tool industry, the content can be applied to many other industries.

The Abstract to TR7 states:

Lean manufacturing includes a variety of initiatives, technologies and methods used to improve productivity (better and faster throughput) by reducing waste, costs and complexity from manufacturing processes. However, the effort to get lean has too frequently led to the misapplication of lean manufacturing principles in ways that result in significant risks to worker safety and to the goal of lean manufacturing. Safety is a critical element in the lean manufacturing effort to yield processes that are better, faster, less wasteful and safer. This document provides guidance for persons responsible for integrating safety into lean manufacturing efforts. This integration is only possible if lean manufacturing concepts and safety concerns of machinery are addressed concurrently. A brief overview of lean manufacturing concepts is presented. The challenge of concurrently addressing safety and lean is described and examples demonstrate situations where this has not occurred. A process model for safety and lean is presented. A risk assessment framework is outlined that demonstrates how lean manufacturing concepts and safety can be implemented concurrently. Examples where safety and lean have been successfully applied are shared. This document also provides design guidelines on how to meet lean objectives without compromising safety. This document does not provide detailed guidance on lean methodologies, the risk assessment process or how to reduce risk. Readers seeking detailed guidance on these topics should consult the references listed in clause 2, the B11 series of standards or other sources.

The table of contents of TR7 is shown in <Sidebar>.

A central premise to lean concepts is to minimize or eliminate waste from production systems, service operations or other business processes. The term lean refers to cutting the "fat" out of production processes. The Production System Design Laboratory at the Massachusetts Institute of Technology described lean as:

Production design that is aimed at the elimination of waste in every area, including customer relations, product design, supplier networks and factory management. Its goal is to incorporate less human effort, less inventory, less time to develop products, and less space to become highly responsive to customer demand, while producing top quality products in the most efficient and economical manner possible.

Safety must not be viewed as a separate activity that is a non-value added effort with objectives contrary to lean concepts. Elimination of waste can also be interpreted as the elimination or minimization of risk that adversely affects wasted human resources and lost time from injuries. Lean imperatives of faster, better, and cheaper must encompass the issue of running safer as well.

Lean focuses on minimizing waste in a system. Safety focuses on minimizing risk in a system. Optimizing for one or the other can lead to a sub-optimal solution for the overall system – lowest waste but with increased risk, or lowest risk with increased waste. Examples of each of these are all too common such as guards removed during operations (low waste, high risk), or excessive procedural safety check offs (high waste, low risk). Just about every experienced safety practitioner has seen machinery that includes guards that prevent necessary work from being done and which are subsequently defeated (a high waste / low risk situation that becomes high risk / low waste after the guard is removed). The focus of TR7 is to obtain an overall system optimum of lowest waste at lowest risk.

B11 TR7 presents a process flow chart of how safety and lean manufacturing concepts can be addressed concurrently. The process is shown in Figure 2 and discussed in detail in B11 TR7.

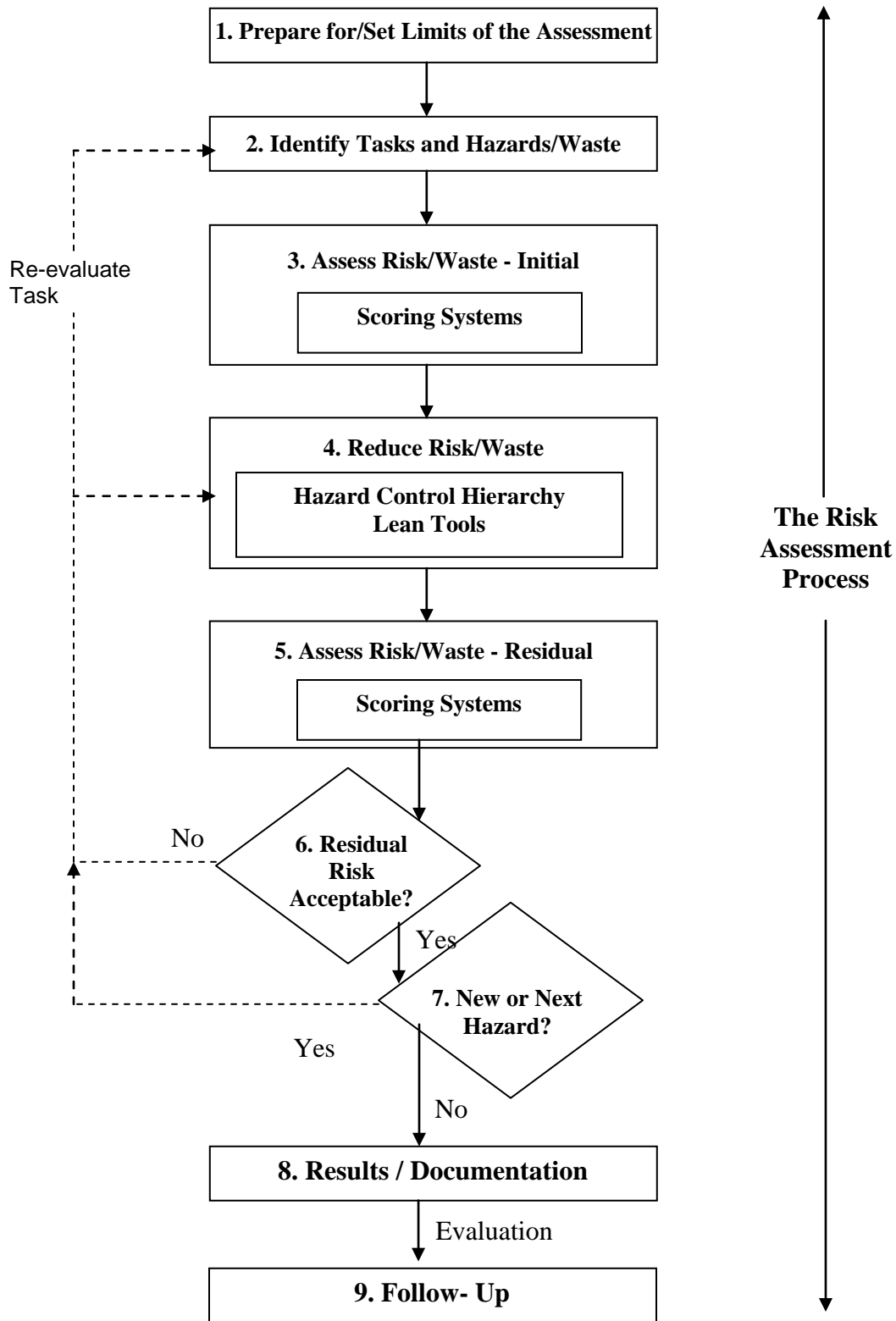


Figure 2 Safety and Lean ANSI B11 TR7-2007

TR7 includes several real world examples of situations where safety and lean have been successfully implemented, and where they have not. These examples ably demonstrate why safety and lean concepts need to be addressed concurrently rather than sequentially. The examples do not simply argue that safety needs to be considered and included, but present lean arguments why failure to include safety actually introduces waste to the system – contrary to the central tenant of lean manufacturing. For example, having to retrofit or add a guard removed during a kaizen workshop introduces the wastes of correction, waiting, excess motion and possibly other of the seven forms of waste. The results demonstrate non-value added cost and wasted time.

Although safety professionals and engineers are becoming familiar with risk assessment, many struggle to explain the actual tools or methods for achieving lean – particularly in the design stage of a project. Part of the reason is the complexity of “getting lean” coupled with the myriad of choices to approach the subject. An understanding of waste will provide a cornerstone to those who are challenged with integrating safety and lean in the design process.

Understanding Waste

The acknowledged global benchmark for lean production is Toyota. In 2005, Fujio Cho, then president of Toyota Motor Company commented:

Some people think that if they just implement our techniques, they can be as successful as we are. But those that try often fail. That's because no mere process can turn a poor performer into a star. Rather, you have to address employees' fundamental way of thinking. **At Toyota, we start with two questions: "Where are we wasting resources like time, people or material?" and "How can we be less wasteful?"**

Identifying waste begins with understanding the different forms of waste. It took Toyota close to 30 years to develop all aspects of their renowned Toyota Production System. The foundation for the system is understanding the seven forms of waste, first introduced by Taiichi Ohno:

- 1) Over-production
- 2) Waiting
- 3) Transporting
- 4) Over-Processing
- 5) Inventories
- 6) Moving
- 7) Defective Parts

An alternate presentation of these seven forms of waste can also be found. The following presentation is commonly referred to by the acronym COMMWIP which stems from the first letters of each source (an acrostic).

- | | | |
|------------------------------|---|----------------|
| 1) C orrection | } | COMMWIP |
| 2) O ver – production | | |
| 3) M otion | | |
| 4) M aterial Movement | | |
| 5) W aiting | | |
| 6) I nventory | | |
| 7) P rocess | | |

After identification of any of the seven forms a waste, it is necessary to have a repeatable method for eliminating waste. That process or method is known as 5S.

5S

5-S refers to the first letters of five words or phrases used to describe a repeatable process used to identify and eliminate all forms of waste. The five S's are Japanese terms, loosely translated as:

1. Sort – remove unneeded materials from the workplace, eliminate distractions and confusion;
2. Set-in-order (straighten) - make it easy to visually find things that are needed including parts, tools, information, etc.;
3. Shine – introduce a regular system for cleaning the work area, also focusing on inspecting the workplace for equipment needing preventive maintenance;
4. Standardize – establish methods to maintain cleanliness; and
5. Sustain (self-discipline) – implement methods to sustain the process, including continuous improvements.

Some 5-S programs add safety as a separate “S” and make it 6-S. Others consider safety to be an integral part of the 5-S process. This seems to be largely a matter of personal preference than substance. As long as safety concerns are addressed there is little difference as to which “S” they fall under.

One key point to clarify is the real purpose of 5S. Many consider 5S as the method to obtain neat, clean, well-organized work places. The real value of 5S as taught in kaizen workshops is the participant’s hands-on learning. While an organized, visually attractive workplace is a typical result, the real purpose of 5S is to inject a fundamental understanding of how to identify and eliminate waste.

Other Lean tools and methods

More and more companies of all kinds and sizes have introduced lean manufacturing into their operations using processes such as 5-S, Kanban, Kaizen, and Value Stream Mapping (VSM). While the primary goals may be to decrease waste, increase quality and reduce costs, the companies, their management and their employees also find benefits from improved safety.

Along the journey, a company will also decide if it needs a powerful quality tool like Six Sigma. For those who need statistical control of a product or business system, this widely recognized process is the path to world class. Six Sigma is powerful, but demands significant resources. Many smaller organizations and those who do not require statistical control use 5S and value stream mapping as the means to reach the low hanging fruit.

5S and Value Stream Mapping as foundations

5S integrated with VSM provides the core tools to unlock muda (waste) in business systems. 5S comes first because it teaches how to identify and eliminate waste. VSM is next in line because this tool forces hidden waste into the open where it becomes visible.

The most important VSM task is to map *actual* steps taken to accomplish the work. This will visibly display the hidden waste causing delays. It will also reveal that most time is not spent in actual work, but in waiting. This is particularly true with business systems.

The big challenge with business system waste is making it visible. System waste is often hard to detect, unlike the overstocked supply room where the waste of excess inventory is readily visible. Many business processes are hidden; they either do not formally exist or they are so incredibly complex (maybe even bizarre) that no one has taken time to map how things happen in the real world.

Lean and Safety

Lean manufacturing has exhibited significant successes in improving manufacturing efficiencies and productivity. Yet as lean concepts have gained attention in manufacturing, there have also been reports of these concepts being misapplied creating significant problems, particularly concerning safety. Safety and lean manufacturing should not be viewed as having conflicting goals. In fact, they share a very common goal of maximizing manufacturing throughput at the lowest risk and waste.

Lean and safety need to be considered concurrently rather than separately. In many cases a common optimum can be developed. The challenge to management is to foster a work environment where safety and lean are addressed concurrently to yield the best throughput at lowest risk and waste. For example, assume that a traditional risk assessment determines that an interlocked gate is sufficient as part of overall safeguarding to obtain acceptable risk for an integrated manufacturing system or cell. However, a concurrent analysis for lean may identify the waste of motion for employees to perform specific tasks at the far end of the cell. This concurrent analysis may show that the extra capital cost of an added interlocked gate provides better productivity and less waste - both lean and safety.

For the interested reader, B11 TR7 presents a process through which safety and lean concepts can be addressed concurrently. Without this type of process safety concerns can be omitted by some lean teams. If safety is perceived to be a detriment to the lean effort, it is very likely that the safety practitioner will not be invited to participate. B11 TR7 presents a process where manufacturers can achieve an optimum of the lowest waste at the lowest risk. This contrasts with approaches that can optimize waste or risk at the detriment of the other yielding a sub-optimal result.

Example – Storage Tank Access

Figure 3 shows the top of a storage tank that is approximately eight meters above the ground. On the left is an access port in which chemicals can be added. There is a fixed ladder to access that port. The task of adding chemicals to the tank can be performed safely and effectively, yet there is another task that occurs in this area.

As indicated in the figure, at the very apex of the tank is a sensor. From time to time that sensor needs to be adjusted or replaced. Although not visible in the photograph, there are footprints walking up to and from the sensor. There is no place to tie off for fall protection. There is no hand rail, no cat walk, nothing to prevent a fall or injury from a fall. Yet the task needs to be completed and someone must do the work. The additional cost to extend a walkway during the construction and erection of the ladder would have been trivial. The rework to provide safe access to this area now is not trivial and is waste. The time to perform the task with a catwalk in place is small. The additional time and increased risk of falling by walking out onto the tank are waste. You cannot get lean without safety.



Figure 3 Storage tank without safe means to access sensor

Example – Poor execution

Figure 4 highlights situations where safety methods represent waste due to poor execution. As highlighted by the caution tape, the fencing shown in the figure does not prevent a person from walking to the hazardous area. Thus the cost to purchase and install that portion of the fencing is waste of material, motion and waiting. This portion of the fencing is not reducing risk nor is it useful.

In certain respects it could be argued that this poor execution is creating risk and waste to the company. For example, assume a person were injured in the hazardous area behind this fencing and that they had gained access to the area by walking through this set up. The fact that the fencing was installed could demonstrate that the company was aware of the hazard and that it knew it needed to prevent workers from accessing the area. It might also be argued that the poor installation of the fencing failed to prevent such access and perhaps invited access.

This installation created waste due to poor execution. It also potentially exposes workers to safety risks and by virtue of the poor installation may create additional liability risks to the company. Correcting the poor execution creates further waste.



Figure 4 Poor execution creates waste and potential liability

Example – Inadequate Access

Figure 5 highlights an example where risk has been designed into the system, resulting in waste. The figure shows an impellor installed at the top of an 8 meter open tank. From time to time the impellor motor and/or blades will need servicing. As installed, there is no method to access this area, nothing to tie fall protection to, no gate and no catwalk. Performing the work will require creating a make-shift work platform, climbing over the existing hand rail. There is considerable waste in terms of motion, material movement, and waiting. There is also considerable risk.



Figure 5 Motor and impellor without access

Conclusion

To be on the forefront of machine safeguarding and to help U.S. manufacturers avoid risk and reduce the cost of risk, manufacturers need to recognize the degree to which lean methodologies are driving change. Change can have the net effect of increasing risk or reducing risk. Seldom does change on the plant floor or even in a service industry have zero net effect on risk.

The policy and intent of most lean programs is that lean efforts will include and support strong safety performance, but it would be a mistake for any company to fail to recognize that its lean efforts can and will sometimes be implemented in ways that fail to adequately consider safety.

The concepts of lean manufacturing are very powerful. Properly applied, companies can obtain great improvements in the way they do business from lean manufacturing. Yet misapplied, safety concerns can be ignored or overlooked resulting in sub-optimal performance or results and considerably increased risks to personnel and the organization.

Efforts to become lean by eliminating waste can be derailed if safety is not properly considered. If not handled properly, waste can easily be inadvertently introduced into systems when unacceptable risk results that require correction. You just cannot get lean without safety.

References

- ANSI B11 Technical Report 7-2007: Designing for Safety and Lean Manufacturing* The Association for Manufacturing Technology (AMT).
Cho, Fujio (2005), as quoted in *Business 2.0*, Jan / Feb.
Main, B.W. (2004) *Risk Assessment: Basics and Benchmarks*, design safety engineering, inc., Ann Arbor, MI.

Copies of ANSI B11 TR#7 can be obtained from The Association of Manufacturing Technology (AMT) at (703) 893-2900 or www.amtonline.org

Author Biographies

Bruce Main, PE, CSP is president of design safety engineering, inc., the chair of ANSI B11 TR7, and the ASSE representative to the B11 Accredited Standards Committee.

Mike Taubitz is the General Motors Corporation representative to the Automotive Industry Action Group and to the B11 Accredited Standards Committee

Will Wood, ARM is a safety administrator and acting safety and health manager for The Boeing Company's Auburn, WA facility and represents the Aerospace Industries Association on the B11 Accredited Standards Committee.

SIDEBAR

Contents of TR7

Introduction

1 Scope

2 References

3 Definitions

4 Overview of Lean Concepts

5 Challenges and Examples

6 Safety and Lean Solutions

7 Overview of the Risk Assessment Process

8 Examples of Safety and Lean Successes

9 Guidelines for Safety and Lean Design

10 Summary

Annex A Detailed Risk Assessment of Deburring Process

Annex B Guidelines for Planning

Annex C Guidelines for Process Design

Annex D Guidelines for Planning the Layout

Annex E Guidelines for Tool and Equipment Design

Annex F Guidelines for Workplace Handling Equipment