ANNALS of the ORADEA UNIVERSITY.
Fascicle of Management and Technological Engineering, Volume VII (XVII), 2008

TEACHING LEAN MANUFACTURING CONCEPT

ROTARU Ana
University of Piteşti, Faculty of Mechanics and Technology, Department of Management and Technology
e-mail: ana_c_rotaru@yahoo.com,

Keywords: Lean manufacturing, waste, inventory, productivity.

Abstract: Manufacturers today must become faster and more nimble than was needed in the past. Offshore competition is getting fierce and customers have become much more demanding and have higher expectations than in the past. Many companies are feeling the pressure to more aggressively pursue lean manufacturing processes to avoid the risk of losing business to lower cost and faster performing competitors. As a result, more manufacturers returning to lean manufacturing techniques to drive out waste and to dramatically improve on cycle time, productivity, inventories and delivery.

1. Introduction

Many of the concepts in Lean Manufacturing originate from the Toyota Production System (TPS) and have been implementing gradually throughout Toyota's operations beginning in the 1950's. By the 1980's Toyota had increasingly become knowing for the effectiveness with which it had implemented Just-In-Time (JIT) manufacturing systems. Today, Toyota is often considering one of the most efficient manufacturing companies in the world and the company that sets the standard for best practices in Lean Manufacturing. The term "Lean Manufacturing" or "Lean Production" first appeared in the 1990 book *The Machine that Changed the World*.

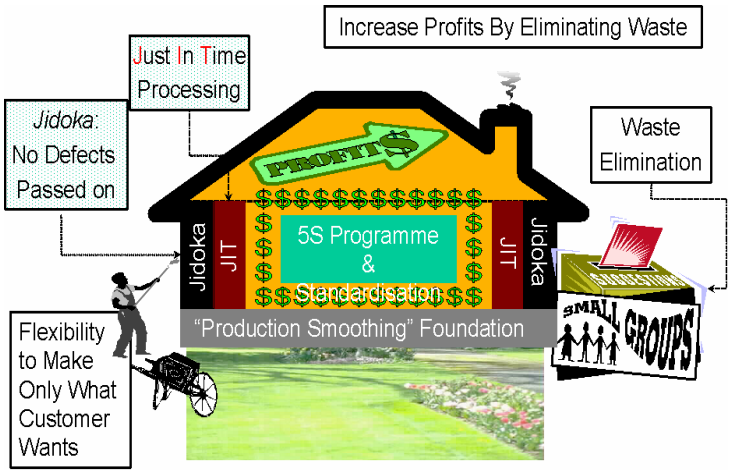

***fig.1*. The Toyota Production System [8]**

Leading manufacturing companies throughout the world lead by the major automobile manufactures and their equipment suppliers have increasingly applied Lean Manufacturing. Lean Manufacturing is becoming an increasingly important topic for manufacturing companies in developed countries as they try to find ways to compete more effectively against competition from Asia.

Lean is most widely used in industries that are assembly-oriented or have a high amount of repetitive human processes. These are typically industries for which productivity is highly influenced by the efficiency and attention to detail of the people who are working manually with tools or operating equipment. For these kinds of companies, improved systems can eliminate significant levels of waste or inefficiency. Examples of this include wood processing, garment manufacturing, automobile assembly, electronics assembly and equipment manufacturing.

Since Lean Manufacturing eliminates many of the problems associated with poor production scheduling and line balancing, Lean Manufacturing is particularly appropriate for companies that don't have ERP systems in place or don't have strong material requirements planning (MRP), production scheduling or production allocation systems in place. This is particularly significant in Vietnam where we believe that many private Vietnamese manufacturing companies are operating significantly below their potential capacity, or experiencing a high level of late-deliveries, due to problems with their current production scheduling and production management systems.

Lean Manufacturing is also appropriate in industries for which it is a strategic priority to shorten the production cycle time to the absolute minimum as a source of competitive advantage for the company.

Recently, some companies in Vietnam have actively conducted training and implemented lean methods to eliminate process inefficiencies. This resulted in an improvement to their production and service lead times. For example, Toyota Ben Thanh, a service center of Toyota in Vietnam, has implemented lean methods to significantly reduce the process time for its automobile maintenance service from 240 minutes to 45-50 minutes per car, and as a result, increased the total number of cars processed at each service center from 4-6 cars up to 16 cars per day. Toyota Ben Thanh achieved significant reductions in the process lead time by successfully eliminating unnecessary waiting time, inefficiencies of physical motions and process flow.

2. Lean Manufacturing – a conceptual definition

Theory building requires that concepts are well defined. However, Osigweh (1989) argues that it is not imperative that every concept in a theory is precisely defined, rather he suggests that the concepts that are defined are well-conceptualized and their definitions are sufficiently precise. Lean production is most frequently associated with elimination of waste commonly held by firms as excess inventory or excess capacity (machine and human capacity) to ameliorate the effects of variability in supply, processing time, or demand. According to Little's law, inventory in a system can be reduced by either maintaining excess capacity or lowering throughput time. Because excess capacity is a type of waste and is counter to lean production principles, lowering throughput time reliably to reduce inventory is preferred. This can be accomplishing through continuous flow without frequent stop-and-go operations that are characteristic of batch and queue systems. Achieving this requires a flexible, dedicated and engaged work force. Therefore, to pursue lean production and minimize inventory, firms have to manage variability in supply, processing time, and demand that in turn require firms to effectively manage their social and technical systems simultaneously. I propose the following definition to capture the many facets of lean production:

"Lean production is an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability"

3. Developing a Foundation for Lean

First, executive management must be committed to lean. If lean is a "grass roots" effort, it will have limited success. This is because lean involves so much of the organization. It involves procurement, manufacturing, quality, sales, marketing, and human resources. Each of these organizations will need to participate in the transformation. Therefore, the executives must want it. They must believe that it will improve their bottom line. If they do not, it will fail.

After management has committed to implementing lean, the next step in forming a foundation for lean is communicating this commitment to the entire organization. This often missing but critical step conveys the importance of the program to the employees. Company newsletters, e-mail, the intranet, and any other such tools should be used, but the most important means of communication is having a company executive directly address the employees. The executive should explain what lean is, why the company is going to implement it, and what the next steps will be.

After the employees have been informing that this program is real and that the company is committed, the organization should begin scouting for team leaders. These are often the people that voluntarily seek to get involving in the program; the team leaders will help to train the rest of the organization. The organization should then find a change agent, often an external (or in some cases internal) consultant that can "train the trainers" and work collaboratively with management to move the program forward.

The final step in forming the foundation for lean is planning a reward system. One common factor in successful lean organizations is a reward system for employees. The system must reward employees for suggesting and implementing useful ideas that eliminate waste in the organization, and the system must reward employees for sustaining lean throughout the organization.

After taking these steps, an organization has an increased likelihood of initial and sustained success as a lean enterprise. Lean is not something that an industrial or manufacturing engineering group does to an organization; it is a cultural change. The importance of developing a foundation for this cultural change is critical to the success of any organization that begins a lean journey.

4. The 7 Manufacturing Wastes

Waste elimination is one of the most effective ways to increase the profitability of any business. Processes either add value or waste to the production of a good or service. The seven wastes originated in Japan, where waste knows as "muda." "The seven wastes" is a tool to further categorize "muda" and was originally developing by Toyota's Chief Engineer Taiichi Ohno as the core of the Toyota Production System, also known as Lean Manufacturing. To eliminate waste, it is important to understand exactly what waste is and where it exists. While products significantly differ between factories, the typical wastes found in manufacturing environments are quite similar. For each waste, there is a strategy to reduce or eliminate its effect on a company, thereby improving overall performance and quality.

The seven wastes consist of:

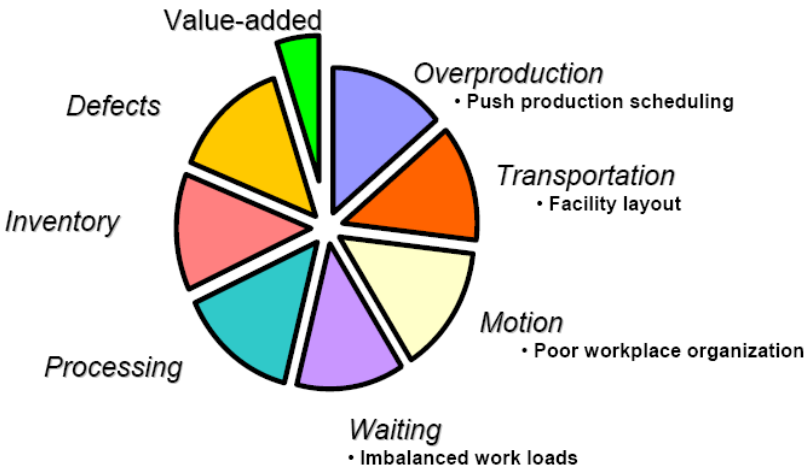

fig. 2 **The 7 Manufacturing Wastes [8]**

- *Overproduction* - Simply put, overproduction is to manufacture an item before it is actually required. Overproduction is highly costly to a manufacturing plant because it prohibits the smooth flow of materials and actually degrades quality and productivity. The Toyota Production System is also referring to as "Just in Time" (JIT) because every item is madding just as it needs. Overproduction manufacturing is referring to as "Just in Case." This creates excessive lead times, results in high storage costs, and makes it difficult to detect defects. The simple solution to overproduction is turning off the tap; this requires a lot of courage because the problems that overproduction is hiding will be revealing.
- *Waiting* **-** Whenever goods are not moving or being processed, the waste of waiting occurs. Typically, more than 99% of a product's life in traditional batch-and-queue manufacture will be spending waiting to be processed. Much of a product's lead-time is tied up in waiting for the next operation; this is usually because material flow is poor, production runs are too long, and distances between work centers are too great.
- *Transporting* **-** Transporting product between processes is a cost incursion that adds no value to the product. Excessive movement and handling cause damage and are an opportunity for quality to deteriorate. Material handlers must be used to transport the materials, resulting in another organizational cost that adds no customer value. Transportation can be difficult to reduce due to the perceived costs of moving equipment and processes closer together. Furthermore, it is often hard to determine which processes should be next to each other. Mapping product flows can make this easier to visualize.
- *Inappropriate Processing* **-** Often termed as "using a sledgehammer to crack a nut," many organizations use expensive high precision equipment where simpler tools would be sufficient. This often results in poor plant layout because preceding or subsequent operations are located far apart. In addition they encourage high asset utilization (over-production with minimal changeovers) in order to recover the high cost of this equipment. Toyota is famous for their use of low-cost automation, combined with immaculately maintained, often older machines. Investing in smaller, more flexible equipment where possible; creating manufacturing cells; and combining steps will greatly reduce the waste of inappropriate processing.

- *Unnecessary Inventory* **-** Work in Progress (WIP) is a direct result of *overproduction* and *waiting*. Excess inventory tends to hide problems on the plant floor, which must be identifying and resolving in order to improve operating performance. Excess inventory increases lead times, consumes productive floor space, delays the identification of problems, and inhibits communication. By achieving a seamless flow between work centers, many manufacturers have been able to improve customer service and slash inventories and their associated costs.
- *Unnecessary / Excess Motion* **-** This waste is related to ergonomics and is seen in all instances of bending, stretching, walking, lifting, and reaching. These are also health and safety issues, which in today's litigious society are becoming more of a problem for organizations. Jobs with excessive motion should be analyzing and redesigned for improvement with the involvement of plant personnel.
- *Defects* **-** Having a direct impact to the bottom line, quality defects resulting in rework or scrap are a tremendous cost to organizations. Associated costs include quarantining inventory, re-inspecting, rescheduling, and capacity loss. In many organizations, the total cost of defects is often a significant percentage of total manufacturing cost. Through employee involvement and Continuous Process Improvement (CPI), there is a huge opportunity to reduce defects at many facilities.

5. Implementing Lean manufacturing

The power of lean manufacturing or "The Toyota Production System" is undeniable. Toyota has repeatedly proven its effectiveness. According to Jeffrey Liker's book *The Toyota Way* Toyota's $8.13 billion annual profit in 2003 was 8.3 times higher than the industry average and larger than the combined earnings of "the big 3." Their automobiles are consistently at the top of the quality rankings; they have the fastest product development process in the world; and they are benchmarking as best in class for high quality, high productivity, manufacturing speed, and flexibility.

The ultimate goal of lean is to increase cash flow and operating profits by:

- Reducing inventory, delivery time, cycle time, and set-up time
- Improving quality
- Increasing overall customer satisfaction
- Improving employee involvement, morale, and company culture

Lean organizations achieve such benefits by eliminating waste or non-value creating activities using a set of tools and principles. They create a culture of continuous improvement, and within that culture, they employ the tools of lean to eliminate waste. Not surprisingly, it begins with the customer (not the plant manager or industrial engineer). The customer is the definer of value. Once value is clearly defining, then value streams can be clearly identified. Single-piece flow is applied where possible; pull systems are applied where single-piece flow is impossible. After using value stream mapping to create a plan to archive this kaizen is used to eliminate waste. Process kaizen tools include:

- *5S*, which is a system for organizing the workplace. It helps to create a culture of continuous improvement at the shop floor level. It can also be applied to administrative processes in the office.
- *Quick Changeover*¸ which is a system for reducing setup or changeover time. This allows organizations to produce smaller batch sizes, with the ultimate goal of one-piece flow.

- *TPM or Total Productive Maintenance,* which is a system for properly maintaining equipment. More effective than simple preventative maintenance, TPM involves operators and makes use of teams to increase the uptime of equipment. Near 100%, uptime is critical for the lean producer.
- *Manufacturing Cells/Cellular manufacturing***,** which are effective systems for manufacturing or assembling product using one-piece flow. Instead of moving product from area of the factory to another in batch-and-queue fashion, cellular manufacturing makes for much shortened lead times and makes one-piece flow possible.

6. Conclusions

Is increasingly apparent that companies must excel in lean capability in order to prosper or even survive in today's global marketplace. The winning companies will be those that have broadly deployed superior methods that accelerate their full attainment of lean capability and then enable them to out-manage their competitors as they go forward in the future.

At the end, a winning lean capability is best describing by lean business performance. The financial managers of a business best gauge lean business performance. I believe that improved business performance, correlated with a company's investment in lean transformation efforts, is evidencing specifically by a measure of expanding gross margin profit levels through:

- **Reduced cost of goods sold** – from labor productivity savings and reduced total material expenditures. Comprehensive elimination of unnecessary costs such as premium freight, overtime expense, rework labor and material scrap costs.
- **Reduced overhead cost** - through streamlined work, continuous improvement deployment, and improved overhead absorption through leveraged sales
- **Capacity productivity** - through increased utilization of plant & equipment assets
- **Reduced interest expense** - through increased inventory turnover
- **Increased sales volumes** - resulting from increased market share as well as pricing premiums that are creating through superior shipping predictability, flexibility, and value propositions delivered to both distribution partners and ultimate customers.

BIBLIOGRAPHY

[1] http://www.factorylogic.com/glossary_11.asp
[2] Dave Gleditsch*, The Lean spectrum of work,* The Northwest Lean Networks, 2004
[3] Freddy Balle*,* 2006 *L'Lean, un mecanisme de progres continu,* Ingeniurs de l'automobile, nr. 781, Paris
[4] Ion Hohan, 2005 *Lean Management versus Gemba Kaizen,* Universitatea Valahia din Târgovişte
[5] James Womack, Daniel Jones and Daniel Roos: The Machine that Changed the World. Simon & Schuster, 1992.
[6] Osigweh, 1989 C.A.B. Osigweh, *Concept fallibility in organizational science*, Academy of Management Review **14** (1989) (4), pp. 579–594
[7] Vicente A. Reynal, *Production system design and its implementation in the automotive and aircraft industry*, Georgia Institute of Technology, 2000
[8] The Vision of Lean Manufacturing, 2004 Johnson Controls, Mioveni