WORK IN PROCESS OPTIMISATION THROUGH LEAN MANUFACTRING

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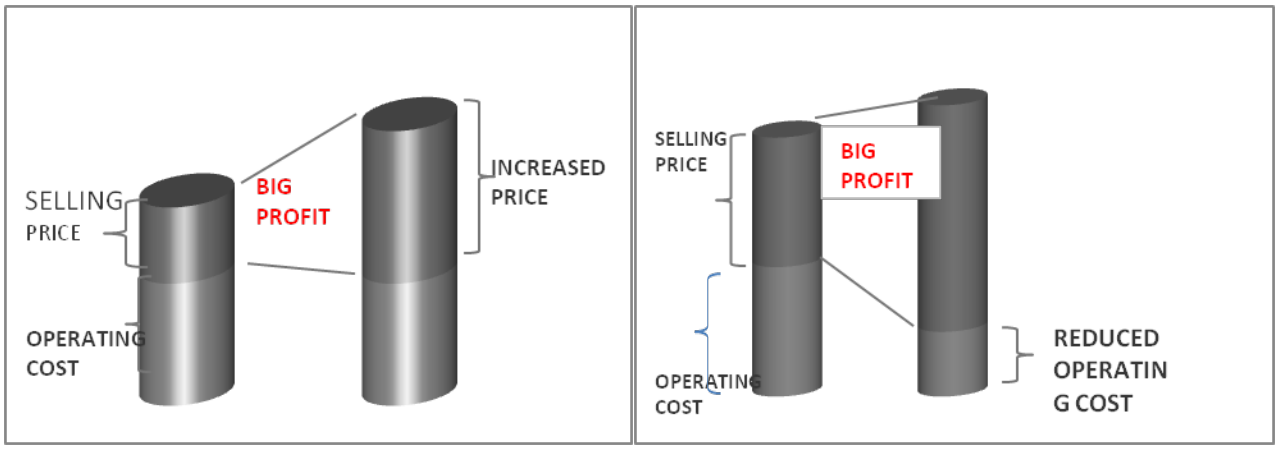
ABSTRACT
Today the global economy has caused a stronger competitive manufacturing environment in all kinds of business. Manufacturing industries face continuous pressure to reduce the price to remain in the market. It eventually results in manufactures need to reduce the profit margins in order to keep a share of the market. The objective of this paper to find the work in process for the optimal size using lean Techniques in a multiproduct single conveyor assembly line of a leading Two Wheeler Manufactures in south India. It is useful to map the dynamics of the supply chain focusing on how the demand information is passed from the final customer, back to the material suppliers and manufactures inside the company. So in this paper attempt has been made to find work in process and reduction of value in terms of Rupees from the current process to the proposed process. A mathematical model developed using general inventory cost model to quantify the Optimal Work In Process for the entire product range in Engine assembly line. Also numerical example is done to demonstrate the mathematical model with the available data. The mathematical results are very much encouraging and it calculated as 40 % reduction in work in process over the current work in process.
KEY WORDS: WIP, optimal WIP, inventory cost method, change over time, multi product single conveyor assembly line.

1.0 INTRODUCTION

Now a day's manufactures are critically evaluating their processes to determine their effectiveness in bringing maximum value to customers with reduced cost. The following diagram shows the difference between usual business and lean business.



BUSINESS AS USUAL COST+ PROFIT = PRICE	LEAN BUSINESS PRICE - COST = PROFIT

Production management techniques yesterday are being replaced by the most efficient methods that greatly reduce the late delivery of products to customer reduces production and operating costs which enhances the process quality. The following are the invention for reducing the work in process inventory

i. In 1890 SAKICHI TOYODA invents the philosophy of KAIZENS.
ii. In 1908 HENRY FORD creates moving assembly line.
iii. In 1937 KIICHIRO TOYODA builds a plant and hangs a sign at shop floor that reads JIT (Just In Time) was to improve the imbalance he found in his production line.
iv. In 1940 and Early 1950"s TAICHII OHNO the assembly manger for TOYOTA developed many improvements that eventually become TPS (TOYOTA PRODUCTION SYTEMS).
v. In 1995 – JAMES VONOCK and JONES publish "lean thinking" lean manufacturing starts to become popular in factories around the world. The five lean principles are 1. Specify the value (what customers are paying for). 2. Expose the waste in the system (Value stream mapping). 3. Establish the flow (Continuous improvement of the product or the process with maximum interruptions and reduces batches and WORK IN PROCESS) 4. Implement pull (Make only what customers ordered).5. Work perfection (continuous improvement in quality and eliminate waste so that all activities create value to the product.

2.0 LITERATURE REVIEW

Brynzer and Johansson (1995) focused on design of kitting system in terms of location of the order picking activity, work organization, picking method, information systems and equipment. Key design aspects and performances from selected case studies are discussed like traveling time and distance, picking information, Design of picking package, picking accuracy and manual picking techniques. In the kitting system, results show that picking efficiency and accuracy can be improved by making better use of the product structure when dividing picking information.

Bicheno et al (2001) described a case situation to pinpoint wasteful activities in the supply chain, and in later stage to develop solutions. They found production scheduling approaches to be a main cause of distortion in the dynamics of the supply chain and the initial studies led to proposal for scheduling improvements both within and between companies. The proposal includes kanban, changeover reduction and TPM for changing the scheduling frequency in accordance to the specific demand pattern. So, they developed a new and holistic scheduling algorithm. The new algorithm is based on three principles: 1) Runner and repeater are produced more often and in small batches, but stranger will be less frequent in large batches, 2) The scheduling pattern is set to be as repetitive and stable as possible, 3) The total amount of time for changeover is set as a fixed properties of the total time available.

Chrisrmansson et al (2002) discussed a material kitting case study using alternative methods like picker – to – material principle and material – to – picker approach. The material kitting was video recorded and pickers physical exposure were assessed. The material kitting shows improved productivity as compared with other kitting methods.

Crute et al (2003) discussed the key drivers for Lean in aerospace and examine the assumption that cross-sector transfer may be difficult. A Lean implementation case comparison examines how difficulties that arise may have more to do with individual plant context and management than with sector specific factors.

Abdulmalek and Rajgopal (2007) described a case where lean principles were adapted for the process sector for application at a large integrated steel mill. Value Stream Mapping was the main tool used to identify the opportunities for various lean techniques. They also described a simulation model that was developed to contrast the "before" and "after" scenarios in detail and in order to illustrate potential benefits such as reduction in production lead time and work in process inventory.

Gurumurthy and Kodali (2008) made an attempt to demonstrate the application of a Multi Attribute Decision Making model, namely Performance Value Analysis (PVA) to analyze the alternatives production system like Traditional manufacturing, Computer Integrated Manufacturing, and Lean Manufacturing among various performance measures. A detailed algorithm of the PVA model is demonstrated using a hypothetical case situation, which shows that Lean Manufacturing System is the best as it results in overall improvement in the performance of the organization.

Kull and Talluri (2008) proposed a combination of Analytic Hierarchy Process and goal programming as a decision tool for supplier selection in the presence of risk measures and product life cycle considerations. The efficiency of the model is tested at a mid-sized, second-tier automotive supplier. They found that, the model provide a feasible and meaningful method for determining strategic supplier allocations while considering multiple dimensional issues.

Saaty (2008) described the Analytical Hierarchy Process (AHP) as a theory of measurement through pairwise comparisons and relies on the judgments of experts to derive priority scales. The comparisons are made using a scale of absolute judgement that represents, how much one element dominates another with respect to a given attributes. The judgment may be consistent, and how to measure the inconsistency and improve the judgments, when possible to obtain better consistency is a concern of AHP. The derived priority scale is synthesized by multiplying them by the priority vector of their parent nodes and adding for all such nodes. In this paper AHP is used to take judgments to estimate the dominance of the consumption of drinks in the USA.

3.0 PRESENT METHOD OF ENGINE ASSEMBLY (CONVENTIONAL ASSEMBLY)

Two main Variety of models namely A" and "B" in which 3 different types (Variants) Totally Six model are assembled .These Models are produced in a single conveyor with Single Piece flow Multi model conveyor line. The company works in Two shifts and produces 160 engines per day. The WORK IN PROCESS calculated as one shift Buffer Requirement of components are kept in different bins / crates

- Total Number of components in Engine assembly – 872 .
- Total Exclusive components for model A – 372.
- Total exclusive components for Model B – 210
- Total Common components for model A and B . – 290.
- Total Cost of Engine Model A – Rs31200.
- Total Cost of Engine Model B – Rs 44250

The Model wise plan per shift was frozen one day in advance (as model a 50 nos and Model B 30 nos.) Hence the Work In Process value of the present process will be (31200*50) + **(**44250*30) =Rs. 28,87,500 Rs. So to Manufacture 80 Engines we need 28.875 lacs of Inventory as WORK IN PROCESS in the present method of Assembly.

4.0 PROPOSED METHOD OF ASSEMBLY SYSTEM (KITTING ASSEMBLY) The components and subassemblies received from the vendors are stored in the storage area. From store some components are sent for components preparation and remaining components are directly sent to kitting area. After preparing kits, some kits may be stored in kit storage and remaining kits sent to production line for carrying out assembly processes. After the components are assembled, they either are taken to storage area as subassemblies or left the system as end product as shown in Figure 1.

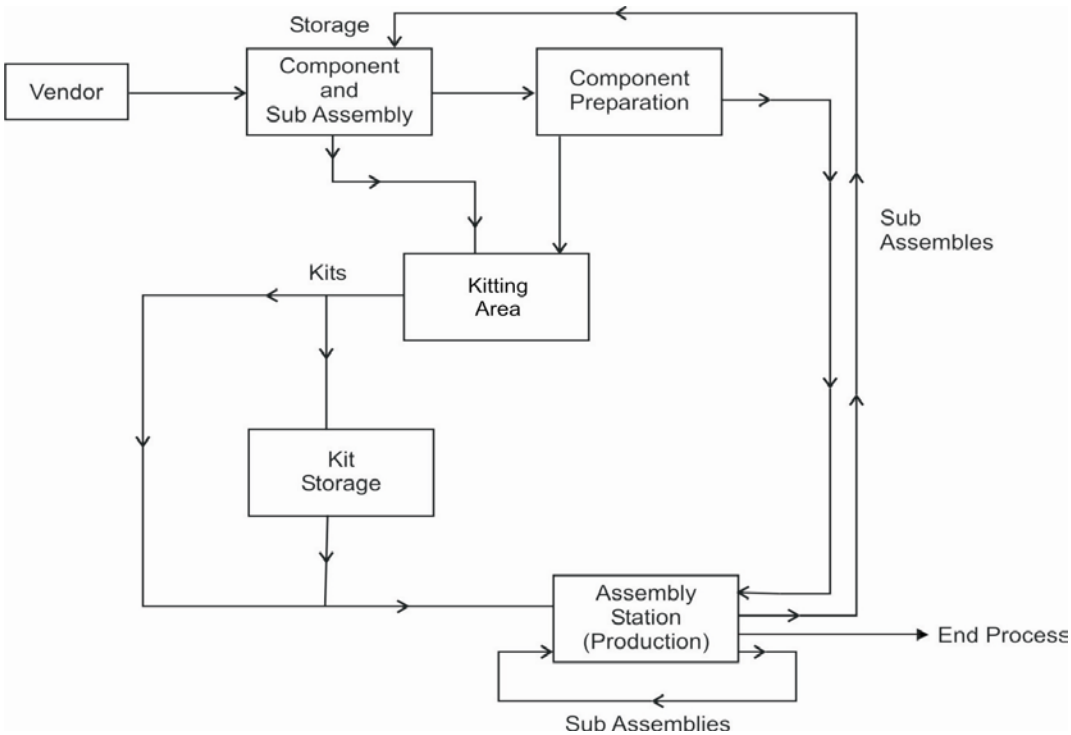


Figure 1 General flow of components in kitting assembly

4.1 ADVANTAGES OF KITTING ASSEMBLY

1) One purchase order
2) One invoice
3) Eliminate carriage costs
4) Reduced inventory
5) Improve cash-flow
6) No more fire-fighting
7) Reduced demand on management
8) 24/7 stock availability
9) Less need for negotiation and expediting
10) Fewer goods-in and stores movements
11) Reduced waste and packaging
12) Eliminate production shortages

5.0 VALIDADTION OF KITTING ASSEMBLY METHOD

The Company Wants to Improve continuously on the Daily production Hit Rate and also to Reduce the Work In Process .The entire present process was Video Graphed and the total work stations are Individually studies and corrected the imbalanced work stations also added one work station by extending the conveyor and Reduced the cycle time from 5.5 Minutes to 4.4 Minutes. The Work In Process was totally controlled and changed from Buffer stock of One shift to Kits System (each work station one kit) for 120 Minutes Irrespective of the changeover of model. If we calculate the Work in Process value at any given time during the day 27 Engine kits will be available and every 120 Minutes next 27 crates will be moved. So the Work In Process value will be Rs.8,42,400 to Rs.11,94,750 only. The Nett Savings in work in process to a Minimum Value of Rs. 16.92 Lacs to Maximum of Rs.20.45 lacs irrespective of the models.

6.0 COMPARISON OF CONVENTIONAL AND KITTING ASSEMBLY

The following table shows the advantages obtained as the result of implementing the kitting assembly for the engine assembly line of the case industry.

SL.NO	TERM	CONVEN-TIONAL ASSEMBLY	KITTING ASSEMBLY
1	Number of components per assembly	**662**	**662**
2	Inventory cost per assembly	**31200**	**31200**
3	Inventory cost per assembly per shift	**15.6 lacs**	**7.8 lacs**
4	Inventory cost per assembly per day	**46.8 lacs**	**7.8 lacs**
5	Operator walking time per day for all assembly (direct observation)	**3 hours**	**0.5 hours**
6	Operator distance travelled per day for all assembly (direct observation)	**4 kilometres**	**0.5 kilometers**

CONCLUSION

We had seen 50 % reduction in work in process inventory cost when we shift over From conventional to kitting system. Over and above this the fatigue of the operators reduced drastically to 85% (direct measurement by observation)

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