IMPLEMENTING LEAN MANUFACTURING IN INDIAN AUTOMOTIVE INDUSTRY

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Abstract: *"The most dangerous kind of waste is the waste we do not recognize." - Shigeo Shingo, Toyota Motors.* Amidst dwindling rupee scenario, Indian economy is no longer what it used to be – robust and fast growing. Automobile companies are facing the heat of this meltdown and thus the importance of reducing waste in manufacturing sector is in the spotlight. However, not all is lost and India is still as attractive a market as ever if the resources are used judiciously. In the last decade, the Indian automotive industry has grown at a Compound Annual Growth Rate (CAGR) of 4 per cent per annum over the last five years. According to the UNIDO International yearbook of Industrial Statistics 2008, India features among the top 15 auto-makers. [1] Currently, it ranks 11th in the world in terms of car production and 13th in terms of commercial vehicle production. As India is becoming a hub for global car makers, companies are looking to enhance their component engineering, product design and development capabilities in India to increase their share in the automotive knowledge-based business. So there is an urgent need to infuse new process improvement techniques to the product development cycle, to stay ahead of the global competition. In traditional manufacturing processes a lot of material is wasted in hidden ways. These can be identified through Lean Manufacturing systems. It was proved that lean product development can reduce new product development timeframe by as much as 30% to 50%. However, there is a lack of studies which are focused on consolidating the various key practices of lean manufacturing and investigating their level of adoption in real life. This paper reviews the practice areas of lean manufacturing as applied to Indian automotive Industries.

Keywords: **Lean manufacturing, Indian Automobile, Toyota Production System.**

I. INTRODUCTION

India has established itself as a manufacturing hub with the host of multinational automobile majors converting India as their export base. It was made possible by rigorous quality principles adopted by the manufacturing companies in India. Currently there is a rapid improvement in the product R&D activities in the country and now all the major automotive companies are looking India as their design hub. Infusing lean principles to new product development will drastically reduce the design cycle time and make the industry competitive. Many manufacturing companies have adopted some type of lean initiatives. However, the level of implementation and education in other areas like product development is very low [3]. Minimizing waste in all aspects of product development and manufacturing becomes the common theme of delivering the products with speed and efficiency.

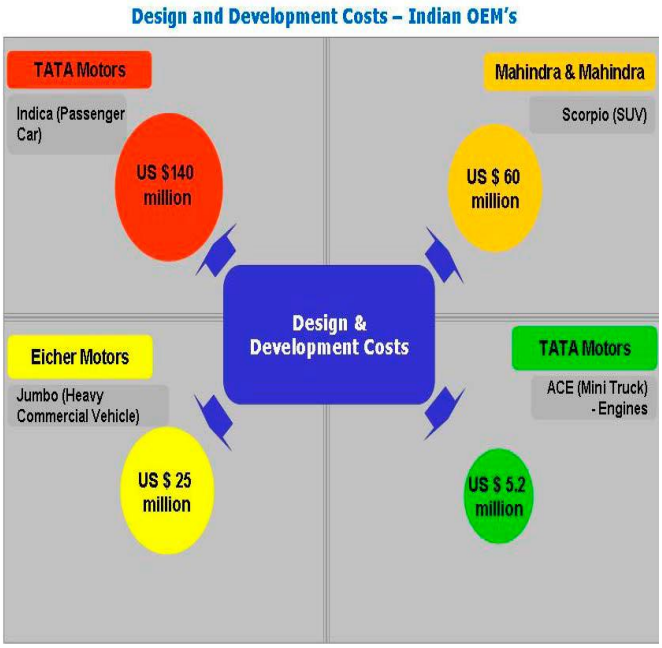

Fig. 1. Design and development cost of Indian OEM [1]

II. WHAT ARE LEAN AND LEAN PRINCIPLES

The primary objective of lean manufacturing is to improve company's operations and become more competitive by implementing different lean manufacturing tools and techniques. Lean manufacturing means "A systematic approach of identifying and eliminating waste through continuous improvement" The term "Lean" as Womack and Jones define it, denotes a system that utilizes less, in terms of all inputs, to create the same outputs as those created by a traditional mass production system, while contributing increased varieties for the end customer. [4] Lean is to manufacture only what is needed, when it is needed and in

what quantity is ordered by the customer. Goods are manufactured in a way that minimizes the time taken to deliver the finished goods, amount of labour and the floor-space required, done with the highest quality at the lowest possible cost. Lean principles have proven to be universally successful at improving the results when appropriately applied.

There are five basic principles of lean manufacturing:
1. Understanding Customer Value
2. Value Stream Analysis
3. Flow
4. Pull
5. Perfection

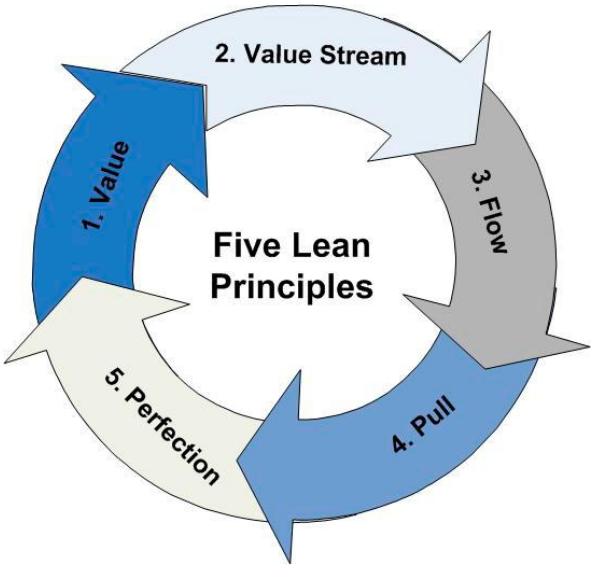

Fig. 2. Five principles of LEAN [2]

III. LEAN WASTE

1. **Excess (or early) production**: Producing more than the customer demands or producing it earlier than the customer needs it. These ties up valuable labour and material resources that might otherwise be used to respond to customer demand.
2. **Delays:** Waiting for material, tools, information, or equipment. This may be a result of poor planning, late supplier deliveries, lack of communication, and overbooking of equipment.
3. **Unnecessary Transportation**: Moving material more often than necessary. Material should be delivered and stored at its point of use.
4. **Inventory:** More material is stored than needed. This wastes valuable space and working capital.
5. **Over Processing:** Doing more work on a part than is necessary, including inspection and reworking. This wastes time and money. Quality must be built into the manufacturing process so that parts are produced correctly first time.
6. **Defects:** Defects consume considerable resources. In addition to the original materials and labour used to manufacture the part, extra labour and machine time are required to fix the effective part. If the defective part is sold to a customer, it will increase unnecessary costs.
7. **Unnecessary Movement:** Excess motion of employees in getting tools, picking parts, or moving material from one point to another is non-value-added activity.

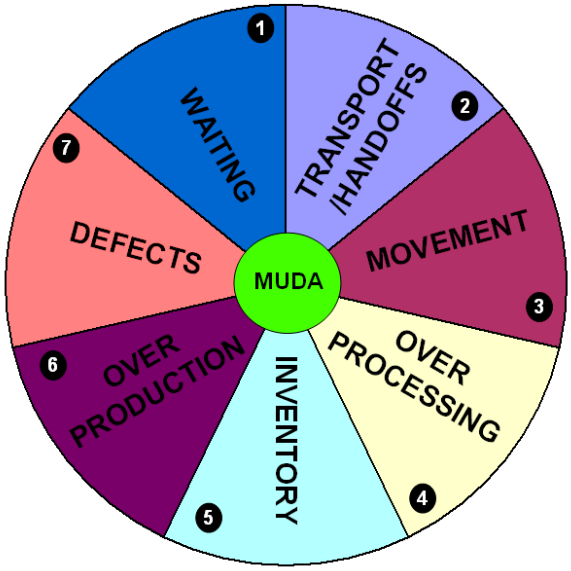

Fig. 3. Seven areas of waste [2]

IV. LEAN PRINCIPLES:

1. Just-in-time

Just-in-time means a system of production that produces and delivers what is needed, when it is needed, and just in the amount needed. It aims the total elimination of all kind of wastes in order to achieve the highest quality, lowest cost, minimum use of resources and delivery time. It relies on *Heijunka* (levelling) concept as a foundation of the system. There are three main elements that support the Just-in-time concept: The *Takt Time*, *Continuous Flow* and *Pull System*.

1.1 Takt Time

Takt means rhythm. Takt Time indicates how often a part or a product should be produced to meet the customer's consumption rate.

1.2 Continuous Flow

Continuous flow processes seek a condition where on item at a time is produced and moved from one process to the next process (without waiting time), providing just what is required by the next process and following the Takt Time pace.

1.3 Pull System

Pull system is an inventory-replenishment method in which each downstream process signals its need to the next upstream process.

1.4 Heijunka

TPS system relies on *heijunka*, a Japanese word which means levelling the type and quantity of production over a fixed period of time. Instead of producing all type of items A over first two days of the week and then produce all type of B on third day, then produce C on fourth and fifth days along the week, the production will be more levelled if produced all three Types A, B and C every day.

1.5 Changeover-Time reduction

Changeover means the process of switching from the production of one product or part number to another in a machine or a series of linked machines by changing parts, dies, moulds, fixtures, etc. Changeover time is measured as the time elapsed between the last piece in the run just completed and the first good piece from the process after the changeover.
In order to allow *heijunka*, more changeovers are required, forcing us to reduce changeover time.

1.6 Jidoka

Jidoka, a Japanese word which means automation with a human touch. It provides equipment and operators the ability to detect when an abnormal situation has occurred and top working immediately and set countermeasures.
It has two main features:
1. An automatic stop;
2. An alert (usually called AND ON device)
Jidoka has another key aim: to separate the human work from machine work and guarantee that machines, equipment, software have the ability to detect abnormal conditions and stop itself so defects are not produced. This feature allows separating operators from machines (instead of keep watching on equipment to prevent defects) making more efficient use of resources for work, maximizing human ability and reduce human waiting time.

1.7 Chaku-Chaku

Chaku-chaku is a Japanese mimetic expression related with a movement of an operator loading a part in a machine then loading another part in another machine in a work-cell. *Chaku-chaku* machines basically have devices (for example, an eject arm) that automatically push a finished good work piece to eject.

1.8 Poka-Yoke

Poka-Yoke, a Japanese word that means error-proofing are devices designed to eliminate all possibility of somebody making mistake or execute wrong operation. Standardized Work Standardized Work is the base of operations to make correct products or activities in the safest, easiest and most effective and efficient way, which can be improved continuously and systematically. Any operation that is performed repetitively should be standardized. There is a difference between standardized work and common operation standards. Even both aims to establish precise procedures for operator's work, Standardized Work are based on three elements:

1. Takt Time
2. Operation or work sequence
3. Standard inventory (work-in-process stock)

All operation sequences for operator are defined in order to achieve the needed output rate for a specific process, according to the Takt Time. To perform that, standard working- process stocks are necessary to allow operators to work and make the materials flow consistently.
Standardized work aims to identify and eliminate waste and it is the base for *Kaizen*, a Japanese word that means improvement, and translated frequently as continuous improvement. For each improvement done in the process, the standardized work is updated and followed by people as most efficient way of work currently known for that process.

1.9 Visual Management

Visual management is a fundamental base for *Kaizen*. It means the placement in plain view of all tools, parts, production activities, indicators of performance, so the status of the system can be well understood at a glance by everyone involved. The standards are the basis of visual management. It allows a quick identification of what is an abnormal situation, then
Corrective action can be taken. A good standard is simple, clear, visual and should be always improved (*Kaizen*). 5S practices are commonly used for better visual management of workplace. The 5 S's are:
1. Sort (Get rid of it): Separate what is needed in the work area from what is not; eliminate the latter.
2. Set in order (Organize): Organize what remains in the work area.
3. Shine (Clean and solve): Clean and inspect the work area.
4. Standardize (Make consistent): Standardize cleaning, inspection, and safety practices.
5. Sustain (Keep it up): Make 5S a way of life.

1.10 Total Productive Maintenance

Total Productive Maintenance or TPM is a method to improve the machine operational availability. TPM aims to eliminate the six major losses:

1. Breakdown
2. Changeovers and adjustments;
3. Minor stoppages;
4. Speed losses;
5. Scrap;
6. Rework;

To achieve this objective, Preventive and Predictive Maintenance (PM) are required. Different from traditional PM activities, which rely on skilled maintenance personnel, TPM also involves operators in routine maintenance, *Kaizen* activities, and simple repairs such as lubricating, cleaning, inspecting machine.

V. LEAN PRODUCT DEVELOPMENT

Product development is the set of activities beginning with the perception of a market opportunity and ending in the production, sale and delivery of a product [4]. Lean product development has many definitions given by various quality experts. In some companies, lean product development simply stands for "doing more with less". In others, it has become a euphemism for downsizing, off-shoring, and disinvesting in product development.

Lean product development (LPD) provides guiding principles and tools for improving the product development process in terms of increasing productivity and eliminating waste, which combined with time to market compression produce world class products and Performance. The main objectives of lean product development (LPD) or lean new product introduction are increased productivity and eliminating waste in a Company's product development process and the adoption of a lean mind-set and culture.

Lean Product Development is a proven approach to redefine how new products come to market – from final design concept to customer launch – with sustainable results.

1. Focusing on the information flow and decision process in product development
2. Identifying/eliminating waste (unnecessary delays, tasks, costs, and errors)
3. Implementing/monitoring an improved process for sustainability.

a) Value Stream Mapping (VSM)

Value stream mapping method is to identify all the specific activities and process steps along the value stream of a specific product or product family. Value stream mapping is conducted in three steps:

1. Mapping the current value stream.
2. Mapping the future value stream.
3. Creating an implementation plan.

Value stream analysis and mapping is a method used for business process and product improvement, which originated with the development of the lean business Philosophy. The engineering and design efforts of product development provide a unique setting for the use of VSM. The VSM will helps to list down the wastes in the PD process that do not add value to the customer and those wastes can be identified and targeted.

VI. CHALLENGES IN IMPLEMENTING LEAN SYSTEM

1. Practical challenges

The practical challenge faced in the product development process occurs with the application of the lean engineering approach. An obstacle often arises as attempts are made to achieve flow, an important component in instituting lean operations principles. To achieve consistent flow, the process is broken down into standard work elements. Standard work is defined as "a precise description of each work activity (specifying cycle time, *Takt* time, and sequence of specific tasks)". Without achieving consistent flow in the process other aspects of a lean product development initiative become complicated, break down, and can become counterproductive leading to frustration and diminished results.

2. Cultural challenges

The most common cultural challenge faced when implementing any of the lean approaches to product development is organizational resistance on behalf of engineers. For example, the lean design approach involves a fundamentally different way of designing products. The process and information utilized to make decisions are unconventional, even though it is very powerful. The improvement potential of the lean design approach if fully embraced includes considerable cycle time reductions as well as new opportunities for innovation and knowledge sharing. The risks however lie in the ability of engineers, particularly in management, to unlearn traditional engineering methodologies and adopt entirely new practices. Engineers and executives educated in traditional methodologies may not understand the lean design approach potentially resulting in cultural resistance that impedes successful implementation. At the end of the day, no matter which approach is applied cultural challenges due to organizational resistance can be anticipated. The ability to select which approach fits best with a company's goals and circumstances and what implementation strategy is most appropriate to achieve success is the real challenge.

VII. ADVANTAGES

1. Significant Reduction in Inventory to the tune of 66% [3].
2. Process Lead time decrease with an increase in efficiency.
3. Effective and controlled utilization of manpower.
4. Cost of goods can be reduced by 11% [2].
5. Improved customer satisfaction

VIII. CONCLUSION

Current automotive industry in India has many challenging new product assignments under its belt and now competing neck to neck with the multinationals. So we have to redefine

our current product development process by implementing the powerful tool lean in Indian industries. Indian Automotive industry should start full-scale implementation of the lean principles into their new product development cycle.
Lean practitioners have an opportunity to realize greater business value by learning to see and eliminate production and environmental waste in Lean initiatives. [5]
We can conclude that the application of lean manufacturing tools will help Indian manufacturers leapfrog competition and stay ahead in the competitive global environment.

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ABBREVIATIONS
OEM – Other Equipment Manufacturer
TPS – Toyota Production System
PM – Predictive Maintenance
TPM – Total Predictive Maintenance
PD – Product Development
LPD – Lean Product Development