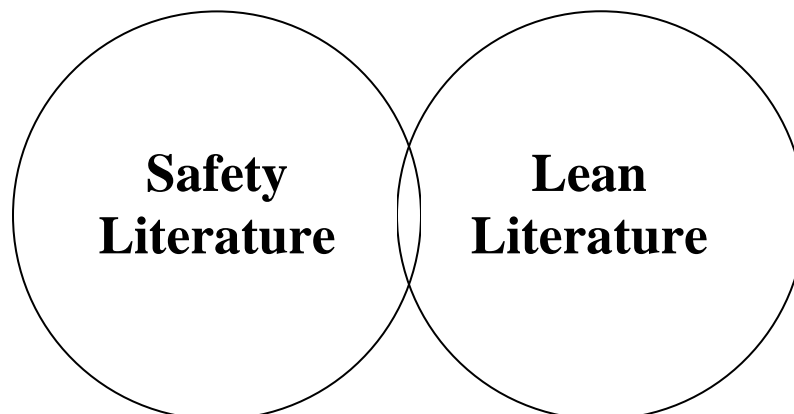


## **Integrating Safety and Lean Manufacturing**

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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 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.

A 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 pages of this journal. Yet as illustrated in Figure 1, a search that addresses both safety and lean concepts yields very little information. 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.



**Figure 1 The Limited Overlapping Space in the Technical Literature**

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* is soon to be released by the B11 secretariat, the Association for Manufacturing Technology (AMT). The content of the report is described in its Abstract and shown in the Table of Contents (see sidebar):

Lean manufacturing includes a variety of initiatives, technologies and methods used to reduce waste, costs and complexity from manufacturing processes. The intent of applying lean concepts is to achieve better and faster throughput at less waste and the related benefits thereof. However, in the effort to get lean, safeguarding systems intended to protect personnel can be defeated resulting in greatly increased risks. Yet safety can be effectively included in the lean manufacturing effort to yield processes that are better, faster, less wasteful and safer. This document provides guidance for persons interested in how to concurrently address lean manufacturing concepts and safety concerns of machinery. 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.

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.

The definition for lean manufacturing used in B11 TR7 is:

A collection of several initiatives, tools, techniques and technologies used to reduce waste, costs and complexity from manufacturing processes.

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, or excessive procedural safety check offs. The focus of the Technical Report #7 is to obtain an overall system optimum of lowest waste at lowest risk.

The Scope of B11 TR7 is both broad and narrow. The document pertains to an extensive array of applications but is limited to the overlap in the technical literature of the safety and lean concepts. The report is not a primer on either subject.

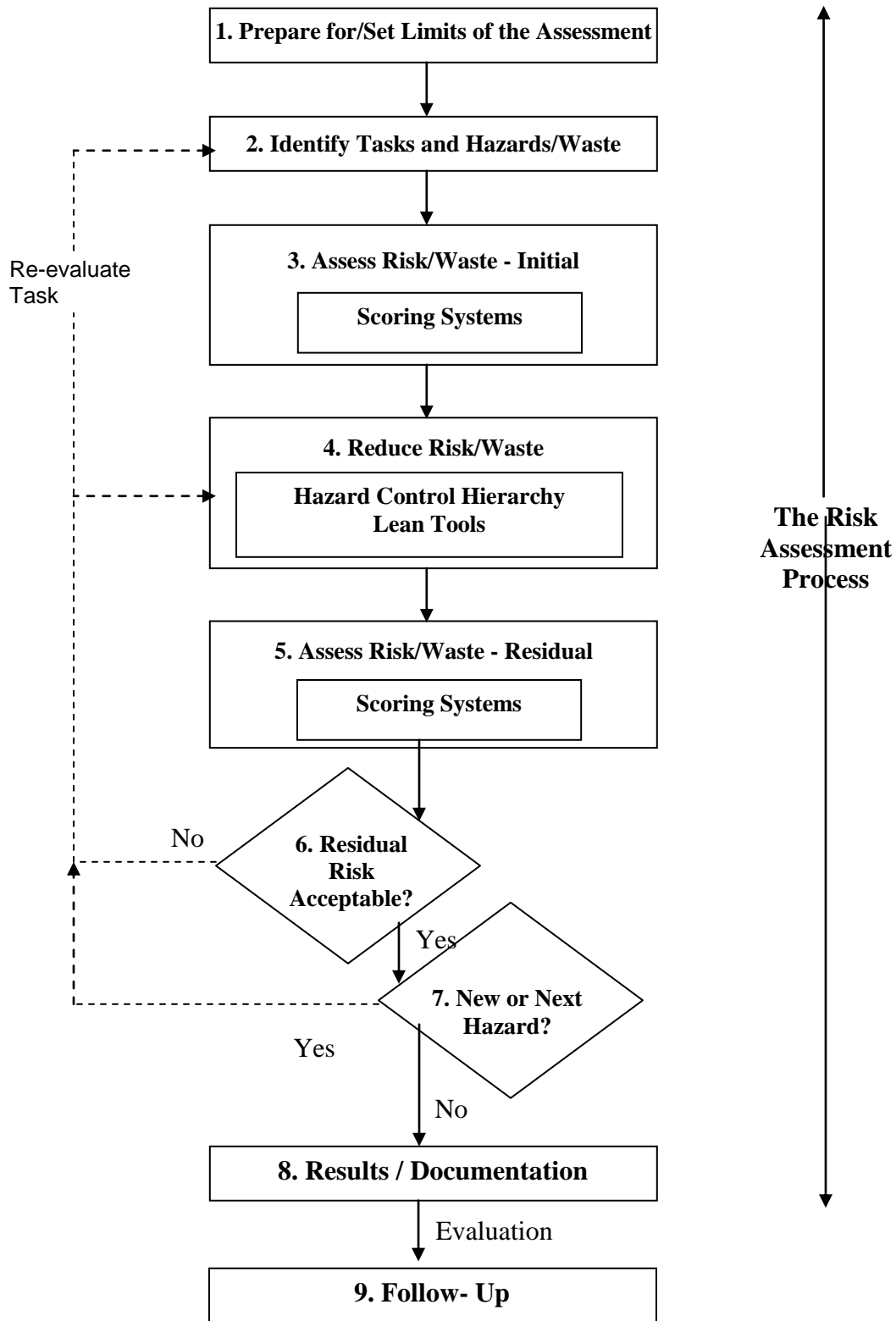
**Scope**

This document provides guidance on the practical application of safety and lean manufacturing principles to machinery and manufacturing systems for improving performance, safety and quality by reducing injury and waste. The guidelines in this technical report assist machine tool users to minimize waste and risk associated with machinery and manufacturing systems, including individual and integrated machine tools and auxiliary components.

**NOTE:** 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.

Although written by and primarily for the machine tool industry, the content can be applied to many other industries. However, the document is not a primer on either safety or lean manufacturing concepts as highlighted in the note above.

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 4 – Safety and Lean: the Risk/Waste Assessment Process**  
ANSI B11 TR7-2007  
Originally adapted from *Risk Assessment: Basics and Benchmarks (2004)*  
*Used with permission*

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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).

- |   |   |                |
|---|---|----------------|
| <ol style="list-style-type: none"><li>1) <b>C</b>orrection</li><li>2) <b>O</b>ver – production</li><li>3) <b>M</b>otion</li><li>4) <b>M</b>aterial Movement</li><li>5) <b>W</b>aiting</li><li>6) <b>I</b>nventory</li><li>7) <b>P</b>rocess</li></ol> | } | <b>COMMWIP</b> |
|---|---|----------------|

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.

As a company progresses along the lean path, it will apply other lean tools as appropriate. These include:

- Knowledge folders
- One page report writing
- Error proofing (poke yoke)
- Visual controls
- 5 Whys
- TPM (total productive maintenance)
- Quick change-over
- Cell manufacturing
- Takt time
- Line / work balancing
- One piece flow
- Kanban

Descriptions of these tools is beyond the scope of this article, but additional information can be found in the lean literature.

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.

To implement lean concepts, make sure that every member of the team has received the following minimum training:

- Introduction to 5S
- Participation in a 5S kaizen workshop
- Introduction to Value Stream Mapping
- Assigned to a Value Stream Mapping Team

Once the above training has occurred, the team should begin seeing the signs of folks thinking, talking and acting in a different way. They will begin to question “what” “why” and “how” from a different perspective. They will be, in fact, in the early stages of acting their way to a new way of thinking.

### Lean Manufacturing

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.

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.

#### Lean and Safety

ANSI B11 TR7 includes 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 7 forms of waste. All of it results in non-value added cost and wasted time.

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.

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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](http://www.amtonline.org)

#### SIDEBAR

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