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LEAN PRODUCTION SYSTEM: A FUTURE APPROACH

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ABSTRACT

All manufacturing activities necessarily generate some form of waste. The manufacturing process does not consist of hundred percent of conversion of material and energy inputs into usable final products; some portion of the material and energy inputs inevitably ends up wastes. When the waste generated exceeds the maximum assimilative capacity of the environment it becomes pollution. The paper focuses on LEAN production, which aims at elimination of wastes there by reducing the environmental degradation.

"Lean manufacturing" is a leading manufacturing paradigm being applied in many sectors of the U.S. Economy, where improving product quality, reducing production costs, and being "first to market" and quick to respond to customer needs are critical to competitiveness and success. Lean principles and methods focus on creating a continual improvement culture that engages employees in reducing the intensity of time, materials, and capital necessary for meeting a customer's needs. While lean production's fundamental focus is on the systematic elimination of non-value added activity and waste from the production process, the implementation of lean principles and methods also results in improved environmental performance.

INTRODUCTION

Lean Manufacturing is a business initiative to reduce waste in manufactured products. The basic idea is to reduce the cost systematically, throughout the product and production process, by means of a series of engineering reviews.

The crucial insight is that, most costs are assigned when a product is designed. Often an engineer will specify familiar, safe materials and processes rather than inexpensive, efficient ones. This reduces project risk, that is, the cost to the engineer, while increasing financial risks, and decreasing profits. Good organizations develop and review checklists to review product designs.

At the system engineering level, requirements are reviewed with marketing and customer representatives to eliminate costly requirements. Shared modules may be developed, such as multipurpose power-supplies or shared mechanical components or fasteners. Requirements are assigned to the cheapest discipline. For example, adjustments may be moved into software and measurements away from a mechanical solution to an electronic solution. Another approach is to choose connection or power-transport methods that are cheap or that used standardized components that become available in a competitive market. In **Mechanical Engineering**, the process usually begins with a team review of the materials and processes. The team will include a cost accountant, manufacturing and design engineers. Quite often, parts can be combined into a single injection-molded plastic or die-cast part reducing both fabrication and assembly costs. Fasteners are eliminated, reduced. Tolerances (critical dimensions) are eliminated, widened and adapted to production processes to achieve theoretical 100% yields.

The tooling cost and any production machinery costs are estimated and financial feasibility established with return on investment. Reuse of existing machinery and capabilities is often essential.

Lean Manufacturing, simply defined, is a method of doing more with less. Specifically, Lean Manufacturing is producing high quality products with minimal floor space, work-in-process (WIP) inventory, finished goods inventory, material movement, non-value-added activities, and human effort. Lean Manufacturing encompasses elements of total quality management (TQM), just-in-time (JIT), etc. within a system designed for flexibility and maximum customer satisfaction. The lean manufacturing approach is the most comprehensive of the popular production management improvement initiatives because it addresses product, process, and human related issues in the production system. Studies have shown that, while many companies claim that they are "lean" or managing production according to TQM, JIT, etc., few are actually doing so. Further, while many understand the underlying concepts of these different management philosophies, few understand the details and/or the order of operations necessary for successful implementation of these concepts.

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WHAT IS LEAN MANUFACTURING?

James Womack, Daniel Jones, and Daniel Roos coined the term "lean production" in their 1990 book The Machine that Changed the World to describe the manufacturing paradigm established by the Toyota Production System.6 In the 1950s, the Toyota Motor Company pioneered a collection of advanced manufacturing methods that aimed to minimize the resources it takes for a single product to flow through the entire production process. Inspired by the waste elimination concepts developed by Henry Ford in the early 1900s, Toyota created an organizational culture focused on the systematic identification and elimination of all waste from the production process. In the lean context, waste was viewed as any activity that does not lead directly to creating the product or service a customer wants when they want it. In many industrial processes, such "non-value added" activity can comprise more than 90 percent of the total activity as a result of time spent waiting, unnecessary "touches" of the product, overproduction, wasted movement, and
Inefficient use of raw materials, energy, and other factors.7 Toyota's success from implementing advanced manufacturing methods has lead hundreds of other companies across numerous industry sectors to tailor these advanced production methods to address their operations. Throughout this report, the term "lean" is used to describe broadly the implementation of several advanced manufacturing methods.

Lean production typically represents a paradigm shift from conventional "batch and queue," functionally aligned mass production to "one-piece flow," product-aligned pull production. This shift requires highly controlled processes operated in a well maintained, ordered, and clean operational setting that incorporates principles of just-in-time production and employee-involved, system-wide, continual improvement. To accomplish this, companies employ a variety of advanced manufacturing tools to lower the time intensity, material intensity, and capital intensity of production.

THE BENEFITS OF LEAN MANUFACTURING: WHAT LEAN THINKING HAS TO OFFER THE PROCESS INDUSTRIES?

T. Melton- How many people in the manufacturing industry can truly say that they have not heard of LEAN? Not many. Yet how many of these believe in lean, have implemented lean, are the passionate change agents who have convinced senior stakeholders that lean is the way forward for their company? Less, much less, Lean is a revolution - it isn't just about using tools, or changing a few steps in our manufacturing processes, it's about the complete change of our businesses, how the supply chain operates, how the directors direct, how the managers manage, how employees, people go about their daily work, Everything. So what is this revolution and how is it impacting the process industries? The background of lean thinking is based in the history of Japanese manufacturing techniques which have now been applied world-wide within many types of industry.

WHEN DO COMPANIES IMPLEMENT SEVERAL OR ALL OF THE LEAN METHODS?

Several outcomes consistently result:

- Reduced inventory levels (raw material, work-in-progress, finished product) along with associated carrying costs and loss due to damage, spoilage, off-specification, etc.
- Decreased material usage (product inputs, including energy, water, metals, chemicals, etc.) by reducing material requirements and creating less material waste during manufacturing.
- Optimized equipment (capital equipment utilized for direct production and support purposes) using lower capital and resource-intensive machines to drive down costs.
- Reduced need for factory facilities (physical infrastructure primarily in the form of buildings and associated material demands) by driving down the space required for product production.
- Increased production velocity (the time required to process a product from initial raw material to delivery to a consumer) by eliminating process steps, movement, wait times, and downtime.
- Enhanced production flexibility (the ability to alter or reconfigure products and processes rapidly to adjust to customer needs and changing market circumstances) enabling the implementation of a pull production, just-in-time oriented system which lowers inventory and capital requirements.
- Reduced complexity (complicated products and processes that increase opportunities for variation and error) by reducing the number of parts and material types in products, and by eliminating unnecessary process steps and equipment with unneeded features.

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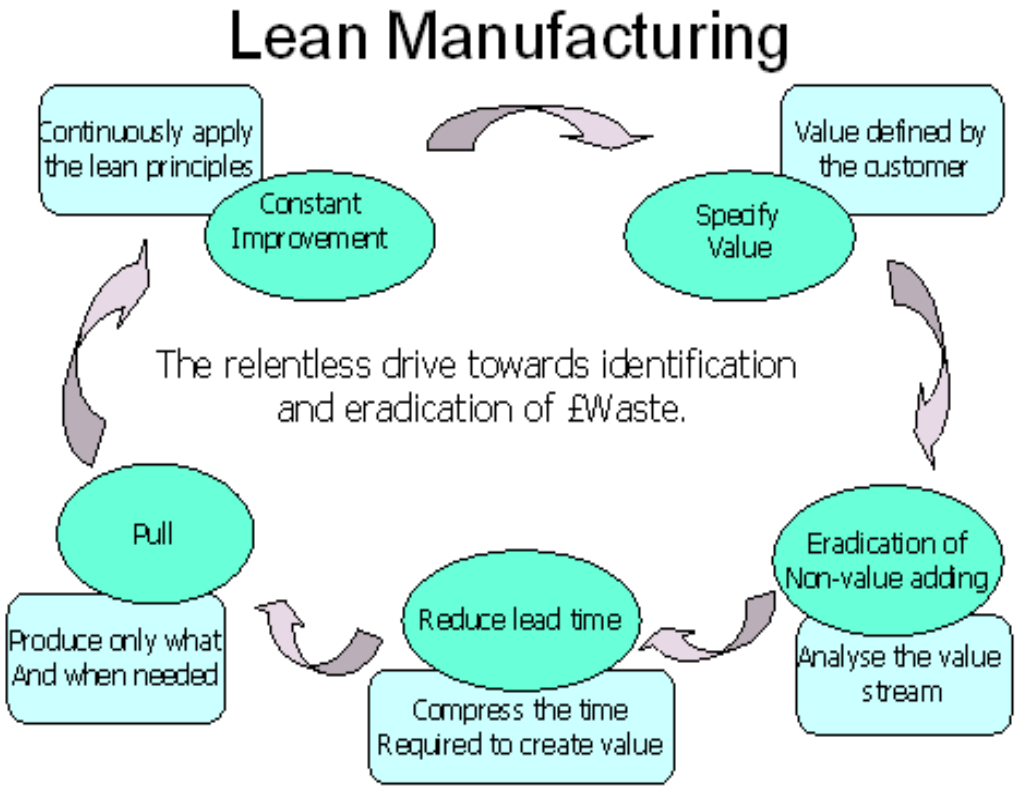

Fig. 1:- An approach towards Lean Manufacturing

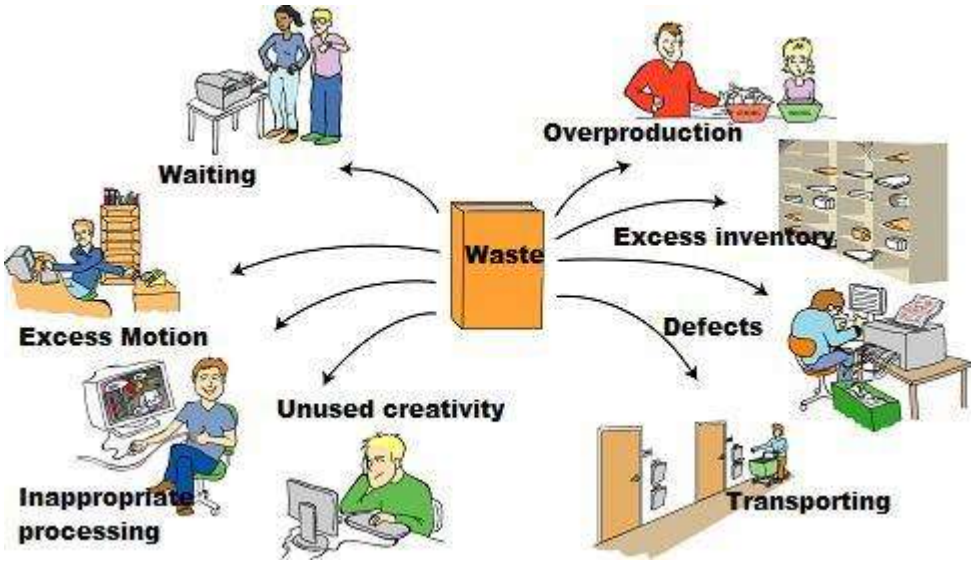

Fig. 2 Eight Types of Manufacturing Waste Targeted by Lean Methods

LEAN TERMS AND DEFINITIONS

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- **Batch and queue:** The mass production process of making large lots of a part and then sending the batch to wait in the queue until the next operation in the production process begins. Contrast with onepiece-flow.
- **Bottleneck:** Any part of a production line that adversely affects throughput. See also constraint.
- **Cell:** An arrangement of machinery, tools, and personnel designed to most logically and efficiently complete a production sequence. Cells help enable one-piece flow.
- **Cellular Manufacturing:** An approach in where manufacturing work centers (cells) have the total capabilities needed to produce an item or group of similar items; contrasts to setting up work centers on the basis of similar equipment or capabilities, in which case items must move among multiple work centers before they are completed.
- **Chaku-Chaku:** A method of conducting one-piece flow, where the operator proceeds from machine to machine, taking the part from one machine and loading it into the next.
- **Changeover Time:** The time that elapses between the completion of one production run and the beginning of another production run.
- **Constraint:** Anything that limits a system from achieving higher performance, or throughput.
- **Cycle Time:** The amount of time to accomplish the standard work sequence for one product, excluding queue (wait) time. If the cycle time for every operation in a complete process can be reduced to equal takt time, products can be made in one-piece flow.
- **Inventory:** The money the system has invested in purchasing things it intends to sell.
- **Just-in-Time:** A production scheduling concept that calls for any item needed at a production operation – whether raw material, finished item, or anything in between, to be produced and available precisely when needed.
- **Kaikaku:** Japanese for "radical improvement of an activity," designed to eliminate waste.
- **Kaizen:** The incremental and continual improvement of production activities aimed at reducing waste, and designed around planned, structured worker-oriented events. Japanese for "to take apart and make good."
- **Kanban:** A card or sheet used to authorize production or movement of an item. See also Kanban System.
- **Kanban System:** A system that controls production inventory and movement through the visual control of operations.
- **Large Lot Production:** The manufacture of the same product in large quantities during a single, designated period of time.
- **Lead Time:** The total amount of time it takes to complete an order for a customer.
- **Lean Supplier Network:** A buyer-supplier relationship where designated lean production protocols, supporting sustained interactions between members, helps produce a network-based competitive advantage.
- **Mistake Proofing:** Technology and procedures designed to prevent defects and equipment malfunction during manufacturing processes. Also known in Japanese as Poka-Yoke.
- **Monument:** A production machine or tool that is difficult and/or costly to move (e.g., into one-piece flow) due to its size or other physical constraint. Often, materials must instead be brought to the monument in batches.
- **Muda:** The Japanese term for any human activity which absorbs resources, but creates no real value, i.e., "waste"; activities and results to be eliminated. W ithin manufacturing, categories of waste include: excess and early production; delays, movement and transport; poor process design; inventory; inefficient performance of a process; and defective items.
- **Non-Value-Added:** Activities or actions taken that add no real value to the product or service, making such activities or actions a form of waste.
- **One-Piece Flow:** A situation in which products proceed, one complete product at a time, through various operations in design, order-taking, and production, without interruptions, backflows, or scrap. Also known as single-piece flow.
- **Point-of-Use:** A system in which all necessary supplies, chemicals, etc. are within arm's reach of the worker, and positioned in a logical sequence of use.
- **Poka-Yoke:** See Mistake Proofing
- **Pre-Production Planning (3P) :** A lean method for product and/or process design. 3P designs and implements production processes, tools, and equipment that support one-piece flow, are designed for manufacturability, and achieve appropriate cost, quality, and lead time. Also known as **"**Production Preparation Process".

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- **Pull Production System:** A production system in which nothing is produced by the upstream supplier until a need is signaled by the downstream customer. See also Kanban.
- **Right-sized:** The matching of production tooling and equipment in a scale that enables its use in the direct flow of products such that no unnecessary transport or waiting is required.
- **Queue Time:** The time a material spends waiting in line for use in the production process.
- **Supply Chain:** A group of all suppliers involved in the manufacture of a product, beginning with the simplest part and ending with the production of the final product.
- **Takt Time:** The available production time divided by the rate of customer demand. Takt time sets the pace of production to match the rate of customer demand and becomes the heartbeat of any lean system.
- **Value Stream:** The set of specific actions required to bring a specific product through three critical management tasks of any business: problem solving, information management, and physical transformation. Value Stream
- **Mapping:** A process mapping method used to document the current and future states of the information and material flows in a value stream from customer to supplier. See Value Stream.
- **Visual Controls:** Displaying the status of an activity so every employee can see it and take appropriate action.
- **Work In Progress (WIP):** Production material in the process of being converted into a saleable product

ORGANIZATIONS' METHODS TO IMPLEMENT LEAN

There are numerous methods and tools that organizations use to implement lean production systems. Eight core lean methods are described briefly below. The methods include:

1. Kaizen Rapid Improvement Process
2. 5S
3. Total Productive Maintenance (TPM)
4. Cellular Manufacturing / One-piece Flow Production Systems
5. Just-in-time Production / Kanban
6. Six Sigma
7. Pre-Production Planning (3P)
8. Lean Enterprise Supplier Networks

Most organizations begin by implementing lean techniques in a particular production area or at a "pilot" facility, and then expand use of the methods over time.
Companies typically tailor these methods to address their own unique needs and circumstances, although the methods generally remain similar. In doing so, they may develop their own terminology around the various methods.

LEAN GOALS AND STRATEGY

The espoused goals of lean manufacturing systems differ between various authors. While some maintain an internal focus, e.g. to increase profit for the organization, others claim that improvements should be done for the sake of the customer

Some commonly mentioned goals are:

- Improve quality: To stay competitive in today's marketplace, a company must understand its customers' wants and needs and design processes to meet their expectations and requirements.
- Eliminate waste: Waste is any activity that consumes time, resources, or space but does not add any value to the product or service. See Types of waste above.
- Reduce time: Reducing the time it takes to finish an activity from start to finish is one of the most effective ways to eliminate waste and lower costs.
- Reduce total costs: To minimize cost, a company must produce only to customer demand. Overproduction increases a company's inventory costs because of storage needs.

The strategic elements of lean can be quite complex, and comprise multiple elements. Four different notions of lean have been identified:

1. Lean as a fixed state or goal (being lean)
2. Lean as a continuous change process (becoming lean)

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3. Lean as a set of tools or methods (doing lean/toolbox lean)
4. Lean as a philosophy (lean thinking)

CONCLUSIONS

The Total Lean Management Model aligns ALL the pillars of Lean – TFM, TPM, TQM, TSM and THM in a systematic way under one umbrella, making Lean understanding, learning and execution a smooth methodology. Creating WORLD CLASS ORGANIZATIONS – begins with the basic requirement of having a good 5S in the workplace, followed by identification, reduction and if possible elimination of the 7 Muda's across the value chain: customers to suppliers.

The following steps should be implemented to create the ideal lean manufacturing system:

- Design a simple manufacturing system
- Recognize that there is always room for improvement
- Continuously improve the lean manufacturing system design.

A fundamental principle of lean manufacturing is demand-based flow manufacturing. In this type of production setting, inventory is only pulled through each production center when it is needed to meet a customer's order. The benefits of this goal include:

- Decreased cycle time
- Less inventory
- Increased productivity
- Increased capital equipment utilization

The core of lean is founded on the concept of continuous product and process improvement and the elimination of non-value added activities. "The Value adding activities are simply only those things the customer is willing to pay for, everything else is waste, and should be eliminated, simplified, reduced, or integrated" (Rizzardo, 2003). Improving the flow of material through new ideal system layouts at the customer's required rate would reduce waste in material movement and inventory.

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