

Analyzing, Validating the Waste Elimination by Implement the Lean Principles for the Production of Wind Mill Gear Box

Mr.S.Duraisivam¹ Mr.N.Gurumoorthi²

¹Assistant Professor, Department of Mechanical Engineering, The Kavery Engineering College, Tamilnadu, India

²Assistant Professor, Department of Mechanical Engineering, The Kavery Engineering College, Tamilnadu, India

ABSTRACT- This project aims the Identification and elimination of waste by implementing a concept of Lean manufacturing in a Wind Mill Gear Box Manufacturing CompanyM/sHANSEN DRIVES Ltd,Coimbatore to get the positive impact on Lean Metrics like Productivity, Quality, Cost , and Safetyetc.Thisproject starts with ValueStream Mapping (VSM) - Present state and futurestate of a component manufacturing. The improvement tasks are identified from theVSM and implemented to achieve Lean metrics.The lean tools VSM, Kanban system, Kaizens, Mistake proofing, and cellular manufacturing are used in this project for attaining the objective.The effectiveness of the Lean implementation is evaluatedby considering the matrices likeOverall Equipment Effectiveness (OEE), TAKT Time, and Productivity.

INTRODUCTION:

In this context, this case study has been carried out. It has been shown that the wastes such as inventory and defects have been reduced which improves the production time. In order to accomplish this task, the managers of the organization have to implement approaches like 5S, Poka-Yoke, etc. Thus, VSMhelps the managers to visualize the wastes occurring in the organization and the future possibility of reducing/eliminating them.

Chapter 2 presents a review of the literature followed by which serves to clarify some issues which are integral to understanding lean manufacturing and which have been misunderstood in the past.

Chapter 3 introduces the problem definition and objective that are faced by nearly every manufacturing plant in the world, and shows how fluctuations in customer demand create cyclical demand patterns which are amplified at each link in supply chains.

It concludes by postulating lean manufacturing principles as a solution to many of the difficulties, and suggests that a truly “lean” factory can deal with the variation in customer demand without the high levels of inventory that are common in most factories today.

IDENTIFIED CAUSES:

Of late, companies trying to adopt new business initiatives in order to stay alive in the new competitive marketplace. Lean manufacturing is one of these initiatives that focuses on cost reduction by eliminating non-value added activities. These tools and techniques of lean manufacturing have been widely used in the discrete industry starting with the introduction of the original Toyota Production System.

Tools including just in time, cellular manufacturing, total productive maintenance, single-minuteexchange of dies, and production smoothing have been widely used in discrete parts manufacturing sectors such as automotive, electronic and appliance manufacturing.

Application of lean manufacturing to the continuous process industry have been far fewer. In part, it has been argued that this is because such industries are inherently more efficient and present relatively less need for such

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization,

Volume 3, Special Issue 2, April 2014

Second National Conference on Trends in Automotive Parts Systems and Applications (TAPSA-2014)

On 21st & 22nd March, Organized by

Sri Krishna College of Engineering & Technology, Kuniamuthur, Coimbatore-641008, Tamilnadu, India

improvement activities. Managers have also been hesitant to adopt lean manufacturing tools and techniques to the 3 continuous process industry because of reasons such as high volume and low variety products, large inflexible machines, and the long setup times that characterize the process industry. As an example, it is difficult to use the cellular manufacturing concept in a process facility due to the fact that equipment is large and not easy to move.

ESSENTIAL OF THIS PROJECT:

The goal of this project is to investigate how the tools of lean manufacturing can be adapted from the discrete to the continuous manufacturing environment and to evaluate their benefits at a specific industrial concern. The research hypothesizes that there are big opportunities for improvement in the process industries if lean tools are utilized.

Although the process and discrete industry share several common characteristics, there are also areas where they are very different. Both manufacturing settings have overlap, but at the extreme, each has its unique characteristics. The objective is to look at commonalities between discrete and continuous manufacturing where lean techniques from the discrete side are directly applicable, and to also examine ways to do so in other areas where this may not be quite so straightforward.

The objective is to systematically demonstrate how lean manufacturing tools when used appropriately can help the process industry to eliminate waste, have better inventory control, better product quality, and better overall financial and operational procedures. In this project the wind mill industry will be used to represent the continuous process industry, and much of the work will be carried out at an actual gear box manufacturing facility, whose identity is protected by referring to it as the **HANSEN DRIVES** Company.

OVERVIEW:

The initial step in this research is to systematically study and define the history of the lean manufacturing concept and its different tools and techniques. It will then examine where most of the lean tools and techniques have been used.

The next step is to develop the continuous process industry with respect to its product/process characteristics and the relative balance of discrete and continuous operations. This categorization is used to contrast the process industry and to characterize the process industry into distinguishable groups.

Next, this categorization is used to examine and identify specific lean manufacturing tools and techniques that could be applicable.

To study the effect of lean tools in the process sector the wind mill industry is used to illustrate the procedures of implementing lean tools at a process facility. First, value stream mapping is used to map the current state for CMH. This is used to identify sources of waste and then identify lean tools to try to reduce this waste.

The future state map is then developed for a system with lean tools applied to it. The benefits gained from using lean tools and techniques in the value stream mapping. For those lean tools that cannot be directly quantified by the simulation, a proposed methodology to implement them at CMH is developed, and a subjective evaluation of its benefits is provided.

Companies must strive to create high-quality, and low cost products that can get to the customers in the shortest time possible. There are sets of tools that were developed at Toyota and that can be utilized to eliminate or at least reduce the sources of waste.

Project milieu:

In this chapter we will discuss relevant background information for our project. First we will briefly describe our sponsoring company, Hansen Drives Ltd. Then we will provide information about the product we worked with. Finally, we will discuss the manufacturing process and the factory layout

Hansen Drives Transmission

Hansen Transmissions International NV is an established global wind turbine gearbox and industrial gearbox designer, manufacturer and supplier, with a leading position (by MW supplied) in the wind turbine gearbox market. The company supplies gearboxes to the world's major manufacturers of gear-driven wind turbines and provides durable gear drives for a wide range of industrial applications throughout the world.

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization,

Volume 3, Special Issue 2, April 2014

Second National Conference on Trends in Automotive Parts Systems and Applications (TAPSA-2014)

On 21st & 22nd March, Organized by

Sri Krishna College of Engineering & Technology, Kuniamuthur, Coimbatore-641008, Tamilnadu, India

Both Hansen's wind energy and industrial activities have established dedicated international service networks. In addition to its principal state-of-the-art manufacturing facilities located in Flanders, Belgium – i.e. a wind turbine and industrial gearbox plant and a fully integrated, dedicated wind turbine gearbox manufacturing facility – Hansen has a production plant for wind turbine gearboxes in Coimbatore, India and an assembly and testing plant for the Chinese market, located in Tianjin, China.

As such, Hansen plans to increase its wind turbine gearbox manufacturing capabilities, from 7,300 MW per annum in the financial year 2009 to 14,300 MW, by financial year 2013. Strong in-house R&D operations maintain Hansen's technological leadership and the company employs over 2,300 people worldwide

Problem Definition:

In the current state, the productivity, Dock to Dock time of the CMH shop floor line is found below the expected level, which affects the customer schedule adherence, inventory management, ultimately the organization profit.

I. Plant carrier – 23 No's/Month

II. LSS & ISS WHEEL – 234 No's/Month

Product Addressed To the Project:

Wind mill gear box having,

1. Ring wheel
2. Planet wheel
3. Housing
4. Torque arm
5. Planet carrier
6. Hollow shaft
7. Sun shaft
8. Pinion shaft
9. Intermediate shaft
10. Lss wheel
11. Iss wheel
12. Planet shaft
13. Support shaft

Functions Addressed To the Project

a) Component manufacturing process

- I. Turning
- II. Milling
- III. Grinding

- b) Heat treatment process
- I. Carburizing
- c) Assembly

Collection of Base Line Data

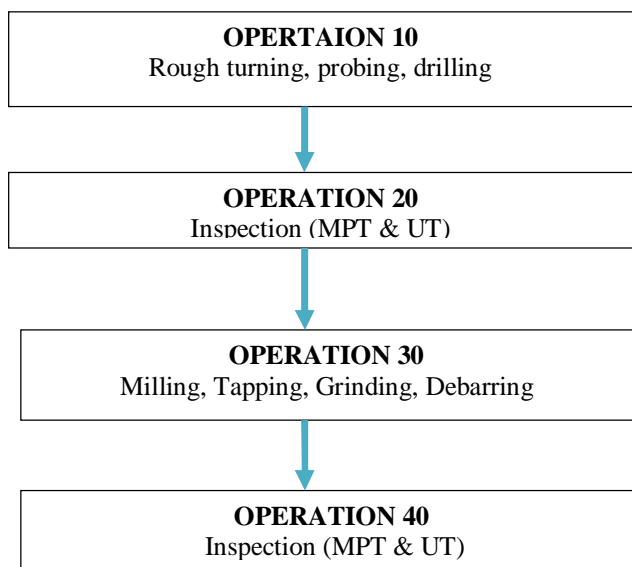


Fig.1: Process in Plant Carrier Manufacturing

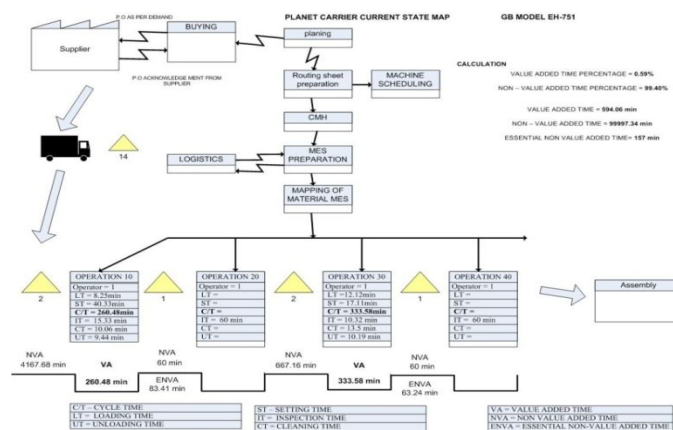


Fig.2: VSM for Plant Carrier Manufacturing

List of Process in LSS & ISS Wheel Manufacturing

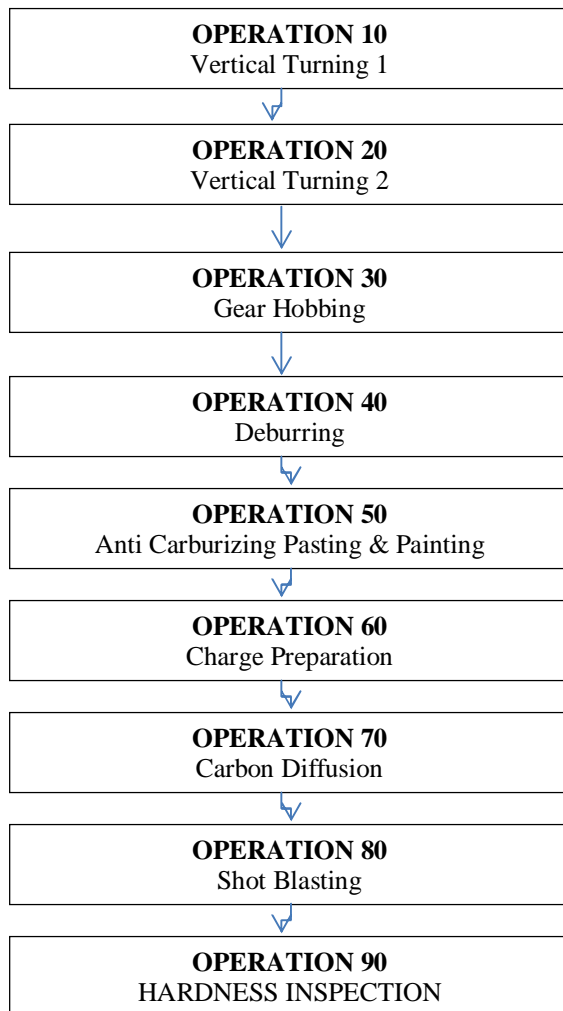
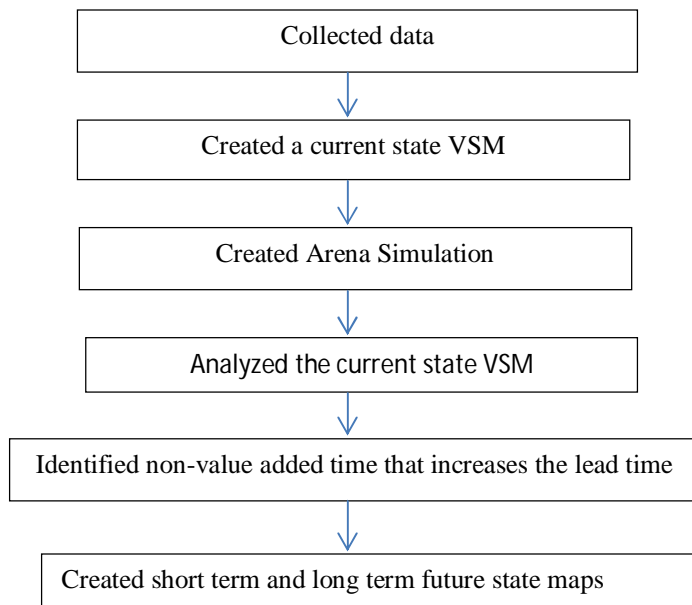


Fig.3: Process in LSS & ISS Wheel Manufacturing

Methodology

One of the main goals of our project was to create a future state VSM that illustrated the ideal material and information flow for the plant. With the creation and implementation of our VSM, current lead time should be reduced by 50%. This project we have completed the following objectives:



In order to accomplish these objectives we applied the following strategies:

Obtained information from various employees

Observed processes during different times of the day, on different days of the week

We used **Microsoft Visio** software to create current and future state VSM

Five Start-Up Steps

1. IDENTIFY THE PRODUCT
2. DRAW THE CURRENT STATE MAP
3. ASSESS THE INFORMATION
4. DRAW THE FUTURE STATE MAP
5. IMPLEMENT THE CHANGES

LEAN IMPLEMENTATION ROADMAP

As we work through the nine start-up steps, need to revisit the eight elements of lean:

Streamline the Value Stream (VSM – Current state & Future state)

Learn how to use value stream maps to create macro-facility workflows and micro-process workflows.

Workplace Organization (The 5S's)

Understand how the 5S's establish a structured approach for storing materials, supplies, and equipment in work areas.

Slashing Lead Times to Increase Profits

Lead time confusion can be a serious disease. Lead times are used in very business and drive many of the results we see on financial performance and customer satisfaction reports. Make sure everyone understands the different types of lead times, what elements need to be carefully managed and seek continuous improvement to high quality lead times, aka short ones! It will help lead your business to profitable growth.

Collecting Related Data:

An essential part in creating the VSMs for the process was to obtain existing data. There were a few ways in which we gained information. The first, we acquired data directly from the company. To do this we talked with the operation in charge of the plant as well as the 25 floor in charge. We met with the managers and remained in contact through e-mail.

The operation managers provided us with production data as well as quality data. When we visited the production lines, it allowed our team to record observations as well as conduct time studies on each specific line.

Conducting Stop Watch Time Studies:

While we received production and work instruction data from the company, as well as observed the factories in motion, we had to conduct our own time studies to get exact information on the cycle times within each factory. The time studies gave us the observed cycle times for each of the three member's productions lines.

We also conducted time studies for the CMH line where we found many areas of improvement, as well as recorded the cycle times.

A time study is a structured process of directly observing and measuring human work in order to establish the time required for completion of that work. We recorded the cycle times for

Value Stream Mapping

Value Stream Mapping VSM is a critical first step in a lean implementation because it takes a lot of the complexity and confusion out of the picture-it is based on hard facts. The mapping process involves examining and recording all of the activities that occur as a product is transformed from raw material to finish product.

The Value Stream Mapping process is an effective way of capturing the current situation (current state), identifying the long term lean vision (future state), and developing a plan to get there.

Current State Mapping

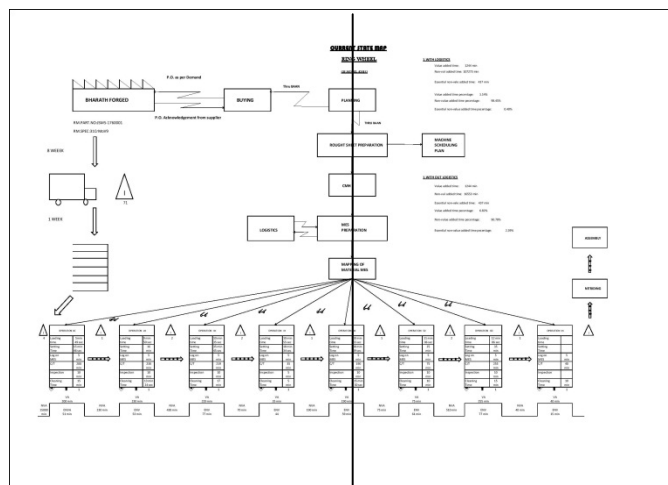


Fig.4: VSM for LSS & ISS Wheel Manufacturing

Identifying Task from VSM & Implementation

COMPONENT DETAILS

- a) Component name: PLANT CARRIER
- b) Model: EH751
- c) Material: Forged steel
- d) Material specification: 31CrMoV9

Task Identified In Current State Value Stream Mapping

Change Over Time Reduction

S.NO	PROCESS NAME	TASK IDENTIFIED DESCRIPTION	ACTIVITIES
1	Operation 30 (horizontal milling)	The components are waiting for unavailability of over head crane. The component is waiting for next operation.	To be implemented over head crane to avoid the unavailability.

Table.1.Change over Time Reduction

Set Up Time Reduction

S.NO	PROCESS NAME	TASK IDENTIFIED & DESCRIPTION	ACTIVITIES
1	Operation 30 (horizontal milling)	In the operation 30, setup time is very high. When the change over time the machine was ideal.	Single minute exchange dies (SMED), to be implemented, to reduce the change over time

Table.2.Set up Time Reduction

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization,

Volume 3, Special Issue 2, April 2014

Second National Conference on Trends in Automotive Parts Systems and Applications (TAPSA-2014)

On 21st & 22nd March, Organized by

Sri Krishna College of Engineering & Technology, Kuniamuthur, Coimbatore-641008, Tamilnadu, India

Process improvement task

S.NO	PROCESS NAME	TASK IDENTIFIED & DESCRIPTION	ACTIVITIES
1	Operation 40 (Inspection NDT)	Presently, the operation 40 is doing non destructive test in two processes are MPT & UT .In future to do the operation in MPT. Using operation 20.	To eliminate the operation and to reduce the human effort.

Table.3.Process improvement

Results & Recommendation

By implementing the lean manufacturing concepts, in the windmill gear box component manufacturing. Shop floor line, many tangible and intangible benefits are achieved as follows,

- ❖ Work personnel safety and morale improved.
- ❖ Product quality improved.
- ❖ Process and hence product cost reduced.
- ❖ Eliminating non value-adding steps.
- ❖ Reducing the cycle times or changeover times of individual steps.
- ❖ Responsiveness improved.
- ❖ Simplifying individual steps.
- ❖ Flexibility increased.

Cost Saving Achieved

Overall equipment efficiency (OEE)

The TPM losses are combined into one measure of overall equipment effectiveness

$$OEE = \text{Equipment availability} \times \text{Performance Efficiency} \times \text{Rate of Quality Products} = 97.5 \% * 93 \% * 95\%$$

$$OEE = 86.14 \%$$

Equipment efficiency rate is increased 86.14%. The lead time will decrease 35 %.

Reduce the Setup Time Cost (Operation 30)

Current state 1 day = 3 shift

1. Value added activity = 594.06 min
2. Non value added activity = 174.11 min
3. Non value added activity/ week = 3133.98 min
4. Non value added activity/ month = 11491.26min

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization,

Volume 3, Special Issue 2, April 2014

Second National Conference on Trends in Automotive Parts Systems and Applications (TAPSA-2014)

On 21st & 22nd March, Organized by

Sri Krishna College of Engineering & Technology, Kuniamuthur, Coimbatore-641008, Tamilnadu, India

5. Operating cost = Rs.6500/hr.

After lean implement

- 1. Value added activity = 594.06 min
- 2. Non value added activity = 157 min
- 3. Non value added activity/ week = 2826 min
- 4. Non value added activity/ month = 10362 min
- 5. Operating cost = Rs.6500/hr.

The idle time for m/c

(Essential Non-value added time) = 17.11 min

Idle time of machining cost / Day = Rs.5560.74/day
34,577.6/year

Idle time of machining cost / Year =Rs.13,

Cost of overhead crane = Rs 20 lakhs

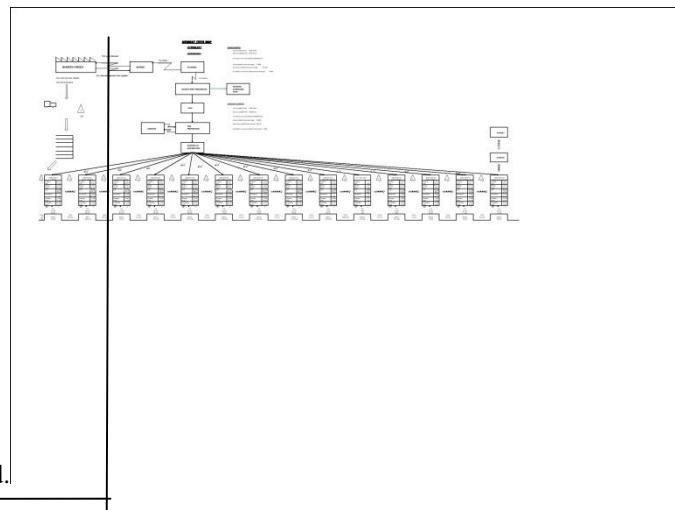
The investment cost of overhead crane can return back within 18 months.

Process improvement

In current state value stream mapping the operation 40 has conducted two inspection test are magnetic particle test (MPT) & ultrasonic test (UT).

Future State Mapping

After implement the lean to eliminate the magnetic particle test, because the magnetic particle test are inspected in operation 20. So,



we have eliminate the manpower and 30min to saved.

Fig.4: VSM for LSS & ISS Wheel Manufacturing

Reduce the Change over Time Cost (Operation 30)

In operation 30 the horizontal milling machine we have only one fixture (751 models) setup are used. This condition the change over time is very high, to use additional fixture setup to used to reduced the change over time(22.31min).

1 day = 3 shift

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization,

Volume 3, Special Issue 2, April 2014

Second National Conference on Trends in Automotive Parts Systems and Applications (TAPSA-2014)

On 21st & 22nd March, Organized by

Sri Krishna College of Engineering & Technology, Kuniamuthur, Coimbatore-641008, Tamilnadu, India

1. Value added activity	= 594.06 min
2. Non value added activity	= 105 min
3. Non value added activity/ week	= 1890min
4. Non value added activity/ month	= 6930min
5. Operating cost	= Rs.6500/hr.
6. Essential Non-value added time	= 22.31 min
7. Cost saving/month	= Rs.1, 59025.68

Conclusion:

This project delivers the valid advantages when applying the lean concept to the windmill gear box manufacturing industry. The lean thinking has implemented in the component manufacturing line and the following conclusions are made:

The LR (Lean rate) was found to have increased after applying lean tools to the gear box CMH line. This indicates that the revised system is moving towards a leaner system of CMH (component manufacturing & heat treatment).

The DtD (Dock to Dock time) was dramatically reduced by optimizing the inventory. This means that the customer can expect his gearbox to be delivered in a shorter duration than before.

By providing multi-skilled training and making instructions clear to the assembly line workers, the employee morale has improved. As discussed, from this project, previous articles, it is evident that, the future of small and medium companies, would be the implementation of the Lean concept into their strategies to become a world class and to be more competitive.

The project clearly points out the reduction in setup time in a lot of machining operations and improvements in operation in order to maximize the production on the whole shop floor and thereby eliminating most all unwanted wastage.

REFERENCES

1. Shingo, S., A Study of the Toyota production system from an industrial engineering Viewpoint (Cambridge, MA: Productivity Press, 1997).
2. Taylor, S.G., S.M. Seward, and S.F. Blander, "Why The Process Industries are Different," Production and Inventory Management Journal, Vol. 22, Fourth Quarter 1981, PP. 9-24.
3. Ohno, T. (1988), The Toyota production system: Beyond large-scale production; Productivity Press; Edition I.
4. Rother, M., and J. Shook, Learning to See: value stream mapping to add value and eliminate muda (1.2 edition; Brookline, MA: The Lean Enterprise Institute, Inc.,(1999)
5. Hines, P., and D. Taylor, Going Lean, Lean Enterprise research center, Cardiff Business School, 2000.
6. Karlsson, C., and A. Par, "Assessing changes towards lean production," International Journal of Operation & Production Management, Vol. 16, No.2, 1996, PP. 24-41.
7. Monden, Y., Toyota Production System-An Integrated Approach to Just-in-time (3rd edition; Norcross, Georgia: Engineering & Management Press, 1998).
8. Monden, Y., Toyota Production System, (Norcross, Georgia: Industrial Engineering and Management Press, 1993).
9. Panizzolo, R., "Applying the lessons learned from 27 lean manufacturers-The relevance of relationships management," International Journal of Production Economics, Vol.55, 1998, PP. 223-240.
10. McDonald, T., E.M. Van Aken, and A.F. Rentes, "Utilizing Simulation to Enhance Value Stream Mapping: A Manufacturing Case Application," International Journal Of Logistics: Research and Applications, Vol. 5, No. 2, July 2002, PP. 213- 232.
11. Hines, P., N. Rich, and A. Esain, "Creating a Lean Supplier Network: a distribution case," European Journal of Purchasing & Supply Management, Vol. 4, 1998, PP. 235-246.
12. Cook, R.C., and R.A. Rogowski, "Applying JIT principles to continuous process manufacturing supply chains," Production and Inventory Management Journal, First Quarter, 1996, PP. 12-16.
13. Tapping, D., Luyster, T., and Shuker, T. (2002). "Value stream management: Eight steps to planning, mapping, and sustaining lean improvements". New York. Productivity Press.
14. Womack, J. (2006). "Value stream mapping. Manufacturing engineering". Manufacturing Engineering. Vol. 136 (5)
15. Womack, J and Jones, D. (2003). "Learning to see; value stream mapping to create value and eliminate muda". Brookline. The lean enterprise institute.
16. John Allen, Charles Robinson and David Stewart, 2001, "Lean Manufacturing – A Plant Floor Guide," Society of Manufacturing Engineers, 2001 edition, Michigan
17. <http://www.systems2win.com/solutions/5S.htm> Definition.htm