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ANSI Technical Report for Machines –

Designing for Safety and Lean Manufacturing

A guide on integrating safety and lean manufacturing principles in the use of machinery

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ABSTRACT

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.

PURPOSE

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 are provided to demonstrate situations where this has not occurred. A process model for safety and lean is presented. A risk assessment framework is outlined that introduces how to effectively address both lean and safety concerns. 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.

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Foreword

This ANSI Technical Report was developed to provide useful and practical guidance to users of machines to effectively and concurrently incorporate the concepts of safety and lean manufacturing. Integrating safety and lean concepts early in the design process should maximize the impact and cost effectiveness of safety and lean interventions during the design process.

A search of the technical literature reveals ample information on lean manufacturing concepts. Similarly, the literature on safety is rich in depth and breadth. Yet 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 or safety will attempt projects and the results can be less than ideal.

This document is written primarily for users of machine tools looking to incorporate lean manufacturing concepts into their operations. Suppliers of machine tools, integrators and others developing manufacturing systems may also benefit. This document is written for engineers, technicians, designers, and safety and health personnel who are involved with lean manufacturing projects and decisions related to machine tools. This is the first publication of this Technical Report.

Publication of this ANSI Technical Report has been approved by the Accredited Standards Developer – AMT- The Association For Manufacturing Technology. This document is registered by the American National Standards Institute as a Technical Report of publications according to the *Procedures for the Registration of ANSI Technical Reports*. This document is not an American National Standard and the material contained herein is informative, not normative in nature.

This ANSI Technical Report is developed and processed under the B11 Accredited Standards Committee Operating Procedures and ANSI Essential Requirements in the same consensus manner and according to the same developmental procedures and principles (openness, balance, due process and consensus) as the American National Standards with the B11 series.

Suggestions for improvement of this technical report are welcomed. They should be sent to: AMT, 7901 Westpark Dr., McLean, VA 22102-4206, Attention: Safety Director.

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Introduction

Background on Lean Manufacturing

The concept of improving efficiencies in manufacturing production has been around since the birth of manufacturing. People and companies have continually searched for better ways to improve products and produce them more efficiently. For many years, these efforts were - and in many cases still are - informal, with energies focused on making a task easier to do, saving material costs, or reducing the time required to perform an operation.

Henry Ford is often recognized as one of the earliest lean thinkers. His organization of automobile manufacturing into assembly lines was a pioneering recognition of product flow. Following World War II, Taiichi Ohno developed the Toyota Production System as a means to efficiently produce small quantities of product based on customer demand – a pull system. The Toyota Production System evolved over many years and continues today. The success of the system has been remarkable, and the methods used to achieve this success have been termed "lean."

In the latter part of the 20th century, manufacturing attention began to formalize the drive for efficiency. Building on the fundamental concepts of the quality movement and the Deming revolution, Toyota and other like-minded companies focused attention on building quality into products from raw materials to finished goods. These companies found that identifying methods to maximize the production of a power press, for example, did not necessarily result in optimal use of resources for the company as a whole. Although the press operation was very efficient, the resulting work in process inventory wasted resources.

Methods to formalize efficiency efforts at an organizational level have resulted in new manufacturing technologies and theories under the generic heading of lean manufacturing. Lean manufacturing is a collection of several initiatives, tools, techniques and technologies used to reduce waste, costs and complexity from manufacturing processes. The intent of applying lean concepts is to achieve throughput that is "better, faster, cheaper."

However, manufacturing is not a static process. The market changes, products change, methods change, and therefore how products are manufactured must change. As a result, manufacturing processes cannot be optimized once and then left to run. Lean manufacturing also applies to helping manufacturing processes change efficiently and quickly to meet market demands. Whether the change is from one color to the next in an injection molding machine, or from one product to an entirely different product in an assembly line, lean manufacturing examines set-up time, change over efforts, and quick reconfigurations to reduce non-productive time.

Lean manufacturing has exhibited significant successes in improving manufacturing efficiencies and productivity. Parts change overs that used to take days are now completed in hours. Long assembly lines with many individual workers have been redesigned into smaller work cells with cross-functionally trained team members that help reduce bottlenecks and keep production running. Work flows have been streamlined to eliminate needless transporting and re-transporting of parts and materials. Piles of work in process no longer spill over into aisles. Idle time waiting for parts has been minimized. Successes are realized by better design or redesign of the work place.

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. 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.

Integration of Safety into Lean Manufacturing

As lean concepts have gained attention in manufacturing, there have also been reports of these concepts being misapplied creating significant problems, particularly concerning safety. For example in the exuberance to minimize cycle or changeover times, lean manufacturing teams have failed to replace guards or safety devices that inhibit access to points of operation. These guards or safety devices were intended to reduce the risk of injuries. Lean manufacturing teams have also modified or disabled guards or safety devices to improve access to points of operation or to improve quality by not allowing the guard to come into contact with the part (preventing scratches). Guards and devices have also been modified to provide the operator with a better view of an area, and therefore more perceived control over the operation of the machine and the quality of the part.

When viewed at a machine level, not replacing the guards or safety devices may appear to be an optimal solution against the lean manufacturing criteria. Yet this approach conflicts with the premises of lean manufacturing because it introduces the waste of preventable employee injuries.

Lean manufacturing does not seek individual machine or cell optimums. Lean manufacturing seeks to optimize the overall production of the organization. If a worker is injured in the above examples, the costs of medical treatment, lost production, lost worker knowledge, additional training for a new worker, etc., clearly does not result in an organizational optimum situation. Saving a few seconds per cycle or even minutes per changeover likely does not warrant the increased risk of incurring the injury and related costs. These additional costs are properly viewed as wastes to the overall production system and should be minimized by keeping the guards or safety devices in place, modifying the guards or safety devices or by finding alternate safer designs.

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. If considered together early in the design stages of lean manufacturing, both safety and lean concerns can be managed effectively. If one or the other is not considered, a sub-optimum result can be expected. In the changeover example, interlocked guards can be designed to open quickly providing good access and easy replacement for necessary changeover work. If the need for quick access is not considered early, a fixed guard might be used greatly slowing the changeover task. Alternatively, if the risk of injury is not considered early, the unguarded area could unnecessarily expose workers to serious injury.

Retrofit and New Design

In many organizations lean is mostly a retrofit activity on the factory floor. An existing system is examined for wastes and potential improvements as either a planned effort or a continuous improvement activity. Changes are made, systems run, new problems/opportunities are identified and the cycle begins again. Many of the problems and opportunites come from errors made where safety was overlooked. With existing systems, this Technical Report can be used to identify and assess both hazards and wastes at the same time, which will enable more robust retrofit efforts to achieve acceptable risk at lowest waste.

In other organizations the concepts of lean manufacturing have migrated to the design of new equipment and processes. For companies working on new product or process designs, lean holds a great opportunity to reduce waste before parts are made or systems installed. Concurrently identifying tasks, hazards and wastes will allow greater opportunity for reducing risk in ways that also minimizes waste. For new designs, this Technical Report provides the methodology to simultaneously identify and reduce risk while minimizing wastes. Used together with the B11 series of standards, product and process designers can achieve acceptable risk at lowest waste.

Designing for Safety and Lean Manufacturing

1 Scope

This ANSI Technical Report provides guidance on the practical application of safety and lean manufacturing principles to machines and manufacturing systems for improving performance, safety and quality by reducing injury and waste. The guidance in this technical report assists machine tool suppliers and users in minimizing waste and risk associated with machines 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 American National Standards or other sources.

2 References

The following references were either used as a basis for developing this document or they represent other good reference sources that may be consulted for additional information on a particular topic.

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